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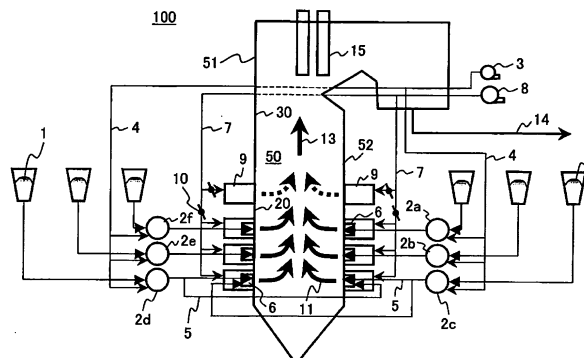
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(54) **Pulverized coal combustion boiler**

(57) A pulverized coal combustion boiler (100) comprising: a furnace (50); a plurality of burners (6) for supplying and burning pulverized coal fuel in the furnace arranged at positions of a plurality of stages having different heights on a furnace front wall (51) and a furnace rear wall (52) of furnace wall surfaces forming the furnace (50), the furnace rear wall (52) arranged for facing the

furnace front wall (51); a plurality of mills (2) arranged for supplying the pulverized coal fuel to the plurality of burners (6) arranged at each of the plurality of stages; and pulverized fuel pipes (5) arranged for distributing and supplying the pulverized coal to the plurality of burners (6) at each of the stages of the furnace front wall (51) and the furnace rear wall (52) from each of the plurality of mills (2).

FIG. 1



Description

BACKGROUND OF THE INVENTION

[Field of the Invention]

[0001] The present invention relates to a pulverized coal combustion boiler to burn pulverized coal.

[Description of Related Art]

[0002] In a conventional pulverized coal combustion boiler as shown in Japanese Application Patent Laid-Open Publication No. 2001-221406, one mill that produces and supplies pulverized coal is disposed on each of three burner stages (upper stage, middle stage, and lower stage) arranged on a furnace front wall and a furnace rear wall that constitute a furnace (six mill total).

[0003] The feed rate of supplying coal to the boiler is reduced to lower the heat output in the furnace when the pulverized coal combustion boiler having such a configuration is in a partial load operation. However, among the six mills in which one mill is arranged on each of the three burner stages on each of the furnace front wall and the furnace rear wall, the operation of some of the mills are sequentially halted in accordance with the load and the decrease in the heat output of the pulverized coal combustion boiler, because the amount of coal that has to be pulverized in the mill decreases.

[0004] When water pipes that form a water wall (also called water pipe wall) of the furnace are vertically arranged, the following problem occurs. In the pulverized coal combustion boiler that performs the variable pressure operation for changing the vapor pressure generated by controlling the combustion rate of the fuel in the boiler for improving the thermal efficiency during the partial load, once the deviation occurs to the pulverized coal fuel supplied into the furnace from the burners when the water pipes vertically arranged on the water wall of the furnace are utilized, the heat load concentrates locally in the furnace, and nucleate boiling departure phenomenon occurs to the vapor of the subcritical pressure region in the water pipes.

[0005] This may result in the heat transfer deterioration and may lead to an insufficient cooling effect of water wall pipes (also called water pipes) of the furnace. The pipe wall temperature of the water pipes may rapidly increase and surpass the allowable temperature of the materials of the water wall pipes, thereby causing breakdown.

[0006] To control a significant increase in the pipe wall temperature of the water pipes of the furnace caused by the nucleate boiling departure in which the nucleate boiling departs to the film boiling, there is a method of sufficiently increasing the mass flow rate of the fluid flowing through the water pipes and preventing the local concentration of the heat load to avoid the increase of the pipe wall temperature caused by the nucleate boiling departure.

ture.

[0007] However, to achieve the method, installation of an orifice or the like at inlets of the water pipes is required for controlling the in-pipe flow rate to maintain the flow rate balance of the fluid, which greatly complicates the configuration of the boiler.

[0008] A technology for solving the problem is disclosed in Japanese Patent No. 3091220 in which the mass flow rate in the water pipes is set less than a predetermined rate, and the pressure loss in pipe is made hydrostatic-head dominant to decrease the relative ratio of the friction pressure loss and the acceleration pressure loss, so that the natural circulation characteristics can be obtained.

[0009] Patent Document 1: Japanese Application Patent Laid-Open Publication No. 2001-221406

[0010] Patent Document 2: Japanese Patent No. 3091220

SUMMARY OF THE INVENTION

[0011] In the pulverized coal combustion boiler described in Japanese Application Patent Laid-Open Publication No. 2001-221406, the operation of some of the mills among the six mills in which one mill is arranged on each of the three burner stages arranged on the furnace front wall and the furnace rear wall must be halted in accordance with the decrease in the heat output of the pulverized coal combustion boiler because the amount of coal that has to be pulverized in the mill decreases during the partial load operation of the boiler.

[0012] In the pulverized coal combustion boiler described in Japanese Application Patent Laid-Open Publication No. 2001-221406, all burners on one stage of the burner stages of either the furnace front wall or the furnace rear wall are turned off when the operation of some of the mills are halted for the partial load operation.

[0013] This results in a substantial difference in the heat absorbing balance between the furnace front wall and the furnace rear wall. As a result, the fluid temperature of water pipe outlets provided in the plurality of water pipe walls that constitute the furnace wall surfaces of the furnace front wall and the surface rear wall becomes imbalanced and the elongation of the water pipes are varied so that the thermal stress is generated on the furnace wall surfaces, which may damage the furnace wall surfaces.

[0014] In the boiler that performs the variable pressure operation as described in Japanese Patent No. 3091220, if the burners that supply the pulverized coal fuel to the furnace are arranged so as to face each other on the vertical water wall pipes of the furnace front wall and the furnace rear wall of the furnace, the deviation of the pulverized coal fuel supplied into the furnace from the burners arranged on the furnace front wall and the furnace rear wall causes the deviation of the distribution of the heat load of fuel burning. This is reflected in the fluid temperature of the outlets of the water wall pipes of the

furnace, causing imbalanced temperatures of the vapor generated in the water wall pipes.

[0015] The reason that the deviation occurs to the distribution of the heat load in the furnace is that the feed pipes are arranged such that the mills in operation supply the pulverized coal to the burners of either the furnace front wall or the furnace rear wall during partial operation of the coal pulverizing mills that produce the pulverized coal fuel in accordance with the partial load of the boiler. This causes a significant difference in the feed rate of the pulverized coal supplied into the furnace from the burners between the furnace front wall and the furnace rear wall of the furnace.

[0016] The imbalance of the heat load occurring in the once-through boiler furnace is not a local deviation between water wall pipes arranged adjacently. Therefore, the imbalance of the vapor temperatures generated in the water wall pipes routinely occurs unless these plurality of water wall pipes are connected by a single header throughout the inner periphery of the furnace.

[0017] Thus, the nucleate boiling departure may occur in the subcritical pressure region of the vapor in the water wall pipes as a result of the imbalance of the heat loads associated with the deviation in the fuel supplied from the burners provided at the water wall pipes of the furnace front wall and the furnace rear wall of the furnace. Consequently, the heat transfer deterioration may result in an insufficient cooling effect of the furnace water wall pipes, causing a significant increase in the pipe wall temperature of the furnace water wall pipes.

[0018] In addition, the connection of the plurality of water wall pipes by the single header is not practical in that the arrangement of the water wall pipes and the header becomes very complicated, thereby complicating the configuration of the boiler.

[0019] The arrangement of opposed burners at the water wall pipes of the furnace front wall and the furnace rear wall of the once-through boiler is excellent in ensuring the combustion performance in a wide load range because of the configuration that is advantageous for the stable retention of the combustion flames by the burners alone. However, because of the imbalance problem of the generated vapor temperatures, the application of the combustion method in which the opposed burners are arranged at the water wall pipes of the furnace front wall and the furnace rear wall of the furnace is difficult when the water walls of the once-through boiler furnace are formed with vertically arranged water wall pipes.

[0020] A first object of the present invention is to provide a pulverized coal combustion boiler for leveling heat loads of the plurality of water pipes constitute the furnace wall surfaces of the furnace in the entire load range to control the thermal stress generated in the furnace water pipes, enhancing safety of the furnace wall surfaces and extending life of the pulverized coal combustion boiler.

[0021] A second object of the present invention is to provide a pulverized coal combustion boiler having opposed burners placed at the water pipes vertically ar-

ranged on the furnace front wall and the furnace rear wall for making the heat loads in the furnace uniform to control an increase in the pipe wall temperatures of the water pipes of the furnace.

[0022] The pulverized coal combustion boiler of the present invention comprises: a furnace; a plurality of burners for supplying and burning pulverized coal fuel in a furnace arranged at positions of a plurality of stages having different heights on a furnace front wall and a furnace rear wall of furnace wall surfaces forming the furnace, the furnace rear wall arranged for facing the furnace front wall; a plurality of mills arranged for supplying the pulverized coal fuel to the plurality of burners arranged at each of the plurality of stages; and pulverized fuel pipes arranged for distributing and supplying the pulverized coal to the plurality of burners at each of the stages of the furnace front wall and the furnace rear wall from each of the plurality of mills.

[0023] According to the present invention, a pulverized coal combustion boiler for leveling heat loads of the water pipes constitute the furnace wall surfaces of the furnace in the entire load range to control the thermal stress generated in the furnace water pipes, enhancing safety of the furnace wall surfaces and extending life of the pulverized coal combustion boiler can be realized.

[0024] Also, according to the present invention, a pulverized coal combustion boiler having opposed burners placed at the water pipes vertically arranged on the furnace front wall and the furnace rear wall for making the heat loads in the furnace uniform to control an increase in the pipe wall temperature of the water pipes of the furnace can be realized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Fig. 1 is a schematic drawing of a pulverized coal combustion boiler system of a first embodiment of the present invention;

Fig. 2 is a block diagram of an arrangement of pulverized fuel pipes for supplying pulverized coal from mills to burners in the pulverized coal combustion boiler of the embodiment shown in Fig. 1;

Fig. 3 is a schematic bird's eye view of the pulverized coal combustion boiler of the embodiment shown in Fig. 1;

Fig. 4 is an explanatory drawing to show situations of turning on and off of the burners arranged on furnace wall surfaces of the embodiment and a comparative example in which the load is changed from the maximum heat output to 50% heat output;

Fig. 5 is a drawing of the amount of absorbed heat of each water pipe of the embodiment and a comparative example in water pipe walls that constitute furnace wall surfaces between burners and after air ports;

Fig. 6 is a schematic drawing of the arrangement

relationship of the mills and the burners in which the pulverized coal is supplied from the mills through the pulverized fuel pipes to the burners arranged on the furnace wall surface of the upper burner stage of the pulverized coal combustion boiler of the embodiment shown in Fig. 1;

Fig. 7 is a schematic drawing of an arrangement in the vertical direction of burner stages provided in a plurality of stages in the pulverized coal combustion boiler of the embodiment shown in Fig. 1;

Fig. 8 is a schematic drawing of an arrangement in the vertical direction of burner stages provided in a plurality of stages in the pulverized coal combustion boiler of a second embodiment of the present invention;

Fig. 9 is a schematic drawing of the arrangement relationship of the mills and the burners in which the pulverized coal is supplied from the mills to the burners arranged on the furnace wall surface of the upper burner stage through the pulverized fuel pipes in the pulverized coal combustion boiler of a third embodiment of the present invention;

Fig. 10 is a schematic drawing of the arrangement relationship of the mills and the burners in which the pulverized coal is supplied from the mills to the burners arranged on the furnace wall surface of the upper burner stage through the pulverized fuel pipes in the pulverized coal combustion boiler of a fourth embodiment of the present invention;

Fig. 11 is a schematic drawing of the arrangement relationship of the mills and the burners in which the pulverized coal is supplied from the mills to the burners arranged on the furnace wall surface of the upper burner stage through the pulverized fuel pipes in the pulverized coal combustion boiler of a fifth embodiment of the present invention;

Fig. 12 is a schematic bird's eye view of the pulverized coal combustion boiler of a sixth embodiment of the present invention, in which spiral water pipes and vertical water pipes are directly connected, the spiral water pipes and the vertical water pipes defining the furnace wall surfaces of the pulverized coal combustion boiler;

Fig. 13 is a schematic drawing of the configuration of the pulverized coal combustion boiler of a seventh embodiment of the present invention;

Fig. 14 is a partial cross sectional view of the configuration of the furnace of the pulverized coal combustion boiler of one embodiment of the present invention in which the furnace of the pulverized coal combustion boiler of the embodiment of the present invention shown in Fig. 13 is cut in the X-X direction; Fig. 15 is a partial cross sectional view of the configuration of the furnace of the pulverized coal combustion boiler of another embodiment of the present invention in which the furnace of the pulverized coal combustion boiler of an eighth embodiment of the present invention shown in Fig. 13 is cut in the X-X

direction;

Fig. 16 is a partial cross sectional view of the configuration of the furnace of the pulverized coal combustion boiler of still another embodiment of the present invention in which the furnace of the pulverized coal combustion boiler of a ninth embodiment of the present invention shown in Fig. 13 is cut in the X-X direction;

Fig. 17 is a partial cross sectional view of the configuration of the furnace of the pulverized coal combustion boiler of another embodiment of the present invention in which the furnace of the pulverized coal combustion boiler of a tenth embodiment of the present invention shown in Fig. 13 is cut in the X-X direction;

Fig. 18 is a schematic drawing of a power plant of an eleventh embodiment having the pulverized coal combustion boiler of the present invention;

Fig. 19 is a schematic drawing of a power plant of a twelfth embodiment having the pulverized coal combustion boiler of the present invention;

Figs. 20A to 20C are distribution diagrams of vapor temperatures, in which outlet vapor temperatures of the water pipes of the furnaces are calculated, in relation to the pulverized coal combustion boiler having a configuration of an embodiment of the present invention and the pulverized coal combustion boiler that does not employ an embodiment of the present invention for comparison.

[0026] Fig. 21 is a distribution diagram of an in-pipe mass flow rate, in which the in-pipe mass flow rate of the fluid flowing through the water pipes of the furnace is calculated, in the pulverized coal combustion boiler of an embodiment of the present invention; and

[0027] Fig. 22 is a schematic drawing of the pulverized coal combustion boiler in which the burners are deviated in the furnace height direction on the boiler front wall and the boiler rear wall in the seventh embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] A pulverized coal combustion boiler of embodiments of the present invention will now be described with reference to the drawings.

[First Embodiment]

[0029] A pulverized coal combustion boiler 100 of a first embodiment of the present invention will be described with reference to Fig. 1 and Fig. 2. In Fig. 1, the pulverized coal combustion boiler 100 of the present embodiment comprises a furnace 50. Furnace wall surfaces that constitute the furnace 50 comprise a furnace front wall 51 constituting a wall surface of the furnace, a furnace rear wall 52 facing the furnace front wall 51, and a furnace sidewall 53 (shown in Fig. 3) serving as a sidewall

between the furnace front wall 51 and the furnace rear wall 52. The furnace wall surfaces surround the furnace 50 so as to form a furnace combustion space in the furnace 50.

[0030] Water pipe walls 20 on which a multiplicity of water pipes are arranged in spirals are provided on the inner walls of the furnace wall surfaces that constitute the furnace 50. The water pipes of the multiplicity of the water pipe walls 20 absorb part of the combustion heat generated by burning the pulverized coal fuel in the furnace combustion space formed in the furnace 50 surrounded by the multiplicity of the water pipe walls 20. The water flowing in the water pipes of the water pipe walls 20 is then heated, and the vapor is generated.

[0031] The combustion heat generated in the furnace combustion space in the furnace 50 flows down the inside of the furnace 50 and is mainly recovered by the sequential heat exchange with a plurality of heat exchangers 15 arranged in the furnace 50 at the furnace downstream.

[0032] The combustion gas generated by burning the pulverized coal fuel in the furnace combustion space in the furnace 50 flows from the down side toward the upper side in the furnace 50. After the combustion, the combustion gas flows down a rear heat transfer unit (not shown) arranged at the downstream in the furnace 50 and exchanges the heat with the rear heat transfer unit, and thus the heat included in the combustion gas is further recovered.

[0033] A plurality of burners 6 are arranged in the lower part of the furnace front wall 51 of the furnace 50 and the lower part of the furnace rear wall 52 facing the furnace front wall 51, and flames with insufficient air are formed by the burners 6.

[0034] A plurality of burners 6 are arranged on each of the furnace front wall 51 and the furnace rear wall 52 (six burners for each in the present embodiment) so as to face each other, constituting an opposed firing system in which the burners on the furnace front wall 51 and the furnace rear wall 52 face each other.

[0035] Coal 1 serving as fuel is pulverized by the mills 2 to form the pulverized coal having the particle diameter of about several tens μm , and subsequently, is conveyed by conveying air 4 supplied from a blower 3 to the mills 2 for conveying the pulverized coal. The pulverized coal is supplied along with the conveying air 4 to each of the burners 6 through coal feeding pipes, and the pulverized coal is injected into the furnace 50 from each of the burners 6 and burned.

[0036] A plurality of after air ports 9 is arranged on the wall surfaces of the furnace 50 at the downstream of the burners 6 and supply the after air into the furnace 50.

[0037] As is the case with the burners 6, the six after air ports 9 are arranged on each of the furnace front wall 51 and the furnace rear wall 52. The after air ports 9 installed on the furnace front wall 51 and the after air ports 9 installed on the furnace rear wall 52 are arranged such that they face each other.

[0038] Combustion air 7 supplied from a blower 8 is

supplied to each of the burners 6 and each of the after air ports 9 after preheating. The flow rate of the combustion air supplied to the burners 6 is controlled by flow rate control valves 10 so that the reduced-combustion is performed near the burners. The flow rate of the air is about 80% of the air flow rate required for the complete combustion of the pulverized coal supplied to the burners 6.

[0039] A reducing combustion gas 11 generated after the combustion of the pulverized coal supplied into the furnace 50 from the burners 6 is injected from the burners 6 toward the center inside the furnace 50. The reducing combustion gas 11 then collides with a reducing combustion gas 11 generated after the combustion of the pulverized coal supplied from the opposing burners 6.

[0040] The collided reducing combustion gases 11 then move upward to the downstream in the furnace 50, and they are mixed with the combustion air supplied from the after air ports 9 arranged at the downstream of the wall surfaces of the furnace 50 at the upper side of the burners 6. The collided reducing combustion gases 11 are then completely burned (oxidized).

[0041] The combustion method of oxidizing after reducing is known as a combustion system (two-stage combustion) for controlling the generation of unburned combustibles such as nitrogen oxide and carbon monoxide.

[0042] A combustion gas 13 generated by completely burning the reducing combustion gas 11 with the combustion air supplied from the after air ports 9 flows down the furnace 50 and is discharged to a flue 14 outside the furnace 50.

[0043] Heat exchangers 15 constituted by a heat transfer pipe group are arranged in the furnace 50 between the upper part of the furnace 50 and the flue 14. The heat exchangers 15 recover the heat by exchanging heat with the combustion gas 13.

[0044] The pulverized coal supplied along with the conveying air from the burners 6 into the furnace 50 through the pulverized fuel pipes 5 is burned in the furnace 50, and the combustion gas 11 of over 1000 °C is generated in the furnace 50 by combustion.

[0045] Water pipe walls 20 comprising a multiplicity of water pipes arranged in spirals are installed on the inner walls of the furnace wall surfaces of the furnace 50. The multiplicity of water pipes of the water pipe walls 20 absorb the heat of the combustion gas 11 generated by burning the pulverized coal.

[0046] The water that flows through water pipes 19 of the water pipe walls 20 flows from a lower part to an upper part of the furnace 50 shown in Fig. 3.

[0047] Six burners 6 are arranged on the furnace wall surfaces at each of the burner stages divided into an upper stage, a middle stage, and a lower stage at different heights on the furnace front wall 51 and the furnace rear wall 52 of the furnace wall surfaces of the furnace 50. The six burners 6 installed on each of the three burner stages are arranged such that the burners 6 on the furnace front wall 51 and the burners 6 of the furnace rear

wall 52 face each other.

[0048] Two mills 2 are arranged on each of the burner stages divided into the upper stage, the middle stage, and the lower stage (six mills total in the upper stage, the middle stage, and the lower stage) on the furnace front wall 51 and the furnace rear wall 52 of the furnace wall surfaces on which the burners 6 are arranged.

[0049] For example, as shown in Fig. 1 and Fig. 2, as for the six burners 6 arranged on each of the furnace front wall 51 and the furnace rear wall 52 forming the lower burner stage, the pulverized fuel pipes 5 for supplying the pulverized coal fuel from two mills 2d and 2c arranged on one side of the furnace sidewall 53 are alternately connected to every burner 6 arranged on each of the furnace front wall 51 and the furnace rear wall 52.

[0050] More specifically, as for the six burners 6 arranged on the furnace front wall 51, the pulverized fuel pipes 5 for supplying the pulverized coal fuel from the two mills 2d and 2c are alternately connected to three burners 6c and three burners 6d respectively. As for the six burners 6 arranged on the furnace rear wall 52, the pulverized fuel pipes 5 for supplying the pulverized coal fuel from the two mills 2d and 2c are alternately connected to three burners 6c and three burners 6d respectively.

[0051] As shown in Figs. 2, 3, and 6 in detail, as for the six burners 6 arranged on each of the furnace front wall 51 and the furnace rear wall 52 forming the upper burner stage of the furnace wall surface, the pulverized fuel pipes 5 for supplying the pulverized coal fuel from two mills 2f and 2a arranged on one side of the furnace sidewall 53 are alternately connected to three burners 6a and three burners 6f on the furnace front wall 51, and alternately to three burners 6a and three burners 6f on the furnace rear wall 52.

[0052] As for the six burners 6 arranged on each of the furnace front wall 51 and the furnace rear wall 52 forming the middle burner stage of the furnace wall surface, like the burners 6 arranged on the upper burner stage shown in Fig. 2 and Fig. 6, the pulverized fuel pipes 5 for supplying the pulverized coal fuel from two mills 2b and 2e arranged on one side of the furnace sidewall 53 are alternately connected to three burners 6b and three burners 6e respectively.

[0053] For the convenience of the description, the configuration of six burners 6 arranged on each of the furnace front wall 51 and the furnace rear wall 52 that form the upper burner stage will be mainly described below.

[0054] As for the six burners 6 arranged on each of the furnace front wall 51 and the furnace rear wall 52 forming the upper burner stage, the pulverized fuel pipes 5 for supplying the pulverized coal fuel from two mills 2f and 2a are alternately connected to respective three burners 6. As for the arrangement of the pulverized fuel pipes 5 that connect the two mills 2f and 2a with the burners 6 and that supply the pulverized coal, the pulverized coal is supplied from the mill 2f through the pulverized fuel pipes 5 to the second, fourth, and sixth burners 6f from the left of the six burners 6 arranged on the furnace front

wall 51, as shown in Fig. 6.

[0055] The pulverized coal is supplied from the mill 2a through the pulverized fuel pipes 5 to the first, third, and fifth burners 6a from the left of the six burners 6 arranged on the furnace front wall 51.

[0056] Similarly, as for the six burners 6 arranged on the furnace rear wall 52 that form the upper burner stage, the pulverized coal is supplied from the mill 2f through the pulverized fuel pipes 5 to the second, fourth, and sixth burners 6f from the left. The burners 6f on the furnace front wall 52 face the burners 6f, to which the pulverized coal is supplied from the same mill 2f, arranged on the furnace front wall 51.

[0057] The pulverized coal is supplied from the mill 2a through the pulverized fuel pipes 5 to the first, third, and fifth burners 6a from the left of the six burners 6 arranged on the furnace rear wall 52. The burners 6a on the furnace rear wall face the burners 6a, to which the pulverized coal is supplied from the same mill 2a, arranged on the furnace front wall 51.

[0058] Due to the limited space, of the pulverized fuel pipes 5 that connect the mill 2a and 2f with the burners 6 arranged on the upper burner stage, only the pulverized fuel pipes 5 arranged on the upper stage of the furnace wall surface of the furnace 50 are illustrated in Fig. 3 in accordance with the pulverized coal combustion boiler of an embodiment of the present invention. The illustration of the pulverized fuel pipes 5 arranged on the middle and lower burner stages on the furnace front wall 51 and the furnace rear wall 52 is omitted.

[0059] In reality, the pulverized fuel pipes 5 are connected to the burners 6 arranged on the middle burner stage and the burners 6 arranged on the lower burner stage. The pulverized coal is supplied from the mill 2e and the mill 2b to the middle stage burners 6 and from the mill 2d and the mill 2c to the lower stage burners 6 through the pulverized fuel pipes 5.

[0060] The partial load operation in which the heat output of the pulverized coal combustion boiler is gradually lowered will now be considered. Fig. 4 illustrates situations of turning on and off of the burners 6 arranged on each of the three stages of the upper stage, the middle stage, and the lower stage in which the load is lowered from 100% maximum heat output to 50% heat output.

[0061] Although not shown, the 100% maximum heat output is defined as the state in which all the six burners arranged on each of the upper stage, the middle stage, and the lower stage of the furnace front wall 51 and the furnace rear wall 52 are turned on.

[0062] The way of turning off of the burners 6 shown in Fig. 4 in the partial load operation of the pulverized coal combustion boiler is merely an example. The turning-off may not be conducted in this order, rather, the tuning-off pattern is specified plant by plant.

[0063] The mills 2 generally have limits to the amount of coal they can process. Therefore, if the heat output demand requested is decreased to some extent in need of control, the plurality of mills 2 in operation must be

sequentially halted one by one in accordance with the decreased load to turn off the burners 6.

[0064] Fig. 4 shows the situations of the heat loads of the furnace front wall 51 and the furnace rear wall 52 of the pulverized coal combustion boiler when sequentially halting operations of a first mill 2, a second mill 2, and a third mill 2 (50% heat load) in compliance with the partial load. The pulverized coal combustion boiler of the present embodiment is illustrated in the lower column, while the pulverized coal combustion boiler that does not employ the configuration of the present embodiment is illustrated on the upper column as a comparative example.

[0065] Describing the case of halting the first mill 2, when halting the operation of either the mill 2f or the mill 2a that supply the pulverized coal to the burners 6 on the upper burner stage, only the three burners 6f or the three burners 6a, among the six burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52, arranged alternately on the furnace front wall 51 and the furnace rear wall 52 connected through the pulverized fuel pipes 5 to the mill 2f or the mill 2a, whose operation have been halted, are turned off in the configuration of the pulverized coal combustion boiler in the present embodiment as shown in the lower column of Fig. 4.

[0066] More specifically, as for the burners 6f and the burners 6a on the upper burner stage, among the six burners (three burners 6f and three burners 6a) that are facing each other on the furnace front wall 51 and the furnace rear wall 52, three burners 6f or three burners 6a arranged alternately are turned on, while adjacent three burners 6a or three burners 6f are turned off.

[0067] In other words, the same number (three) of burners 6f and burners 6a among the six burners 6 on the upper burner stage arranged on each of the furnace front wall 51 and the furnace rear wall 52 are turned on. Therefore, the heat loads of the furnace front wall 51 and the furnace rear wall 52 maintain 1 to 1 relationship, meaning there is no variation in the heat loads.

[0068] The ratio of the heat loads in this case is determined by the ratio of the numbers of burners turned on. In Fig. 4, the burners that are turned on are illustrated with black circles, while the burners that are turned off are illustrated with white circles.

[0069] Meanwhile, in the pulverized coal combustion boiler of the comparative example as shown in the upper column of Fig. 4, when the operation of one mill of the two mills arranged on the upper burner stage is halted, all six burners 6 arranged on the upper burner stage on the furnace front wall or the furnace rear wall 52 are turned off. In this case, the ratio of the heat output of the furnace front wall 51 and the furnace rear wall 52 is 1 to 1.5, generating a large imbalance in the heat loads.

[0070] When the load of the partial load operation is reduced and the operation of the second mill 2 is halted, all of the burners 6f or the burners 6a on the upper stages in both of the comparative example shown in the upper column and the present embodiment shown in the lower

column are tuned off. The heat loads of the furnace front wall 51 and the furnace rear wall 52 in the comparative example and the present embodiment are 1 to 1, meaning they are in the same condition.

[0071] When the load of the partial load operation is further reduced and the operation of the third mill 2 is halted to provide the 50% load condition, all six burners of the burners 6b or the burners 6e on the middle burner stage arranged on the furnace front wall 51 are turned off in the comparative example shown in the upper column of Fig. 4, while all six burners of the burners 6b or the burners 6e on the middle burner stage arranged on the furnace rear wall 52 are turned on. As a result, the heat loads of the furnace front wall 51 and the furnace rear wall 52 are greatly imbalanced with the ratio of 1 to 2, meaning the heat load of the furnace rear wall 52 is twice as large as that of the furnace front wall 51.

[0072] On the other hand, in the present embodiment shown in the lower column of Fig. 4, although half of the burners 6b and the burners 6e on the middle burner stage arranged on the furnace front wall 51 are turned off, the remaining half of the burners 6b and the burners 6e are turned on even when the operation of the third mill 2 is halted to provide the 50% load condition.

[0073] Similarly, half of the burners 6b and the burners 6e on the middle burner stage arranged on the furnace rear wall 52 are tuned off, while the remaining half of the burners 6b and the burners 6e are turned on, maintaining 1 to 1 heat loads between the furnace front wall 51 and the furnace rear wall 52.

[0074] Thus, the pulverized coal combustion boiler of the present embodiment allows the operation in which the 1 to 1 heat loads between the furnace front wall 51 and the furnace rear wall 52 is maintained in the entire load range including the partial load operation. As a result, leveling of the heat loads of the water pipe walls that constitute the furnace wall surfaces of the pulverized coal combustion boiler enables to control the thermal stress generated in the water pipes of the water pipe walls to a low level, realizing the pulverized coal combustion boiler capable of enhancing the safety of the furnace wall surfaces and extending the life of the pulverized coal combustion boiler.

[0075] Fig. 5 shows a comparative example of the amount of absorbed heat in each of the water pipe walls 20 between the burners 6 and the after air ports 9 of (1) the pulverized coal combustion boiler comprising a plurality of mills, specifically, two mills 2, on each of the upper burner stage, the middle burner stage, and the lower burner stage as in the present embodiment having the configuration shown in Figs. 1 to 4, and of (2) the pulverized coal combustion boiler comprising one mill on each of the burner stage as in the comparative example shown in Fig. 4.

[0076] The graph shown in Fig. 5 denotes the result obtained from the combustion analysis during the partial load of the pulverized coal combustion boiler and shows the amount of absorbed heat of each of the water pipe

walls 2 that constitute the furnace wall surfaces between the burners 6 and the after air ports 9.

[0077] As can be understood from Fig. 5, the variation in the absorbed heat of the water pipe walls 20 is smaller in the pulverized coal combustion boiler of the present embodiment compared to that in the comparative example. Therefore, it can be seen that the heat load leveling of the water pipe walls is effective in the pulverized coal combustion boiler of the present embodiment.

[0078] In the above described pulverized coal combustion boiler of the present embodiment, for example, the pulverized coal is distributed and supplied from one mill 2a or 2f through the pulverized fuel pipes 5 to the opposing same number of burners 6a or the burners 6f on the upper burner stage of the furnace front wall 51 and the furnace rear wall 52. Thus, the pulverized coal distributed and supplied to the burners 6a or the burners 6f of the furnace front wall 51 and the furnace rear wall 52 has about the same particle diameter distribution.

[0079] Therefore, supplying of the pulverized coal to the burners 6a or the burners 6f has an effect of equalizing the combustion status of the burners 6a or the burners 6f of the furnace front wall 51 and the furnace rear wall 52, realizing the heat load leveling of the furnace front wall 51 and the furnace rear wall 52.

[0080] Although a configuration of arranging two mills 2 on each of the upper burner stage, middle burner stage, and the lower burner stage arranged on the furnace wall surfaces has been illustrated in the pulverized coal combustion boiler of the present embodiment, a configuration with more than two mills allows more continuous changing of the loads, and the variation in the amount of absorbed heat can be reduced as the number of the mills increases.

[0081] However, the routing of the pulverized fuel pipes 5 may become complicated, or the increase in the number of mills 2 may increase the cost. Therefore, the number of mills 2 necessary for each of the burner stages is preferably determined in consideration of factors such as an increase in cost.

[0082] Furthermore, as shown in Fig. 1, the pulverized fuel pipes 5 from each of the mills 2 are alternately arranged on the burners 6 in the horizontal direction on each of the burner stages in the pulverized coal combustion boiler of the present embodiment. The arrangement of the pulverized fuel pipes 5 in such a way enables to deconcentrate the number of burners 6 turned on in the horizontal direction, allowing reduction of the imbalance of the heat loads. In this way, the leveling effect of the heat loads in the horizontal direction of the furnace 50 can be expected.

[0083] Of the six burners 6 arranged on each of the upper burner stage, the middle burner stage, and the lower burner stage of the furnace front wall 51 and the furnace rear wall 52 of the furnace wall surfaces of the furnace 50 in the pulverized coal combustion boiler of the present example described above, only the six burners 6 arranged on the upper burner will now be described

to simplify the description.

[0084] As shown in Fig. 6 and Fig. 7, on the upper burner stage of the furnace front wall 51 of the furnace wall surfaces and on the upper burner stage of the furnace rear wall 52 of the furnace wall surfaces to which the pulverized coal is supplied from the mill 2a and the mill 2f arranged on one side of the furnace sidewall 53 through the pulverized fuel pipes 5, three burners 6a are arranged to face each other on the burner stage at the same height, and the burners 6f are alternately arranged adjacent to the burners 6a.

[0085] Each of the burners 6a on the furnace front wall 51 on the burner stage at the same height faces one on one with each of the burners 6a on the furnace rear wall 52 on the burner stage at the same height, and each of the burners 6f on the furnace front wall 51 of the burner stage at the same height faces one on one with each of the burners 6f on the furnace rear wall 52 on the burner stage at the same height. Thus, the flames generated from the turned-on burners 6a or burners 6f completely face each other in the furnace, and the flames just collide inside the furnace.

[0086] The case of halting the mill 2f of the mills 2a and 2f that supply the pulverized coal to the upper burner stage and turning off the burners 6f for the partial load operation will now be considered. Although the mill 2f is halted, the burners 6a are turned on because the mill 2a is in operation.

[0087] In this case, flames as shown with dotted lines in Fig. 6 are generated in the furnace, and flames of opposing burners 6a collide with the flames. The reason that the flames generated from the turned-on opposing burners 6a among the burners arranged to face each other are designed to collide in the furnace is that to prevent the generation of imbalanced heat loads between the furnace front wall and the furnace rear wall because if the flames do not collide, the flames reach the opposing furnace wall surface, resulting in the creation of locally high heat load sections.

[0088] Even if the operation of one of the two mills, for example, the mill 2a, is halted, the flames of the opposing burners 6f collide in the furnace because the burners 6f are turned on with the pulverized coal supplied from the mill 2f in operation.

[0089] Thus, implementation of the configuration of the present embodiment described above enables to form collided flames of opposing burners in the furnace throughout the entire loads.

[0090] Therefore, according to the embodiment of the present invention, a pulverized coal combustion boiler can be realized which levels the heat loads of the water pipes constituting the furnace wall surfaces of the furnace in the entire load range to control the thermal stress generated in the furnace water pipes, and which enhances the safety of the furnace wall surfaces and extends the life of the pulverized coal combustion boiler.

[Second Embodiment]

[0091] The pulverized coal combustion boiler of a second embodiment of the present invention will be described with reference to Fig. 8. The fundamental configuration of the pulverized coal combustion boiler of this embodiment is in common with that of the pulverized coal combustion boiler of the preceding embodiment shown in Figs. 1 to 7. Therefore, the explanation of the configuration in common will be omitted, and only different configurations will be described.

[0092] As for each of the upper burner stage, the middle burner stage, and the lower burner stage on the furnace front wall 51 and the furnace rear wall 52 of the furnace wall surfaces of the furnace 50 in the pulverized coal combustion boiler of the present embodiment shown in Fig. 8, the height in the vertical direction of the burner stages on the furnace rear wall 52 is arranged to be higher than the height in the vertical direction of the burner stages of the furnace front wall 51.

[0093] Vertical shifting of the positions of the burner stages in the height directions between the furnace front wall 51 and the furnace rear wall 52 as in the present embodiment is referred to as a staggered arrangement of the burner stages.

[0094] According to a finding of combustion flow calculation in the furnace, in the pulverized coal combustion boiler in the staggered combustion, the generation rate of toxic carbon monoxide or nitrogen oxide was sometimes low compared to the configuration of the perfectly opposing arrangement in which the burners are arranged on the furnace front wall 51 and the furnace rear wall 52 as shown in Fig. 6, depending on the shape of the boiler or the shape of the burners. However, the generation rate of carbon monoxide or nitrogen oxide varies depending on the shape of the furnace or operation conditions.

[0095] The heat loads need to be leveled as much as possible in the pulverized coal combustion boiler in the staggered arrangement as well, because the generation rate of carbon monoxide or nitrogen oxide is also an important performance index for the pulverized coal combustion boiler. Thus, as in the pulverized coal combustion boiler of the present embodiment, the positions of the burner stages in the vertical direction arranged on the furnace rear wall 52 are preferably vertically shifted relative to the burner stages arranged on the furnace front wall 51.

[0096] The burner stages should be shifted so that the interference of opposing flames is limited as far as possible. When the burner stages are shifted this way, even if the flames generated from the burners on the burner stages are headed toward the opposite wall surface, the heat loads exerted on the furnace front wall 51 and the furnace rear wall 52 are substantially the same.

[0097] In the pulverized coal combustion boiler of the present embodiment, although the burner stages of the furnace rear wall 52 are shifted upward to be positioned over the burner stages of the furnace front wall 51 in the

vertical direction, conversely, the burner stages of the furnace front wall 51 may be shifted to be positioned over the burner stages of the furnace rear wall 52 in the vertical direction.

[0098] The embodiment of the present invention can also realize a pulverized coal combustion boiler which levels the heat loads of the water pipes constituting the wall surfaces of the furnace in the entire load range to control the thermal stress generated in the furnace water pipes, and which enhances the safety of the furnace wall surfaces and extends the life of the pulverized coal combustion boiler.

[Third Embodiment]

[0099] The pulverized coal combustion boiler of still a third embodiment of the present invention will be described with reference to Fig. 9. The fundamental configuration of the pulverized coal combustion boiler of this embodiment is in common with that of the pulverized coal combustion boiler of the preceding embodiment shown in Figs. 1 to 7. Therefore, the explanation of the configuration in common will be omitted, and only different configurations will be described.

[0100] In the pulverized coal combustion boiler of the present embodiment shown in Fig. 9, the pulverized fuel pipes 5 for supplying the pulverized coal fuel to three burners 6a and three burners 6f arranged on the furnace front wall 51 and the furnace rear wall 52 from two mills (mill 2f and mill 2a) arranged on one side of the furnace sidewall 53 are connected to six burners 6 that are arranged on each of the furnace front wall 51 and the furnace rear wall 52 and that form the upper burner stage of the furnace wall surfaces.

[0101] The pulverized fuel pipes 5 extending from the mill 2a and the mill 2f are connected to three burners 6a and three burners 6f arranged to face each other on the furnace front wall 51 and the furnace rear wall 52. The feed rate of the pulverized coal supplied to three burners 6a and three burners 6f can be equalized because the lengths of the pulverized fuel pipes 5 distributed to the furnace front wall 51 and the furnace rear wall 52 are substantially the same. Therefore, the heat loads between the furnace front wall 51 and the furnace rear wall 52 during supplying of the pulverized coal from the burners into the furnace and during burning can be leveled.

[0102] Therefore, the embodiment of the present invention can also realize a pulverized coal combustion boiler which levels the heat loads of the water pipes constituting the furnace wall surfaces of the furnace in the entire load range to control the thermal stress generated in the furnace water pipes, and which enhances the safety of the furnace wall surfaces and extends the life of the pulverized coal combustion boiler.

[Fourth Embodiment]

[0103] The pulverized coal combustion boiler of a

fourth embodiment of the present invention will be described with reference to Fig. 10. The fundamental configuration of the pulverized coal combustion boiler of this embodiment is in common with that of the pulverized coal combustion boiler of the preceding embodiment shown in Figs. 1 to 7. Therefore, the explanation of the configuration in common will be omitted, and only different configurations will be described.

[0104] In the pulverized coal combustion boiler of the present embodiment shown in Fig. 10, the pulverized fuel pipes 5 for supplying the pulverized coal fuel to three burners 6a and three burners 6f arranged on the furnace front wall 51 and the furnace rear wall 52 from two mills (mill 2f and mill 2a) that are arranged separately on both sides of the furnace sidewall 53 are connected to six burners 6 arranged on each of the furnace front wall 51 and the furnace back wall 52 forming the upper burner stage of the furnace wall surfaces.

[0105] The pulverized fuel pipes 5 extending from the mill 2a and the mill 2f are connected to three burners 6a and three burners 6f arranged to face each other on the furnace front wall 51 and the furnace rear wall 52. The feed rate of the pulverized coal supplied to three burners 6a and three burners 6f can be equalized because the lengths of the pulverized fuel pipes 5 distributed to the furnace front wall 51 and the furnace rear wall 52 are substantially the same. Therefore, the heat loads between the furnace front wall 51 and the furnace rear wall 52 can be leveled during supplying of the pulverized coal from the burners into the furnace and during burning.

[0106] Therefore, the embodiment of the present invention can also realize a pulverized coal combustion boiler which levels the heat loads of the water pipes constituting the furnace wall surfaces of the furnace in the entire load range to control the thermal stress generated in the furnace water pipes, and which enhances the safety of the furnace wall surfaces and extends the life of the pulverized coal combustion boiler.

[Fifth Embodiment]

[0107] The pulverized coal combustion boiler of a fifth embodiment of the present invention will be described with reference to Fig. 11. The fundamental configuration of the pulverized coal combustion boiler of this embodiment is in common with that of the pulverized coal combustion boiler of the preceding embodiment shown in Figs. 1 to 7. Therefore, the explanation of the configuration in common will be omitted, and only different configurations will be described.

[0108] In the pulverized coal combustion boiler of the present embodiment shown in Fig. 11, the pulverized fuel pipes 5 for supplying the pulverized coal fuel to three burners 6a and three burners 6f arranged on the furnace front wall 51 and the furnace rear wall 52 from two mills (mill 2f and mill 2a) arranged on one side of the furnace sidewall 53 are connected to six burners 6 arranged on each of the furnace front wall 51 and the furnace rear

wall 52 forming the upper burner stage on the furnace wall surfaces.

[0109] The pulverized fuel pipes 5 extending from the mill 2a and the mill 2f are connected to three burners 6a and three burners 6f arranged to face each other on the furnace front wall 51 and the furnace rear wall 52. The feed rate of the pulverized coal supplied to three burners 6a and three burners 6f can be equalized because the lengths of the pulverized fuel pipes 5 distributed to the furnace front wall 51 and the furnace rear wall 52 are substantially the same. Therefore, the heat loads between the furnace front wall 51 and the furnace rear wall 52 can be leveled during supplying of the pulverized coal from the burners into the furnace and during burning.

[0110] Although the pulverized fuel pipes 5 extending from the mills 2a, and 2f are connected to opposing burners 6a and burners 6f on the furnace front wall 51 and furnace rear wall 52, a coal feed rate controllers 21 that control the coal feed rate of the pulverized coal supplied to the burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 are additionally disposed on the pulverized fuel pipes 5 in the pulverized coal combustion boiler of the present embodiment.

[0111] The coal feed rate controllers 21 comprise control valves, such as butterfly valves, and flowmeters. The controllers 21 of the coal feed rate as in the present embodiment can control the feed rate of the pulverized coal supplied to the burners 6a and the burners 6f to substantially the same level. Moreover, monitoring of the coal feed rate with the flowmeters and the control by the control valves based on the coal feed rate detected by the flowmeters allow the accurate control of the feed rate of the pulverized coal. Thus, the heat loads of the water pipe walls that constitute the furnace wall surfaces can always be leveled.

[0112] Therefore, the embodiment of the present invention can also realize a pulverized coal combustion boiler which levels the heat loads of the water pipes constituting the furnace wall surfaces of the furnace in the entire load range to control the thermal stress generated in the furnace water pipes, and which enhances the safety of the furnace wall surfaces and extends the life of the pulverized coal combustion boiler.

[Six embodiment]

[0113] The water pipe walls constituting the furnace wall surfaces of the pulverized coal combustion boiler of a sixth embodiment of the present invention will be described with reference to Fig. 12. The fundamental configuration of the pulverized coal combustion boiler of this embodiment is in common with that of the pulverized coal combustion boiler of the preceding embodiments shown in Figs. 1 to 11. Therefore, the explanation of the configuration in common will be omitted, and only different configurations will be described.

[0114] In the pulverized coal combustion boiler of the present embodiment in Fig. 12, a plurality of water pipes

provided on the plurality of water pipe walls 20 constituting the furnace wall surfaces are arranged in spirals on the lower side of the furnace wall surfaces. On the water pipe walls 20 arranged on the upper side of the furnace wall surfaces, straight water pipes are connected to the water pipes in spirals on the lower side of the furnace wall surfaces and extend in the vertical direction.

[0115] In a pulverized coal combustion boiler having a general configuration, the imbalance of the heat loads in the furnace near the burners leads to different heating conditions for each of the water pipes and results in differences in hot stretching. This may damage the water pipe walls depending on the amount of generated thermal stress.

[0116] The pulverized coal combustion boiler of the present embodiment can reduce the imbalanced heat loads in the furnace by employing the burner arrangement configured as in the embodiments shown in Figs. 1 to 11.

[0117] The reduction in the imbalance of the heat loads in the furnace results in fewer differences in heating conditions for each of the water pipes. Thus, the arrangement of a mixing header for communicating the water pipes in spirals arranged on the water pipe walls 20 in the lower side of the furnace wall surfaces and vertical straight pipes arranged on the water pipe walls 20 in the upper side of the furnace wall surfaces is no longer required in a general pulverized coal combustion boiler. Therefore, the water pipe walls constituting the furnace wall surfaces can be directly connected from the spiral water pipe walls on the lower part of the furnace wall surfaces to the vertical straight pipe walls on the upper part of the furnace wall surfaces.

[0118] As a result, the simplification in the constitution of the water pipe walls of the furnace wall surfaces allows a significant reduction in the production cost of the furnace wall surfaces. The cost reduction effect is profound in constructing a pulverized coal combustion boiler.

[0119] Therefore, the embodiment of the present invention can also realize a pulverized coal combustion boiler which levels the heat loads of the water pipes constituting the furnace wall surfaces of the furnace in the entire load range to control the thermal stress generated in the furnace water pipes, and which enhances the safety of the furnace wall surfaces and extends the life of the pulverized coal combustion boiler.

[Seventh Embodiment]

[0120] The pulverized coal combustion boiler of a seventh embodiment of the present invention will be described. Fig. 13 shows a configuration of the pulverized coal combustion boiler 100 of this embodiment of the present invention. The pulverized coal combustion 100 comprises the furnace 50 that constitutes the boiler.

[0121] The plurality of water pipes 19 on which a plurality of water pipes are arranged in parallel in the vertical direction are provided on the water pipe walls 20 that

constitute the inner walls of the furnace 50. The water pipe walls 20 of the furnace 50 on which the water pipes 19 are arranged in the vertical direction comprise the furnace front wall 51 on the front side of the boiler, the furnace rear wall 52 on the rear side of the boiler facing the furnace front wall 51, and a boiler right wall and a boiler left wall that serve as sidewalls of the furnace front wall 51 and the furnace rear wall 52.

[0122] A heat recovery area 18 having the water pipes 19 are provided on the ceiling of the furnace 50.

[0123] The plurality of burners 6 that supply the pulverized coal fuel as well as the conveying air into the furnace 50 for burning and a plurality of air nozzles (after air ports) 9 that supply the combustion air into the furnace 50 and that are positioned higher than the burners 6 are arranged on each of the furnace front wall 51 and the furnace rear wall 52 provided with the water pipes 19 that form the water pipe walls 20 of the furnace 50 of the pulverized coal combustion boiler 100.

[0124] A mixing header 17 that accumulates vapor heated and generated from the radiant heat from the combustion gas 13 in the plurality of vertically arranged water pipes 19 that form the water pipe walls 20 of the furnace 50 is arranged in the furnace 50.

[0125] The mills 2 pulverize coal to produce the pulverized coal fuel. The pulverized coal produced by the mills 2 is accompanied by the primary air of the conveying air and supplied from the plurality of burners 6 into the furnace 50 of the boiler through the plurality of pulverized fuel pipes 5. The pulverized coal is then burned in the furnace 50.

[0126] The pulverized coal combustion boiler 100 of the present embodiment comprises six mills 2, and the six mills 2 are numbered from 2a to 2f for distinction.

[0127] Each of the plurality of burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 that comprise the water pipes 19 constituting the water pipe walls 20 of the furnace 50 has a different predetermined height on the wall surface of the furnace 50. The burners are shown to be at positions of the height E of the furnace front wall 51 and F of the furnace rear wall 52 at a predetermined height on the upper most stage, the height C of the furnace front wall 51 and D of the furnace rear wall 52 at a predetermined height of the middle stage, and the height A of the furnace front wall 51 and B of the furnace rear wall 52 at a predetermined height of the lower stage.

[0128] The burners 6 are arranged to face each other on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50. Six burners 6 are arranged at each of the height E and F of the uppermost stage, the height C and D of the middle stage, and the height A and B of the lower stage.

[0129] The burners 6 facing each other on the furnace front wall 51 and the furnace rear wall 52 are not necessarily arranged at the same height. Each of the height E and F of the uppermost stage, the height C and D of the middle stage, and the height A and B of the lower stage

may be alternately shifted in the height direction to properly control the heat loads of the boiler water walls as the embodiment of the pulverized coal combustion boiler shown in Fig. 22. In that case too, the burners on the uppermost stage, the middle stage, and the lower stage on the furnace front wall 51 and the furnace rear wall 52 are referred to as opposing burners.

[0130] An air supply system that supplies the combustion air to the burners 6 and the air nozzles (after air ports) 9 comprises an air blower 8, an air heater 22 that takes in the air from the air blower 8 and heats the air, and air piping 16 that supplies the air preheated by the air heater 22 to the burners 6 and the air nozzles 9 (after air ports) as a combustion air.

[0131] The combustion gas 13, generated from burning the pulverized coal fuel in the furnace 50 with the pulverized coal and the air supplied from the burners 6 and the combustion air supplied from the air nozzles (after air ports) 9, flows down the furnace 50 and is discharged from the pulverized coal combustion boiler 100 as an exhaust gas 14b.

[0132] The discharged exhaust gas 14b is denitrified by a catalytic device 12 arranged in the downstream of the pulverized coal combustion boiler 100, and then the heat is recovered by the air heater 22. Subsequently, the exhaust gas 14b is dust-removed and desulfurized in the downstream and then released into the atmosphere.

[0133] An arrangement method of the pulverized fuel pipes 5 for supplying the pulverized coal fuel from the mills 2 to the burners 6 will now be described with reference to Fig. 14. Fig. 14 schematically illustrates a partial cross sectional view in which the furnace 50 of the pulverized coal combustion boiler 100 of Fig. 13 is cut in the X-X direction.

[0134] The burners 6 on the furnace front wall 51 and the furnace rear wall 52 are arranged in a plurality of stages in the height direction of the furnace. The pulverized coal pulverized by the mills 2 is directed to the burners 6 arranged on the same stage on the furnace front wall 51 and the furnace rear wall 52 through the pulverized fuel pipes. In Fig. 13, three stages of the burners 6 are arranged in the height direction of the furnace on each of the furnace front wall 51 and the furnace rear wall 52.

[0135] The pulverized coal pulverized by the six mills 2 numbered with 2a to 2f in Fig. 14 is directed to six burners 6 arranged at positions of each of the height E and F that is the predetermined uppermost stage height, the height C and D that is the predetermined middle stage height, and the height A and B that is the predetermined lower stage height on the furnace front wall 51 and the furnace rear wall 52 of the wall surfaces of the furnace 50.

[0136] As shown in Fig. 14, as for the arrangement of the pulverized fuel pipes 5 for supplying the pulverized coal to the burners 6 positioned at the height E of the furnace front wall 51 and the height F of the furnace rear wall 52 of the uppermost stage, three of the six pulverized fuel pipes 5 branched out from the mill 2a are respectively

connected to three burners of the six burners 6 arranged at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50.

[0137] The three of the six pulverized fuel pipes 5 branched out from the mill 2a are alternately connected to the burner 6, that is, first, third, and fifth burners 6 from left to right of the furnace 50 positioned at the height F of the furnace rear wall 52. The pulverized coal is supplied into the furnace 50 from these three burners 6, and the pulverized coal is burned to form combustion flames 30.

[0138] The other three of the six pulverized fuel pipes 5 branched out from the mill 2a are connected to three of the six burners 6 arranged at the height E of the uppermost stage of the furnace front wall 51 of the furnace 50.

[0139] They are alternately connected to the burner 6, that is, first, third, and fifth burners 6 from right to left of the furnace 50 positioned at the height E of the furnace front wall 51. The pulverized coal is supplied into the furnace 50 from these three burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0140] Similarly, three of the six pulverized fuel pipes 5 branched out from the mill 2f are alternately connected to the burner 6, that is, second, fourth, and sixth burners 6 from left to right of the furnace 50 positioned at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50. The pulverized coal is supplied into the furnace 50 from the burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0141] The other three of the six pulverized fuel pipes 5 branched out from the mill 2f are alternately connected to the burner 6, that is, second, fourth, and sixth burners 6 from right to left of the furnace 50 positioned at the height E of the uppermost stage of the furnace front wall 51 of the furnace 50. The pulverized coal is supplied into the furnace 50 from the burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0142] In the arrangement with an even number of burners on the furnace front wall 51 and the furnace rear wall 52 at the same predetermined height as in the above case in which six burners 6 are arranged on each of the furnace front wall 51 and the furnace rear wall 52 at the same height E and F of the uppermost stage, the pulverized fuel pipes 5 that connect the mill 2a and the mill 2f with the burners are connected from different mills 2 to the burners 6 arranged on the furnace front wall 51 of the wall surfaces of the furnace 50 and the burners 6 arranged on the furnace rear wall 52 so as to face the burners 6.

[0143] In other words, the pulverized fuel pipes 5 are connected to the opposing burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 such that the pulverized coal is supplied from the different mill 2a and mill 2f.

[0144] Therefore, when there is no difference in the pressure loss during transfer of the pulverized coal by the pulverized fuel pipes 5, substantially the same amount of coal can be equally supplied from the mill 2a

and the mill 2f to the plurality of burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 of the wall surfaces of the furnace 50 through the pulverized fuel pipes 5.

[0145] According to the above described embodiment, the pulverized coal to be supplied from the mill 2a and the mill 2f to the burners 6 arranged on the predetermined height of the furnace 50 can be equally supplied from the furnace front wall 51 and the furnace rear wall 52 into the furnace 50.

[0146] Thus, as for the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100, even if the operation of some of the plurality of mills 2 are halted during the partial load operation of the boiler, the heat loads can be leveled between the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100 because the pulverized coal can be equally supplied from the mills 2 in operation to the burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100.

[0147] Although not explicitly shown in Fig. 14, the arrangement methods of (1) the pulverized fuel pipes 5 for supplying the pulverized coal pulverized by the mills 2e and 2b to six burners 6 arranged at each of the height C of the furnace front wall 51 and the height D of the furnace rear wall 52 of the middle stage and of (2) the pulverized fuel pipes 5 for supplying the pulverized coal pulverized by the mills 2d and 2c to six burners 6 arranged at each of the height A of the furnace front wall 51 and the height B of the furnace rear wall 52 of the lower stage are the same as the above described arrangement method of the pulverized fuel pipes 5 for supplying the pulverized coal from the mill 2a and 2f to six burners 6 positioned at the height E of the furnace front wall 51 and the height F of the furnace rear wall 52 of the uppermost stage. Therefore, the arrangement methods will not be described herein.

[0148] According to the present embodiment, the input of the fuel supplied from the plurality of burners arranged on the boiler front wall and the boiler rear wall of the furnace can be controlled to be substantially equal in the entire load range of the pulverized coal combustion boiler, even in the partial load condition in which about half the burners are halted. Thus, the differences in the feed rates of the pulverized coal fuel into the furnace can be controlled to make the heat loads of the pulverized coal combustion boiler uniform.

[0149] This can prevent the nucleate boiling departure in the subcritical pressure region of the vapor in the water wall pipes of the furnace generated as a result of the imbalance in the heat loads of the boiler front wall and the boiler rear wall of the furnace of the pulverized coal combustion boiler, and the increase in the pipe wall temperature of the water wall pipes of the furnace due to the heat transfer deterioration can be controlled.

[0150] Operational effects of the pulverized coal com-

bustion boiler of the present embodiment will now be described.

[0151] Figs. 20A to 20C illustrate distributions of vapor temperatures along the inner circumference directions of the furnace 50 in which the vapor temperatures of the outlets of the water pipes 19 vertically arranged as water pipe walls 20 of the furnace 50 are calculated for the pulverized coal combustion boiler of the present embodiment shown in Fig. 13 and Fig. 14 and for a pulverized coal combustion boiler having a different configuration from the present embodiment for comparison.

[0152] The configuration of the pulverized coal combustion boiler which is the basis for calculating the vapor temperatures of the outlets of the water pipes 19 of the furnace 50 shown in Fig. 20 is the one in which all the burners 6 are arranged to face each other on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50.

[0153] Fig. 20C illustrates the calculation result of the pulverized coal combustion boiler employing a configuration in which the pulverized fuel pipes 5 for supplying the pulverized coal from two mills 2 to the burners 6 are branched out from the mills 2 to the furnace front wall 51 and the furnace rear wall 52 of the furnace 50, and in which the burners 6 are arranged to face each other at the same predetermined heights of the uppermost stage, the middle stage, and the lower stage, as in the embodiments shown in Fig. 13 and Fig. 14.

[0154] The average in-pipe mass flow rate of the fluid that moves up the water pipes 19 constituting the water pipe walls 20 of the furnace 50 arranged in parallel in the vertical direction is set up at the condition of 1000 kg/m²s which is a relatively low flow rate and is an operation condition of 50% boiler load.

[0155] Fig. 20A and Fig. 20B illustrate the calculation results of the pulverized coal combustion boiler for comparison with Fig. 20C in which the pulverized fuel pipes for supplying the pulverized coal from one mill to the burners are connected to the burners arranged to face each other at the same height.

[0156] In Fig. 20A, the average in-pipe mass flow rate of the fluid that moves up the water pipes is set up at the condition of 2000 kg/m²s which is a relatively high flow rate. In Fig. 20B, the average in-pipe mass flow rate of the fluid that moves up the water pipes is set up at the condition of 1000 kg/m²s which is a relatively low flow rate. The boiler loads in both cases are set up at 50% operation conditions.

[0157] When implementing the operation of 50% boiler load, three of the six mills are operated, and the other three mills are halted. As for the burners in normal operation in this case, the burners arranged to face each other on the furnace front wall and the furnace rear wall of the furnace at the height C and D of the middle stage and the burners arranged on the furnace rear wall at the height B on the lower stage are preferably operated in the pulverized coal combustion boiler. Thus, three mills that supply the pulverized coal to the burners through the

pulverized fuel pipes are to be in operation.

[0158] This leads to the supply of twice as much pulverized coal to the burners of the furnace rear wall as compared to the burners of the furnace front wall. As a result, as for the vapor temperatures of the outlets of the water pipes, the vapor temperature distribution of the water pipe outlets of the rear wall forms a high temperature distribution compared to that of the furnace front wall as shown in Fig. 20A, reflecting the differences in the supplied fuel.

[0159] In the case shown in Fig. 20A, the increase in the friction pressure loss exceeds the decrease in the hydrostatic head if the evaporation of the water pipes at the center of the furnace having large heat load increases, because the average in-pipe mass flow rate is in a high flow rate condition and the friction pressure loss is dominant in the total head.

[0160] Therefore, the flow rate further decreases at parts of the furnace front wall and the furnace rear wall where the heat load is large. As a result, departure from nucleate boiling easily occurs in the pipes of the furnace, greatly increasing the possibility of damaging the heat transfer pipes due to the increase in the metal temperature of the water pipes.

[0161] In Fig. 20B, the average in-pipe mass flow rate is in a condition of $1000 \text{ kg/m}^2\text{s}$ which is a low flow rate. The hydrostatic head is dominant in the entire pressure loss so that the decrease in the hydrostatic head exceeds the increase in the friction pressure loss if the evaporation of the water pipes at the center of the furnace with large heat load increases. Thus, the total head of the water pipes at the center of the furnace becomes smaller than that of the water pipes at the periphery, and the flow rate in the water pipes at the center of the furnace 50 increases.

[0162] Therefore, in the furnace front wall and the furnace rear wall of the furnace, the difference in the vapor temperatures of the water pipes is mitigated compared to the case in Fig. 20A even if there is a difference in the distribution of the heat loads at corners and the center. However, the vapor temperature distribution of the water pipes of the furnace rear wall is still high compared to the furnace front wall, reflecting the differences in the amount of fuel inputted from the burners. The difference in the temperature distributions cannot be eliminated just by decreasing the in-pipe mass flow rate in the water pipes.

[0163] On the other hand, when implementing the operation of 50% load in the present embodiment shown in Fig. 20C, the pulverized fuel pipes 5 are arranged from the mills 2 to the burners 6 such that the feed rates of the pulverized coal supplied to the furnace 50 from the burners 6 arranged to face each other on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 become substantially the same, as described in Fig. 13 and Fig. 14. Then, three mills 2 (2d, 2e, and 2c) of the six mills 2 are operated such that (1) a half of the burners 6 arranged to face each other on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 at the

height C and D of the middle stage and (2) the burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 at the height A and B of the lower stage supply and burn the pulverized coal in the furnace 50.

[0164] In other words, as for the burners 6 at the height A of the lower stage of the furnace front wall 51 of the furnace 50, the pulverized coal is supplied from each of the mills 2d and 2c to a half of the burners 6 through the pulverized fuel pipes 5. Similarly, as for the burners 6 at the height B of the lower stage of the furnace rear wall 52 of the furnace, the pulverized coal is supplied from each of the mills 2d and 2c to a half of the burners 6 through the pulverized fuel pipes 5.

[0165] As for the burners 6 at the height C of the middle stage of the furnace front wall 51 of the furnace 50, the pulverized coal is supplied from the mill 2b to a half of the burners 6 through the pulverized fuel pipes 5. As for the burners 6 at the height D of the middle stage of the furnace rear wall 52 of the furnace 50, the pulverized coal is supplied from the mill 2e to a half of the burners 6 through the pulverized fuel pipes 5.

[0166] The implementation of the pulverized fuel pipes 5 that connect mills 2 and the burners 6 arranged at the heights of each stage of the furnace front wall and the furnace rear wall eliminates the occurrence of the imbalanced vapor temperatures generated in the water pipes 19 of the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 because the pulverized coal is inputted from the mills 2 into the furnace 50 from the half of the burners 6 at the height C and D of the middle stage and the burners 6 at the height of A and B of the lower stage through the pulverized fuel pipes 5.

[0167] Therefore, the difference in temperatures of the vapor generated in the water pipes 19 arranged vertically on the furnace front wall 51 and the furnace rear wall 52 of the furnace is controlled by setting up the average in-pipe mass flow rate of the fluid flowing through the water pipes 19 arranged in the vertical direction in the furnace to a condition of $1000 \text{ kg/m}^2\text{s}$ or less which is a relatively low flow rate and by setting up the boiler load to an operation condition of 50% or less for operation. Thus, the heat loads can be leveled along the inner circumference of the furnace 50 even when the pulverized coal combustion boiler having the burners 6 arranged to face the water pipes 19 arranged vertically is in the partial load operation. As a result, the increase in the pipe wall temperatures of the water pipes 19 due to the heat transfer deterioration caused by departure from nucleate boiling can be controlled.

[0168] The difference in the vapor temperatures of the vapor generated in the water pipes 19 arranged vertically on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 is similarly controlled, even when the average in-pipe mass flow rate of the liquid flowing through the water pipes 19 is set up and operated within the range of $1000 \text{ kg/m}^2\text{s}$, about 50% boiler load, to 400 kg/m^2 , about 30% boiler load for operation. The increase in the pipe wall temperatures of the water pipes due to

the heat transfer deterioration caused by departure from nucleate boiling can be controlled because the heat loads can be leveled along the inner circumference of the furnace during the partial load operation of the pulverized coal combustion boiler.

[0169] Other operational effects of the pulverized coal combustion boiler of the present embodiment will now be described.

[0170] Fig. 21 illustrates, similar to Fig. 20C, a distribution of the in-pipe mass flow rates along the inner circumference direction of the furnace 50 in which the in-pipe mass flow rates of the fluid flowing through the water pipes 19 arranged vertically as the water pipe walls 20 of the furnace 50 are calculated in relation to the pulverized coal combustion boiler of the embodiments of the present invention shown in Figs. 13 to 17.

[0171] In the case shown in Fig. 21, the operation of the 50% load is also implemented as in Fig. 20C, and the pulverized coal is supplied from each of the mills 2d and 2c to a half of the burners 6 at the height A of the lower stage of the furnace front wall 51 of the furnace 50 through the pulverized fuel pipes 5 such that the feed rates of the pulverized coal supplied to the furnace 50 from the burners 6 arranged to face each other on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 become substantially the same, as described in Fig. 13 and Fig. 14. Similarly, as for the burners at the height B of the lower stage of the furnace rear wall 52 of the furnace 50, the pulverized coal is supplied from each of the mills 2d and 2c to a half of the burners 6 through the pulverized fuel pipes 5.

[0172] This allows for the burners 6 arranged at the heights A, B, C, and D of each stage of the furnace 50 to equally input the pulverized coal into the furnace 50, eliminating the imbalance of the heat loads in the furnace 50.

[0173] In Fig. 21, the hydrostatic head is dominant in the total head because the average in-pipe mass flow rate in the vertically arranged water pipes 19 of the furnace 50 is set up at a condition of $1000 \text{ kg/m}^2\text{s}$ which is a relatively low rate. Thus, the water pipes 19 at the center of the furnace 50 are smaller than the water pipes at the corners in the total head because the decrease in the hydrostatic head exceeds the increase in the friction pressure loss even if the evaporation of the water pipes 19 increases at the center of the furnace 50 with increased heat loads.

[0174] Therefore, if the average in-pipe mass flow rate of the fluid flowing through the water pipes 19 vertically arranged in the furnace is set up for operation at a condition of $1000 \text{ kg/m}^2\text{s}$ to $400 \text{ kg/m}^2\text{s}$ at 50% boiler load, which is a relatively low flow rate, the flow rate of the water pipes 19 at the center of the furnace 50 increases and more fluid flows through the water pipes at the center having larger heat load, and the natural circulation characteristics can be obtained in which the flow rate of the water pipes at the center increases. This inevitably leads to leveling of the vapor temperatures of the water pipe

outlets, providing the suitable characteristics in terms of the temperature control of the pulverized coal combustion boiler.

5 [Eighth Embodiment]

[0175] A configuration of the pulverized coal combustion boiler of an eighth embodiment of the present invention will be described with reference to Fig. 15.

10 **[0176]** The fundamental configuration of the pulverized coal combustion boiler 100 of this embodiment is in common with that in the preceding embodiment shown in Fig. 13 and Fig. 14. Therefore, the explanation of the configuration in common with the preceding embodiment will be omitted, and only different configurations will be described.

15 **[0177]** The present embodiment shown in Fig. 15 schematically illustrates a partial cross sectional view in which the furnace 50 of the pulverized coal combustion boiler 100 of Fig. 13 is cut in the X-X direction as in the preceding embodiment shown in Fig. 14.

[0178] In the embodiment of Fig. 15, among the burners 6 arranged on each of the uppermost stage, the middle stage, and the lower stage, the burners 6 arranged at the height E of the furnace front wall 51 and the height F of the furnace rear wall 52 which is a predetermined height of the uppermost stage, and the arrangement of the pulverized fuel pipes 5 for supplying the pulverized coal fuel from the mills 2 to the burners 6 will be described. 20 The configuration of the burners 6 arranged on each of the stages at predetermined heights of the middle stage and the lower stage, and the arrangement of the pulverized fuel pipes 5 are the same as that of the uppermost stage. Therefore, the description will be omitted.

25 **[0179]** In Fig. 15, as for the arrangement of six pulverized fuel pipes 5 for supplying the pulverized coal to six burners 6 positioned at each of the height E of the furnace front wall 51 of the uppermost stage and the height F of the furnace rear wall 52 which is a predetermined height, three of the six pulverized fuel pipes 5 branched out from the mill 2a are respectively connected to three of the six burners 6 arranged at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50.

30 **[0180]** The three of the six pulverized fuel pipes 5 branched out from the mill 2a are alternately connected to the burner 6, that is, first, third, and fifth burners 6 from left to right of the furnace 50 positioned at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50. The pulverized coal is supplied into the furnace 50 from these three burners 6, and the pulverized coal is burned to form the combustion flames 30.

35 **[0181]** The other three of the six pulverized fuel pipes 5 branched out from the mill 2a are connected to three of the burners 6 on the right side of the furnace 50 arranged at the height E of the uppermost stage of the furnace front wall 51 of the furnace 50.

40 **[0182]** They are alternately connected to the burner 6, that is, second, fourth, and sixth burners 6 from right to

left of the furnace 50 positioned at the height E of the furnace rear wall 51. The pulverized coal is supplied into the furnace 50 from these three burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0183] Similarly, three of the six pulverized fuel pipes 5 branched out from the mill 2f are alternately connected to the burner 6, that is, second, fourth, and sixth burners 6 from left to right of the furnace 50 positioned at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50. The pulverized coal is supplied into the furnace 50 from the burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0184] The other three of the six pulverized fuel pipes 5 branched out from the mill 2f are alternately connected to the burner 6, that is, first, third, and fifth burners 6 from right to left of the furnace 50 positioned at the height E of the uppermost stage of the furnace front wall 51 of the furnace 50. The pulverized coal is supplied into the furnace 50 from the burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0185] In the present embodiment, the six pulverized fuel pipes 5 branched out from the single mill 2a and the single mill 2f are connected to each of three burners 6 arranged on the furnace rear wall 52 at the position F of the uppermost stage and three burners 6 arranged on the furnace front wall 51 at the position E of the uppermost stage which are the same height. However, the difference from the arrangement of the burners 6 in the preceding embodiment shown in Fig. 14 is that the six pulverized fuel pipes 6 branched out from the single mill 2a and the single mill 2f are connected to opposing burners 6 arranged on the positions F and E of the uppermost stage which are the same height.

[0186] In other words, the pulverized fuel pipes 5 are connected to the opposing burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 such that the pulverized coal fuel is supplied from the single mill 2a or the single mill 2f.

[0187] Therefore, in the arrangement with an even number of burners 6, for example six, at the same predetermined height on the furnace front wall 51 and the furnace rear wall 52 of the furnace, the same number of the pulverized fuel pipes 5 as the burners 6 are connected from the single mill 2a and the single mill 2f to the burners 6 that are arranged at the same height of the furnace front wall 51 and the furnace rear wall 52 of the wall surfaces of the furnace 50 and that are arranged to face each other. Thus, the burners 6 supplied with the pulverized coal from the mills in operation through the pulverized fuel pipes 5 always face each other, even if some of the mills 2 are partially halted.

[0188] According to the present embodiment, the combustion flames 30 generated by burning the pulverized coal supplied from the opposing burners 6 can be formed to face each other in the furnace 50. Therefore, the heat loads of the furnace front wall and the furnace rear wall of the pulverized coal combustion boiler can be more leveled.

[0189] According to the present embodiment, the pulverized coal supplied into the furnace 50 from the burners 6 arranged to face each other on the furnace front wall 51 and the furnace rear wall 52 of the boiler furnace 50 collides at the center of the furnace. This promotes mixing of the pulverized coal fuel as well as burning of the pulverized coal, allowing stable retention of the heat loads of the furnace.

[Ninth Embodiment]

[0190] The pulverized coal combustion boiler of a ninth embodiment of the present invention will be described with reference to Fig. 16.

[0191] The fundamental configuration of the pulverized coal combustion boiler 100 of this embodiment is in common with that in the preceding embodiment shown in Fig. 13 and Fig. 14. Therefore, the explanation of the configuration in common will be omitted, and only different configurations will be described.

[0192] The present embodiment shown in Fig. 16 schematically illustrates a partial cross sectional view in which the furnace 50 of the pulverized coal combustion boiler 100 of Fig. 13 is cut in the X-X direction as shown in the preceding embodiment of Fig. 14.

[0193] In the embodiment of Fig. 16, five burners 6 and five pulverized fuel pipes 5 are arranged on each of the furnace front wall 51 and the furnace rear wall 52 on the wall surfaces of the furnace 50.

[0194] In the embodiment of Fig. 16, among the burners 6 arranged on each of the uppermost stage, the middle stage, and the lower stage, the burners 6 arranged at the height E of the furnace front wall 51 and the height F of the furnace rear wall 52 which is a predetermined height of the uppermost stage, and the arrangement of the pulverized fuel pipes 5 for supplying the pulverized coal fuel from the mill 2a and the mill 2f to the burners 6 will be described. The configurations of the burners 6 and the pulverized fuel pipes 5 arranged on each of the stages at predetermined heights of the middle stage and the lower stage are the same as that of the uppermost stage. Therefore, the description will be omitted.

[0195] In Fig. 16, as for the arrangement of five pulverized fuel pipes 5 for supplying the pulverized coal to five burners 6 positioned at each of the height E of the furnace front wall 51 of the uppermost stage and the height F of the furnace rear wall 52, three of the five pulverized fuel pipes 5 branched out from the mill 2a are respectively connected to three of the five burners 6 arranged at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50.

[0196] The three of the five pulverized fuel pipes 5 branched out from the mill 2a are alternately connected to the burner 6, that is, first, third, and fifth burners 6 from left to right of the furnace 50 positioned at the height F of the uppermost stage of the furnace rear wall 51 of the furnace 50. The pulverized coal is supplied into the furnace 50 from these three burners 6, and the pulverized

coal is burned to form combustion flames 30.

[0197] The other two pulverized fuel pipes 5 branched out from the mill 2a are connected to second and fourth burners 6 from right to left of the furnace 50 positioned at the height E of the uppermost stage of the furnace front wall 51 of the furnace 50. The pulverized coal is supplied into the furnace 50 from these two burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0198] Similarly, two of the five pulverized fuel pipes 5 branched out from the mill 2f are connected to second and fourth burners 6 from left to right of the furnace 50 positioned at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50. The pulverized coal is supplied into the furnace 50 from the burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0199] The other three of the five pulverized fuel pipes 5 branched out from the mill 2f are alternately connected to the burner 6, that is, first, third, and fifth burners 6 from right to left of the furnace 50 positioned at the height E of the uppermost stage of the furnace rear wall 51 of the furnace 50. The pulverized coal is supplied into the furnace 50 from the burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0200] With the arrangement as in the present embodiment in which an odd number of burners 6, for example five, are arranged at the same height of the furnace front wall 51 and the furnace rear wall 52 of the furnace 50, and in which the odd number of burners are arranged at the same height of the furnace front wall 51 and the furnace rear wall 52 of the furnace 50, the same number of pulverized fuel pipes 5 as the number of the burners 6 cannot be connected from the single mill 2a and the single mill 2f to the furnace front wall 51 and the furnace rear wall 52 of the furnace 50. Thus, there is a difference of one in the number of pulverized fuel pipes 5 connected to the burners 6 between the furnace front wall 51 and the furnace rear wall 52 of the furnace 50.

[0201] When there is no difference in pressure loss during transfer of the pulverized coal by the pulverized fuel pipes 5 connected to the burners 6, the amount of the pulverized coal corresponding to the ratio of the number of the pulverized fuel pipes 5 is supplied to the burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100.

[0202] As described, although there is a difference in the amount of the supplied coal between the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100 in the present embodiment, the fact remains that a predetermined amount of fuel can be supplied from the single mill 2 in operation to the burners 6 arranged at the same height of the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100 through the pulverized fuel pipes 5, even when part of the mills 2 are partially inactive. Thus, leveling of the

heat loads of the pulverized coal combustion boiler 100 is not significantly hindered.

[0203] In some cases, an odd number of the burners 6 such as in the boiler of the present embodiment are implemented because the arrangement of the burners are determined by the capacity of the boiler and the size of the burners implemented in the furnace. However, as described, the heat loads of the furnace can still be made uniform even in the pulverized coal combustion boiler with an odd number of burners 6.

[Tenth Embodiment]

[0204] The pulverized coal combustion boiler of a tenth embodiment of the present invention will be described with reference to Fig. 17.

[0205] The fundamental configuration of the pulverized coal combustion boiler 100 of this embodiment is in common with that in the preceding embodiment shown in Fig. 13 and Fig. 14. Therefore, the explanation of the configuration in common will be omitted, and only different configurations will be described.

[0206] The present embodiment shown in Fig. 17 schematically illustrates a partial cross sectional view in which the furnace 50 of the pulverized coal combustion boiler 100 of Fig. 13 is cut in the X-X direction as shown in the preceding embodiment of Fig. 14.

[0207] In the embodiment of Fig. 17, five burners 6 and five pulverized fuel pipes 5 that connect from the mill 2a or the mill 2f to the burners 6 are arranged on each of the furnace front wall 51 and the furnace rear wall 52 of the wall surfaces of the furnace 50, as in the embodiment shown in Fig. 16.

[0208] In the embodiment of Fig. 17, among the burners 6 arranged on each of the uppermost stage, the middle stage, and the lower stage, the burners 6 arranged at the height E of the furnace front wall 51 and the height F of the furnace rear wall 52 which is a predetermined height of the uppermost stage, and the arrangement of the pulverized fuel pipes 5 for supplying the pulverized coal fuel from the mill 2a and the mill 2f to the burners 6 will be described. The configuration of the burners 6 arranged on each of the stages at predetermined heights of the middle stage and the lower stage, and the arrangement of the pulverized fuel pipes 5 are the same as that of the uppermost stage. Therefore, the description will be omitted.

[0209] In Fig. 17, as for the arrangement of five pulverized fuel pipes 5 for supplying the pulverized coal to five burners 6 positioned at each of the height E of the furnace front wall 51 of the uppermost stage and the height F of the furnace rear wall 52, three of the five pulverized fuel pipes 5 branched out from the mill 2a are respectively connected to three of the five burners 6 arranged at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50.

[0210] The three of the five pulverized fuel pipes 5 branched out from the mill 2a are alternately connected

to the burner 6, that is, first, third, and fifth burners 6 from left to right of the furnace 50 positioned at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50. The pulverized coal is supplied into the furnace 50 from these three burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0211] The other two pulverized fuel pipes 5 branched out from the mill 2a are connected to first and third burners 6 from left of the furnace 50 positioned at the height E of the uppermost height of the furnace front wall 51 of the furnace 50. The pulverized coal is supplied into the furnace 50 from these two burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0212] Furthermore, one of the five pulverized fuel pipes 5 branched out not from the mill 2a but from the mill 2f is connected to the first burner 6 from the right of the furnace 50 positioned at the height E of the furnace front wall 51 of the uppermost stage.

[0213] Two of the five pulverized fuel pipes 5 branched out from the mill 2f are connected to second and fourth burners 6 from left to right of the furnace 50 positioned at the height F of the uppermost stage of the furnace rear wall 52 of the furnace 50. The pulverized coal is supplied into the furnace 50 from the burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0214] The other three of the five pulverized fuel pipes 5 branched out from the mill 2f are connected to the first, second, and fourth burners 6 from right to left of the furnace 50 positioned at the height E of the uppermost stage of the furnace front wall 51 of the furnace 50. The pulverized coal is supplied into the furnace 50 from the burners 6, and the pulverized coal is burned to form the combustion flames 30.

[0215] In the present embodiment, unlike the preceding embodiment shown in Fig. 16, four of the five pulverized fuel pipes 5 branched out from the single mill 2a and the single mill 2f are connected to two pairs of burners 6 arranged to face each other on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50, the first burner 6 from the right of the furnace rear wall of the furnace 50 and the first burner 6 from the right of the furnace front wall 51 of the furnace 50 excluded.

[0216] With the arrangement as in the present embodiment in which an odd number of burners 6, for example five, are arranged at the same height of the furnace front wall 51 and the furnace rear wall 52 of the furnace 50, and in which the odd number of burners are arranged at the same height of the furnace front wall 51 and the furnace rear wall 52 of the furnace 50, the same number of pulverized fuel pipes 5 as the number of the burners 6 cannot be connected from the single mill 2a and the single mill 2f to the furnace front wall 51 and the furnace rear wall 52 of the furnace 50. Thus, there is a difference of one in the number of pulverized fuel pipes 5 connected to the burners 6 between the furnace front wall 51 and the furnace rear wall 52 of the furnace 50.

[0217] When there is no difference in pressure loss during transfer of the pulverized coal by the pulverized

fuel pipes 5 connected to the burners 6, the amount of the pulverized coal corresponding to the ratio of the number of the pulverized fuel pipes 5 is supplied to the burners 6 arranged on the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100.

[0218] As described, although there is a difference in the amount of the supplied coal between the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100 in the present embodiment, the fact remains that a predetermined amount of fuel can be supplied from the single mill 2 in operation to the burners 6 arranged at the same height of the furnace front wall 51 and the furnace rear wall 52 of the furnace 50 of the pulverized coal combustion boiler 100 through the pulverized fuel pipes 5, even when part of the mills 2 are partially inactive. Thus, leveling of the heat loads of the pulverized coal combustion boiler 100 is not significantly hindered.

[Eleventh Embodiment]

[0219] Fig. 18 illustrates the overall configuration of a power plant that provides relatively large electric power of 500 MW or more according to an eleventh embodiment including the pulverized coal combustion boiler of the present invention.

[0220] The pulverized coal combustion boiler according to the present invention is applicable to a power plant with an output of 500 MW to 1100 MW level.

[0221] The detailed structure of the pulverized coal combustion boiler employed in the power plant of the present embodiment in Fig. 18 is basically the same as the configurations of the embodiments shown in Figs. 13 to 17. Therefore, the description will be omitted.

[0222] In the pulverized coal combustion boiler 100 of the power plant shown in Fig. 18, the coal fuel is carried from a coal yard 31 to a coal bunker 32 by coal handling equipment (not shown). The coal is supplied from the coal bunker 22 to the mills 2 and pulverized for producing the pulverized coal.

[0223] The combustion gas generated by burning the pulverized coal fuel in the furnace 50 heats the water pipes constituting the water walls of the furnace 50, flows down a super heater, a reheater, and an economizer (all of which are not shown) arranged at the downstream of the furnace 50, and is discharged from the furnace 50 as the exhaust gas 14b.

[0224] NO_x of the exhaust gas 14b discharged from the furnace 50 is reduced in the catalytic device 12 arranged at the downstream of the furnace 50. The exhaust gas 14b then flows down into the air heater 22 arranged at the further downstream to be heat-recovered.

[0225] The exhaust gas 14b that has sequentially flown down the catalytic device 12 and the air heater 22 flows into the dry electrostatic precipitator 23 arranged at their downstream, and the fly ash in the exhaust gas 14b is removed. The exhaust gas 14b then flows into the wet

desulfurization equipment 25 arranged at the further downstream, and sulfur oxide in the exhaust gas 14b is removed. The cleaned exhaust gas 14b is released into the atmosphere from the stack 29.

[0226] The wet desulfurization equipment 25 removes SO_x in the exhaust gas 14b by dissolving it into the water, and the wet electrostatic precipitator 27 removes mist SO₃ mainly generated by spraying in the desulfurization equipment.

[0227] Such exhaust gas 14b from which the controlled substances are removed is saturated with water. Thus, a gas-gas heater (reheater) 28b arranged at the downstream of the wet electrostatic precipitator 27 reheats the exhaust gas 14b, thereby avoiding the smoke generated in the exhaust gas 14b released from the stack 29 from becoming white.

[0228] The heat recovered by a gas-gas heater (heat recovering device) 28a arranged at the upstream of the dry electrostatic precipitator 23 is used as the heat required in the gas-gas heater 28b.

[Twelfth Embodiment]

[0229] Fig. 19 illustrates the overall configuration of a power plant that provides relatively large electric power of 500 MW to 1100 MW according to a twelfth embodiment of the present invention including the pulverized coal combustion boiler.

[0230] The detailed structure of the pulverized coal combustion boiler employed in the power plant of the present embodiment in Fig. 19 is basically the same as the configurations of the embodiments shown in Figs. 13 to 17. Therefore, the description will be omitted. Furthermore, the fundamental configuration of the power plant of the present embodiment is also in common with that of the power plant shown in Fig. 18. Therefore, the explanation of the configuration in common will be omitted, and only different configurations will be described.

[0231] In Fig. 19, the exhaust gas 14b that has been discharged from the furnace 50 and flown down the catalytic device 12 and the air heater 22 flows into a bag filter 24 arranged at the downstream, and the fly ash in the exhaust gas 14b is removed. The exhaust gas is further used in the pulverized coal combustion boiler with less S content arranged at the further downstream and then flows into the dry desulfurization equipment 26 capable of simple desulfurization.

[0232] The cleaned exhaust gas 14b from which sulfur oxide is removed by the dry desulfurization equipment 26 is released into the atmosphere from the stack 29.

[0233] The present invention is applicable to a configuration of a pulverized coal combustion boiler that burns coal, and to a combustion system thereof.

[0234] The present invention is applicable to a pulverized coal combustion once-through boiler provided with water wall pipes vertically arranged in the furnace, and particularly to a pulverized coal combustion once-through boiler that is provided with water wall pipes ver-

tically arranged in the furnace and that has pulverized fuel pipes for supplying the pulverized coal fuel to burners arranged in the furnace.

[0235] The present invention is suitable for use in the pulverized coal combustion once-through boiler that operates not only in the entire load range but also in the partial load in which part of the burners are halted, because the present invention can make the heat loads uniform.

Claims

1. A pulverized coal combustion boiler (100) comprising:

a furnace (50);
a plurality of burners (6a-6f) for supplying and burning pulverized coal fuel in the furnace arranged at positions of a plurality of stages having different heights on a furnace front wall (51) and a furnace rear wall (52) of furnace wall surfaces forming the furnace (50), the furnace rear wall (52) arranged for facing the furnace front wall (51);
a plurality of mills (2a-2f) arranged for supplying the pulverized coal fuel to the plurality of burners (6a-6f) arranged at each of the plurality of stages; and
pulverized fuel pipes (5) arranged for distributing and supplying the pulverized coal to the plurality of burners (6a-6f) at each of the stages of the furnace front wall (51) and the furnace rear wall (52) from each of the plurality of mills (2a-2f).

2. The pulverized coal combustion boiler (100) according to claim 1, further comprising
water pipes (19) arranged on a plurality of water pipe walls (20) constituting the furnace wall surfaces of the furnace (50), wherein
the water pipes (19) arranged on the water pipe walls (20) at a lower part of the furnace wall surfaces are arranged in spirals, and
the water pipes (19) arranged on the water pipe walls (20) at an upper part of the furnace wall surfaces are arranged in the vertical direction by straight pipes connected to the water pipes arranged in spirals.

3. The pulverized coal combustion boiler (100) according to claim 1, further comprising:

first pulverized fuel pipes (5) for distributing and supplying the pulverized coal from one of the plurality of mills (2a-2f) to some of the plurality of burners (6) arranged to face each other on the furnace front wall (51) and the furnace rear wall (52) of each of the stages; and
second pulverized fuel pipes (5) for distributing

- and supplying the pulverized coal from the other of the plurality of mills (2a-2f) to other some of the plurality of burners (6) arranged to face each other on the furnace front wall (51) and the furnace rear wall (52) of each of the stages.
4. The pulverized coal combustion boiler according to claim 3, wherein the burners (6a-6f) connected to the first pulverized fuel pipes (5) and the burners (6) connected to the second pulverized fuel pipes (5) are arranged to be adjacently alternately positioned on the furnace front wall (51) and the furnace rear wall (52) of each of the stages.
 5. The pulverized coal combustion boiler (100) according to claim 1, wherein the burners (6) disposed on each of the stages are arranged in a staggered pattern such that the position at the height of the furnace wall surface of the burners (6) arranged on the furnace rear wall (52) and the position at the height of the furnace wall surface of the burners (6) arranged on the furnace front wall (51) are different.
 6. The pulverized coal combustion boiler (100) according to claim 1, wherein the burners (6) disposed on each of the stages are arranged such that the position at the height of the furnace wall surface of the burners (6a-6f) arranged on the furnace rear wall (52) and the position at the height of the furnace wall surface of the burners (6a-6f) arranged on the furnace front wall (51) are substantially the same.
 7. The pulverized coal combustion boiler (100) according to claim 3, wherein the burners (6a-6f) connected to the first pulverized fuel pipes and disposed on the furnace front wall (51) are arranged to face the burners (6) connected to the first pulverized fuel pipes and disposed on the furnace rear wall (52), and the burners (6) connected to the second pulverized fuel pipes and disposed on the furnace front wall (51) are arranged to face the burners (6a-6f) connected to the second pulverized fuel pipes (5) and disposed on the furnace rear wall (52).
 8. The pulverized coal combustion boiler (100) according to claim 1, further comprising controllers (21) are arranged on the pulverized fuel pipes (5) to control the coal feed rates of the pulverized coal supplied from each of the mills (2a-2f) to the burners (6a-6f).
 9. The pulverized coal combustion boiler (100) according to claim 1, wherein the plurality of mills is arranged on both sides of the furnace sidewall (53) connecting the furnace front wall (51) and the furnace rear wall (52) for constituting the furnace (50).
 10. The pulverized coal combustion boiler (100) according to claim 9, wherein the plurality of mills (2a-2f) are separately arranged on both sides of the furnace sidewall (53).
 11. The pulverized coal combustion boiler (100) according to claim 9, wherein the plurality of mills (2a-2f) are arranged on one side of the furnace sidewall.
 12. A pulverized coal combustion boiler (100) comprising:
 - a furnace (50);
 - a plurality of water pipes (19) arranged on the furnace (50) such as to form a water pipe wall (20) of the furnace (50);
 - a furnace front wall (51) and a furnace rear wall (52) facing the furnace front wall (51) to form the water pipe wall (20) of the furnace (50) having the water pipes (19);
 - a plurality of burners (6a-6f) arranged on the furnace front wall (51) and the furnace rear wall (52) for supplying pulverized coal into the furnace (50);
 - a plurality of mills (2a-2f) for pulverizing coal fuel to produce the pulverized coal; and
 - pulverized fuel pipes (5) arranged for supplying the pulverized coal produced by the mills (2a-2f) to the plurality of burners (6a-6f), **characterized in that**
 - the plurality of water pipes (19) are arranged substantially vertical direction to constitute the water pipe wall (20) of the furnace (50),
 - the plurality of burners (6a-6f) are arranged to face each other on the water pipe walls (20) of the furnace front wall (51) and the furnace rear wall (52) at positions of a predetermined height of the furnace (50),
 - the pulverized fuel pipes (5) for supplying the pulverized coal from one of the plurality of mills (2a-2f) to some of the plurality of burners (6a-6f) facing each other at the positions of the predetermined height of the furnace (50) are arranged on the water pipe wall surface to branch out into the furnace front wall (51) and the furnace rear wall (52) and connect to the some of the plurality of burners (6a-6f), and
 - other pulverized fuel pipes (5) for supplying the pulverized coal from another one of the plurality of mills (2a-2f) to the remaining plurality of mills (2a-2f) facing each other at the positions of the predetermined height of the furnace (50) are arranged on the water pipe wall surface to branch out into the furnace front wall (51) and the fur-

nace rear wall (52) and connect to the remaining plurality of burners (6a-6f).

13. The pulverized coal combustion boiler (100) according to claim 12, wherein
the pulverized fuel pipes (5) for supplying the pulverized coal from one of the plurality of mills (2a-2f) are arranged to branch out into the furnace front wall (51) and the furnace rear wall (52) and connect to burners (6a-6f), arranged to face each other, among the plurality of opposing burners (6a-6f) arranged on the water pipe walls of the furnace front wall (51) and the furnace rear wall (52) at the positions of the predetermined height of the furnace (50). 5 10
14. The pulverized coal combustion boiler (100) according to claim 12, wherein
the pulverized fuel pipes (5) for supplying the pulverized coal from one of the plurality of mills (2a-2f) are arranged to branch out into one of the furnace front wall (51) and the furnace rear wall (52) and connect to the opposing burners (6a-6f) arranged on one of the furnace front wall (51) and the furnace rear wall (52), the burners (6a-6f) being among the plurality of opposing burners (6a-6f) arranged on the water pipe walls (20) of the furnace front wall (51) and the furnace rear wall (52) at the positions of the predetermined height of the furnace (50), and other pulverized fuel pipes for supplying the pulverized coal from another one of the plurality of mills (2a-2f) are arranged to branch out into the other of the furnace front wall (51) and the furnace rear wall (52) and connect to the opposing burners (6a-6f) arranged on the other of the furnace front wall (51) and the furnace rear wall (52). 20 25 30 35
15. The pulverized coal combustion boiler (100) according to claim 12, wherein
the plurality of burners (6a-6f) arranged on the water pipe walls of the furnace front wall (51) and the furnace rear wall (52) at the position of the predetermined height of the furnace are arranged with an even number of burners (6a-6f). 40
16. The pulverized coal combustion boiler (100) according to claim 12, wherein
the plurality of burners (6a-6f) arranged on the water pipe walls of the furnace front wall (51) and the furnace rear wall (52) at the position of the predetermined height of the furnace (50) are arranged with an odd number of burners. 45 50
17. The pulverized coal combustion boiler (100) according to claim 12, wherein
the ratio of the amount of the pulverized coal supplied to the plurality of burners (6a-6f) arranged on the furnace front wall (51) of the furnace (50) through the pulverized fuel pipes branched out from the mills 55

to the amount of the pulverized coal supplied to the plurality of burners (6a-6f) arranged on the furnace rear wall (52) through the pulverized fuel pipes branched out from the mills (2a-2f) is substantially equal to the ratio of the number of burners (6a-6f) arranged on the water pipe walls of the furnace front wall (51) at the same height of the furnace (50) to the number of burners (6a-6f) arranged on the water pipe walls of the furnace rear wall (52) at the same height of the furnace (50).

18. The pulverized coal combustion boiler (100) according to claim 12, wherein
the pulverized coal combustion boiler (100) is operated so that the average in-pipe mass flow rate of the fluid flowing through the water pipes (19) arranged substantially vertically in the furnace (50) becomes 1000 kg/m²s to 400 kg/m²s at 50% boiler load. 15 20
19. A power plant having a pulverized coal combustion boiler, the power plant providing 500 MW to 1100 MW electric power, the pulverized coal combustion boiler (100) comprising:
a furnace (50);
a plurality of water pipes arranged on the furnace (50) such as to form a water pipe wall (20) of the furnace (50);
a furnace front wall (51) and a furnace rear wall (52) facing the furnace front wall (51) to form the water pipe wall (20) of the furnace (50) having the water pipes (19);
a plurality of burners (6a-6f) arranged on the furnace front wall (51) and the furnace rear wall (52) for supplying pulverized coal fuel into the furnace (50);
a plurality of mills (2a-2f) for pulverizing coal to produce the pulverized coal; and
pulverized fuel pipes arranged for supplying the pulverized coal produced by the mills (2a-2f) to the plurality of burners (6a-6f), **characterized in that**
the plurality of water pipes (19) are arranged substantially vertical direction to constitute the water pipe wall (20) of the furnace (50),
the plurality of burners (6a-6f) are arranged to face each other on the water pipe walls (20) of the furnace front wall (51) and the furnace rear wall (52) at positions of a predetermined height of the furnace (50),
the pulverized fuel pipes (5) for supplying the pulverized coal from one of the plurality of mills (2a-2f) to some of the plurality of burners (6a-6f) facing each other at the positions of the predetermined height of the furnace (50) are arranged on the water pipe wall surface to branch out into the furnace front wall (51) and the fur-

nace rear wall (52) and connect to the some of
the plurality of burners (6a-6f),
other pulverized fuel pipes (5) for supplying the
pulverized coal from another one of the plurality
of mills (2a-2f) to the remaining plurality of mills
(2a-2f) facing each other at the positions of the
predetermined height of the furnace (50) are ar-
ranged on the water pipe wall surface to branch
out into the furnace front wall (51) and the fur-
nace rear wall (52) and connect to the remaining
plurality of burners (6a-6f); and
at least one of an air heater (22), an electrostatic
precipitator (23, 27), and a bag filter (24) are
disposed at the downstream of the pulverized
coal combustion boiler (100) for flowing down
an exhaust gas discharged from the pulverized
coal combustion boiler (100).

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FIG. 1

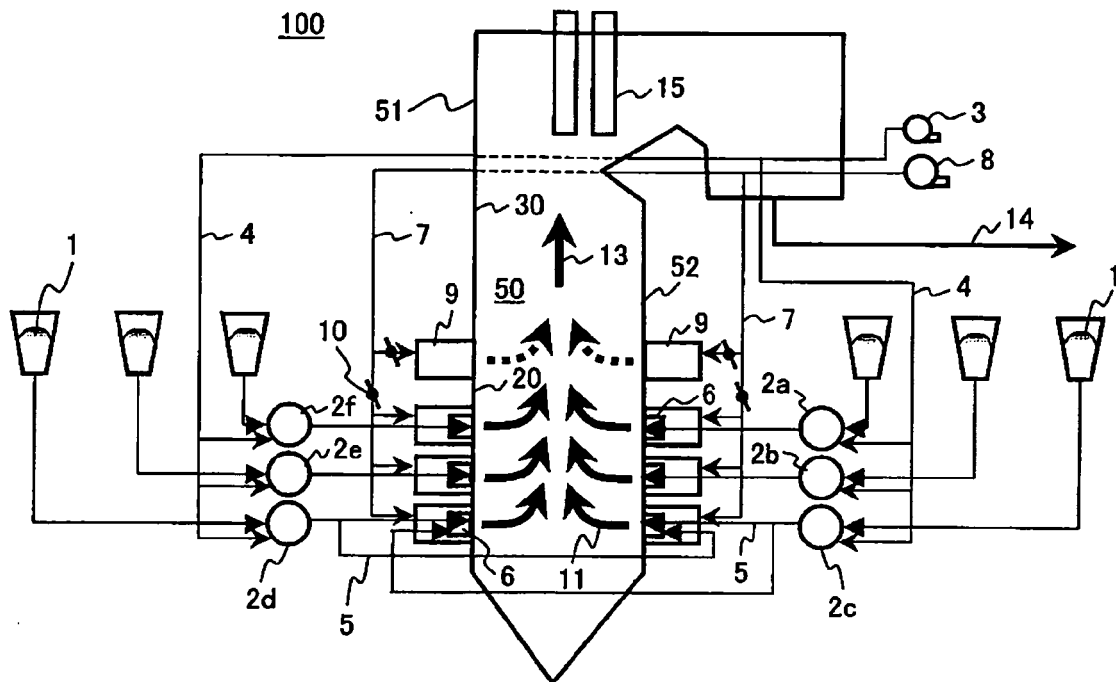


FIG. 2

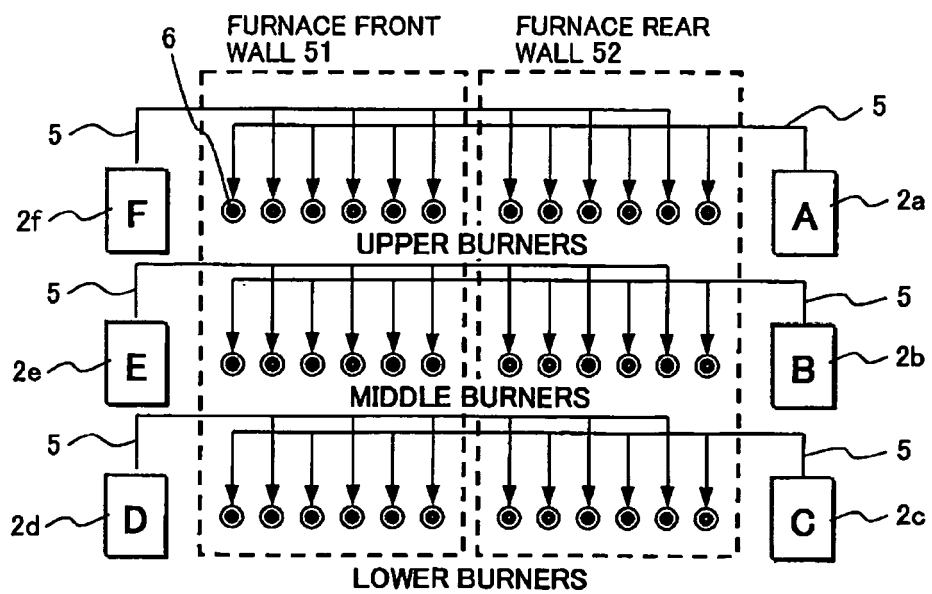


FIG. 3

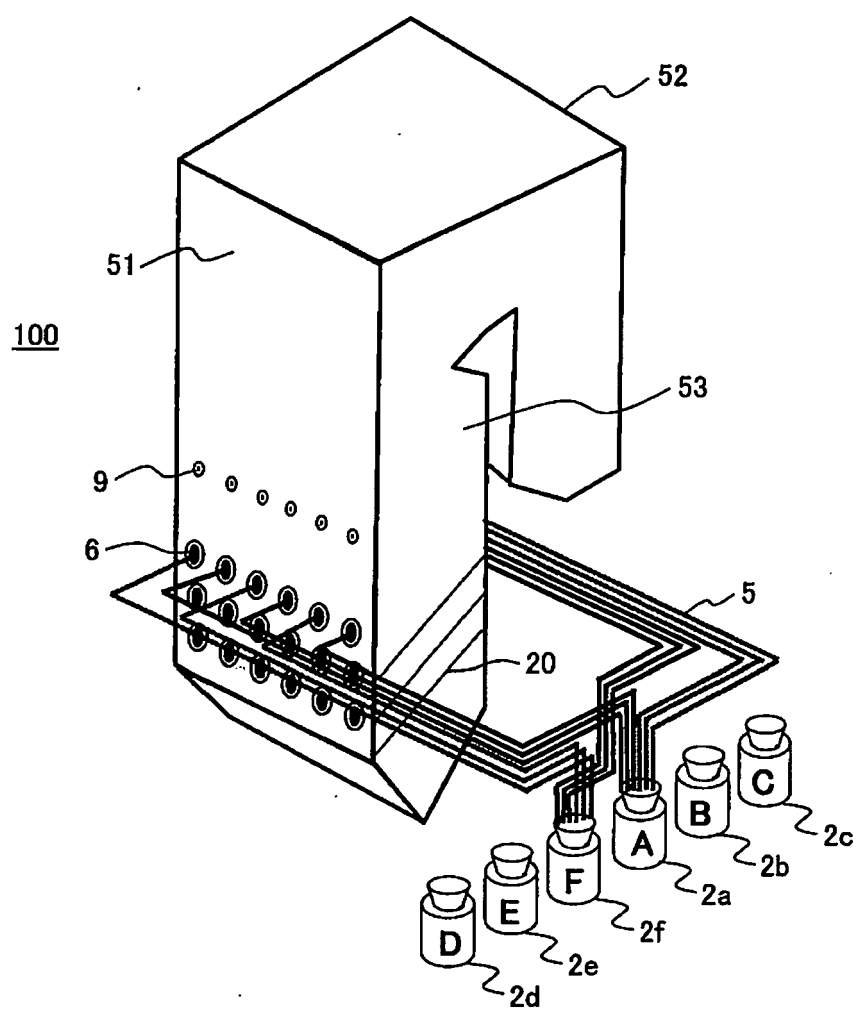


FIG. 4

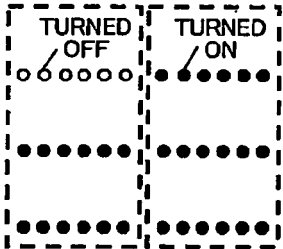
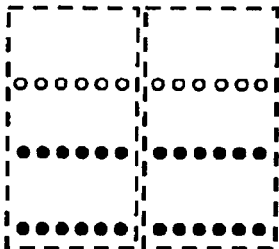
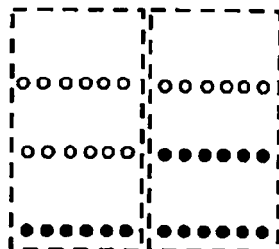
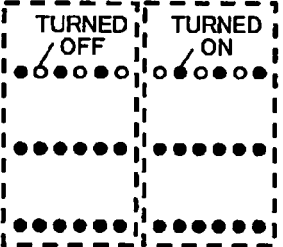
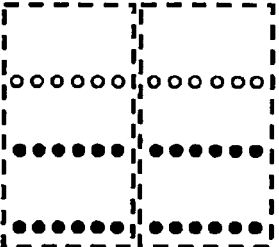
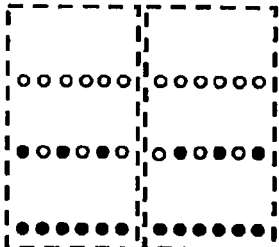
	ONE MILL HALTED	TWO MILLS HALTED	THREE MILLS HALTED 50% HEAT LOAD
COMPARATIVE EXAMPLE	FURNACE FRONT WALL 51 FURNACE REAR WALL 52  HEAT LOAD 1:15	 HEAT LOAD 1:1	 HEAT LOAD 1:2
PRESENT INVENTION	FURNACE FRONT WALL 51 FURNACE REAR WALL 52  HEAT LOAD 1:1	 HEAT LOAD 1:1	 HEAT LOAD 1:1

FIG. 5

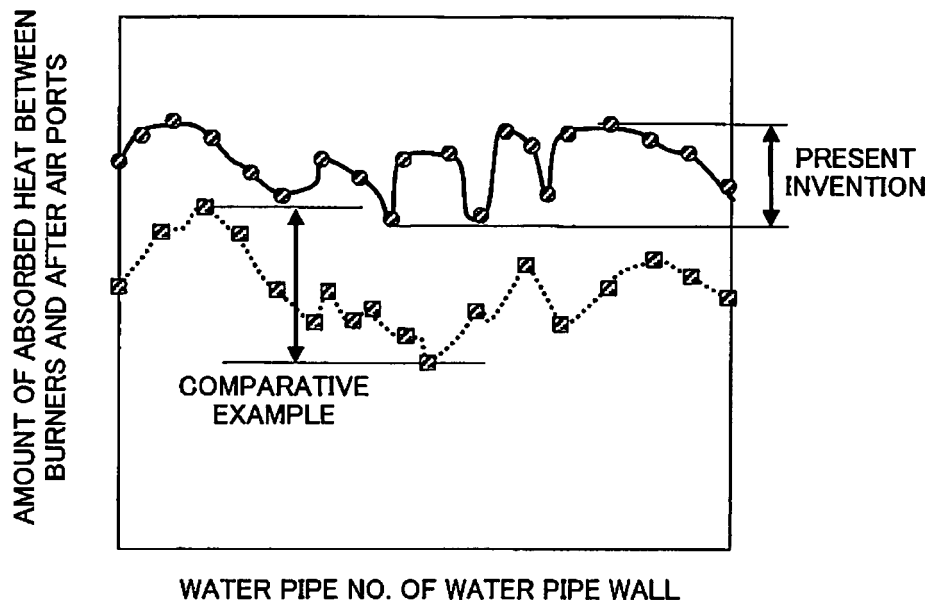


FIG. 6

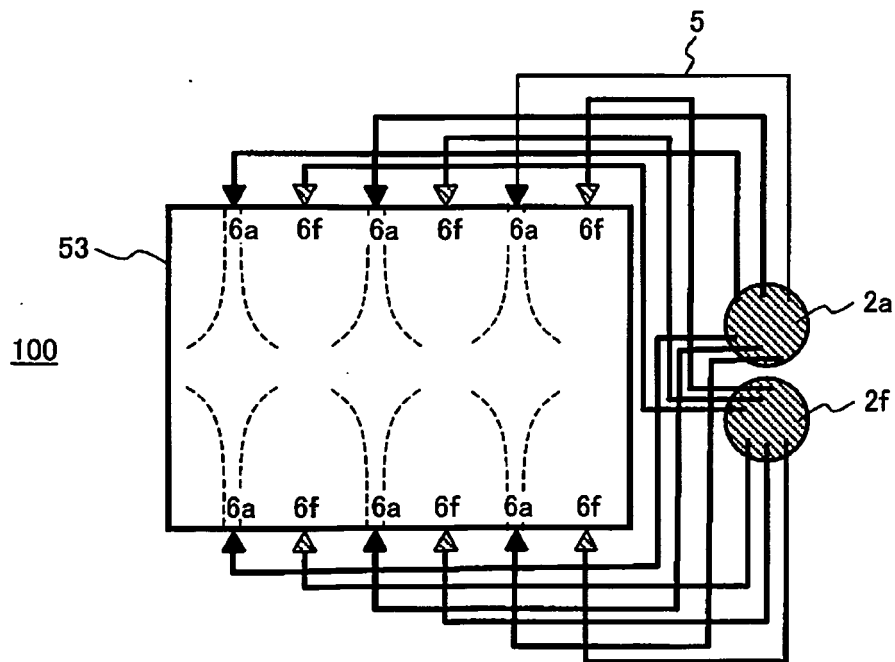


FIG. 7

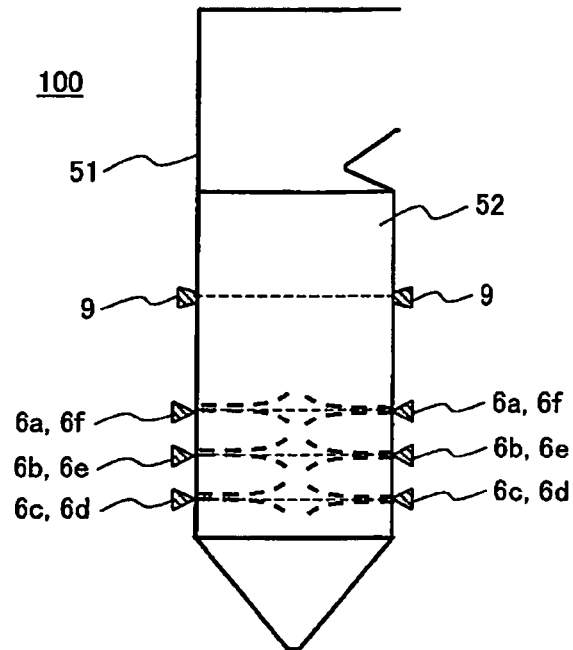


FIG. 8

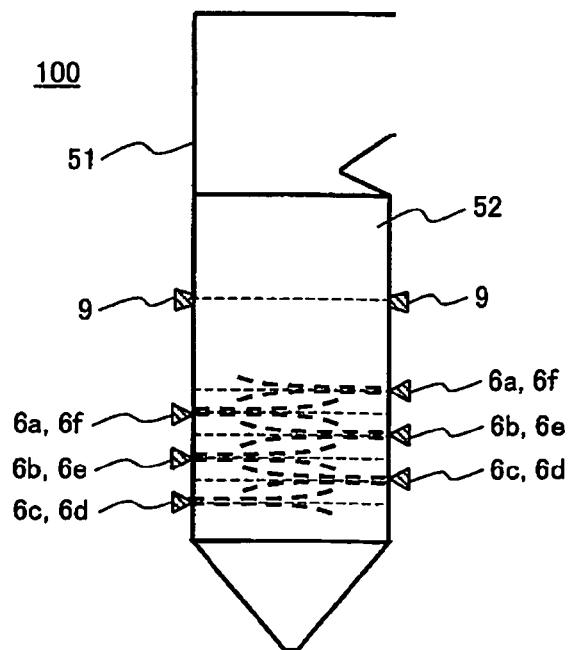


FIG. 9

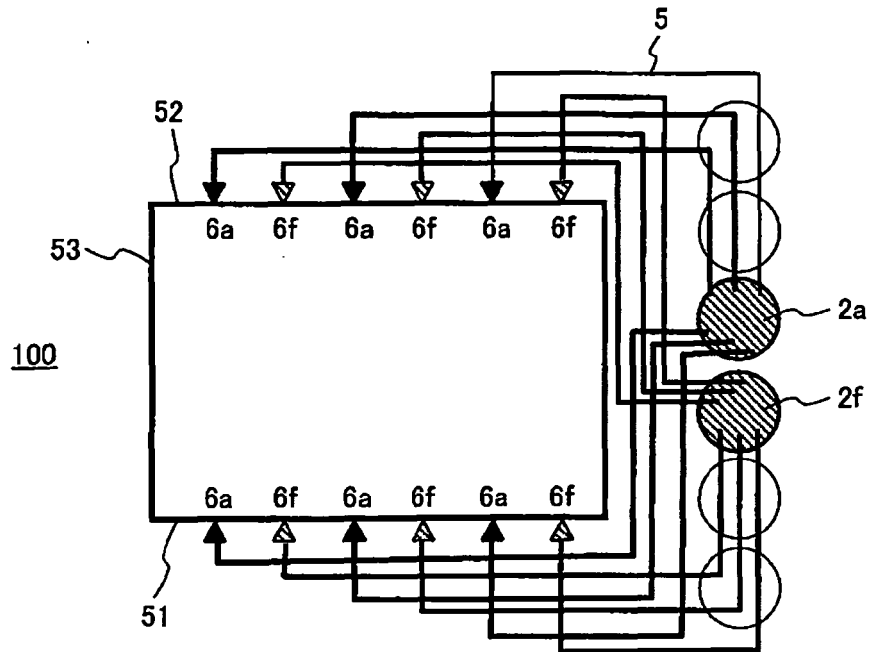


FIG. 10

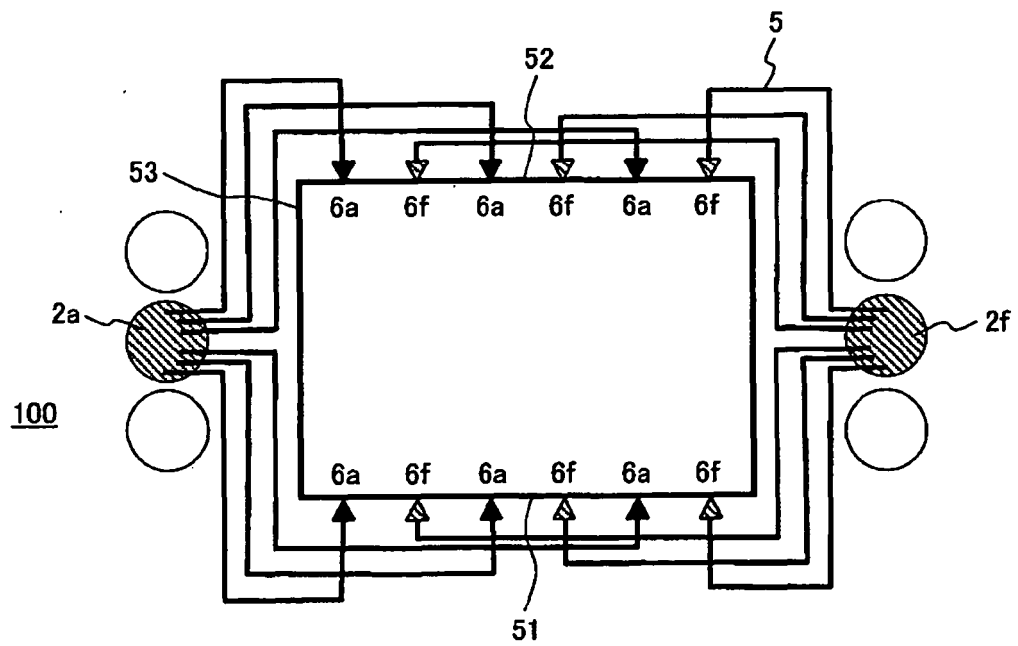


FIG. 11

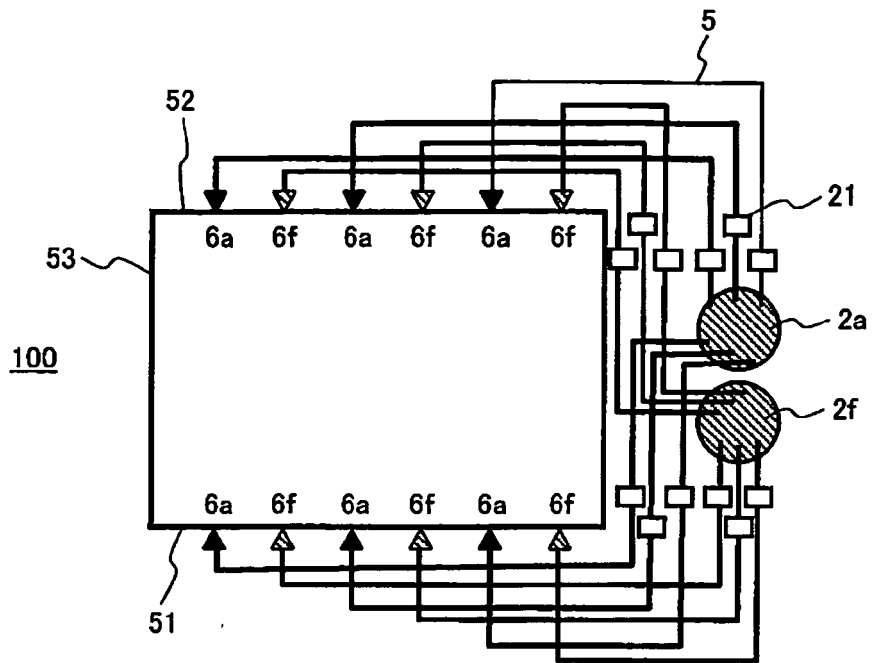


FIG. 12

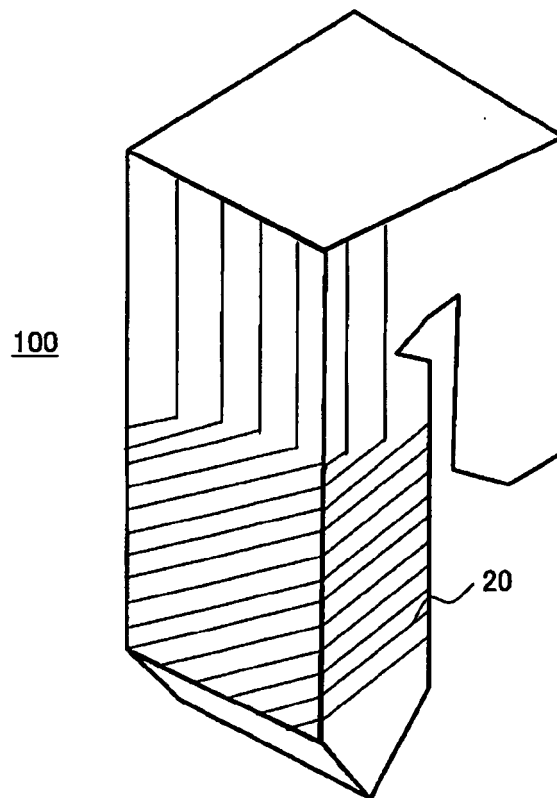


FIG. 13

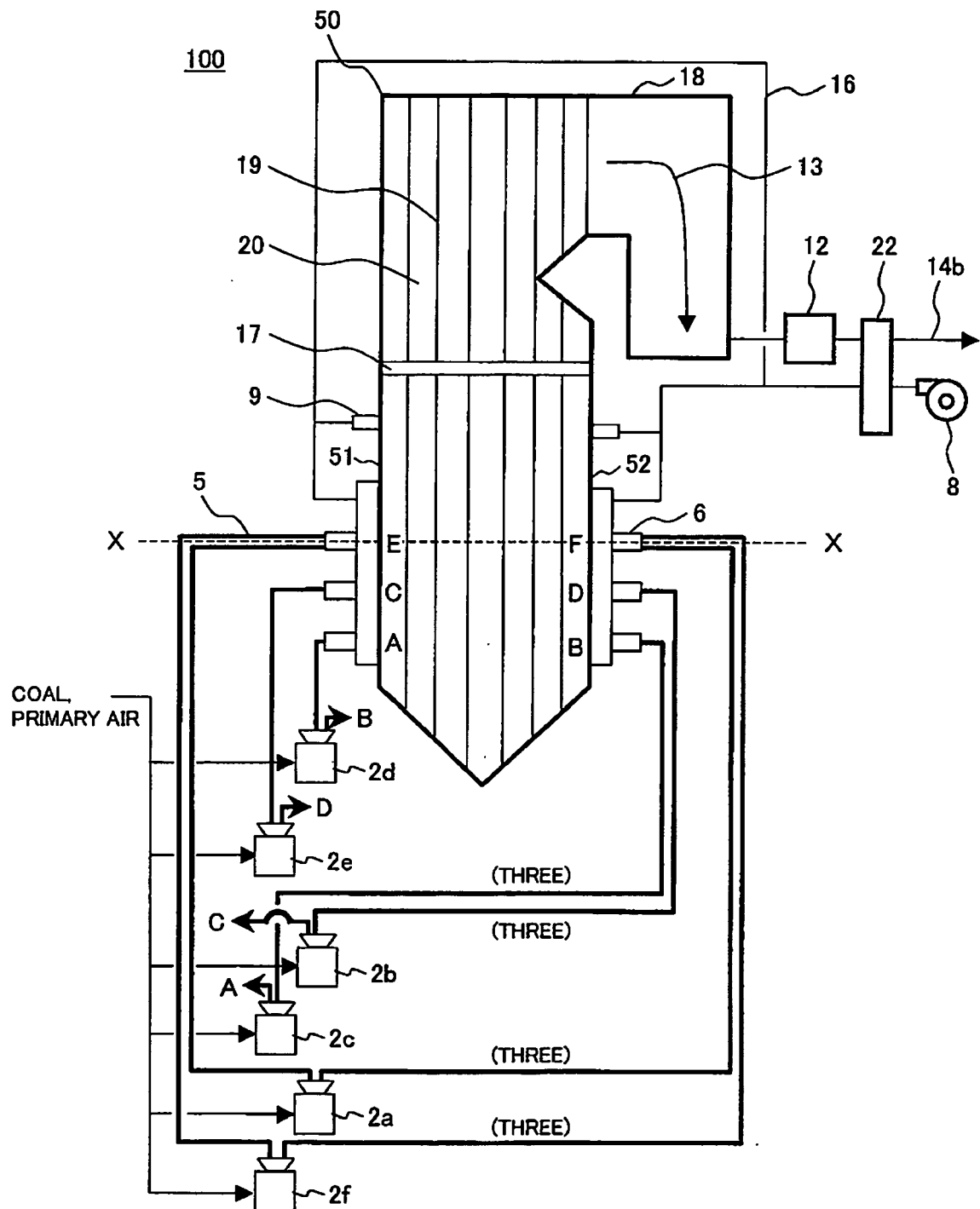


FIG. 14

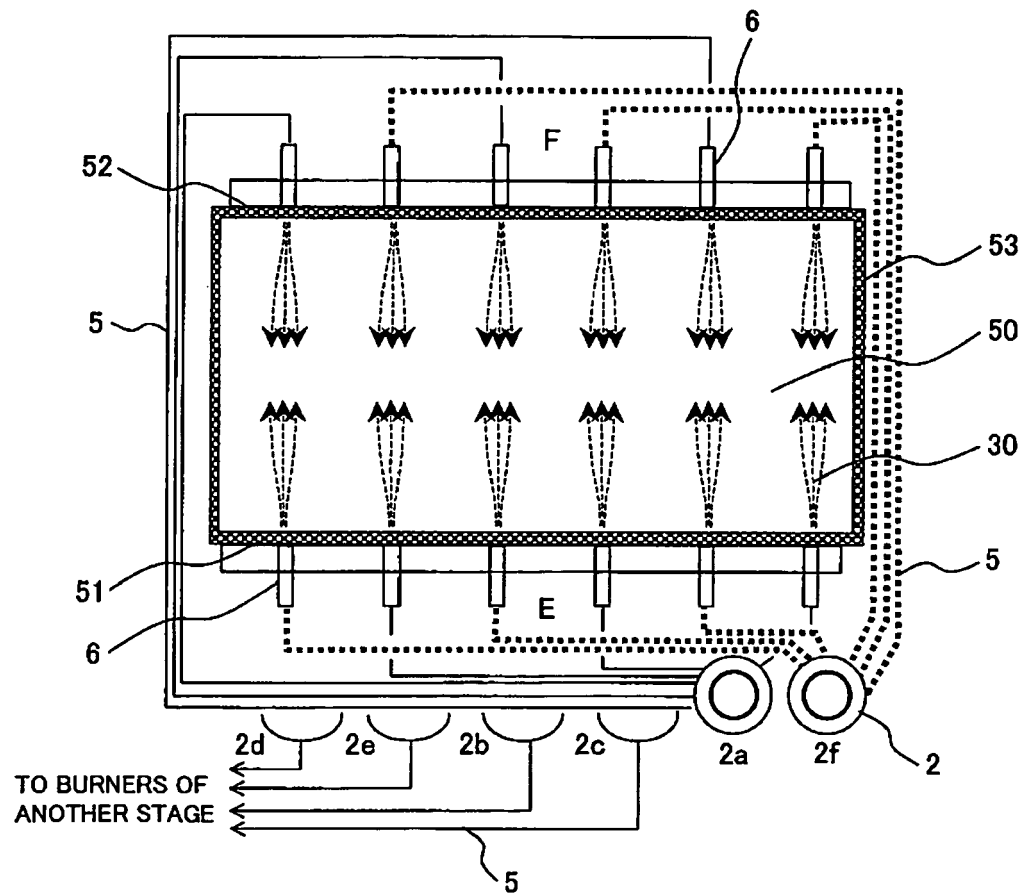


FIG. 15

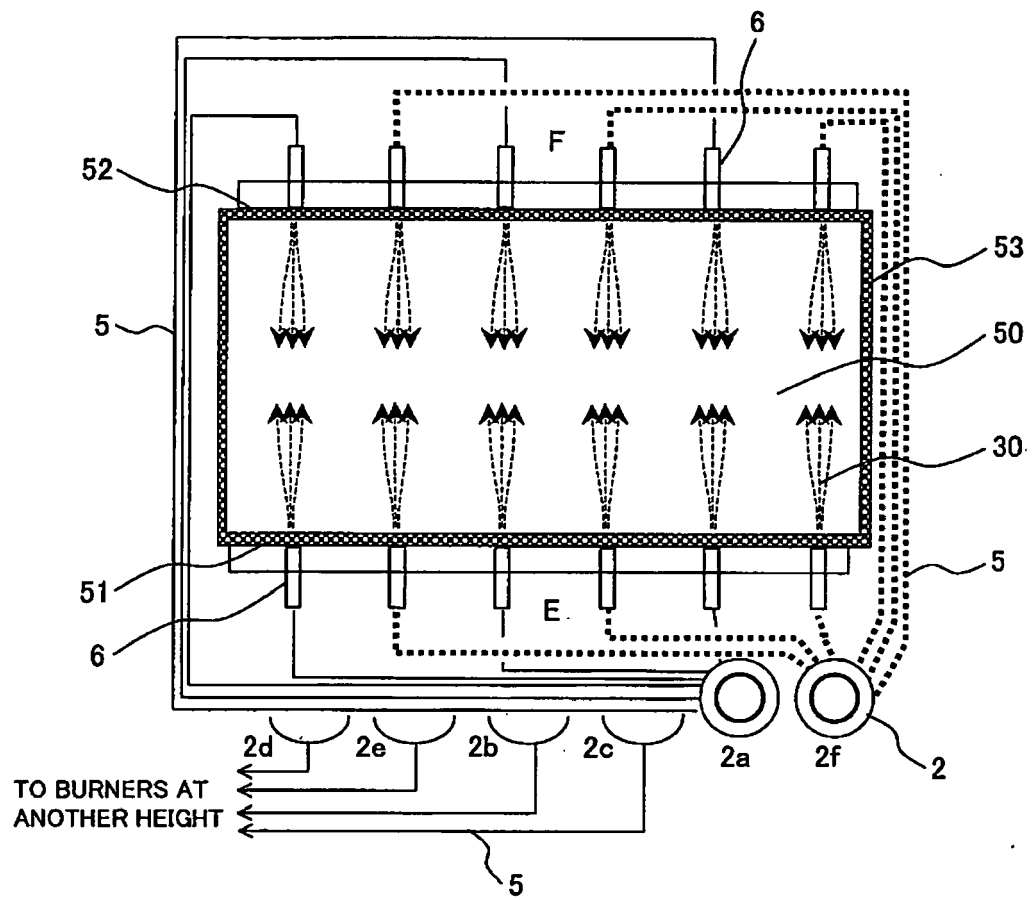


FIG. 16

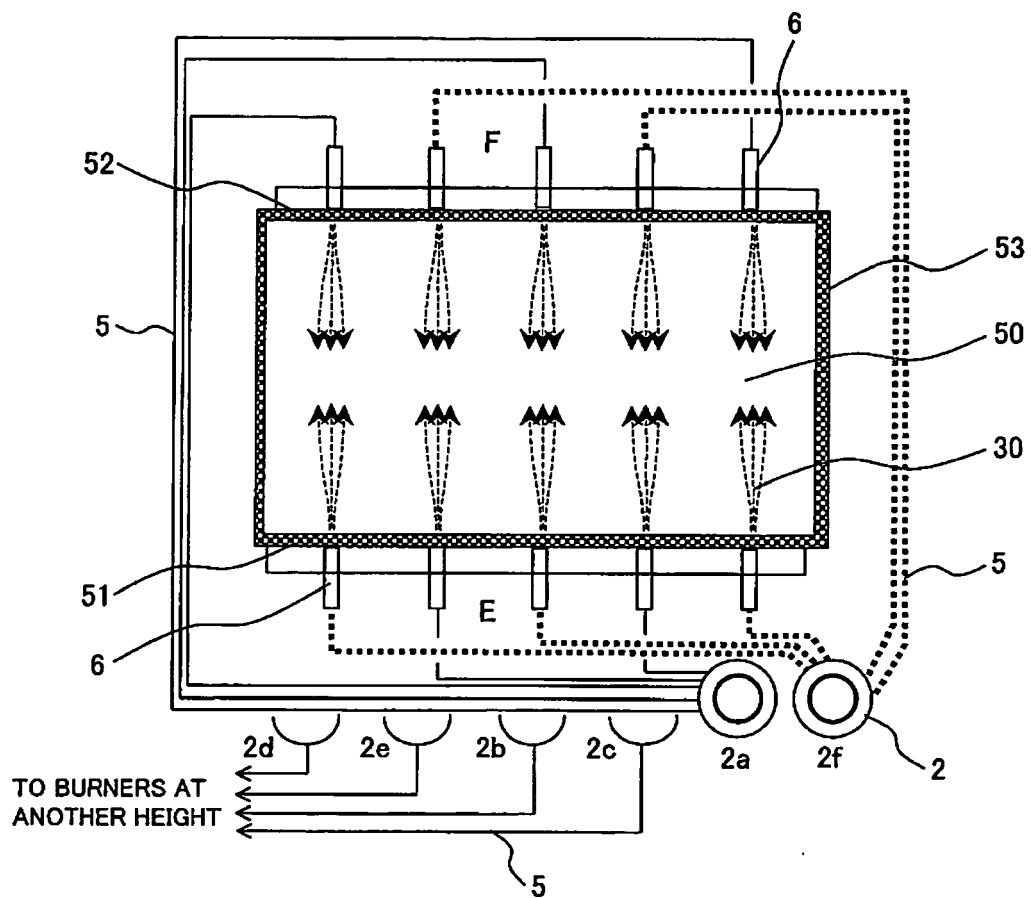


FIG. 17

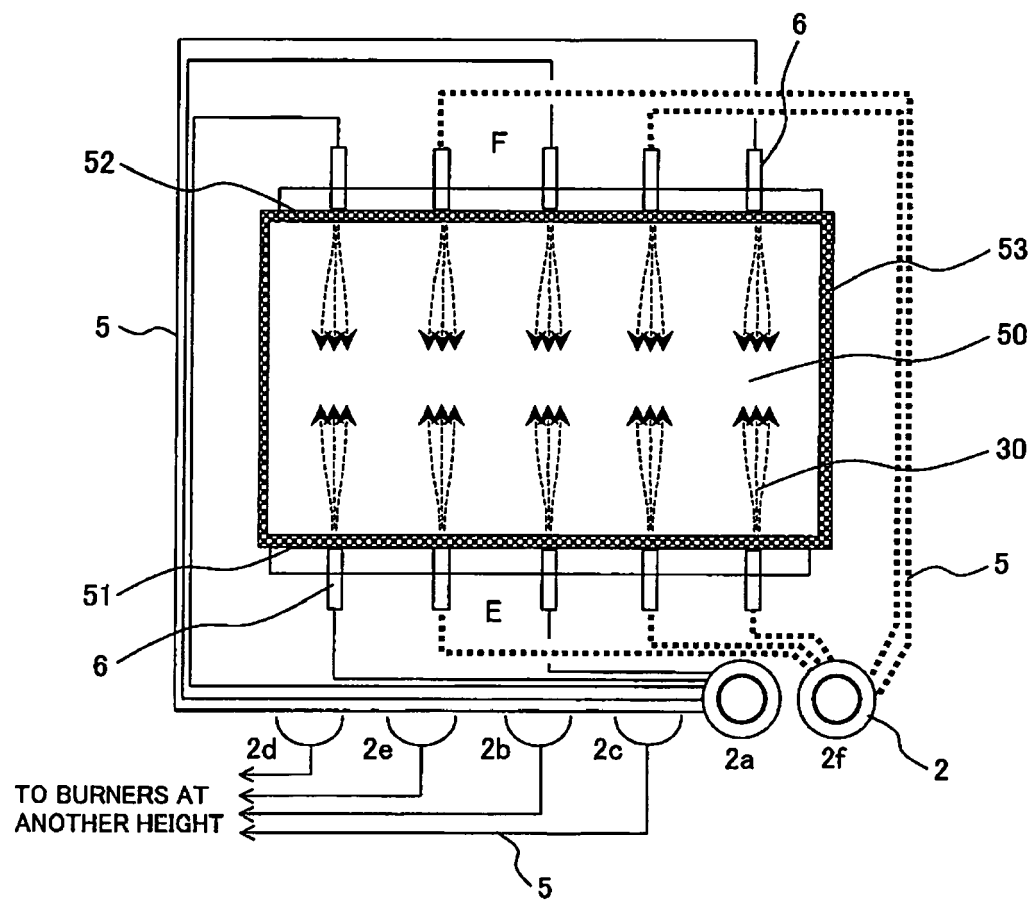


FIG. 18

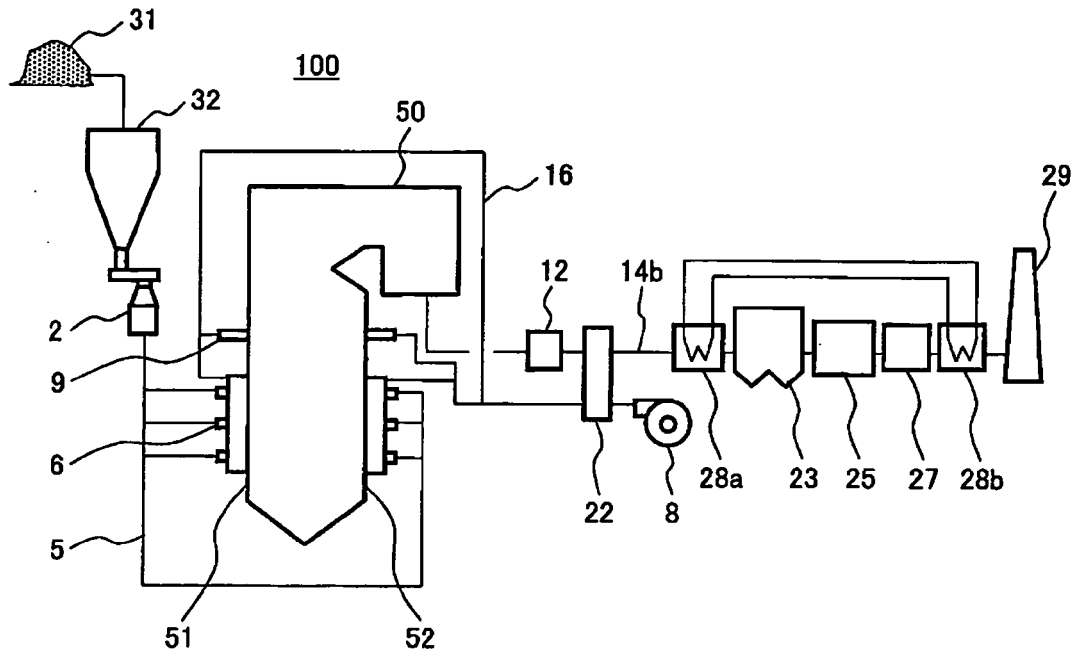


FIG. 19

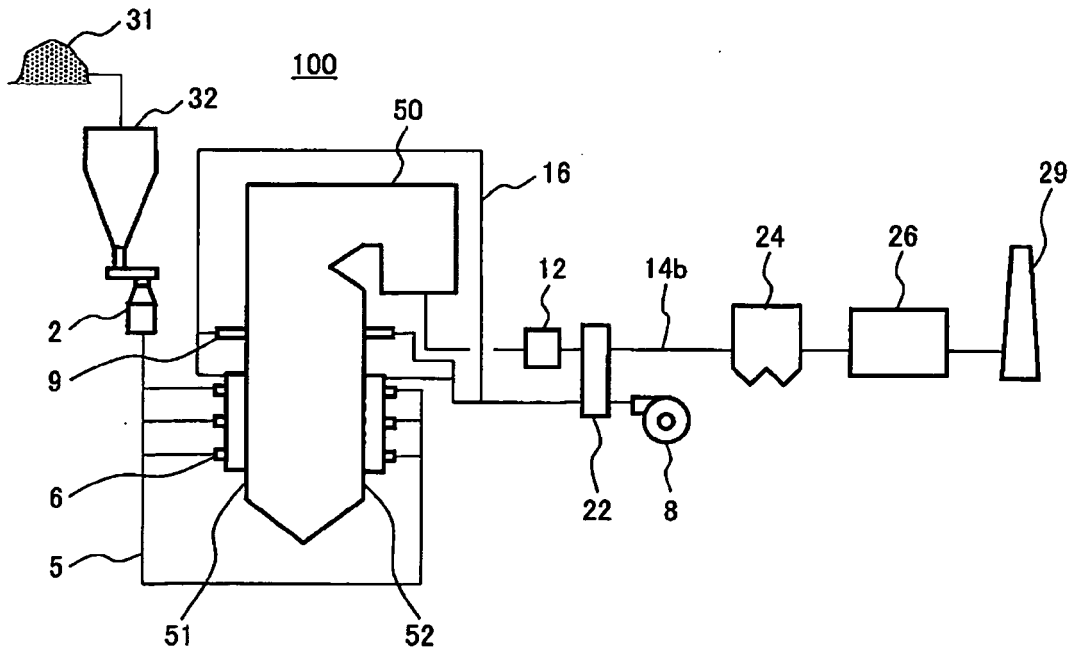
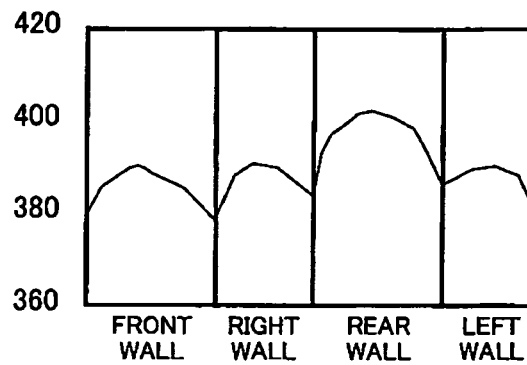


FIG. 20A

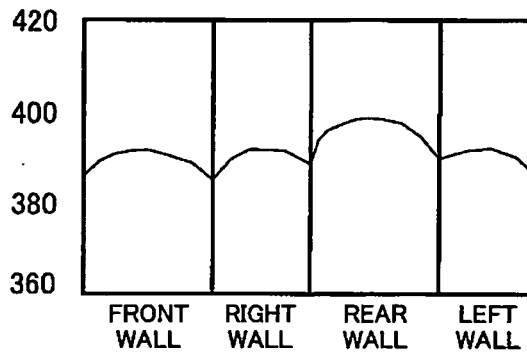
VAPOR TEMPERATURE
OF WATER WALL PIPE
OUTLETS (°C)



AVERAGE IN-PIPE MASS FLOW RATE : 2000kg/m²s
BOILER LOAD : 50%

FIG. 20B

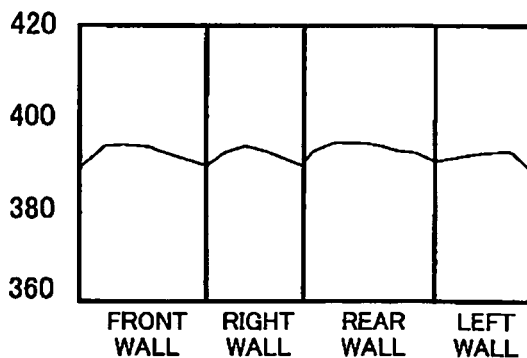
VAPOR TEMPERATURE
OF WATER WALL PIPE
OUTLETS (°C)



AVERAGE IN-PIPE MASS FLOW RATE : 1000kg/m²s
BOILER LOAD : 50%

FIG. 20C

VAPOR TEMPERATURE
OF WATER WALL PIPE
OUTLETS (°C)



AVERAGE IN-PIPE MASS FLOW RATE : 1000kg/m²s
BOILER LOAD : 50%

FIG. 21

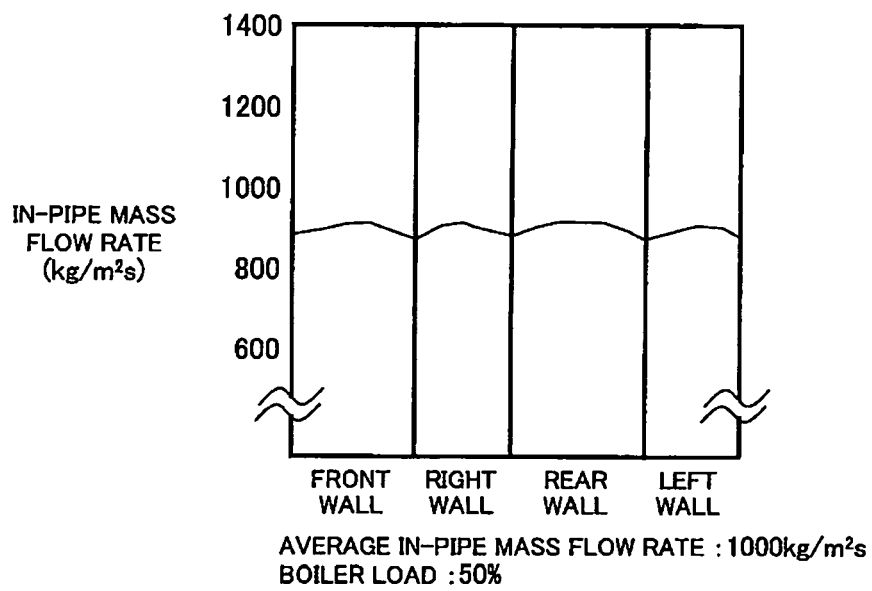
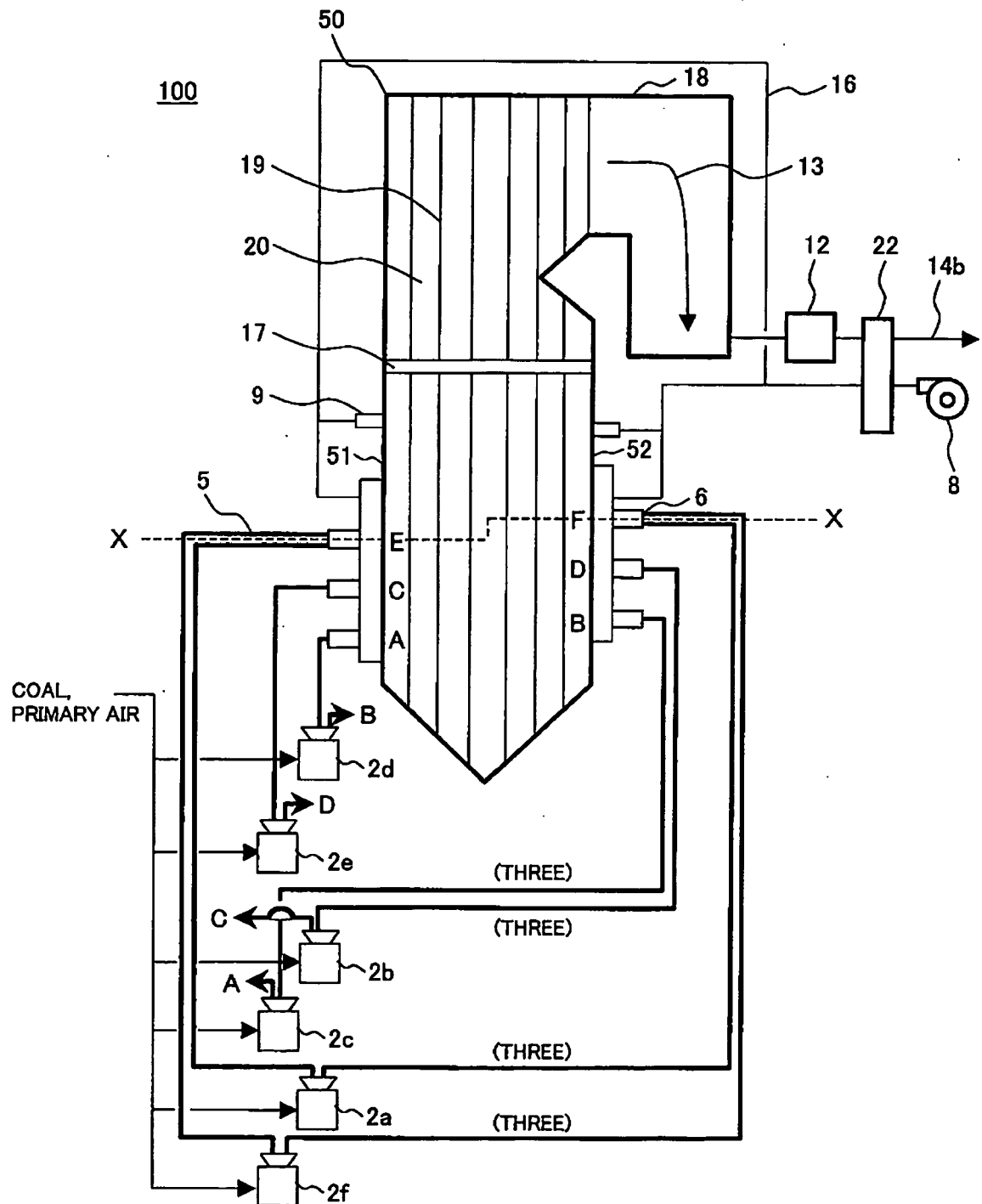


FIG. 22



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2001221406 A [0002] [0009] [0011] [0012]
- JP 3091220 B [0008] [0010] [0014]