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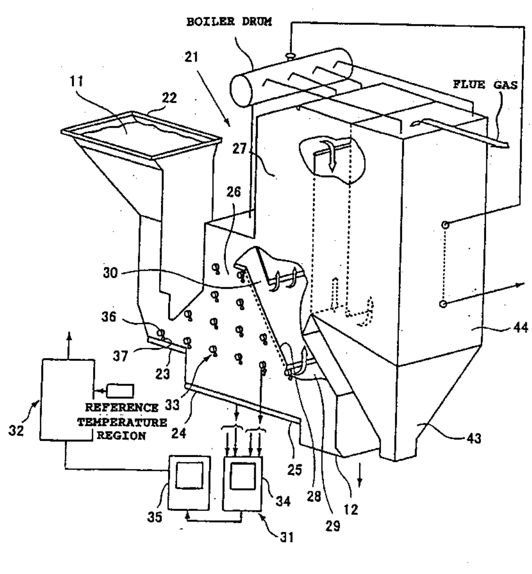
(54) WASTE INCINERATOR AND METHOD OF OPERATING THE INCINERATOR

(57) A refuse incinerator includes a combustion chamber for burning waste, a plurality of acoustic gas temperature measuring devices, means for estimating the temperature distribution in the combustion chamber, means for recognizing a block number, means for inferring the temperature distribution of each block number, means for comparing the temperature distribution, and means for controlling the gas temperature. The refuse incinerator has a waste heat boiler. The gas temperature distribution in the waste heat boiler is measured by temperature measuring devices. The gas temperature distribution is combined with block numbers in the waste heat boiler.

FIG. 1



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a refuse incinerator provided with a combustion chamber for burning waste such as urban refuse and an operating method therefor.

BACKGROUND OF THE INVENTION

[0002] With an increase in waste such as urban refuse, various types of refuse incinerators for incinerating waste have been put to practical use. In particular, a stoker type refuse incinerator (hereinafter referred to as a stoker incinerator) are widely known. FIG. 7 is a side sectional view of a typical type of stoker incinerator.

[0003] In FIG. 7, a stoker incinerator 1 includes a hopper 2, a drying stoker 3, a burning stoker 4, an after burning stoker 5, a main combustion chamber 6, and a secondary combustion chamber 7. In this type of the stoker incinerator, an intermediate ceiling 8 is installed to provide a main flue 9 and a bypass flue 10 between the main combustion chamber 6 and the secondary combustion chamber 7.

[0004] Urban refuse 11 charged into a hopper 2 is sent to the drying stoker 3 through a chute, and is dried and heated by air supplied from the bottom and radiation heat in the incinerator, thereby being ignited. The urban refuse 11 having been ignited and started burning is sent to the burning stoker 4, where the urban refuse 11 is gasified by combustion air supplied from the bottom, and some of the gas is burned. Further, unburned gas is burned completely in the after burning stoker 5. Ash remaining after burning is taken out to the outside through a main ash chute 12. Combustion is effected in the main combustion chamber 6, and flue gas is discharged being separated into the main flue 9 and the bypass flue 10 by the presence of the intermediate ceiling. The flue gas passing through the main flue 9 scarcely contains unburned gas, and contains about 10% of oxygen. The flue gas passing through the bypass flue 10 contains about 8% of unburned gas. These flue gases are mixed with each other in the secondary combustion chamber 7, where secondary combustion is attained, and unburned gas is burned completely. The flue gas coming from the secondary combustion chamber 7 is sent to a waste heat boiler 14 after dust having a large particle size is removed in a dust chamber 13. After being heat exchanged, the flue gas passes through a flue gas treatment apparatus or the like, and is discharged to the outside.

[0005] In the case where the urban refuse 11 is incinerated by using the stoker incinerator 1. it is difficult to keep the combustion state in the incinerator steady because the urban refuse 11 consists of many substances having different properties, so that the temperature distribution in the main combustion chamber 6 and the concentration distribution of combustion gas are inevitably nonuniform in terms of time and space. In particular, in the drying region above the drying stoker 3, a large amount of water vapor is produced according to the properties of the urban refuse 11, or ignition is made unstable by a temporary decrease in combustible matter in the urban refuse 11. This sometimes causes a phenomenon called a CO spike. This phenomenon is unfavorable from the viewpoint of pollution prevention because flames are partially extinguished, so that unburned gas containing a large amount of CO flows into the second combustion chamber 7, and is discharged to the outside without being burned completely in the second combustion chamber 7. Also, if the flame temperature in the main combustion chamber 7 increases, there arises a problem in that dust adheres to the intermediate ceiling 8 and the incinerator walls in a melted state, and a deposit called a clinker is produced, so that the combustion gas flow path in the incinerator is narrowed, or a clinker having been made huge drops onto the bottom of the incinerator, thereby damaging a grate or the like. Further, if the flame state is unstable, flames are liable to blow off, resulting in difficulties of high-load combustion.

[0006] In order to solve such problems, it is necessary to first grasp the combustion state in the incinerator and then provide means for stabilizing flames in the incinerator.

[0007] In the conventional stoker incinerator, there has generally been used a method in which the furnace temperature is measured by using a thermocouple with protector tube to grasp the combustion state in the incinerator or a method in which the properties of combustion gas in the incinerator is investigated by gas sampling in the incinerator, and the data obtained by the method have been used for combustion control in the incinerator.

[0008] In the above-described stoker incinerator, it is necessary to grasp the temperatures at locations in the high- and low-temperature regions produced by nonuniform combustion in the main and secondary combustion chambers to stabilize the combustion in the incinerator.

[0009] However, when a contact type measurement method using a thermocouple is used as a furnace temperature measuring method, there arise problems of decreased durability of the thermocouple body or thermocouple protector tube, a measurement error caused by radiation, and the like.

[0010] Further, the measurement of gas temperature in a central portion of furnace requires a long probe, so that it is sometimes difficult to measure the temperature.

[0011] Also, a radiation type temperature measuring method using the spectral characteristics of flames etc. is a non-contact type measuring method. With this method, an observation window (for example, an infrared camera) is generally provided, and measurement can be made only in the range visible through the observation window. Therefore, this method is unsuitable in an environment in which much dust exists because of dirty measurement window, scattering, and the like.

[0012] Also, in a method in which the properties of combustion gas in the incinerator are investigated by gas sampling in the incinerator, even if gas sampling is performed continuously at a location at which it is difficult to keep the combustion state in the incinerator steady, the variations are large, so that it is difficult to take proper measures based on the investigation result obtained by this method.

SUMMARY OF THE INVENTION

[0013] It is an object of the present invention to provide a refuse incinerator capable of stabilizing the combustion state in the incinerator and an operating method therefor.

[0014] To achieve the object, firstly, the present invention provides a refuse incinerator comprising a combustion chamber for burning waste, a plurality of acoustic gas temperature measuring devices, estimation means for estimating the temperature distribution in the combustion chamber, comparison means for comparing the temperature distribution, and control means for controlling the gas temperature distribution. The acoustic gas temperature measuring devices measure the gas temperature in the combustion chamber. The estimation means estimates the temperature distribution in the combustion chamber from the measured gas temperature. The comparison means compares the estimated temperature distribution with a preset temperature. The control means controls the gas temperature distribution by regulating at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices, waste supply means, and waste feed means based on the comparison result.

[0015] The comparison means and the control means are preferably as follows:

(a) Comparison means for comparing the estimated temperature distribution with a preset temperature range and for specifying a temperature deviation from the preset temperature range and a position at which the temperature deviation is produced

(b) Control means for controlling the gas temperature distribution by regulating at least one control element corresponding to the position at which the temperature deviation is produced with respect to at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, and a plurality of cooling fluid blowing devices

[0016] The incinerator may be a stoker incinerator, and the combustion chamber may comprise a main combustion chamber. Alternatively, the combustion chamber may comprise a main combustion chamber and a secondary combustion chamber. The incinerator may be an incinerator having a fluidized bed, and the combustion chamber may consist of a freeboard above a fluidized bed.

[0017] The means for estimating the temperature distribution very preferably comprises means for estimating the temperature distribution in the three-dimensional direction in the combustion chamber. The means for estimating the temperature distribution may comprise means for estimating the temperature distribution in the transverse cross-sectional direction in the combustion chamber, or may comprise means for estimating the temperature distribution in the longitudinal cross-sectional direction in the combustion chamber.

[0018] Secondly, the present invention provides a refuse incinerator comprising a combustion chamber for burning waste, a plurality of acoustic gas temperature measuring devices, estimation means for estimating the temperature distribution in the combustion chamber, recognition means for recognizing a block number, inference means for inferring the temperature distribution of each block number, comparison means for comparing the temperature distribution, and control means for controlling the gas temperature. The acoustic gas temperature measuring devices measure the gas temperature in the combustion chamber. The gas temperature measuring devices are preferably provided at a plurality of locations in the lengthwise direction and the height direction on both side walls of the combustion chamber. The estimation means for estimating the temperature distribution in the combustion chamber estimates the temperature distribution in the combustion chamber from the measured gas temperature. This estimation means preferably comprises means for estimating the temperature distribution by the computerized tomography method. The recognition means for recognizing a block number recognizes a space in the combustion chamber as block numbers consisting of a plurality of divided blocks. The inference means for inferring the temperature distribution of each block number infers the temperature distribution of each block number from the block number and the estimated temperature distribution. The comparison means compares the inferred temperature distribution of each block number with a preset temperature of each block number. The control means controls the gas temperature distribution of each block number based on the comparison result.

[0019] The control means for controlling the gas temperature distribution of each block number preferably comprises control means for controlling the gas temperature distribution by regulating at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices; waste supply means, and waste feed means.

[0020] The control means very preferably comprises control means for controlling the gas temperature distribution by regulating at least one control element corresponding to each block number with respect to at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, and a plurality of cooling fluid blowing devices.

[0021] Thirdly, the present invention provides an operating method for a refuse incinerator comprising the steps of measuring the gas temperature, estimating the temperature distribution, comparing, and controlling the gas temperature. In the step of measuring the gas temperature, the gas temperature in a combustion chamber for burning waste is measured by using a plurality of acoustic gas temperature measuring devices. In the step of estimating the temperature distribution, the temperature distribution in the combustion chamber is estimated from the measured gas temperature. In the step of comparing, the estimated temperature distribution is compared with a preset temperature. In the step of controlling the gas temperature, the gas temperature distribution is controlled by regulating at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices, waste supply means, and waste feed means based on the comparison result.

[0022] The comparing step and the controlling step are preferably as follows:

(a) The comparing step comprises comparing the estimated temperature distribution with a preset temperature range and specifying a temperature deviation from the preset temperature range and a position at which the temperature deviation is produced.

(b) The controlling step comprises controlling the gas temperature distribution by regulating at least one control element corresponding to the position at which the temperature deviation is produced with respect to at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, and a plurality of cooling fluid blowing devices.

[0023] The step of estimating the temperature distribution very preferably comprises estimating the temperature distribution in the three-dimensional direction in the combustion chamber. The estimating step may comprise estimating the temperature distribution in the transverse cross-sectional direction in the combustion chamber, or may consist of a step of estimating the temperature distribution in the longitudinal cross-sectional direction in the combustion chamber.

[0024] Fourthly, the present invention provides an operating method for a refuse incinerator comprising the steps of measuring the gas temperature, estimating the temperature distribution, recognizing a block number, inferring the temperature distribution, comparing the temperature, and controlling the gas temperature distribution. The gas temperature measuring step comprises measuring the gas temperature in a combustion chamber for burning waste by using a plurality of acoustic gas temperature measuring devices. The acoustic gas temperature measuring devices are preferably provided at a plurality of locations in the lengthwise direction and the height direction on both side walls of the combustion chamber. The temperature distribution estimating step comprises estimating the temperature distribution in the combustion chamber from the measured gas temperature. In the temperature distribution estimating step, the temperature distribution is preferably estimated by the computerized tomography method. The block number recognizing step comprises recognizing a space in the combustion chamber as block numbers comprising a plurality of divided blocks. The temperature distribution inferring step comprises inferring the temperature distribution of each block number from the block number and the estimated temperature distribution. The temperature comparing step comprises comparing the inferred temperature distribution of each block number with a preset temperature of each block number. The gas temperature distribution controlling step comprises controlling the gas temperature distribution of each block number based on the comparison result.

[0025] The step of controlling the gas temperature distribution of each block number preferably comprises controlling the gas temperature distribution by regulating at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices, waste supply means, and waste feed means.

[0026] The controlling step very preferably comprises controlling the gas temperature distribution by regulating at least one control element corresponding to each block number with respect to at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, and a plurality of cooling fluid blowing devices.

[0027] Further, it is another object of the present invention to provide a refuse incinerator capable of steadily keeping the concentration of dioxins at the outlet of a waste heat boiler at a remarkably low value and an operating method therefor.

[0028] To achieve the object, the present invention provides a refuse incinerator comprising a combustion chamber for burning waste, a waste heat boiler connected to the combustion chamber, a plurality of acoustic gas temperature measuring devices for measuring the gas temperature in the waste heat boiler, means for estimating the gas temperature distribution in the waste heat boiler from the measured gas temperature, and means for controlling the temperature distribution in the waste heat boiler based on the comparison result.

[0029] The control means is preferably a control unit for avoiding stagnation or staying in a temperature range of 300 to 400°C occurring in the flow of flue gas passing through the waste heat boiler.

[0030] The means for controlling the gas temperature distribution of each block number preferably comprises a control unit for controlling the gas temperature of each block number by regulating at least one selected from a group consisting of soot blow hammering, air blowing, and circulating gas blowing in the waste heat boiler.

[0031] The means for controlling the gas temperature distribution of each block number may also comprise a control unit for controlling the gas temperature of each block number by regulating at least one selected from a group consisting of a primary air quantity, a secondary air quantity, a waste feed rate, a waste supply quantity, and a cooling fluid quantity of the refuse incinerator.

[0032] Further, the present invention provides a refuse incinerator comprising a combustion chamber for burning waste, a waste heat boiler connected to the combustion chamber, a plurality of acoustic gas temperature measuring devices, means for estimating the gas temperature distribution, means for recognizing a block number, means for inferring the temperature distribution of each block number, means for comparing the temperature, and control means for controlling the gas temperature distribution. The acoustic gas temperature measuring devices measure the gas temperature in the waste heat boiler. The means for estimating the gas temperature distribution estimates the gas temperature distribution in the waste heat boiler from the measured gas temperature. The recognizing means recognizes a space in the waste heat boiler as block numbers comprising a plurality of blocks. The inference means for inferring the temperature distribution of each block number infers the temperature distribution of each block number from the block number and the estimated temperature distribution. The comparison means compares the inferred temperature distribution of each block number with a preset temperature of each block number. The control means controls the gas temperature distribution of each block number based on the comparison result.

[0033] Further, the present invention provides an operating method for a refuse incinerator comprising the steps of measuring the gas temperature, estimating the gas temperature distribution, comparing the temperature distribution, and controlling the temperature distribution. In the step of measuring the gas temperature, the gas temperature in a waste heat boiler connected to a combustion chamber for burning waste is measured by using a plurality of acoustic gas temperature measuring devices. In the step of estimating the temperature distribution, the temperature distribution in the waste heat boiler is estimated from the measured gas temperature. In the step of comparing the temperature distribution, the estimated temperature distribution is compared with a preset temperature distribution. In the step of controlling the temperature distribution, the temperature distribution in the waste heat boiler is controlled based on the comparison result.

[0034] The step of controlling the temperature distribution preferably comprises controlling for avoiding stagnation or staying in a temperature range of 300 to 400°C occurring in the flow of flue gas passing through the waste heat boiler.

[0035] The step of controlling the temperature distribution preferably comprises controlling the gas temperature of each block number by regulating at least one selected from a group consisting of soot blow hammering, air blowing, and circulating gas blowing in the waste heat boiler.

[0036] The step of controlling the temperature distribution may also comprise controlling the gas temperature of each block number by regulating at least one selected from a group consisting of a primary air quantity, a secondary air quantity, a waste feed rate, a waste supply quantity, and a cooling fluid quantity of the refuse incinerator.

[0037] Still further, the present invention provides an operating method for a refuse incinerator comprising a gas temperature measuring step, a gas temperature distribution estimating step, a block number recognizing step, a temperature distribution inferring step for each block number, a temperature comparing step, and a gas temperature distribution controlling step.

[0038] In the gas temperature measuring step, the gas temperature in a waste heat boiler connected to a combustion chamber for burning waste is measured by using a plurality of acoustic gas temperature measuring devices.

[0039] In the temperature distribution estimating step, the gas temperature distribution in the waste heat boiler is estimated from the measured gas temperature.

[0040] In the recognizing step, a space in the waste heat boiler is recognized as block numbers comprising a plurality of blocks.

[0041] In the temperature distribution inferring step, the temperature distribution of each block number is inferred from the block number and the estimated temperature distribution.

[0042] In the temperature comparing step, the inferred temperature distribution of each block number is compared with a preset temperature distribution.

[0043] In the controlling step, the gas temperature distribution of each block number is controlled based on the comparison result.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044]

FIG. 1 is a perspective view of a refuse incinerator in accordance with a first embodiment;

FIG. 2 is a schematic view showing a control system for the refuse incinerator of the first embodiment;

FIG. 3 is a schematic view showing one example of temperature distribution of blocks in the transversely sectioned direction (plan direction) for the refuse incinerator of the first embodiment;
FIG. 4 is a schematic view showing one example of temperature distribution of blocks in the longitudinally sectioned direction (height direction) corresponding to FIG. 3;
FIG. 5 is a perspective view of another refuse incinerator in accordance with the first embodiment;
FIG. 6 is a partially broken side view showing one example of a fluidized bed furnace in accordance with the first embodiment;
FIG. 7 is a sectional view showing a control method for combustion temperature in a conventional refuse incinerator;
FIG. 8 is a schematic perspective view of a waste heat boiler in accordance with a second embodiment;
FIG. 9 is a schematic view showing a temperature distribution of divided block number for the waste heat boiler of the second embodiment;
FIG. 10 is a schematic view showing a control system for the waste heat boiler of the second embodiment;
FIG. 11 is a schematic side sectional view of a stoker type refuse incinerator in accordance with a third embodiment;
FIG. 12 is a schematic side sectional view of a stoker type refuse incinerator in accordance with a fourth embodiment;
FIG. 13 is a schematic configuration view of a stoker type refuse incinerator in accordance with the fourth embodiment;
FIG. 14 is a schematic configuration view of pipes viewed from the upside in accordance with the fourth embodiment;
FIG. 15 is a schematic configuration view of pipes viewed from the upside in accordance with the fourth embodiment;
FIG. 16 is a schematic side sectional view of a stoker type refuse incinerator in accordance with a fifth embodiment;
FIG. 17 is a view showing a configuration in which a radiator is disposed in a part of a furnace wall in the fifth embodiment;
FIG. 18 is a view showing a configuration in which an electric heater is used as heating means and a heating control method in the fifth embodiment;
FIG. 19 is a view showing a configuration in which flue gas is used and a heating control method in the fifth embodiment;
FIG. 20 is a view showing a configuration in which an electric heater is incorporated in refractory brick and a heating control method in the fifth embodiment;
FIG. 21 is a view showing a configuration in which flue gas is introduced into a space provided in refractory brick and a heating control method in the fifth embodiment;
FIG. 22 is a view showing a configuration in which an air cooling apparatus is provided as cooling means and a cooling control method in the fifth embodiment; and
FIG. 23 is a view showing means for preventing a decrease in the efficiency of heating by radiation caused by the melting and solidification of fly ash in the surface layer portion of a radiator without the use of cooling means in the fifth embodiment.

EMBODIMENT FOR CARRYING OUT THE INVENTION

First embodiment

[0045] According to a first embodiment, there are provided a combustion chamber, an acoustic gas temperature measuring device, and a control unit. The combustion chamber is preferably provided with a grate and made up of a main combustion chamber and a secondary combustion chamber. The acoustic gas temperature measuring device measures the temperature distribution in the combustion chambers by dividing a space in these combustion chambers, the main combustion chamber and/or the secondary combustion chamber, into a plurality of blocks and inputting these blocks as block numbers. The control unit is configured so that the data of gas temperature distribution obtained by the measuring device are combined as the data of gas temperature distribution of each block number, the temperatures in high- and low-temperature regions of the combustion chambers, the main combustion chamber and/or the secondary combustion chamber, are compared with a preset temperature of a reference temperature region, one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate, and cooling fluid quantity are combined based on the comparison result, and the temperature in the temperature region of that block number is controlled so as to be the preset temperature of the reference temperature region. By this configuration, the actual temperature distribution formed by the incineration of urban refuse at each portion in the combustion chambers, the main combustion chamber and/or the secondary combustion chamber, can be grasped exactly as the gas temperature distribution of block number. When the temperature in the temperature region of that block number becomes higher or lower than the preset temperature of the reference temperature region, the temperature region of that block number is handled as an abnormal state, and regulation is made by the manipulated variables to make the temperature in the temperature region of that block number normal.

[0046] Also, in the first embodiment, the combustion chamber preferably consists of a freeboard above a fluidized bed, and the acoustic gas temperature measuring device and the control unit are provided in the freeboard. As in the case of the combustion chamber that is provided with a grate and made up of the main combustion chamber and the secondary combustion chamber, regulation is made by using the manipulated variables to make the temperature in the temperature region of the block number in the freeboard.

[0047] FIG. 1 is a perspective view of a refuse incinerator in accordance with the first embodiment.

[0048] In FIG. 1, a stoker incinerator 21 includes a hopper 22, a drying stoker 23, a burning stoker 24, an after burning stoker 25, a main combustion chamber 26, and a secondary combustion chamber 27. In this type of the stoker incinerator, an intermediate ceiling 28 is installed to provide a main flue 29 and a bypass flue 30 between the main combustion chamber 26 and the secondary combustion chamber 27.

[0049] In the first embodiment, an acoustic gas temperature measuring device (hereinafter referred to as an acoustic measuring device) 31 and a control unit 32 are provided in the main combustion chamber 26. A space in the main combustion chamber 26 is divided into a plurality of blocks, and the blocks are inputted in the control unit 32 as block numbers.

[0050] The gas temperature in the main combustion chamber 26 is measured continuously by using the acoustic measuring device 31. The data of gas temperature distribution based on the measured temperature values are combined into gas temperature distribution data (three-dimensional data) of each block number by the control unit 32.

[0051] In the control unit 32, for the gas temperature distribution data of each block number in the main combustion chamber 26, the temperatures in high- and low-temperature regions are compared with the preset temperature value of the reference temperature region, one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate, and cooling fluid quantity due to water spray quantity are combined based on the comparison result to make regulation, and the temperature is controlled so that the temperature in the high-or low-temperature region of block number deviated from the preset temperature value of the reference temperature region is the preset temperature of the reference temperature region.

[0052] The gas temperature measurement using acoustic waves is based on the fact that the velocity c of a sound transmitted in a gas is represented as a function of temperature T as shown below.

$$c = a \cdot \sqrt{T}$$

where a is a constant determined by gas composition etc.

[0053] A temperature sensor is made up of an acoustic wave transmitter and an acoustic wave receiver. The acoustic wave transmitter and the acoustic wave receiver are installed with a known distance provided therebetween. If an acoustic wave generated from the acoustic wave transmitter is received by the acoustic wave receiver, and the propagation time is measured, the gas temperature between the acoustic wave transmitter and the acoustic wave receiver can be measured.

[0054] A plurality of temperature sensors are installed in a measurement section, the propagation times for a plurality of paths are measured, and the measurement results are processed by the computerized tomography method (CT method), by which the temperature distribution can be determined. In the CT method, the measurement section is divided into several elements, and simultaneous equations are formed for one path assuming that the temperature in the element is constant. Simultaneous equations are formed for a plurality of paths, and these equations are solved, by which the temperature of each element can be determined.

[0055] The acoustic measuring device 31 is made up of temperature sensors 33, a signal processor 34, and a CT processor 35.

[0056] The temperature sensor 33 is made up of a speaker 36, a microphone 37, and a horn (not shown).

[0057] A plurality of temperature sensors 33 are installed on both walls of the main combustion chamber 26 in a checkered form. The reason for installing the temperature sensors 33 in a checkered form is that the temperature distribution on a transverse cross section perpendicular to the flow direction of an urban refuse group passing through the main combustion chamber 26 and the temperature distribution on a longitudinal cross section in the flow direction of an urban refuse group are measured, and by combining these temperature distributions by the control unit 32, the actual temperature distribution at each location produced by the incineration of urban refuse is grasped exactly as the three-dimensional gas temperature distribution using block number.

[0058] When the temperature in the temperature region of that block number becomes higher or lower than the preset temperature value of the reference temperature region, the temperature region of that block number is handled as an abnormal state, and temperature control is carried out to make the temperature in the temperature region of that block number normal.

[0059] The number and installation positions of the temperature sensors 33 are selected and determined according to the shapes, sizes, etc. of the main combustion chamber 26 and the secondary combustion chamber 27 in which the temperature sensors are installed.

[0060] The temperature measurement values obtained by the temperature sensors 33 are processed by the signal processor 34, and the temperature distributions in longitudinal and transverse cross sections of the space in the main combustion chamber 26 are displayed by the CT processor 35.

[0061] The temperature distribution data obtained by the CT processor 35 are sent to the control unit 32, where the temperature distribution data for longitudinal and transverse cross sections are combined into three-dimensional temperature distribution data to grasp the temperature distribution as three-dimensional temperature distribution using block number of each location in the main combustion chamber 26.

[0062] In the control unit 32, preset temperature values on the high- and low-temperature region sides (preset temperature value of the reference temperature region) in the main combustion chamber have been inputted in advance, and the measured temperature in the temperature region of block number is compared with the preset temperature value of the reference temperature region. When the measured temperature is higher than the preset temperature value on the high-temperature region side, or when it is lower than the preset temperature value on the low-temperature region side, the optimum control pattern is selected from one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate (including refuse supply quantity), and cooling fluid quantity for that block number, and temperature control is carried out to make the temperature in the high- or low-temperature region in the main combustion chamber normal by using the selected control pattern. Therefore, the temperature in the temperature region of block number in the main combustion chamber 26 is made normal, with the result that the combustion gas temperature in the main combustion chamber 26 is stabilized. If the combustion gas temperature in the main combustion chamber 26 is stabilized, the combustion gas temperature in the secondary combustion chamber 27 connected to the main combustion chamber 26 is easily stabilized.

[0063] That is to say, as described above, the combustion of urban refuse is effected in the main combustion chamber 26, and generated flue gas is discharged being separated into the main flue 29 and the bypass flue 26 by the presence of the intermediate ceiling 28. The separated flue gases are mixed with each other in the secondary combustion chamber 7, and the secondary combustion is attained so that unburned gas is burned completely.

[0064] At this time, generally, the flue gas passing through the main flue 29 scarcely contain unburned gas, and the flue gas passing through the bypass flue 26 non-uniformly contains unburned gas. According to the present invention, the flue gas passing through the bypass flue 26 uniformly contains unburned gas because the temperature in the temperature region of block number at each location in the main combustion chamber 26 is made normal so that the combustion gas temperature is stabilized. Therefore, when these flue gases are mixed with each other in the secondary combustion chamber 7, unburned gas can be burned completely by the secondary combustion. The flue gas coming from the secondary combustion chamber 27 is sent to a waste heat boiler 44 after dust having a large particle size is removed in a dust chamber 43. After being heat exchanged, the flue gas passes through a flue gas treatment apparatus or the like, and is discharged to the outside as a flue gas.

[0065] FIG. 2 is a schematic view showing a control system for the refuse incinerator of the first embodiment. FIG. 3 is a schematic view showing one example of temperature distribution of blocks in the transversely sectioned direction (plan direction) for the refuse incinerator of the first embodiment. FIG. 4 is a schematic view showing one example of temperature distribution of blocks in the longitudinally sectioned direction (height direction) corresponding to FIG. 3. The blocks are shown with a gap provided therebetween for ease of understanding.

[0066] In FIG. 2, signals of measured values obtained by the temperature sensors 33 are sent continuously to the signal processor 34 because the temperature sensors 33 are installed on both walls of the main combustion chamber 26 in a checkered form as shown in FIG. 1. In the signal processor 34, the measured temperature values obtained by the temperature sensors 33 are processed, and the temperature distributions in longitudinal and transverse cross sections of the space in the main combustion chamber 26 are displayed by the CT processor 35.

[0067] The temperature distribution data displayed by the CT processor 35 are sent to the control unit 32. The control unit 32 combines the temperature distribution data for longitudinal and transverse cross sections to form three-dimensional temperature distribution in the temperature region of block number.

[0068] As is apparent from FIGS. 3 and 4, the block number can be handled as a three-dimensional temperature region by using axis A and axis B in the plane and height axis C with respect to the plane axes A and B in coordinates of image.

[0069] Therefore, the block number is specified by determining an origin by using axes ABC. For example, in FIGS. 3 and 4, the block numbers at which the temperature in the low-temperature region is generated are grasped as A1B1C1, A2B1C1, A5B1C1, A6B1C1, A2B2C1, A6B2C1, A1B2C2, and A6B2C2. Also, the block numbers in which the temperature in the high-temperature region is generated can be grasped in the same way. A thin patterned block number represents a low-temperature region, a thick patterned one represents a high-temperature region, and no-patterned one represents a normal temperature region.

[0070] In FIG. 2, in order to check whether the temperature of block number in the main combustion chamber 26 is in the high-temperature region (approximately 1000°C or higher) or in the low-temperature region (approximately 700°C or lower), in the high-temperature region, 1000°C was taken as the preset temperature value of the reference temperature region, and in the low-temperature region, 700°C was taken as the preset temperature value of the reference temperature region.

[0071] The temperature region of each block number is compared with two preset reference temperature values in block units. When the temperature region exceeds the preset temperature value on the high-temperature region side, a control pattern is selected from one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate on grate, water spray quantity, and refuse supply quantity for a location at which that block number is formed, and temperature control is carried out to make the temperature in the high-temperature region normal based on the selected control pattern. The temperature region of each block number constituting the space in the main combustion chamber 26 is restored to normal, by which the combustion gas temperature in the main combustion chamber is resultantly stabilized.

[0072] Although the control pattern is selected from one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate on grate, water spray quantity, and refuse supply quantity, the control pattern is generally determined empirically or other means for the block number corresponding to the space location in the main combustion chamber 26. When the temperature in the temperature region of block number exceeds the preset temperature value on the high-temperature region side, a regulating valve for the manipulated variable corresponding to the selected control pattern is operated to carry out the temperature control. When the temperature cannot be restored by the selected control pattern, the control pattern is changed successively so that the temperature in the normal temperature region is reached.

[0073] Next, the control of combustion gas temperature in the main combustion chamber 26 in the case where urban refuse 11 is continuously incinerated by the stoker incinerator 21 will be described in detail with reference to FIGS. 1 to 4.

[0074] The urban refuse 11 charged into the hopper 22 is sent to the drying stoker 23 through a chute, and is dried and heated by preheated air (primary air) supplied from the bottom and radiation heat in the incinerator, thereby being ignited. The urban refuse 11 having been ignited and started burning is sent to the burning stoker 24, where the urban refuse 11 is gasified by combustion air supplied from the bottom, and some of the gas is burned. Further, unburned gas is burned completely in the after burning stoker 25. Ash remaining after burning is taken out to the outside through a main ash chute 12.

[0075] Combustion is effected in the main combustion chamber 26, and flue gas is discharged being separated into the main flue 29 and the bypass flue 30 by the presence of the intermediate ceiling 28. These flue gases are mixed with each other in the secondary combustion chamber 27, and unburned gas is burned completely by the secondary combustion. The flue gas coming from the secondary combustion chamber 27 is sent to the waste heat boiler 44 after dust having a large particle size is removed in the dust chamber 43. After being heat exchanged, the flue gas passes through a flue gas treatment apparatus or the like, and is discharged to the outside as a flue gas.

[0076] The main combustion chamber 26 is provided with the acoustic measuring device 31 for continuously measuring the gas temperature distribution in the chamber and the control unit 32. The space in the main combustion chamber 26 is divided into a plurality of blocks, and the blocks are inputted to the control unit 32 as block numbers. The control unit 32 combines the temperature distribution data based on the measured temperature values measured by the acoustic measuring device 31 in the main combustion chamber 26, grasps the combined data as three-dimensional gas temperature distribution data in the temperature region of block number, and compares the temperature in the temperature region of block number with the preset temperature value on the high- or low-temperature region side (reference temperature region). The preset temperature value on the high-temperature region side is 1000°C, and the preset temperature value on the low-temperature region side is 700°C.

[0077] As shown in FIGS. 3 and 4, at the block numbers of A1B1C1, A2B1C1, A5B1C1, A6B1C1, A2B2C1, A6B2C1, A1B2C2, and A6B2C2, a temperature lower than the preset temperature value on the low-temperature region side is generated. The temperatures in the temperature regions of these block numbers are grasped immediately by the control unit 32. In order to make the temperature in the temperature region normal, from manipulated variables of refuse supply quantity 38, refuse feed rate 39 on grate, water spray quantity 40, secondary air quantity 41, and primary air quantity 42, a control pattern using the primary air quantity 42 and the water spray quantity 40 is selected. In order to regulate the manipulated variables of the primary air quantity 42 and the water spray quantity 40, the regulating valves 42a and 40a are regulated. Reference numerals 38a, 39a, and 41a denote regulating valves corresponding to the manipulated variables of the refuse supply quantity, the refuse feed rate 39, and the secondary air quantity 41.

[0078] As the primary air quantity 42, air having been preheated by a steam air preheater is supplied from the bottom of the drying stoker 23 to burn the urban refuse 11. Therefore, to make the temperature of a block number at which the above-described low-temperature region is generated normal, the regulating valve 42a is opened to blow a large quantity of primary air from the bottom of the drying stoker 23. Also, the water spray quantity supply section 41 cools the combustion gas by water spray when the combustion gas temperature is raised by plastics etc. of a high calorific value mixed in the burning stoker 24 etc. Therefore, in this case, the regulating valve 40a is closed. After the regulating valves 42a and 40a are regulated, the temperatures in the temperature regions of these block numbers are measured and checked. When the three-dimensional temperature distribution at the block numbers of A1B1C1, A2B1C1, A5B1C1, A6B1C1, A2B2C1, A6B2C1, A1B2C2, and A6B2C2, at which the low temperature region is generated, has been restored, the operation is continued as the normal state. If not restored, how things proceed is continuously seen in this state, or the control pattern is changed to another one to make the temperature normal.

[0079] The temperature region of block number above the drying stoker 23 is made a low-temperature region by water vapor being generated in large quantities. According to the acoustic measuring device 31, however, even if water vapor is generated in large quantities, measurement can be made exactly without being affected by the water vapor. Therefore, the above-described measures can be taken quickly. Also, even if a high-temperature region is generated at a block number, the temperature of the temperature region of that block number can be measured by the acoustic measuring device 31. Therefore, a control pattern suitable for the temperature is selected, and the temperature is restored by the regulation of a regulating valve, so that the temperature can be made normal.

[0080] When all three-dimensional temperature distributions in the temperature regions of block numbers constituting the space in the main combustion chamber 26 are controlled so as to be normal, the mixing with flue gas sent from the main flue 29 in the secondary combustion chamber 27 can be performed smoothly, so that unburned gas of flue gas can be burned completely in the secondary combustion chamber 27. Therefore, the temperature at a flue gas outlet of the secondary combustion chamber 27 is surely controlled so as to be 850°C to 950°C, and thus the flue gas temperature can be controlled steadily with less variations, so that the concentrations of CO and NOx can be reduced significantly to a specified or lower value.

[0081] The flue gas coming from the secondary combustion chamber 27 is sent to the waste heat boiler 44 after dust having a large particle size is removed in the dust chamber 43. After being heat exchanged, the flue gas passes through a flue gas treatment apparatus or the like, and is discharged to the outside.

[0082] As described above, according to the first embodiment, the temperature control for combustion gas in the main combustion chamber 26 can be carried out accurately for each temperature region of block number, so that the flue gas temperature in the secondary combustion chamber can be controlled steadily. Therefore, the concentrations of both CO and NOx in the flue gas passing through the flue gas outlet of the secondary combustion chamber can be stabilized at a specified or lower value.

[0083] FIG. 5 is a perspective view of another refuse incinerator in accordance with the first embodiment. In FIG. 5, the same reference numerals are applied to the elements common to those in FIGS. 1 to 4, and some explanation is omitted.

[0084] In FIG. 5, the stoker incinerator 21 includes the hopper 22, the drying stoker 23, the burning stoker 24, the after burning stoker 25, the main combustion chamber 26, and the secondary combustion chamber 27. In this type of the stoker incinerator, the intermediate ceiling 28 is installed to provide the main flue 29 and the bypass flue 30 between the main combustion chamber 26 and the secondary combustion chamber 27.

[0085] In the first embodiment, the acoustic measuring device 31 and the control unit 32 are provided in the secondary combustion chamber 27. A space in the secondary combustion chamber 27 is divided into a plurality of blocks, and the blocks are inputted in the control unit 32 as block numbers.

[0086] The gas temperature in the secondary combustion chamber 27 is measured continuously by using the acoustic measuring device 31. The data of gas temperature distribution based on the measured temperature values are combined into gas temperature distribution data (three-dimensional data) of each block number by the control unit 32.

[0087] In the control unit 32, for the gas temperature distribution data of each block number in the secondary combustion chamber 27, the temperatures in high- and low-temperature regions are compared with the preset temperature value of the reference temperature region, one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate, and cooling fluid quantity due to water spray quantity are combined based on the comparison result to make regulation, and the temperature is controlled so that the temperature in the high- or low-temperature region of block number deviated from the preset temperature value of the reference temperature region is the preset temperature of the reference temperature region.

[0088] The acoustic measuring device 31 is made up of the temperature sensors 33, the signal processor 34, and the CT processor 35. The temperature sensor 33 is made up of the speaker 36, the microphone 37, and the horn (not shown).

[0089] According to the acoustic measuring device 31, signals of measured values obtained by the temperature sensors 33, which are installed on both walls of the secondary combustion chamber 27 in a checkered form, are sent continuously to the signal processor 34. In the signal processor 34, the measured values obtained by the temperature sensors 33 are processed, and the temperature distributions in longitudinal and transverse cross sections of the space in the secondary combustion chamber 27 are displayed by the CT processor 35.

[0090] The temperature distribution data displayed by the CT processor 35 are sent to the control unit 32. The control unit 32 combines the temperature distributions in longitudinal and transverse cross sections, and grasps the combined data as three-dimensional temperature distribution data in the temperature region of block number.

[0091] In the control unit 32, preset temperature values on the high- and low-temperature region sides (preset temperature value of the reference temperature region) in the secondary combustion chamber 27 have been inputted in advance, and the measured temperature in the temperature region of block number is compared with a preset temperature value of the reference temperature region. When the measured temperature is higher than the preset temperature value on the high-temperature region side, or when it is lower than the preset temperature value on the low-temperature region side, the optimum control pattern is selected from one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate (including refuse supply quantity), and cooling fluid quantity for that block number, and temperature control is carried out to make the temperature in the high- or low-temperature region in the main combustion chamber normal by using the selected control pattern.

[0092] Therefore, the temperature in the temperature region of block number at each location in the secondary combustion chamber 27 is made normal, with the result that the combustion gas temperature in the secondary combustion chamber 27 can be stabilized, so that the concentrations of both CO and NOx in the flue gas passing through the flue gas outlet of the secondary combustion chamber can be stabilized at a specified or lower value.

[0093] Although the case where the acoustic gas temperature measuring device for measuring gas temperature distribution is provided in the main combustion chamber or the secondary combustion chamber of the stoker incinerator has been described with reference to FIGS. 1 to 5, even when the acoustic gas temperature measuring device for measuring gas temperature distribution is provided in both of the main combustion chamber and the secondary combustion chamber, the same effect can be achieved.

[0094] Also, although the case where the temperature distribution in the furnace is measured or controlled in detail has been described in the first embodiment, for example, if it is necessary only that the average temperature between opposed walls at a specific position in the furnace be monitored, a pair of temperature sensors provided with a microphone and a speaker have only to be disposed, and needless to say, the number and arrangement of the installed temperature sensors can be set individually according to the furnace shape and the like.

[0095] Next, a fluidized bed furnace having been practically used as a refuse incinerator will be described in detail. FIG. 6 is a partially broken side view showing one example of a fluidized bed furnace in accordance with the first embodiment.

[0096] A fluidized bed furnace 45 includes an incinerator 46. At the upper part of the incinerator 46 is provided a freeboard (combustion chamber) 47, and on the side face of the freeboard 47 are provided the acoustic measuring device 31 and the control unit 32. A space in the secondary combustion chamber 27 is divided into a plurality of blocks, and the blocks are inputted in the control unit 32 as block numbers.

[0097] The gas temperature in the freeboard 47 is measured continuously by the acoustic measuring device 31. The data of gas temperature distribution based on the measured temperature values are combined into three-dimensional gas temperature distribution data in the temperature region of each block number by the control unit 32.

[0098] In the control unit 32, preset temperature values on the high- and low-temperature region sides in the freeboard 47 have been inputted in advance, and the measured temperature in the temperature region of block number is compared with the preset temperature value of the reference temperature region. When the measured temperature is higher than the preset temperature value on the high-temperature region side, or when it is lower than the preset temperature value on the low-temperature region side, the optimum control pattern is selected from one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate (including refuse supply quantity), and cooling fluid quantity for that block number, and temperature control is carried out to make the temperature in the high- or low-temperature region in the freeboard 47 normal by using the selected control pattern.

[0099] Therefore, the temperature in the temperature region of block number at each location in the freeboard 47 is made normal, with the result that the combustion gas temperature in the freeboard 47 can be stabilized, so that the concentrations of both CO and NOx in the flue gas passing through the flue gas outlet of the freeboard 47 can be stabilized at a specified or lower value.

[0100] The acoustic measuring device 31 is made up of the temperature sensors 33, the signal processor 34, and the CT processor 35. The temperature sensor 33 is made up of the speaker, microphone, and horn as described above.

[0101] According to the acoustic measuring device 31, signals of measured values obtained by the temperature sensors 33, which are installed on both walls of the freeboard 47 in a checkered form, are sent continuously to the signal processor 34. In the signal processor 34, the measured values obtained by the temperature sensors 33 are processed, and the temperature distributions in longitudinal and transverse cross sections of the space in the secondary combustion chamber 27 are displayed by the CT processor 35.

[0102] The temperature distribution data displayed by the CT processor 35 are sent to the control unit 32. The control unit 32 combines the temperature distributions in longitudinal and transverse cross sections, and grasps the combined data as three-dimensional temperature distribution data in the temperature region of block number.

[0103] In the control unit 32, preset temperature values on the high- and low-temperature region sides (preset temperature value of the reference temperature region) in the secondary combustion chamber 27 have been inputted in advance, and the measured temperature in the temperature region of block number is compared with the preset temperature value of the reference temperature region. When the measured temperature is higher than the preset temperature value on the high-temperature region side, or when it is lower than the preset temperature value on the low-temperature region side, the optimum control pattern is selected from one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate (including refuse supply quantity), and cooling fluid quantity for that block number, and temperature control is carried out to make the temperature in the high- or low-temperature region in the main combustion chamber normal by using the selected control pattern.

[0104] Therefore, the temperature in the temperature region of block number at each location in the secondary combustion chamber 27 is made normal, with the result that the combustion gas temperature in the secondary combustion chamber 27 can be stabilized, so that the concentrations of both CO and NOx in the flue gas passing through the flue gas outlet of the secondary combustion chamber can be stabilized at a specified value or lower.

[0105] At the lower part of the incinerator 46 of the fluidized bed furnace 45 is provided an air diffuser 48 having a distribution plate 48a. In the center of the distribution plate 48a is provided a noncombustible discharge port 49 extending over the whole width of incinerator 46. On the lower side of the air diffuser 48, a wind box 50 for supplying primary air is provided to blow off primary air to above the air diffuser 48 via the distribution plate 48a.

[0106] A fluidized bed 51 using a sand circulation system is formed on the upper face of the distribution plate 48a. The fluidization of sand is effected by a bubbling system. Reference numeral 52 denotes a sand suction nozzle.

[0107] At the start time, the fluidization of bed is effected while fluid sand is heated to about 500 to 700°C with kerosene or a gas burner.

[0108] A refuse supply device 54 having a hopper 53 for supplying the urban refuse 11 onto the fluidized bed 51 is provided on the side face of the incinerator 46.

[0109] The fluidized bed 51 is configured so that the wind box 50 of a divided type is provided to blow off primary air while the blow quantity of primary air is regulated, by which a vortex flow is generated in the fluidized bed 51.

[0110] When the urban refuse 11 is charged into the fluidized bed 51, the temperature of the interior of bed is naturally kept at 700°C. The charged urban refuse 11 is mixed vigorously with high-temperature sand in the fluidized bed 51, and is turned into a dry distillation gas in a short period of time, being burned. At this time, since the vortex flow is generated in the fluidized bed 51, the urban refuse 11 is diffused, and noncombustibles contained in the urban refuse 11 move rapidly to the noncombustible discharge port 49.

[0111] Flue gas is generated by being turned into dry distillation gas and partially burned in the fluidized bed 51, and unburned gas and light dust are burned in the freeboard 47. In the freeboard 47, secondary air is blown positively through a nozzle 55 so that the flue gas is mixed with the secondary air and is burned.

[0112] At this time, an intermediate ceiling 55 is installed in the freeboard 47 to produce two flowing-round gases for collision mixing, by which complete combustion is attained by the mixing of two flowing-round gases above the intermediate ceiling 55.

[0113] The temperature of flue gas in the freeboard 47 is generally liable to be nonuniform. In the present invention, however, the acoustic measuring device 31 and the control unit 32 are provided on the side face of the freeboard 47 as described above to measure the temperature in the temperature region of block number in the freeboard 47 and to compare the measured temperature with the preset temperature value of the reference temperature region. When the measured temperature is higher than the preset temperature value on the high-temperature region side, or when it is lower than the preset temperature value on the low-temperature region side, the optimum control pattern is selected from one or more of manipulated variables of primary air quantity, secondary air quantity, waste feed rate (including refuse supply quantity), and cooling fluid quantity for that block number, and temperature control is carried out to make the temperature in the high- or low-temperature region in the freeboard 47 normal by using the selected control pattern.

[0114] Therefore, the temperature at a flue gas outlet of the freeboard 47 is surely controlled so as to be 850°C to 950°C, and thus the flue gas temperature can be controlled steadily with less variations, so that the concentrations of CO and NOx can be reduced significantly to a specified value or lower.

[0115] The flue gas coming from the freeboard 47 is sent to the waste heat boiler 44 after dust having a large particle size is removed in the dust chamber 43. After being heat exchanged, the flue gas passes through a flue gas treatment apparatus or the like, and is discharged to the outside.

[0116] Although the stoker incinerator and the fluidized bed furnace have been described in this embodiment, an ash melting furnace or an ash treatment furnace which effects melting or heat treatment of ash of refuse incineration residue can be used as equipment connected to the incinerator.

Second embodiment

[0117] According to a waste heat boiler for a refuse incinerator in accordance with a second embodiment, by providing the aforementioned temperature measuring device and control unit, regulation can be made to avoid stagnation and/or staying in a temperature region of 300 to 400°C occurring in the flow of flue gas passing through the waste heat boiler, and the gas temperature region of each block number can be controlled, so that the temperature region of 300 to 400°C in which dioxins are produced easily can be avoided. Therefore, the concentration of dioxins at the outlet of the waste heat boiler can always be kept at a low value.

[0118] In the present invention, for the waste heat boiler for the incinerator, the concentration of dioxins at the outlet of the waste heat boiler can always be kept at a low value. There will be described below, with reference to the accompanying drawings, a preferred embodiment in which an acoustic gas temperature measuring device is used; the data of gas temperature distribution measured by the measuring device are combined into three-dimensional gas temperature distribution data; based on the data, regulation is made to avoid stagnation and/or staying in the temperature region of 300 to 400°C occurring in the flow of flue gas passing through the waste heat boiler; and the control unit is provided to control the gas temperature region of each block number. The term "stagnation" means a state in which flue gas cannot pass through the temperature region of 300 to 400°C in a short period of time, and the term "staying" means a state in which flue gas stays in the temperature region of 300 to 400°C.

[0119] FIG. 8 is a partially broken schematic side view showing an embodiment of the present invention.

[0120] In FIG. 8, a stoker incinerator 101 includes a hopper 102, a drying stoker 103 , a burning stoker 104, an after burning stoker 105, a main combustion chamber 106, and a secondary combustion chamber 107. In this type of the stoker incinerator, an intermediate ceiling 108 is installed to provide a main flue 109 and a bypass flue 110 between the main combustion chamber 106 and the secondary combustion chamber 107.

[0121] The present invention relates to a waste heat boiler 111 disposed so as to be connected to the secondary combustion chamber 107 of the above-described stoker incinerator 101. The waste heat boiler 111 includes a second radiation chamber 112 connected to the secondary combustion chamber (also called a first radiation chamber) 107, and a cooling chamber 116 in which an evaporator tube 113a, a superheater 114, evaporator tubes 113b and 113c, and a fuel economizer 115 are disposed from the upstream side to the downstream side. Between the second radiation chamber 112 and the cooling chamber 116 is provided a bypass 117.

[0122] In the present invention, a control unit 118 is provided to control the gas temperature distribution at locations through which flue gas passing through the second radiation chamber 112 and the cooling chamber 116 of the waste heat boiler 111 passes. A space in the waste heat boiler is divided into a plurality of three-dimensional blocks, and the blocks are inputted in the control unit 118 as block numbers in advance. In the case of the space in the waste heat boiler, since the gas temperature distribution region differs along the path from the upstream side to the downstream side, a region number is provided at an appropriate location by collecting the block numbers. A first region number represents a space at the lower part of the second radiation chamber 112, a second region number represents a space of a hopper 119 under the boiler, a third region number represents a space between the evaporator tube 113a, the superheater 114, and the evaporator tube 113b, a fourth region number represents a space between the evaporator tube 113b and the evaporator tube 113c, a fifth region number represents a space between the evaporator tube 113c and the fuel economizer 115, and a sixth region number represents a space on the downstream side of the fuel economizer 115. Block numbers are provided in each region number.

[0123] In the present invention, in order to measure the temperature region of each block number in the first to sixth region numbers based on the data of three-dimensional gas temperature distribution, an acoustic gas temperature measuring device (hereinafter referred to as an acoustic measuring device) 120 is provided to continuously measure the gas temperature distribution in each block number in the aforementioned first to sixth region numbers. The data of gas temperature distributions in longitudinal and transverse cross sections which have been measured by the acoustic measuring device 120 are combined into three-dimensional gas temperature distribution data, and based on the data, the temperature region in the first to sixth region numbers is compared with the reference temperature region in that region number. If the difference is outside a predetermined range, one or more of primary air quantity, secondary air quantity, refuse feed rate on grate, water spray quantity, refuse supply quantity, soot blow hammering, air blowing, and circulating flue gas blowing are controlled based on the difference. Reference numeral 134 denotes an air blowing devices provided with regulating valves 134a to 134e, respectively.

[0124] The acoustic measuring device 120, for which a commercially available device can be used, is made up of sensors 121, a signal processor 122, and a CT processor 123.

[0125] The sensor 121 is made up of a speaker, a microphone, and a horn.

[0126] Although the acoustic type is used for the flue gas temperature measuring device in this embodiment, any gas temperature measuring device that can measure the temperature of flue gas in which dust scatters can be used in the same way.

[0127] The sensors 121 are installed on both walls defining spaces of the first to sixth region numbers in a checkered form.

[0128] The reason for the sensors being installed in a checkered form is that temperature distribution in transverse cross section perpendicular to the flow direction of flue gas passing through the first to sixth region numbers and temperature distribution in longitudinal cross section in the flow direction of flue gas are measured, and they are combined to grasp the temperature distribution of the first to sixth region numbers as a three-dimensional block. In the case where a decrease in measurement accuracy is allowed, the sensors may be arranged at larger intervals or irregularly.

[0129] By grasping the temperature distribution of spaces in the first to sixth regions as the three-dimensional block, the actual temperature distribution at each location of flue gas of the first to sixth region numbers can be grasped exactly as block number. If the temperature region of block number of each region number exceeds each preset reference temperature value for each region number, the block number of that region number is handled as an abnormal state, and control is carried out to make the temperature region of that block number normal.

[0130] The number and installation positions of the sensors 133 are selected and determined according to the shapes, sizes, etc. of the region number whose temperature is to be measured.

[0131] The measured value obtained by each sensor 122 is processed by the signal processor 122, and the temperature distributions in longitudinal and transverse cross sections of the first to sixth region numbers are displayed by the CT processor 123.

[0132] The temperature distribution data displayed by the CT processor 123 is sent to the control unit 118.

[0133] The control unit 118 combines the temperature distribution data, and grasps the combined data as three-dimensional temperature distribution of block number of the first to sixth region numbers.

[0134] In the control unit 118, each block number of the first to sixth region number and a preset value of reference temperature region for each region number have been inputted in advance, and the measured temperature of block number of each region number is compared with the preset value of the reference temperature region of that region number. When the measured temperature is higher than the preset value, the optimum control pattern is selected from one or more of primary air quantity, secondary air quantity, refuse feed rate on grate, cooling fluid quantity, refuse supply quantity, soot blow hammering, air blowing, and circulating flue gas blowing, and control is carried out based on the selected control pattern to make each block number for each region number normal.

[0135] Therefore, by the delicate control based on the temperature measurement of each block number, the temperature region of about 300°C to 400°C in which dioxins are produced vigorously, of the temperature distribution in which the temperature of flue gas changes from 800 to 950°C to a temperature lower than 300°C in the region ranging from the inlet to the outlet of the waste heat boiler, is avoided, or flue gas is caused to pass through in a shortest possibly period of time. Thereby, the concentration of dioxins at the outlet of the waste heat boiler can be kept steadily at a specified value or lower.

[0136] FIG. 2 is a schematic view showing a state of block numbers of each region number inputted in the control unit used in the present invention. Each region number and the block numbers therein are drawn out as indicated by thick arrow marks for ease of understanding, and ordinates of axes A, B and C of image is shown. Specifically, the temperature region of three-dimensional block number can be controlled by using axis A and axis B in the plane and height axis C with respect to the plane axes A and B.

[0137] Therefore, the block number of each region number is specified by determining an origin by using axes ABC for each region number because the temperature range of temperature region of each region number differs. For example, for the fourth, fifth, and sixth region numbers, the block numbers are grasped as A1B1C1, A2B1C1, A3B1C1, A1B2C1, A2B2C1, A3B2C1, A1B3C1, A2B3C1, and A3B3C1.

[0138] Each block number of the sixth region number is a region of temperature lower than 300°C, so that a temperature of 250°C or lower is set as the preset reference temperature value. Therefore, in designing, the preset reference temperature value of each region number on the upstream side is determined based on the temperature region of the sixth region number so that the temperature of the sixth region number is surely in the above-described range when flue gas is heat exchanged smoothly. As one example, the preset reference temperature value of the fifth region number is set at 300°C, the preset reference temperature value of the fourth region number is set at 500°C, the preset reference temperature value of the third region number is set at 700°C, and the preset reference temperature values of the second and first region numbers are set at 900°C.

[0139] In the present invention, design is made so that when flue gas with a temperature of 850 to 950°C is fed into the waste heat boiler, the temperature of flue gas at the outlet of the waste heat boiler is made lower than 250°C by heat transfer due to water walls of the second radiation chamber and cooling chamber and heat transfer due to the evaporator tube, superheater, and fuel economizer in the cooling chamber. Therefore, when the temperature distribution of region number of each location is outside the range of preset reference temperature value of each region number, it is judged that abnormality has occurred in flue gas in a region number before that region number, and the temperature control is carried out to return the temperature distribution to normal by using the optimum control pattern.

[0140] The control items for temperature control include primary air quantity, secondary air quantity, refuse feed rate on grate, cooling fluid quantity, refuse supply quantity, soot blow hammering, air blowing, and circulating flue gas blowing. The control pattern is formed by combining one or more of these items.

[0141] Since the production of dioxins in the waste heat boiler is greatly affected by the operating conditions of the incinerator in the preceding process, it is necessary to prevent the production of dioxins more strictly including these operation control items.

[0142] Therefore, as the control pattern, generally, in the cooling chamber 116, the adhesion and accumulation of dust is restrained by soot blow hammering, which is the control item in the waste heat boiler, to prevent the production of dioxins, and also, by combining one or more of primary air quantity, secondary air quantity, refuse feed rate on grate, cooling fluid quantity, refuse supply quantity, air blowing, and circulating flue gas blowing, the production of dioxins is prevented strictly.

[0143] FIG. 10 is a schematic view showing one example of a control system in accordance with the present invention.

[0144] In FIG. 10, signals of measured values obtained by the sensors 121, which are installed on both walls of the first to sixth region numbers of the waste heat boiler 111 in a checkered form, are sent continuously to the signal processor 122. In the signal processor 122, the measured values obtained by the sensors 121 are processed, and the temperature distributions in longitudinal and transverse cross sections of a space in the first to sixth region numbers are displayed by the CT processor 123, the displayed temperature distributions being sent to the control unit 118.

[0145] In the control unit 118, each block number and a preset value of reference temperature region for each region number have been inputted in advance, the data of gas temperature distribution in longitudinal and transverse cross sections measured by the acoustic measuring device 120 are combined into three-dimensional gas temperature distribution data, and the temperature region in the first to sixth region numbers is compared with the reference temperature region of that region number. If the difference is outside a predetermined range, one or more of primary air quantity, secondary air quantity, refuse feed rate on grate, water spray quantity, refuse supply quantity, soot blow hammering, air blowing, and circulating flue gas blowing are controlled based on the difference.

[0146] When the temperature region of block number in region number exceeds the reference temperature region, the control unit 132 immediately grasps the block number. In order to make the block number normal, a refuse supply quantity supply section 126, a controller 127 for refuse feed rate on grate, a primary air quantity supply section 128, a water spray quantity supply section 129, a secondary air quantity supply section 130, a soot blow hammering device 131, and an air blowing device 134 (capable of being switched to a circulating flue gas blowing device) are provided as control items, and regulating valves 126a, 127a, 128a, 129a, 130a, 131a, and 134a to 134e for the control items are provided.

[0147] As shown in FIG. 9, for example, when the temperature regions of block numbers of A1B1C1, A2B2C1, and A3B3C1 of the fourth and fifth region numbers are grasped as a high temperature exceeding the reference temperature region of the block number, soot blow hammering and secondary air quantity are determined as the control pattern. After the control pattern is selected by the control unit 132, the regulating valve 131a for the soot blow hammering 131 is regulated accordingly. The stationary soot blow hammering devices 131 are disposed in the fuel economizer 115 between the sixth region number and the fifth region number, the evaporator tube 113c between the fifth region number and the fourth region number, and the evaporator tube 113b between the fourth region number and the third region number. In the evaporator tube 113a, a long extraction type soot blow hammering device is disposed. In this case, the stationary soot blow hammering devices 131 disposed in the fuel economizer 115 and the evaporator tube 113c are operated, and steam ejected through twenty-seven nozzle holes is blown to the fuel economizer 115 and the evaporator tube 113c to remove the adhering dust etc.

[0148] According to the soot blow hammering, the heat exchange is returned to normal by the removal of dust etc. adhering in the fuel economizer 115 and the evaporator 113c, so that the temperature of flue gas decreases uniformly. Also, the temperature of flue gas can be decreased uniformly by steam or cold air, and flue gas can be allowed to pass through the temperature region of about 300°C to 400°C at which dioxins are easily produced.

[0149] At this time, by regulating the secondary air supply quantity by using the regulating valve 129a, the flue gas outlet temperature of the secondary combustion chamber (first radiation chamber) of the incinerator 101 is controlled so as to feed flue gas in the normal state into the waste heat boiler 111.

[0150] The control pattern is selected and determined by experience etc. of location of each region number so that the concentration of dioxins steadily has a specified or lower value at the outlet of the waste heat boiler by the comprehensive judgment of flue gas treatment as the waste heat boiler for incinerator.

[0151] Next, there will be described, with reference to FIGS. 8 to 10, a method in which the urban refuse 111 is continuously incinerated by the stoker incinerator 101, and the combustion gas temperature in the waste heat boiler connected to the incinerator is controlled, by which the production of dioxins is kept at a low value.

[0152] The urban refuse charged into the hopper 102 is sent to the drying stoker 103 through a chute, and is dried and heated by primary air supplied from the bottom and radiation heat in the incinerator, thereby being ignited. The urban refuse having been ignited and started burning is sent to the burning stoker 104, where the urban refuse is gasified by primary air supplied from the bottom, and some of the gas is burned. Further, unburned gas is burned completely in the after burning stoker 105. Ash remaining after burning is taken out to the outside through a main ash chute 124.

[0153] Combustion is effected in the main combustion chamber 106, and flue gas is discharged being separated into the main flue 109 and the bypass flue 110 by the presence of the intermediate ceiling 108. These flue gases are mixed with each other in the secondary combustion chamber 107 (first radiation chamber), and unburned gas is burned completely by the secondary combustion. The flue gas coming from the secondary combustion chamber 27 is sent to the waste heat boiler 111.

[0154] In the waste heat boiler 111, the second radiation chamber 112 and the cooling chamber 116 are arranged in that order from the upstream side. In order to decrease the flue gas temperature of 850 to 950°C at the inlet to 250°C or lower at the outlet, heat exchange is effected with feed water etc. by using the water wall, the superheater 114, the evaporator tubes 113a, 113b and 113c, and the fuel economizer 115.

[0155] The waste heat boiler 111 contains the temperature region of about 300°C to 400°C in which dioxins are produced vigorously. In the reaction for this production, it is said that unburned carbon, hydrocarbon (in the presence of HC, catalytic action of copper and iron in dust is strong) etc. are synthesized by the relating catalytic reaction in an atmosphere of 300 to 4500°C. Therefore, to prevent the production of these dioxins, the following control is carried out.

[0156] In order to measure the temperature region of each block number in the first to sixth region numbers based on the data of three-dimensional gas temperature distribution, the acoustic gas temperature measuring device (hereinafter referred to as an acoustic measuring device) 120 is provided to continuously measure the gas temperature distribution in each block number in the aforementioned first to sixth region numbers. The data of gas temperature distributions in longitudinal and transverse cross sections which have been measured by the acoustic measuring device 120 are combined into three-dimensional gas temperature distribution, and based on the data, the temperature region in the first to sixth region numbers is compared with the reference temperature region in that region number. If the difference is outside a predetermined range, one or more of primary air quantity, secondary air quantity, refuse feed rate on grate, water spray quantity, refuse supply quantity, soot blow hammering, air blowing, and circulating flue gas blowing are controlled based on the difference.

[0157] Although the waste heat boiler for the stoker incinerator has been described in the embodiment shown in FIGS. 8 to 10, the present invention can be applied to a waste heat boiler for an incinerator such as a fluidized bed furnace.

[0158] As described above, according to the present invention, since the gas temperature distribution in each block number in the first to sixth region numbers can be measured continuously, the flue gas temperature at the outlet can be made 250°C or lower, and also the temperature region of about 300°C to 400°C in which dioxins are produced vigorously, can be avoided, or flue gas can be caused to pass through in a shortest possibly period of time. Thereby, the concentration of the produced dioxins can be kept steadily at a specified or lower value.

Third embodiment

[0159] A third embodiment relates to a method for controlling the temperature of a grate in a refuse incinerator having the grate. In this method, control is carried out so that the surface temperature of a grate group located on the upstream side in the waste conveying direction is higher than the surface temperature of a grate group located on the downstream side.

[0160] By carrying out control so that the surface temperature of the grate group located on the upstream side in the waste conveying direction is higher than the surface temperature of the grate group located on the downstream side, even in the case where a large quantity of domestic refuse etc. containing much water is mixed in, condensation caused by the supercooling of the grate group located on the upstream side is prevented, by which corrosion of grate group caused by the condensation is prevented. Further, this embodiment has an effect that unstable combustion and nonuniform combustion temperature caused by the supercooling of the grate group located on the upstream side are prevented.

[0161] The above-described method can be attained, for example, by providing grate heating means or grate heating means and grate cooling means on the grate group located on the upstream side in the waste conveying direction, and grate cooling means on the grate group located on the downstream side in the waste conveying direction.

[0162] The aforementioned "grate group located on the upstream side in the waste conveying direction" on which grate heating means or grate heating means and grate cooling means are provided means a grate group located in a region in which drying and burning of waste are mainly performed. The aforementioned "grate group located on the downstream side in the waste conveying direction" on which grate cooling means is provided means a grate group located in a region in which burning and after burning of waste are mainly performed. The positions at which the grate heating means and the grate cooling means are provided are selected appropriately according to the size, construction, etc. of the refuse incinerator.

[0163] FIG. 11 is a schematic side sectional view of a stoker type refuse incinerator in accordance with the third embodiment. This refuse incinerator is a stoker type refuse incinerator having a drying stoker 203, a burning stoker 204, and an after burning stoker 205.

Waste 202 charged into a hopper 201 is conveyed to the drying stoker 203 through a chute, and is dried and heated on the grate by air supplied from the bottom and radiation heat in the incinerator, thereby being gasified and ignited. The waste 202 having been ignited and started burning is sent to the burning stoker 104, where the waste is gasified by combustion air supplied from the bottom, and is burned on the grate. Further, unburned gas is burned completely on the grate of the after burning stoker 205. Ash remaining after burning is taken out to the outside through a main ash chute 206.

[0164] Combustion is effected in a main combustion chamber 207, and flue gas is divided into two gas flows by the presence of an intermediate ceiling 208 provided in the main combustion chamber 207 and is discharged from the main combustion chamber 207 being separated into a main flue 209 on the downstream side of furnace and a bypass flue 210 on the upstream side of furnace. The main flue gas discharged through the main flue 209 and the bypass flue gas discharged through the bypass flue 210 are mixed with each other and agitated in a secondary combustion chamber 211 disposed so as to be connected to the main combustion chamber 207, and unburned gas is burned completely by the secondary combustion. The flue gas coming from the secondary combustion chamber 211 is sent to a waste heat boiler 213 after dust having a large particle size is removed in a dust chamber 212. After being heat exchanged, the flue gas passes through a flue gas treatment apparatus or the like, and is discharged to the outside.

[0165] This embodiment relates to a method for controlling the temperature of grate in a refuse incinerator having the above-described configuration. In this method, control is carried out so that the surface temperature of a grate group of the drying stoker is higher than the surface temperature of the grate group of the burning stoker and the after burning stoker.

[0166] By carrying out control so that the surface temperature of the grate group located on the upstream side in the waste conveying direction is higher than the surface temperature of the grate group located on the downstream side, even in the case where a large quantity of domestic refuse etc. containing much water is mixed in, condensation caused by the supercooling of the grate group located on the upstream side is prevented, by which corrosion of grate group caused by the condensation is prevented. Further, this embodiment has an effect that unstable combustion and nonuniform combustion temperature caused by the supercooling of the grate group located on the upstream side are prevented.

[0167] The above-described method can be attained by the following means.

[0168] Specifically, in the stoker type refuse incinerator having the above-described configuration, the drying stoker is provided with grate heating means or grate heating means and grate cooling means, and the burning stoker and/or the after burning stoker is provided with grate cooling means.

[0169] In this case, steam is preferably used for heating in the grate group of the drying stoker. The heating means can be realized by a configuration such as to have, for example, as shown in FIG. 11, a steam passage 220 disposed in the grate group of the drying stoker 203, a steam generator 221 for generating steam, a steam supply pipe 222 for supplying steam from the steam generator to the steam passage 220 disposed in the grate group of the drying stoker, a steam flowmeter 223 and a flow regulating valve 224 provided in the steam supply pipe 222, a thermometer 225 for measuring the temperature in the grate group, and a grate temperature controller 226 for controlling the steam flow rate and steam temperature based on the temperature measured by the thermometer 225.

[0170] The thermometer 225 for measuring the surface temperature in the grate group may be installed at one location at which a typical temperature in the grate group can be measured, but is preferably installed at a plurality of locations in the grate group. By controlling the steam flow rate and steam temperature based on the temperatures measured by the thermometers installed at a plurality of locations, the temperature distribution in the grate group can be controlled more precisely.

[0171] The grate temperature controller 226 receives a signal (temperature) from the thermometer 225 installed on the grate group, a signal (flow rate) from the steam flowmeter 223, a preset temperature signal of steam generated in the steam generator 221, and the like, and controls the steam flow rate and steam temperature by regulating the flow regulating valve 224 or the steam generator 221 so that the steam temperature has a preset value.

[0172] Needless to say, the steam generator 221 can be replaced by the waste heat boiler 213 provided so as to connect with the refuse incinerator.

[0173] Further, the configuration is preferably such that grate cooling means is provided in the grate group of the drying stoker. This is because combustion occurs vigorously on the grate of the drying stoker depending on the kind of waste, which results in the necessity of cooling.

[0174] Also, as the grate cooling means provided in the burning stoker and/or the after burning stoker, the same means as the grate cooling means for the drying stoker can be used.

[0175] Hereafter, for convenience in drawing, explanation of the grate cooling means will be given with reference to the schematic view showing the burning stoker 204 of FIG. 11. The grate cooling means for the drying stoker and the after burning stoker can also be configured in the same way.

[0176] For the grate cooling means, cooling air or cooling water is preferably used for the cooling of grate group. The following description will be given with reference to the view of the burning stoker 204 of FIG. 11.

[0177] The cooling means can be realized by a configuration such as to have, for example, a cooling air or cooling water passage 227 disposed in the grate group of the burning stoker 204, a cooling air or cooling water supply device 228, a supply pipe 229 for supplying cooling air or cooling water from the cooling air or cooling water supply device 228 to the cooling air or cooling water passage 227 disposed in the grate group of the drying stoker, a flowmeter 230 and a flow regulating valve 231 provided in the supply pipe 229, a thermometer 232 for measuring the temperature in the grate group, and the grate temperature controller 226 for controlling the flow rate and temperature of cooling air or cooling water based on the temperature measured by the thermometer 232. As the thermometer installed in the drying stoker, the thermometer used for the aforementioned heating means can be used in common. Further, the temperature of each grate group must be controlled considering the temperatures of other grate groups, so that and the grate temperature controller 226 used for the grate heating means and each of the grate cooling means is preferably controlled by the same device.

[0178] The grate temperature controller 226 receives a signal (temperature) from the thermometer 232 installed on the grate group, a signal (flow rate) from the flowmeter 230, a preset temperature signal of cooling air or cooling water at the cooling air or cooling water supply device 228, and the like, and controls the flow rate and temperature of cooling air or cooling water by regulating the flow regulating valve 231 or the cooling air or cooling water supply device 228 so that the temperature has a preset value.

[0179] Also, in the control method for the grate temperature, it is preferable to carry out control so that the surface temperature in the furnace width direction of the grate group decreases toward the furnace center.

[0180] Since there is a tendency for the combustion temperature of waste on the grate group to increase in the center, by carrying out control so that the temperature of grate group decreases toward the furnace center, thermal damage in a central portion of the grate group can be prevented effectively. Further, a difference in furnace temperature in the furnace width direction on the grate group decreases, which contributes to the stabilization of combustion.

[0181] The above-described control method in the case where steam is supplied to the grate group of the drying stoker to perform heating can be achieved by disposing the steam passage in the grate group so as to supply steam from the periphery to the center of furnace in the case where the aforementioned grate heating means is used. By supplying steam from the periphery to the center of the furnace, the peripheral portion is heated earlier by high-temperature steam and steam with a somewhat decreased temperature heats the central portion, so that control can be carried out in such a manner that the temperature of grate group decreases toward the furnace center. The number of steam passages disposed in the grate group of the drying stoker is selected appropriately according to the system configuration etc.

[0182] The above-described control method in the case where cooling air or cooling water is supplied to the grate group of the drying stoker, burning stoker, and after burning stoker to perform cooling can be achieved by disposing the cooling air or cooling water passage in the grate group so as to supply cooling air or cooling water from the center to the periphery of the furnace in the case where the aforementioned grate cooling means is used. By supplying cooling air or cooling water from the center to the periphery of the furnace, the central portion is cooled earlier by cooling air or cooling water and gas with a somewhat increased temperature cools the peripheral portion, so that control can be carried out in such a manner that the temperature of grate group decreases toward the furnace center. The number of cooling air or cooling water passages disposed in each grate group is selected appropriately according to which of cooling air and cooling water is used, or the system configuration etc.

[0183] Also, in the control method for grate temperature, it is preferable to carry out control so that the surface temperature in the waste conveying direction of the grate group decreases toward the downstream side.

[0184] Since there is a tendency for the combustion temperature of waste on the grate group to increase on the downstream side in the waste conveying direction, by carrying out control so that the temperature of grate group decreases toward the downstream side, thermal damage on the downstream side in the waste conveying direction can be prevented effectively. Further, a difference in furnace temperature in the waste conveying direction on the grate group decreases, which contributes to the stabilization of combustion.

[0185] The above-described control method in the case where steam is supplied to the grate group of the drying stoker to perform heating can be achieved by disposing the steam passage in the grate group so as to supply steam from the upstream side in the waste conveying direction of the grate group to the downstream side in the case where the aforementioned grate heating means is used. By supplying steam from the upstream side in the waste conveying direction to the downstream side, the upstream side is heated earlier by high-temperature steam and steam with a somewhat decreased temperature heats the downstream side, so that control can be carried out in such a manner that the temperature of grate group decreases toward the downstream side. The number of steam passages disposed in the grate group of the drying stoker is selected appropriately according to the system configuration etc.

[0186] The above-described control method in the case where cooling air or cooling water is supplied to the grate group of the drying stoker, burning stoker, and after burning stoker to perform cooling can be achieved by disposing the cooling air or cooling water passage in the grate group so as to supply cooling air or cooling water into the grate group from the downstream side in the waste conveying direction to the upstream side in the case where the aforementioned grate cooling means is used. By supplying cooling air or cooling water into the grate group from the downstream side in the waste conveying direction to the upstream side, the downstream side is cooled earlier by cooling air or cooling water and gas with a somewhat increased temperature cools the upstream side, so that control can be carried out in such a manner that the temperature of grate group decreases toward the downstream side. The number of cooling air or cooling water passages disposed in each grate group is selected appropriately according to which of cooling air and cooling water is used, or the system configuration etc.

[0187] Needless to say, the above-described grate heating means and grate cooling means can be applied in the same way to a stoker type refuse incinerator using an integrated type grate group that cannot be divided definitely into the drying stoker, burning stoker, and after burning stoker.

Fourth embodiment

[0188] FIG. 12 is a schematic side sectional view of a stoker type refuse incinerator in accordance with a fourth embodiment. This refuse incinerator is a stoker type refuse incinerator having a drying stoker 303, a burning stoker 304, and an after burning stoker 305. Refuse 302 charged into a hopper 301 is sent to the drying stoker 303 through a chute, and is dried and heated on a grate by air supplied from the bottom and radiation heat in the incinerator, thereby being ignited. The refuse 302 having been ignited and started burning is sent to the burning stoker 304, where the refuse is gasified by combustion air supplied from the bottom, and is burned on a grate. Further, unburned gas is burned completely on a grate of the after burning stoker 305. Ash remaining after burning is taken out to the outside through a main ash chute 306.

[0189] Combustion is effected in a main combustion chamber 307, and flue gas is divided into two gas flows by the presence of an intermediate ceiling 308 provided in the main combustion chamber 307 and is discharged from the main combustion chamber 307 being separated into a main flue 309 on the downstream side of furnace and a bypass flue 310 on the upstream side of furnace. The main flue gas discharged through the main flue 309 and the bypass flue gas discharged through the bypass flue 310 are mixed with each other and agitated in a secondary combustion chamber 311 disposed so as to be connected to the main combustion chamber 307, and unburned gas is burned completely by the secondary combustion. The flue gas coming from the secondary combustion chamber 311 is sent to a waste heat boiler 313 after dust having a large particle size is removed in a dust chamber 312. After being heat exchanged, the flue gas passes through a flue gas treatment apparatus or the like, and is discharged to the outside.

[0190] The stoker type refuse incinerator in accordance with this embodiment has means for circulating some of the main flue gas to the upstream side in the incinerator in the above-described configuration.

[0191] Since the main flue gas has a relatively high gas temperature of about 800 to 900°C and contains about 8 to 15% of oxygen, the circulation of the main flue gas to the upstream side in the incinerator promotes the drying of refuse and contributes to the stabilization of combustion in the combustion start region.

[0192] A pipe 320 for circulating gas shown in FIG. 12 represents one example of embodiment of means for circulating some of main flue gas to the upstream side in the incinerator. The pipe 320 has a dust collector 321 and a blower 322, and further has heating means 323 for preventing a decrease in gas temperature in the pipe 320. The provision of the heating means prevents the adhesion of dust into the pipe and the decrease in furnace temperature caused by a decrease in temperature of circulating gas.

[0193] As the heating means, for example, a method in which an electric heater etc. are wound around the pipe 320 is used. The electric heater is preferably wound in a portion of pipe on the downstream side of the dust collector 321, or it can be wound over the entire length of the pipe 320. The pipe 320 is preferably provided with a flow regulating valve 324, and the flow rate of circulating gas is preferably changed appropriately according to the properties of refuse, the refuse charge quantity, the combustion state in the furnace, and the like.

[0194] Some of gas in the main flue 309 is sucked into the pipe 320 by the blower 322 through a suction nozzle 325 provided on the furnace wall near the main flue. After dust is removed by the dust collector 321, the gas is introduced again into the furnace through a blow-off nozzle 326 provided on the furnace wall on the downstream side in the furnace. The blow-off nozzle 326 is preferably disposed, for example, at a position such that gas can be supplied so that a stagnation region of gas is formed at a part near a position just over the refuse layer in the drying stoker 303 or the burning stoker 304. The position at which the blow-off nozzle 326 is disposed is selected appropriately according to the furnace shape and the like. Thereby, the stabilization of combustion in the combustion start region can be achieved while promoting the drying of refuse, and also a decrease in flue gas quantity due to a decrease in air ratio and an improved heat recovery efficiency due to flue gas circulation, that is, an increased power generation efficiency can be achieved.

[0195] FIGS. 13 and 14 show one example of the embodiment in the case where means for circulating some of the main flue gas to the upstream side in the furnace consists of a pipe for circulating gas, which is disposed in refractory brick forming the inside wall of furnace. FIG. 13 is a schematic configuration view of the pipe viewed from the side of furnace, and FIG. 14 is a schematic configuration view of the pipe viewed from the upside of furnace. This embodiment represents a case where a pipe for circulating gas is provided on both sides on the side walls of the furnace.

[0196] Some of the main flue gas is sucked into a pipe 331 in the refractory brick through a pipe inlet 330 provided in the main flue, and is introduced into the furnace again through a pipe outlet 332 provided on the upstream side in the furnace. The pipe outlet 332 is preferably disposed, for example, at a position such that gas can be supplied so that a stagnation region of gas is formed at a part near a position just over the refuse layer in the drying stoker 303 or the burning stoker 304. The position at which the pipe outlet 332 is disposed is selected appropriately according to the furnace shape and the like. Also, the installation positions and the number of pipes are not subject to any special restriction, and are selected appropriately according to the furnace shape and the like.

[0197] Also, the pipes can be provided within the furnace so as to be in contact with the inside walls of the furnace. In this case, the pipe is preferably formed of a refractory such as refractory brick and castable.

[0198] According to the above-described configuration, the circulating gas passes through the pipe subjected to a high-temperature environment. Thereby, a decrease in circulating gas temperature due to heat loss in the pipe in which gas is circulated can be prevented. Therefore, the circulating gas that maintains a high temperature can be utilized, and the drying and burning of refuse can be promoted further, so that the heat recovery efficiency, that is, the power generation efficiency can be vastly improved.

[0199] As a method for increasing the gas flow velocity in the pipe for circulating gas, for example, a method in which a heat resisting fan 333 with cooler is provided in the pipe or a method in which a fast burner is provided near the pipe outlet and its ejection effect is utilized can be used.

[0200] FIG. 15 shows one example of this embodiment in the case where a device is disposed to generate a pulsating flow in the pipe for circulating gas, which is disposed in the refractory brick forming the side wall in the furnace. This figure is a schematic configuration view of the pipe viewed from the upside of the furnace.

[0201] As the device for generating the pulsating flow, for example, a pulse combustion burner 334 can be used. The pulse combustion burner 334, which has a tail pipe with a length of about 1 m and is used to generate the pulsating flow, is disposed so that the opening thereof communicates with the pipe outlet 332. by which gas circulation accompanied by pulsating flow can be accomplished by the ejection effect of the pulse combustion burner.

[0202] By the ejection effect, the flow rate and flow velocity of the main flue gas passing through the pipe are increased, and at the same time, the temperature distribution in the pipe is kept small. Also, dust can be prevented from adhering on the inside wall of pipe by the heat migration effect.

[0203] According to the above-described configuration, by the increase in flow velocity of circulating gas to the combustion start region, the drying of refuse and the stabilization of combustion in the furnace can further be promoted, and a dust trouble in the pipe can be prevented.

[0204] Also, it is a matter of course that the means for generating the pulsating flow can be applied to the pipe 320 shown in FIG. 12 in the same way. In this case, the means can be used, for example, by disposing the opening of the pulse combustion burner so as to communicate with the blow-off nozzle 326.

Fifth embodiment

[0205] FIG. 16 is a schematic side sectional view of a stoker type refuse incinerator in accordance with a fifth embodiment. This refuse incinerator is a stoker type refuse incinerator having a drying stoker 403, a burning stoker 404, and an after burning stoker 405. The incinerator of this type has a hopper 401 into which refuse is charged, a main combustion chamber 407 for burning refuse, an intermediate ceiling 410 for discharging combustion gas generated in the main combustion chamber 407 being separated into a main flue 409 and a bypass flue 410, a secondary combustion chamber 411 for effecting secondary combustion of combustion gas discharged being separated into the main flue 409 and the bypass flue 410, a dust chamber 412 for removing dust having a large particle size from flue gas generated in the secondary combustion chamber 411, and a waste heat boiler 413 for making heat exchange. Refuse 402 charged into a hopper 401 is sent to the drying stoker 403 through a chute, and is dried and heated by combustion air supplied from the bottom and radiation heat in the incinerator, thereby being ignited. The refuse 402 having been ignited and started burning is sent to the burning stoker 404, where the refuse is gasified by combustion air supplied from the bottom, and is burned. Further, unburned gas is burned completely in the after burning stoker 405. Ash remaining after burning is taken out to the outside through a main ash chute 406.

[0206] The stoker type refuse incinerator in accordance with the present invention is characterized in that an externally heated radiator is disposed on a part of furnace wall in the above-described configuration.

[0207] A radiator 420 should be installed near a region in which stagnation of gas flow in the furnace takes place. For example, it is preferably installed between the main ash chute 406 and the main flue 409 and in two chambers in the waste heat boiler 413 as shown in FIG. 16. The position, size, shape, etc. of the radiator are selected appropriately according to the incinerator shape and the like.

[0208] By installing the radiator in the furnace wall near a region in which stagnation of gas flow takes place, radiation heat radiated from the radiator heated to a high temperature selectively heats fly ash in the stagnation region. By preventing fly ash itself from having a temperature in a temperature region (300 to 400°C) suitable for re-synthesis of dioxins, the synthesis of dioxins is restrained, and at the same time, unburned matters in fly ash are heated and burned. The radiation heat radiated from the radiator heated to a high temperature can heat gas in a wide range, so that fly ash near the furnace wall in which the radiator is installed can be heated effectively.

[0209] FIG. 17 shows one example of a configuration in which the radiator is disposed in a part of the furnace wall. The furnace wall shown in FIG. 17 is made up of an iron skin 421, a heat insulator 422, and refractory brick 423, and the refractory brick 423 forms the inside wall of the incinerator. The radiator 420 is preferably installed so as to be embedded in the heat insulator 422 at a position at which the radiator is in contact with the refractory brick 423. By this configuration, radiation heat is radiated effectively in the furnace without the radiator being subjected to burning by flames in the furnace.

[0210] The radiator is not subject to any special restriction as long as it has heat resistance. A radiator formed of a refractory such as castable is preferably used.

[0211] As the heating means for the radiator, for example, an electric heater can be used. FIG. 18 shows one example of a configuration in which an electric heater is used as the heating means and a heating control method. In this figure, the same reference numerals are applied to the elements common to those shown in FIG. 17, and the explanation thereof is omitted.

[0212] FIG. 18 shows a case where the radiator 420 is installed at the position shown in FIG. 17. The radiator 420 shown in FIG. 18 is configured so as to incorporate an electric heater 431. The incorporated electric heater 431 is connected with a temperature controller 432 for controlling the temperature of the radiator 420. The temperature controller 432 receives a signal (temperature) sent from a thermometer 430 installed so as to be capable of measuring the furnace gas temperature near the furnace wall in which the radiator 420 is installed.

[0213] The temperature controller 432 carries out temperature control for the heater so that the temperature indicated by the thermometer 430 is in a predetermined temperature range.

[0214] As the temperature control method, there may be used a method in which for example, when the temperature of the thermometer is 400°C or lower, the power source for the electric heater is turned on, and when the temperature is 600°C or higher, the electric heater is turned off, or there may be used a method in which control is carried out so that the temperature of the thermometer is a predetermined temperature.

[0215] As the method for incorporating the electric heater in the radiator, a configuration in which the electric heater is directly embedded in the radiator may be adopted, and a configuration in which a pipe etc. are embedded in the radiator and the heater is disposed in the pipe etc. should preferably be adopted. By adopting the configuration in which a pipe etc. are embedded in the radiator and the heater is disposed in the pipe etc., repair work such as replacement of heater at the time of heater breakage is made easy.

[0216] Also, as another heating means for the radiator, flue gas can also be used. In this case, as the flue gas, flue gas of LNG, LPG, kerosene, heavy oil, etc. can be used. FIG. 19 shows one example of a configuration in which flue gas is used and a heating control method. In this figure, the same reference numerals are applied to the elements common to those shown in FIG. 17, and the explanation thereof is omitted.

[0217] The radiator 420 shown in FIG. 19 has a configuration such that high-temperature flue gas produced by combustion in an external combustion apparatus can be introduced into the inside of the furnace. By introducing flue gas into a space provided in the radiator 420, the radiator 420 is heated. The flue gas, after heating the radiator, may be blown into a flue gas treatment apparatus installed in the incinerator or outside the incinerator. When the flue gas is blown into the flue gas treatment apparatus, however, it is a matter of course that means for avoiding the temperature (300 to 400°C) at which dioxins are easily re-synthesized must be provided.

[0218] An external combustion apparatus 433 is connected with the temperature controller 432 for controlling the temperature of the radiator 420. This temperature controller 432 receives a signal (temperature) sent from the thermometer 430 installed so as to be capable of measuring the furnace gas temperature near the furnace wall in which the radiator 420 is installed.

[0219] The heated air controller 432 carries out control for the combustion of the external combustion apparatus 433 so that the temperature indicated by the thermometer 430 is in a predetermined temperature range.

[0220] As the temperature control method, there may be used a method in which for example, when the temperature of the thermometer is 400°C or lower, the combustion of the external combustion apparatus 433 is effected, and when the temperature is 600°C or higher, the combustion of the external combustion apparatus 433 is stopped, or there may be used a method in which the combustion is controlled so that the temperature of the thermometer is a predetermined temperature.

[0221] The method for heating the radiator has only to be a method capable of heating the radiator to a predetermined temperature, and is not limited to the above-described method.

[0222] In the above-described temperature measurement, particle temperature is preferably monitored because most of dioxins are absorbed in a fly ash surface layer portion. Therefore, the use of a radiation thermometer is most desirably used as the thermometer, but the control can be carried out by using a thermometer such as a thermocouple. Also, the number of thermometers is not limited to one, and a plurality of thermometers can be installed to carry out control.

[0223] The heater or the flue gas for heating the radiator can be incorporated in the refractory brick forming the inside wall of furnace or can be allowed to pass through the refractory brick. In this case, the refractory brick incorporating the heater or the refractory brick causing heating air to pass through forms a radiator, so that a separate radiator need not be provided.

[0224] FIG. 20 shows a configuration in which the electric heater 431 in FIG. 18 is incorporated in the refractory brick 423, and other configurations are the same as those shown in FIG. 18. Also, the method for controlling the temperature and the method for incorporating the electric heater can be the same as the method having been described with reference to FIG. 18.

[0225] FIG. 21 shows a configuration in which high-temperature flue gas produced by the combustion of the external combustion apparatus in FIG. 19 can be introduced into a space provided in the refractory brick 423, and other configurations are the same as those shown in FIG. 19. Also, the temperature control method etc. can be the same as the method having been described with reference to FIG. 19.

[0226] By the configuration shown in FIG. 20 or FIG. 21, the refractory brick in the furnace can be used effectively without the necessity for installing a separate radiator.

[0227] Also, in the present invention, it is preferable that cooling means be provided to prevent overheat of the radiator.

[0228] As the cooling means, for example, an air cooling apparatus can be used. FIG. 22 shows one example of a configuration in which the air cooling apparatus is provided and a cooling control method. FIG. 22 shows a configuration in which air having been cooled by an air cooling apparatus 434 can be introduced into the space provided in the refractory brick 423, and other configurations are the same as those shown in FIG. 21.

[0229] As the method for controlling the radiator temperature, there may be used a method in which when the temperature indicated by the thermometer installed on the inside wall (wall exposed to flue gas in the furnace) of the radiator is 1000°C or higher, the air cooling apparatus 434 is operated, and the cooled air is introduced into the space provided in the refractory brick 423 to perform cooling, and when the temperature is 800°C or lower, the air cooling apparatus 434 is stopped, or there may be used a method in which control is carried out so that the temperature of the thermometer is a predetermined temperature.

[0230] By providing the cooling means, the radiator can be prevented from overheating. Thereby, a decrease in the efficiency of heating by radiation caused by the melting and solidification of fly ash in the surface layer portion of the radiator can be prevented, and further fuel expanses or electricity expenses can be saved.

[0231] FIG. 23 shows one example of means for preventing a decrease in the efficiency of heating by radiation caused by the melting and solidification of fly ash in the surface layer portion of a radiator without the use of cooling means. In this example, the radiator is disposed in a recess in the furnace wall. Although FIG. 23 shows a case where the electric heater is incorporated in the refractory brick as shown in FIG. 20, it is a matter of course that the means shown in FIG. 23 can be applied to the configurations shown in FIGS. 18, 19 and 21.

[0232] By disposing the radiator in the recess as shown in FIG. 23, a vortex flow is formed near the surface layer portion of the radiator, so that the flow of flue gas containing fly ash does not come directly into contact with the radiator. Therefore, the melting and solidification of fly ash in the surface layer portion of the radiator can be prevented.

[0233] Also, as shown in FIG. 23, by using a radiation thermometer 435 as the thermometer, the temperature of fly ash, which is a heated element, in gas flow can be measured directly, so that the overheat of fly ash and the melting and solidification of fly ash on the nearby furnace wall etc. can be prevented effectively. When the radiation thermometer is used, an observation window capable of observing the interior of furnace through a wide angle must be provided on the furnace wall.

Claims

1. A refuse incinerator comprising:

> a combustion chamber for burning waste;
> a plurality of acoustic gas temperature measuring devices for measuring gas temperature in said combustion chamber;
> estimation means for estimating the temperature distribution in the combustion chamber from the measured gas temperature;
> comparison means for comparing the estimated temperature distribution with a preset temperature range; and
> control means for controlling the gas temperature distribution by regulating at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices, waste supply means, and waste feed means based on the comparison result.

2. The refuse incinerator according to claim 1, wherein said comparison means comprising comparison means for comparing said estimated temperature distribution with a preset temperature range and for specifying a temperature deviation from the preset temperature range and a position at which said temperature deviation is produced, and

said control means comprising control means for controlling the gas temperature distribution by regulating at least one control element corresponding to the position at which the temperature deviation is produced with respect to at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, and a plurality of cooling fluid blowing devices.

3. The refuse incinerator according to claim 1, wherein said estimation means comprises means for estimating the temperature distribution in the transverse cross-sectional direction in the combustion chamber.

4. The refuse incinerator according to claim 1, wherein said estimation means comprises means for estimating the temperature distribution in the longitudinal cross-sectional direction in the combustion chamber.

5. The refuse incinerator according to claim 1, wherein said estimation means comprises means for estimating the temperature distribution in the three-dimensional direction in the combustion chamber.

6. A refuse incinerator comprising:

a combustion chamber for burning waste;
a plurality of acoustic gas temperature measuring devices for measuring the gas temperature in said combustion chamber;
estimation means for estimating the temperature distribution in said combustion chamber from the measured gas temperature;
recognition means for recognizing a space in said combustion chamber as block numbers consisting of a plurality of divided blocks;
inference means for inferring the temperature distribution of each block number from said block number and said estimated temperature distribution;
comparison means for comparing said inferred temperature distribution of each block number with a preset temperature of each block number; and
control means for controlling the gas temperature distribution of each block number based on the comparison result.

7. The refuse incinerator according to claim 6, wherein said control means comprises control means for controlling the gas temperature distribution by regulating at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices, waste supply means, and waste feed means.

8. The refuse incinerator according to claim 7, wherein said control means comprises control means for controlling the gas temperature distribution by regulating at least one control element corresponding to each block number with respect to at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, and a plurality of cooling fluid blowing devices.

9. The refuse incinerator according to claim 1 or 6, wherein said incinerator is a stoker incinerator, and said combustion chamber comprises a main combustion chamber.

10. The refuse incinerator according to claim 1 or 6, wherein said incinerator is a stoker incinerator, and said combustion chamber comprises a main combustion chamber and a secondary combustion chamber.

11. The refuse incinerator according to claim 1 or 6, wherein said incinerator is an incinerator having a fluidized bed, and said combustion chamber comprises a freeboard above a fluidized bed.

12. The refuse incinerator according to claim 1 or 6, wherein said acoustic gas temperature measuring devices are provided at a plurality of locations in the lengthwise direction and the height direction on both side walls of said combustion chamber.

13. The refuse incinerator according to claim 1 or 6, wherein said estimation comprises means for estimating the temperature distribution by the computerized tomography method.

14. An operating method for a refuse incinerator, comprising the steps of:

measuring gas temperature in a combustion chamber for burning waste by using a plurality of acoustic gas temperature measuring devices;
estimating temperature distribution in said combustion chamber from the measured gas temperature;
comparing the estimated temperature distribution with a preset temperature range; and
controlling the gas temperature distribution by regulating at least one control element selected from a group consisting of a plurality of primary

air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices, waste supply means, and waste feed means based on the comparison result.

15. The operating method according to claim 14, wherein

said comparing step comprises comparing said estimated temperature distribution with a preset temperature range and specifying a temperature deviation from the preset temperature range and a position at which said temperature deviation is produced, and

said controlling step comprises controlling the gas temperature distribution by regulating at least one control element corresponding to the position at which the temperature deviation is produced with respect to at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, and a plurality of cooling fluid blowing devices.

16. The operating method according to claim 14, wherein said step of estimating the temperature distribution comprises estimating the temperature distribution in the transverse cross-sectional direction in the combustion chamber.

17. The operating method according to claim 14, wherein said step of estimating the temperature distribution comprises estimating the temperature distribution in the longitudinal cross-sectional direction in the combustion chamber.

18. The operating method according to claim 14, wherein said step of estimating the temperature distribution comprises estimating the temperature distribution in the three-dimensional direction in the combustion chamber.

19. An operating method for a refuse incinerator, comprising the steps of:

measuring the gas temperature in a combustion chamber for burning waste by using a plurality of acoustic gas temperature measuring devices;
estimating the temperature distribution in said combustion chamber from the measured gas temperature;
recognizing a space in said combustion chamber as block numbers consisting of a plurality of divided blocks;
inferring the temperature distribution of each block number from said block number and said estimated temperature distribution;
comparing said inferred temperature distribution of each block number with a preset temperature of each block number; and
controlling the gas temperature distribution of each block number based on the comparison result.

20. The operating method according to claim 19, wherein said step of controlling the gas temperature distribution of each block number comprises controlling the gas temperature distribution by regulating at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices, waste supply means, and waste feed means.

21. The operating method according to claim 20, wherein said controlling step comprises controlling the gas temperature distribution by regulating at least one control element corresponding to each block number with respect to at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, and a plurality of cooling fluid blowing devices.

22. The operating method according to claim 14 or 19, wherein said acoustic gas temperature measuring devices are provided at a plurality of locations in the lengthwise direction and the height direction on both side walls of said combustion chamber.

23. The operating method according to claim 14 or 19, wherein said step of estimating the temperature distribution comprises estimating the temperature distribution by the computerized tomography method.

24. A refuse incinerator comprising:

a combustion chamber for burning waste;
a waste heat boiler connected to said combustion chamber;
a plurality of acoustic gas temperature measuring devices for measuring the gas temperature in said waste heat boiler;
estimation means for estimating the gas temperature distribution in said waste heat boiler from the measured gas temperature;
comparison means for comparing said estimated temperature distribution with a preset temperature distribution; and
control means for controlling the temperature distribution in said waste heat boiler based on the comparison result.

25. The refuse incinerator according to claim 24, wherein said control means is a control unit for avoiding stagnation or staying in a temperature range of 300 to 400°C occurring in the flow of flue gas passing through said waste heat boiler.

26. The refuse incinerator according to claim 24, wherein said control means comprises control means for controlling the gas temperature distribution by regulating at least one control element selected from a group consisting of a plurality of primary air blowing devices, a plurality of secondary air blowing devices, a plurality of cooling fluid blowing devices, waste supply means, and waste feed means.

27. The refuse incinerator according to claim 24, wherein said control means comprises control means for controlling the gas temperature distribution by regulating at least one selected from a group consisting of a soot blow hammering device, an air blowing device, and a circulating gas blowing device in said waste heat boiler.

28. A refuse incinerator comprising:

a combustion chamber for burning waste;
a waste heat boiler connected to said combustion chamber;
a plurality of acoustic gas temperature measuring devices for measuring the gas temperature in said waste heat boiler;
estimation means for estimating the gas temperature distribution in said waste heat boiler from the measured gas temperature;
recognition means for recognizing a space in said waste heat boiler as block numbers consisting of a plurality of blocks;
inference means for inferring the temperature distribution of each block number from said block number and said estimated temperature distribution;
comparison means for comparing said inferred temperature distribution of each block number with a preset temperature of each block number; and
control means for controlling the gas temperature distribution of each block number based on the comparison result.

29. An operating method for a refuse incinerator, comprising the steps of:

measuring gas temperature in a waste heat boiler connected to a combustion chamber for burning waste by using a plurality of acoustic gas temperature measuring devices;
estimating temperature distribution in said waste heat boiler from the measured gas temperature;
comparing said estimated temperature distribution with a preset temperature distribution; and
controlling the gas temperature distribution in said waste heat boiler based on the comparison result.

30. The operating method according to claim 29, wherein said step of controlling the temperature distribution comprises controlling to avoid stagnation or staying in a temperature range of 300 to 400°C occurring in the flow of flue gas passing through said waste heat boiler.

31. The operating method according to claim 29 or 30, wherein said step of controlling the temperature distribution comprises controlling the gas temperature of each block number by regulating at least one selected from a group consisting of soot blow hammering, air blowing, and circulating gas blowing in said waste heat boiler.

32. An operating method for a refuse incinerator, comprising the steps of:

measuring the gas temperature in a waste heat boiler connected to a combustion chamber for burning waste by using a plurality of acoustic gas temperature measuring devices;
estimating the temperature distribution in said waste heat boiler from the measured gas temperature;
recognizing a space in said waste heat boiler as block numbers consisting of a plurality of blocks;
inferring the temperature distribution of each block number from said block number and said estimated temperature distribution;
comparing said inferred temperature distribution of each block number with a preset temperature of each block number; and
controlling the gas temperature distribution of each block number based on the comparison result.

FIG. 1

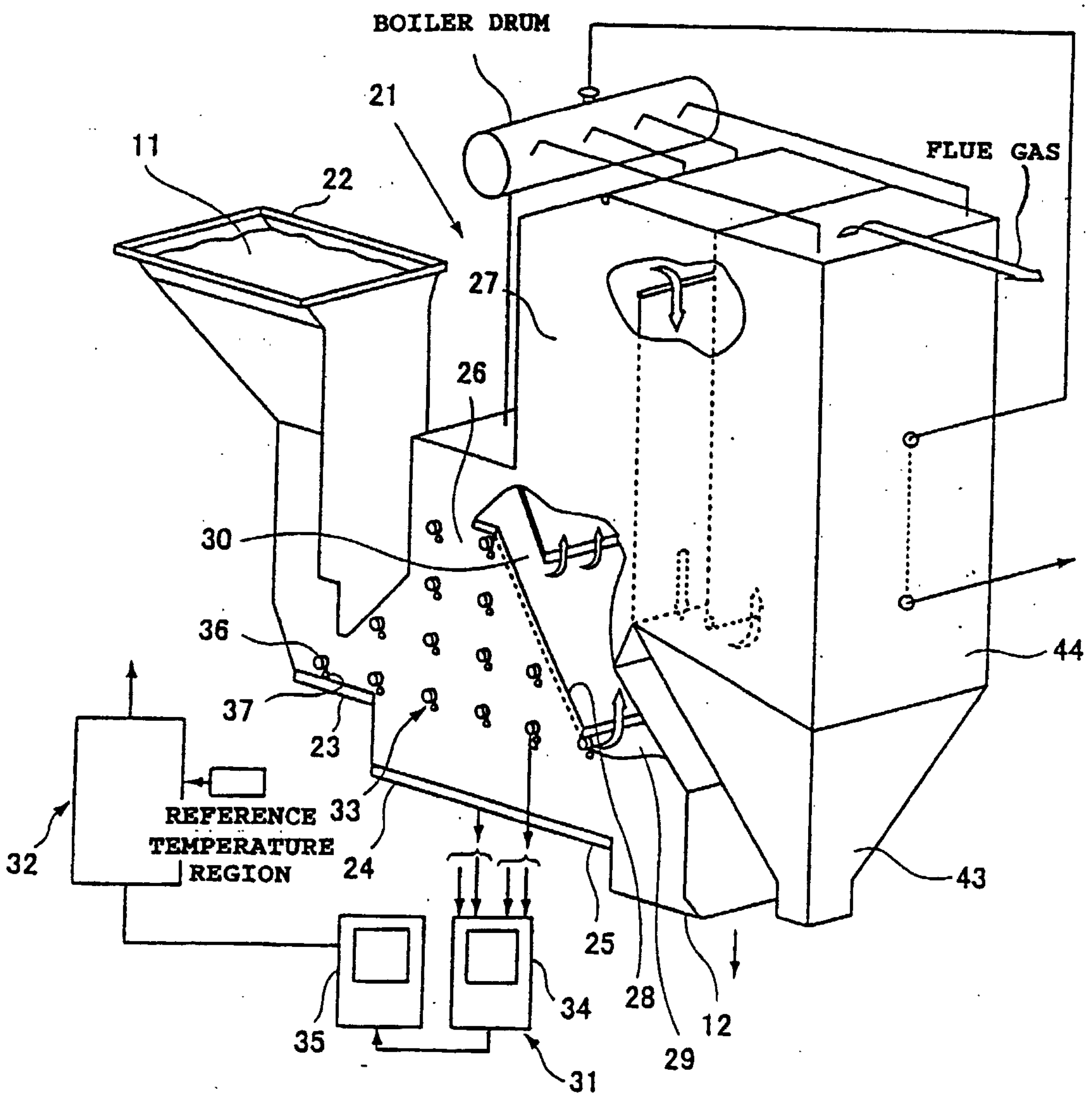

BOILER DRUM
21
11
22
FLUE GAS
27
26
30
36
37
23
33
24
44
32
REFERENCE TEMPERATURE REGION
25
43
35
34
31
28
29
12

FIG. 2

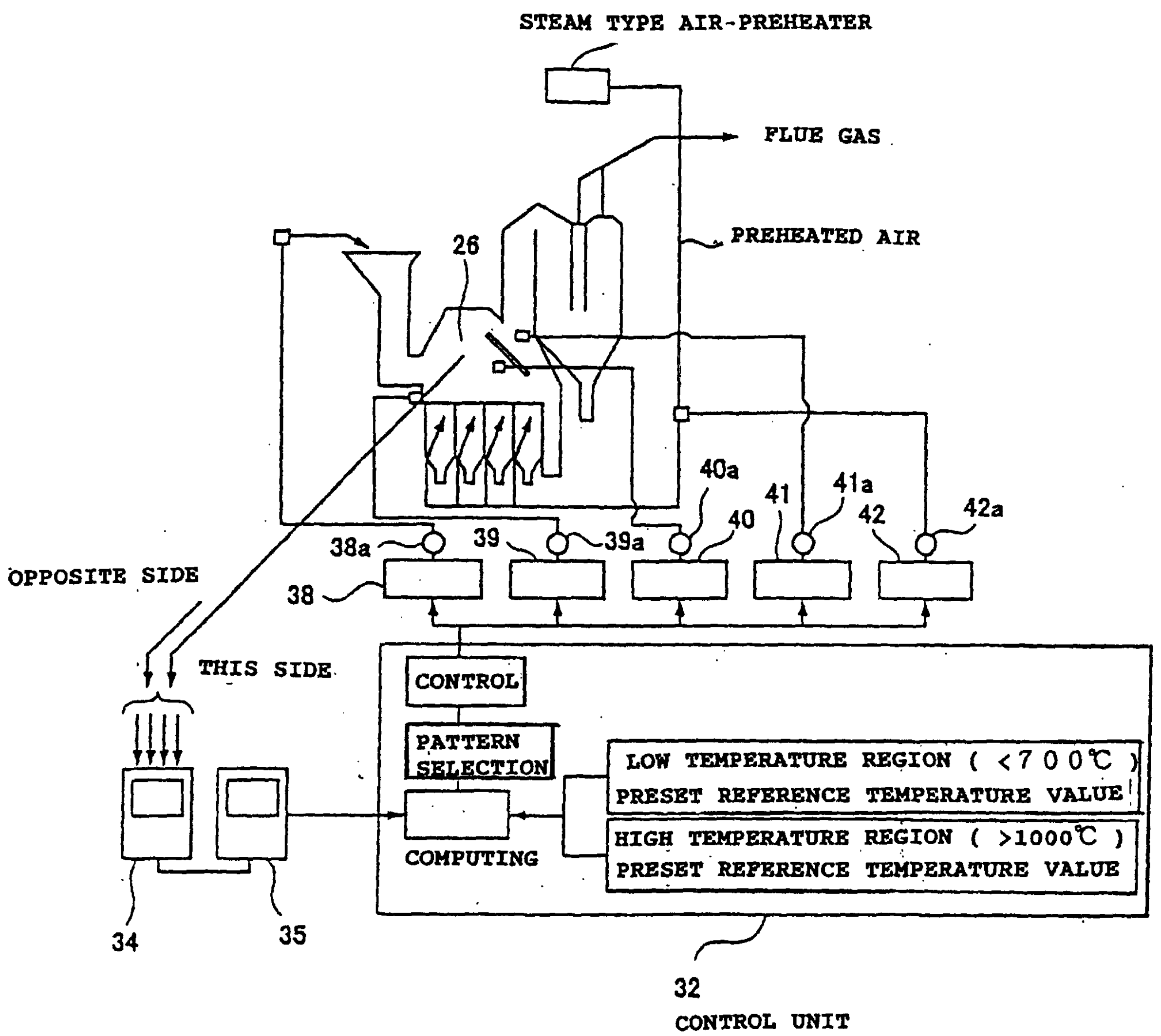

STEAM TYPE AIR-PREHEATER
FLUE GAS
PREHEATED AIR
26
40a
41
41a
42
42a
40
38a
39
39a
38
OPPOSITE SIDE
THIS SIDE
CONTROL
PATTERN SELECTION
LOW TEMPERATURE REGION (<700℃)
PRESET REFERENCE TEMPERATURE VALUE
HIGH TEMPERATURE REGION (>1000℃)
PRESET REFERENCE TEMPERATURE VALUE
COMPUTING
34
35
32
CONTROL UNIT

FIG. 3

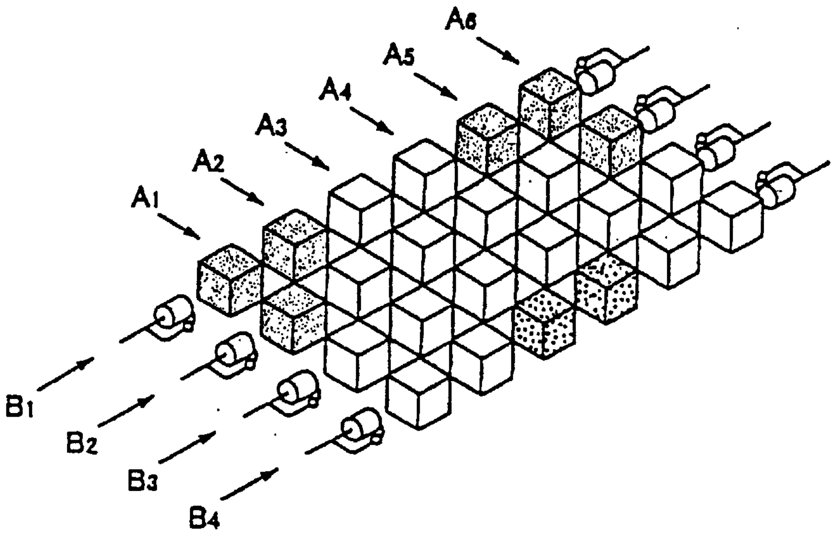


FIG. 4

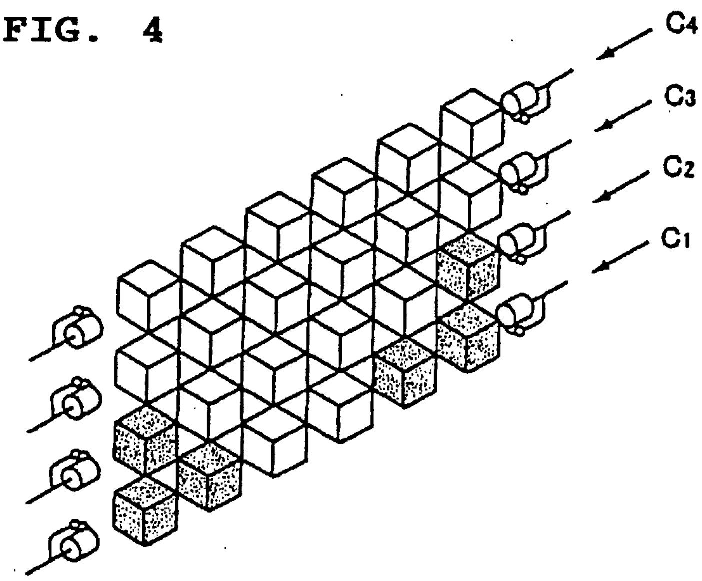


FIG. 5

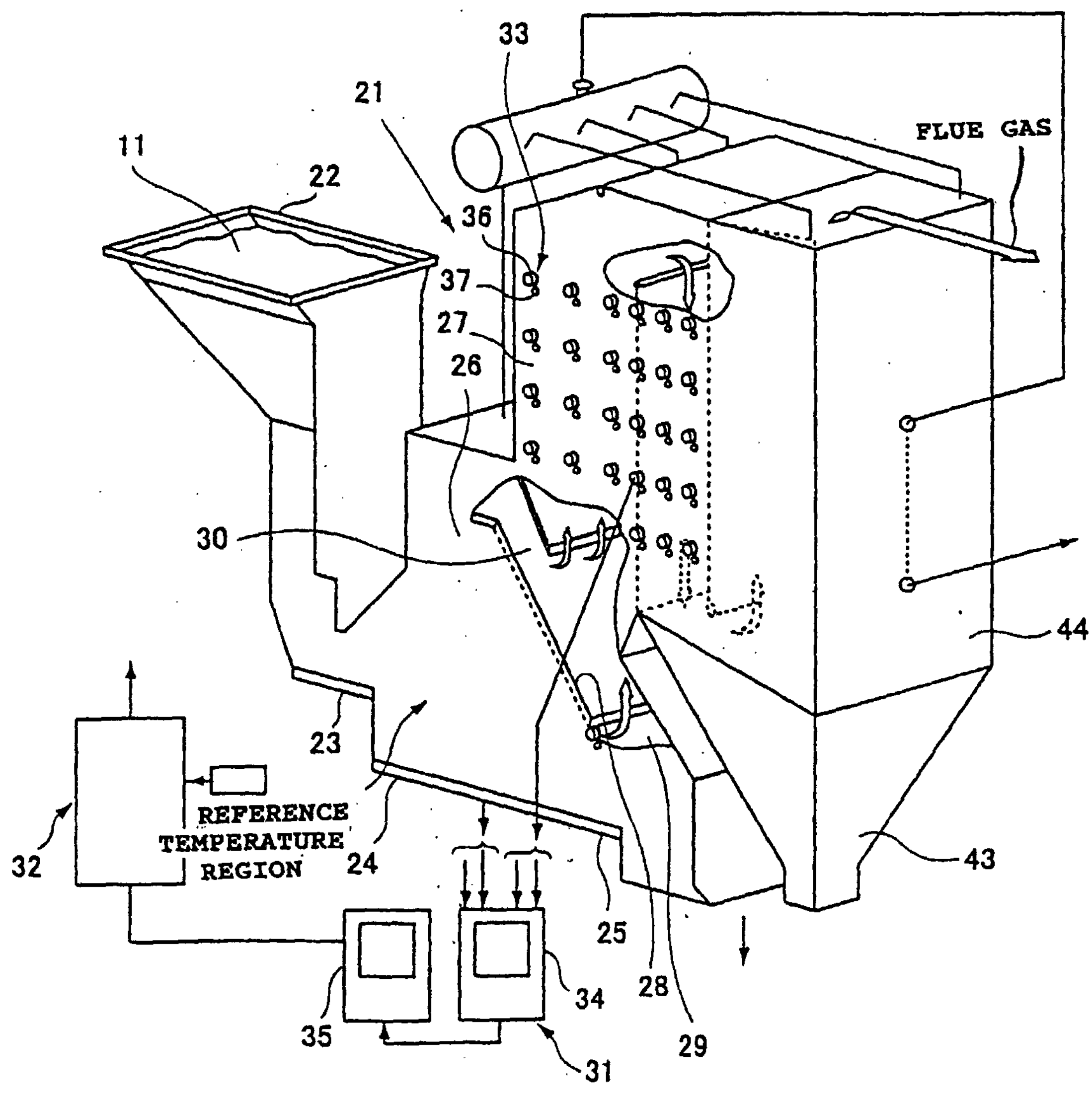

33
21
11
22
FLUE GAS
36
37
27
26
30
44
23
32
REFERENCE
TEMPERATURE
REGION
24
43
25
35
34
28
29
31

FIG. 6

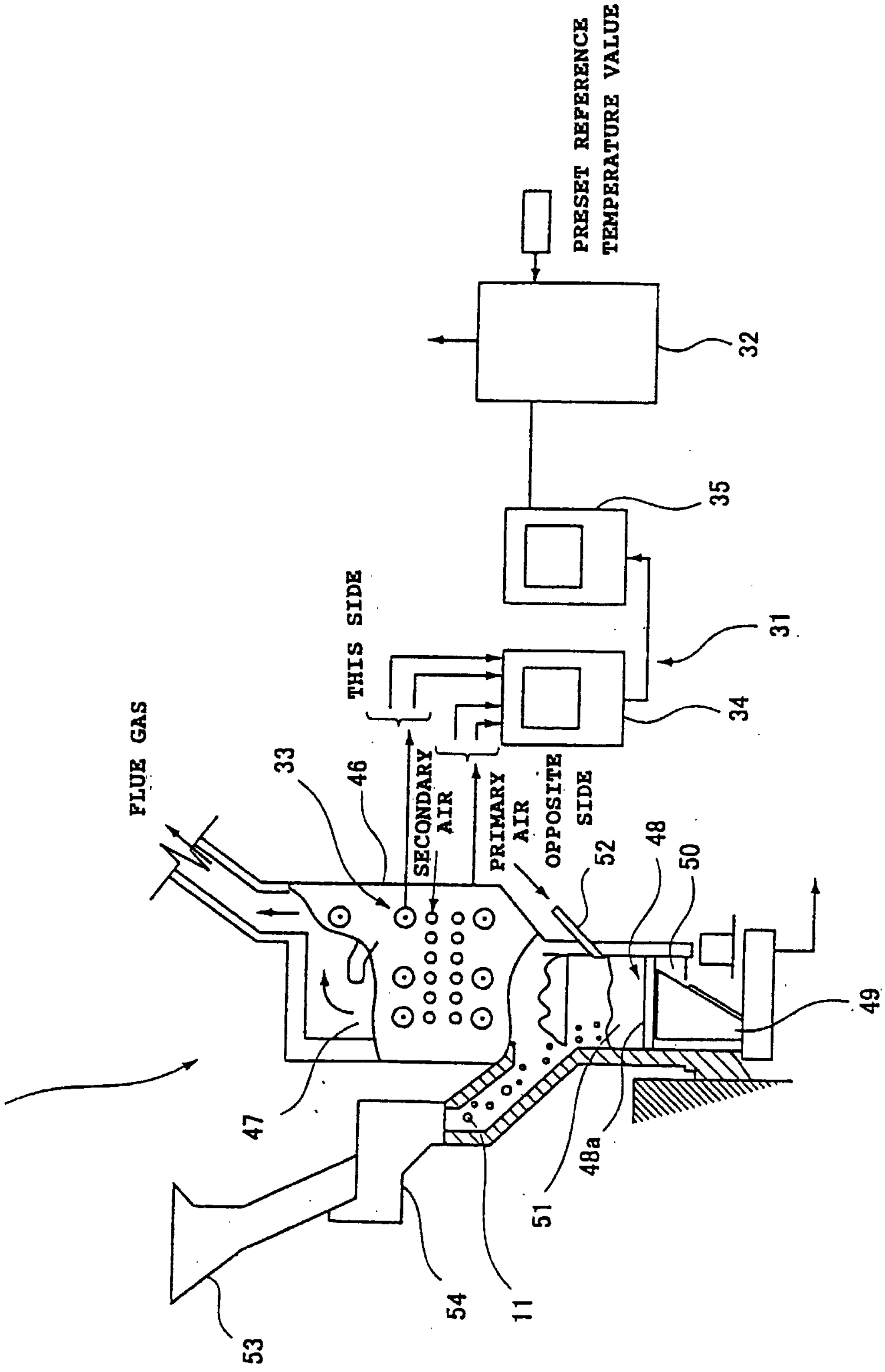
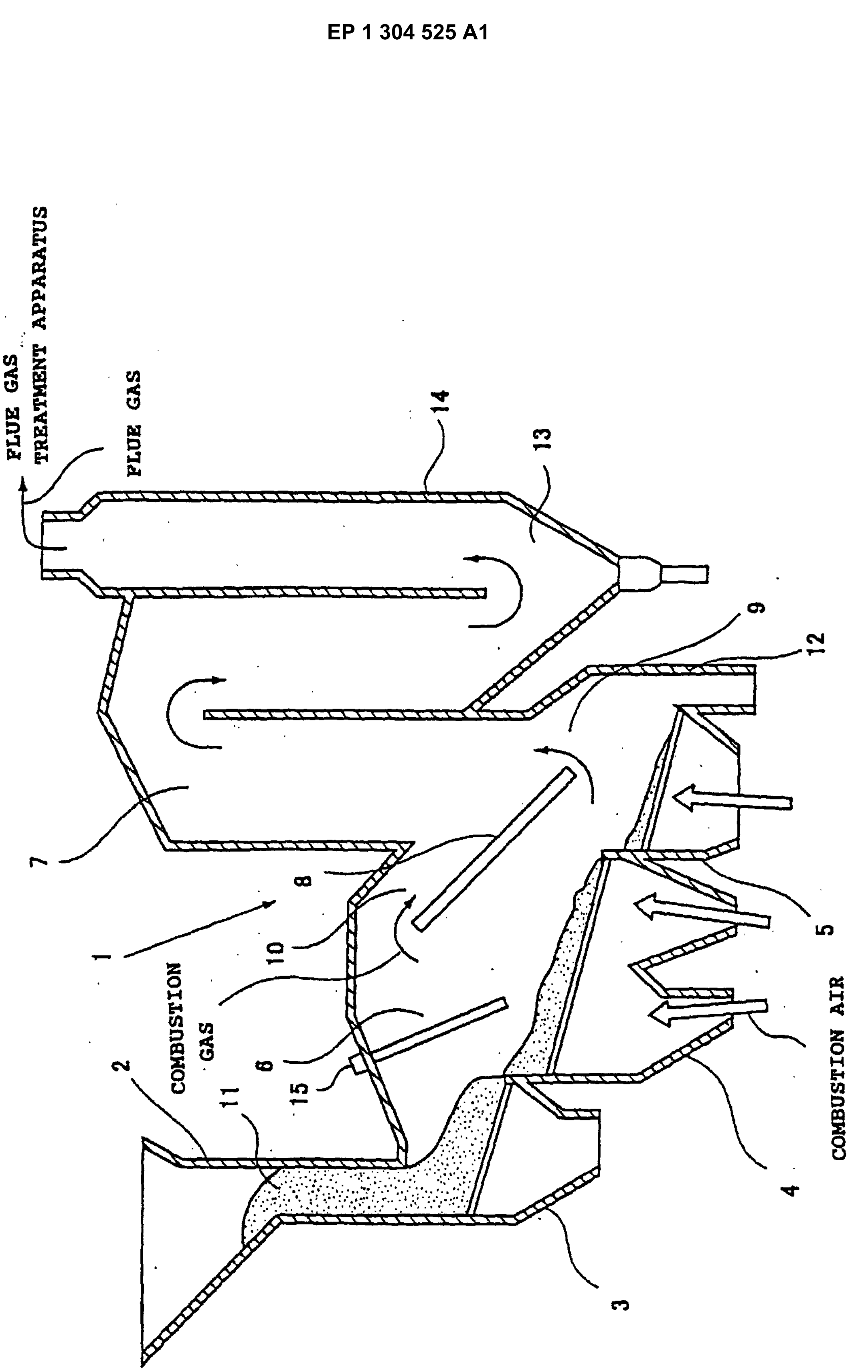
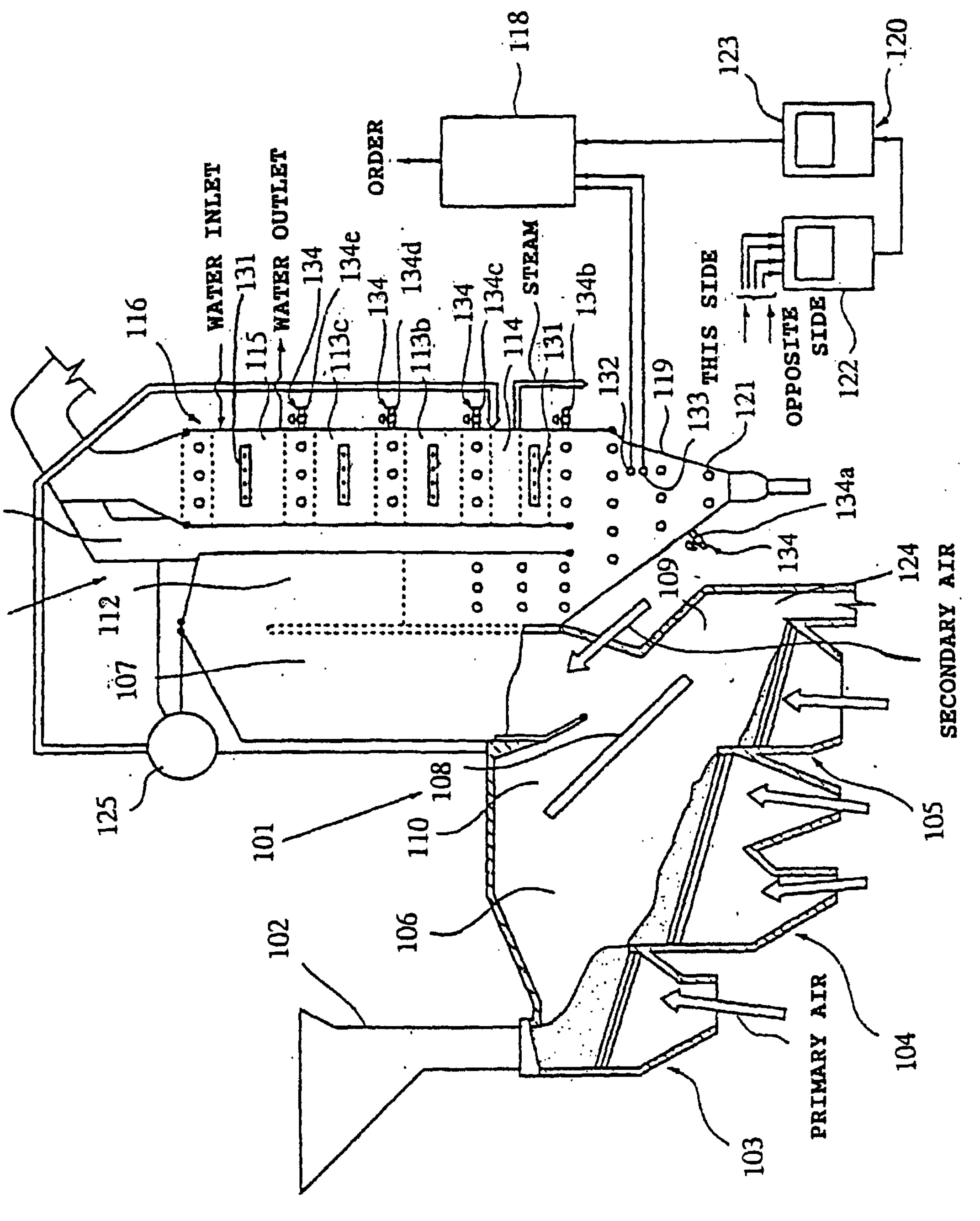

PRESET REFERENCE TEMPERATURE VALUE
32
35
31
34
THIS SIDE
OPPOSITE SIDE
SECONDARY AIR
PRIMARY AIR
FLUE GAS
33
46
52
48
50
49
45
47
48a
51
11
54
53

FIG. 7



FLUE GAS
TREATMENT APPARATUS
FLUE GAS
14
13
9
12
7
8
1
10
COMBUSTION
GAS
2
11
6
15
5
COMBUSTION AIR
4
3

FIG. 8



WATER INLET
WATER OUTLET
STEAM
ORDER
THIS SIDE
OPPOSITE SIDE
PRIMARY AIR
SECONDARY AIR
101
102
103
104
105
106
107
108
109
110
111
112
113b
113c
114
115
116
117
118
119
120
121
122
123
124
125
131
132
133
134
134a
134b
134c
134d
134e

FIG. 9

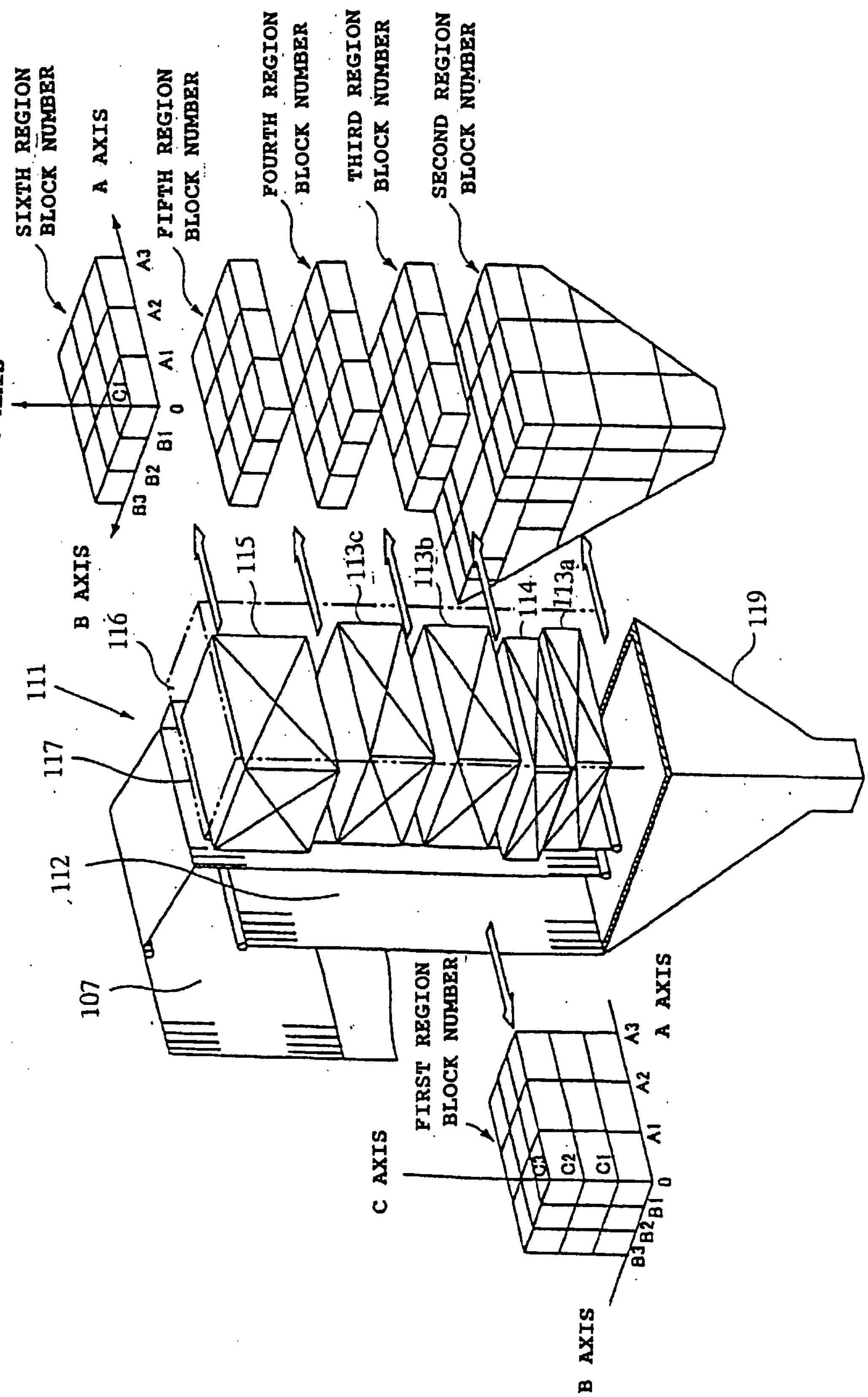

SIXTH REGION BLOCK NUMBER
A AXIS
FIFTH REGION BLOCK NUMBER
FOURTH REGION BLOCK NUMBER
THIRD REGION BLOCK NUMBER
SECOND REGION BLOCK NUMBER
C AXIS
B AXIS
A1
A2
A3
B1
B2
B3
C1
C2
C3
0
115
113c
113b
113a
114
116
111
117
112
107
119
FIRST REGION BLOCK NUMBER

FIG. 10

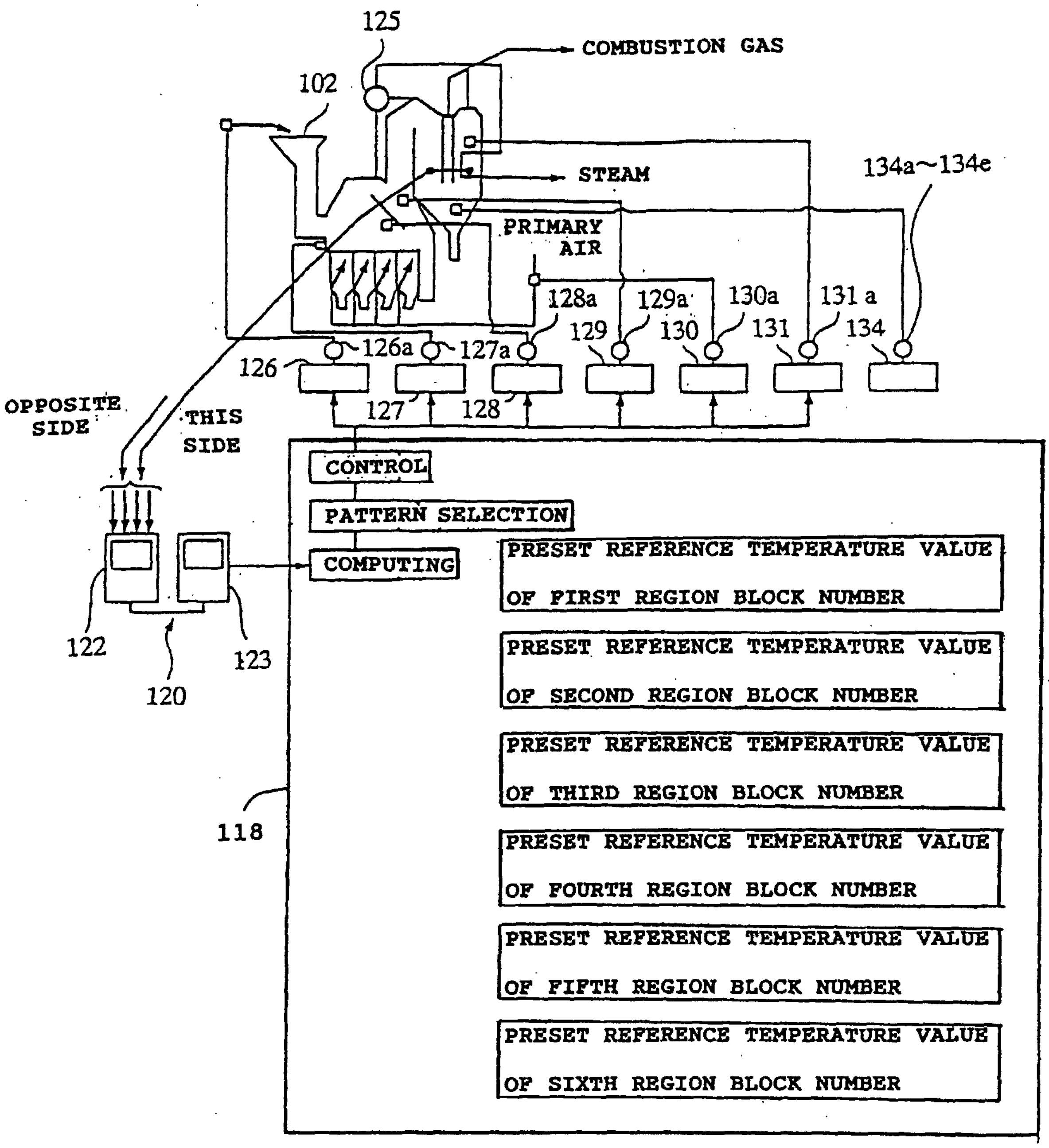

125
COMBUSTION GAS
102
STEAM
134a~134e
PRIMARY
AIR
128a
129a
130a
131 a
129
130
131
134
126a
127a
126
127
128
OPPOSITE
SIDE
THIS
SIDE
CONTROL
PATTERN SELECTION
COMPUTING
PRESET REFERENCE TEMPERATURE VALUE
OF FIRST REGION BLOCK NUMBER
PRESET REFERENCE TEMPERATURE VALUE
OF SECOND REGION BLOCK NUMBER
PRESET REFERENCE TEMPERATURE VALUE
OF THIRD REGION BLOCK NUMBER
PRESET REFERENCE TEMPERATURE VALUE
OF FOURTH REGION BLOCK NUMBER
PRESET REFERENCE TEMPERATURE VALUE
OF FIFTH REGION BLOCK NUMBER
PRESET REFERENCE TEMPERATURE VALUE
OF SIXTH REGION BLOCK NUMBER
122
123
120
118

FIG. 11

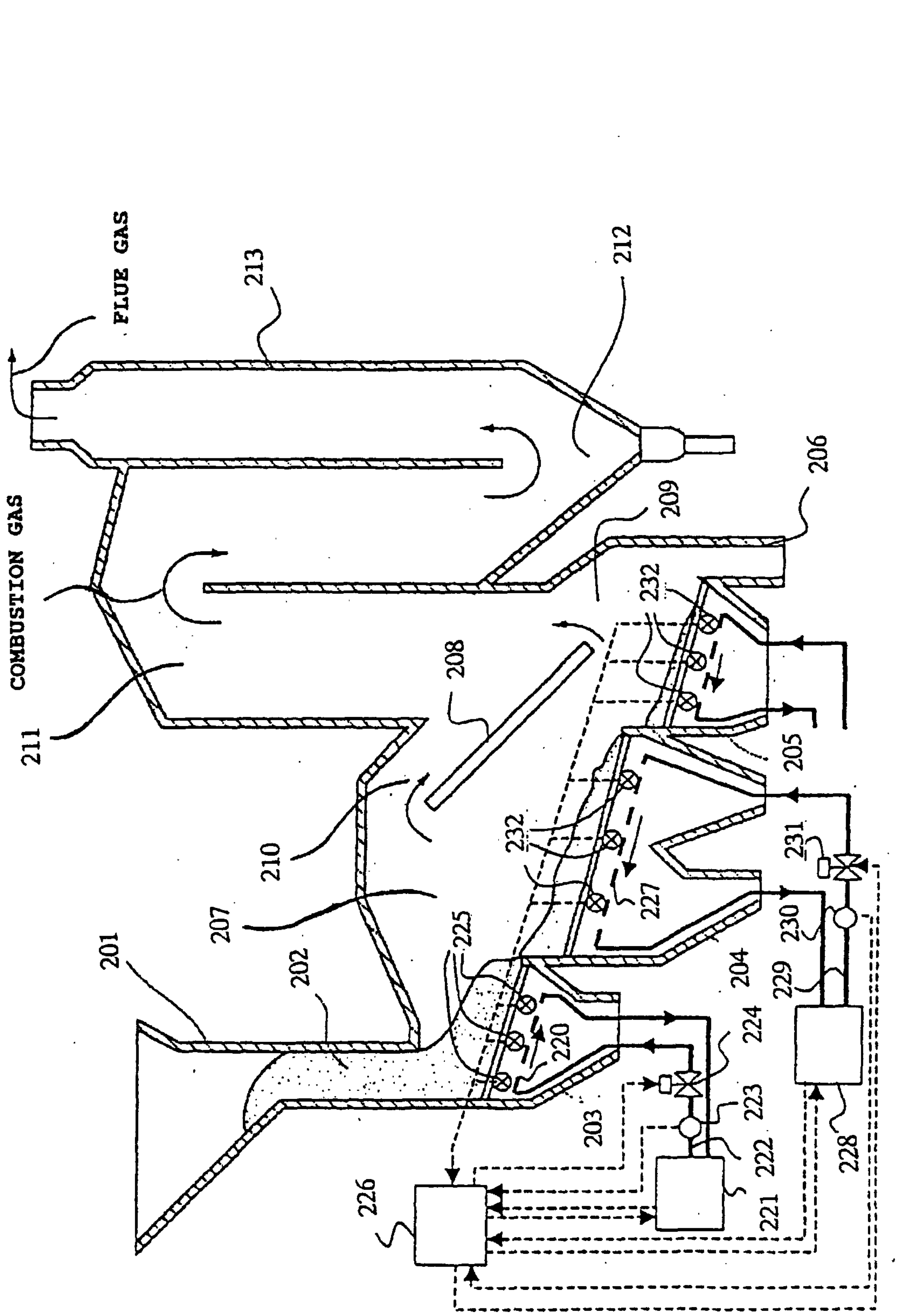
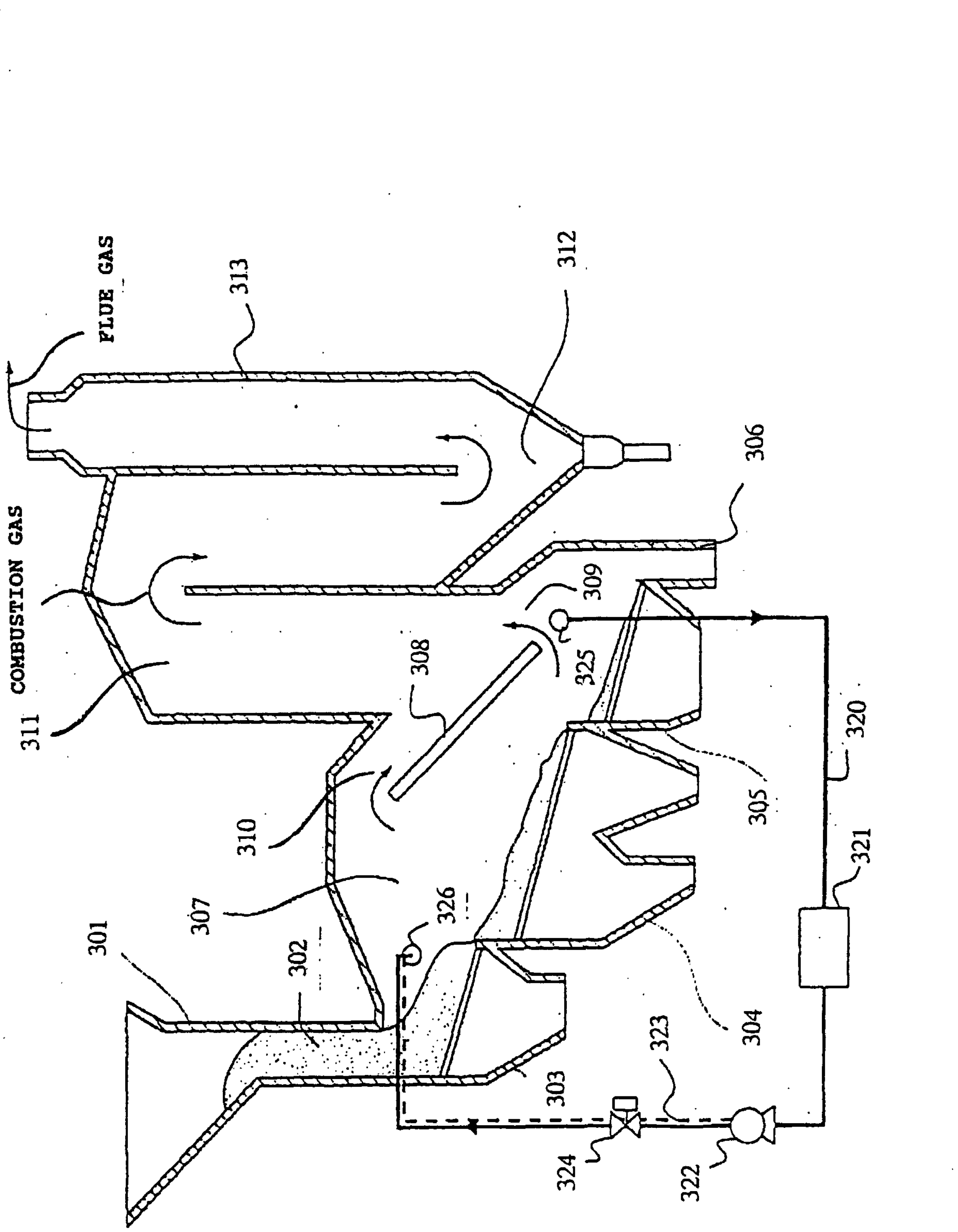

TO FLUE GAS TREATMENT APPARATUS
FLUE GAS
COMBUSTION GAS
201
202
203
204
205
206
207
208
209
210
211
212
213
220
221
222
223
224
225
226
227
228
229
230
231
232
232

FIG. 12


To FLUE GAS TREATMENT APPARATUS
FLUE GAS
COMBUSTION GAS
301
302
303
304
305
306
307
308
309
310
311
312
313
320
321
322
323
324
325
326

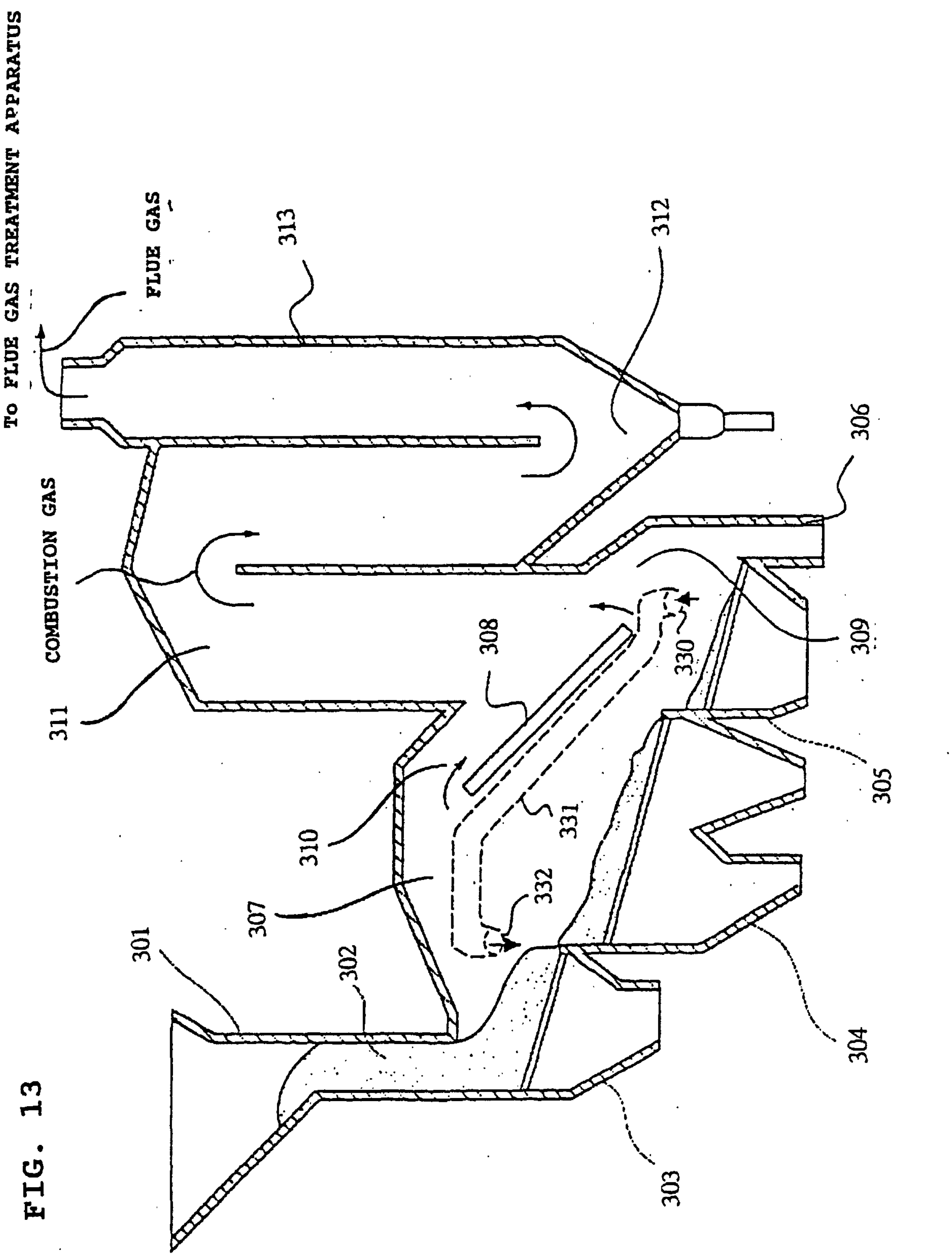

TO FLUE GAS TREATMENT APPARATUS
FLUE GAS
COMBUSTION GAS
313
312
306
311
308
309
330
305
310
331
307
332
301
302
304
303

FIG. 13

FIG. 14

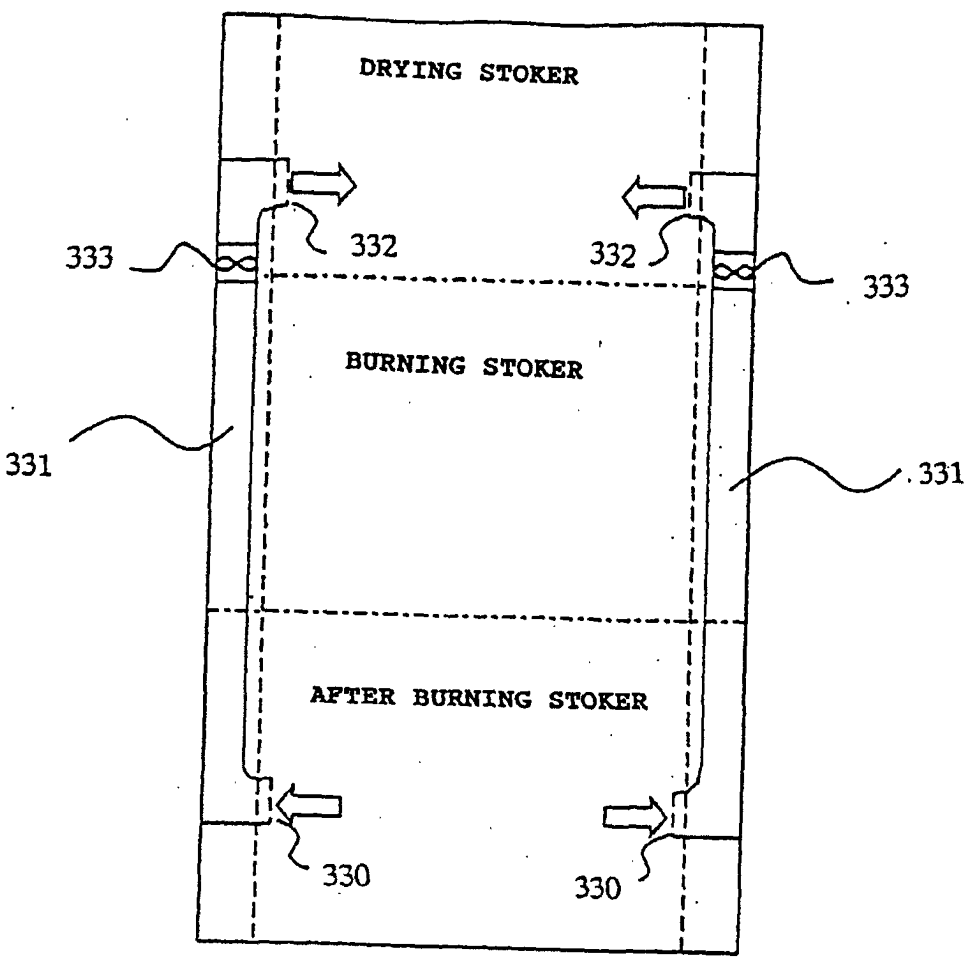

DRYING STOKER
332
332
333
333
BURNING STOKER
331
331
AFTER BURNING STOKER
330
330

FIG. 15

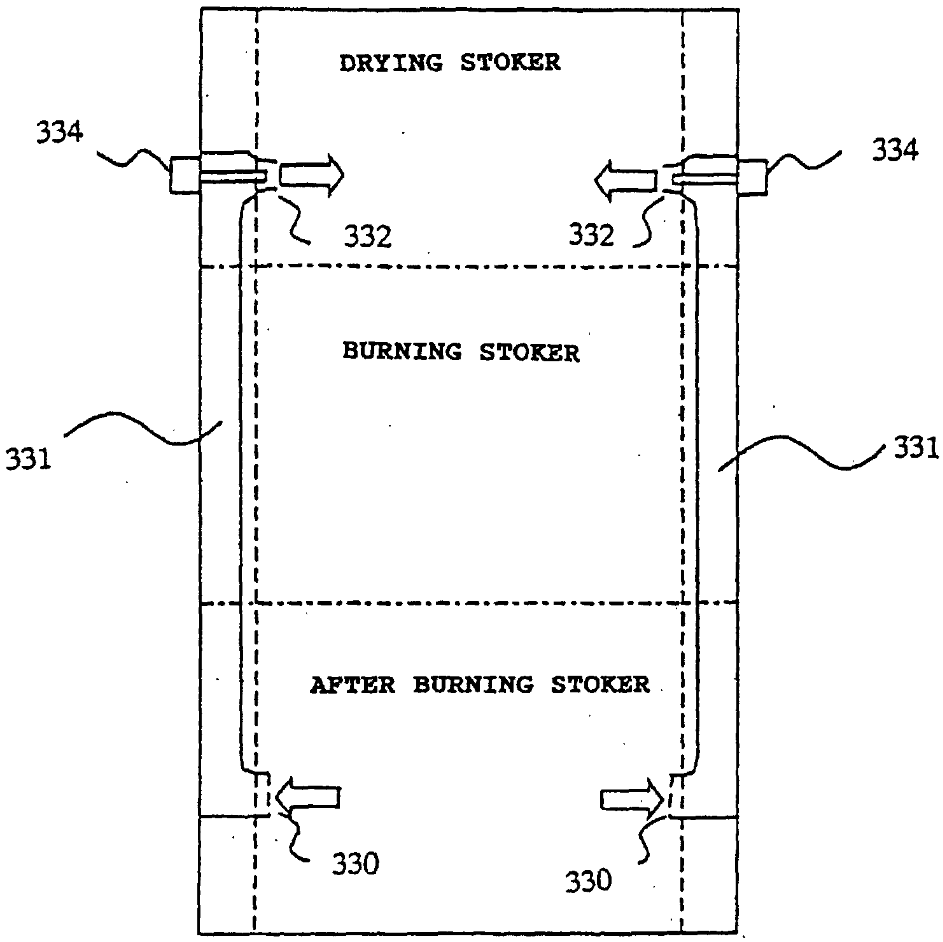

DRYING STOKER
334
334
332
332
BURNING STOKER
331
331
AFTER BURNING STOKER
330
330

FIG. 16

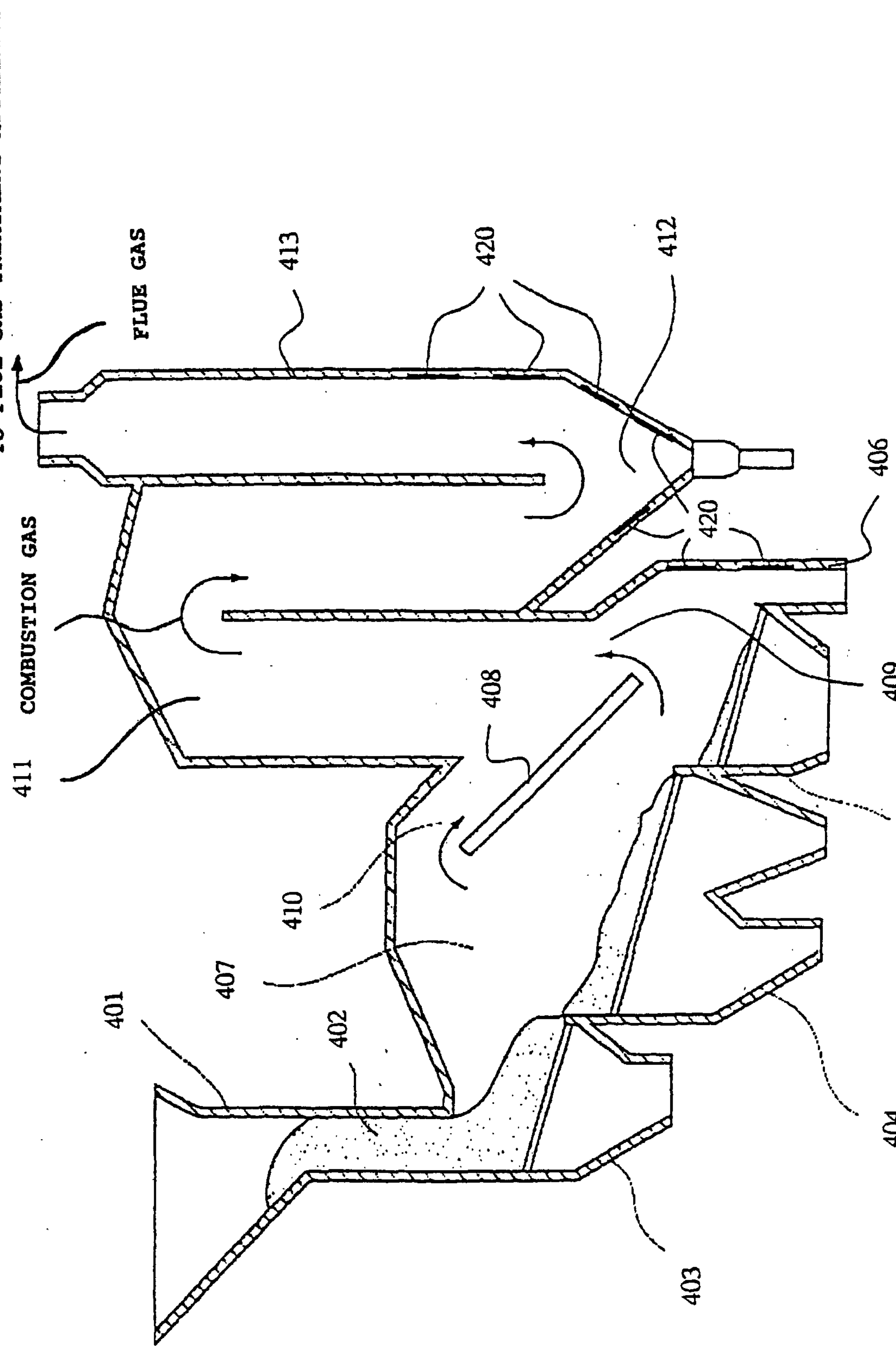

To FLUE GAS TREATMENT APPARATUS
FLUE GAS
COMBUSTION GAS
401
402
403
404
405
406
407
408
409
410
411
412
413
420
420

FIG. 17

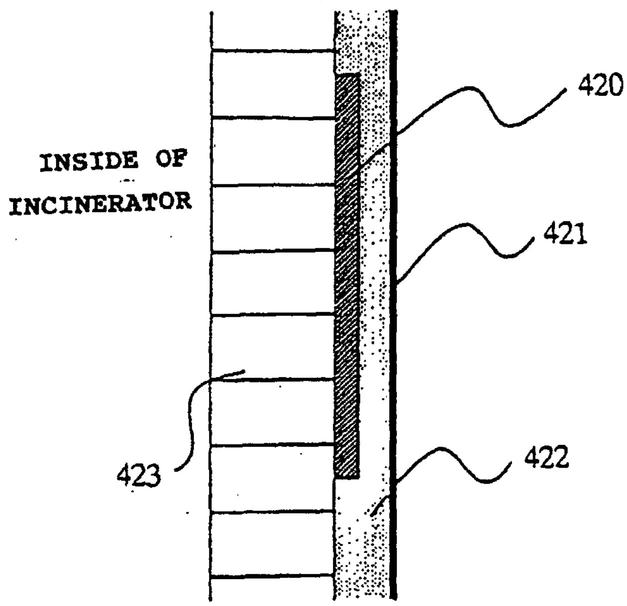

INSIDE OF INCINERATOR
420
421
422
423

FIG. 18

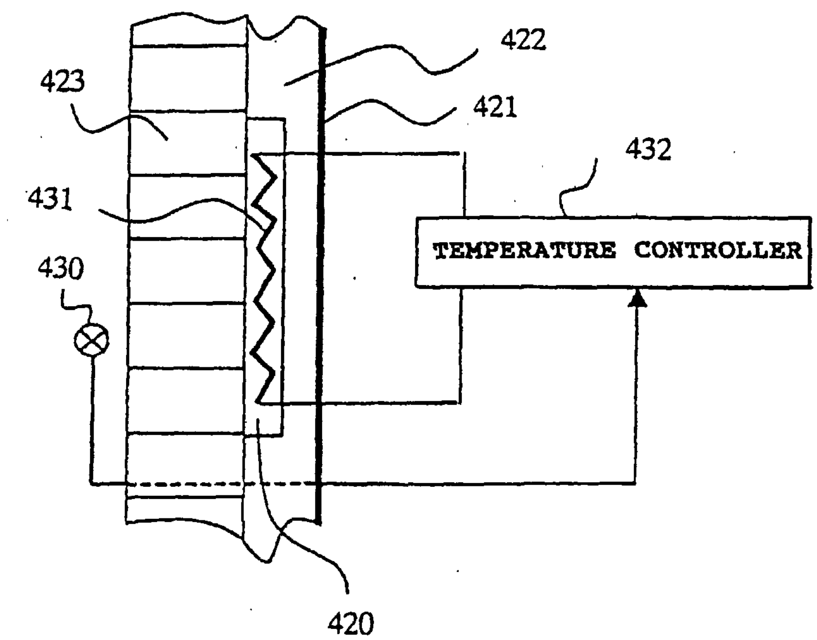

422
423
421
432
431
TEMPERATURE CONTROLLER
430
420

FIG. 19

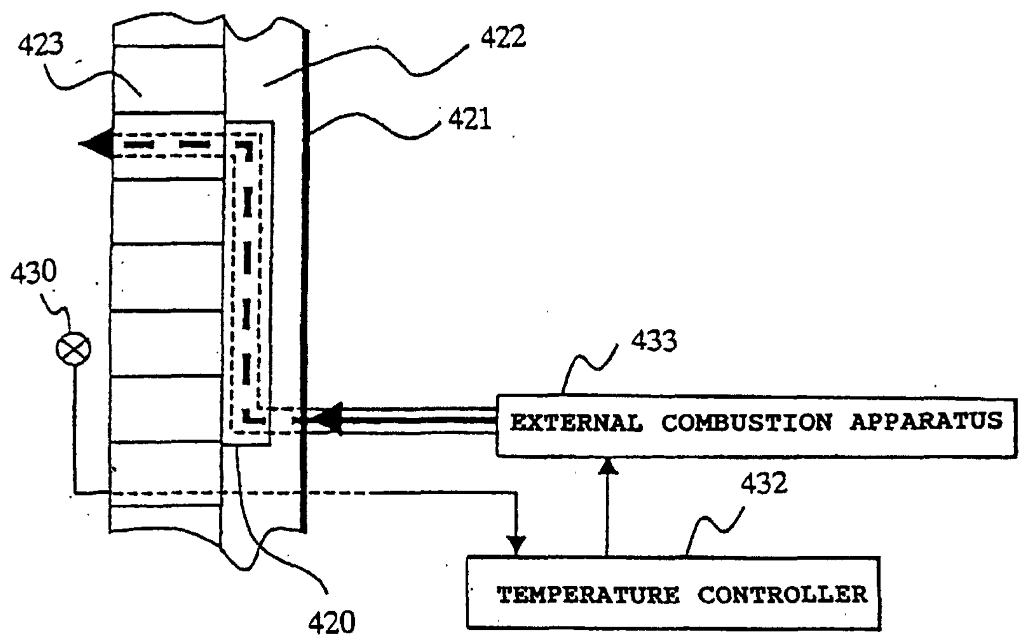

423
422
421
430
433
EXTERNAL COMBUSTION APPARATUS
432
TEMPERATURE CONTROLLER
420

FIG. 20

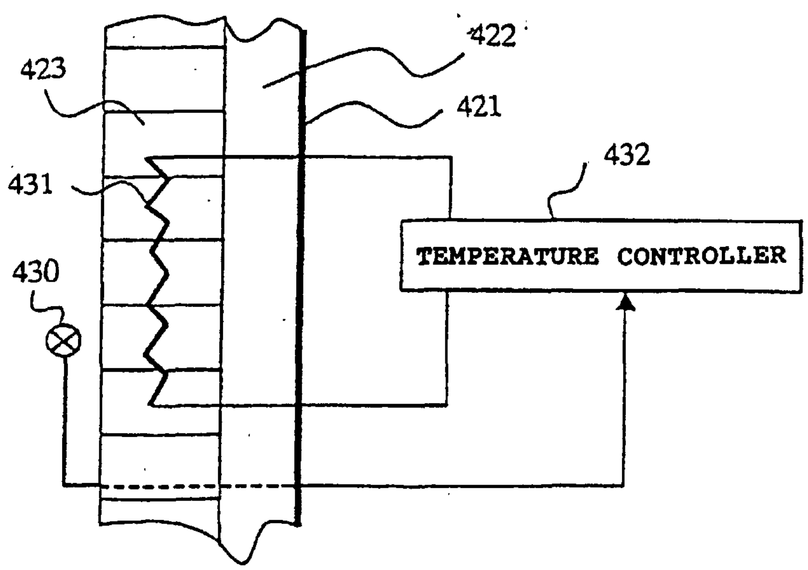

422
423
421
432
431
TEMPERATURE CONTROLLER
430

FIG. 21

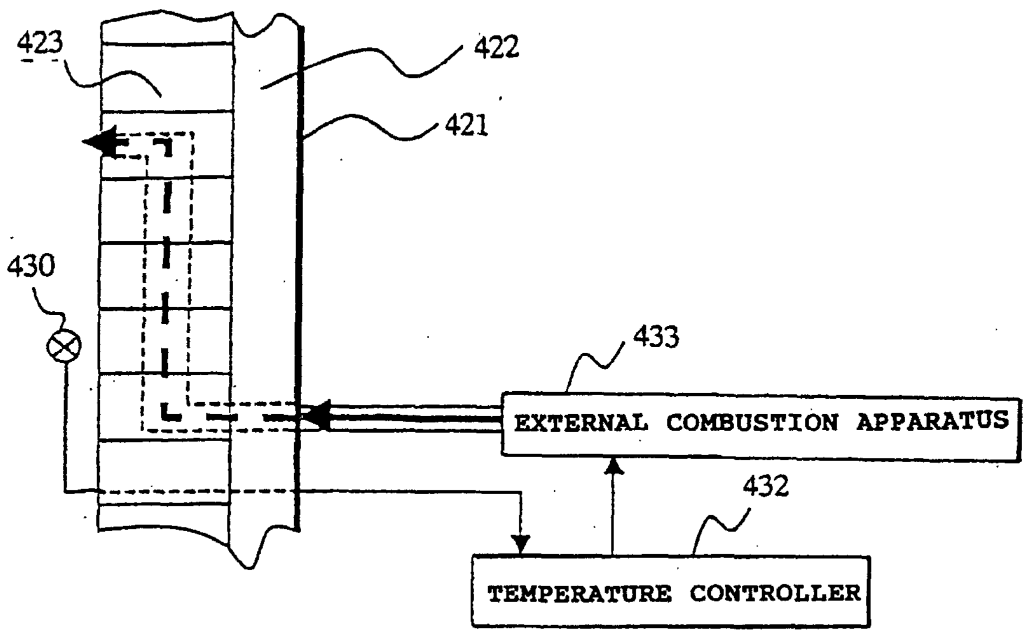

423
422
421
430
433
EXTERNAL COMBUSTION APPARATUS
432
TEMPERATURE CONTROLLER

FIG. 22

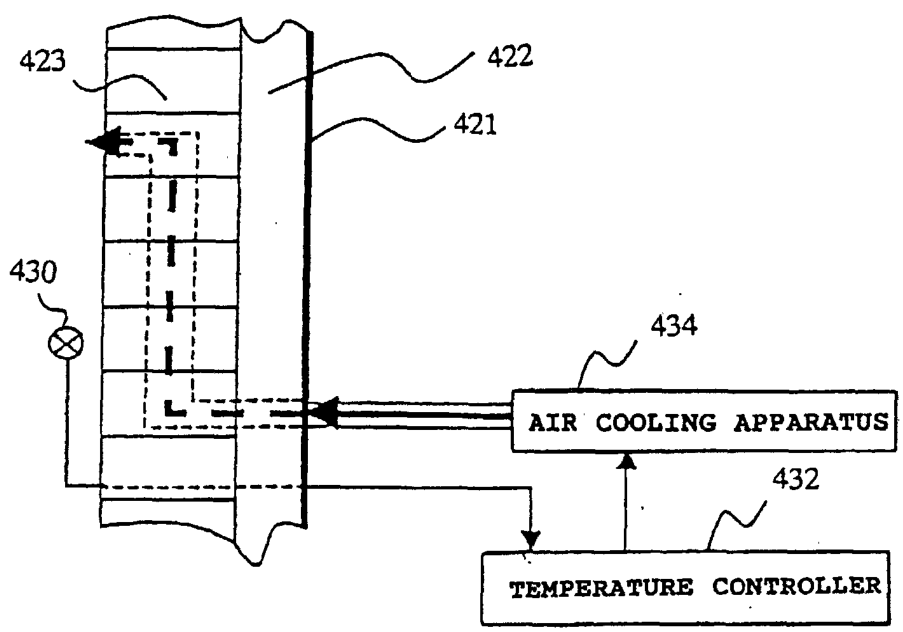
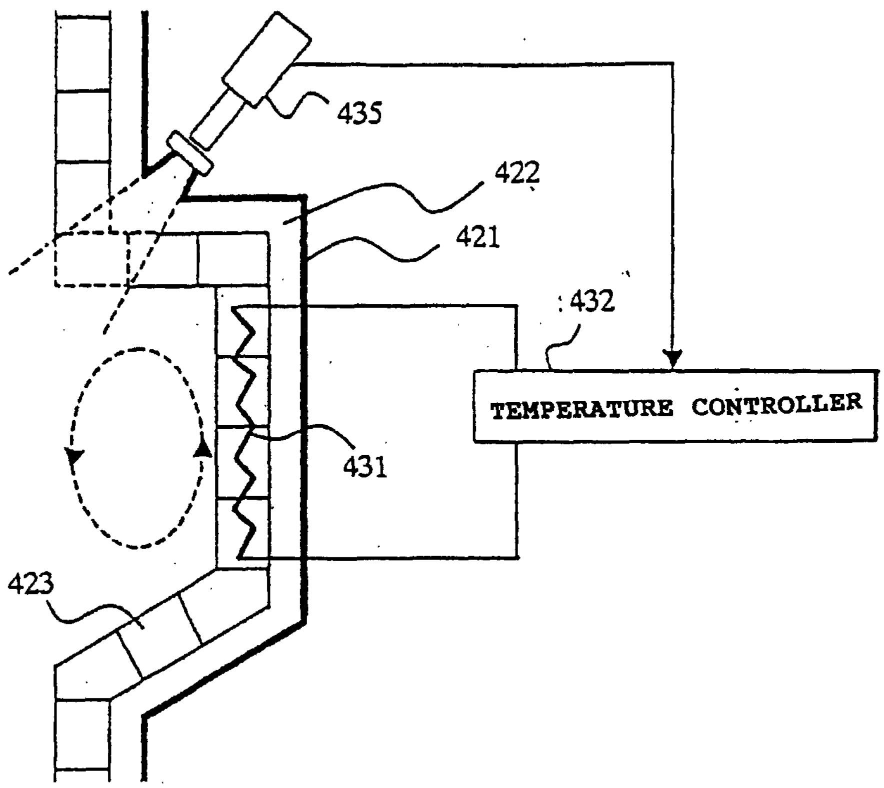

423
422
421
430
434
AIR COOLING APPARATUS
432
TEMPERATURE CONTROLLER

FIG. 23



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/05746

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F23G 5/50

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F23G 5/50, F23J 3/00

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

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Kokai Jitsuyo Shinan Koho	1971-2001	Jitsuyo Shinan Toroku Koho	1996-2001

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-318517 A (NKK Corporation), 04 December, 1998 (04.12.98), Full text; Fig. 1 (Family: none)	1-32
Y	JP 8-145812 A (Babcock-Hitachi K.K.), 07 June, 1996 (07.06.96), Full text; Fig. 1 (Family: none)	1-32
Y	JP 9-310834 A (Mitsubishi Heavy Industries, Ltd.), 02 December, 1997 (02.12.97), column 1, lines 2 to 8 (Family: none)	1-32
Y	JP 56-37409 A (Mitsubishi Heavy Industries, Ltd.), 11 April, 1981 (11.04.81), page 2, lower left column, line 10 to lower right column, line 11 (Family: none)	2,6-13,15, 19-23,28,32
Y	JP 6-34118 A (Kubota Corporation), 08 February, 1994 (08.02.94), Full text; Fig. 3 (Family: none)	3,5,9,10,12, 16,18,22

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

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 25 September, 2001 (25.09.01)	Date of mailing of the international search report 09 October, 2001 (09.10.01)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/05746

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 61-265540 A (The Tokyo Electric Power Company, Incorporated), 25 November, 1986 (25.11.86), page 1, left column, line 16 to right column, line 5; Fig. 5 (Family: none)	13,23
Y	JP 2-191784 A (Jujo Paper Co., Ltd.), 27 July, 1990 (27.07.90), Full text; Fig. 1 (Family: none)	24-32
Y	JP 59-38523 A (Babcock-Hitachi K.K.), 02 March, 1984 (02.03.84), Full text; Fig. 2 (Family: none)	27,31

Form PCT/ISA/210 (continuation of second sheet) (July 1992)