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(54) FLUIDIZED BED FURNACE AND WASTE PROCESSING METHOD

WIRBELSCHICHTFEUERUNG UND ABFALLVERARBEITUNGSVERFAHREN

FOUR À LIT FLUIDISÉ ET PROCÉDÉ DE TRAITEMENT DES DÉCHETS

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Description

TECHNICAL FIELD

[0001] The present invention relates to a fluidized bed furnace designed to heat waste in a fluidized bed formed by fluidizing fluidizable particles to thereby extract a combustible gas from the waste, and a waste treatment method.

BACKGROUND ART

[0002] Heretofore, as a fluidized bed furnace, there has been known one type described in the following Patent Document 1. As illustrated in FIG. 9, this fluidized bed furnace comprises a furnace body 104 having fluidizable sand (fluidizable particles) 102 in a furnace bottom section, and an air supply section 106 for supplying air into the fluidizable sand 102 in the furnace bottom section so as to fluidize the fluidizable sand 102 to form a fluidized bed. The furnace body 104 has a sidewall. The sidewall is provided with an input section 108 for inputting waste onto the fluidized bed therefrom.

[0003] In this fluidized bed furnace 100, the air supply section 106 is adapted to supply air into high-temperature fluidizable sand 102. Consequently, the fluidizable sand 102 is fluidized in a levitated or suspended state to form a fluidized bed. In this process, the air supply section 106 is adapted to supply air in such a manner that a fluidized state of the fluidizable sand 102 becomes approximately equalized in the entire region of the fluidized bed so as to allow waste input from the input section 108 onto the fluidized bed to be entrapped inside the fluidized bed and efficiently combusted.

[0004] Every time waste is input from the input section 108 onto the high-temperature fluidizable sand 102, the input waste is mixed with the high-temperature fluidizable sand 102 of the fluidized bed, and thermally decomposed (gasified). Consequently, a combustible gas is generated. For example, this combustible gas will be combusted at high temperatures in a melting furnace in a subsequent stage.

[0005] Waste input into the fluidized bed furnace 100 is entrapped in the active fluidized bed and combusted or gasified. In this process, every time waste is intermittently input, combustible substances in the waste are rapidly combusted, so that a rapid fluctuation in amount, concentration, etc., of a generated combustible gas will repeatedly occur. A change in the gasification reaction is largely dependent on a quantitative characteristic in supply of waste. Thus, in the case where there is a fluctuation in supply of waste or a qualitative change in components of waste, it is impossible to stably generate a combustible gas. Particularly, when a large amount of easily combustible trash such as paper or sheet-shaped plastic is comprised in waste, a fluctuation of generation of a combustible gas becomes larger, and therefore there is a need for stabilizing the gas generation.

[0006] For example, in the case where generated combustible gas is used for a gas engine to generate electric power, if a combustible gas is generated with large fluctuations, it is impossible to obtain stable energy. Therefore, there is a need for further stabilizing a combustible gas to be obtained in a fluidized bed furnace.

LIST OF PRIOR ART DOCUMENTS

10 [PATENT DOCUMENTS]

[0007]

Patent Document 1: JP 2006-242454A

Patent Document 2: JPH07110122A also describes a fluidized bed furnace to extract a combustible gas from waste.

20 SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to provide a fluidized bed furnace according to claim 1 and a waste treatment method according to claim 9.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a schematic configuration diagram of a fluidized bed furnace where the thermometers and the air supply section according to the invention are not represented.

FIG. 2 is a horizontal sectional view of a furnace body, for explaining an introduction position of waste and an introduction position of fluidizable particles in the fluidized bed furnace.

FIG. 3 is a diagram for explaining a nozzle arrangement in a bottom wall of the furnace body.

FIG. 4 is a diagram for explaining a furnace body having a reflecting portion in a front wall thereof, in a fluidized bed furnace where the thermometers and the air supply section according to the invention are not represented.

FIG. 5 is a diagram for explaining a furnace body having a guide portion in a rear wall thereof, in a fluidized bed where the thermometers and the air supply according to the invention are not represented.

FIG. 6 is a diagram for explaining a furnace body having a roof portion in each of front and rear walls thereof, in a fluidized bed where the thermometers and the air supply section according to the invention are not represented.

FIG. 7 is a diagram for explaining a furnace body comprising a thermometer and an air supply section, in a fluidized bed furnace according to the present invention.

FIG. 8 is a diagram for explaining a waste supply section, in a fluidized bed furnace where the thermometers and the air supply section according to the present invention are not represented.

FIG. 9 is a schematic configuration diagram of a conventional fluidized bed furnace.

DESCRIPTION OF EMBODIMENTS

[0010] With reference to the accompanying drawings, the present invention will now be described based on one embodiment thereof.

[0011] A fluidized bed furnace according to this embodiment is designed to heat waste by high-temperature fluidizable particles, to extract a combustible gas from the waste. As illustrated in FIG. 1, the fluidized bed furnace comprises fluidizable particles 12, a furnace body 20, a gas supply section 30, a waste supply section 40, a sand circulation device 50 and a carbide introduction device 60.

[0012] The fluidizable particles 12 make up a fluidized bed 14 to heat waste 18, inside the furnace body 20. More specifically, the fluidizable particles 12 are mixed with waste 18 while being heated up to a high temperature by combustion of a part of waste components, so that the waste 18 is gasified to generate a combustible gas. For example, the fluidizable particles 12 may be silica sand.

[0013] The furnace body 20 is configured to internally have the fluidizable particles 12 and extract a combustible gas from waste 18 by means of the fluidizable particles 12 in a high temperature state. The furnace body 20 has a bottom wall 21 supporting the fluidizable particles 12 from therebelow, a sidewall 22 standing upwardly from the bottom wall 21, and a combustible gas outlet portion 23 provided at an upper end of the sidewall 22.

[0014] The sidewall 22 has a rectangular tubular shape extending in an up-down (vertical) direction. Specifically, as also illustrated in FIG. 2, the sidewall 22 has a front wall (supply-side sidewall portion) 24 and a rear wall (opposite-side sidewall portion) 25 which are disposed in opposed and spaced-apart relation to each other in a front-rear direction (in FIG. 2, in a right-left direction), and a pair of lateral walls 26, 26 each connecting corresponding ends of the front wall 24 and the rear wall 25. The lateral walls 26, 26 are disposed parallel to each other. In other words, the furnace body 20 has a shape in plan view, in which a dimension in a width direction (widthwise dimension) as a distance between the lateral walls 26, 26 is equalized in the front-rear direction.

[0015] A portion (front wall) 24 of the sidewall 22 located on the same side as an aftermentioned mixture discharge port 29 with respect to a center position of the bottom wall 21 has a sand introduction section 27 and a waste introduction port 28. The sand introduction section 27 is designed to introduce fluidizable particles 12 into the furnace body 20, and the waste introduction port 28 is designed to introduce waste 18 into the furnace body

20. Further, a portion (rear wall) 25 of the sidewall 22 located on a side opposite to the aftermentioned mixture discharge port 29 across the center position of the bottom wall 21 has a carbide introduction section 63. The carbide introduction section 63 is designed to introduce carbides (e.g., char) produced by heating of the waste 18, into the furnace body 20.

[0016] Specifically, the sand introduction section 27 is provided at a widthwise central region of a lower portion of the front wall 24 to allow fluidizable particles to be introduced into the furnace body 20 in a widthwise central area adjacent to the front wall 24 (see FIG. 2). The sand introduction section 27 is provided at a height position where fluidizable particles 12 can be input from above the fluidizable particles 12 supported by the bottom wall 21 of the furnace body 20 (fluidized bed 14), toward the fluidized bed 14 (more specifically, the waste 18 supplied onto and accumulated on the fluidized bed 14). Based on providing the sand introduction section 27 at the above specific position, it becomes possible to input fluidizable particles 12 onto the waste 18 accumulated on the fluidized bed 14. In this case, the fluidizable particles 12 serve as an ignition source to allow easily-combustible trash in the waste 18 to be stably combusted (gasified) initially. It is to be noted that a section for inputting fluidizable particles 12 is not limited to the front wall, but may be provided in the rear wall 25 or the lateral wall 26.

[0017] The carbide introduction section 63 is provided at a widthwise central region of a lower portion of the rear wall 25 to allow carbides to be introduced into the furnace body 20 in a widthwise central area adjacent to the rear wall 25 (see FIG. 2). The carbide introduction section 63 is provided at a height position where carbides can be input from above the fluidized bed 14 in the furnace body 20, toward the fluidized bed 14. Alternatively, the carbide introduction section 63 may be provided at a vertically intermediate height position of the fluidized bed 14. When the carbide introduction section 63 is provided at the above position, the carbides are directly introduced into the fluidized bed 14. This allows carbides to be reliably introduced into the fluidized bed 14 and reliably gasified, although carbide is light in weight, so that, when the carbides are input from above the fluidized bed 14, they are apt to be accumulated on the fluidized bed 14 and hard to be sufficiently mixed with the fluidizable particles 12.

[0018] The waste introduction port 28 is provided in approximately the entire region of the lower portion of the front wall 24 in the width direction. The waste introduction port 28 is provided at a height position where waste 18 can be pushed generally horizontally onto an upper surface of the fluidized bed 14 made up of the fluidizable particles 12 supported by the bottom end 21 of the furnace body 20. In other words, the waste introduction port 28 is provided in such a manner that a lower end thereof is located at a position slightly higher than the upper surface of the fluidized bed 14.

[0019] The combustible gas outlet portion 23 is designed to discharge a combustible gas generated inside

the furnace body 20. The combustible gas outlet portion 23 has an outer diameter squeezed more than the side-wall 22, so that a duct or the like for supplying the combustible gas obtained in the furnace body 20 to a subsequent stage, for example, a gas engine for electric power generation processes, can be connected thereto.

[0020] The bottom wall 21 has a mixture discharge port 29 provided at a position offset from the center position thereof in a specific direction to discharge non-combustible substances in waste 18 and carbides produced by heating of the waste 18, together with a part of the fluidizable particles 12. The mixture discharge port 29 has an opening extending over the widthwise entire region of the bottom wall 21. The bottom wall 21 has an upper surface 21a inclined to become lower toward the mixture discharge port 29 so as to cause the fluidizable particles 12 to fall on the upper surface 21a. The bottom wall 21 in this embodiment has a mixture discharge port 29 at a position offset frontwardly, and the upper surface 21a of the bottom wall 21 extends frontwardly (in FIG. 1, in a left-to-right direction) at a constant downward inclination. Specifically, the upper surface 21a of the bottom wall 21 has an inclination angle of 15 degrees to 25 degrees with respect to a horizontal plane. Based on providing the mixture discharge port 29 at the above position, non-combustible substances and carbides sinking down from the waste 18 introduced from the waste introduction port 28 provided in the front wall 24, to a region on the fluidized bed 14 adjacent to the front wall 24, are efficiently discharged to an outside of the furnace body 20 there-through. Further, non-combustible substances and carbides sinking down from the waste 18 spread on the fluidized bed 14 toward the rear wall 25 while passing through the fluidized bed 14, and fall to the mixture discharge port 29 along the inclination of the upper surface 21a of the bottom wall 21 and will reach. Thus, the non-combustible substances and carbides which have sunk down on the side of the rear wall 25 are also discharged to the outside of the furnace body 20 in an easy manner.

[0021] The upper surface 21a of the bottom wall 21 is inclined to become lower toward the mixture discharge port 29. Thus, during operation of the fluidized bed furnace 10, the fluidizable particles 12 in a region of the fluidized bed 14 adjacent to the upper surface 21a are moved from the side of the rear wall 25 toward the front wall 24.

[0022] The gas supply section 30 is designed to blow a fluidizing gas from the bottom wall 21 toward the fluidizable particles 12 to fluidize the fluidizable particles 12. The gas supply section 30 comprises a plurality of nozzles 31 for blowing the fluidizing gas, a gas box 32 for supplying the fluidizing gas to the nozzles 31, and a gas feeding unit 33 for feeding the fluidizing gas to the gas box 32.

[0023] The plurality of nozzles 31 are installed to the bottom wall 21 in spaced-apart relation to each other in the width direction and the front-rear direction, i.e., in a lattice arrangement. Each of the nozzles 31 is attached

to the bottom wall 21 to penetrate through the bottom wall 21. In this embodiment, as also illustrated in FIG. 3, the bottom wall 21 is divided into a rear region 21b and a front region 21c. Then, the plurality of nozzles 31 are installed to the rear and front regions 21b, 21c in such a manner that the number of nozzles 31 provided in the rear region 21b becomes greater than the number of nozzles 31 provided in the front region 21c. It is to be noted that a relationship between the respective numbers of nozzles 31 in the rear and front regions 21b, 21c is not particularly limited. For example, the number of nozzles 31 in the front region 21c may be equal to the number of nozzles 31 in the rear region 21b. Alternatively, the number of nozzles 31 in the front region 21c may be greater than the number of nozzles 31 in the rear region 21b.

[0024] The gas box 32 has a box shape extending in the width direction, and serves as a header for distributing the fluidizing gas to an array of the nozzles 31 arranged side-by-side in the width direction in the bottom wall 21. The gas box 32 has a function of equalizing respective flow volumes of the fluidizing gas to be blown from the array of nozzles 31 arranged in the width direction. In this embodiment, a plurality of the gas boxes 32 are provided on the side of a lower surface of the bottom wall 21 and arranged side-by-side in the front-rear direction. Thus, with respect to each of a plurality of the arrays of nozzles 31 corresponding to respective ones of the gas boxes 32, the flow volume of the fluidizing gas to be blown from the array of nozzles 31 can be changed. In this embodiment, five gas boxes 32a, 32b, 32c, 32d, 32e are arranged side-by-side in the front-rear direction. Specifically, four gas boxes 32a, 32b, 32c, 32d are disposed on the side of the rear wall 25 with respect to the mixture discharge port 29, and one gas box 32e is disposed on the side of the front wall 24 with respect to the mixture discharge port 29.

[0025] The gas feeding unit 33 is designed to feed (supply) the fluidizing gas to the respective gas boxes 32. The gas feeding unit 33 is capable of feeding the fluidizing gas to each of the gas boxes 32 in a different flow volume. The gas feeding unit 33 in this embodiment is configured to feed the fluidizing gas to two of the gas boxes 32 adjacent to each other in the front-rear direction, in such a manner that a flow volume of the fluidizing gas to be fed to a rear one of the adjacent gas boxes 32 becomes greater than a flow volume of the fluidizing gas to be fed to a front one of the adjacent gas boxes 32. The gas feeding unit 33 is adapted to feed only air to the respective gas boxes 32 to serve as the fluidizing gas. Alternatively, an inert gas such as nitrogen may be fed in combination with the air.

[0026] Specifically, during a normal operation of the fluidized bed furnace 10, i.e., when waste 18 is introduced into the furnace body 20 to generate a combustible gas from the introduced waste 18, the gas feeding unit 33 is operable to cause the fluidizing gas to be blown from around the mixture discharge port 29. In this process,

the gas feeding unit 33 is operable to form a first fluidization region 15 having a degree of fluidization of the fluidizable particles 12 which is set to an extent allowing the waste 18 to be accumulated on the fluidizable particles 12. Concurrently, the gas feeding unit 33 is operable to blow the fluidizing gas between the first fluidization region 15 and the rear wall 25 at a flow velocity greater than that of the fluidizing gas to be blown in the first fluidization region 15, to form a second fluidization region 16 having a degree of fluidization of the fluidizable particles 12 higher than that in the first fluidization region 15. More specifically, as mentioned above, the gas feeding unit 33 is configured such that a flow volume of the fluidizing gas to be fed to a rear one (e.g., the gas box 32b) of the gas boxes 32 adjacent to each other in the front-rear direction becomes greater than a flow volume of the fluidizing gas to be fed to a front one (e.g., the gas box 32c) of the adjacent gas boxes 32. In this case, the gas feeding unit 33 is operable to, in the fluidized bed 14, form the first fluidization region 15 restrained in fluidization, around the mixture discharge port 29, while forming the second fluidization region 16 actively fluidized, between the first fluidization region 15 and the rear wall 25. Alternatively, the gas feeding unit 33 may be configured to feed the fluidizing gas to each of the gas boxes 32c, 32d, 32e on the side of the front wall 24, in a constant flow volume, and feed the fluidizing gas to each of the gas boxes 32a, 32b on the side of the rear wall 25, in a flow volume greater than the constant flow volume. In this case, the gas feeding unit 33 is operable to, in the fluidized bed 14, form the first fluidization region 15 restrained in fluidization, in a region corresponding to the gas boxes 32c, 32d, 32e on the side of the front wall 24, while forming the second fluidization region 16 actively fluidized, in a region corresponding to the gas boxes 32a, 32b on the side of the rear wall 25.

[0027] Specifically, the gas feeding unit 33 is adapted to cause the fluidizing gas to be blown in the first fluidization region 15 at the flow velocity satisfying a condition that U_o/U_{mf} ranges from 1 to less than 2, and blown in the second fluidization region 16 at the flow velocity satisfying a condition that U_o/U_{mf} ranges from 2 to less than 5. In this formula, U_{mf} is a minimum fluidization velocity which is a minimum flow velocity of the fluidizing gas to be blown so as to fluidize the fluidizable particles 12. Further, U_o is a cross-sectional average flow velocity of the fluidizing gas.

[0028] On the other hand, during stop of the fluidized bed furnace 10, i.e., when the introduction of waste 18 into the furnace body 20 is stopped, the gas feeding unit 33 is operable to feed a mixture formed by mixing an inert gas with air, as the fluidizing gas to be supplied to the respective gas boxes 32. Then, the gas feeding unit 33 is operable to gradually increase the inert gas in a ratio between air and the inert gas in the fluidizing gas. Consequently, the gas feeding unit 33 can suppress violent or rapid combustion of the waste 18 remaining in the furnace body 20, thereby restraining a rise in internal

temperature of the furnace body 20.

[0029] More specifically, during the normal operation, in the furnace body 20, combustion, gasification, etc., of the waste 18 are performed under a condition that an oxygen concentration is set to a value less than that suitable for combustion of the waste 18. In this state, when the introduction of waste 18 into the furnace body 20 is stopped, an amount of combustible substances in the furnace body 20 will be reduced. In this process, the fluidizing gas (air) is continuously supplied into the furnace body 20 in a predetermined flow volume to maintain the fluidized bed 14, so that the oxygen concentration in the furnace body 20 will be increased. When the oxygen concentration in the furnace body 20 reaches a value suitable for combustion of the waste 18 remaining in the furnace body 20, the waste 18 is violently or rapidly combusted, so that the internal temperature of the furnace body 20 becomes higher than that during the normal operation. In such a high-temperature state of the inside of the furnace body 20, the fluidizable particles 12 forming the fluidized bed 14 are agglomerated due to the heat. Once the fluidizable particles 12 are agglomerated, even if the fluidizing gas is subsequently blown into the agglomerated fluidizable particles 12 in order to form the fluidized bed 14, the agglomerated fluidizable particles 12 will never be fluidized. Therefore, the gas feeding unit 33 is operable, when the introduction of waste 18 into the furnace body 20 is stopped, to mix an inert gas with air to be blown into the furnace body 20, and gradually increase the ratio of the inert gas. This allows the oxygen concentration in the furnace body 20 to be kept at a value less than that suitable for combustion of the waste 18. Consequently, it becomes possible to suppress violent or rapid combustion of the waste 18 remaining in the furnace body 20.

[0030] Further, the gas feeding unit 33 is adapted to be capable of adjusting a temperature of the fluidizing gas to be fed to the gas boxes 32. The gas feeding unit 33 is operable, upon start of the operation of the fluidized bed furnace 10, to blow the fluidizing gas in a high temperature state from a region corresponding to the second fluidization region 16, toward the fluidizable particles 12. In this way, the gas feeding unit 33 is operable to heat the fluidizable particles 12 until the fluidizable particles 12 reach a temperature capable of performing combustion and gasification of the waste 18. In this case, when the fluidizable particles 12 is heated up to a high temperature and combustion of the waste 18 is started, the temperature of the fluidizable particles 12 will be maintained by the combustion. Thus, the gas feeding unit 33 may be configured to lower the temperature of the fluidizing gas to be fed to the gas boxes 32 just after start of the combustion.

[0031] The waste supply section 40 is designed to supply waste 18 from the front wall 24 to a region on the fluidized bed 14 adjacent to the front wall 24. The waste supply section 40 in this embodiment is configured to push waste 18 generally horizontally from the front wall

24 (specifically, the waste introduction port 28 of the front wall 24) onto the fluidized bed 14, thereby causing the waste 18 to be moved toward the second fluidization region 16. In other words, the waste supply section 40 is adapted to push waste 18 to cause the waste 18 to be accumulated on the first fluidization region 15 while causing the accumulated waste 18 to be moved into the second fluidization region 16 step-by-step. The waste supply section 40 comprises a pusher 41 and a drive unit (illustration is omitted) for driving the pusher 41. The pusher 41 has a pushing surface 42 extending in the width direction. In this embodiment, the pushing surface 42 has a widthwise length equal to a width of the waste introduction port 28 of the front wall 24. Further, the pushing surface 42 has a vertical length which is approximately a half of a height dimension of an opening of the waste introduction port 28. The pusher 41 is installed to be movable in the front-rear direction, at the same height position as that of the waste introduction port 28. The drive unit comprises a driving power source such as a motor or a cylinder, and is adapted to reciprocatingly move the pusher 41 in the front-rear direction by the driving power. It is to be noted that the waste supply section 40 is not limited to a specific configuration. For example, the waste supply section 40 in this embodiment is configured such that the pusher 41 is employed to push waste 18 into the furnace body. However, the waste supply section may be configured such that a screw extruder or the like is employed to push waste 18 into the furnace body (see FIG. 8A). Based on employing the pusher 41 or the screw extruder, it becomes possible to supply trash which is likely to be scattered due to its small bulk specific gravity, such as paper or plastic sheet, into the furnace body 20 while keeping a massive form. This makes it possible to suppress scattering of trash inside the furnace body 20, as compared to a conventional furnace in which trash is input from an upper portion thereof.

[0032] The sand circulation device 50 is designed to separate the fluidizable particles 12 from a mixture of the non-combustible substances, the carbides and the fluidizable particles 12 discharged from the mixture discharge port 29, and return the separated fluidizable particles 12 to the inside of the furnace body 20, thereby circulating the fluidizable particles 12. As above, according to the sand circulation device 50, the high-temperature fluidizable particles 12 are separated from the mixture and returned to the inside of the furnace body 20, which makes it possible to maintain an amount of the fluidizable particles 12 making up the fluidized bed 14 inside the furnace body 20, and makes it easy to maintain a temperature of the fluidized bed 14. The sand circulation device 50 comprises a mixture discharge section 51, a fluidizable-particle separation section 52, and a fluidizable-particle conveyance section 53.

[0033] The mixture discharge section 51 is provided just below the mixture discharge port 29 of the bottom wall 21, and adapted to move the mixture of the non-combustible substances, the carbides and the fluidizable

particles 12 dropping from the mixture discharge port 29, to the fluidizable-particle separation section 52. The mixture discharge section 51 in this embodiment is configured to move the mixture dropping from the mixture discharge port 29, to the fluidizable-particle separation section 52 by using a screw extruder. The fluidizable-particle separation section 52 is adapted to separate the fluidizable particles 12 from the mixture sent from the mixture discharge section 51. The fluidizable-particle separation section 52 in this embodiment is configured to separate the fluidizable particles 12 from the mixture by using a sieve. The fluidizable-particle separation section 52 is operable to send the mixture after subjected to the separation of the fluidizable particles 12, to a carbide separation section 61. The fluidizable-particle conveyance section 53 is adapted to convey the fluidizable particles 12 separated in the fluidizable-particle separation section 52, to the sand introduction section 27, and introduce the conveyed fluidizable particles 12 into the furnace body 20 via the sand introduction section 27.

[0034] In this embodiment, the sand circulation device 50 is configured to input the fluidizable particles 12 from above the fluidized bed 14 toward the upper surface of the fluidized bed 14. Alternatively, the sand circulation device may be configured to return the fluidizable particles 12 to the fluidized bed 14 in such a manner as to push the fluidizable particles 12 directly into the fluidized bed 14.

[0035] The carbide introduction device 60 is designed to separate the carbides from the mixture discharged from the mixture discharge port 29, and return the separated carbides to the inside of the furnace body 20 from the side of the rear wall 25. As above, according to the carbide introduction device 60, the carbides discharged from the mixture discharge port 29 are returned to the second fluidization region 16, which makes it possible to obtain a combustible gas from the carbides discharged to outside of the furnace body 20 together with the non-combustible substances. Consequently, a combustible gas can be efficiently obtained from waste 18 supplied to the fluidized bed furnace 10. In addition, a temperature of the second fluidization region 16 can be kept at a high value by heat generated when the carbides are gasified. The carbide introduction device 60 comprises a carbide separation section 61, and a carbide conveyance section 62.

[0036] The carbide separation section 61 is adapted to separate the carbides from the mixture sent from the fluidizable-particle separation section 52. The carbide separation section 61 in this embodiment is configured to separate the carbides from the mixture after subjected to the separation of the fluidizable particles 12 in the fluidizable-particle separation section 52. For example, the carbide separation section 61 may be a gravity (specific gravity) separator for separating a carbide from a mixture by means of vibration. The carbide conveyance section 62 is adapted to convey the carbides separated in the carbide separation section 61, to the carbide introduction

section 63, and introduce the conveyed carbides into the furnace body 20 via the carbide introduction section 63.

[0037] In the fluidized bed furnace 10 configured as above, a combustible gas is collected from waste 18 in the following manner.

[0038] The gas feeding unit 33 feeds the fluidizing gas to the respective gas boxes 32. Thus, the fluidizing gas is blown from the bottom wall 21 into the furnace body 20 toward the fluidizable particles 12, so that the fluidized bed 14 is formed inside the furnace body 20. In this process, the gas feeding unit 33 adjusts a flow volume of the fluidizing gas to be fed to each of the gas boxes 32. Through this adjustment, in the fluidized bed 14, the first fluidization region 15 restrained in fluidization is formed on the side of the mixture discharge port 29, and the second fluidization region 16 actively fluidized is formed between the first fluidization region 15 and the rear wall 25. Further, the gas feeding unit 33 feeds the fluidizing gas in a high-temperature state to a part (e.g., in this embodiment, the gas boxes 32a, 32b) of the gas boxes 32 corresponding to the second fluidization region 16 to positively heat the fluidizable particles 12 in the second fluidization region 16. Concurrently, heat is supplied to the first fluidization region 15 by a movement of the fluidizable particles 12 from the second fluidization region 16 to the first fluidization region 15 which occurs in a region of the fluidized bed 14 adjacent to the upper surface 21a of the bottom wall 21 due to the inclination of the upper surface 21a.

[0039] Subsequently, when temperatures of the regions 15, 16 in the fluidized bed 14 formed inside the furnace body 20 reach respective predetermined values (in this embodiment, the predetermined temperature of the second fluidization region 16 is in the range of about 600 to 800°C, and the predetermined temperature of the first fluidization region 15 is in the range of about 400 to 600°C), the waste supply section 40 starts to push waste 18 into the furnace body 20 via the waste introduction port 28. Specifically, the pusher 41 driven by the drive unit pushes waste 18 generally horizontally toward the rear wall 25. Through this operation, the waste 18 is pushed onto the first fluidization region 15 at a position adjacent to the front wall 24 (see FIG. 2).

[0040] The fluidization of the fluidizable particles 12 in the first fluidization region 15 is restrained. Thus, the pushed waste 18 is not positively mixed with the fluidizable particles 12, so that most of the waste 18 is accumulated on the first fluidization region 15, and heavy non-combustible substances and a part of carbides therein sink down. Consequently, in the first fluidization region 15, rapid combustion of the waste 18 is suppressed, and easily gasifiable substances in the waste 18 are gasified by heat radiation within the furnace body 20. In other words, easily gasifiable waste 18 such as plastic or paper is gasified while being moved in a surface layer of the first fluidization region 15. On the other hand, not-easily gasifiable waste such as a wood piece is partially gasified, but a large part thereof reaches the second fluidi-

zation region 16 without being gasified. In this manner, the easily gasifiable waste 18 is gasified under a mild condition in the first fluidization region 15 before it reaches the highly fluidized bed (second fluidization region 16).

5 This makes it possible to suppress a fluctuation of generation of the combustible gas. The heavy non-combustible substances sink down in the first fluidization region 15, and directly discharged from the mixture discharge port 29. This, the non-combustible substances are less likely to be accumulated on a furnace floor. Further, in
10 some cases, a part of the not-easily gasifiable waste such as a wood piece is also discharged from the mixture discharge port 29 in a state in which it is carbonized by passing through the first fluidization region 15. The
15 accumulated waste 18 is combusted due to the internal temperature of the furnace body 20 (heat in a free board section), as mentioned above. However, although the internal temperature of the furnace body 20 is in the range
20 of 800 to 900°C which is greater than that of the fluidizable particles 12 forming the fluidized bed 14, a contact between the waste 18 and air is not satisfactory. Thus, easily combustible trash, such as paper or sheet-shaped plastic, in waste 18, is mainly gasified. In this process,
25 the first fluidization region 15 has a relatively low temperature, and an amount of air (fluidizing gas) to be supplied to the first fluidization region 15 is relatively small, so that even the easily combustible trash will be gradually gasified. Further, according to fluidization of the fluidizable
30 particles 12 caused by the fluidizing gas, a part of the accumulated waste 18 is moved or spread from the first fluidization region 15 to the second fluidization region 16 (in FIG. 1, in a right-to-left direction) step-by-step. Therefore, even if waste 18 is input in a massive form,
35 and easily combustible papers are comprised therein, the papers will be gasified based on a phenomenon that the papers are moved toward a surface of the massive waste during the spreading. As above, in the first fluidization region 15, rapid combustion of the waste 18 is suppressed to prevent a rapid increase of combustible
40 gas during introduction of waste 18.

[0041] Subsequently, new waste 18 is pushed into the furnace body 20 via the waste introduction port 28 by the pusher 41. Thus, the waste 18 accumulated on the first fluidization region 15 is pushed by the new waste 18, and
45 moved into the second fluidization region 16 step-by-step. The second fluidization region 16 is actively fluidized and heated up to a high temperature by combustion of the waste 18, so that the waste 18 moved from a position on the first fluidization region 15 is mixed with the
50 fluidizable particles 12 and sufficiently gasified. Consequently, a combustible gas is generated. More specifically, in the fluidized bed 14, a fluidized state gradually becomes more active in a direction from the front wall 24 to the rear wall 25. Thus, when the waste 18 is moved
55 from a position on the first fluidization region 15 adjacent to the front wall 24 to the second fluidization region 16 step-by-step, it will be gradually mixed with the fluidizable particles 12. Further, an amount of air (fluidizing gas)

blown toward the fluidized bed 14 is gradually increased in the direction from the front wall 24 to the rear wall 25. Thus, when the waste 18 is moved from the first fluidization region 15 to the second fluidization region 16 step-by-step, it will be gradually combusted, causing an increase in temperature of the fluidizable particles 12. In the high-temperature second fluidization region 16, the waste 18 is sufficiently mixed with the fluidizable particles 12. This allows the uncombusted waste 18 remaining after passing through the first fluidization region 15 to be sufficiently gasified in the second fluidization region 16.

[0042] On the other hand, the waste 18 newly pushed onto the first fluidization region 15 by the pusher 41 is accumulated on the first fluidization region 15 almost without being mixed with the fluidizable particles 12 as mentioned above. Then, the accumulated waste 18 is gradually combusted under the condition that violent or rapid combustion is suppressed.

[0043] As above, under the condition that the first fluidization region 15 and the second fluidization region 16 are formed in the fluidized bed 14, waste 18 is pushed in one after another by the pusher 41, which makes it possible to suppress intermittent and rapid generation of a combustible gas, thereby stabilizing the gas generation.

[0044] The non-combustible substances and carbides which have sunk down in the first fluidization region 15 are discharged from the mixture discharge port 29 provided on the underside of the first fluidization region 15, together with a part of the fluidizable particles 12. Further, the non-combustible substances and carbides which have sunk down in the second fluidization region 16 are moved to the mixture discharge port 29 while falling along the upper surface 21a of the bottom wall 21, because the upper surface 21a is inclined with a downward slope toward the mixture discharge port 29. The moved non-combustible substances and carbides are discharged together with a part of the fluidizable particles 12. Then, the sand circulation device 50 separates the fluidizable particles 12 from the mixture discharged from the mixture discharge port 29, and introduces the separated fluidizable particles 12 into the furnace body 20. Concurrently, the carbide introduction device 60 separates the carbides from the mixture discharged from the mixture discharge port 29, and introduces the separated carbides into the furnace body 20. Specifically, the mixture discharge section 51 sends the mixture dropping from the mixture discharge port 29 of the furnace body 20, to the fluidizable-particle separation section 52. The fluidizable-particle separation section 52 separates the fluidizable particles 12 from the mixture, and the fluidizable-particle conveyance section 53 conveys the fluidizable particles 12 separated by the fluidizable-particle separation section 52, to the sand introduction section 27 of the furnace body 20. In this way, in the furnace body 20, an amount of the fluidizable particles 12 forming the fluidized bed 14 is maintained. Further, the fluidizable-particle separation section 52 sends the mixture after subjected to the sep-

aration of the fluidizable particles 12, to the carbide separation section 61, and then the carbide separation section 61 separates the carbides. Then, the carbide conveyance section 62 conveys the carbides separated by the carbide separation section 61, to the carbide introduction section 63 of the furnace body 20. This allows the carbides discharged from the furnace body 20 together with the non-combustible substances to be returned to the inside of the furnace body 20, and gasified. Consequently, the fluidized bed furnace 10 becomes capable of efficiently obtaining a combustible gas from waste 18.

[0045] In advance of stopping the fluidized bed furnace 10, the pushing of waste 18 into the furnace body 20 by the pusher 41 is firstly stopped. Upon stopping the pushing of waste 18, the gas feeding unit 33 feeds a mixture formed by mixing an inert gas with air, as the fluidizing gas to be supplied to the respective gas boxes 32. In this process, the gas feeding unit 33 operates to gradually increase the inert gas in a ratio between air and the inert gas in the fluidizing gas, with time. In this manner, the gas feeding unit 33 restrains an oxygen concentration within the furnace body 20 to suppress violent or rapid combustion of the waste 18 remaining in the fluidized bed 14.

[0046] In this embodiment, during stop of the fluidized bed furnace 10, violent or rapid combustion of the waste 18 remaining in the fluidized bed 14 is suppressed by gradually increasing the ratio of the inert gas occupied in the fluidizing gas. Alternatively, during stop of the fluidized bed furnace 10, combustion of the remaining waste 18 may be prevented by spraying water onto the fluidized bed 14.

[0047] As mentioned above, the fluidized bed furnace 10 according to the above embodiment is capable of suppressing intermittent and rapid generation of a combustible gas to stabilize the gas generation, even in a situation where a large amount of easily combustible trash is comprised in waste 18. Specifically, in the fluidized bed 14, the first fluidization region 15 around the mixture discharge port 29 and the second fluidization region 16 having a fluidization degree higher than that in the first fluidization region 15 are formed. In this state, new waste 18 is pushed onto the first fluidization region 15. The input of the new waste 18 causes the waste 18 accumulated on the first fluidization region 15 to be moved toward the second fluidization region 16 step-by-step. The above operation will be repeated. Thus, the fluidized bed furnace 10 can sufficiently gasify the waste 18, while suppressing rapid fluctuation of generation of a combustible gas. Consequently, it becomes possible to stably generate a combustible gas from the waste 18. In addition, just after input into the furnace body 20, the waste 18 is not exposed to the highly fluidized bed (the second fluidization region 16), so that it becomes possible to suppress a situation where a large amount of lightweight trash flies up inside the furnace body 20 and undergoes rapid combustion in a free board section.

[0048] In addition, the first fluidization region 15 is

formed just above the mixture discharge port 29, and waste 18 is supplied onto the first fluidization region 15. Thus, even if the waste 18 is accumulated on the first fluidization region 15, and, during a period where easily combustible trash in the waste 18 is slowly gasified, non-combustible substances and carbides sink down to a furnace bottom, such non-combustible substances and carbides can be easily discharged from the furnace body 20. Further, even when non-combustible substances and carbides sink down to the bottom wall 21 after the waste 18 is moved from the first fluidization region 15 into the second fluidization region 16, the non-combustible substances and carbides will fall along the upper surface 21a of the bottom wall 21 which is inclined to become lower toward the mixture discharge port 29. Thus, such non-combustible substances and carbides can also be easily discharged. In the second fluidization region 16, the fluidizing gas is actively supplied. This also accelerates the falling of the non-combustible substances and carbides toward the mixture discharge port 29.

[0049] The furnace body 20 has a shape in plan view, in which a dimension in the width direction thereof is equalized in a pushing direction of waste 18. Thus, when the waste 18 on the first fluidization region 15 is pushed by waste 18 newly pushed by the waste supply section 40, and moved toward the second fluidization region 16, the movement of the waste 18 is stabilized.

[0050] In the waste supply section 40, the pusher 41 is adapted to be reciprocatingly moved in a direction parallel to the pushing direction (front-rear direction) to allow the pushing surface 42 to push waste 18 onto the fluidized bed 14 simultaneously by the entire widthwise region of the pushing surface 42. This allows the pushing surface 42 to push waste 18 onto the fluidized bed 14 with an even force in the width direction. Thus, the movement of the waste 18 from the first fluidization region 15 to the second fluidization region 16 is approximately equalized in the width direction, so that it becomes possible to prevent the waste 18 from concentrating on a certain portion inside the furnace.

[0051] In the above embodiment, the sidewall 22 stands upwardly and straight from the bottom wall 21 to the combustible gas outlet portion 23. Alternatively, for example, as illustrated in FIG. 4, the sidewall may comprise a front wall 24A having a reflecting portion 224 extending toward the rear wall 25 to cover an upper side of the first fluidization region 15 at a predetermined height position. The front wall 24A allows the waste 18 accumulated on the first fluidization region 15 to be heated by radiation heat from the reflecting portion 224. Consequently, it becomes possible to generate a combustible gas from the waste 18 accumulated on the first fluidization region 15. In other words, gasification of the waste 18 accumulated on the first fluidization region 15 is promoted. In this case, the sand introduction section 27 may be provided in the portion of the front wall 24A standing vertically from the bottom wall 21, or may be provided in the reflecting portion 224.

[0052] Alternatively, as illustrated in FIG. 5, the sidewall may comprise a rear wall 25A having a guide portion 225 extending toward the front wall 24 to cover an upper side of the second fluidization region 16 at a predetermined height position. The guide portion 225 is adapted to guide a high-temperature combustible gas generated from the waste 18 in the second fluidization region 16 to allow the combustible gas to be brought into contact with the waste 18 accumulated on the first fluidization region 15. In this way, the guide portion 225 allows the combustible gas to contribute to heating of the waste 18 accumulated on the first fluidization region 15. Consequently, it becomes possible to promote gasification of the waste 18 accumulated on the first fluidization region 15 without adding special heating means to the furnace body 20. In this case, the carbide introduction section 63 may be provided in the portion of the rear wall 25 standing vertically from the bottom wall 21, or may be provided in the guide portion 225.

[0053] Alternatively, as illustrated in FIG. 6, the sidewall may comprise a front wall 24B and a rear wall 25B having, respectively, two roof portions 324, 325 extending in a direction causing them to come closer to each other at the same height position. The front wall 24B and the rear wall 25B allow the waste 18 accumulated on the first fluidization region 15 to be heated by radiation heat from the roof portion 324 of the front wall 24B, so as to promote gasification thereof. In addition, a dimension of a furnace body 20B in the front-rear direction is reduced at a position lower than the combustible gas outlet portion 23 at the upper end of the furnace body 20B, so that it becomes possible to facilitate a reduction in size of the furnace body 20B. In this case, the sand introduction section 27 may be provided in a portion of the front wall 24B standing vertically from the bottom wall 21, or may be provided in the roof portion 324. Further, the carbide introduction section 63 may be provided in a portion of the rear wall 25B standing vertically from the bottom wall 21, or may be provided in the roof portion 325.

[0054] In the above embodiment, only carbides are introduced into the furnace body 20 from the carbide introduction section 63. Alternatively, the carbides may be introduced into the furnace body 20 from the carbide introduction section 63, together with fluidizable particles 12.

[0055] In the above embodiment, the carbide introduction device 60 is adapted to introduce the carbides separated from the mixture directly into the furnace body 20 from the carbide introduction section 63. Alternatively, the carbides separated from the mixture may be pulverized and then introduced into the furnace body 20. In this case, even if carbides discharged from the mixture discharge port 29 are agglomerated into a large block, the block can be pulverized into a size suitable for facilitating gasification by heating, and returned to the furnace body 20.

[0056] The upper surface 21a of the bottom wall 21 may be curved from the rear wall 25 to the mixture dis-

charge port 29, instead of being inclined straight.

[0057] As illustrated in FIG. 7, and according to the invention, a plurality of thermometers T are disposed just above the first fluidization region 15, and an air supply section 65 capable of supplying air onto the first fluidization region 15 is provided. In this fluidized bed furnace, an accumulated amount of the waste 18 accumulated on the first fluidization region 15 can be estimated, so that it becomes possible to control the accumulated amount. Specifically, the accumulated amount of the waste 18 on the first fluidization region 15 is estimated by utilizing a phenomenon that an indication value of the thermometer T embedded in the waste 18 is lowered. When the accumulated amount is relatively large, i.e., the number of the thermometers T embedded in the waste 18 is relatively large, the air supply section 65 is operable to supply air to increase an internal temperature of the furnace body 20. Accordingly, gasification of the waste 18 accumulated on the first fluidization region 15 is prompted, so that the accumulated amount of the waste 18 is reduced. As another method, an amount of the air may be controlled based on determinations made as follows: when a temperature of a designated one of the thermometers T is equal to or greater than a threshold value, it is determined that there is no waste at a position of the designated thermometer T, and, when the temperature is less than the threshold value, it is determined that there is waste at the position of the designated thermometer T (the designated thermometer T is embedded in waste).

[0058] The gas feeding unit 33 is configured to feed air and/or an inert gas as the fluidizing gas. Alternatively, for example, the gas feeding unit 33 may be configured to feed water vapor and/or oxygen as the fluidizing gas, depending on a combustion state within the furnace body 20. The fluidized bed furnace 10 may further comprise a second gas supply section provided in the sidewall 22 in addition to the first gas supply section 30, wherein the second gas supply section may be configured to be capable of supplying air, oxygen, water vapor or the like into the furnace body 20, depending on a combustion state in the fluidized bed 14 or of the waste 18.

[0059] The fluidizing gas to be supplied to the first fluidization region 15 may be a high-temperature fluidizing gas. In the case of supplying the high-temperature fluidizing gas, even in a situation where it is difficult to sufficiently keep a temperature of the first fluidization region 15 only by heat transferred from the second fluidization region 16, the temperature of the first fluidization region 15 can be maintained at a high value without increasing an amount of the fluidizing gas to be supplied.

[0060] In the above embodiment, the waste introduction port 28 is provided at a height position partially overlapping with respect to the waste 18 accumulated on the fluidized bed 14 in the up-down direction, so that waste 18 supplied from the waste introduction port 28 positively moves the waste 18 accumulated on the upper surface of the fluidized bed 14, generally horizontally (toward the first fluidization region 15). Alternatively, the fluidized bed

furnace 10 may have any configuration capable of supplying waste 18 to a region on the fluidized bed 14 adjacent to the front wall (supply-side sidewall portion) 24. For example, as illustrated in FIG. 8A and FIG. 8B, the waste introduction port 28 may be provided at a height position which is located adjacent to the upper surface of the fluidized bed 14, and where new waste can be introduced in such a manner that it is placed on the waste 18 accumulated on the fluidized bed 14. In this case, as illustrated, for example, in FIG. 8A, the waste introduction port 28 may be provided to allow new waste to be supplied generally horizontally from a height position above the waste 18 accumulated on the fluidized bed 14. Alternatively, as illustrated in FIG. 8B, the waste introduction port 28 may be provided to allow new waste to be supplied downwardly from a height position above the waste 18 accumulated on the fluidized bed 14. Even if waste 18 is supplied into the furnace body 20 in the above manner, when the new waste 18 is supplied onto the accumulated waste 18, a pile of waste 18 is broken and spread, and the spread waste 18 is moved toward the second fluidization region 16. Thus, gasification of the waste 18 is sufficiently performed while suppressing rapid fluctuation of generation of a combustible gas to be collected from the fluidized bed furnace 10. Consequently, it becomes possible to stably generate a combustible gas from the waste 18.

[0061] In the above embodiment, in a situation where non-combustible substances are accumulated around the mixture discharge port 29 of the furnace floor (upper surface 21a of the bottom wall 21) without being discharged to the outside, the fluidizing gas may be supplied in the first fluidization region 15 at a flow velocity satisfying the condition that U_o/U_{mf} ranges from 2 to less than 5, only for a certain period of time in order to discharge the accumulated non-combustible substances to the outside. In this case, preferably, an amount of the fluidizing gas to be supplied to each of the gas boxes 32 is increased to a value greater than that during the normal operation, step-by-step in a direction from the rear wall 25 (left side in FIG. 1) to the front wall 24 (right side in FIG. 1) of the furnace body 20, instead of blowing the fluidizing gas evenly in the entire first fluidization region 15. Based on the above operation, even if non-combustible substances are accumulated around the mixture discharge port 29 of the furnace floor during the normal operation, it becomes possible to reliably discharge the non-combustible substances to the outside of the furnace body 20. The above specific operation is performed only for a significantly short time, so that an influence on facilities in a subsequent stage can be minimized.

[0062] The fluidized bed furnace according to the invention and described in claim 1 is designed to heat waste to extract a combustible gas from the waste.

[0063] In this fluidized bed furnace, the first fluidization region around the mixture discharge port and the second fluidization region having a fluidization degree higher than that in the first fluidization region are formed in the

fluidized bed. In this state, the waste supply section supplies waste to a region on the fluidized bed adjacent to the supply-side sidewall portion to cause the waste to be accumulated on the first fluidization region while causing the waste accumulated on the first fluidization region to be moved into the second fluidization region step-by-step. Thus, gasification of the waste is sufficiently performed while suppressing rapid fluctuation of generation of a combustible gas to be collected from the fluidized bed furnace, so that it becomes possible to stably generate a combustible gas from the waste.

[0064] Specifically, in the first fluidization region, fluidization is restrained to allow the waste to be accumulated on the upper surface of the first fluidization region, so that the waste is accumulated on the first fluidization region without being mixed with the fluidizable particles, and easily combustible trash in the waste is slowly gasified. Therefore, in the first fluidization region, rapid combustion of the waste is suppressed, and generation of a combustible gas caused by rapid gasification of the waste is minimized. When new waste is supplied into the furnace body by the waste supply section, the waste accumulated on the first fluidization region is moved into the second fluidization region step-by-step. In the second fluidization region, the fluidizable particles are actively fluidized and heated to a high temperature by combustion of the waste, so that the waste moved from a position on the first fluidization region is sufficiently mixed with the fluidizable particles, and thereby the waste is sufficiently gasified to generate a combustible gas. Consequently, it becomes possible to suppress intermittent and rapid generation of a combustible gas, thereby stabilizing the gas generation.

[0065] The first fluidization region is formed just above the mixture discharge port, and waste is supplied onto the first fluidization region. Thus, even if the waste is accumulated on the first fluidization region, and, during a period where easily combustible trash in the accumulated waste is slowly gasified, non-combustible substances in the waste and carbides produced by heating of the waste sink down to a furnace bottom, such non-combustible substances and carbides can be easily discharged from the furnace body. Further, even when non-combustible substances and carbides sink down to the bottom wall after the waste is moved from the first fluidization region into the second fluidization region, the non-combustible substances and carbides will fall along the upper surface of the bottom wall which is inclined to become lower toward the mixture discharge port. Thus, such non-combustible substances and carbides can also be easily discharged from the furnace body.

[0066] The upper surface of the bottom wall is inclined to become lower toward the mixture discharge port (i.e., inclined to become lower in the direction from the second fluidization region to the first fluidization region), so that the high-temperature fluidizable particles in the second fluidization region fall on the upper surface of the bottom wall toward the first fluidization region. Consequently,

ly, heat is supplied to the first fluidization region.

[0067] Preferably, the waste supply section is adapted to push new waste generally horizontally from the supply-side sidewall portion toward the waste accumulated on the first fluidization region, thereby causing the waste accumulated on the first fluidization region to be moved into the second fluidization region step-by-step.

[0068] According to this feature, new waste is pushed generally horizontally toward the waste accumulated on the first fluidization region. Thus, the waste accumulated on the first fluidization region is pushed by the new waste and reliably moved into the second fluidization region.

[0069] Preferably, the fluidized bed furnace comprises a carbide introduction device for separating the carbides from a mixture of the non-combustible substances, the carbides and the fluidizable particles discharged from the mixture discharge port, and returning the separated carbides to the fluidized bed from the side of the opposite-side sidewall portion.

[0070] According to this feature, the carbide introduction device operates to return the carbides discharged from the mixture discharge port together with the fluidizable particles and the non-combustible substances, to the second fluidization region actively fluidized and highly heated. This makes it possible to obtain a combustible gas from the carbides. Consequently, the combustible gas can be efficiently obtained from waste. In addition, the temperature of the second fluidization region can be kept at a high value by heat generated when the carbides are gasified.

[0071] Preferably, in the fluidized bed furnace of the present invention, the gas supply section is adapted to blow the fluidizing gas in the first fluidization region at a flow velocity satisfying a condition that U_o/U_{mf} ranges from 1 to less than 2, and blow the fluidizing gas in the second fluidization region at a flow velocity satisfying a condition that U_o/U_{mf} ranges from 2 to less than 5, where U_{mf} is a minimum fluidization velocity which is a minimum flow velocity of the fluidizing gas to be blown enough to fluidize the fluidizable particles, and U_o is a cross-sectional average flow velocity of the fluidizing gas. The first fluidization region and the second fluidization region can be desirably formed in the fluidized bed by blowing the fluidizing gas at the above flow velocities. Consequently, it becomes possible to desirably gasify the waste while suppressing rapid combustion of the waste, thereby stably obtaining a combustible gas from the waste.

[0072] Preferably, the fluidized bed furnace comprises a sand circulation device for separating the fluidizable particles from the mixture discharged from a mixture of the non-combustible substances, the carbides and the fluidizable particles, the mixture discharge port, and returning the separated fluidizable particles to the furnace body.

[0073] According to this feature, the sand introduction device operates to return the high-temperature fluidizable particles discharged from the mixture discharge port to the inside of the furnace body. This makes it possible

to maintain an amount of the fluidizable particles making up the fluidized bed, and makes it easy to maintain a temperature of the fluidized bed.

[0074] More preferably, the sand circulation device is adapted to return the fluidizable particles separated from the mixture onto the waste accumulated on the first fluidization region.

[0075] According to this feature, the sand circulation device operates to return the high-temperature fluidizable particles discharged from the mixture discharge port onto the waste accumulated on the first fluidization region. Thus, the high-temperature fluidizable particles serve as an ignition source to allow easily-combustible trash in the waste to be stably combusted (gasified).

[0076] Preferably, the furnace body has a shape in plan view, in which a dimension in a width direction perpendicular to a pushing direction along which waste is pushed by the waste supply section is equalized in the pushing direction.

[0077] According to this feature, when the waste on the first fluidization region is pushed by waste newly pushed by the waste supply section, and moved toward the second fluidization region, the movement of the waste is stabilized, because the dimension of the furnace body in a direction perpendicular to the waste pushing direction (width direction) is equalized.

[0078] Preferably, the waste supply section comprises a pusher having a pushing surface extending in the width direction, and a drive unit for reciprocatingly moving the pusher in a direction parallel to the pushing direction to allow the pushing surface of the pusher to push waste onto the fluidized bed simultaneously by the entire width-wise region of the pushing surface.

[0079] According to this feature, waste can be pushed with an even force in the width direction, so that the movement of the waste from the first fluidization region to the second fluidization region is approximately equalized in the width direction. Thus, it becomes possible to prevent the waste from concentrating on a certain portion inside the furnace.

[0080] The waste treatment method according to the invention and described in claim 9 is designed to heat waste to extract a combustible gas from the waste.

[0081] In this waste treatment method, the first fluidization region around the mixture discharge port and the second fluidization region having a fluidization degree higher than that in the first fluidization region are formed in the fluidized bed. In this state, the waste is accumulated on the first fluidization region, and the waste accumulated on the first fluidization region is moved into the second fluidization region step-by-step. Thus, gasification of the waste is sufficiently performed while suppressing rapid fluctuation of generation of a combustible gas to be collected from the fluidized bed furnace, so that it becomes possible to stably generate a combustible gas from the waste.

[0082] The first fluidization region is formed just above the mixture discharge port, and waste is supplied onto

the upper surface of the first fluidization region. Thus, even if the waste is accumulated on the first fluidization region, and, during a period where easily combustible trash in the accumulated waste is slowly gasified, non-combustible substances in the waste and carbides produced by heating of the waste sink down to a furnace bottom, such non-combustible substances and carbides can be easily discharged from the furnace body. Further, even when non-combustible substances and carbides sink down to the bottom wall after the waste is moved from the first fluidization region into the second fluidization region, the non-combustible substances and carbides will fall along the upper surface of the bottom wall which is inclined to become lower toward the mixture discharge port. Thus, such non-combustible substances and carbides can also be easily discharged from the furnace body.

[0083] The upper surface of the bottom wall is inclined to become lower toward the mixture discharge port (i.e., inclined to become lower in the direction from the second fluidization region to the first fluidization region), so that the high-temperature fluidizable particles in the second fluidization region fall on the upper surface of the bottom wall toward the first fluidization region. Consequently, heat is supplied to the first fluidization region.

[0084] Preferably, the gasification step includes pushing new waste generally horizontally from the supply-side sidewall portion toward the waste accumulated on the first fluidization region, thereby causing the waste accumulated on the first fluidization region to be moved into the second fluidization region step-by-step and gasified.

[0085] According to this feature, new waste is pushed generally horizontally toward the waste accumulated on the first fluidization region. Thus, the waste accumulated on the first fluidization region is pushed by the new waste and reliably moved into the second fluidization region, and gasified.

[0086] Preferably, the above waste treatment method comprises a step of separating the carbides from a mixture of the non-combustible substances, the carbides and the fluidizable particles discharged from the mixture discharge port, and returning the separated carbides to the fluidized bed from the side of the opposite-side sidewall portion.

[0087] According to this feature, the carbides discharged from the mixture discharge port together with the fluidizable particles and the non-combustible substances are separated and returned to the second fluidization region actively fluidized and highly heated. This makes it possible to reliably gasify the carbides. In addition, the temperature of the second fluidization region can be kept at a high value by heat generated when the carbides are gasified.

[0088] Preferably, in the above waste treatment method, the fluidizing gas is blown in the first fluidization region at a flow velocity satisfying a condition that U_0/U_{mf} ranges from 1 to less than 2, and blown in the second fluidization region at a flow velocity satisfying a condition that U_0/U_{mf}

ranges from 2 to less than 5, where U_{mf} is a minimum fluidization velocity which is a minimum flow velocity of the fluidizing gas to be blown so as to fluidize the fluidizable particles, and U_o is a cross-sectional average flow velocity of the fluidizing gas.

[0089] The first fluidization region and the second fluidization region can be desirably formed in the fluidized bed by blowing the fluidizing gas at the above flow velocities. Consequently, it becomes possible to desirably gasify the waste while suppressing rapid combustion of the waste, thereby stably obtaining a combustible gas from the waste.

INDUSTRIAL APPLICABILITY

[0090] As above, the fluidized bed furnace and the waste treatment method of the present invention are useful in heating waste in a fluidized bed formed by fluidizing fluidizable particles, to extract a combustible gas from the waste, and suitable for stably obtaining a combustible gas even from waste comprising easily combustible trash.

Claims

1. A fluidized bed furnace (10) for heating waste (18) to extract a combustible gas from the waste (18), comprising:

fluidizable particles (12) making up a fluidized bed (14) to heat the waste (18);

a furnace body (20) having a bottom wall (21) supporting the fluidizable particles (12) from therebelow, and a sidewall (22) standing upwardly from the bottom wall (21), wherein the bottom wall (21) has a mixture discharge port (29) provided at a position offset from a center position of the bottom wall (21) in a specific direction to discharge non-combustible substances in the waste (18) and carbides produced by heating of the waste (18), together with a part of the fluidizable particles (12), and an upper surface (21a) of the bottom wall (21) is inclined to become lower toward the mixture discharge port (29) so as to cause the fluidizable particles (12) to fall on the upper surface (21a) of the bottom wall (21) toward the mixture discharge port (29);

a gas supply section (30) for blowing a fluidizing gas from the bottom wall (21) of the furnace body (20) toward the fluidizable particles (12) to fluidize the fluidizable particles (12);

a waste supply section (40) for supplying waste (18) from a supply-side portion of the sidewall (22) located on the same side as the mixture discharge port (29) with respect to the center position of the bottom wall (21), to a region on

the fluidized bed (14) adjacent to the supply-side sidewall portion (24), thereby causing the waste (18) on the fluidized bed (14) to be moved toward an opposite-side portion of the sidewall (22) on a side opposite to the mixture discharge port (29) across the center position of the bottom wall (21),

a plurality of thermometers (T) disposed above the fluidized bed (14);

an air supply section (65) for supplying air above the fluidized bed (14),

wherein:

the gas supply section (30) is configured to blow the fluidizing gas from around the mixture discharge port (29) to form a first fluidization region (15) having a degree of fluidization of the fluidizable particles (12) which is set to an extent allowing waste (18) to be accumulated on the fluidizable particles (12), while blowing the fluidizing gas between the first fluidization region (15) and the opposite-side sidewall portion (25) at a flow velocity greater than that of the fluidizing gas to be blown in the first fluidization region (15), to form a second fluidization region (16) having a degree of fluidization of the fluidizable particles (12) greater than that in the first fluidization region (15), whereby the fluidizable particles (12) are moved in a convection-like pattern and mixed with the waste (18) to gasify the waste (18);

the waste supply section (40) is adapted to supply waste (18) from the supply-side sidewall portion (24) to the fluidized bed (14) to cause the waste (18) to be accumulated on the first fluidization region (15) while causing the accumulated waste (18) to be moved into the second fluidization region (16) step-by-step;

the plurality of thermometers (T) are disposed at different positions from each other above the first fluidization region (15); and the air supply section (65) is configured to supply air above the first fluidization region (15) in accordance with an indication value of each of the plurality of thermometers (T) so that the furnace body (20) has a predetermined internal temperature.

2. The fluidized bed furnace (10) as defined in claim 1, wherein the waste supply section (40) is adapted to push new waste (18) generally horizontally from the supply-side sidewall portion (24) toward the waste (18) accumulated on the first fluidization region (15), thereby causing the waste (18) accumulated on the first fluidization region (15) to be moved into the sec-

ond fluidization region (16) step-by-step.

3. The fluidized bed furnace (10) as defined in claim 1 or 2, which comprises a carbide introduction device (60) for separating the carbides from a mixture of the non-combustible substances, the carbides and the fluidizable particles (12) discharged from the mixture discharge port (29), and returning the separated carbides to the fluidized bed (14) from the side of the opposite-side sidewall portion (25). 5
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4. The fluidized bed furnace (10) as defined in any one of claims 1 to 3, wherein the gas supply section (30) is configured to blow the fluidizing gas in the first fluidization region (15) at a flow velocity satisfying a condition that U_o/U_{mf} ranges from 1 to less than 2, and blow the fluidizing gas in the second fluidization region (16) at a flow velocity satisfying a condition that U_o/U_{mf} ranges from 2 to less than 5, where U_{mf} is a minimum fluidization velocity which is a minimum flow velocity of the fluidizing gas to be blown enough to fluidize the fluidizable particles (12), and U_o is a cross-sectional average flow velocity of the fluidizing gas. 15
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5. The fluidized bed furnace (10) as defined in any one of claims 1 to 4, which comprises a sand circulation device (50) for separating the fluidizable particles (12) from a mixture of the non-combustible substances, the carbides and the fluidizable particles (12), the mixture discharged from the mixture discharge port (29), and returning the separated fluidizable particles (12) to the furnace body (20). 30
6. The fluidized bed furnace (10) as defined in claim 5, wherein the sand circulation device (50) is adapted to return the fluidizable particles (12) separated from the mixture onto the waste (18) accumulated on the first fluidization region (15). 35
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7. The fluidized bed furnace (10) as defined in any one of claims 1 to 6, wherein the furnace body (20) has a shape in plan view, in which a dimension in a width direction perpendicular to a pushing direction along which waste (18) is pushed by the waste supply section (40) is equalized in the pushing direction. 45
8. The fluidized bed furnace (10) as defined in claim 7, wherein the waste supply section (40) comprises a pusher (41) having a pushing surface (42) extending in the width direction, and a drive unit for reciprocatingly moving the pusher (41) in a direction parallel to the pushing direction to allow the pushing surface (42) of the pusher (41) to push waste (18) onto the fluidized bed (14) simultaneously by the entire width-wise region of the pushing surface (42). 50
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9. A waste treatment method for heating waste (18) to

extract a combustible gas from the waste (18), comprising:

a preparation step of preparing a fluidized bed furnace (10) comprising fluidizable particles (12) making up a fluidized bed (14) to heat the waste (18), a furnace body (20) having a bottom wall (21) supporting the fluidizable particles (12) from therebelow and a sidewall (22) standing upwardly from the bottom wall (21), wherein the bottom wall (21) has a mixture discharge port (29) provided at a position offset from a center position of the bottom wall (21) in a specific direction to discharge non-combustible substances in the waste (18) and carbides produced by heating of the waste (18), together with a part of the fluidizable particles (12), and an upper surface (21a) of the bottom wall (21) is inclined to become lower toward the mixture discharge port (29) so as to cause the fluidizable particles (12) to fall on the upper surface (21a) of the bottom wall (21) toward the mixture discharge port (29);

a fluidization-region formation step of blowing a fluidizing gas from a region of the bottom wall (21) of the furnace body (20) around the mixture discharge port (29) toward the fluidizable particles (12) to form a first fluidization region (15) having a degree of fluidization of the fluidizable particles (12) which is set to an extent allowing waste (18) to be accumulated on the fluidizable particles (12), while blowing the fluidizing gas between the first fluidization region (15) and an opposite-side portion of the sidewall (22) on a side opposite to the mixture discharge port (29) across the center position of the bottom wall (21), at a flow velocity greater than that of the fluidizing gas to be blown in the first fluidization region (15), to form a second fluidization region (16) having a degree of fluidization of the fluidizable particles (12) greater than that in the first fluidization region (15);

a gasification step of supplying waste (18) from a supply-side portion of the sidewall (22) located on the same side as the mixture discharge port (29) with respect to the center position of the bottom wall (21), to a region on the fluidized bed (14) adjacent to the supply-side sidewall portion (24), thereby causing the waste (18) to be accumulated on the first fluidization region (15), while causing the accumulated waste (18) to be moved into the second fluidization region (16) step-by-step and gasified;

an air supplying step of supplying air above the fluidized bed (14);

wherein:

in the preparation step, the fluidized bed fur-

nace (10) further including a plurality of thermometers (T) and an air supply section (65) is prepared, the plurality of thermometers (T) being disposed at different positions from each other above the first fluidization region (15), and the air supply section (65) supplying air above the first fluidization region (15); and

in the supplying step, the air supply section (65) supplies air above the first fluidization region (15) in accordance with an indication value of each of the plurality of thermometers (T) so that the furnace body (20) has a predetermined internal temperature.

10. The waste treatment method as defined in claim 9, wherein the gasification step includes pushing new waste (18) generally horizontally from the supply-side sidewall portion (24) toward the waste (18) accumulated on the first fluidization region (15), thereby causing the waste (18) accumulated on the first fluidization region (15) to be moved into the second fluidization region (16) step-by-step and gasified.

11. The waste treatment method as defined in claim 9 or 10, which comprises a step of separating the carbides from a mixture of the non-combustible substances, the carbides and the fluidizable particles (12), the mixture discharged from the mixture discharge port (29), and returning the separated carbides to the fluidized bed (14) from the side of the opposite-side sidewall portion (25).

12. The waste treatment method as defined in any one of claims 9 to 11, wherein the fluidizing gas is blown in the first fluidization region (15) at a flow velocity satisfying a condition that U_o/U_{mf} ranges from 1 to less than 2, and blown in the second fluidization region (16) at a flow velocity satisfying a condition that U_o/U_{mf} ranges from 2 to less than 5, where U_{mf} is a minimum fluidization velocity which is a minimum flow velocity of the fluidizing gas to be blown so as to fluidize the fluidizable particles (12), and U_o is a cross-sectional average flow velocity of the fluidizing gas.

Patentansprüche

1. Wirbelschichtofen (10) zum Erwärmen von Abfall (18) zum Extrahieren eines brennbaren Gases aus dem Abfall (18), umfassend:

fluidisierbare Teilchen (12), die eine Wirbelschicht (14) zum Erwärmen des Abfalls (18) bilden;

ein Ofengehäuse (20), aufweisend eine Unterseitenwand (21), welche die fluidisierbaren Teil-

chen (12) von unten stützt, und eine Seitenwand (22), welche aufwärts von der Unterseitenwand (21) steht, wobei die Unterseitenwand (21) eine Mischungsentleerungsöffnung (29) aufweist, die an einer Position versetzt von einer Zentralposition der Unterseitenwand (21) in eine spezifische Richtung zum Entleeren von unbrennbaren Substanzen in dem Abfall (18) und Carbiden, hergestellt durch Erwärmen des Abfalls (18), zusammen mit einem Teil der fluidisierbaren Teilchen (12) bereitgestellt ist, und wobei eine Oberseite (21a) der Unterseitenwand (21) geneigt ist, um tiefer in Richtung der Mischungsentleerungsöffnung (29) zu werden, um so zu verursachen, dass die fluidisierbaren Teilchen (12) auf die Oberseite (21a) der Unterseitenwand (21) in Richtung der Mischungsentleerungsöffnung (29) fallen; einen Gaszuführungsabschnitt (30) zum Blasen eines fluidisierenden Gases von der Unterseitenwand (21) des Ofengehäuses (20) in Richtung der fluidisierbaren Teilchen (12) zum Fluidisieren der fluidisierbaren Teilchen (12); einen Abfallzuführungsabschnitt (40) zum Zuführen von Abfall (18) von einem Zuführseitenabschnitt der Seitenwand (22), welcher sich auf der gleichen Seite wie die Mischungsentleerungsöffnung (29) in Bezug auf die Zentralposition der Unterseitenwand (21) befindet, in einen Bereich auf der Wirbelschicht (14), der benachbart zu dem Seitenwandabschnitt der Zuführungsseite (24) ist, dabei verursachend, dass der Abfall (18) auf der Wirbelschicht (14) in Richtung eines Gegenseitenabschnitts der Seitenwand (22) auf einer Seite gegenüber der Mischungsentleerungsöffnung (29) über die Zentralposition der Unterseitenwand (21) bewegt wird, eine Vielzahl an Thermometern (T), angeordnet über der Wirbelschicht (14); einen Luftzuführungsabschnitt (65) zum Zuführen von Luft über die Wirbelschicht (14), wobei:

der Gaszuführungsabschnitt (30) eingerichtet ist, um das fluidisierende Gas von der Mischungsentleerungsöffnung (29) zu blasen, um einen ersten Fluidisierungsbereich (15) zu bilden, welcher einen Grad an Fluidisierung der fluidisierbaren Teilchen (12) aufweist, der auf einen Bereich eingestellt ist, der es dem Abfall (18) erlaubt, auf den fluidisierbaren Teilchen angesammelt zu werden, während das fluidisierende Gas zwischen dem ersten Fluidisierungsbereich (15) und dem Gegenseitenabschnitt (25) bei einer höheren Flussgeschwindigkeit geblasen wird als der

- des fluidisierenden Gases, das in den ersten Fluidisierungsbereich (15) geblasen wird, zum Bilden eines zweiten Fluidisierungsbereichs (16), welcher einen höheren Grad an Fluidisierung der fluidisierbaren Teilchen (12) aufweist als der in dem ersten Fluidisierungsbereich (15), wobei die fluidisierbaren Teilchen (12) in einem konvektionsartigen Muster bewegt und mit dem Abfall (18) vermischt werden, um den Abfall (18) zu vergasen,
- der Abfallzuführungsabschnitt (40) geeignet ist, Abfall (18) von dem Seitenwandabschnitt der Zuführungsseite (24) zu der Wirbelschicht (14) zuzuführen, um zu verursachen, dass der Abfall (18) in dem ersten Fluidisierungsbereich (15) angesammelt wird während verursacht wird, dass der angesammelte Abfall (18) Schritt für Schritt in den zweiten Fluidisierungsbereich (16) bewegt wird;
- die Vielzahl an Thermometern (T) an voneinander unterschiedlichen Stellen über dem ersten Fluidisierungsbereich (15) angeordnet sind; und
- der Luftzuführungsabschnitt (65) eingerichtet ist, um Luft über den ersten Fluidisierungsbereich (15) in Übereinstimmung mit einer Wertangabe von jedem der Vielzahl an Thermometern (T) zuzuführen, so dass das Ofengehäuse (20) eine vorbestimmte innere Temperatur aufweist.
2. Wirbelschichtofen (10) nach Anspruch 1, wobei der Abfallzuführungsabschnitt (40) ausgelegt ist, neuen Abfall (18) im Allgemeinen horizontal von dem Seitenwandabschnitt der Zuführungsseite (24) zum Abfall (18) hin, der auf dem ersten Fluidisierungsbereich (15) angesammelt ist, zu schieben, wodurch verursacht wird, dass der Abfall (18), der auf dem ersten Fluidisierungsbereich (15) angesammelt ist, Schritt für Schritt in den zweiten Fluidisierungsbereich (16) bewegt wird.
 3. Wirbelschichtofen (10) nach Anspruch 1 oder 2, welcher eine Carbideinführungsvorrichtung (60) zum Trennen der Carbide von einem Gemisch der unbrennbaren Substanzen umfasst, wobei die Carbide und die fluidisierbaren Teilchen (12) von der Mischungsentleerungsöffnung (29) abgelassen werden, und zum Zurückführen der abgetrennten Carbide zu der Wirbelschicht (14) von der Seite des Gegenseitenseitenwandabschnitts (25).
 4. Wirbelschichtofen (10) nach einem der Ansprüche 1 bis 3, wobei der Gaszuführungsabschnitt (30) eingerichtet ist, um das fluidisierende Gas in den ersten Fluidisierungsbereich (15) mit einer Flussgeschwindigkeit zu blasen, die einer Voraussetzung, dass U_o/U_{mf} sich von 1 bis weniger als 2 erstreckt, genügt, und um das fluidisierende Gas in den zweiten Fluidisierungsbereich (16) mit einer Flussgeschwindigkeit zu blasen, die einer Voraussetzung, dass U_o/U_{mf} sich von 2 bis weniger als 5 erstreckt, genügt, wobei U_{mf} eine minimale Fluidisierungsgeschwindigkeit ist, welche eine minimale Flussgeschwindigkeit des fluidisierenden Gases ist, um ausreichend geblasen zu werden, um die fluidisierbaren Teilchen (12) zu fluidisieren, und U_o eine durchschnittliche Querschnittsflussgeschwindigkeit des fluidisierenden Gases ist.
 5. Wirbelschichtofen (10) nach einem der Ansprüche 1 bis 4, welcher eine Sandzirkulationsvorrichtung (50) zum Trennen der fluidisierbaren Teilchen (12) von einem Gemisch der unbrennbaren Substanzen, der Carbide und der fluidisierbaren Teilchen (12), wobei das Gemisch von der Mischungsentleerungsöffnung (29) abgelassen wird, und zum Zurückführen der abgetrennten fluidisierbaren Teilchen (12) zum Ofengehäuse (20), umfasst.
 6. Wirbelschichtofen (10) nach Anspruch 5, wobei die Sandzirkulationsvorrichtung (50) dazu ausgelegt ist, die fluidisierbaren Teilchen (12), die von dem Gemisch abgetrennt werden, auf den Abfall (18), der in dem ersten Fluidisierungsbereich angesammelt ist, zurückzuführen.
 7. Wirbelschichtofen (10) nach einem der Ansprüche 1 bis 6, wobei das Ofengehäuse (20) in der Draufsicht eine Gestalt hat, in welcher eine Dimension in eine Breitenrichtung senkrecht zu einer Schieberichtung, entlang welcher Abfall (18) von dem Abfallzuführungsabschnitt (40) geschoben wird, in der Schieberichtung gleichgemacht ist.
 8. Wirbelschichtofen (10) nach Anspruch 7, wobei der Abfallzuführungsabschnitt (40) einen Schieber (41), der eine Schiebeoberfläche (42), die sich in die Breitenrichtung erstreckt, aufweist, und eine Antriebseinheit zum hin- und herbewegen des Schiebers (41) in einer Richtung parallel zu der Schieberichtung, umfasst, um es der Schiebeoberfläche (42) des Schiebers (41) zu ermöglichen, Abfall (18) auf die Wirbelschicht (14) gleichzeitig über den gesamten Breitenbereich der Schiebeoberfläche (42) zu schieben.
 9. Abfallverarbeitungsverfahren zum Erwärmen von Abfall (18) zum Extrahieren eines brennbaren Gases aus dem Abfall (18), umfassend:
 - einen Herstellungsschritt des Herstellens eines Wirbelschichtofens (10), umfassend fluidisierbare Teilchen (12), die eine Wirbelschicht (14)

zum Erwärmen des Abfalls (18) bilden, ein Ofengehäuse (20), aufweisend eine Unterseitenwand (21), welche die fluidisierbaren Teilchen (12) von unten stützt, und eine Seitenwand (22), welche aufwärts von der Unterseitenwand (21) steht, wobei die Unterseitenwand (21) eine Mischungsentleerungsöffnung (29) aufweist, die an einer Position versetzt von einer Zentralposition der Unterseitenwand (21) in eine spezifische Richtung zum Entleeren von unbrennbaren Substanzen in dem Abfall (18) und Carbiden, hergestellt durch Erwärmen des Abfalls (18), zusammen mit einem Teil der fluidisierbaren Teilchen (12), bereitgestellt ist, und wobei eine Oberseite (21a) der Unterseitenwand (21) geneigt ist, um tiefer in Richtung der Mischungsentleerungsöffnung (29) zu werden, um so zu verursachen, dass die fluidisierbaren Teilchen (12) auf die Oberseite (21a) der Unterseitenwand (21) in Richtung der Mischungsentleerungsöffnung (29) fallen;

einen Fluidisierungsbereichbildungsschritt des Blasens eines fluidisierenden Gases von einem Bereich der Unterseitenwand (21) des Ofengehäuses (20) um die Mischungsentleerungsöffnung (29) in Richtung der fluidisierbaren Teilchen (12) zum Bilden eines ersten Fluidisierungsbereichs (15), welcher einen Grad an Fluidisierung der fluidisierbaren Teilchen (12) aufweist, der auf einen Bereich eingestellt ist, der es dem Abfall (18) erlaubt, auf den fluidisierbaren Teilchen (12) angesammelt zu werden, während das fluidisierende Gas zwischen dem ersten Fluidisierungsbereich (15) und einem Gegenseitenabschnitt der Seitenwand (22) auf einer Seite gegenüber der Mischungsentleerungsöffnung (29) über die Zentralposition der Unterseitenwand (21) bei einer höheren Flussgeschwindigkeit geblasen wird als die des fluidisierenden Gases, das in den ersten Fluidisierungsbereich (15) geblasen wird, zum Bilden eines zweiten Fluidisierungsbereichs (16), welcher einen höheren Grad an Fluidisierung der fluidisierbaren Teilchen (12) aufweist als der in dem ersten Fluidisierungsbereich (15);

einen Vergasungsschritt des Zuführens von Abfall (18) von einem Zuführseitenabschnitt der Seitenwand (22), welcher sich auf der gleichen Seite wie die Mischungsentleerungsöffnung (29) in Bezug auf die Zentralposition der Unterseitenwand (21) befindet, in einen Bereich auf der Wirbelschicht (14), der benachbart zu dem Seitenwandabschnitt der Zuführungsseite (24) ist, wodurch verursacht wird, dass der Abfall (18) in dem ersten Fluidisierungsbereich (15) angesammelt wird während verursacht wird, dass der angesammelte Abfall (18) Schritt für Schritt in den zweiten Fluidisierungsbereich (16) bewegt

und vergast wird;
einen Luftzuführungsschritt des Zuführens von Luft über der Wirbelschicht (14); wobei:

in dem Herstellungsschritt der Wirbelschichtofen (10) weiter eine Vielzahl an Thermometern (T) einschließt und ein Luftzuführungsabschnitt (65), hergestellt wird, wobei die Vielzahl an Thermometern (T) an voneinander unterschiedlichen Stellen über dem ersten Fluidisierungsbereich (15) angeordnet sind und der Luftzuführungsabschnitt (65) Luft über den ersten Fluidisierungsbereich (15) zuführt; und
im Luftzuführungsschritt der Luftzuführungsabschnitt (60) Luft über den ersten Fluidisierungsbereich (15) in Übereinstimmung mit einer Wertangabe von jedem der Vielzahl an Thermometern (T) zuführt, so dass das Ofengehäuse (20) eine vorbestimmte innere Temperatur aufweist.

10. Abfallverarbeitungsverfahren nach Anspruch 9, wobei der Vergasungsschritt das Schieben von neuem Abfall (18) im Allgemeinen horizontal von dem Seitenwandabschnitt der Zuführungsseite (24) zum Abfall (18) hin, der auf dem ersten Fluidisierungsbereich (15) angesammelt ist, einschließt, wodurch verursacht wird, dass der Abfall (18), der auf dem ersten Fluidisierungsbereich (15) angesammelt ist, Schritt für Schritt in den zweiten Fluidisierungsbereich (15) bewegt und vergast wird.

11. Abfallverarbeitungsverfahren nach Anspruch 9 oder 10, welches einen Schritt des Trennens der Carbide von einem Gemisch der unbrennbaren Substanzen, der Carbide und der fluidisierbaren Teilchen (12), wobei die Mischung von der Mischungsentleerungsöffnung (29) abgelassen wird, und des Zurückführens der abgetrennten Carbide zu der Wirbelschicht (14) von der Seite des Gegenseitenabschnitts (25) umfasst.

12. Abfallverarbeitungsverfahren nach einem der Ansprüche 9 bis 11, wobei das fluidisierende Gas in den ersten Fluidisierungsbereich (15) mit einer Flussgeschwindigkeit geblasen wird, die einer Voraussetzung, dass U_o/U_{mf} sich von 1 bis weniger als 2 erstreckt, genügt, und das fluidisierende Gas in den zweiten Fluidisierungsbereich (16) mit einer Flussgeschwindigkeit geblasen wird, die einer Voraussetzung, dass U_o/U_{mf} sich von 2 bis weniger als 5 erstreckt, genügt, wobei U_{mf} eine minimale Fluidisierungsgeschwindigkeit ist, welche eine minimale Flussgeschwindigkeit des fluidisierenden Gases ist, die geblasen wird, um so die fluidisierbaren Teilchen (12) zu fluidisieren, und U_o eine durchschnittliche Querschnittsflussgeschwindigkeit des fluidisieren-

den Gases ist.

Revendications

1. Four à lit fluidisé (10) pour chauffer des déchets (18) afin d'extraire des déchets (18) un gaz combustible, comprenant :

des particules fluidisables (12) formant un lit fluidisé (14) pour chauffer les déchets (18) ;
 un corps de four (20) présentant une paroi inférieure (21) supportant les particules fluidisables (12) depuis le dessous, et une paroi latérale (22) se dressant vers le haut depuis la paroi inférieure (21), dans lequel la paroi inférieure (21) présente un orifice d'évacuation de mélange (29) prévu à une position en déport d'une position centrale de la paroi inférieure (21) dans une direction spécifique à l'évacuation des substances non combustibles dans les déchets (18) et des carbures produits par chauffage des déchets (18), conjointement avec une partie des particules fluidisables (12), et une surface supérieure (21a) de la paroi inférieure (21) est inclinée pour s'abaisser vers l'orifice d'évacuation de mélange (29) de manière à amener les particules fluidisables (12) à tomber sur la surface supérieure (21a) de la paroi inférieure (21) vers l'orifice d'évacuation de mélange (29) ;
 une section d'alimentation en gaz (30) pour insuffler un gaz fluidisant depuis la paroi inférieure (21) du corps de four (20) vers les particules fluidisables (12) pour fluidiser les particules fluidisables (12) ;
 une section d'alimentation en déchets (40) pour alimenter en déchets (18) à partir d'une partie côté alimentation de la paroi latérale (22) située du même côté que l'orifice d'évacuation de mélange (29) par rapport à la position centrale de la paroi inférieure (21), une région sur le lit fluidisé (14) adjacente à la partie de paroi latérale côté alimentation (24), amenant ainsi les déchets (18) sur le lit fluidisé (14) à être déplacés vers une partie côté opposé de la paroi latérale (22) sur un côté opposé à l'orifice d'évacuation de mélange (29) à travers la position centrale de la paroi inférieure (21),
 une pluralité de thermomètres (T) disposés au-dessus du lit fluidisé (14) ;
 une section d'alimentation en air (65) pour alimenter en air le dessus du lit fluidisé (14), dans lequel :

la section d'alimentation en gaz (30) est configurée pour insuffler le gaz fluidisant autour de l'orifice d'évacuation de mélange (29) afin de former une première région de

fluidisation (15) présentant un degré de fluidisation des particules fluidisables (12) qui est défini dans une mesure permettant aux déchets (18) d'être accumulés sur les particules fluidisables (12) tout en insufflant le gaz fluidisant entre la première région de fluidisation (15) et la partie de paroi latérale opposée (25) à une vitesse de flux supérieure à celle du gaz fluidisant à insuffler dans la première région de fluidisation (15), pour former une seconde région de fluidisation (16) présentant un degré de fluidisation des particules fluidisables (12) supérieur à celui dans la première région de fluidisation (15), moyennant quoi les particules fluidisables (12) sont déplacées dans un motif de type convection et mélangées avec les déchets (18) pour gazéifier les déchets (18) ;

la section d'alimentation en déchets (40) est adaptée pour alimenter en déchets (18) depuis la partie de paroi latérale côté alimentation (24) le lit fluidisé (14) pour amener les déchets (18) à être accumulés sur la première région de fluidisation (15) tout en amenant les déchets accumulés (18) à être déplacés dans la seconde région de fluidisation (16) étape par étape ;

la pluralité de thermomètres (T) est disposée à des positions différentes les unes des autres au-dessus de la première région de fluidisation (15) ; et

la section d'alimentation en air (65) est configurée pour alimenter en air le dessus de la première région de fluidisation (15) selon une valeur d'indication de chacun de la pluralité de thermomètres (T) de sorte que le corps de four (20) présente une température interne prédéterminée.

2. Four à lit fluidisé (10) selon la revendication 1, dans lequel la section d'alimentation en déchets (40) est adaptée pour pousser de nouveaux déchets (18) généralement horizontalement depuis la partie de paroi latérale côté alimentation (24) vers les déchets (18) accumulés sur la première région de fluidisation (15), amenant ainsi les déchets (18) accumulés sur la première région de fluidisation (15) à être déplacés vers la seconde région de fluidisation (16) étape par étape.
3. Four à lit fluidisé (10) selon la revendication 1 ou 2, qui comprend un dispositif d'introduction de carbure (60) pour séparer les carbures d'un mélange de substances non combustibles, les carbures et les particules fluidisables (12) étant évacués de l'orifice d'évacuation de mélange (29), et retourner les carbures séparés vers le lit fluidisé (14) depuis le côté

de la partie de paroi latérale opposée (25).

4. Four à lit fluidisé (10) selon l'une quelconque des revendications 1 à 3, dans lequel la section d'alimentation en gaz (30) est configurée pour insuffler le gaz fluidisant dans la première région de fluidisation (15) à une vitesse de flux satisfaisant une condition selon laquelle U_o/U_{mf} varie de 1 à moins de 2, et insuffler le gaz fluidisant dans la seconde région de fluidisation (16) à une vitesse de flux satisfaisant une condition selon laquelle U_o/U_{mf} varie de 2 à moins de 5, où U_{mf} est une vitesse de fluidisation minimum qui est une vitesse de flux minimum du gaz fluidisant à insuffler en quantité suffisante pour fluidiser les particules fluidisables (12), et U_o est une vitesse de flux moyenne de section transversale du gaz fluidisant. 5
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5. Four à lit fluidisé (10) selon l'une quelconque des revendications 1 à 4, qui comprend un dispositif de circulation de sable (50) pour séparer les particules fluidisables (12) d'un mélange de substances non combustibles, les carbures et les particules fluidisables (12), le mélange évacué depuis l'orifice d'évacuation de mélange (29), et retourner les particules fluidisables séparées (12) vers le corps de four (20). 15
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6. Four à lit fluidisé (10) selon la revendication 5, dans lequel le dispositif de circulation de sable (50) est adapté pour retourner les particules fluidisables (12) séparées du mélange sur les déchets (18) accumulés sur la première région de fluidisation (15). 30
7. Four à lit fluidisé (10) selon l'une quelconque des revendications 1 à 6, dans lequel le corps de four (20) présente une forme dans une vue en plan, dans laquelle une dimension dans une direction de largeur perpendiculaire à une direction de poussée, le long de laquelle des déchets (18) sont poussés par la section d'alimentation en déchets (40), est égalisée dans la direction de poussée. 35
40
8. Four à lit fluidisé (10) selon la revendication 7, dans lequel la section d'alimentation en déchets (40) comprend un poussoir (41) présentant une surface de poussée (42) s'étendant dans la direction de la largeur, et une unité d'entraînement pour le déplacement alternatif du poussoir (41) dans une direction parallèle à la direction de poussée pour permettre à la surface de poussée (42) du poussoir (41) de pousser des déchets (18) sur le lit fluidisé (14) simultanément par toute la largeur de la surface de poussée (42). 45
50
9. Procédé de traitement de déchets pour chauffer des déchets (18) afin d'extraire un gaz combustible des déchets (18), comprenant : 55

une étape de préparation pour préparer un four à lit fluidisé (10) comprenant des particules fluidisables (12) formant un lit fluidisé (14) pour chauffer les déchets (18), un corps de four (20) présentant une paroi inférieure (21) supportant les particules fluidisables (12) depuis le dessous et une paroi latérale (22) se dressant vers le haut depuis la paroi inférieure (21), dans lequel la paroi inférieure (21) présente un orifice d'évacuation de mélange (29) prévu à une position en déport d'une position centrale de la paroi inférieure (21) dans une direction spécifique pour évacuer des substances non combustibles dans les déchets (18) et des carbures produits par chauffage des déchets (18), conjointement avec une partie des particules fluidisables (12), et une surface supérieure (21a) de la paroi inférieure (21) est inclinée pour s'abaisser vers l'orifice d'évacuation de mélange (29) de sorte à amener les particules fluidisables (12) à tomber sur la surface supérieure (21a) de la paroi inférieure (21) vers l'orifice d'évacuation de mélange (29) ; une étape de formation de région de fluidisation pour insuffler un gaz fluidisant depuis une région de la paroi inférieure (21) du corps de four (20) autour de l'orifice d'évacuation de mélange (29) vers les particules fluidisables (12) pour former une première région de fluidisation (15) présentant un degré de fluidisation de particules fluidisables (12) qui est réglé à une étendue permettant aux déchets (18) d'être accumulés sur les particules fluidisables (12), tout en insufflant le gaz fluidisant entre la première région de fluidisation (15) et une partie côté opposé de la paroi latérale (22) sur un côté opposé à l'orifice d'évacuation de mélange (29) au travers de la position centrale de la paroi inférieure (21), à une vitesse de flux supérieure à celle du gaz fluidisant à insuffler dans la première région de fluidisation (15), pour former une seconde région de fluidisation (16) présentant un degré de fluidisation des particules fluidisables (12) supérieur à celui dans la première région de fluidisation (15) ; une étape de gazéification pour alimenter en déchets (18) à partir d'une partie côté alimentation de la paroi latérale (22) située du même côté que l'orifice d'évacuation de mélange (29) par rapport à la position centrale de la paroi inférieure (21), une région sur le lit fluidisé (14) adjacente à la partie de paroi latérale côté alimentation (24), amenant ainsi les déchets (18) à être accumulés sur la première région de fluidisation (15), tout en amenant les déchets accumulés (18) à être déplacés dans la seconde région de fluidisation (16) étape par étape et gazéifiés ; une étape d'alimentation en air pour alimenter en air le dessus du lit fluidisé (14) ; dans lequel :

dans l'étape de préparation, le four à lit fluidisé (10) incluant en outre une pluralité de thermomètres (T) et une section d'alimentation en air (65) est préparé, la pluralité de thermomètres (T) étant disposée à des positions différentes les unes des autres au-dessus de la première région de fluidisation (15), et la section d'alimentation en air (65) alimentant en air le dessus de la première région de fluidisation (15) ; et
 dans l'étape d'alimentation, la section d'alimentation en air (65) alimente en air le dessus de la première région de fluidisation (15) selon une valeur d'indication de chacun de la pluralité de thermomètres (T) de sorte que le corps de four (20) présente une température interne prédéterminée.

10. Procédé de traitement de déchets selon la revendication 9, dans lequel l'étape de gazéification inclut la poussée de nouveaux déchets (18) généralement horizontalement depuis la partie de paroi latérale côté alimentation (24) vers les déchets (18) accumulés sur la première région de fluidisation (15), amenant ainsi les déchets (18) accumulés sur la première région de fluidisation (15) à être déplacés dans la seconde région de fluidisation (16) étape par étape et gazéifiés.
11. Procédé de traitement de déchets selon la revendication 9 ou 10, qui comprend une étape pour séparer les carbures d'un mélange de substances non combustibles, les carbures et les particules fluidisables (12), le mélange évacué depuis l'orifice d'évacuation de mélange (29), et retourner les carbures séparés vers le lit fluidisé (14) depuis le côté de la partie de paroi latérale opposée (25).
12. Procédé de traitement de déchets selon l'une quelconque des revendications 9 à 11, dans lequel le gaz fluidisant est insufflé dans la première région de fluidisation (15) à une vitesse de flux satisfaisant une condition selon laquelle U_o/U_{mf} varie de 1 à moins de 2, et insufflé dans la seconde région de fluidisation (16) à une vitesse de flux satisfaisant une condition selon laquelle U_o/U_{mf} varie de 2 à moins de 5, où U_{mf} est une vitesse de fluidisation minimum qui est une vitesse de flux minimum du gaz fluidisant à insuffler de manière à fluidiser les particules fluidisables (12), et U_o est une vitesse de flux moyenne de section transversale du gaz fluidisant.

FIG.1

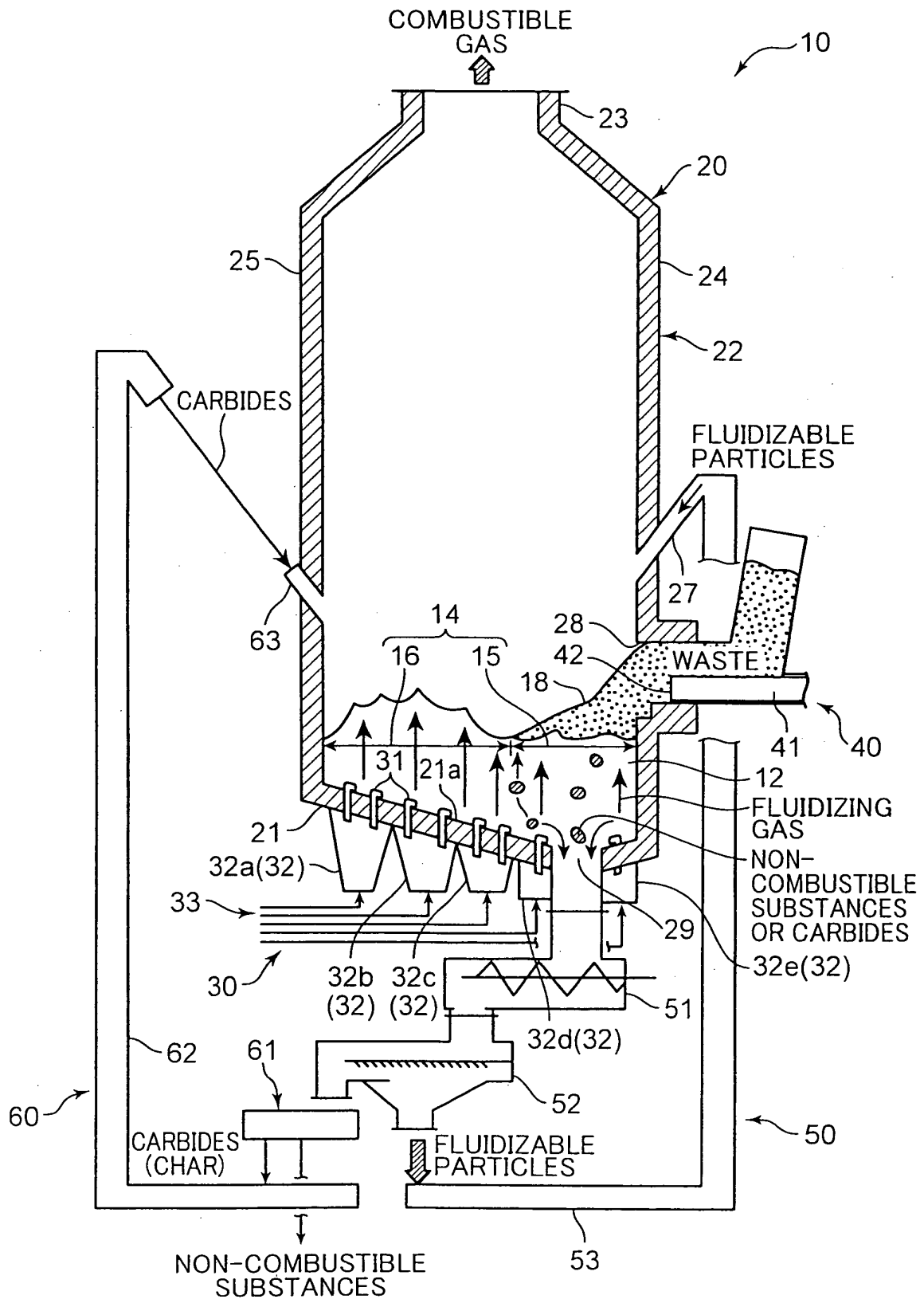


FIG.2

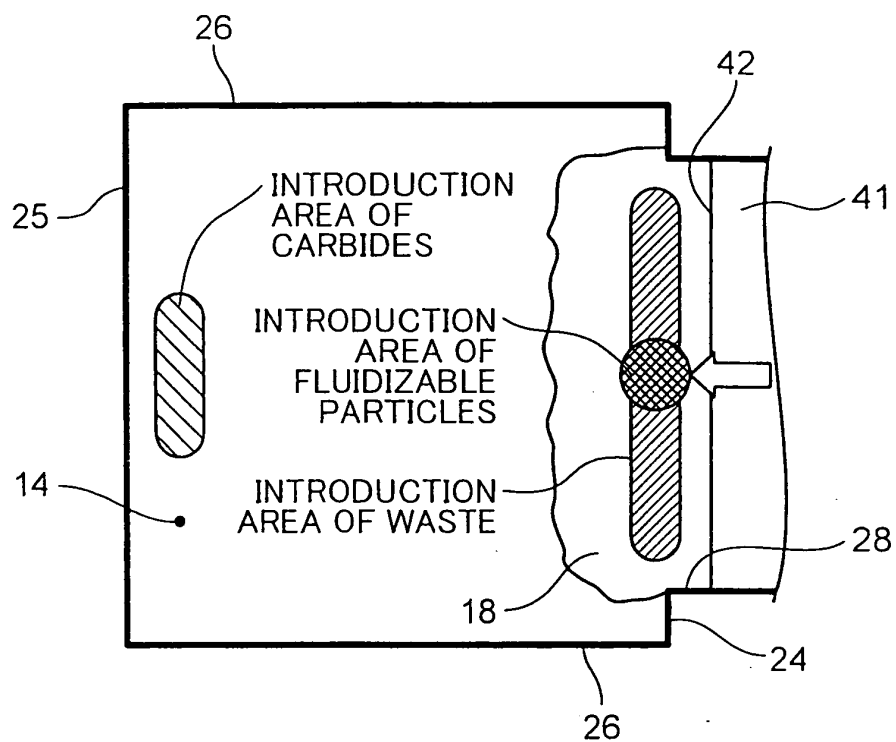


FIG.3

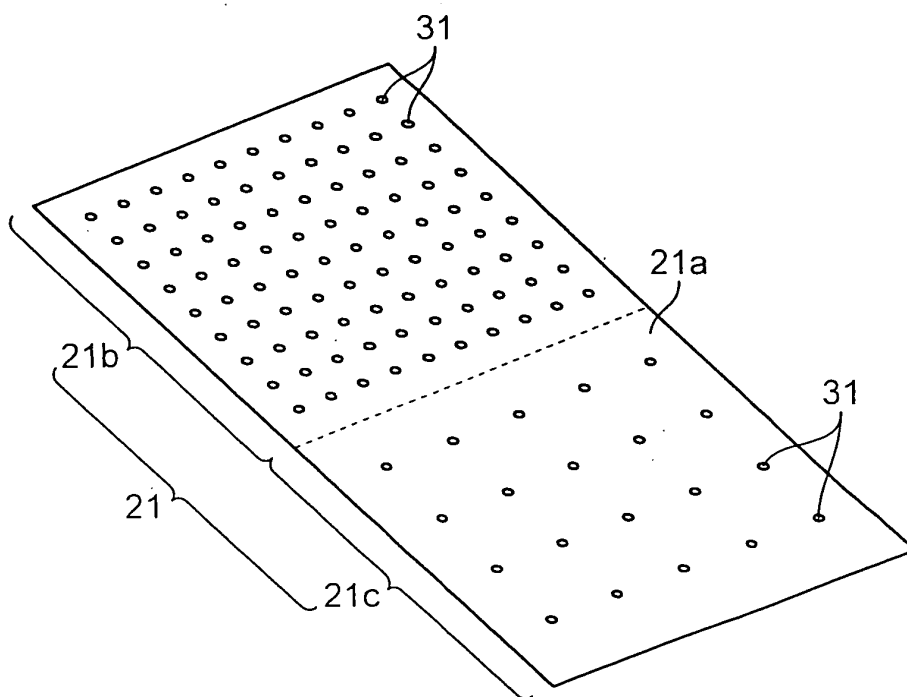


FIG.4

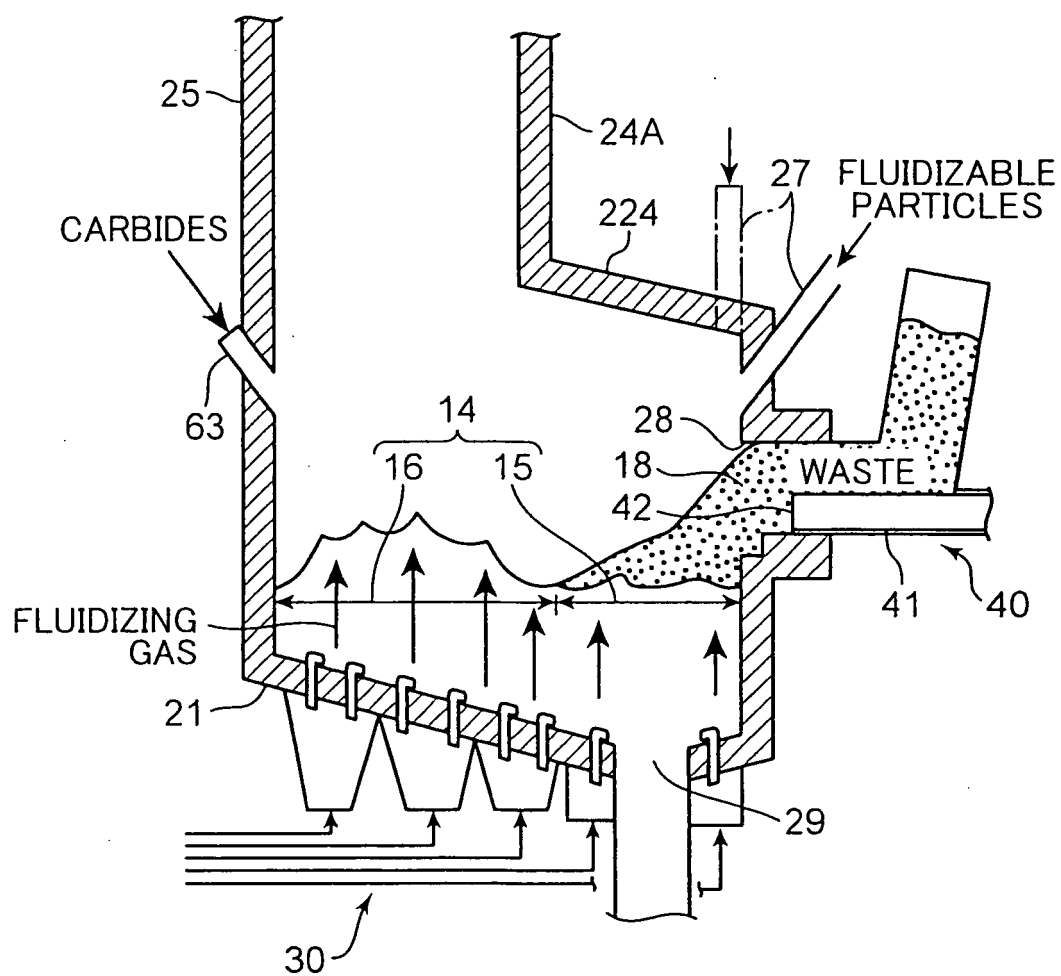


FIG.5

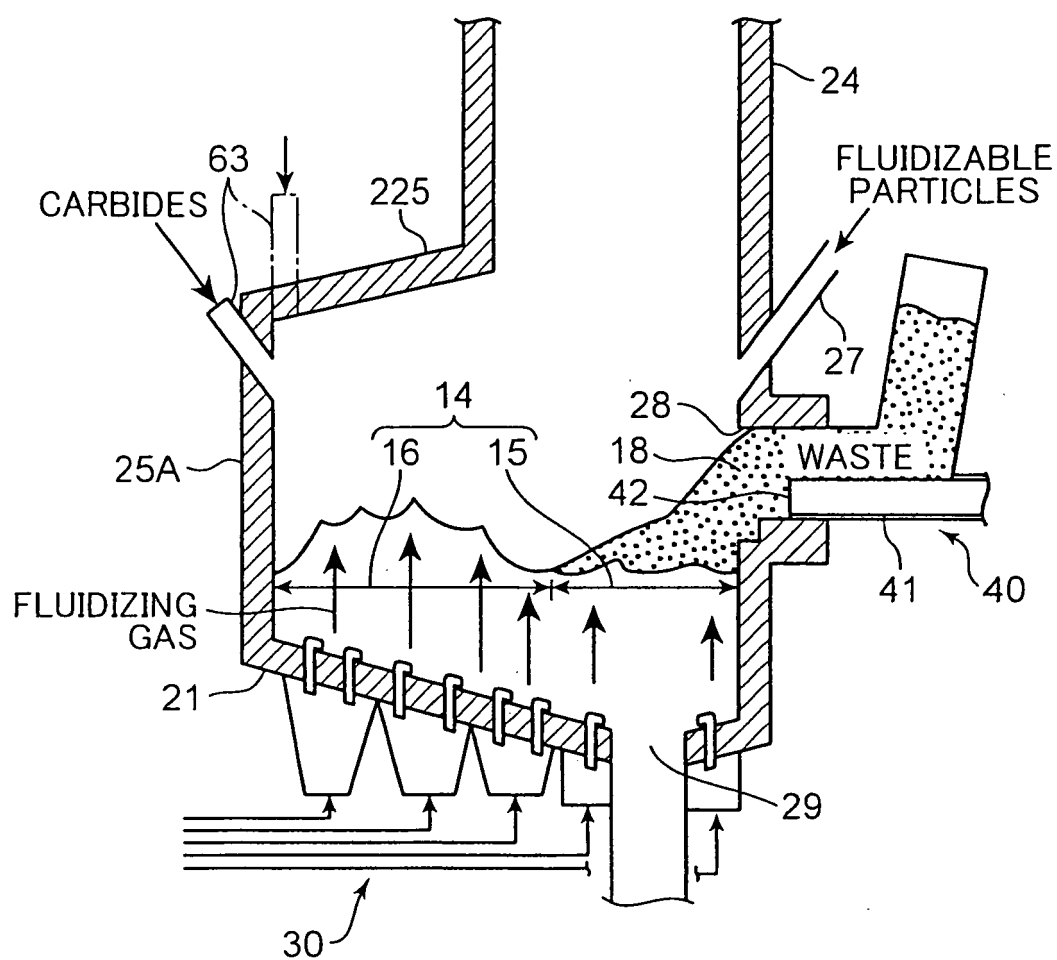
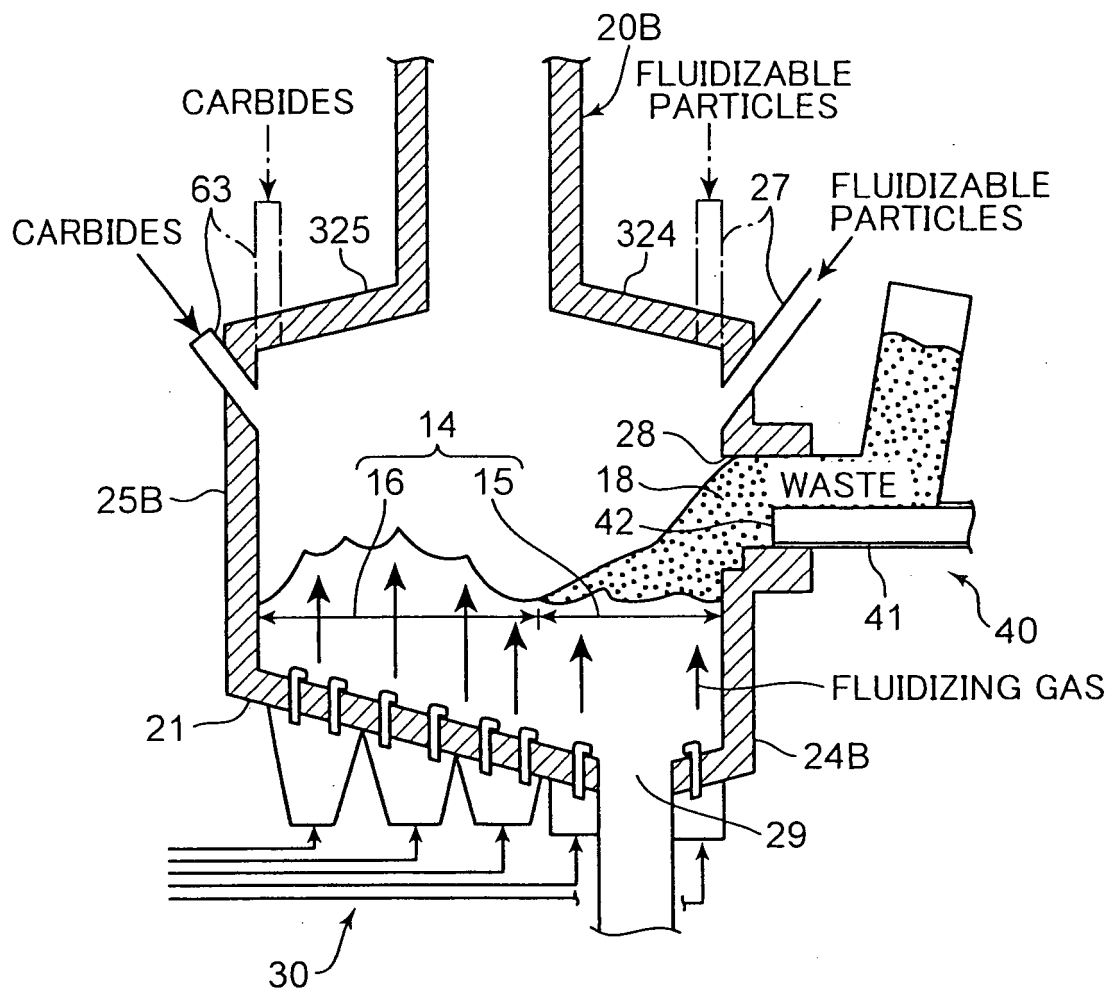


FIG.6



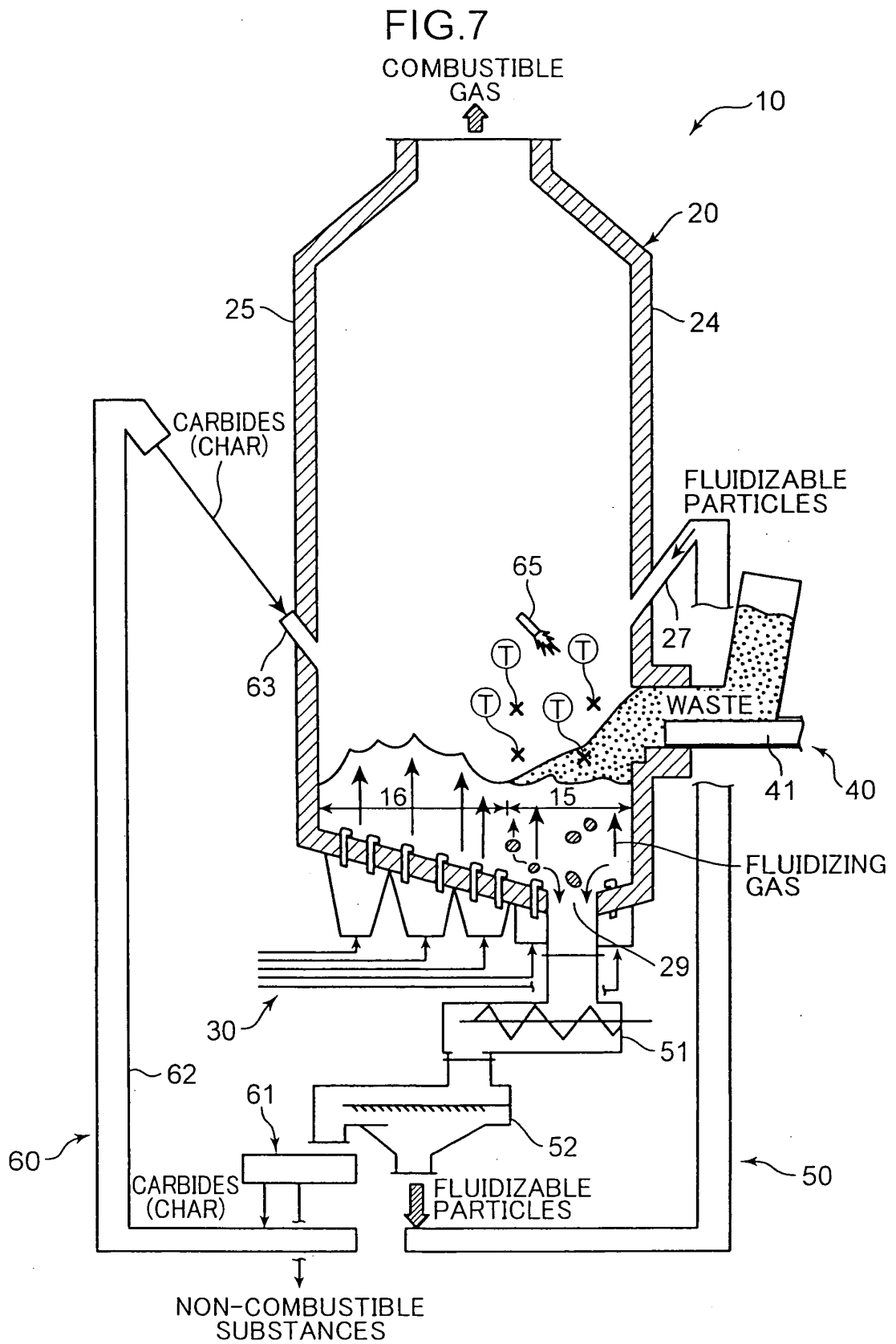


FIG.8A

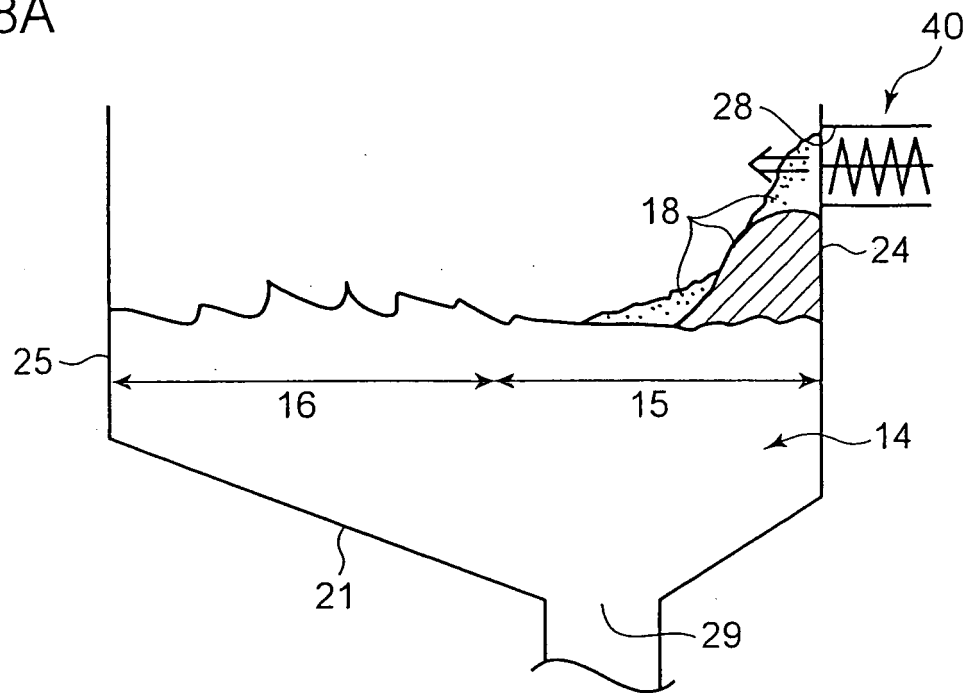


FIG.8B

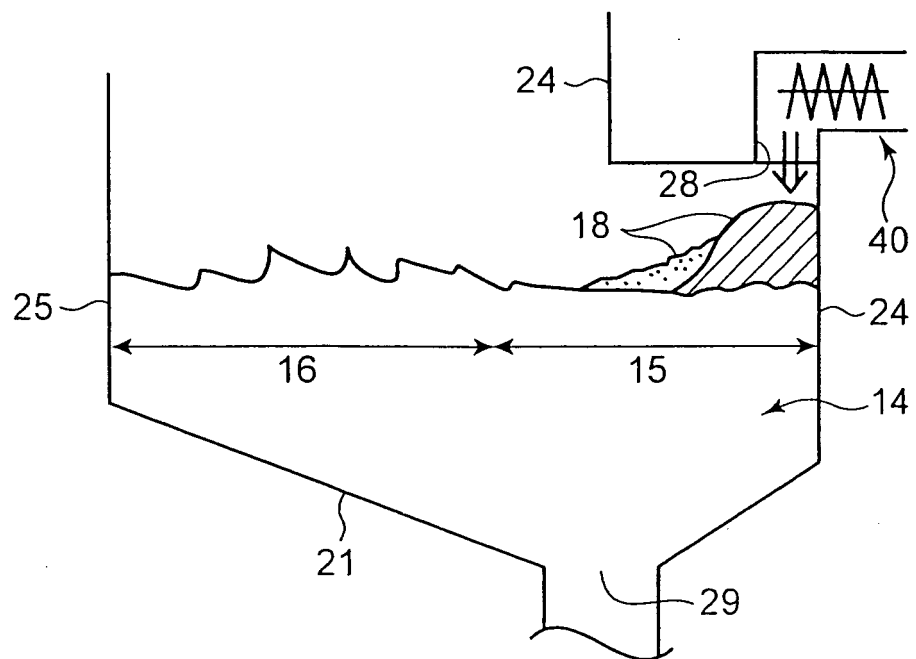
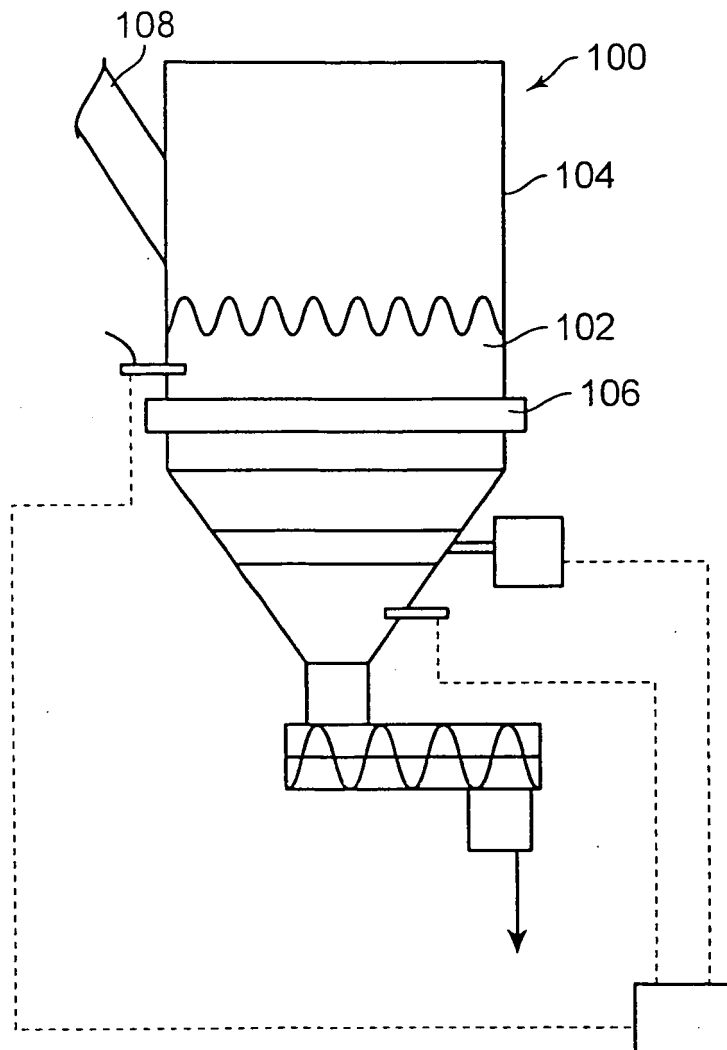


FIG.9



REFERENCES CITED IN THE DESCRIPTION

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