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(54) **WATER HEATING APPARATUS AND METHOD FOR CONTROLLING THE SAME**

(57) Disclosed is a water heating apparatus including an outer container having openings formed at opposite ends thereof with respect to a reference direction, an interior hollow communicated with the openings at the opposite ends, an outer container outlet formed at one end thereof to deliver heated water to a heating passage, and an outer container inlet provided at an opposite end thereof to retrieve the water from the heating passage, a combustion chamber covering the opening at one end of the outer container and defining a combustion space in an interior thereof, a burner coupled to the combustion chamber and the outer container to cause a combustion reaction in the combustion space, a pipe plate spaced

apart from the combustion chamber along the reference direction, and covering the opening at an opposite end of the outer container, a plurality of flues provided in the hollow of the outer container to guide a combustion gas generated through the combustion reaction from the combustion chamber to an outside of the pipe plate, a hot water heat exchange part that transfers heat received from the water accommodated in the hollow to introduced direct water and discharge the direct water after making the direct water hot, and a circulation part coupled to the outer container inlet and the outer container outlet to circulate the water accommodated in the hollow from one end to an opposite end thereof.

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority to Korean Patent Application No. 10-2021-0152132, filed in the Korean Intellectual Property Office on November 8, 2021, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a water heating apparatus and a method for controlling the same.

BACKGROUND

[0003] Frequently, a heat exchanger of a type called a shell- and-tube type uses heat of a combustion gas that flows through a flue to heat heating water by using a combustion chamber and the flue, and produces hot water by heating direct water with the heated heating water. That is, it is general to form hot water by indirectly heating direct water by using heating water.

[0004] Because the hot water is produced through indirect heating, elements that influence production of the hot water are related to characteristic of the heating water. Because the heating water transfers heat while flowing around a part that produces hot water, a temperature of the hot water, a flow rate of the hot water, or the like is considered as being important in relation to production of the hot water.

[0005] The heating water is circulated when heating is used, and is not circulated when heating is not used. Accordingly, when heating is not used, the heating water is stopped in a water heating apparatus. Accordingly, when a long time elapses while heating is not used, a temperature gradient of the heating water increases according to a location thereof. When hot water is not used, the hot water also stays in a part that produces hot water, and a temperature gradient of the hot water increases according to a location thereof when a long time elapses.

[0006] Because heating and using hot water are separate operations, the hot water may be used while the heating is not used. When the hot water is used a long time since the heating is not used, the hot water having the temperature gradient may be discharged like the heating water having a larger temperature gradient, and a temperature difference of the hot water discharged first may be severe.

[0007] Meanwhile, when the burner of the water heating apparatus frequently repeatedly switched on and off for producing hot water or heating water of a proper temperature, soot that is a cause of a breakdown of the water heating apparatus is generated a lot and a large amount of the fuel is consumed, whereby a quality of the hot water (an amount of the hot water, a temperature deviation of the hot water, or the like) may be degraded.

SUMMARY

[0008] The present disclosure has been made to solve the above-mentioned problems occurring in the prior art while advantages achieved by the prior art are maintained intact.

[0009] An aspect of the present disclosure provides a water heating apparatus that may provide hot water of a high quality, and a method for controlling the same.

[0010] The technical problems to be solved by the present disclosure are not limited to the aforementioned problems, and any other technical problems not mentioned herein will be clearly understood from the following description by those skilled in the art to which the present disclosure pertains.

[0011] According to an embodiment of the present disclosure, a water heating apparatus includes an outer container having openings formed at opposite ends thereof with respect to a reference direction, an interior hollow communicated with the openings at the opposite ends, an outer container outlet formed at one end thereof to deliver heated water to a heating passage, and an outer container inlet provided at an opposite end thereof to retrieve the water from the heating passage, a combustion chamber covering the opening at one end of the outer container and defining a combustion space in an interior thereof, a burner coupled to the combustion chamber and the outer container to cause a combustion reaction in the combustion space, a pipe plate spaced apart from the combustion chamber along the reference direction, and covering the opening at an opposite end of the outer container, a plurality of flues provided in the hollow of the outer container to guide a combustion gas generated through the combustion reaction from the combustion chamber to an outside of the pipe plate, a hot water heat exchange part that transfers heat received from the water accommodated in the hollow to introduced direct water and discharge the direct water after making the direct water hot, and a circulation part coupled to the outer container inlet and the outer container outlet to circulate the water accommodated in the hollow from one end to an opposite end thereof.

[0012] According to an embodiment of the present disclosure, a method for controlling a water heating apparatus including a burner, a hot water heat exchange part that heats direct water by using heat generated through a combustion reaction caused by the burner, and discharges hot water, an outer container that heats water by using the heat generated through the combustion reaction and provides heating, and a circulation part that circulates the water in the outer container, includes acquiring a flow rate of the direct water provided by the hot water heat exchange part, recognizing whether it is necessary to provide heating, and circulating the water through the circulation part when it is determined that it is not necessary to provide heating and that the direct water is introduced into the hot water heat exchange part based on the flow rate of the direct water.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The above and other objects, features and advantages of the present disclosure will be more apparent from the following detailed description taken in conjunction with the accompanying drawings:

FIG. 1 is a view of a water heating apparatus such that an internal structure thereof is revealed, according to an embodiment of the present disclosure;
 FIG. 2 is a view conceptually illustrating a water heating apparatus according to an embodiment of the present disclosure;
 FIG. 3 is a time-voltage graph illustrating a signal obtained through conversion by a processor of a water heating apparatus according to a first modification of an embodiment of the present disclosure;
 FIG. 4 is a time-voltage graph illustrating a signal obtained through conversion by a processor of a water heating apparatus according to a second modification of an embodiment of the present disclosure;
 FIG. 5 is a time-voltage graph illustrating a signal obtained through conversion by a processor of a water heating apparatus according to a third modification of an embodiment of the present disclosure;
 FIG. 6 is a time-voltage graph illustrating a signal obtained through conversion by a processor of a water heating apparatus according to a fourth modification of an embodiment of the present disclosure;
 FIG. 7 is a time-voltage graph illustrating a signal obtained through conversion by a processor of a water heating apparatus according to a fifth modification of an embodiment of the present disclosure;
 FIG. 8 is a time-voltage graph illustrating a signal obtained through conversion by a processor of a water heating apparatus according to a sixth modification of an embodiment of the present disclosure; and
 FIG. 9 is a graph depicting a relationship of a PWM value applied to a fuel pump by a processor, which may be obtained when a proportional control is performed by using a processor of the water heating apparatus according to the third modification of the embodiment of the present disclosure, to a fuel consumption and a fuel pressure.

DETAILED DESCRIPTION

[0014] Hereinafter, some embodiments of the present disclosure will be described in detail with reference to the exemplary drawings. In adding the reference numerals to the components of each drawing, it should be noted that the identical or equivalent component is designated by the identical numeral even when they are displayed on other drawings. Further, in describing the embodiment of the present disclosure, a detailed description of the related known configuration or function will be omitted when it is determined that it interferes with the understanding of the embodiment of the present disclosure.

[0015] In describing the components of the embodiment according to the present disclosure, terms such as first, second, A, B, (a), (b), and the like may be used. These terms are merely intended to distinguish the components from other components, and the terms do not limit the nature, order or sequence of the components. When it is described that one element is connected, coupled, or electrically connected to another element, the element may be directly connected or coupled to the other element, but a third element may be connected, coupled, or electrically connected between the elements.

[0016] FIG. 1 is a view of a water heating apparatus 1 such that an internal structure thereof is revealed, according to an embodiment of the present disclosure. FIG. 2 is a view conceptually illustrating the water heating apparatus 1 according to the embodiment of the present disclosure.

[0017] Referring to the drawings, the water heating apparatus 1 according to the embodiment of the present disclosure includes an outer container 10, a combustion chamber 20, a burner 30, a flue 50, a hot water heat exchange part 60, and a circulation part 70.

Outer Container 10

[0018] The outer container 10 is a cylindrical body of the water heating apparatus 1 of a flue (50) type of the present disclosure, and components of the water heating apparatus 1 are accommodated in a cylindrical interior space thereof. The outer container 10 may extend along a reference direction "D". The reference direction "D" may be an upward/downward direction, but the direction may be different according to a direction, in which the water heating apparatus 1 is disposed.

[0019] Openings may be formed at opposite ends of the outer container 10 with respect to the reference direction "D", and a hollow 100 communicated with the openings of the opposite ends may be provided in an interior thereof. Water may be accommodated in the hollow 100. The water accommodated in the hollow 100 may be heating water in the embodiment of the present disclosure. One end of the outer container 10 may be an upper end and an opposite end thereof may be a lower end with respect to the reference direction "D".

[0020] An outer container inlet 12, through which the heating water is introduced into the hollow 100, may be provided on a lower end side of the outer container 10, and an outlet, through which the heating water is discharged from the hollow 100, may be provided on an upper side thereof. The heating water introduced into the outer container inlet 12 flows along the hollow 100, and is discharged through an outer container outlet 13. While the heating water flows in the hollow 100, it receives heat from the flue 50 of a high temperature and the combustion chamber 20 and is heated. As the heated heating water is discharged through the outer container outlet 13, and flows through a heating passage HP to perform heating.

[0021] The outer container 10 may include an outer

container extension part 11 that extends in the reference direction "D" and is a wall of the outer container 10, and an upper end and a lower end of the outer container extension part 11 may have opened cylindrical shapes, respectively.

[0022] An opening on an upper end side of the outer container 10 may be covered by the combustion chamber 20. Here, the description that the combustion chamber 20 covers the opening may mean that a periphery of the opening located at an upper end of the outer container 10 is completely covered from an outside as illustrated in the drawings. However, it may be expressed that the opening is covered even though the hollow 100 is coupled in a scheme of being blocked from an outside because the combustion chamber 20 is inserted into an interior of the opening of the outer container 10 and is coupled to an inner peripheral surface of the hollow 100 of the outer container 10 while a periphery of the opening protrudes toward the outside.

Burner 30

[0023] The burner 30 is configured to cause a combustion reaction in a combustion space 200 of the combustion chamber 20 by igniting a fuel and air. The fuel used by the burner 30 may be of an oil type. The burner 30 may be coupled to the combustion chamber 20 and the outer container 10 along a direction that crosses the reference direction "D". A fuel discharge part 31 that is located at a distal end of the burner 30 to discharge the fuel may be located in the combustion chamber 20 to cause the combustion reaction in the combustion space 200 of the combustion chamber 20. The fuel discharge part 31 may inject the fuel to the combustion space 200. Accordingly, the fuel discharge part 31 may include a nozzle for injecting the fuel. The fuel may be vaporized while being injected.

[0024] The burner 30 may include a fuel pump 32. The fuel pump 32 may pump the fuel and supply the fuel to the fuel discharge part 31. The fuel pump 32 may include a fuel pressure forming part 322 including a device, such as an impeller, which may compress the fuel to pump the fuel, and a fuel motor that generates and provides power, by which the fuel pressure forming part 322 may be driven, as it is driven by electric power. The fuel pump 32 may include a fuel filter 321 that filters out foreign substances from the fuel to be injected.

[0025] The burner 30 may include an air providing part 33. The air providing part 33 is a device for pumping the air supplied from the outside to the combustion space 200. Accordingly, the air providing part 33 may be a blower. The air providing part 33 may include a blower that may be operated to pump air as the electric power is provided thereto.

[0026] The burner 30 may include an ignition part. The ignition part is a component that ignites a mixture material, in which the injected fuel and the injected air are mixed. The ignition part may be an ignition plug, but a

device that performs ignition in a scheme other than the ignition plug may be used as the ignition part. The ignition part may cause an electric spark to ignite the mixture material. As the electric spark is caused in a situation, in which the fuel of the oil type is injected, the air is blown, and the fuel and the air are mixed to form the mixture material, the flames may be formed.

[0027] The burner 30 may include an air supply pipe 34. The air supply pipe 34 may be a pipe that is connected to the air providing part 33 to guide the air to the air providing part 33. An inlet of the air supply pipe 34 may be connected to a combustion chamber cover 22, and may deliver the air introduced into the combustion chamber cover 22 to the air providing part 33. Accordingly, because the air is provided to the burner 30 after passing through the combustion chamber cover 22, the air provided to the burner 30 while cooling the combustion chamber 20 may be preheated, whereby a stable combustion may be performed. Furthermore, a situation, such as an ignition, in which reverse flows of the gas may be generated due to a resistance generated by the air supply pipe 34, may be prevented and noise may be restrained.

Combustion Chamber 20

[0028] The combustion chamber 20 may cover an opening on an upper end side of the outer container 10. The combustion chamber 20 may have a cylindrical shape. The combustion space 200 that is a space, in which flames generated by the burner 30 are formed in an interior of the combustion chamber 20, may be disposed. The combustion space 200 may extend from an upper end side to a lower end side of the outer container 10. The combustion chamber 20 may extend from an upper end side of the outer container 10 toward a lower end side of the outer container 10, but may not reach a lower end of the outer container 10. The combustion reaction may be caused in the combustion space 200 by the burner 30 and thus flames may be formed to generate the combustion gas of a high temperature, whereby heat may be transferred to the heating water. The combustion gas generated by the burner 30 may be discharged from the combustion chamber 20 to an outside through the flue 50. In this process, the combustion gas that passes through the flue 50 may heat the heating water that flows around the flue 50 in the hollow 100.

[0029] An upper end of the flue 50 may be coupled to a lower wall of the combustion chamber 20, which is formed at a lower end of the combustion chamber 20, and an upper end of the flue 50 may pass through the lower wall of the combustion chamber 20. An outer diameter of the upper end of the combustion chamber 20 may have a size corresponding to an inner diameter of the upper end of the outer container 10 such that the upper end of the combustion chamber 20 is coupled to an upper end or the outer container 10 to close the upper end of the outer container 10, whereby the hollow 100 of

the closed outer container 10 may be formed. However, an outer diameter of a combustion chamber extension part 21 that extends from an upper end side of the outer container 10 to a lower end side of the outer container 10 may be formed to be smaller than an outer diameter of the outer container 10. Accordingly, the upper end of the combustion chamber 20 may have a shape that is tapered while being connected from the combustion chamber extension part 21 to the upper end of the combustion chamber 20. An opening formed at an upper end of the combustion chamber extension part 21 may be covered by the combustion chamber cover 22.

[0030] An outer diameter of the combustion chamber extension part 21 may be formed to be smaller than an inner diameter of the outer container 10, and thus a flow space may be formed between an inner peripheral surface of the outer container 10 and an outer peripheral surface of the combustion chamber 20. The heating water may flow from the hollow 100 through the flow space. The outer container outlet 13 formed at an upper end of the outer container 10 may be communicated with the flow space. Accordingly, the heating water that flows in the flow space may be discharged through the outer container outlet 13. The heating water that flows in the flow space finally receives heat from the combustion chamber 20, and is discharged through an outlet of the outer container 10.

Flue 50

[0031] A plurality of flues 50 are disposed between the pipe plate and the combustion chamber 20, and are pipe type components that are communicated with the combustion space 200 of the combustion chamber 20 and a lower side of the pipe plate. Accordingly, the flues 50 may be disposed in the hollow 100. The plurality of flues 50 may guide the combustion gas generated by the burner 30 from the combustion space 200 to a lower side or the pipe plate via the hollow 100 of the outer container 10. According to an embodiment of the present disclosure, the flues 50 may extend along the reference direction "D". The heated combustion gas may flow from the combustion chamber 20 to a lower side through the flues 50. In the flow process of the combustion gas, the heating water that flows to an upper side through the hollow 100 of the outer container 10 and the combustion gas that flows to a lower side may exchange heat through the flues 50.

[0032] The plurality of flues 50 may be provided, and may be disposed radially from a center of a circular transverse section of the outer container 10 and the combustion chamber 20. The center of the circular transverse section may be the same as the center of a disk-shaped partition. Accordingly, the flues 50 may be disposed along one circumference at a specific interval. However, the flues 50 may be disposed at a specific interval along two circumferences of different diameters and may be disposed in two steps, and the disposition thereof is not

limited thereto.

[0033] The pipe plate may be spaced downwards apart from the combustion chamber 20, and may cover the opening on a lower end side of the outer container 10. Lower ends of the flues 50 may pass through the pipe plate to discharge the combustion gas and the condensate to a lower side of the pipe plate.

[0034] The water heating apparatus 1 according to the embodiment of the present disclosure may further include the partition. The partition may have a disk shape. The partition may be disposed between the pipe plate and the combustion chamber 20 to cross the reference direction "D" to divide the hollow 100 into a plurality of zones so as to define passages for the heating water. The flues 50 may pass through the partition.

[0035] The water heating apparatus 1 according to an embodiment of the present disclosure may include a condensate receiver 40. The condensate receiver 40 may accommodate and discharge the condensate, and may be located on a lower side of the pipe plate. A reception part of the condensate receiver 40 may be located to be spaced downwards apart from the pipe plate to define a space in an interior of the condensate receiver 40, and the condensate and the combustion gas may be accommodated in the defined space. The condensate receiver 40 may accommodate the condensate and may discharge the condensate through a discharge hole that is communicated with an outer side of the condensate receiver 40. Not the condensate but the gaseous combustion gas may be discharged through an exhaust hole that is formed upwards to be communicated with an outer side or the condensate receiver 40.

Hot Water Heat Exchange Part 60

[0036] The water heating apparatus 1 according to the embodiment of the present disclosure may include the hot water heat exchange part 60. The hot water heat exchange part 60 may transfer the heat received from the water accommodated in the hollow 100 to direct water and may discharge the direct water after making the direct water hot. Accordingly, the direct water introduced from the outside may be heated to be made hot, and may be used at a source of demand.

[0037] The hot water heat exchange part 60 may be configured such that the received direct water exchanges heat with the heating water to be heated. Accordingly, the hot water heat exchange part 60 may be disposed in the hollow 100 and may be formed such that the direct water flows in an interior thereof, whereby the heating water that flows in the hollow 100 and the direct water may exchange heat through the hot water heat exchange part 60.

[0038] The hot water heat exchange part 60 may include a hot water pipeline 61 that is wound while surrounding the combustion chamber 20. The hot water pipeline 61 may be wound spirally. Accordingly, the hot water heat exchange part 60 may be disposed on an

upper side of the hollow 100. The hot water heat exchange part 60 may further surround portions of the flues 50. The hot water pipeline 61 may be disposed in the hollow 100. The hot water pipeline 61 may be disposed to be spaced apart from the combustion chamber 20 and the outer container 10 by a specific distance while not contacting them.

[0039] A hot water inlet 62 that is an inlet of the hot water pipeline 61, through which the direct water is introduced, and a hot water outlet 63 that is an outlet of the hot water pipeline 61, through which the hot water is discharged, may be disposed on an outer side of the outer container 10. The inlet of the hot water pipeline 61 may be located on an upper side of the outlet of the hot water pipeline 61, but the locations thereof are not limited thereto, and the upward/downward locations of the hot water inlet and the hot water outlet may be disposed to be opposite.

[0040] The hot water heat exchange part 60 may include a hot water flow rate acquiring part 64 that is configured to acquire a flow rate of the direct water introduced into the hot water heat exchange part 60 and delivers the flow rate to a processor 80. The hot water flow rate acquiring part 64 may include various types of flow rate gauges, such as a differential pressure flow rate gauge, a capacity flow rate gauge, an electronic flow rate gauge, an ultrasonic flow rate gauge, and a vortex flow rate gauge, which acquires a flow rate of the water that passes through the hot water heat exchange part 60, but the kinds of the used flow rate gauges are not limited thereto, and a hot water flow detection sensor may be disposed instead of the flow rate gauge. A portion of the hot water flow rate acquiring part 64 may be disposed on an inner side of the hot water pipeline 61 and may acquire a flow rate of the water that flows through an interior of the hot water pipeline 61. Although it is illustrated that the hot water flow rate acquiring part 64 is adjacent to the hot water inlet 62, a location thereof is not limited thereto.

Circulation Part 70

[0041] The circulation part 70 is coupled to the outer container inlet 12 and the outer container outlet 13 to circulate the water accommodated in the hollow 100 from an upper end to a lower end of the hollow 100. The heating passage HP disposed at a location that requires heating and the outer container 10 may be connected to the circulation part 70. That is, the outer container 10 may be indirectly connected to the heating passage HP through the circulation part 70.

[0042] The circulation part 70 may include a circulation passage 71. The circulation passage 71 connects the outer container inlet 12 and the outer container outlet 13. The circulation passage 71 may include a circulation introduction passage 711, a circulation discharge passage 713, and a circulation connection passage 712. The circulation introduction passage 711 is connected to the outer container outlet 13. The circulation discharge pas-

sage 713 is connected to the outer container inlet 12. The circulation connection passage 712 connects the circulation introduction passage 711 and the circulation discharge passage 713. Accordingly, for circulation, the heating water discharged from the outer container outlet 13 may be circulated to the outer container outlet 13 while flowing through the circulation introduction passage 711, the circulation connection passage 712, and the circulation discharge passage 713, in a sequence thereof

[0043] The heating passage HP may be connected to the circulation passage 71. The heating water that is delivered from the outer container 10 through the circulation introduction passage 711 may be selectively delivered to the circulation connection passage 712 or the heating passage HP. For determination of a passage, the circulation part 70 may include a circulation valve 73. The circulation valve 73 may be disposed in the circulation passage 71, and may determine whether the passage connected from the circulation introduction passage 711 is to be connected to the heating passage HP for heating or is to be connected to the circulation connection passage 712 for circulation. For this operation, the circulation valve 73 may be a 3-way valve connected to the circulation introduction passage 711, the heating passage HP, and the circulation connection passage 712.

[0044] The circulation part 70 may include a circulation pump 72. The circulation pump 72 may be disposed in the circulation passage such that the heating water is pumped from the outer container outlet 13 to the outer container inlet 12 through the circulation passage 71. Although it is illustrated in the drawings that the circulation pump 72 is disposed in the circulation discharge passage 713, a location thereof is not limited thereto.

Processor 80

[0045] The water heating apparatus 1 may include the processor 80. The processor 80 is a constituent element including an element that may perform logical operations for performing a control command, and may include a central processing unit (CPU). The processor 80 may be connected to the elements to transmit signals according to the control commands to the element, and may be connected to the sensors and the acquirers to receive the acquired information in a form of signals. Accordingly, in the embodiment of the present disclosure, the processor 80 may be electrically connected to the burner 30 included in the water heating apparatus 1, the circulation valve 73 and the circulation pump 72 of the circulation part 70, the hot water heat exchange part 60, and the like. Because the processor 80 may be electrically connected to the elements, it may be connected to the elements by wire or may further include a communication module that may perform communication wirelessly for mutual communications.

[0046] The water heating apparatus 1 may further include a storage medium, and control commands performed by the processor 80 may be stored in the storage

medium to be utilized. The storage medium may be a device such as a hard disk drive (HDD), a solid state drive (SSD), a server, a volatile medium, or a nonvolatile medium, but the kinds thereof are not limited thereto. In addition, the storage medium may further store data that is necessary to allow the processor 80 to perform an operation. Furthermore, the water heating apparatus 1 may include an input part including a display device, and an input unit, such as a button, a joystick, and a touchscreen, and the input part may be electrically connected to the processor 80 to deliver information received from a user to the processor 80.

[0047] Here, the electrical connection comprehensively means not only that the components are connected to each other by a conductive material that may transmit electric power but also that the components are connected to each other such that electrical communication for transmitting and receiving information may be allowed without any physical contact.

Circulation Control

[0048] The processor 80 may determine that it is not necessary to provide heating and the direct water is introduced into the hot water heat exchange part 60, based on the flow rate of the direct water acquired by the hot water flow rate acquiring part 64 and whether it is necessary to provide heating. Accordingly, a method for controlling the water heating apparatus 1 may include an operation of acquiring a flow rate of the direct water provided to the hot water heat exchange part 60 by using the hot water flow rate acquiring part 64. The acquired flow rate information is delivered to the processor 80. Furthermore, the method for controlling the water heating apparatus 1 may include an operation of recognizing whether it is necessary for the processor 80 to provide heating.

[0049] It may be determined whether it is necessary to provide heating, in a scheme of comparing a temperature of a temperature sensor disposed adjacent to the heating passage HP or at a location, at which heating is provided, with a target heating temperature. Furthermore, it may be determined whether it is necessary to provide heating, based on that the user inputs necessity of heating or inputs a command that indicates that heating is not necessary, through the input part. The target heating temperature may be programmed in advance, or may be input by using the input part by the user.

[0050] When it is determined that it is not necessary to provide heating and the direct water is introduced into the hot water heat exchange part 60, the processor 80 may control the circulation valve 73 and the circulation pump 72 such that the heating water is circulated through the circulation connection passage 712. Accordingly, the method for controlling the water heating apparatus 1 may include an operation of circulating the heating water through the circulation part 70 when it is determined that it is not necessary to provide heating and the direct water

is introduced into the hot water heat exchange part 60. Because heating is not used, the heating water is not provided to the heating passage HP by the circulation valve 73. The processor 80 may control the circulation valve 73 such that the direct water is introduced into the hot water heat exchange part 60 so that the hot water is generated regardless of whether it is necessary to provide heating.

[0051] The processor 80 may control the circulation valve 73 and the circulation pump 72 such that the heating water is circulated through the circulation connection passage 712 for a delay time period that is a specific time period when it is determined that delivery of the direct water to the hot water heat exchange part 60 is stopped, based on the flow rate of the direct water acquired by the hot water flow rate acquiring part 64. The method for controlling the water heating apparatus 1 may include an operation of controlling the circulation part 70 such that the heating water is circulated through the circulation part 70 for a delay time period when delivery of the direct water to the hot water heat exchange part 60 is stopped.

[0052] In this scheme, when the hot water is used, the heating water may be circulated and a temperature gradient may be decreased, and thus the temperature of the heating water is flattened and overheating or lack of the hot water may be alleviated, whereby the hot water of a high quality may be provided.

Proportional Control

[0053] The processor 80 may receive an electric voltage and may apply the voltage to the components. The processor 80 may include a signal converting part. The signal converting part may convert the received electric voltage to a signal in a form, in which the fuel pump 32 may be proportional-controlled, and may apply the signal to the fuel pump 32. The signal converting part may control an air controller 33 together with the fuel pump 32 at the same time.

[0054] Accordingly, the burner 30 is not only controlled in a simple scheme of being switched on and off but an electric signal is converted and provided to the burner 30 for a proportional control, and thus an amount of discharged fuel and a pressure of the fuel may be proportional-controlled and a calorie generated through the combustion reaction, which is influenced by the amount of the discharged fuel may be controlled. Accordingly, even though the burner 30 is not repeatedly switched on and off to maintain a targeted temperature, a scheme of controlling an amount of discharged fuel while the burner 30 is maintained in a switch-on state may be used. Because the burner 30 does not have to be repeatedly switched on and off, soot may be decreased and an amount of the used fuel may be decreased, and a temperature deviation between the produced hot water and heating water may be decreased, making it possible to produce hot water of a high quality.

[0055] The electric voltage applied to the processor 80

may be a commercial AC voltage. Accordingly, an aspect of the electric voltage is drawn while a transverse axis is taken as time and a longitudinal axis is taken as voltage, a sinusoidal wave shape having a specific frequency and a specific magnitude may be formed.

[0056] FIG. 3 is a time-voltage graph illustrating a signal obtained through conversion by the processor 80 of the water heating apparatus 1 according to a first modification of an embodiment of the present disclosure. FIG. 4 is a time-voltage graph illustrating a signal obtained through conversion by the processor 80 of the water heating apparatus 1 according to a second modification of an embodiment of the present disclosure.

[0057] Referring to the drawings, a signal converting part according to the first modification and the second modification of the embodiment of the present disclosure may convert the input electric voltage to a signal in a sinusoidal wave form selected from a half wave or a full wave for phase-control of the fuel pump 32 and apply the signal to the fuel pump 32.

[0058] In the first modification, the input electric voltage may be made to be converted and stabilized to be output, and such that the electric voltage is output only when the waveform shape of the signal is in a half period of a (+) phase. Based on this, a phase control method of adjusting a magnitude of the output voltage of a half wave in a scheme of selecting and outputting at least some of the parts indicated by 2a, 2b, and 2c may be used.

[0059] In the second modification, the input electric voltage may be made to be converted and stabilized to be output, and such that the electric voltage is output only when the waveform shape of the signal is in a half period of a (+) phase and a half period of a (-) phase. Based on this, a phase control method of adjusting a magnitude of the output voltage of a half wave in a scheme of selecting and outputting at least some of the parts indicated by 3a, 3b, and 3c may be used.

[0060] FIG. 5 is a time-voltage graph illustrating a signal obtained through conversion by the processor 80 of the water heating apparatus 1 according to a third modification of an embodiment of the present disclosure.

[0061] In the third modification, the fuel pump 32 may be controlled in a pulse width modulation (PWM) scheme because the signal converting part converts the input electric voltage to a signal in a form of a direct current pulse, adjusts a width of the pulse according to a desired magnitude of the voltage, and applies the pulse to the fuel pump 32.

[0062] FIG. 6 is a time-voltage graph illustrating a signal obtained through conversion by the processor 80 of the water heating apparatus 1 according to a fourth modification of an embodiment of the present disclosure.

[0063] In the fourth modification, the fuel pump 32 may be controlled in a frequency modulation (FM) scheme because the signal converting part converts the input electric voltage to a signal in a form of a direct current pulse, adjusts a frequency of the pulse according to a desired magnitude of the voltage, and applies the pulse

to the fuel pump 32.

[0064] FIG. 7 is a time-voltage graph illustrating a signal obtained through conversion by the processor 80 of the water heating apparatus 1 according to a first modification of an embodiment of the present disclosure. FIG. 8 is a time-voltage graph illustrating a signal obtained through conversion by the processor 80 of the water heating apparatus 1 according to a sixth modification of an embodiment of the present disclosure.

[0065] In the fifth modification and the sixth modification, the signal converting part may convert the input electric voltage to a signal in a half-wave form, and may adjust the number of times and an interval, by which the electric voltage in a half-wave form is applied to the fuel pump 32, according to a preset program. In the fifth modification, the waveforms of 6a, 6c, and 6e of FIG. 7 may be output and 6b, 6d, and 6f that are waveforms therebetween may not be output. In the sixth modification, the waveforms of 6a', 6c', and 6e' of FIG. 8 may not be output and 6b', 6d', and 6f' that are waveforms therebetween may be output.

[0066] FIG. 9 is a graph depicting a relationship of a PWM value applied to the fuel pump 32 by a processor, which may be obtained when a proportion control is performed by using the processor 80 of the water heating apparatus 1 according to the third modification of the embodiment of the present disclosure, to a fuel consumption and a fuel pressure.

[0067] In the graph of FIG. 9, a transverse axis is a PWM value and a longitudinal axis is fuel consumption and a pressure of the fuel. The PWM value that is the transverse axis is a value that increases as the pulse width decreases. The PWM value may be considered as a value obtained by dividing a maximum value of the voltage that may be applied to the fuel pump 32 by an arbitrary value. For example, a voltage of 0 V to 220 V may be applied to the fuel pump 32, and when the maximum PWM value is 3500 as illustrated in the graph, the unit PWM value may be a value obtained by dividing 220 V by 3500. In this case, as an example, it may be considered that 94.29 V is applied to the fuel pump 32 when the PWM value is 1500.

[0068] The fuel consumption in the longitudinal axis is a value that indicates an amount of the fuel used in unit time by kg, and a pressure of the fuel is a value that indicates the pressure of the fuel by kgf/cm².

[0069] Referring to the graph of FIG. 9, the fuel consumption and the pressure of the fuel increase in proportion as the PWM value increases, and the power consumption and the pressure of the fuel are saturated from a specific PWM value. When the pressure of the fuel is 5 kgf/cm² or less, a combustion defect may occur. Due to the proportional control, the power consumption and the soot may be reduced by reducing the number of times, by which ignitions and extinguishments are repeated, as compared with a case, in which the fuel pump 32 is simply on/off-controlled.

[0070] Accordingly, a temperature deviation may be

reduced so that hot water of a high quality may be provided.

[0071] Although it may have been described until now that all the elements constituting the embodiments of the present disclosure are coupled to one or coupled to be operated, the present disclosure is not essentially limited to the embodiments. That is, without departing from the purpose of the present disclosure, all the elements may be selectively coupled into one or more elements to be operated. Furthermore, because the terms, such as "comprising", "including", or "having" may mean that the corresponding element may be included unless there is a specially contradictory description, it should be construed that another element is not extruded but may be further included. In addition, unless defined otherwise, all terms used herein, including technical or scientific terms, have the same meanings as those generally understood by those skilled in the art to which the present disclosure pertains. The terms, such as the terms defined in dictionaries, which are generally used, should be construed to coincide with the context meanings of the related technologies, and are not construed as ideal or excessively formal meanings unless explicitly defined in the present disclosure.

[0072] The above description is a simple exemplification of the technical spirits of the present disclosure, and the present disclosure may be variously corrected and modified by those skilled in the art to which the present disclosure pertains without departing from the essential features of the present disclosure. Accordingly, the embodiments disclosed in the present disclosure is not provided to limit the technical spirits of the present disclosure but provided to describe the present disclosure, and the scope of the technical spirits of the present disclosure is not limited by the embodiments. Accordingly, the technical scope of the present disclosure should be construed by the attached claims, and all the technical spirits within the equivalent ranges fall within the scope of the present disclosure.

Claims

1. A water heating apparatus comprising:

an outer container having openings formed at opposite ends thereof with respect to a reference direction, an interior hollow communicated with the openings at the opposite ends, an outer container outlet formed at one end thereof to deliver heated water to a heating passage, and an outer container inlet provided at an opposite end thereof to retrieve the water from the heating passage;
a combustion chamber covering the opening at one end of the outer container and defining a combustion space in an interior thereof;
a burner coupled to the combustion chamber

and the outer container to cause a combustion reaction in the combustion space;

a pipe plate spaced apart from the combustion chamber along the reference direction, and covering the opening at an opposite end of the outer container;

a plurality of flues provided in the hollow of the outer container to guide a combustion gas generated through the combustion reaction from the combustion chamber to an outside of the pipe plate;

a hot water heat exchange part configured to transfer heat received from the water accommodated in the hollow to introduced direct water and discharge the direct water after making the direct water hot; and

a circulation part coupled to the outer container inlet and the outer container outlet to circulate the water accommodated in the hollow from one end to an opposite end thereof.

2. The water heating apparatus of claim 1, wherein the circulation part further includes:

a circulation passage connecting the outer container inlet and the outer container outlet; and
a circulation pump disposed in the circulation passage to pump the water from the outer container outlet to the outer container inlet through the circulation passage.

3. The water heating apparatus of claim 2, wherein the outer container is configured to be indirectly connected to the heating passage through the circulation part, wherein the circulation passage includes:

a circulation introduction passage connected to the outer container outlet;
a circulation discharge passage connected to the outer container inlet; and
a circulation connection passage connecting the circulation introduction passage and the circulation discharge passage, and
wherein the circulation part further includes:
a circulation valve disposed in the circulation passage to selectively deliver the water discharged from the outer container outlet to the heating passage or the circulation connection passage.

4. The water heating apparatus of claim 3, further comprising:

a processor electrically connected to the circulation valve and the circulation pump.

5. The water heating apparatus of claim 4, further comprising:

- a hot water flow rate acquiring part configured to acquire a flow rate of the direct water introduced into the hot water heat exchange part and deliver the flow rate to the processor, wherein the processor is configured to: control the circulation valve and the circulation pump such that the water is circulated through the circulation connection passage when it is determined that it is not necessary to provide heating and the direct water is introduced into the hot water heat exchange part, based on the flow rate of the direct water, which is acquired by the hot water flow rate acquiring part, and whether it is necessary to provide the heating.
6. The water heating apparatus of claim 4, further comprising:
- a hot water flow rate acquiring part configured to acquire a flow rate of the direct water introduced into the hot water heat exchange part and deliver the flow rate to the processor, wherein the processor is configured to: control the circulation valve and the circulation pump such that the water is circulated through the circulation connection passage for a specific delay time period when it is determined that delivery of the direct water to the hot water heat exchange part is stopped, based on the flow rate of the direct water, which is acquired by the hot water flow rate acquiring part.
7. The water heating apparatus of claim 4, wherein the burner includes:
- a fuel discharge part configured to discharge a fuel for the combustion reaction; and
a fuel pump configured to pump the fuel and supply the fuel to the fuel discharge part, and wherein the processor is configured to receive an electric voltage, convert the electric voltage to a signal in a form that may proportional-control the fuel pump, and apply the signal to the fuel pump.
8. The water heating apparatus of claim 7, wherein the processor is configured to: convert the input electric voltage to a signal of a sinusoidal wave form selected from a half-wave or a full-wave, and apply the signal to the fuel pump, to control a phase of the fuel pump.
9. The water heating apparatus of claim 7, wherein the processor is configured to: convert the input electric voltage to a signal of a direct current pulse form and apply the signal to the fuel pump, to control the fuel pump in a pulse width modulation (PWM) scheme.
10. The water heating apparatus of claim 7, wherein the processor is configured to: convert the input electric voltage to a signal of a direct current pulse form and apply the signal to the fuel pump, to control the fuel pump in a frequency modulation (FM) scheme.
11. The water heating apparatus of claim 7, wherein the processor is configured to: convert the input electric voltage to a signal of a half-wave form, and adjust the number of times of applications of the electric voltage in the half-wave form and an interval, at which the electric voltage is applied to the fuel pump according to a preset program.
12. The water heating apparatus of claim 1, wherein the hot water heat exchange part includes: a hot water pipeline that is wound while surrounding the combustion chamber such that the direct water flows through an interior thereof and is heated.
13. The water heating apparatus of claim 1, wherein the burner includes: an air supply pipe that is a pipe, through which air for the combustion reaction is delivered from a combustion chamber cover that covers the combustion chamber.
14. The water heating apparatus of claim 1, wherein the burner includes:
- a fuel discharge part configured to discharge a fuel for the combustion reaction; and
a fuel pump configured to pump the fuel and supply the fuel to the fuel discharge part, and wherein the processor is configured to receive an electric voltage, convert the electric voltage to a signal in a form that may proportional-control the fuel pump, and apply the signal to the fuel pump.
15. A method for controlling a water heating apparatus including a burner, a hot water heat exchange part configured to heat direct water by using heat generated through a combustion reaction caused by the burner, and discharge hot water, an outer container configured to heat water by using the heat generated through the combustion reaction and provide heating, and a circulation part configured to circulate the water in the outer container, the method comprising:
- acquiring a flow rate of the direct water provided by the hot water heat exchange part;
recognizing whether it is necessary to provide heating; and
circulating the water through the circulation part when it is determined that it is not necessary to provide heating and that the direct water is in-

roduced into the hot water heat exchange part
based on the flow rate of the direct water.

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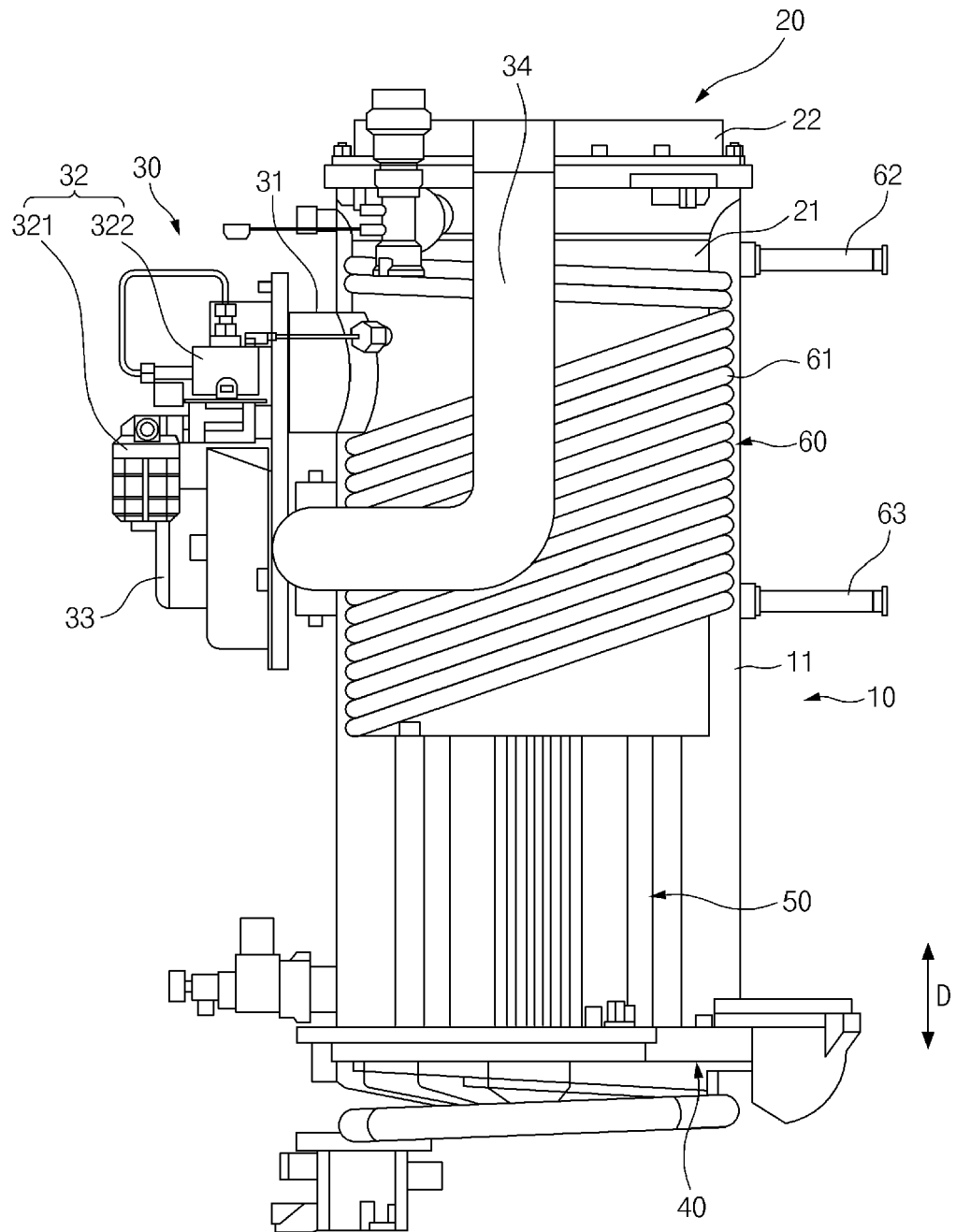


FIG.1

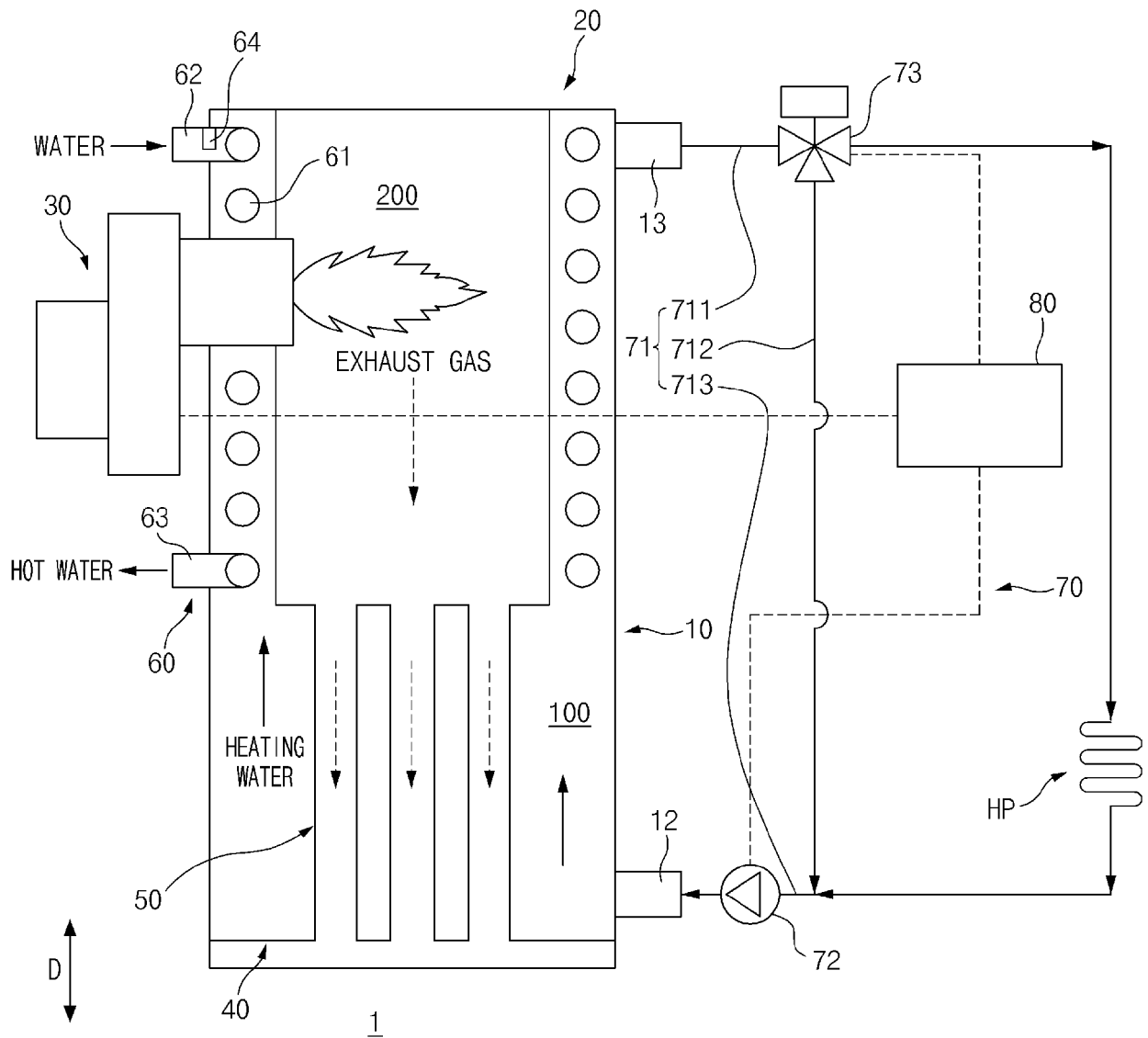


FIG.2

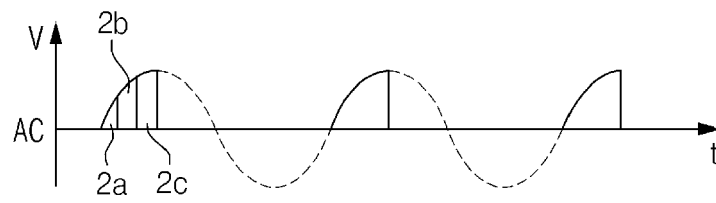


FIG.3

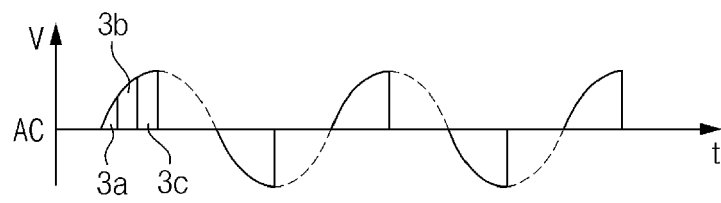


FIG.4

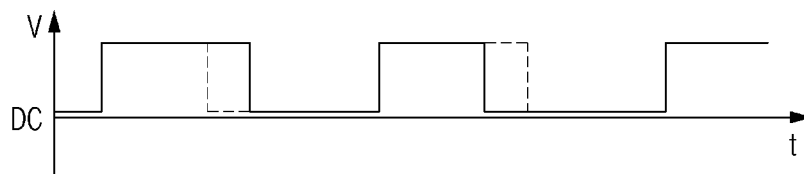


FIG.5

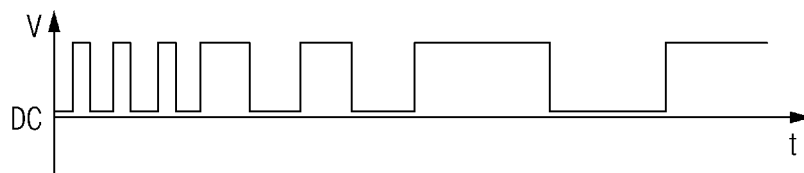


FIG.6

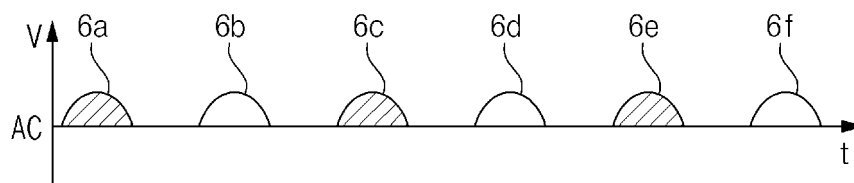


FIG.7

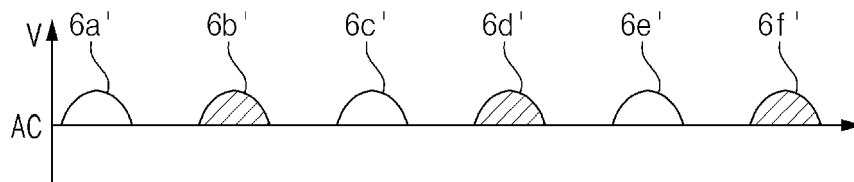


FIG.8

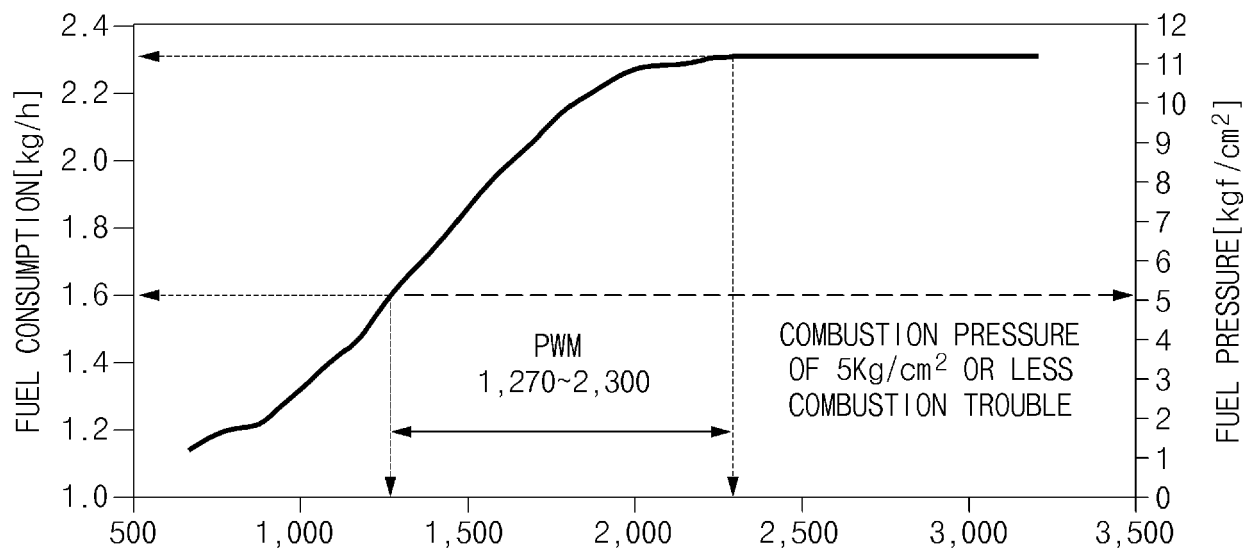


FIG.9



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Application Number

EP 22 20 2740

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	* paragraphs [0045] - [0056]; claims 1-2; figure 13 *		F24H9/20
	* *		F24D3/08
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			F23N
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		17 March 2023	Hoffmann, Stéphanie
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