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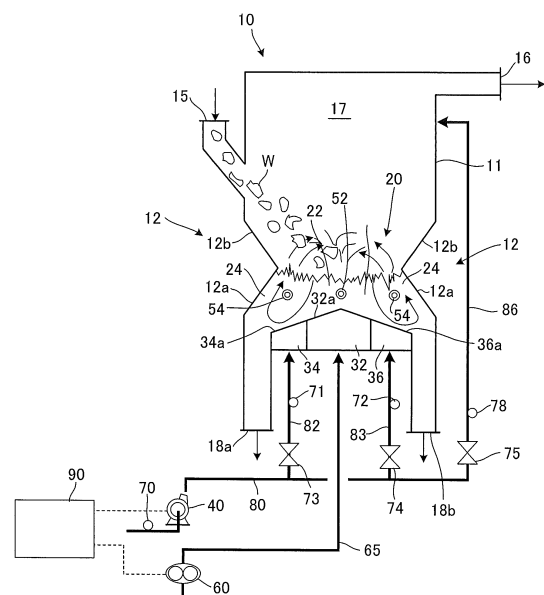
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(54) **SWIRLING TYPE FLUIDIZED BED FURNACE**

(57) Provided is a swirling type fluidized bed furnace capable of supplying a moving layer with an appropriate air quantity without providing a moving-layer pipe with a flow meter or a damper. A swirling type fluidized bed furnace 10 of the present invention includes a furnace body 11, a moving bed plate 32a supporting a moving layer 22, a first fluidized bed plate 34a and a second fluidized bed plate 36a supporting a fluidized layer 24, a roots blower 60 supplying the moving layer 22 with gas, and a turbo blower 40 supplying the fluidized layer 24 with gas, wherein the roots blower 60 is a volumetric air blower (60).

FIG. 1



Description

[0001] The present invention relates to a swirling type fluidized bed furnace forming a moving layer and a fluidized layer for waste disposal.

[0002] As a device disposing waste while suppressing occurrence of an unburned material, a fluidized bed furnace is known. A fluidized bed furnace dries, pyrolyzes and burns waste thrown into a high-temperature fluid medium such as sand.

[0003] As one of such fluidized bed furnaces, it is known a swirling type fluidized bed furnace forming a moving layer in which a fluid medium such as sand is deposited at a center part of the furnace and a fluidized layer in which a fluid medium flows actively at a peripheral part of the furnace, by supplying the fluid mediums with fluidized gas to make a mass velocity in the peripheral part higher than that in the center part (see Japanese Patent Laid-Open No. 57-124608, for example). In the swirling type fluidized bed furnace, the fluidized air supplied to the moving layer and the fluidized layer causes the fluid medium to descend in the moving layer to a bottom of the fluidized layer in the peripheral part, ascend in the fluidized layer to scatter in an upper part of the fluidized layer, be taken into the moving layer again, and then descend in the moving layer, such that a so-called swirling flow (circulating flow) is generated.

[0004] In a conventional swirling type fluidized bed furnace, in which a furnace bed temperature is generally kept uniform, partial decrease in furnace bed temperature has been considered as a result of an inadequate flow. Therefore, it is known a technique for eliminating a furnace bed temperature differential by increasing fluidized air supplied to a part having a decreased furnace bed temperature (see Japanese Patent Laid-Open No. 2007-113880, for example).

[0005] In a conventional swirling type fluidized bed furnace, furnace bed water pouring has been performed to adjust a furnace bed temperature. If water supplied by the water pouring comes into contact with a high-temperature furnace wall, the furnace wall may be damaged due to a sudden drop in temperature. Therefore, to prevent water from coming into contact with the furnace wall, furnace bed water pouring is performed at a center part of the furnace bed, i.e., a moving layer. Thus, the temperature of the entire furnace bed is adjusted by a fluid medium swirling in the moving layer and a fluidized layer.

[0006] Recently, measures against toxic substances such as dioxin generated by incomplete combustion have been strictly urged. When waste lacking uniformity in quality and quantity such as urban garbage is burned, variation in quality and quantity of waste supplied to an incinerator is large. Thus, variation in combustion quantity is large. It may be difficult to supply oxygen required for combustion appropriately to a fluidized bed furnace. In a swirling type fluidized bed furnace forming a moving layer and a fluidized layer, a fluidized bed needs to be controlled to avoid incomplete combustion. Accordingly,

a technique for stable combustion of waste lacking uniformity in quality and quantity such as urban garbage is known (see International Publication No. WO2012/066802). Specifically, in the technique, a moving layer and a fluidized layer are controlled to have respective optimum temperatures, drying and gasifying of waste in the moving layer are performed slowly, waste from which volatilized materials have volatilized (unburned material) is burned in the fluidized layer, a fluid medium is heated, and thus, an appropriate temperature is maintained for securing a heat source for the moving layer.

[0007] Further, when waste lacking uniformity in quality and quantity such as urban garbage is burned as described above, occurrence of large variation in combustion quantity may cause a temporal sudden increase in combustion quantity. For such case, it is known a technique for controlling a combustion quantity by part of fluidized air being sent to a freeboard of an incinerator (see Japanese Patent Laid-Open No. 11-94225).

[0008] An example of a configuration of a swirling type fluidized bed furnace applying the aforementioned conventional techniques will be described. FIG. 5 is a schematic longitudinal sectional front view of a conventional swirling type fluidized bed furnace. As illustrated in FIG. 5, a conventional swirling type fluidized bed furnace 100 includes a furnace body 110 disposing waste. In the furnace body 110, a fluidized bed 120 including a fluid medium such as sand is formed. The fluidized bed 120 flows with air from a turbo blower 140, which will be described later. Thus, a moving layer 122 in which a fluid medium moves downward is formed at a center part of the fluidized bed 120. Fluidized layers 124 in which a fluid medium moves upward are formed at both sides of the fluidized bed 120.

[0009] The swirling type fluidized bed furnace 100 further includes a moving-layer wind box 132 supplying the moving layer 122 with air, a first fluidized-layer wind box 134 and a second fluidized-layer wind box 136 supplying the fluidized layers 124 with air, a moving-layer thermometer 152 measuring a temperature of the moving layer 122, two fluidized-layer thermometers 154 measuring temperatures of the fluidized layers 124, and the turbo blower 140 supplying the moving layer 122 and the fluidized layers 124 with air for fluidization and combustion.

[0010] The both side walls of the furnace body 110 have dents 112 formed to reduce the width of the furnace body 110. The dent 112 includes an inclined wall 112a formed of the side wall of the furnace body 110 inclined upward in an inside direction of the furnace body 110 and an expanded wall 112b that is disposed at an upper end of the inclined wall 112a and is inclined to expand to an outside upward. Inside the furnace body 110, a freeboard 117 that is a space above the fluidized bed 120 is formed.

[0011] The furnace body 110 includes a throw-in port 115 from which waste is supplied, an exhaust port 116 from which exhaust gas etc. generated by thermal reaction of waste is emitted, and a pair of incombustible-material paths 118a and 118b from which incombustible ma-

materials included in waste are extracted. The throw-in port 115, which is disposed on a furnace wall above the upper end of the expanded wall 112b, guides thrown waste to drop the waste onto the moving layer 122. The exhaust port 116, which is formed at an upper part of the furnace body 110, emits exhaust gas etc. generated in the furnace to the outside. The incombustible-material paths 118a and 118b are formed to extend downward at respective lower parts of the inclined walls 112a.

[0012] The moving-layer wind box 132 is disposed at a bottom center of the furnace body 110 between the incombustible-material paths 118a and 118b. At the both sides of the moving-layer wind box 132, the first fluidized-layer wind box 134 and the second fluidized-layer wind box 136 are disposed. On the upper face of the moving-layer wind box 132, a moving bed plate 132a supporting the moving layer 122 is formed. On the upper faces of the first fluidized-layer wind box 134 and the second fluidized-layer wind box 136, a first fluidized bed plate 134a and a second fluidized bed plate 136a supporting the fluidized layers 124 are respectively formed.

[0013] The moving bed plate 132a is formed in a ridged shape having a height being highest at a center and lowering toward both side edges thereof. The first fluidized bed plate 134a and the second fluidized bed plate 136a are inclined at an inclined angle substantially same as that of the moving bed plate 132a such that the ends of the ridge-shaped moving bed plate 132a are extended. Diffusion nozzles (not illustrated) for injecting air having been supplied to the corresponding wind boxes into the furnace are disposed at the moving bed plate 132a, the first fluidized bed plate 134a and the second fluidized bed plate 136a.

[0014] The swirling type fluidized bed furnace 100 includes a total air flow meter 170 measuring a quantity of air supplied by the turbo blower 140, a connecting pipe 180 through which air passes from the turbo blower 140, a moving-layer pipe 184 having one end connected to the connecting pipe 180 and the other end connected to the moving-layer wind box 132, a first fluidized-layer pipe 182 having one end connected to the connecting pipe 180 and the other end connected to the first fluidized-layer wind box 134, a second fluidized-layer pipe 183 having one end connected to the connecting pipe 180 and the other end connected to the second fluidized-layer wind box 136, and a freeboard pipe 186 having one end connected to the connecting pipe 180 and the other end connected to the freeboard 117 of the furnace body 110.

[0015] The moving-layer pipe 184 includes a moving-layer air quantity adjusting damper 176 adjusting a quantity of air passing through the moving-layer pipe 184 and a moving-layer air flow meter 172 measuring a quantity of air passing through the moving-layer pipe 184. The first fluidized-layer pipe 182 includes a first fluidized-layer air quantity adjusting damper 175 adjusting a quantity of air passing through the first fluidized-layer pipe 182 and a first fluidized-layer air flow meter 171 measuring a quantity of air passing through the first fluidized-layer

pipe 182. The second fluidized-layer pipe 183 includes a second fluidized-layer air quantity adjusting damper 177 adjusting a quantity of air passing through the second fluidized-layer pipe 183 and a second fluidized-layer air flow meter 173 measuring a quantity of air passing through the second fluidized-layer pipe 183. The freeboard pipe 186 includes a freeboard air quantity adjusting damper 179 adjusting a quantity of air passing through the freeboard pipe 186 and a freeboard air flow meter 178 measuring a quantity of air passing through the freeboard pipe 186.

[0016] Air supplied by the turbo blower 140 is passed through the connecting pipe 180 and is branched into the moving-layer pipe 184, the first fluidized-layer pipe 182 and the second fluidized-layer pipe 183. The flows of air supplied to the moving-layer pipe 184, the first fluidized-layer pipe 182 and the second fluidized-layer pipe 183 are adjusted by adjustment of openings of the moving-layer air quantity adjusting damper 176, the first fluidized-layer air quantity adjusting damper 175 and the second fluidized-layer air quantity adjusting damper 177, respectively. The adjusted air is supplied to the moving-layer wind box 132, the first fluidized-layer wind box 134 and the second fluidized-layer wind box 136. From the non-illustrated diffusion nozzle at the moving bed plate 132a, fluidized air is injected to provide the moving layer 122 with a relatively small fluidization velocity. From the non-illustrated diffusion nozzles at the first fluidized bed plate 134a and the second fluidized bed plate 136a, fluidized air is injected to provide the fluidized layers 124 with a relatively large fluidization velocity. In this way, the moving layer 122 in which a flowing fluid medium moves downward at a relatively low velocity is formed above the moving bed plate 132a, while the respective fluidized layers 124 in which a flowing fluid medium moves upward are formed above the first fluidized bed plate 134a and the second fluidized bed plate 136a.

[0017] Therefore, in the lower part of the fluidized bed 120, a fluid medium moves from the moving layer 122 to the fluidized layers 124. In the upper part of the fluidized bed 120, a fluid medium moves from the fluidized layers 124 to the moving layer 122. Thus, a circulating flow (swirling flow) caused by a fluid medium circulating between the moving layer 122 and the fluidized layer 124 is formed at each side of the fluidized bed 120.

[0018] An effective way to avoid incomplete combustion is to reduce a fluidized air quantity to a moving layer for suppression of fluidization and to dry and gasify waste slowly. To maintain a fluidized bed temperature, unburned materials need to be burned in the fluidized layers to heat a fluid medium. An effective way in a case of sudden increase in combustion quantity is to supply a freeboard with part of fluidized air, to suppress thermal reaction in the fluidized bed, and to supply the freeboard with air required for combustion.

[0019] However, the conventional swirling type fluidized bed furnace 100 illustrated in FIG. 5 includes the single turbo blower 140 as a device for supplying fluidized

air. If quantities of air to be supplied to the moving layer 122 and the fluidized layer 124 are adjusted separately, such adjustment cannot be performed only by adjustment of the output of the turbo blower 140. Specifically, as the output of the turbo blower 140 is adjusted for adjustment of the quantity of air to the moving layer 122, the quantity of air to the fluidized layers 124 is also varied.

[0020] If the fluidized-layer air quantity adjusting dampers 175 and 177 are opened to increase the quantity of air supplied to the fluidized layers 124, the quantity of air supplied to the moving layer 122 is decreased. An inadequate flow may occur in the moving layer 122 which suppresses the air supply. Further, if the combustion quantity suddenly increases and the freeboard air quantity adjusting damper 179 is opened to supply the freeboard 117 with fluidized air, pressure loss at the discharge side decreases. Due to the characteristic of the turbo blower 140, the discharged air quantity increases, while the quantities of fluidized air to be supplied to the moving layer 122 and the fluidized layers 124 decrease. Thus, an inadequate flow may occur in the moving layer 122.

[0021] Air discharged from the turbo blower 140 is passed through the connecting pipe 180 and is branched to the moving-layer pipe 184, the first fluidized-layer pipe 182 and the second fluidized-layer pipe 183. The moving-layer pipe 184, the first fluidized-layer pipe 182 and the second fluidized-layer pipe 183 are branched such that the total of the pressure losses at the respective pipes, air flow adjusting dampers, diffusion nozzles and the fluidized bed is left approximately same. The respective pressure losses at the respective pipes, air flow adjusting dampers and diffusion nozzles are approximately proportional to the square of the flow. The pressure loss at the fluidized bed 120 is proportional to the layer height and is constant with any flow. That is, since the pressure loss at the fluidized bed 120 in the moving layer 122 having a lower sand height is smaller than that in the fluidized layer 124 having a higher sand height, the pressure losses at the pipe, the air flow adjusting damper and the diffusion nozzle in the moving layer 122 are made larger. If the output adjustment of the turbo blower 140 reduces the discharged air quantity, the pressure losses at the pipe, the air flow adjusting damper and the diffusion nozzle become small. Thus, the quantity of air to the moving layer 122 having a lower sand height increases to balance with the difference between the pressure losses in the sand layers.

[0022] In this way, if adjustment of the output of the turbo blower 140 reduces the discharged air quantity, more air tends to flow into the moving layer 122. If such adjustment increases the discharged flow, more air tends to flow into the fluidized layers 124. In any case, the ratio between the quantity of air to the moving layer 122 and the quantity of air to the fluidized layers 124 becomes unstable. The swirling flow of a fluid medium is not appropriately maintained. Thus, it may be difficult to emit incombustible materials included in waste such as large-

sized metals from the fluidized bed 120.

[0023] In this way, if the turbo blower 140, which is a turbo-type air blower, supplies the moving layer 122 with a relatively small quantity of air, it may be difficult to supply the moving layer 122 with a desired quantity of air by adjusting the openings of the first fluidized-layer air quantity adjusting damper 175 and the second fluidized-layer air quantity adjusting damper 177 or operating the freeboard air quantity adjusting damper 179. The term "turbo-type air blower" means an air blower that sends pressured gas by rotating an impeller etc. and generating kinetic energy.

[0024] To measure a flow of air to be supplied to the moving layer 122 and control the flow with the moving-layer air quantity adjusting damper 176, the moving-layer air flow meter 172 illustrated in FIG. 5 is needed. However, for accurate measurement of the flow with a flow meter, the length of a straight part of the moving-layer pipe 184 needs to be not less than substantially five times as long as a diameter of the pipe. There is a problem that the arrangement of the moving-layer pipe 184 has a limit, accordingly. The flow of air supplied to the moving layer 122 is relatively small. To secure a led pressure required for measurement by the small flow, an orifice with a short hole diameter needs to be provided to the moving-layer pipe 184. If such orifice is provided to the moving-layer pipe 184, there is a problem that a limit of a maximum flow of air passing through the moving-layer pipe 184 is given.

[0025] At the time of start-up after regular inspection (cold-start), for example, when the fluidized bed temperature is cooled to a normal temperature, a minimum quantity of fluidized air required for fluidizing a fluid medium increases, since the lower temperature decreases viscosity of air more. In setting an orifice, to secure the fluidized air quantity at the start-up, measures such as selecting a larger hole diameter of the orifice at the sacrifice of accuracy of flow measurement or providing a bypass pipe at an orifice set position are needed.

[0026] The present invention has been made in view of the aforementioned problems. The object of the present invention is to provide a swirling type fluidized bed furnace capable of supplying a moving layer with an appropriate quantity of air without fail with no flow meter or damper provided to a moving-layer pipe.

[0027] To achieve the aforementioned object, a swirling type fluidized bed furnace of a first aspect of the present invention comprises: a furnace body; a moving bed plate disposed at a bottom of the furnace body, the moving bed plate supporting a moving layer; a fluidized bed plate disposed at the bottom of the furnace body, the fluidized bed plate supporting a fluidized layer; a moving-layer gas supplying mechanism supplying the moving layer with gas; and a fluidized-layer gas supplying mechanism supplying the fluidized layer with gas, wherein the moving-layer gas supplying mechanism has a volumetric air blower.

[0028] To achieve the aforementioned object, a swirl-

ing type fluidized bed furnace of a second aspect of the present invention is the swirling type fluidized bed furnace of the first aspect further comprising: a moving-layer temperature measuring section measuring a temperature of the moving layer; and a control section controlling a rotation speed of the volumetric air blower in accordance with the measured temperature of the moving layer.

[0029] To achieve the aforementioned object, a swirling type fluidized bed furnace of a third aspect of the present invention is the swirling type fluidized bed furnace of the first or second aspect in which the fluidized-layer gas supplying mechanism contains a volumetric air blower.

[0030] To achieve the aforementioned object, a swirling type fluidized bed furnace of a fourth aspect of the present invention is the swirling type fluidized bed furnace of any one of the first to third aspects in which the fluidized bed plate has a first fluidized bed plate and a second fluidized bed plate, and the fluidized-layer gas supplying mechanism has a first volumetric air blower supplying gas to the fluidized layer supported by the first fluidized bed plate and a second volumetric air blower supplying gas to the fluidized layer supported by the second fluidized bed plate.

[0031] To achieve the aforementioned object, a swirling type fluidized bed furnace of a fifth aspect of the present invention is the swirling type fluidized bed furnace of the fourth aspect further comprising: a first freeboard pipe connecting the first volumetric air blower with a freeboard of the furnace body; a first freeboard flow rate adjusting section adjusting a flow rate of gas supplied from the first volumetric air blower to the freeboard, the first freeboard flow rate adjusting section being disposed at the first freeboard pipe; a second freeboard pipe connecting the second volumetric air blower with the freeboard; and a second freeboard flow rate adjusting section adjusting a flow rate of gas supplied from the second volumetric air blower to the freeboard, the second freeboard flow rate adjusting section being disposed at the second freeboard pipe.

[0032] To achieve the aforementioned object, a swirling type fluidized bed furnace of a sixth aspect of the present invention is the swirling type fluidized bed furnace of the first or second aspect in which the fluidized bed plate has a first fluidized bed plate and a second fluidized bed plate, and the swirling type fluidized bed furnace further comprises: a first fluidized-layer pipe supplying gas from the fluidized-layer gas supplying mechanism to the fluidized layer supported by the first fluidized bed plate; a first fluidized-layer flow rate adjusting section adjusting a flow rate of the gas supplied from the fluidized-layer gas supplying mechanism to the fluidized layer supported by the first fluidized bed plate, the first fluidized-layer flow rate adjusting section being disposed at the first fluidized-layer pipe; a second fluidized-layer pipe supplying gas from the fluidized-layer gas supplying mechanism to the fluidized layer supported by the second fluidized bed plate; and a second fluidized-layer flow rate

adjusting section adjusting a flow rate of the gas supplied from the fluidized-layer gas supplying mechanism to the fluidized layer supported by the second fluidized bed plate, the second fluidized-layer flow rate adjusting section being disposed at the second fluidized-layer pipe.

[0033] To achieve the aforementioned object, a swirling type fluidized bed furnace of a seventh aspect of the present invention is the swirling type fluidized bed furnace of the sixth aspect further comprising: a first fluidized-layer flow meter measuring a flow of gas having passed through the first fluidized-layer flow rate adjusting section, the first fluidized-layer flow meter being disposed at the first fluidized-layer pipe; and a second fluidized-layer flow meter measuring a flow of gas having passed through the second fluidized-layer flow rate adjusting section, the second fluidized-layer flow meter being disposed at the second fluidized-layer pipe.

[0034] To achieve the aforementioned object, a swirling type fluidized bed furnace of an eighth aspect of the present invention is the swirling type fluidized bed furnace of the sixth or seventh aspect further comprising: a freeboard pipe supplying gas from the fluidized-layer gas supplying mechanism to the freeboard of the furnace body; and a freeboard flow rate adjusting section adjusting a flow rate of the gas supplied from the fluidized-layer gas supplying mechanism to the freeboard, the freeboard flow rate adjusting section being disposed on the freeboard pipe.

[0035] To achieve the aforementioned object, a swirling type fluidized bed furnace of a ninth aspect of the present invention is the swirling type fluidized bed furnace of any one of the sixth to eighth aspect in which the fluidized-layer gas supplying mechanism includes a turbo-type air blower.

[0036] To achieve the aforementioned object, a swirling type fluidized bed furnace of a tenth aspect of the present invention is the swirling type fluidized bed furnace of any one of the first to ninth aspect further comprising a water pouring section performing furnace bed water pouring of the fluidized layer.

[0037] To achieve the aforementioned object, a swirling type fluidized bed furnace of an eleventh aspect of the present invention comprises: a furnace body; a first bed plate disposed at a bottom of the furnace body; a second bed plate disposed at the bottom of the furnace body; a first gas supplying mechanism configured to supply an inside of the furnace body with gas through the first bed plate; and a second gas supplying mechanism configured to supply the furnace body with gas a flow of which is larger than a flow of gas supplied by the first gas supplying mechanism, through the second bed plate, wherein the first gas supplying mechanism has a volumetric air blower.

[0038] The present invention provides a swirling type fluidized bed furnace capable of supplying a moving layer with an appropriate quantity of air without providing a moving-layer pipe with a flow meter or a damper.

FIG. 1 is a schematic longitudinal sectional front view of a swirling type fluidized bed furnace of a first embodiment;

FIG. 2 is a schematic longitudinal sectional front view of a swirling type fluidized bed furnace of a second embodiment;

FIG. 3 is a schematic longitudinal sectional front view of a swirling type fluidized bed furnace of a third embodiment;

FIG. 4 is a schematic longitudinal sectional front view of a swirling type fluidized bed furnace of a fourth embodiment; and

FIG. 5 is a schematic longitudinal sectional front view of a conventional swirling type fluidized bed furnace.

[0039] Hereinafter, descriptions will be given of embodiments of the present invention with reference to the drawings. In the drawings described below, a same or corresponding component will be denoted by the same reference numerals, and the description thereof will be omitted.

<First embodiment>

[0040] FIG. 1 is a schematic longitudinal sectional front view of a swirling type fluidized bed furnace of a first embodiment of the present invention. As illustrated in FIG. 1, a swirling type fluidized bed furnace 10 of the first embodiment includes a furnace body 11 disposing waste W. Inside the furnace body 11, a fluidized bed 20 formed of a fluid medium such as sand is formed. The fluidized bed 20 flows with air from a turbo blower 40 and a roots blower 60, which will be described later. Thus, a moving layer 22 in which a fluid medium flows and moves downward is formed at a center part of the fluidized bed 20. Fluidized layers 24 in which a fluid medium flows and moves upward are formed at both sides of the fluidized bed 20.

[0041] The swirling type fluidized bed furnace 10 further includes a moving-layer wind box 32 supplying the moving layer 22 with air, a first fluidized-layer wind box 34 and a second fluidized-layer wind box 36 supplying the fluidized layers 24 with air, a moving-layer thermometer 52 measuring a temperature of the moving layer 22, two fluidized-layer thermometers 54 measuring temperatures of the fluidized layers 24, the roots blower 60 (moving-layer gas supplying mechanism) supplying the moving layer 22 with gas (for example, air) for fluidization and combustion, and the turbo blower 40 (fluidized-layer gas supplying mechanism) supplying the fluidized layers 24 with air for fluidization and combustion.

[0042] Each both side wall of the furnace body 11 has a dent 12 formed to reduce the width of the furnace body 11. The dent 12 includes an inclined wall 12a formed of the side wall of the furnace body 11 inclined upward in an inside direction of the furnace body 11 and an expanded wall 12b that is disposed at an upper end of the inclined wall 12a and is inclined to expand to an outside upward:

Inside the furnace body 11, a freeboard 17 that is a space above the moving layer 22 and the fluidized layers 24 is formed.

[0043] The furnace body 11 includes a throw-in port 15 from which the waste W is supplied, an exhaust port 16 from which combustion exhaust gas etc. generated by thermal reaction of the waste W is emitted, and a pair of incombustible-material paths 18a and 18b from which incombustible materials included in the waste W are extracted. The throw-in port 15, which is disposed on a furnace wall above the upper end of the expanded wall 12b, guides the thrown waste W to drop the waste W onto the fluidized bed 20. The exhaust port 16, which is formed at an upper part of the furnace body 11, emits combustion exhaust gas etc. generated in the furnace to the outside. The incombustible-material paths 18a and 18b are formed to extend downward at respective lower parts of the inclined walls 12a. The throw-in port 15 only has to guide the thrown waste W to drop the waste W onto the moving layer 22 at the center of the fluidized bed 20. The position of the throw-in port 15 is not limited to the one in the first embodiment. That is, the throw-in port 15 may be disposed at any position in the vicinity of the side wall of the furnace body 11.

[0044] A moving-layer wind box 32 is disposed at the bottom center of the furnace body 11 between the incombustible-material paths 18a and 18b. At the respective both sides of the moving-layer wind box 32, a first fluidized-layer wind box 34 and a second fluidized-layer wind box 36 are disposed. At an upper face of the moving-layer wind box 32, a moving bed plate 32a (first bed plate) supporting the moving layer 22 is formed. At upper faces of the first fluidized-layer wind box 34 and the second fluidized-layer wind box 36, a first fluidized bed plate 34a (second bed plate) and a second fluidized bed plate 36a (second bed plate) supporting the fluidized layers 24 are respectively formed.

[0045] The moving bed plate 32a is formed in a ridged shape having a height being highest at a center and lowering toward both side edges thereof. The first fluidized bed plate 34a and the second fluidized bed plate 36a are inclined at an inclined angle substantially same as that of the moving bed plate 32a such that the ends of the ridge-shaped moving bed plate 32a are extended. Diffusion nozzles (not illustrated) for injecting air supplied to the corresponding wind boxes into the furnace are disposed at the moving bed plate 32a, the first fluidized bed plate 34a and the second fluidized bed plate 36a.

[0046] The swirling type fluidized bed furnace 10 further includes a connecting pipe 80 through which air passes from the turbo blower 40, a first fluidized-layer pipe 82 having one end connected to the connecting pipe 80 and the other end connected to the first fluidized-layer wind box 34, a second fluidized-layer pipe 83 having one end connected to the connecting pipe 80 and the other end connected to the second fluidized-layer wind box 36, and a freeboard pipe 86 having one end connected to the connecting pipe 80 and the other end connected to

the freeboard 17 of the furnace body 11. The swirling type fluidized bed furnace 10 further includes a moving-layer pipe 65 having one end connected to the roots blower 60 and the other end connected to the moving-layer wind box 32. The moving-layer pipe 65 transfers air supplied from the roots blower 60 to the moving-layer wind box 32.

[0047] The first fluidized-layer pipe 82 includes a first fluidized-layer air quantity adjusting damper 73 (first fluidized-layer flow rate adjusting section) adjusting a quantity of air passing through the first fluidized-layer pipe 82 and a first fluidized-layer air flow meter 71 (first fluidized-layer flow meter) measuring the quantity of air passing through the first fluidized-layer pipe 82. The second fluidized-layer pipe 83 includes a second fluidized-layer air quantity adjusting damper 74 (second fluidized-layer flow rate adjusting section) adjusting a quantity of air passing through the second fluidized-layer pipe 83 and a second fluidized-layer air flow meter 72 (second fluidized-layer flow meter) measuring the quantity of air passing through the second fluidized-layer pipe 83. The freeboard pipe 86 includes a freeboard air quantity adjusting damper 75 adjusting a quantity of air passing through the freeboard pipe 86 and a freeboard air flow meter 78 measuring the quantity of air passing through the freeboard pipe 86. A suction side of the turbo blower 40 is provided with a fluidized-layer air flow meter 70 measuring a total flow of air supplied from the turbo blower 40.

[0048] The swirling type fluidized bed furnace 10 can communicate with the first fluidized-layer air quantity adjusting damper 73, the second fluidized-layer air quantity adjusting damper 74, the freeboard air quantity adjusting damper 75, the turbo blower 40 and the roots blower 60. Further, the swirling type fluidized bed furnace 10 includes a control section 90 that can control the respective dampers and blowers to drive. The control section 90 can receive a temperature signal from the moving-layer thermometer 52 and the fluidized-layer thermometer 54. Further, the control section 90 can receive a flow signal from the first fluidized-layer air flow meter 71 and the second fluidized-layer air flow meter 72.

[0049] Air supplied from the turbo blower 40 is passed through the connecting pipe 80 and is branched to the first fluidized-layer pipe 82 and the second fluidized-layer pipe 83. Flows of the air supplied to the first fluidized-layer pipe 82 and the second fluidized-layer pipe 83 are adjusted by adjustment of openings of the first fluidized-layer air quantity adjusting damper 73 and the second fluidized-layer air quantity adjusting damper 74, respectively. The adjusted air is supplied to the first fluidized-layer wind box 34 and the second fluidized-layer wind box 36. The flows of the air passing through the first fluidized-layer pipe 82 and the second fluidized-layer pipe 83 are measured by the first fluidized-layer air flow meter 71 and the second fluidized-layer air flow meter 72, respectively.

[0050] The control section 90 adjusts the openings of the first fluidized-layer air quantity adjusting damper 73

and the second fluidized-layer air quantity adjusting damper 74, and thus, adjusts the flows of air passing through the first fluidized-layer pipe 82 and the second fluidized-layer pipe 83, respectively, that is, flows of air introduced to the fluidized layers 24. The respective openings of the first fluidized-layer air quantity adjusting damper 73 and the second fluidized-layer air quantity adjusting damper 74 are controlled in accordance with the temperature of the fluidized layers 24 measured by the fluidized-layer thermometer 54. In other words, if the temperature of the fluidized layers 24 sent by the fluidized-layer thermometer 54 is higher than a target temperature, the control section 90 makes the openings of the first fluidized-layer air quantity adjusting damper 73 and the second fluidized-layer air quantity adjusting damper 74 small to reduce a combustion quantity in the fluidized layers 24. If the temperature of the fluidized layers 24 sent by the fluidized-layer thermometer 54 is lower than the target temperature, the control section 90 makes the openings of the first fluidized-layer air quantity adjusting damper 73 and the second fluidized-layer air quantity adjusting damper 74 large to increase the combustion quantity in the fluidized layers 24. As the rotation speed of the turbo blower 40 is lowered, discharge pressures from the respective non-illustrated diffusion nozzles of the first fluidized bed plate 34a and the second fluidized bed plate 36a are lowered, whereby no air may be discharged from the diffusion nozzles due to the pressures in the fluidized layers 24. Thus, to maintain an air pressure required to fluidize the fluidized layers 24, the control section 90 maintains the rotation speed of the turbo blower 40 to a predetermined value or more.

[0051] The swirling type fluidized bed furnace 10 may include, for example, an illuminance sensor to detect an illuminance in the furnace. In such case, when the control section 90 receives a signal indicating an illuminance in the furnace from the illuminance sensor and the illuminance in the furnace is a predetermined value or more, that is, when the combustion quantity in the furnace suddenly increases, the control section 90 can bypass air from the turbo blower 40 to the freeboard 17 by making the opening of the freeboard air quantity adjusting damper 75 large temporarily. As a result, temporary reduction in quantity of air to be supplied to the fluidized layer 24 to reduce the combustion quantity in the fluidized layer 24 and increase in air for combustion to be supplied to the freeboard 17 can be achieved. When the illuminance in the furnace is lower than the predetermined value, that is, when the combustion quantity in the furnace is appropriate, the control section 90 makes the opening of the freeboard air quantity adjusting damper 75 minimum, and adjusts the respective openings of the first fluidized-layer air quantity adjusting damper 73 and the second fluidized-layer air quantity adjusting damper 74 so that the quantity of air to be supplied to the fluidized layer 24 is controlled.

[0052] The control section 90 controls a rotation speed of the roots blower 60 in accordance with the temperature

of the moving layer 22 detected by the moving-layer thermometer 52. Specifically, if the temperature of the moving layer 22 is higher than a target temperature, the control section 90 reduces the rotation speed of the roots blower 60 within a predetermined range to decrease a quantity of fluidized air to be supplied to the moving layer 22. In contrast, if the temperature of the moving layer 22 is lower than the target temperature, the control section 90 raises the rotation speed of the roots blower 60 within the predetermined range to increase the quantity of fluidized air to be supplied to the moving layer 22.

[0053] The roots blower 60 is a volumetric air blower to send a constant volume of gas. The quantity of air supplied by the roots blower 60 is determined by the rotation speed of the roots blower 60. Specifically, the quantity of air discharged from the non-illustrated diffusion nozzle of the moving bed plate 32a is determined based on the rotation speed of the roots blower 60 irrespective of the discharge pressure. Thus, the moving-layer pipe 65 can supply the moving layer 22 with a desired air quantity by controlling the rotation speed, without requiring a damper adjusting a flow rate or a flow meter measuring a flow. The term "volumetric air blower" means an air blower that sends pressured gas by volume change due to expansion/shrinkage of a space formed of a piston, a cylinder etc.

[0054] To burn the waste W in the swirling type fluidized bed furnace 10, first, the waste W is supplied from the throw-in port 15 to the moving layer 22. At that time, the control section 90 controls the roots blower 60 to provide the moving layer 22 with a relatively small fluidization velocity from the non-illustrated diffusion nozzle disposed at the moving bed plate 32a (to supply a relatively small flow of gas). Further, the control section 90 controls the turbo blower 40 to provide the fluidized layers 24 with a relatively large fluidization velocity from the non-illustrated respective diffusion nozzles at the first fluidized bed plate 34a and the second fluidized bed plate 36a (to supply a relatively large flow of gas). Thus, above the moving bed plate 32a, the moving layer 22 in which a fluid medium flows and moves downward relatively slowly is formed. Above the first fluidized bed plate 34a and the second fluidized bed plate 36a, the respective fluidized layers 24 in which a fluid medium flows and moves upward are formed:

[0055] The quantity of fluidized air to be supplied to the moving layer 22 is preferably set to a range from 200m^3 (NTP)/h/m² to 600m^3 (NTP) /h/m², and more preferably to a range from 250m^3 (NTP) /h/m² to 400m^3 (NTP)/h/m². The quantity of fluidized air to be supplied to the fluidized layers 24 is preferably set to a range from 400m^3 (NTP)/h/m² to 1200m^3 (NTP)/h/m², and more preferably to a range from 500m^3 (NTP) /h/m² to 1000m^3 (NTP)/h/m².

[0056] Accordingly, in the lower part of the fluidized bed 20, inclinations of the moving bed plate 32a, the first fluidized bed plate 34a and the second fluidized bed plate 36a cause a fluid medium to move from the moving layer

22 to the fluidized layer 24. In the upper part of the fluidized bed 20, the inclined wall 12a serving as a deflector causes a fluid medium to move from the fluidized layer 24 to the moving layer 22. Thus, a circulating flow (swirling flow) caused by a fluid medium circulating between the moving layer 22 and the fluidized layer 24 is formed at each side of the fluidized bed 20.

[0057] The waste W having been supplied to the moving layer 22 is taken into a fluid medium and moved downward in the moving layer 22 along with the fluid medium. At that time, the supplied waste W is dried and pyrolyzed by heat of the fluid medium so that combustion exhaust gas etc. is generated from combustible materials included in the waste W. As a result, a brittle pyrolyzed residue is generated. A typical pyrolyzed residue includes an incombustible material and an unburned material (char) that is made brittle by the pyrolyzation. The pyrolyzed residue generated in the moving layer 22 reaches the moving bed plate 32a along with the flow of the fluid medium, and then moves to the fluidized layer 24 along the inclined moving bed plate 32a. The pyrolyzed residue having reached the fluidized layer 24 contacts with a violently flowing fluid medium, and an unburned material is separated from the pyrolyzed residue. The remaining incombustible material after the separation of the unburned material from the pyrolyzed residue is emitted from the incombustible-material paths 18a and 18b along with part of fluid mediums.

[0058] The unburned material separated from the pyrolyzed residue moves upward in the fluidized layer 24 along with a fluid medium. At that time, the unburned material is burned by supplied fluidized air to heat the fluid medium and to generate combustion exhaust gas, incombustible gas and the like. Thus, the unburned material becomes fine unburned materials and ash particles. The high-temperature fluid medium having moved to the upper part of the fluidized layer 24 flows into the moving layer 22. In the fluidized layer 24, the temperature of the fluid medium increases to such a high temperature to pyrolyze the waste W appropriately. The fluid medium having flowed into the moving layer 22 takes waste W again to repeat the aforementioned thermal reaction in the moving layer 22 and the fluidized layers 24.

[0059] If the waste W lacks uniformity in quality and quantity such as urban garbage, variation in quality and quantity of the waste W to be supplied to the swirling type fluidized bed furnace 10 is large. Thus, variation in combustion quantity is large. It may be difficult to supply appropriately oxygen required for combustion to the fluidized bed 20. For this reason, in the swirling type fluidized bed furnace 10 of the present embodiment, unburned materials are burned in the fluidized layers 24 to maintain an appropriate temperature for a heat source of the moving layer 22. The waste W is disposed slowly in the moving layer 22. Thus, even the waste W lacking uniformity in quality and quantity such as urban garbage can be burned stably.

[0060] In the swirling type fluidized bed furnace 10 of

the present embodiment, to dry and pyrolyze the waste W in the fluidized bed 20 slowly, the roots blower 60 is controlled to obtain the temperature of the moving layer 22 of 500 to 560°C while the turbo blower 40 is controlled to obtain the temperature of the fluidized layers 24 of 520 to 580°C.

[0061] To control the temperatures of the moving layer 22 and the fluidized layers 24 to such a low temperature as described above, not only control of the roots blower 60 and the turbo blower 40 but also furnace bed water pouring may be needed. However, if water is poured to the furnace bed in the relatively low-temperature moving layer 22, extreme decrease in temperature of the moving layer 22 may make the recovery difficult. Thus, the swirling type fluidized bed furnace 10 of the present embodiment includes a non-illustrated water pouring nozzle, which pours water to the furnace bed in the fluidized layers 24. Accordingly, the temperature of the moving layer 22 is prevented from decreasing extremely, and the temperatures of the moving layer 22 and the fluidized layers 24 can be maintained appropriately.

[0062] As described above, the swirling type fluidized bed furnace 10 of the first embodiment includes the turbo blower 40 supplying the fluidized layers 24 with air, and the roots blower 60 which is a volumetric air blower supplying the moving layer 22 with gas, i.e., the roots blower 60 supplying the inside of the furnace body 11, through the moving bed plate 32a, with a quantity of gas smaller than that supplied by the turbo blower 40. Thus, the respective quantities of air to be supplied to the moving layer 22 and the fluidized layers 24 can be adjusted separately.

[0063] Since the swirling type fluidized bed furnace 10 of the first embodiment includes the roots blower 60 which is a volumetric air blower supplying the moving layer 22 with gas, the swirling type fluidized bed furnace 10 can supply even a relatively small quantity of air to the moving layer 22 without fail. Thus, a circulating flow of a fluid medium can be formed without fail, incombustible materials can be emitted without fail, the quantity of air can be made minimum to maintain the furnace bed temperature low, and no pressure loss at the damper adjusting an air quantity is generated. Accordingly, a consumption power to supply air can be reduced. As a result, the waste W is slowly dried and gasified. Even if the quality or quantity of the waste W varies, variation in the combustion quantity is suppressed. Variations in furnace exit temperature, furnace pressure and oxygen concentration in exhaust gas are decreased. Thus, stable combustion is performed. The stable combustion results in appropriate control of air supply for combustion even when a ratio of air is lowered. Low air-ratio operation can be performed with the total ratio of air being 1.5 or less. High-efficiency heat recovery with exhaust-gas loss reduced can be performed. Simultaneously, consumption power of a forced draft blower, a secondary blower and an exhaust-gas inducing blower, which occupies most of consumption power in an incineration facility, can be largely

reduced.

[0064] Only adjustment of the rotation speed of the roots blower 60 causes supply of a desired fluidized air to the moving layer 22 without fail. The moving-layer pipe 65 needs to have no flow meter or no damper, no pipe length required for a flow meter measuring an accurate flow needs to be secured, or no orifice securing a dynamic pressure required for flow measurement. Thus, even in a cold-start, air required for fluidization can be easily supplied by increasing the rotation speed of the roots blower 60.

[0065] The swirling type fluidized bed furnace 10 of the first embodiment includes the moving-layer thermometer 52 measuring the temperature of the moving layer 22 and the control section 90 controlling the rotation speed of the roots blower 60 in accordance with the measured temperature of the moving layer 22. Thus, the temperature of the moving layer 22 can be maintained to a target temperature. The roots blower 60 is rotated at the rotation speed controlled by a motor equipped with an inverter.

[0066] In the first embodiment, the single roots blower 60 supplying the moving layer 22 with fluidized air is provided. However, if the swirling type fluidized bed furnace 10 has large processing capacity, the moving-layer wind box 32 may be divided into two at the center. In such case, two roots blowers 60 are provided to correspond to the respective moving-layer wind boxes 32 and also two moving-layer thermometers 52 are set above the respective divided moving-layer wind boxes 32. The respective rotation speeds of the roots blowers 60 are controlled in accordance with the respective temperatures of the moving layer 22 so that the respective temperatures of the moving layer 22 are maintained to the target temperature.

[0067] Air supplied from the turbo blower 40 is passed through the connecting pipe 80 and is branched to the first fluidized-layer pipe 82 and the second fluidized-layer pipe 83. The first fluidized-layer pipe 82 is provided with the first fluidized-layer air quantity adjusting damper 73. The second fluidized-layer pipe 83 is provided with the second fluidized-layer air quantity adjusting damper 74. The quantities of air supplied from the turbo blower 40 to the first fluidized-layer wind box 34 and the second fluidized-layer wind box 36 are relatively large. The sand height in the fluidized layer 24 on the first fluidized bed plate 34a is substantially same as the sand height in the fluidized layer 24 on the second fluidized bed plate 36a. The diffusion nozzle at the first fluidized bed plate 34a and the diffusion nozzle at the second fluidized bed plate 36a have the substantially same condition. Thus, the air quantities to be supplied to the fluidized layers 24 can be adjusted appropriately such that the air quantities in the respective fluidized layers 24 become substantially same.

[0068] Since the first fluidized-layer pipe 82 is provided with the first fluidized-layer air flow meter 71 and the second fluidized-layer pipe 83 is provided with the second fluidized-layer air flow meter 72, the respective quantities

of air supplied to the first fluidized-layer wind box 34 and the second fluidized-layer wind box 36 can be measured. Whether a desired quantity of air is supplied to the fluidized layers 24 can be determined.

[0069] Since the swirling type fluidized bed furnace 10 includes the freeboard pipe 86 supplying the freeboard 17 with air from the turbo blower 40 and the freeboard air quantity adjusting damper 75 adjusting the quantity of air to be supplied to the freeboard 17, the opening of the freeboard air quantity adjusting damper 75 is temporarily made large on sudden increase in combustion quantity in the furnace, so that discharged air from the turbo blower 40 can be bypassed to the freeboard 17. Accordingly, the quantity of air to be supplied to the fluidized layers 24 can be temporarily reduced to suppress thermal reaction in the fluidized layers 24, and thus, complete combustion can be promoted by supplying the freeboard 17 with air required for combustion. In this case, since opening the freeboard air quantity adjusting damper 75 causes decrease in pressure loss at the discharge side of the turbo blower 40, the discharged flow by the turbo blower 40 increases due to the characteristic of the turbo blower 40. More quantity of air for combustion can be supplied to the freeboard 17 by corresponding to increase in combustion quantity in the freeboard 17. However, since the flow is adjusted while generating the pressure loss by providing the fluidized-layer pipe part with the first fluidized-layer air quantity adjusting damper 73 and the second fluidized-layer air quantity adjusting damper 74, corresponding consumption power is needed.

<Second embodiment>

[0070] FIG. 2 is a schematic longitudinal sectional front view of a swirling type fluidized bed furnace of a second embodiment of the present invention. The second embodiment is different from the first embodiment in that the second embodiment uses a roots blower 42. The other components are same as those in the first embodiment. The components same as those in the first embodiment are denoted by the same reference numerals and the descriptions thereof are omitted.

[0071] As illustrated in FIG. 2, the swirling type fluidized bed furnace 10 of the second embodiment includes the roots blower 42 (fluidized-layer gas supplying mechanism) supplying the fluidized layer 24 with air for fluidization and combustion. The roots blower 42, which is connected to the connecting pipe 80, can supply air to the first fluidized-layer wind box 34 and the second fluidized-layer wind box 36 through the first fluidized-layer pipe 82 and the second fluidized-layer pipe 83, respectively.

[0072] The swirling type fluidized bed furnace 10 of the second embodiment has advantages similar to those of the swirling type fluidized bed furnace of the first embodiment. Furthermore, since the swirling type fluidized bed furnace 10 of the second embodiment includes the roots

blower 42 which is a volumetric air blower, the quantity of air discharged from the non-illustrated respective diffusion nozzles of the first fluidized bed plate 34a and the second fluidized bed plate 36a is determined depending not on the discharge pressure but on a rotation speed of the roots blower 42, and thus, a desired quantity of air can be supplied to the fluidized bed 20. Moreover, the freeboard pipe 86 includes the freeboard air quantity adjusting damper 75 adjusting a quantity of air passing through the freeboard pipe 86 and the freeboard air flow meter 78 measuring the quantity of air passing through the freeboard pipe 86.

[0073] The swirling type fluidized bed furnace 10 includes the freeboard pipe 86 supplying air from the roots blower 42 to the freeboard 17 and the freeboard air quantity adjusting damper 75 adjusting a quantity of air to be supplied to the freeboard 17. Thus, on sudden increase in combustion quantity in the furnace, discharged air from the roots blower 42 can be bypassed to the freeboard 17 by making the opening of the freeboard air quantity adjusting damper 75 temporarily large. In such case, the rotation speed of the roots blower 42 is unchanged. As a result, temporary reduction in the quantity of air to be supplied to the fluidized layers 24 to suppress thermal reaction in the fluidized layers 24 and supply of air required for combustion to the freeboard 17 can promote complete combustion. However, opening the freeboard air quantity adjusting damper 75 does not cause increase in discharged flow from the roots blower 42. The increased quantity of air to be supplied to the freeboard 17 is small, compared to a case where a turbo blower is used. Accordingly, the swirling type fluidized bed furnace 10 of the second embodiment only has to cause the first fluidized-layer air quantity adjusting damper 73 and the second fluidized-layer air quantity adjusting damper 74 to balance the quantities of air to be supplied to the two fluidized layers 24, requiring a small pressure loss. The consumption power reduction effect is larger than that in the first embodiment.

<Third embodiment>

[0074] FIG. 3 is a schematic longitudinal sectional front view of a swirling type fluidized bed furnace of a third embodiment of the present invention. The third embodiment is different from the first embodiment in that the third embodiment uses a different mechanism for supplying the fluidized layer 24 with air. The other components are same as those in the first embodiment. The components same as those in the first embodiment are denoted by the same reference numerals and the descriptions thereof are omitted.

[0075] As illustrated in FIG. 3, the swirling type fluidized bed furnace 10 of the third embodiment includes a roots blower 44 (first volumetric air blower) that is a volumetric air blower supplying the fluidized layer 24 supported by the first fluidized bed plate 34a with gas (for example, air) for fluidization and combustion, and a roots blower

46 (second volumetric air blower) supplying the fluidized layer 24 supported by the second fluidized bed plate 36a with gas (for example, air) for fluidization and combustion. Each of projected areas of the first fluidized bed plate 34a and the second fluidized bed plate 36a is substantially half of a furnace bed projected area of the moving layer 22 (projected area of the moving bed plate 32a). If each of the roots blowers 44, 46 and 60 is a volumetric air blower with a same specification (capacity), the quantity of fluidized air to be supplied to the fluidized layers 24 is made substantially twice a quantity of fluidized air to be supplied to the moving layer 22 so that a swirling flow in the fluidized bed can be formed appropriately.

[0076] The swirling type fluidized bed furnace 10 includes a first fluidized-layer pipe 84 having one end connected to the roots blower 44 and the other end connected to the first fluidized-layer wind box 34, a first freeboard pipe 87 having one end connected to the first fluidized-layer pipe 84 and the other end connected to the freeboard 17, a second fluidized-layer pipe 85 having one end connected to the roots blower 46 and the other end connected to the second fluidized-layer wind box 36, and a second freeboard pipe 88 having one end connected to the second fluidized-layer pipe 85 and the other end connected to the freeboard 17.

[0077] The first freeboard pipe 87 includes a first freeboard air quantity adjusting damper 76 (first freeboard flow rate adjusting section) adjusting a quantity of air passing through the first freeboard pipe 87 and a first freeboard air flow meter 91. The second freeboard pipe 88 includes a second freeboard air quantity adjusting damper 77 (second freeboard flow rate adjusting section) adjusting a quantity of air passing through the second freeboard pipe 88 and a second freeboard air flow meter 92. Air from the roots blower 44 is supplied to the first fluidized-layer wind box 34 through the first fluidized-layer pipe 84. Air from the roots blower 46 is supplied to the second fluidized-layer wind box 36 through the second fluidized-layer pipe 85.

[0078] The control section 90 can communicate with the roots blower 60, the roots blower 44, the roots blower 46, the first freeboard air quantity adjusting damper 76 and the second freeboard air quantity adjusting damper 77 and can control the respective dampers and blowers to drive.

[0079] To supply a quantity of air required to fluidize the fluidized layer 24, the control section 90 controls the roots blower 44 and the roots blower 46 to have a predetermined rotation speed or more. Simultaneously, the control section 90 controls the respective rotation speeds of the roots blower 44 and the roots blower 46 in accordance with the respective temperatures of the fluidized layers 24 detected by the two fluidized-layer thermometers 54. Specifically, if the temperatures of the fluidized layers 24 are higher than a target temperature, the control section 90 reduces the respective rotation speeds of the roots blower 44 and the roots blower 46 within a predetermined range to reduce quantities of fluidized air to be

supplied to the fluidized layers 24. In contrast, if the temperatures of the fluidized layers 24 are lower than the target temperature, the control section 90 raises the respective rotation speeds of the roots blower 44 and the roots blower 46 within the predetermined range to increase the quantities of fluidized air to be supplied to the fluidized layers 24.

[0080] The roots blower 44 and the roots blower 46 are a volumetric air blower to send a constant volume of gas. The quantities of air supplied by the roots blower 44 and the roots blower 46 are determined by the respective rotation speeds of the roots blower 44 and the roots blower 46, respectively. Specifically, the quantities of air discharged from the non-illustrated diffusion nozzles of the first fluidized bed plate 34a and the second fluidized bed plate 36a are determined based on the rotation speeds of the roots blower 44 and the roots blower 46, respectively, irrespective of the discharge pressure. Thus, the first fluidized-layer pipe 84 and the second fluidized-layer pipe 85 can supply the fluidized layers 24 with respective desired quantities of air by controlling the rotation speeds, without requiring a damper adjusting a flow rate or a flow meter measuring a flow.

[0081] The swirling type fluidized bed furnace 10 of the third embodiment may include, for example, an illuminance sensor to detect an illuminance in the furnace, as in the first and second embodiments. In such case, when the illuminance sensor detects an illuminance in the furnace and the illuminance in the furnace is a predetermined value or more, that is, when the combustion quantity in the furnace suddenly increases, the control section 90 can bypass air from the roots blower 44 and the roots blower 46 to the freeboard 17 by making the openings of the first freeboard air quantity adjusting damper 76 and the second freeboard air quantity adjusting damper 77 temporarily large, respectively. As a result, temporary reduction of the quantities of air to be supplied to the fluidized layers 24 to suppress thermal reaction in the fluidized layers 24 and supply of air required for combustion to the freeboard 17 can promote complete combustion. In such case, the respective rotation speeds of the roots blower 44 and the roots blower 46 are maintained to be fixed and unchanged. When the illuminance in the furnace is lower than a predetermined value, that is, when the combustion quantity in the furnace is appropriate, the control section 90 closes the first freeboard air quantity adjusting damper 76 and the second freeboard air quantity adjusting damper 77.

[0082] The swirling type fluidized bed furnace 10 of the third embodiment has a similar advantage in that the moving layer 22 of the first embodiment is provided with the roots blower 60. Furthermore, since the swirling type fluidized bed furnace 10 of the third embodiment includes the roots blowers 44 and 46 which are a volumetric air blower, a desired quantity of air can be supplied to the fluidized layers 24 based on the rotation speeds of the roots blowers 44 and 46, irrespective of the resistance of the fluidized layers 24 against the non-illustrated dif-

fusion nozzles of the first fluidized bed plate 34a and the second fluidized bed plate 36a. Accordingly, a circulating flow of a fluid medium can be formed without fail and incombustible materials can be emitted without fail. Furthermore, since the quantities of fluidized air to be supplied to the moving layer 22 and the fluidized layers 24 are adjusted in accordance with the rotation speeds of the roots blowers 60, 44 and 46 without using a damper, a consumption power to supply such fluidized air is smaller than that in the first or second embodiment. Moreover, the roots blowers 44, 46 and 60 are a volumetric air blower having a same specification (capacity). Thus, a common spare part required for maintenance of the air blower can be used, whereby making the maintenance management easy.

[0083] Each of the moving-layer pipe 65, the first fluidized-layer pipe 84 and the second fluidized-layer pipe 85 needs no flow meter or no damper. No pipe length required for a flow meter to measure an accurate flow needs to be secured, whereby allowing the fluidized air pipes to be compact. The moving-layer pipe 65, the first fluidized-layer pipe 84 and the second fluidized-layer pipe 85 need no orifice securing a dynamic pressure required for flow measurement, either.

<Fourth embodiment>

[0084] FIG. 4 is a schematic longitudinal sectional front view of a swirling type fluidized bed furnace of a fourth embodiment of the present invention. As illustrated in FIG. 4, the fourth embodiment is different from the third embodiment in that the swirling type fluidized bed furnace 10 of the fourth embodiment is formed of only the right half in a front view of that of the third embodiment. Specifically, the swirling type fluidized bed furnace 10 of the fourth embodiment lacks the roots blower 44, the first fluidized-layer pipe 84, the first freeboard pipe 87, the first freeboard air quantity adjusting damper 76, the first freeboard air flow meter 91, the first fluidized-layer wind box 34 and the incombustible-material path 18a, which are included in the third embodiment. The swirling type fluidized bed furnace 10 includes the single moving-layer thermometer 52 and the single fluidized-layer thermometer 54.

[0085] The furnace body 11 of the swirling type fluidized bed furnace 10 of the fourth embodiment includes the dent 12 at only one side wall of the furnace body 11. A side wall of the furnace body 11 opposite to the side wall having the dent 12 formed, at which no dent is formed, is flat. The throw-in port 15 from which the waste W is supplied to the furnace body 11 is disposed at the side wall of the furnace body 11 opposite to the side wall having the dent 12 formed. The throw-in port 15 guides the thrown waste W to the upper part of the moving layer 22. The other components are same as in the first embodiment, and the descriptions thereof will be omitted.

[0086] The swirling type fluidized bed furnace 10 of the fourth embodiment has advantages similar to those of

the swirling type fluidized bed furnace of the third embodiment.

[0087] The embodiments of the present invention have been described. The described embodiments make the present invention easy to understand and do not give any limitation to the present invention. The present invention may be changed or modified without deviating from the scope thereof, and further the present invention of course includes the equivalence thereof. Within a range where at least part of the aforementioned problems is solved or where at least part of the advantageous effects is provided, any combination or omission of the components described in the claims or the specification is possible.

10	swirling type fluidized bed furnace
11	furnace body
17	freeboard
22	moving layer
24	fluidized layer
32a	moving bed plate
34a	first fluidized bed plate
36a	second fluidized bed plate
40	turbo blower
42	roots blower
52	moving-layer thermometer
54	fluidized-layer thermometer
60	roots blower
71	first fluidized-layer air flow meter
72	second fluidized-layer air flow meter
73	first fluidized-layer air quantity adjusting damper
74	second fluidized-layer air quantity adjusting damper
75	freeboard air quantity adjusting damper
76	first freeboard air quantity adjusting damper
77	second freeboard air quantity adjusting damper
82	first fluidized-layer pipe
83	second fluidized-layer pipe
86	freeboard pipe
87	first freeboard pipe
88	second freeboard pipe
90	control section

Claims

1. A swirling type fluidized bed furnace (10) comprising:
 - a furnace body (11);
 - a moving bed plate (32a) disposed at a bottom of the furnace body (11), the moving bed plate (32a) supporting a moving layer (22);
 - a fluidized bed plate (34a, 36a) disposed at the bottom of the furnace body (11), the fluidized bed plate (34a, 36a) supporting a fluidized layer (24);
 - a moving-layer gas supplying mechanism (60) supplying the moving layer (22) with gas; and

- a fluidized-layer gas supplying mechanism (40, 42, 44, 46) supplying the fluidized layer (24) with gas, wherein the moving-layer gas supplying mechanism (60) has a volumetric air blower (60). 5
2. The swirling type fluidized bed furnace (10) according to Claim 1 further comprising:
- a moving-layer temperature measuring section (52) measuring a temperature of the moving layer (22); and 10
- a control section (90) controlling a rotation speed of the volumetric air blower (60) in accordance with the measured temperature of the moving layer (22). 15
3. The swirling type fluidized bed furnace (10) according to Claim 1 or 2, wherein the fluidized-layer gas supplying mechanism (42, 44, 46) contains a volumetric air blower (42, 44, 46). 20
4. The swirling type fluidized bed furnace (10) according to any one of Claims 1 to 3, wherein the fluidized bed plate (34a, 36a) has a first fluidized bed plate (34a) and a second fluidized bed plate (36a), and the fluidized-layer gas supplying mechanism (44, 46) has a first volumetric air blower (44) supplying gas to the fluidized layer (24) supported by the first fluidized bed plate (34a) and a second volumetric air blower (46) supplying gas to the fluidized layer (24) supported by the second fluidized bed plate (36a). 25 30
5. The swirling type fluidized bed furnace (10) according to Claim 4 further comprising: 35
- a first freeboard pipe (87) connecting the first volumetric air blower (44) with a freeboard (17) of the furnace body (11);
- a first freeboard flow rate adjusting section (76) adjusting a flow rate of gas supplied from the first volumetric air blower (44) to the freeboard (17), the first freeboard flow rate adjusting section (76) being disposed at the first freeboard pipe (87); 40
- a second freeboard pipe (88) connecting the second volumetric air blower (46) with the freeboard (17); and
- a second freeboard flow rate adjusting section (77) adjusting a flow rate of gas supplied from the second volumetric air blower (46) to the freeboard (17), the second freeboard flow rate adjusting section (77) being disposed at the second freeboard pipe (88). 45 50
6. The swirling type fluidized bed furnace (10) according to Claim 1 or 2, wherein the fluidized bed plate (34a, 36a) has a first fluidized bed plate (34a) and a 55
- second fluidized bed plate (36a), and the swirling type fluidized bed furnace (10) further comprises:
- a first fluidized-layer pipe (82) supplying gas from the fluidized-layer gas supplying mechanism (40, 42) to the fluidized layer (24) supported by the first fluidized bed plate (34a);
- a first fluidized-layer flow rate adjusting section (73) adjusting a flow rate of the gas supplied from the fluidized-layer gas supplying mechanism (40, 42) to the fluidized layer (24) supported by the first fluidized bed plate (34a), the first fluidized-layer flow rate adjusting section (73) being disposed at the first fluidized-layer pipe (82);
- a second fluidized-layer pipe (83) supplying gas from the fluidized-layer gas supplying mechanism (40, 42) to the fluidized layer (24) supported by the second fluidized bed plate (36a); and
- a second fluidized-layer flow rate adjusting section (74) adjusting a flow rate of the gas supplied from the fluidized-layer gas supplying mechanism (40, 42) to the fluidized layer (24) supported by the second fluidized bed plate (36a), the second fluidized-layer flow rate adjusting section (74) being disposed at the second fluidized-layer pipe (83).
7. The swirling type fluidized bed furnace (10) according to Claim 6 further comprising:
- a first fluidized-layer flow meter (71) measuring a flow of gas passing through the first fluidized-layer flow rate adjusting section (73), the first fluidized-layer flow meter (71) being disposed at the first fluidized-layer pipe (82); and
- a second fluidized-layer flow meter (72) measuring a flow of gas passing through the second fluidized-layer flow rate adjusting section (74), the second fluidized-layer flow meter (72) being disposed at the second fluidized-layer pipe (83).
8. The swirling type fluidized bed furnace (10) according to Claim 6 or 7 further comprising:
- a freeboard pipe (86) supplying gas from the fluidized-layer gas supplying mechanism to a freeboard (17) of the furnace body (11); and
- a freeboard flow rate adjusting section (75) adjusting a flow rate of the gas supplied from the fluidized-layer gas supplying mechanism (40, 42) to the freeboard (17), the freeboard flow rate adjusting section (75) being disposed on the freeboard pipe (86).
9. The swirling type fluidized bed furnace (10) according to any one of Claims 6 to 8, wherein the fluidized-layer gas supplying mechanism (40) contains a tur-

bo-type air blower (40).

10. The swirling type fluidized bed furnace (10) according to any one of Claims 1 to 9 further comprising a water pouring section performing furnace bed water pouring of the fluidized layer (24). 5

11. A swirling type fluidized bed furnace (10) comprising:

a furnace body (11); 10
a first bed plate (32a) disposed at a bottom of the furnace body (11);
a second bed plate (34a, 36a) disposed at the bottom of the furnace body (11);
a first gas supplying mechanism (60) configured to supply an inside of the furnace body (11) with gas through the first bed plate (32a); and 15
a second gas supplying mechanism (40, 42, 44, 46) configured to supply the furnace body (11) with gas a flow of which is larger than a flow of gas supplied by the first gas supplying mechanism (60), through the second bed plate (34a, 36a), wherein 20
the first gas supplying mechanism (60) has a volumetric air blower (60). 25

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FIG. 1

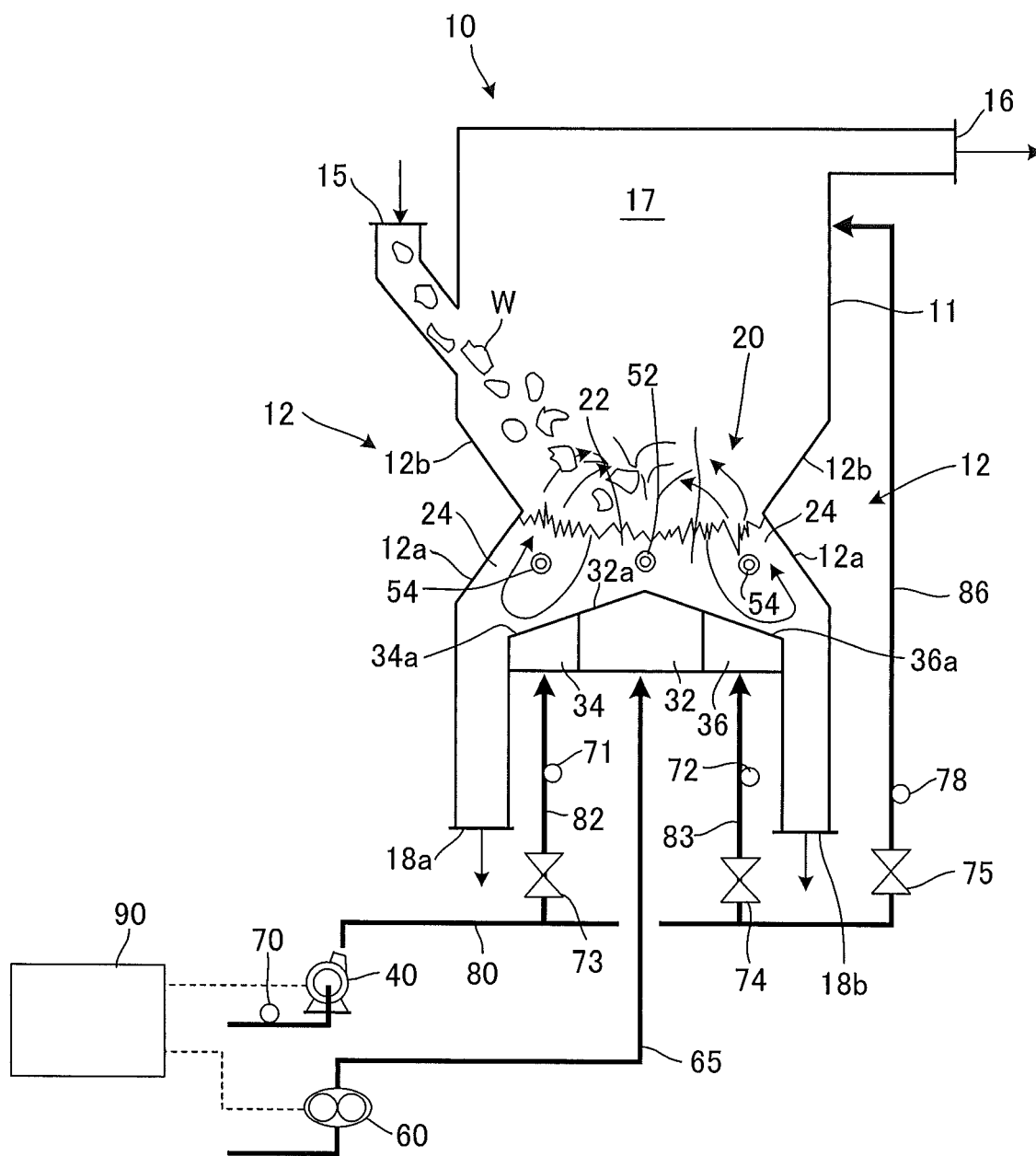


FIG. 2

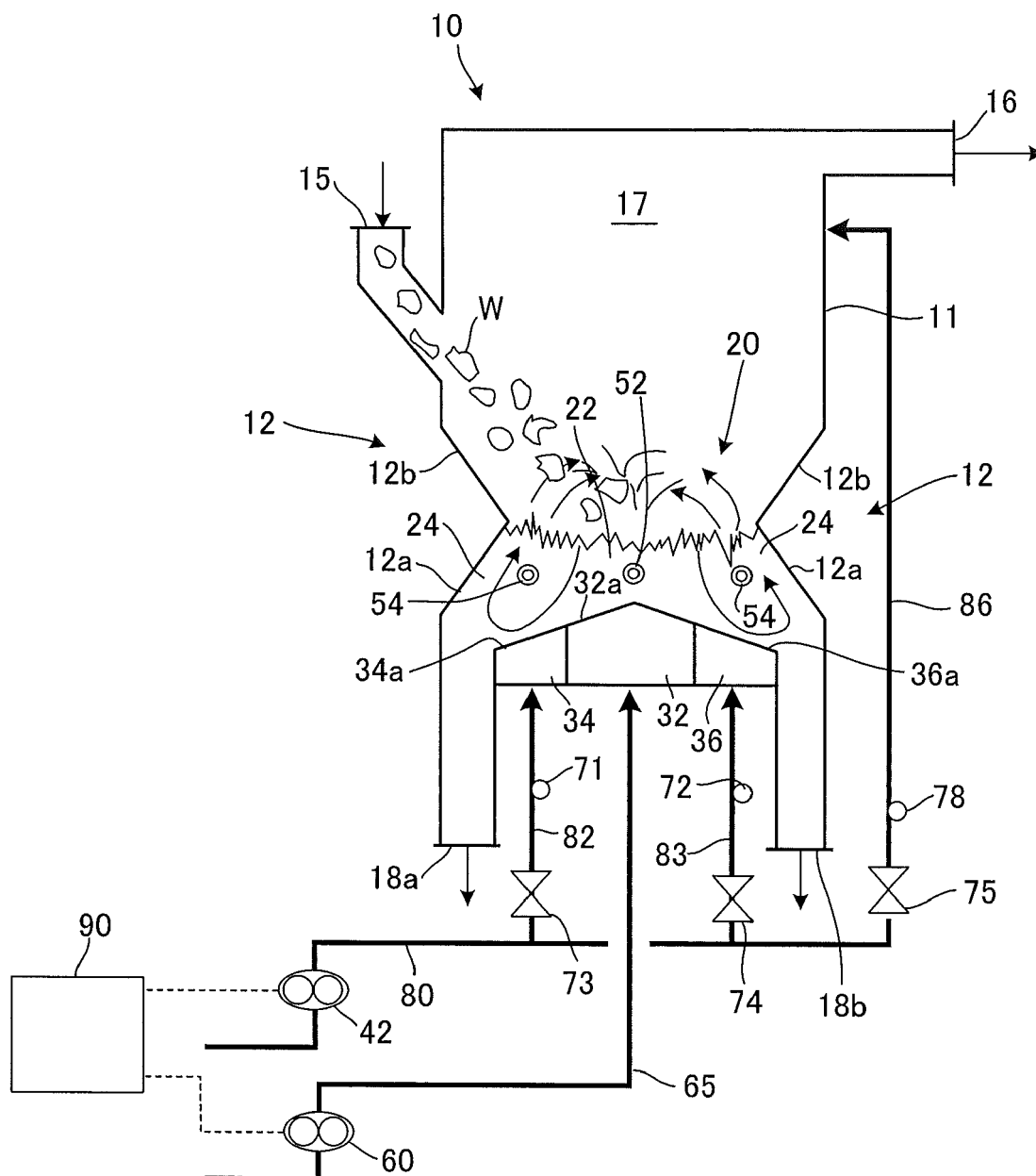


FIG. 3

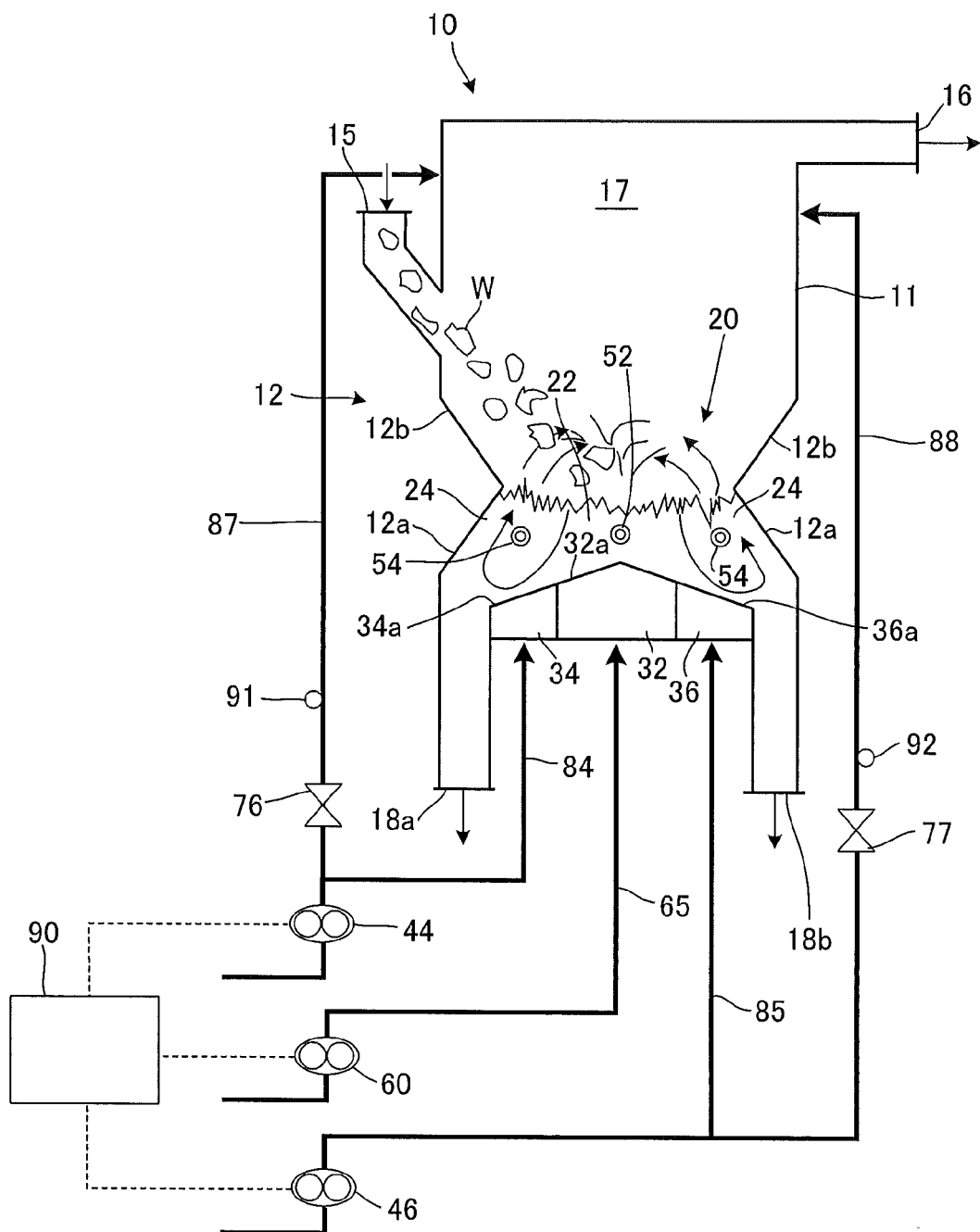


FIG. 4

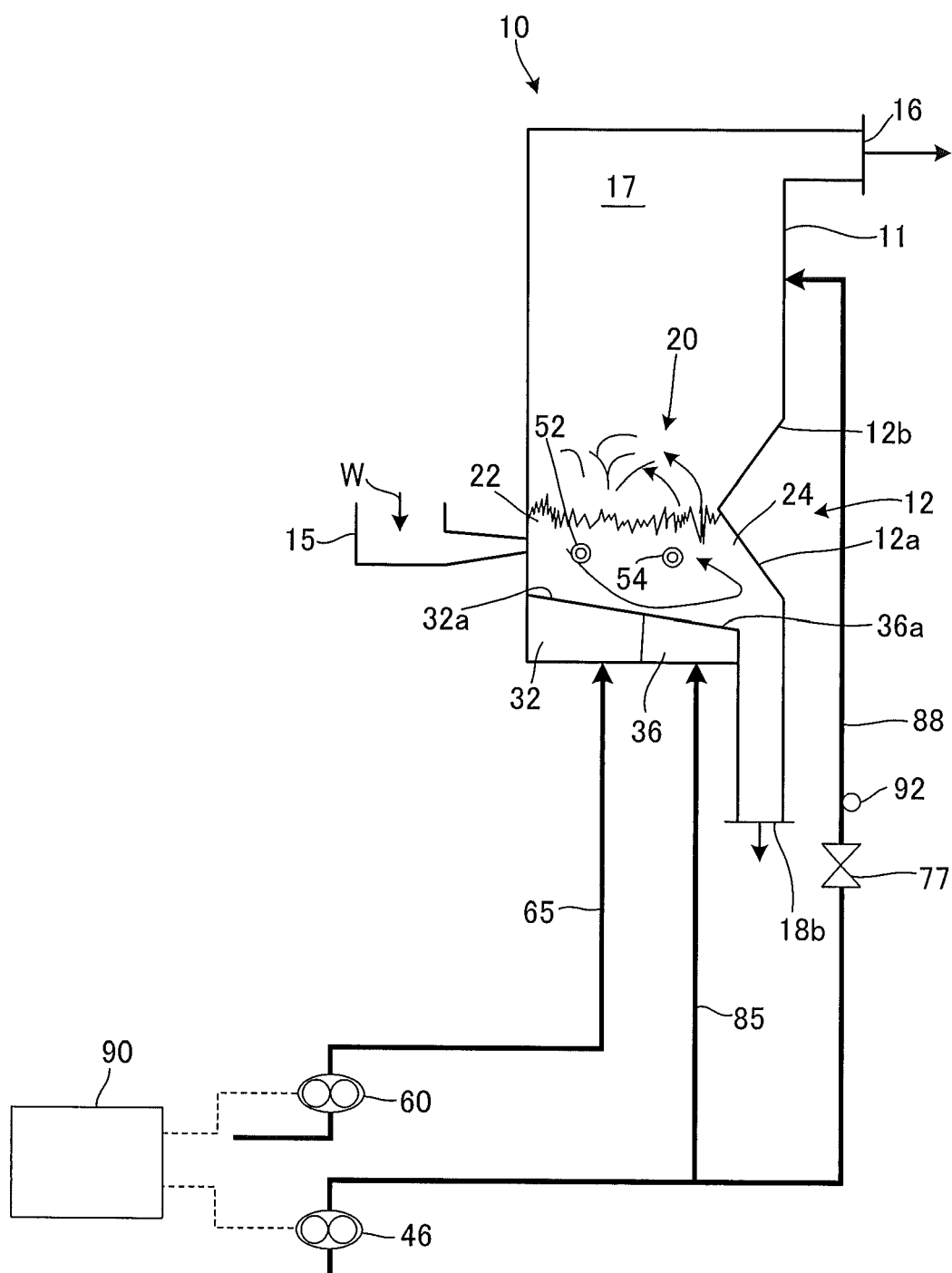
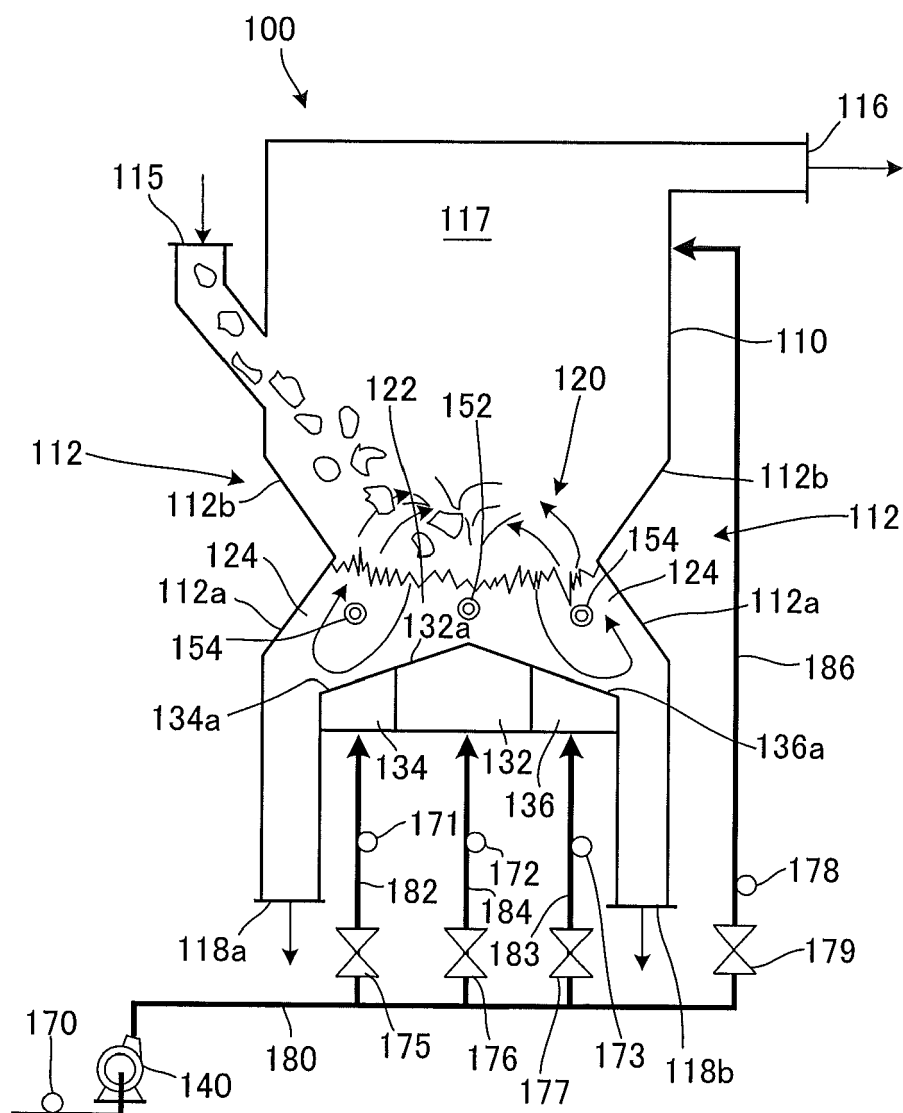


FIG. 5





EUROPEAN SEARCH REPORT

Application Number
EP 15 16 3680

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Y	* claim 1; figure 1 *	1	

Y	EP 2 320 141 A1 (JTS INTERNAT CORP [JP]; GOMI YOSHIO [JP]) 11 May 2011 (2011-05-11)	1	
	* column 16, line 40 *		

The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F23C
Place of search		Date of completion of the search	Examiner
Munich		5 August 2015	Christen, Jérôme
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05-08-2015

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