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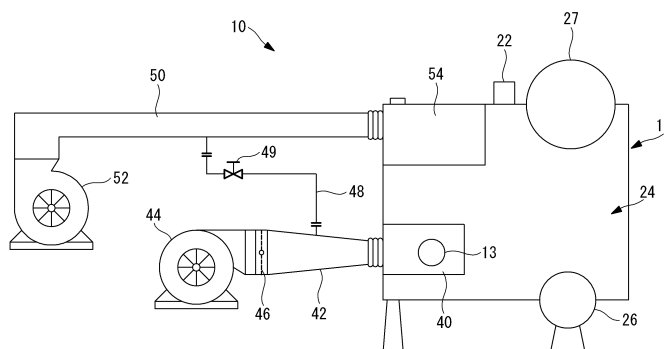
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(54) **BOILER**

(57) Provided is a boiler that can cool a secondary burner even if the small capacity secondary burner is not in operation when a large capacity primary burner is in operation. The boiler includes: a combustion vessel (11) forming a combustion chamber (24); a primary burner provided to the combustion vessel (11); a secondary burner (13) provided to the combustion vessel (11), provided downstream of flame formed by the primary burner, and having a smaller capacity than the primary burner; a secondary burner wind box (40) accommodating the

secondary burner (13) and attached to the combustion vessel (11); a secondary burner air fan (44) configured to supply air to the secondary burner wind box (40); and a control unit configured to control the secondary burner air fan (44). When the primary burner is in operation and the secondary burner (13) is not in operation, the control unit controls the secondary burner air fan (44) such that the pressure of the secondary burner wind box (40) is higher than the pressure of the combustion vessel (11).

FIG. 4



Description

{Solution to Problem}

{Technical Field}

[0001] The present invention relates to a boiler.

{Background Art}

[0002] Boilers that form flame in a combustion chamber by using a burner and generate steam are known. PTL 1 listed below discloses a ship boiler installed in a ship. The boiler disclosed in PTL 1 is provided with a small capacity burner in addition to a large capacity burner and thereby can cover a need for a large capacity burner to a small capacity burner.

{Citation List}

{Patent Literature}

[0003] {PTL 1}
Japanese Utility Model Laid-Open No. S57-81999

{Summary of Invention}

{Technical Problem}

[0004] As a boiler installed in a ship, there is a main engine boiler used for a power source for driving a propulsion propeller. As a boiler having a smaller capacity than the main engine boiler, there is an auxiliary boiler used for an auxiliary power source that activates various devices installed in the ship or drives a detonator.

[0005] An auxiliary boiler used for generating high pressure steam for a high load device and an auxiliary boiler used for generating low pressure steam for a low load device may be required, respectively. This will result in an increase in the number of units in the ship. Further, since the auxiliary boiler requires time for increasing the pressure, it is also necessary to continue a warm-up operation in order to promptly supply steam to a device. Thus, there is a problem of increased fuel consumption due to a warm-up operation of an auxiliary boiler that generates high pressure steam in particular.

[0006] Accordingly, it is considered that burners having different capacities as disclosed in PTL 1 to cover a need for a large capacity burner to a small capacity burner to increase the turndown.

[0007] However, the small capacity burner is stopped during the operation of a large capacity burner, and there is a risk of damage to the small capacity secondary burner due to radiation heat of flame of the large capacity primary burner.

[0008] The present disclosure has been made in view of such circumstances and intends to provide a boiler that can cool a small capacity burner while a large capacity primary burner is in operation.

[0009] The boiler according to one aspect of the present disclosure includes: a combustion vessel forming a combustion chamber; a primary burner provided to the combustion vessel; a secondary burner provided to the combustion vessel, provided downstream of flame formed by the primary burner, and having a smaller capacity than the primary burner; a secondary burner wind box accommodating the secondary burner and attached to the combustion vessel; an air supply unit configured to supply air to the secondary burner wind box; and a control unit configured to control the air supply unit, and the control unit drives the air supply unit when the primary burner is in operation and the secondary burner is not in operation.

[0010] The secondary burner is provided downstream of flame formed by the primary burner. Thus, when the primary burner is in operation and the secondary burner is not in operation, there is a risk of damage to the secondary burner caused by radiation heat of the flame of the primary burner if no combustion air is supplied to the secondary burner. Thus, even when the secondary burner is not in operation, air is supplied from the secondary burner air fan to cool the secondary burner. Further, since air is supplied so that the pressure in the secondary burner wind box is higher than the pressure in the combustion vessel, the secondary burner and the secondary burner wind box can be sealed from the pressurized combustion chamber.

[0011] The control unit may control the air supply unit such that a pressure of the secondary burner wind box is higher than a pressure of the combustion vessel when the primary burner is in operation and the secondary burner is not in operation.

[0012] The boiler according to one aspect of the present disclosure includes a cooling steam supply unit configured to supply cooling steam that cools the secondary burner.

[0013] Since the cooling steam is further supplied, damage on the secondary burner due to radiation heat can be suppressed.

[0014] In the boiler according to one aspect of the present disclosure, the secondary burner includes an oil ejection nozzle configured to eject oil fuel to the combustion chamber as combustion fuel, and the oil ejection nozzle is a part of the cooling steam supply unit.

[0015] Since the oil ejection nozzle of the secondary burner is not supplied with any oil when the secondary burner is not in operation, the oil ejection nozzle is provided as a part of the cooling steam supply unit and supplies cooling steam from the oil ejection nozzle. Since the oil ejection nozzle ejects cooling steam from the tip of the secondary burner into the combustion chamber, the secondary burner can be effectively protected from radiation heat.

[0016] In the boiler according to one aspect of the present disclosure, a steam supply nozzle is provided as

a part of the cooling steam supply unit in the secondary burner wind box.

[0017] The steam supply nozzle is provided as a part of the cooling steam supply unit in the secondary burner wind box. This enables cooling of the secondary burner accommodated in the secondary burner wind box. Further, since a path used for supplying cooling steam can be provided separately from the fuel nozzle of the secondary burner, cooling steam can be supplied regardless of the operation of the secondary burner.

[0018] The steam supply nozzle may be, for example, a steam ring nozzle that is a ring-shaped nozzle surrounding the secondary burner.

[0019] In the boiler according to one aspect of the present disclosure, the secondary burner includes a gas ejection nozzle configured to eject gas fuel to the combustion chamber as combustion fuel, and the gas ejection nozzle is a part of the cooling steam supply unit.

[0020] The secondary burner has a gas ejection nozzle so that gas fuel can be used in addition to oil fuel. The gas ejection nozzle is provided as a part of the cooling steam supply unit to supply cooling steam from the gas ejection nozzle. Since the gas ejection nozzle ejects cooling steam from the tip of the secondary burner into the combustion chamber, the secondary burner can be effectively protected from radiation heat.

[0021] In the boiler according to one aspect of the present disclosure, the cooling steam supply unit supplies cooling steam to downstream of flame formed by the primary burner.

[0022] With steam being supplied downstream of flame from the primary burner, this can reduce the flame temperature and thereby reduce thermal NOx.

[0023] The boiler according to one aspect of the present disclosure includes: a primary burner wind box accommodating the primary burner and attached to the combustion vessel; a primary burner air fan configured to supply air to the primary burner wind box; and an air supply tube configured to supply air from the primary burner air fan to the secondary burner wind box.

[0024] Air is supplied from the primary burner air fan to the secondary burner wind box. Accordingly, even if the secondary burner air fan should fail, cooling air can be supplied to the secondary burner wind box.

[0025] Note that the air supply from the primary burner air fan to the secondary burner wind box is controlled by the control unit. That is, when the secondary burner air fan has not failed, the control unit controls an on-off valve or the like so as to stop the air flow. If the secondary burner air fan fails, the control unit controls the on-off valve or the like so that air flows. Note that, without limited to a failure of the secondary burner air fan, when the amount of air supplied from the secondary burner air fan is insufficient, air may be supplied from the primary burner fan to the secondary burner wind box.

[0026] In the boiler according to one aspect of the present disclosure, a damper configured to open and close a channel is provided to an outlet of the air supply

unit.

[0027] A damper is provided to the outlet of the air supply unit. Accordingly, the damper is closed when the air supply unit is stopped, air guided from the primary burner air fan via the air supply tube can be prevented from flowing back to the air supply unit side.

{Advantageous Effects of Invention}

[0028] Even when the secondary burner is not in operation while the primary burner is in operation, since air is supplied from the air supply unit, the secondary burner can be cooled.

{Brief Description of Drawings}

[0029]

{Fig. 1} Fig. 1 is a vertical sectional view illustrating a boiler according to a first embodiment.

{Fig. 2} Fig. 2 is a transverse sectional view illustrating taken along a line A-A of Fig. 1.

{Fig. 3} Fig. 3 is a transverse sectional view illustrating a general configuration of a secondary burner.

{Fig. 4} Fig. 4 is a side view illustrating a state where an air fan is connected to the boiler.

{Fig. 5} Fig. 5 is a schematic configuration diagram illustrating a fuel oil path and a steam path of a secondary burner applied to a boiler according to a second embodiment.

{Fig. 6} Fig. 6 is a transverse sectional view illustrating a boiler according to a third embodiment.

{Fig. 7} Fig. 7 is a front view illustrating a steam ring nozzle of Fig. 6.

{Description of Embodiments}

[0030] Embodiments according to the present disclosure will be described below with reference to the drawings.

[First Embodiment]

[0031] The first embodiment of the present disclosure will be described below.

[0032] The boiler of the present embodiment will be described as being a ship boiler installed in a ship. Specifically, the boiler will be described as being used for an auxiliary boiler that generates general service steam used for driving a steam turbine or the like for a cargo oil pump, for example. Note that, without being limited to the above auxiliary boiler, the boiler can also be used as a main engine boiler that serves as a power source during navigation or an auxiliary boiler that activates a machine installed in a ship, in a case of a ship, for example. The boiler can be used for boilers of various uses without being limited to the ship use.

[General Configuration of Boiler]

[0033] As illustrated in Fig. 1, a boiler 10 has a combustion vessel 11, a primary burner 12, a secondary burner 13, an evaporator 14, and a control unit 15.

[0034] The combustion vessel 11 has a box-like shape, and a combustion chamber 24 is formed inside. The combustion chamber 24 is pressurized when the primary burner 12 or the secondary burner 13 is in operation. Note that the burner 12 or 13 being in operation means a state where flame is formed, and the burner 12 or 13 being not in operation means a state where no flame is formed.

[0035] The combustion vessel 11 has a top 11a, a bottom 11b, a front wall 11c (see Fig. 2), a rear wall 11d (see Fig. 2), and a pair of side walls 11e and 11f. A gas outlet 22 is formed in the top 11a. The bottom 11b is provided facing the top 11a. The front wall 11c, the rear wall 11d, and the pair of side walls 11e and 11f extend so as to connect the top 11a and the bottom 11b to each other. The top 11a, the bottom 11b, the front wall 11c, the rear wall 11d, and the side wall 11e form the combustion chamber 24. The combustion chamber 24 is defined by the top 11a, the bottom 11b, the front wall 11c, the rear wall 11d, the side wall 11e, and a front bank tube 28 described later. The primary burner 12 and the secondary burner 13 are situated facing the combustion chamber 24.

[0036] In the combustion vessel 11, an exhaust chamber 33 defined by the top 11a, the bottom 11b, the front wall 11c, rear wall 11d, the side wall 11f, and an evaporator tube 25 described later is provided. The gas outlet 22 is in communication with the exhaust chamber 33. The combustion vessel 11 is provided with a partition plate 29 near the center in the height direction (the vertical direction in Fig. 1) of the evaporator 14 and the front bank tube 28. The partition plate 29 forms a gas outlet-side passage 23 between the bottom 11b and the partition plate 29 in a region in which the evaporator 14 and the front bank tube 28 are arranged. The gas outlet-side passage 23 is a passage of a combustion gas G mainly flowing from the combustion chamber 24 to the exhaust chamber 33.

[0037] A single primary burner 12 is provided at a position of the top 11a in which the position is on the side wall 11e side and is spaced apart from the gas outlet 22. Note that, although the single primary burner 12 is provided in the present embodiment, a plurality of primary burners 12 may be provided. The primary burner 12 is connected to a fuel supply line and an air supply line. The primary burner 12 has an igniter (not illustrated). The primary burner 12 combusts a fuel gas in the combustion chamber 24 surrounded by the top 11a, the bottom 11b, and the side wall 11e and forms flame F1 toward the bottom 11b side.

[0038] As illustrated in Fig. 2, a single secondary burner 13 is provided to the front wall 11c. Note that, although the single secondary burner 13 is provided in the present

embodiment, a plurality of secondary burners 13 may be provided. The secondary burner 13 is connected to a fuel supply line and an air supply line that are different from those for the primary burner 12. The secondary burner 13 has an igniter (not illustrated) that is different from that of the primary burner 12. The secondary burner 13 combusts a fuel oil and/or a fuel gas in the combustion chamber 24 and forms flame F2 from the front wall 11c to the rear wall 11d, as illustrated in Fig. 2. The secondary burner 13 has a smaller capacity than the primary burner 12. In the present embodiment, the capacity of the secondary burner 13 is one-fifth to one-third of the capacity of the primary burner 12, for example.

[0039] As illustrated in Fig. 2, the secondary burner 13 is accommodated in the secondary burner wind box 40. The secondary burner wind box 40 is provided so as to protrude outward from the front wall 11c. Secondary burner air AR1 is supplied into the secondary burner wind box 40. The secondary burner air AR1 is used as combustion air of the secondary burner 13 and also used as seal air or cooling air as described later.

[0040] As illustrated in Fig. 3, the secondary burner 13 has an oil ejection nozzle 13a that ejects oil fuel and gas ejection nozzles 13b that eject gas fuel. The oil ejection nozzle 13a is located at the center on a transverse plane of the secondary burner 13. The plurality of gas ejection nozzles 13b are provided at predetermined angle intervals around the oil ejection nozzle 13a as the center. The periphery of the oil ejection nozzle 13a and the gas ejection nozzles 13b serves as a channel through which the secondary burner air AR1 (see Fig. 2) flows. Note that the number of oil ejection nozzles 13a and the number of the gas ejection nozzles 13b are not limited to those in Fig. 3, a plurality of the oil ejection nozzles 13a may be provided, or more gas ejection nozzles 13b may be provided.

[0041] As illustrated in Fig. 1 and Fig. 2, the secondary burner 13 is provided to the front wall 11c on the side closer to the bottom 11b of the combustion vessel 11 than to the primary burner 12. As illustrated in Fig. 1, the secondary burner 13 is provided at a position near the lower end that is downstream of the flame F1 formed by the primary burner 12, and air can be supplied to the lower end of the flame F1. In more details, as an example, the secondary burner 13 is provided in the center part of a wall tube (not illustrated) provided to the side wall 11e and the front bank tube 28 in a width direction (the lateral direction of Fig. 1) of the combustion chamber 24. The secondary burner 13 is provided in the center part of the gas outlet-side passage 23 in the height direction (the vertical direction of Fig. 1) of the combustion chamber 24, as an example. Note that the secondary burner 13 may be provided near the center part of the wall tube (not illustrated) provided to the side wall 11e and the front bank tube 28 or may be provided near the center part of the gas outlet-side passage 23.

[0042] The evaporator 14 is formed of a group of evaporators that are a plurality of bundled evaporator tubes

25. The plurality of evaporator tubes 25 are arranged along a fuel gas ejection direction of the primary burner 12 inside the combustion vessel 11. The lower ends of the plurality of evaporator tubes 25 are connected to a water drum 26 supported by the bottom 11b, and the upper ends of the plurality of evaporator tubes 25 are connected to a steam drum 27 supported by the top 11a. Some of the evaporator tubes 25 are arranged bent to the front wall 11c side, and thereby, the evaporator 14 is arranged as the front bank tube 28.

[0043] In the boiler 10, the combustion chamber 24, the front bank tube 28, the evaporator 14, and the exhaust chamber 33 are arranged in this order from the primary burner 12 and the secondary burner 13 to the gas outlet 22. Note that a plurality of wall tubes (furnace wall tubes) (not illustrated) as a heat exchanger are provided on each wall face of the combustion vessel 11. A superheater used for superheating steam in the steam drum 27 to generate superheated steam may be provided between the evaporator 14 and the front bank tube 28.

[0044] In the boiler 10, the primary burner 12 or the secondary burner 13 ejects fuel to the combustion chamber 24 and combusts the fuel, thereby the flame F1 or flame F2 is formed, and the combustion gas G is generated. The generated combustion gas G flows from the side wall 11e side to the side wall 11f side of the combustion vessel 11. At this time, the combustion gas G sequentially passes, from the combustion chamber 24, through a region in which the front bank tube 28 is arranged and a region in which the evaporator 14 is arranged and then reaches the exhaust chamber 33. The combustion gas G passes through the front bank tube 28 and the evaporator 14 via the lower region in Fig. 1 mainly partitioned by the partition plate 29, that is, via the gas outlet-side passage 23. The combustion gas G is mainly redirected to and flows in the upper region in Fig. 1 partitioned by the partition plate 29 in the exhaust chamber 33, again passes through the evaporator 14, and reaches the gas outlet 22. The front bank tube 28 and the evaporator 14 are heat exchangers, respectively, exchange heat with the combustion gas G when the combustion gas G passes therethrough, and collect heat of the combustion gas G to increase the temperature of water or steam (heating medium) passing inside.

[0045] The front bank tube 28 is arranged on the side of the primary burner 12 and the secondary burner 13 in the combustion vessel 11, that is, arranged in a region with a high temperature inside the combustion vessel 11. The front bank tube 28 is connected to the water drum 26 and the steam drum 27, and water or steam flows inside the front bank tube 28. The front bank tube 28 collects heat of the combustion gas G by heat exchange between the combustion gas G and water or steam, thereby increases the temperature of the water or steam, and reduces the temperature of the combustion gas G.

[0046] The evaporator 14 has the plurality of evaporator tubes 25 and is arranged on the gas outlet 22 side with respect to the front bank tube 28 in the combustion

vessel 11. The combustion gas G that has passed through the region in which the front bank tube 28 is arranged passes through the evaporator 14. In the evaporator 14, the water drum 26 and the steam drum 27 are connected to respective ends of the plurality of evaporator tubes 25, respectively, and water or steam flows in each evaporator tube 25. During the flow from the water drum 26 to the steam drum 27 through each evaporator tube 25, the evaporator 14 collects heat of the combustion gas G by heat exchange between the combustion gas G and water or steam, thereby increases the temperature of the water or steam, and reduces the temperature of the combustion gas G. That is, the water or steam in each evaporator tube 25 is heated by the combustion gas G, and thereby, only the steam rises and reaches the steam drum 27.

[0047] The heat of the combustion gas G that has passed through the evaporator 14 is collected, the temperature thereof decreases, and the combustion gas G then reaches the exhaust chamber 33 and is discharged to the outside from the gas outlet 22 as an exhaust gas (combustion gas G).

[0048] The combustion vessel 11 and the wind box 40 are each provided with a pressure sensor (not illustrated). The output of each pressure sensor is transmitted to the control unit 15.

[0049] The control unit 15 controls the operation of the boiler such as the primary burner 12 or the secondary burner 13 described above. The control unit is formed of a central processing unit (CPU), a random access memory (RAM), a read only memory (ROM), a computer readable storage medium, and the like, for example. Further, as an example, a series of processes to implement various functions is stored in a storage medium or the like in a form of a program. The CPU reads such a program into the RAM or the like and executes a process of edition and operation of information, and thereby various functions are implemented. Note that a form in which a program is installed in advance in a ROM or other storage mediums, a form in which a program is provided in a state of being stored in a computer readable storage medium, a form in which a program is delivered via a wired or wireless communication unit, or the like may be applied. The computer readable storage medium is a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like.

[Cooling Structure of Secondary Burner 13]

[0050] Next, the cooling structure of the secondary burner 13 will be described with reference to Fig. 4.

[0051] A secondary burner air fan 44 is connected to the secondary burner wind box 40 via a secondary burner air duct 42. The secondary burner air AR1 (see Fig. 2) is supplied into the secondary burner wind box 40 by the secondary burner air fan 44. Start and stop of the secondary burner air fan 44 is controlled by the control unit 15 (see Fig. 1). Further, the rotating speed of the sec-

ondary burner air fan 44 may be controlled by the control unit 15 to adjust the air flow rate.

[0052] A damper 46 that opens and closes a channel is provided to the outlet of the secondary burner air fan 44. The opening and closing of the damper 46 is controlled by an instruction from the control unit 15. One end of an air supply tube 48 is connected to a position that is downstream of the damper 46 and in the middle of the secondary burner air duct 42. The other end of the air supply tube 48 is connected to a position in the middle of a primary burner air duct 50. An on-off valve 49 is provided to the air supply tube 48. The on-off valve 49 is controlled by the control unit 15.

[0053] A primary burner air fan 52 is connected to the upstream end of the primary burner air duct 50. Start and stop of the primary burner air fan 52 is controlled by the control unit 15 (see Fig. 1). Further, the rotating speed of the primary burner air fan 52 may be controlled by the control unit 15 to adjust the air flow rate.

[0054] A primary burner wind box 54 is connected to the downstream end of the primary burner air duct 50. The primary burner 12 (see Fig. 1) is accommodated in the primary burner wind box 54. Air supplied to the primary burner wind box 54 is used as combustion air of the primary burner 12.

[Operation Method of Boiler 10]

[0055] Next, the operation method of the boiler 10 will be described. The control unit 15 adjusts combustion performed by the primary burner 12 and the secondary burner 13 to adjust the operation load of the boiler 10 in accordance with a load in which the steam generated by the boiler 10 is used.

[0056] The control unit 15 does not operate the primary burner 12 to be not in operation when a low load less than a predetermined value is demanded such as when a steam turbine for a cargo oil pump is not driven, for example. That is, no combustion by the primary burner 12 is performed. At this time, the boiler 10 is warmed up by the secondary burner 13. The control unit 15 operates only the secondary burner 13 to combust a fuel oil and/or a fuel gas. Accordingly, it is possible to operate the primary burner 12 and promptly supply steam from the boiler 10 when a steam turbine needs to be driven or the like, for example, while warming up the boiler 10 by using the small capacity secondary burner 13 without using the large capacity primary burner 12 to suppress fuel consumption.

[0057] When a high load above a predetermined value is demanded such as when a steam turbine for a cargo oil pump is required to be driven, for example, the control unit 15 gradually increases the supply amount of the fuel oil and/or the fuel gas to the primary burner 12 in accordance with an increase in the load of the steam turbine (increase in the operation load demanded for the boiler 10). In such a way, when only the primary burner 12 is used for combustion, the control unit 15 supplies air from

the secondary burner air fan 44 to cool the secondary burner 13. At this time, the fuel oil and the fuel gas are not supplied to the secondary burner 13. The control unit 15 controls the secondary burner air fan 44 so that the pressure in the secondary burner wind box 40 is higher than the pressure in the combustion vessel 11.

[0058] The air supplied to the secondary burner wind box 40 cools the secondary burner 13 and is then supplied near the lower end of the flame F1 formed by the primary burner 12. As a result, the flame is cooled near the lower end of the flame F1, and thereby, the NOx production amount due to the combustion by the primary burner 12 is reduced.

[Operation in Failure of Secondary Burner Air Fan 44]

[0059] When the secondary burner air fan 44 fails and no air can be supplied to the secondary burner wind box 40, the following operation is performed.

[0060] Once the control unit 15 detects the failure of the secondary burner air fan 44, the control unit 15 operates the on-off valve 49 provided to the air supply tube 48 from fully closed to fully open. This causes a part of the air supplied from the primary burner air fan 52 to be supplied to the secondary burner wind box 40 via the air supply tube 48 and the secondary burner air duct 42. At this time, the control unit 15 operates the damper 46 from fully open to fully closed. This prevents the air from flowing back to the secondary burner air fan 44. Note that it is possible to detect a failure of the secondary burner air fan 44 by monitoring the fan rotating speed or the like.

[0061] According to the present embodiment, the following effects and advantages are achieved. The secondary burner 13 is provided downstream of the flame F1 formed by the primary burner 12. Thus, when the primary burner 12 is in operation and the secondary burner 13 is not in operation, there is a risk of damage to the secondary burner 13 due to radiation heat of the flame F1 from the primary burner 12 if no combustion air is supplied to the secondary burner 13. Accordingly, even when the secondary burner 13 is not in operation, air is supplied from the secondary burner air fan 44 to cool the secondary burner 13. Further, since the air is supplied so that the pressure in the secondary burner wind box 40 is higher than the pressure in the combustion vessel 11, the secondary burner 13 and the secondary burner wind box 40 can be sealed from the pressurized combustion chamber 24. This can avoid a risk of entry (flowing back) of the combustion gas of the primary burner 12 to the secondary burner 13 when the pressure in the secondary burner wind box 40 is lower than the pressure in the combustion vessel 11.

[0062] The air supply tube 48 is used to supply air from the primary burner air fan 52 to the secondary burner wind box 40. Accordingly, if the secondary burner air fan 44 should fail, a cooling air can be supplied to the secondary burner wind box 40.

[0063] Note that, without limited to the case of a failure

of the secondary burner air fan 44, air may be supplied from the primary burner air fan 52 to the secondary burner wind box 40 when the air amount supplied from the secondary burner air fan 44 is insufficient.

[0064] The damper 46 is provided to the outlet of the secondary burner air fan 44. Accordingly, by closing the damper 46 when the secondary burner air fan 44 is stopped, the air guided from the primary burner air fan 52 via the air supply tube 48 can be prevented from flowing back to the secondary burner air fan 44 side.

[Second Embodiment]

[0065] Next, the second embodiment of the present invention will be described. The present embodiment differs from the first embodiment in that the present embodiment has a feature to cool the secondary burner 13 by using steam in addition to the features of the first embodiment. Therefore, features different from the first embodiment will be described below.

[0066] Fig. 5 illustrates a system that supplies a fuel oil to the oil ejection nozzle 13a (see Fig. 3) provided to the secondary burner 13. A fuel oil supply path 60 and a steam supply path (cooling steam supply unit) 62 are connected to the oil ejection nozzle 13a.

[0067] An oil tank and an oil supply pump (not illustrated) are connected to the upstream of the fuel oil supply path 60. The fuel oil supply path 60 is provided with a control valve 64. The control valve 64 is controlled by the control unit 15.

[0068] A steam source (not illustrated) is connected to the upstream of the steam supply path 62. The steam supply path 62 is branched into an atomize steam supply path 62a and a purge steam supply path 62b.

[0069] The atomize steam supply path 62a is connected to the oil ejection nozzle 13a. The atomize steam supply path 62a is provided with a control valve 66 and a check valve 67 controlled by the control unit 15. The steam supplied from the atomize steam supply path 62a is originally used for atomizing a fuel oil. In the present embodiment, however, such steam can be used as cooling steam.

[0070] The downstream end of the purge steam supply path 62b is connected to the fuel oil supply path 60. The purge steam supply path 62b is provided with a control valve 68 and a check valve 69 controlled by the control unit 15. The steam supplied from the purge steam supply path 62b is originally used for purging, with steam, a path in which a fuel oil flows. In the present embodiment, however, such steam can be used as cooling steam.

[0071] The steam cooling of the secondary burner 13 according to the present embodiment is performed as follows.

[0072] Once the control valve 64 of the fuel oil supply path 60 is closed and the supply of the fuel oil is stopped, the secondary burner 13 will be out of operation. At this time, if the primary burner 12 is in operation, the control unit 15 causes the oil ejection nozzle 13a to eject steam

by using the steam supply path 62. Specifically, the control valve 66 of the atomize steam supply path 62a is opened and the control valve 68 of the purge steam supply path 62b is opened to guide steam to the oil ejection nozzle 13a. The steam is atomized from the oil ejection nozzle 13a, and thereby, the secondary burner 13 is protected from radiation heat radiated from the flame F1 formed in the combustion chamber 24.

[0073] With cooling steam being atomized from the tip of the oil ejection nozzle 13a radially (in an umbrella-shaped manner), a portion that is likely to be damaged by radiation heat of the flame of the primary burner 12, such as a swirler attached to the oil ejection nozzle 13a or a gas nozzle, can be shielded with cooling steam, and the secondary burner 13 can be more effectively protected.

[0074] According to the present embodiment, the following effects and advantages are achieved.

[0075] Since the oil ejection nozzle 13a of the secondary burner 13 is not supplied with any oil when the secondary burner 13 is not in operation, the oil ejection nozzle 13a is provided as a part of the cooling steam supply unit to supply cooling steam from the oil ejection nozzle 13a. Since the oil ejection nozzle 13a ejects cooling steam from the tip of the secondary burner 13 into the combustion chamber 24, the secondary burner 13 can be effectively protected from radiation heat.

[0076] By ejecting steam from the oil ejection nozzle 13a of the secondary burner 13, it is possible to supply the steam to the backwash side of the flame F1 of the primary burner 12. This can reduce the temperature of the flame F1 and thereby reduce thermal NOx. Further, if steam is supplied to the root of the flame F1, the mixture of fuel and air will be inhibited, which results in unstable combustion. The combustion reaction almost ends on the backwash side of the flame F1 (at the tip of the flame F1), a large amount of air is not necessary, and there is no risk of unstable combustion.

[0077] Note that, instead of ejecting steam from the oil ejection nozzle 13a or in addition to ejecting steam from the oil ejection nozzle 13a, steam may be supplied from the gas ejection nozzle 13b (see Fig. 3) of the secondary burner 13. Accordingly, the gas ejection nozzle 13b can be a part of the cooling steam supply unit and supply cooling steam from the gas ejection nozzle 13b. Since the gas ejection nozzle 13b ejects cooling steam from the tip of the secondary burner 13 into the combustion chamber 24, the secondary burner 13 can be effectively protected from radiation heat. Further, the gas ejection nozzle 13b projecting in the combustion chamber 24 can be effectively cooled.

[Third Embodiment]

[0078] Next, the third embodiment of the present invention will be described. The present embodiment differs from the first embodiment in that the present embodiment has a feature to cool the secondary burner 13 by

using steam in addition to the features of the first embodiment. Therefore, features different from the first embodiment will be described below.

[0079] As illustrated in Fig. 6, a steam ring nozzle (steam supply nozzle) 72 is provided in the secondary burner wind box 40. The steam ring nozzle 72 is connected to a steam source (not illustrated) and ejects steam from the secondary burner wind box 40 into the combustion chamber 24. As illustrated in Fig. 7, the steam ring nozzle 72 has a ring-shaped pipe, and a plurality of ejection holes 72a are formed to the pipe at predetermined intervals. The steam ring nozzle 72 is arranged so as to surround the base part of the secondary burner 13.

[0080] According to the present embodiment, the following effects and advantages are achieved.

[0081] The steam ring nozzle 72 is provided as a part of the cooling steam supply unit in the secondary burner wind box 40. This enables cooling of the secondary burner 13 accommodated in the secondary burner wind box 40.

[0082] Further, since cooling steam can be supplied to the whole secondary burner 13 by the steam ring nozzle 72, a portion that is likely to be damaged by radiation heat of the flame of the primary burner 12, such as a swirler or the gas ejection nozzle 13b, can be effectively cooled. Further, a flame cooling effect due to steam blowing also extends to a wide area, and this enables a reduction of NOx.

[0083] Further, since a path used for supplying cooling steam can be provided separately from the oil ejection nozzle 13a or the gas ejection nozzle 13b of the secondary burner 13, the cooling steam can be supplied regardless of the operation of the secondary burner 13. By blowing steam when the secondary burner 13 is in operation, this enables the secondary burner 13 itself to reduce NOx.

[0084] Further, by supplying steam from the steam ring nozzle 72 into the combustion chamber 24, it is possible to supply the steam to the downstream of the flame F1 of the primary burner 12. This can reduce the temperature of the flame F1 and thereby reduce thermal NOx.

{Reference Signs List}

[0085]

10	boiler
11	combustion vessel
12	primary burner
13	secondary burner
13a	oil ejection nozzle
13b	gas ejection nozzle
14	evaporator
15	control unit
22	gas outlet
24	combustion chamber
26	water drum

27	steam drum
29	partition plate
33	exhaust chamber
40	secondary burner wind box
42	secondary burner air duct
44	secondary burner air fan (air supply unit)
46	damper
48	air supply tube
49	on-off valve
50	primary burner air duct
52	primary burner air fan
54	primary burner wind box
60	fuel oil supply path
62	steam supply path
62s	atomize steam supply path
62b	purge steam supply path
64	control valve
66	control valve
67	check valve
68	control valve
69	check valve
72	steam ring nozzle (steam supply nozzle)
AR1	secondary burner air
F1, F2	flame
G	combustion gas

Claims

1. A boiler comprising:
 - a combustion vessel forming a combustion chamber;
 - a primary burner provided to the combustion vessel;
 - a secondary burner provided to the combustion vessel, provided downstream of flame formed by the primary burner, and having a smaller capacity than the primary burner;
 - a secondary burner wind box accommodating the secondary burner and attached to the combustion vessel;
 - an air supply unit configured to supply air to the secondary burner wind box; and
 - a control unit configured to control the air supply unit,
 - wherein the control unit drives the air supply unit when the primary burner is in operation and the secondary burner is not in operation.
2. The boiler according to claim 1, wherein the control unit controls the air supply unit such that a pressure of the secondary burner wind box is higher than a pressure of the combustion vessel.
3. The boiler according to claim 1 further comprising a cooling steam supply unit configured to supply cooling steam that cools the secondary burner.

4. The boiler according to claim 3,

wherein the secondary burner comprises an oil
ejection nozzle configured to eject oil fuel to the
combustion chamber as combustion fuel, and 5
wherein the oil ejection nozzle is a part of the
cooling steam supply unit.

5. The boiler according to claim 3, wherein a steam
supply nozzle is provided as a part of the cooling 10
steam supply unit in the secondary burner wind box.

6. The boiler according to claim 3 or 4,

wherein the secondary burner comprises a gas 15
ejection nozzle configured to eject gas fuel to
the combustion chamber as combustion fuel,
and
wherein the gas ejection nozzle is a part of the
cooling steam supply unit. 20

7. The boiler according to claim 3, wherein the cooling
steam supply unit supplies cooling steam to down-
stream of flame formed by the primary burner. 25

8. The boiler according to claim 1 or 2 further compris-
ing:

a primary burner wind box accommodating the
primary burner and attached to the combustion 30
vessel;
a primary burner air fan configured to supply air
to the primary burner wind box; and
an air supply tube configured to supply air from
the primary burner air fan to the secondary burn- 35
er wind box.

9. The boiler according to claim 8, wherein a damper
configured to open and close a channel is provided
to an outlet of the air supply unit. 40

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FIG. 1

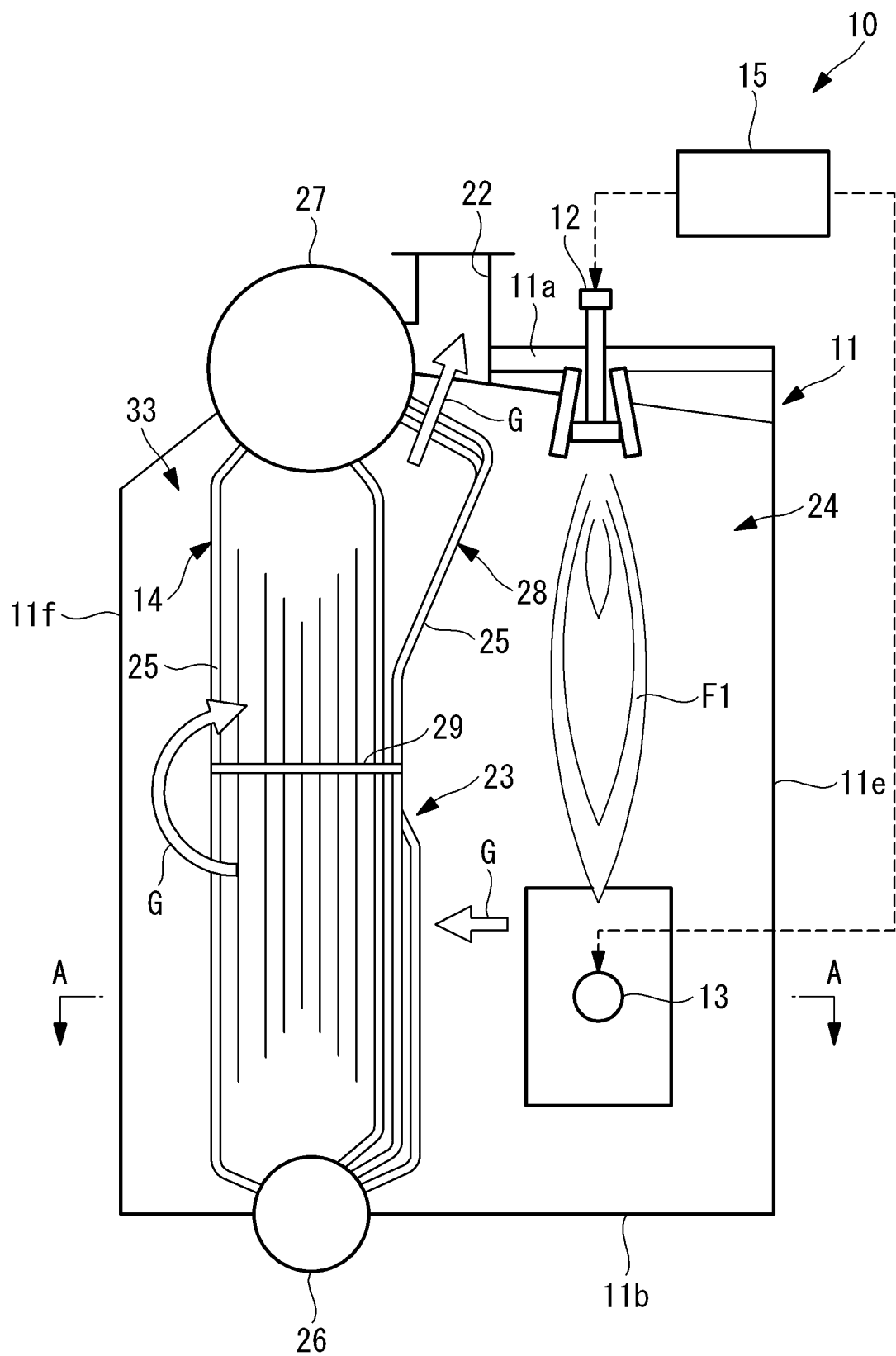


FIG. 2

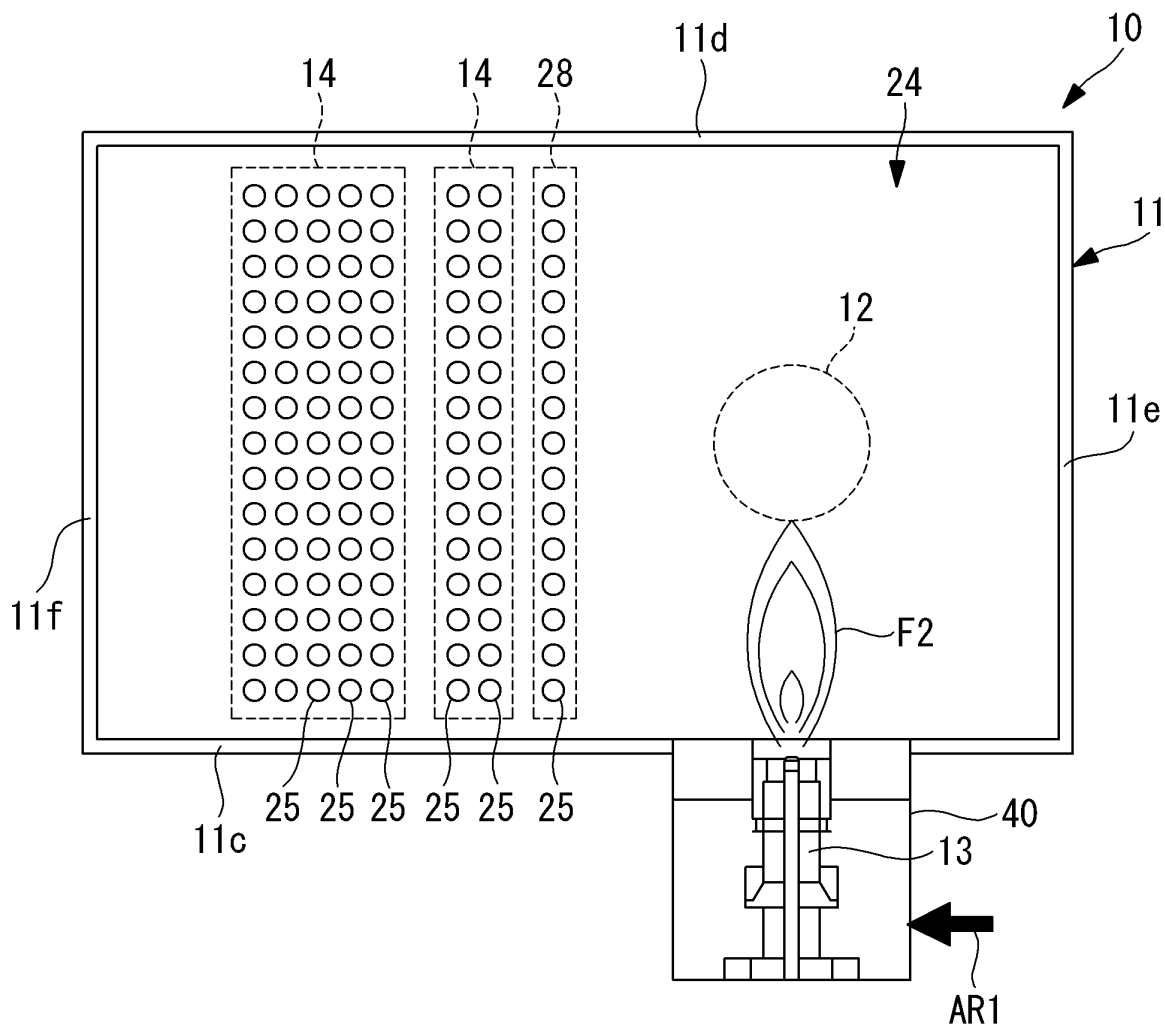


FIG. 3

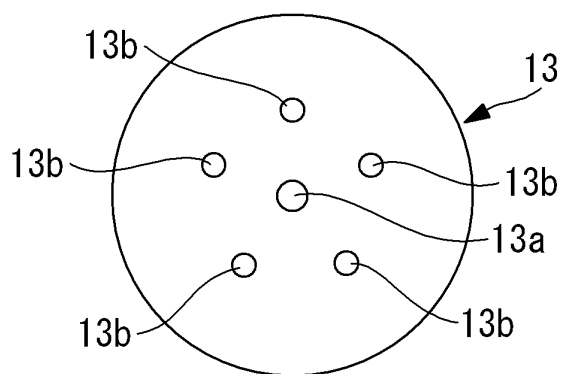


FIG. 4

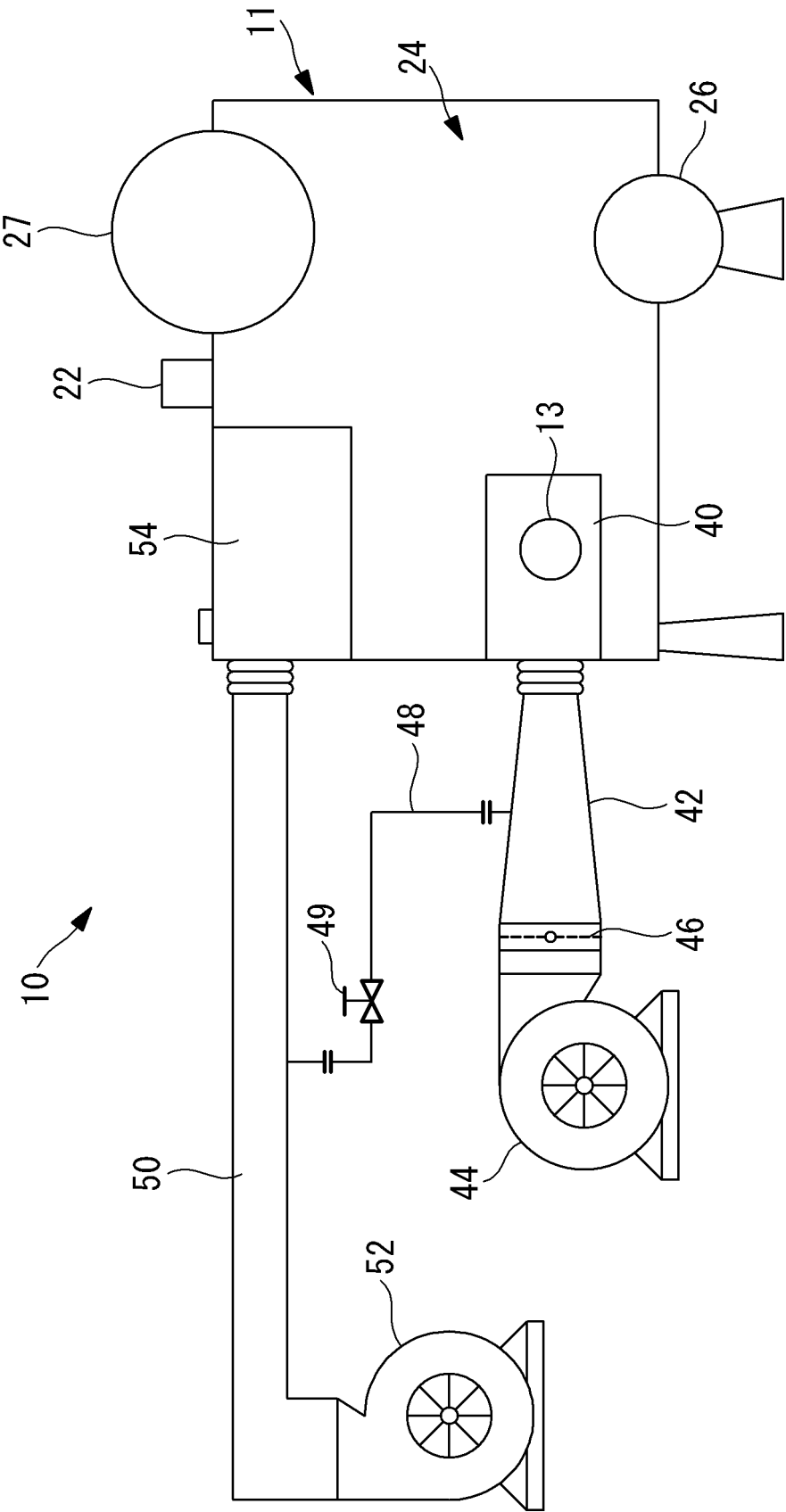


FIG. 5

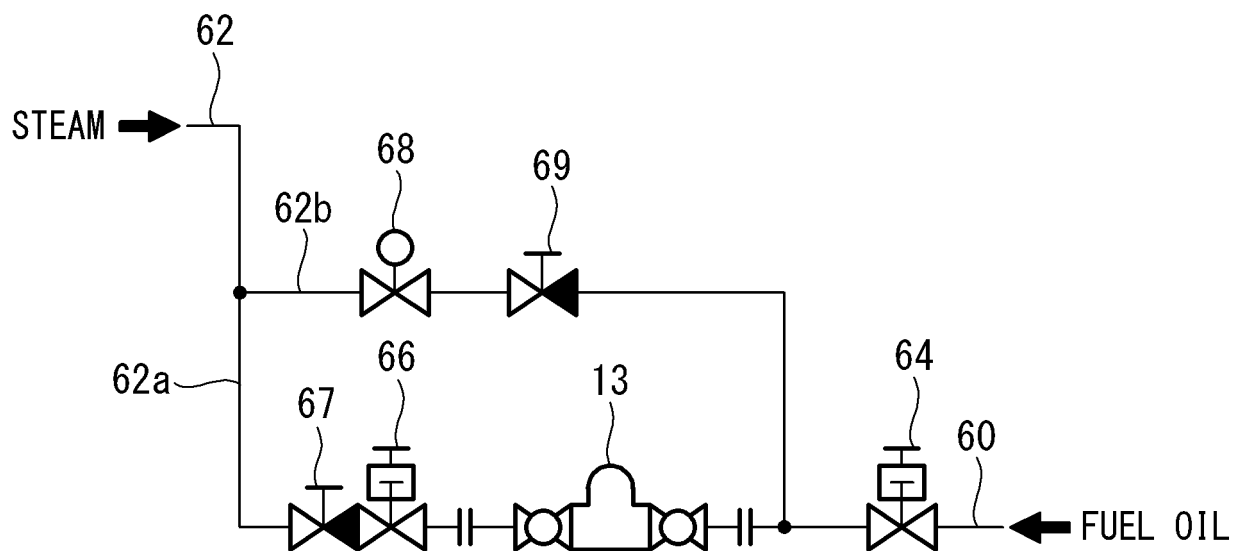


FIG. 6

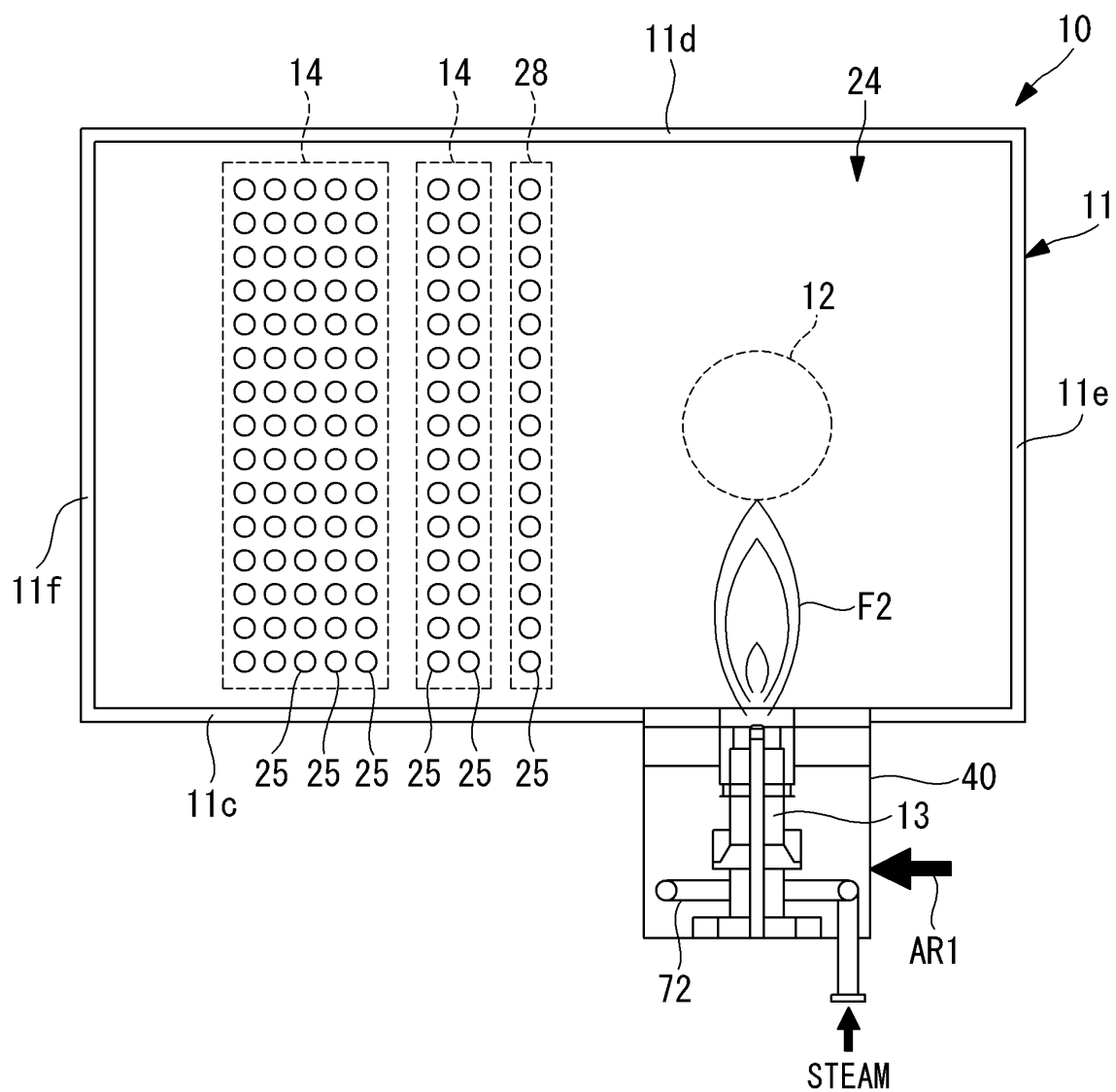
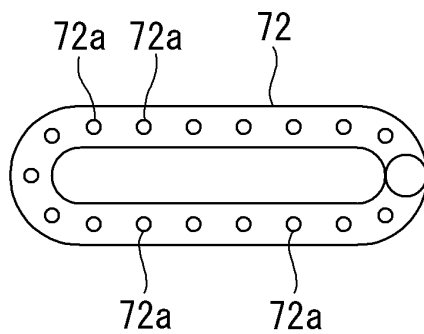


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/000220

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F22B31/00 (2006.01) i, F23D14/78 (2006.01) i
 FI: F23D14/78 Z, F22B31/00 A

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. F22B31/00, F23D14/78

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2020
 Registered utility model specifications of Japan 1996-2020
 Published registered utility model applications of Japan 1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2018-141585 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 13 September 2018, paragraphs [0024]-[0042],	1-2, 8
Y	fig. 1-3, paragraphs [0024]-[0042], fig. 1-3,	3-6, 9
A	paragraphs [0024]-[0042], fig. 1-3	7
Y	JP 01-121612 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 15 May 1989, claims, fig. 1	3-6, 9
Y	JP 09-210325 A (ASAHI CHEMICAL INDUSTRY CO., LTD.) 12 August 1997, paragraphs [0009], [0010], fig. 2	3-6, 9

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search
11.03.2020

Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/000220

C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 057086/1986 (Laid-open No. 172905/1987) (KAWASAKI THERMAL ENGINEERING CO., LTD.) 02 November 1987, claims, fig. 1-3	3-6, 9
Y	JP 55-023870 A (BABCOCK-HITACHI KABUSHIKI KAISHA) 20 February 1980, page 2, upper right column, line 19 to lower left column, line 16, fig. 2	3-6, 9
Y	JP 2008-014574 A (KASHIMA OIL CO., LTD.) 24 January 2008, claims, paragraphs [0013]-[0028], fig. 1	3-6, 9
A	JP 2005-233483 A (VOLCANO CO., LTD.) 02 September 2005, entire text, all drawings	1-9
A	JP 2016-194408 A (VOLCANO CO., LTD.) 17 November 2016, entire text, all drawings	1-9
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 017963/1982 (Laid-open No. 122804/1983) (HITACHI ZOSEN CORP.) 20 August 1983, entire text, all drawings	1-9
A	JP 57-047107 A (BABCOCK-HITACHI KABUSHIKI KAISHA) 17 March 1982, entire text, all drawings	1-9
A	JP 59-170601 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 26 September 1984, entire text, all drawings	1-9
A	KR 10-2013-0001432 A (KANGRIM INDUSTRIES) 04 January 2013, entire text, all drawings	1-9
A	WO 2009/078191 A1 (MITSUBISHI HEAVY INDUSTRIES, LTD.) 25 June 2009, entire text, all drawings	1-9

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2020/000220

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP S5781999 U [0003]