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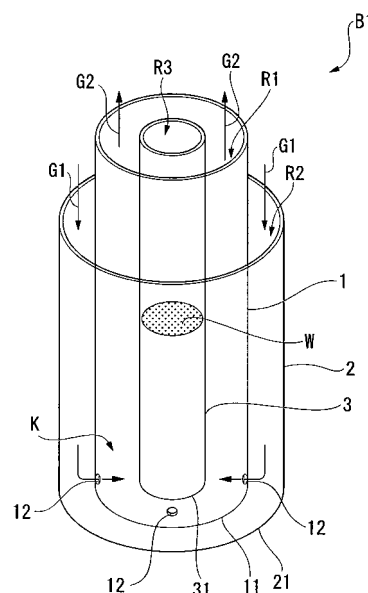
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(54) **HEATING APPARATUS**

(57) A first flow passage (R1) in which uncombusted gas (G1) that contains a combustible fuel is injected from a nozzle hole that is smaller than the flame quenching distance at a flow speed to thereby enable flame maintenance is combusted, and thereby enables flow of combustion gas (G2) resulting from such combustion, and a second flow passage (R2) formed about the first flow passage and enabling flow of uncombusted gas supplied through the nozzle hole are provided. According to the present invention, the combustion chamber in a heating apparatus that heats a liquid to be heated is reduced in size, the flame in the combustion chamber can be stabilized, and energy efficiency can be improved.

FIG. 1



Description**TECHNICAL FIELD**

[0001] The present invention relates a heating apparatus for heating a fluid to be heated. This application claims the benefit of Japanese Patent Application 2008-053901 filed in Japan on March 4, 2008 and Japanese Patent Application 2008-053903 filed in Japan on March 4, 2008, the entire disclosure of which is incorporated by reference herein.

BACKGROUND ART

[0002] In an eating and drinking establishments, or in lodging facilities, a small heating apparatus may be installed for the heating of water for use in bathing or for steaming during cooking. For example, a heating apparatus has been disclosed which heats water flowing in a pipe using high-temperature combustion gas produced by combustion of a fuel in the presence of combustion air to thereby evaporate the water into steam. Furthermore in addition to production of steam or hot water, the heating apparatus may be also used for heating of various liquids (a liquid to be heated) (Patent Literature 1). [Patent Literature 1] Japanese Patent Application, First Publication No. 2007-139358

DISCLOSURE OF THE INVENTION**[Problem to be Solved by the Invention]**

[0003] Meanwhile, in a conventional heating apparatus, a large combustion chamber must be provided in order to maintain the time for complete combustion within the combustion chamber. As a result, it is not possible to sufficiently downsize the heating apparatus. Consequently, a stable flame can be maintained even in a small combustion chamber by performing combustion after heating uncombusted gas in advance using combustion gas. However since combustion gas has a considerably high temperature, there is the possibility that the uncombusted gas may undergo spontaneous combustion as a result of excessive heating prior to supply of the uncombusted gas to the combustion chamber and that flame propagation may occur thereby resulting in occurrence of combustion outside of the combustion chamber. Furthermore a large amount of heat is radiated to the periphery from a large combustion chamber, and thereby results in a reduction in energy efficiency.

[0004] The present invention is proposed in light of the above problems, and has the object of providing a heating apparatus for heating of a liquid to be heated that reduces the size of a combustion chamber, stabilizes the flame in the combustion chamber and thereby improves energy efficiency.

[Means for Solving the Problem]

[0005] In order to achieve the above object, the present invention is a heating apparatus for heating of a liquid to be heated including a first flow passage in which uncombusted gas that contains a combustible fuel is injected from a nozzle hole that is smaller than the flame quenching distance at a flow speed to thereby enable flame maintenance and is combusted, and thereby enables flow of combustion gas resulting from the combustion, and a second flow passage enabling flow of uncombusted gas supplied through the nozzle hole.

[0006] The above configuration may form the second flow passage about the first flow passage.

[0007] According to the heating apparatus, uncombusted gas is heated by flowing through the second flow passage formed about the first flow passage which enables flow of the combustion gas. In order to form the second flow passage about the first flow passage, the entire periphery of the second flow passage does not make contact with the first flow passage. Therefore a part of the heat amount transmitted from the combustion gas is radiated from the uncombusted gas.

[0008] In the present invention, a third flow passage is surrounded by the first flow passage and enables flow of a liquid to be heated.

[0009] According to the heating apparatus above, a configuration in which the third flow passage is formed from an inner space of a third pipe, a configuration in which the first flow passage is formed from a space sandwiched by the third pipe and the first pipe concentrically enclosing the third pipe, and a configuration in which the second flow passage is formed from a space sandwiched by the first pipe and the second pipe concentrically enclosing the first pipe are enabled.

[0010] In the above configuration, a plurality of fins may be provided to project towards the first flow passage from an outer peripheral face of the third pipe.

[0011] In the above configuration, the third pipe is curved toward the first flow passage side and the second flow passage side at a predetermined interval.

[0012] A configuration is possible in which the first flow passage is formed about the second flow passage, and the third flow passage enables flow of the liquid to be heated and is formed about the first flow passage.

[0013] According to the heating apparatus above, the first flow passage is formed about the second flow passage that enables flow of uncombusted gas, and combustion gas flows in the first flow passage. Thus the uncombusted gas flowing in the second flow passage is heated by high-temperature combustion gas which flows in the first flow passage. Furthermore a stable flame is formed by injection of uncombusted gas from the second flow passage at a flow speed enabling maintenance of a flame through a nozzle hole that is set to be smaller than the flame quenching distance. Furthermore, the third flow passage is formed about the first flow passage which enables combustion of uncombusted gas by the stable

flame and flow of the uncombusted gas, and the liquid to be heated flows in the third flow passage.

[0014] In the above configuration, a guide portion may be provided to guide the combustion gas from the first flow passage to a region opposite the first flow passage that is a region on an outer side of the third flow passage.

[0015] In the above configuration, the second flow passage is configured from an inner space in the second pipe, the first flow passage is configured from the space sandwiched by the second pipe and the first pipe that concentrically surrounds the second pipe, and the third flow passage is configured from the space sandwiched by the first pipe and the third pipe that concentrically surrounds the first pipe.

[0016] In the above configuration, the second flow passage is configured from an inner space in the second pipe, the third flow passage is configured from the inner space of a plurality of fourth pipes disposed at a distance from the second pipe centering on the second pipe, and the first flow passage is configured from a space surrounded by the second pipe and the partitions closing the interval between the pairs of fourth pipes and fourth pipes.

[Effects of the Invention]

[0017] According to the heat apparatus in the present invention, the following excellent effects are obtained.

(1) The second passage which enables flow of the uncombusted gas is formed about the first flow passage which enables flow of the combustion gas. Therefore although the entire periphery of the second flow passage does not come into contact with the first flow passage, a part of the heat amount transmitted from the combustion gas is radiated from the uncombusted gas. As a result, in addition to reduce the size of a combustion chamber by heating uncombusted gas, overheating of the uncombusted gas can be suppressed, and it is possible to form a stable flame in the combustion chamber. Therefore the combustion chamber in the heating apparatus that heats the liquid to be heated can be reduced in size and maintenance of a stable flame in the combustion chamber is possible.

(2) The first passage is formed about the second flow passage which enables flow of the uncombusted gas and the combustion gas flows in the first passage. Therefore the uncombusted gas flowing in the second passage can be heated by the high-temperature combustion gas flowing in the first flow passage. Furthermore a stable flame is formed by injection of uncombusted gas from the second flow passage at a flow speed enabling maintenance of a flame through a nozzle hole that is set to be smaller than the flame quenching distance. This stable flame enables stable combustion even when coming into direct contact with the partition face making contact with the cold

liquid to be heated, and enables efficient transmission of heat to the partition face. Furthermore the third flow passage is formed about the first flow passage in which the uncombusted gas is combusted by the stable flame and enables flow of the combustion gas, and the liquid to be heated flows in the third flow passage. As a result, the liquid to be heated flowing in the third flow passage is heated by direct heating of the third flow passage by the stable flame. Therefore in comparison to use of a passage for the liquid to be heated that is heated only by combustion gas, since the heat amount is effectively transmitted to the liquid to be heated, it is possible to improve the energy efficiency of the heating apparatus that heats the liquid to be heated.

(3) Uncombusted gas flowing in the second flow passage is heated by high-temperature combustion gas flowing in the first flow passage, the heated uncombusted gas is injected from the second flow passage at a flow speed enabling maintenance of a flame through a nozzle hole that is set to be smaller than the flame quenching distance, and the uncombusted gas is combusted. Since this configuration enables sufficient heating of the uncombusted gas by the high-temperature combustion gas, there is no need for a large combustion chamber to enable stable combustion, and therefore enables continuous combustion in the microchannels of the combustion chamber. Therefore the combustion chamber can be downsized thereby enabling reduction in size of the heating apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a perspective view showing a schematic configuration of a small boiler according to a first embodiment of a heating apparatus of the present invention.

FIG. 2 is a horizontal sectional view of the schematic configuration of the apparatus shown in Fig. 1.

FIG. 3 is a vertical sectional view of the schematic configuration of the apparatus shown in Fig. 1.

FIG. 4 is a vertical sectional view of the schematic configuration of the small boiler according to a second embodiment of the present invention.

FIG. 5 is a horizontal sectional view of the schematic configuration of the small boiler according to a third embodiment of the present invention.

FIG. 6 is a horizontal sectional view of the schematic configuration of the small boiler according to a fourth embodiment of the present invention.

FIG. 7 is a perspective view of the schematic configuration of the small boiler according to a fifth embodiment of the present invention.

FIG. 8 is a horizontal sectional view of the schematic configuration of the apparatus shown in Fig. 7.

FIG. 9 is a vertical sectional view of the schematic configuration of the apparatus shown in Fig. 7.

FIG. 10 is a horizontal sectional view of the schematic configuration of the small boiler according to a sixth embodiment of the present invention.

FIG. 11 is a perspective view of the schematic configuration of the apparatus shown in Fig. 10.

FIG. 12 is a horizontal sectional view of the schematic configuration of the small boiler according to a seventh embodiment of the present invention.

FIG. 13 is a horizontal sectional view of the schematic configuration of the small boiler according to an eighth embodiment of the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

[0019] A first embodiment of a heating apparatus according to the present invention will be described below making reference to the figures and using an example of a small boiler. In the figures below, the dimensions of respective members have been suitably varied to a size that enables recognition of each member.

First Embodiment

[0020] FIG. 1 to FIG. 3 are schematic views of a small boiler B1 according to the present embodiment. FIG. 1 is a perspective view, FIG. 2 is a horizontal sectional view, and FIG. 3 is a vertical sectional view. As shown in these views, a small boiler B1 according to the present embodiment has a three-layered structure in which a first pipe 1 (first pipe), a second pipe 2 (second pipe), a third pipe 3 (third pipe) are disposed concentrically when viewed horizontally.

[0021] The first pipe 1 extends in a vertical direction and the lower end 11 thereof is closed. A plurality of nozzle holes 12 set so that the diameter thereof is smaller than the flame quenching distance of the uncombusted gas is provided in a side partition portion near to the lower end 11. The first pipe 1 is formed from a material that has superior heat transmission characteristics (for example, brass or the like).

[0022] The second pipe 2 extends vertically and concentrically surrounds the first pipe 1. A lower end 21 thereof is closed, and in the same manner as the first pipe 1, it is formed from a material having superior heat transmission characteristics.

[0023] The third pipe 3 extends vertically and is inserted into the first pipe 1. A lower end 31 thereof is closed, and in the same manner as the first pipe 1 and the second pipe 2, the third pipe 3 is preferably formed from a material having superior heat transmission characteristics.

[0024] An inner space in the third pipe 3 forms a water flow passage R3 (third flow passage) which enables flow of the water (liquid to be heated) W. More specifically, in the small boiler B1 according to the present embodiment, the water flow passage R3 is configured from the inner space of the third pipe 3. A water supply portion (not

shown) to supply water W to the water flow passage R3 is connected in proximity to the lower end of the water flow passage R3. A regulated flow amount of water W is supplied to the water flow passage R3 by the water supply portion. Furthermore a discharge portion (not shown) is connected to enable discharge of steam produced by evaporation of water W in the water flow passage R3 in proximity to the upper end of the water flow passage R3. A regulated amount of steam is discharged to an external portion from the water flow passage R3 via the discharge portion.

[0025] A space sandwiched by the third pipe 3 and the first pipe 1 forms a combustion gas flow passage R1 (first flow passage) in which a combustion of uncombusted gas G1 occurs and combustion gas G2 produced by combustion of the uncombusted gas G1 can flow. More specifically, in the small boiler B1 according to the present embodiment, the combustion gas flow passage R1 is configured from a space sandwiched by the third pipe 3 and the first pipe 1 that concentrically surrounds the third pipe. Furthermore the water flow passage R3 is surrounded by the combustion gas flow passage R1. A section near to the lower end of the combustion gas flow passage R1 (near to the nozzle hole 12) forms a combustion chamber K in which uncombusted gas G1 injected from the nozzle holes 12 is combusted. An ignition apparatus (not shown) is provided in the combustion chamber K.

[0026] A space sandwiched by the first pipe 1 and the second pipe 2 forms the uncombusted gas flow passage R2 (second flow passage) that enables flow of uncombusted gas G1 including combustible fuel. More specifically, the uncombusted gas flow passage R2 is configured from a space sandwiched by the first pipe 1 and the second pipe 2 that concentrically covers the first pipe 1. The upper end portion of the second pipe 2 is connected to an uncombusted gas supply apparatus (not shown) that supplies uncombusted gas G1 to the uncombusted gas flow passage R2.

[0027] The uncombusted gas G1 may be a mixed gas of fuel with an oxidation agent. The fuel may be an oil fuel, natural gas or the like.

[0028] In the small boiler B1 according to the present embodiment, firstly uncombusted gas G1 is supplied from the uncombusted gas supply apparatus that is connected to the second pipe 2 to the uncombusted gas flow passage R2. The uncombusted gas G1 injected from nozzle holes 12 formed in the first pipe 1 is ignited and combusted to thereby form a flame in the combustion chamber K. Then the combustion gas G2 produced by the combustion of the uncombusted gas G1 flows through the combustion gas flow passage R2 and is discharged.

[0029] When a flame is formed in the combustion chamber K, since high-temperature combustion gas G2 flows into the combustion gas flow passage R1, the uncombusted gas G1 flowing through the uncombusted gas flow passage R2 becomes heated. More specifically, the

heat amount of the combustion gas G2 is transmitted to the uncombusted gas G1 through the first pipe 1 that functions as a heat-exchanging partition to thereby heat the uncombusted gas G1.

[0030] The uncombusted gas G1 heated by heat exchange with the combustion gas G2 is injected in a heated state into an inner portion of the first pipe 1 through the nozzle holes 12. The uncombusted gas G1 is injected from the nozzle holes 12 and combusted in the combustion chamber K.

[0031] Since the nozzle holes 12 formed in the first pipe 1 are set to be smaller than the flame quenching distance of the uncombusted gas G1 in the combustion environment of the combustion chamber K, it is possible to suppress propagation of the flame to the uncombusted gas flow passage R2. Furthermore since the uncombusted gas flow passage R2 is formed about the combustion gas flow passage R1, the entire periphery of the uncombusted gas flow passage R2 does not come into contact with the combustion gas flow passage R1, and a part of the heat amount transmitted from the combustion gas G2 is radiated from the uncombusted gas G1. As a result, overheating of the uncombusted gas G1 can be suppressed, and therefore propagation of the flame to the uncombusted gas flow passage R2, and spontaneous combustion of the uncombusted gas G1 can be suppressed. As a result, the flame in the combustion chamber K is stable and combustion can be continuously executed.

[0032] As described above, uncombusted gas G1 supplied to the combustion chamber K through the uncombusted gas flow passage R2 is heated by the combustion gas G2 flowing through the combustion gas flow passage R1 in a state in which combustion in the combustion chamber K is continuously executed. Therefore, a stable flame can be formed by a combustion chamber K which is extremely small in comparison to the combustion chamber in a conventional heating apparatus.

[0033] Water W in the water flow passage R3 is heated and evaporated by the combustion gas G2 in the combustion gas flow passage R2 and the flame in the combustion chamber K in a state in which a stable flame is formed in the combustion chamber K and combustion is continuously executed. More specifically, heat produced by combustion is transmitted to water W through the second pipe 2 that functions as a heat exchange partition, and therefore the water W is heated and evaporates. The steam produced by evaporation of the water W is discharged to an external portion of the small boiler B1 through the discharge portion (not shown). Since the water flow passage R3 is surrounded by the combustion gas flow passage R1, a heat amount can be transmitted to the water W from the entire periphery of the water flow passage R3 and thereby enables efficient heating of the water W.

[0034] According to the small boiler B1 of the present embodiment, an uncombusted gas flow passage R2 which enables flow of the uncombusted gas G1 is formed

about the combustion gas flow passage R1 which enables flow of the combustion gas G2. Consequently, the entire periphery of the uncombusted gas flow passage R2 makes no contact with the combustion gas flow passage R1, and a portion of the heat amount transmitted from the combustion gas G2 is radiated from the uncombusted gas G1. As a result, the combustion chamber K can be made smaller due to the heating of the uncombusted gas G1, and it is possible to suppress the overheating of the uncombusted gas G1 and stabilize the flame in the combustion chamber K. Therefore the combustion chamber K can be made smaller and the flame in the combustion chamber K can be stabilized.

15 Second Embodiment

[0035] Next, a second embodiment of the present invention will be described. In the description of the second embodiment, description of those sections which are the same as the first embodiment will be omitted or simplified.

[0036] FIG. 4 is a vertical sectional view of the schematic configuration of a small boiler B2 according to an embodiment. As shown in the figure, the small boiler B2 according to the present embodiment includes a fourth pipe 4 which concentrically surrounds the second pipe 2. A space sandwiched by the second pipe 2 and the fourth pipe 4 is formed as a storage portion 5 that stores water W and is connected to the water flow passage R3.

[0037] According to the small boiler B2 in the present embodiment having the above configuration, although water W stored temporarily in the water storage portion 5 is supplied to the water flow passage R3, the water W receives a portion of the heat amount radiated from the uncombusted gas G1 in the storage portion 5. Consequently, the amount of heat radiated from the uncombusted gas G1 can be used to heat the water W, and therefore enables more efficient heating of the water W.

40 Third Embodiment

[0038] Next, a third embodiment of the present invention will be described. In the description of the third embodiment, description of those sections which are the same as the first embodiment will be omitted or simplified.

[0039] FIG. 5 is a horizontal sectional view of the schematic configuration of a small boiler B3 according to an embodiment. As shown in the figure, the small boiler B3 according to the present embodiment includes a plurality of fins 10 that project towards the combustion gas flow passage R1 from an outer peripheral face of the third pipe 3. The fins 10 are integrally formed with the third pipe 3 and are formed from a material having superior heat transmission characteristics in the same manner as the third pipe 3.

[0040] According to the small boiler B3 in the present embodiment that has the above configuration, the fins 10 enable an increase in the heat exchanging surface area with water W flowing through the water flow passage

R3 and the combustion gas G2 flowing through the combustion gas flow passage R1, and thereby enable more efficient heating of the water.

Fourth Embodiment

[0041] Next, a fourth embodiment of the present invention will be described. In the description of the fourth embodiment, description of those sections which are the same as the first embodiment will be omitted or simplified.

[0042] FIG. 7 is a horizontal sectional view of the schematic configuration of a small boiler B4 according to an embodiment. As shown in the figure, the small boiler B4 according to the present embodiment is such that the second pipe 2 is configured in a star shape that is curved toward the combustion gas flow passage R1 and the water flow passage R3 at a fixed interval.

[0043] According to the small boiler B4 in the present embodiment that has the above configuration, the formation of the third pipe 3 into a star shape which is curved at a fixed interval enables an increase in the heat exchanging surface area with water W flowing through the water flow passage R3 and the combustion gas G2 flowing through the combustion gas flow passage R1, and thereby enables more efficient heating of the water.

[0044] FIG. 7 to FIG. 9 are schematic views of a small boiler B101 according to a fifth embodiment of the present invention. FIG. 7 is a perspective view, FIG. 8 is a horizontal sectional view, and FIG. 9 is a vertical sectional view. As shown in these views, a small boiler B101 according to the present embodiment has a three-layered structure in which a first pipe 101 (first pipe), a second pipe 102 (second pipe), a third pipe 103 (third pipe) are disposed concentrically when viewed horizontally.

[0045] The second pipe 102 extends vertically and a lower end 111 thereof is closed. A plurality of nozzle holes 112 set so that the diameter thereof is smaller than the flame quenching distance of the uncombusted gas is provided in a side partition portion near to the lower end 111. The second pipe 102 is formed from a material that has superior heat transmission characteristics (for example, brass or the like). The inner space in the second pipe 102 forms an uncombusted gas flow passage R2 (second flow passage) which enables flow of the uncombusted gas G1 including combustible fuel. More specifically, in the small boiler B101 according to the present embodiment, the uncombusted gas flow passage R2 is configured from the inner space of the second pipe 102. An upper end portion of the second pipe 102 is connected to the uncombusted gas supply passage (not shown) that supplies uncombusted gas G1 to the uncombusted gas flow passage R2.

[0046] The uncombusted gas G1 may be a mixture gas of fuel with an oxidation agent. The fuel may be an oil fuel, natural gas or the like.

[0047] The first pipe 101 extends vertically and is disposed to concentrically surround the second pipe 102. A lower end 121 thereof is closed, and in the same manner

as the second pipe 102, it is formed from a material displaying superior heat transmission characteristics. A space sandwiched by the first pipe 101 and the second pipe 102 forms a combustion gas flow passage R1 (first flow passage) which enables combustion of uncombusted gas G1 and enables flow of the combustion gas G2 produced by the combustion of uncombusted gas G1. More specifically, in the small boiler B101 according to the present embodiment, the combustion gas flow passage R1 is configured from a space sandwiched by the second pipe 2 and the first pipe 101 that concentrically surrounds the second pipe 2. Furthermore a section near to the lower end of the combustion gas flow passage R1 (near to the nozzle hole 112) forms a combustion chamber K in which uncombusted gas G1 injected from the nozzle holes 112 is combusted. An ignition apparatus (not shown) is provided in the combustion chamber K.

[0048] The third pipe 103 extends vertically and is disposed to concentrically surround the first pipe 101. A lower end 131 thereof is closed, and it is preferred that the third pipe 3 is formed from a material displaying low heat transmission characteristics. A space sandwiched by the first pipe 101 and the third pipe 103 forms a water flow passage R3 (third flow passage) which enables flow of the water (liquid to be heated) W. More specifically, in the small boiler B101 according to the present embodiment, the water flow passage R3 is configured from a space sandwiched by the first pipe 101 and the third pipe 103 that concentrically surrounds the first pipe 101. Furthermore, a water supply portion (not shown) for supplying water to the water flow passage R3 is connected to a section near to the lower end of the water flow passage R3, and a regulated flow amount of water W is supplied to the water flow passage R3 by the water supply portion. Furthermore a discharge portion (not shown) for discharging steam produced by evaporation of water W in the water flow passage R3 is connected in proximity to an upper end of the water flow passage R3, and a regulated flow amount of steam is discharged from the water flow passage R3 to an external portion by the discharge portion.

[0049] In a small boiler B101 according to the present embodiment having the above configuration, firstly uncombusted gas G1 is supplied from the uncombusted gas supply apparatus that is connected to the second pipe 102 to the uncombusted gas flow passage R2. The uncombusted gas G1 injected from nozzle holes 112 formed in the second pipe 102 is ignited and combusted to thereby form a flame in the combustion chamber K. Then the combustion gas G2 produced by the combustion of the uncombusted gas G1 flows through the combustion gas flow passage R1 and is discharged.

[0050] When a flame is formed in the combustion chamber K, since high-temperature combustion gas G2 flows into the combustion gas flow passage R1 formed about the uncombusted gas flow passage R2, the uncombusted gas G1 flowing through the uncombusted gas flow passage R2 becomes heated. More specifically, the

heat amount of the combustion gas G2 is transmitted to the uncombusted gas G1 through the second pipe 102 that functions as a heat-exchanging partition to thereby heat the uncombusted gas G1.

[0051] The uncombusted gas G1 heated by heat exchange with the combustion gas G2 is ejected into an outer portion of the second pipe 102 through the nozzle holes 112 in a state of being heated to almost an ignition temperature. The uncombusted gas G1 ejected from the nozzle holes 112 is ignited by the flame formed in the combustion chamber K, and is combusted.

[0052] Since the nozzle holes 112 formed in the second pipe 102 are set to be smaller than the flame quenching distance of the uncombusted gas G1 in the combustion environment of the combustion chamber K, the flame does not propagate to the uncombusted gas flow passage R2. Consequently the flame is stabilized in the combustion chamber K, and thereby enables continuous combustion.

[0053] As described above, uncombusted gas G1 supplied to the combustion chamber K through the uncombusted gas flow passage R2 is heated by the combustion gas G2 flowing through the combustion gas flow passage R1 in a state in which combustion in the combustion chamber K is continuously executed. Therefore, a stable flame can be formed by a combustion chamber K which is extremely small in comparison to the combustion chamber in a conventional heating apparatus.

[0054] Water W in the water flow passage R3 is heated and evaporated by the combustion gas G2 in the combustion gas flow passage R1 and the flame in the combustion chamber K in a state in which a stable flame is formed in the combustion chamber K and combustion is continuously executed. More specifically, a heat amount of the flame and a heat amount of the combustion gas G2 are transmitted to the water W through the first pipe 101 that functions as a heat exchange partition, and therefore the water W is heated and evaporated. The steam produced by evaporation of the water W is discharged to an external portion of the small boiler B101 through the discharge portion (not shown).

[0055] According to the small boiler B101 of the present embodiment, a combustion gas flow passage R1 in which combustion gas G2 flows is formed about the uncombusted gas flow passage R2 which enables flow of the uncombusted gas G1. Consequently, the uncombusted gas G1 flowing in the uncombusted gas flow passage R2 is heated by the combustion gas G2 that flows in the combustion gas flow passage R1. Furthermore a stable flame is formed by injection of uncombusted gas G1 from the uncombusted gas flow passage R2 at a flow speed enabling maintenance of a flame through a nozzle holes 112 that are set to be smaller than the flame quenching distance. This stable flame is enabled even when coming into direct contact with the partition face (first pipe 101) making contact with the cold liquid. Furthermore the water flow passage R3 is formed about the combustion gas flow passage R1 which forms the stable

flame and water W is supplied to the water flow passage R3. As a result, the water W that flows in the third flow passage is heated by direct heating of the water flow passage R3 by the stable flame. Therefore in comparison to heating the water flow passage R3 only by combustion gas G2, the amount of heat can be efficiently transmitted to the water W. Consequently, the small boiler B101 of the present embodiment enables an improvement in energy efficiency.

[0056] According to the small boiler B101 of the present embodiment, since the uncombusted gas G1 flowing in the combusted gas flow passage R2 is heated by high-temperature combustion gas G2 flowing in the combustion gas flow passage R1, the heated uncombusted gas G1 is combusted by ejection from the uncombusted gas flow passage R2 at a flow speed enabling maintenance of a flame through a nozzle hole 112 that is set to be smaller than the flame quenching distance. The adoption of the above configuration enables sufficient heating of the uncombusted gas G1 by the high-temperature combustion gas G2, and therefore enables continuous stable combustion in a small combustion chamber K. Thus the combustion chamber can be made smaller thereby enabling downsizing of the apparatus.

[0057] Therefore according to the small boiler B101 of the present embodiment, further downsizing of the apparatus is enabled at the same time as improvement to energy efficiency.

30 Sixth Embodiment

[0058] Next, a sixth embodiment of the present invention will be described. In the description of the sixth embodiment, description of those sections which are the same as the fifth embodiment will be omitted or simplified.

[0059] FIG. 10 and FIG. 11 are schematic views of a small boiler B102 according to a fifth embodiment of the present invention. FIG. 10 is a horizontal sectional view and FIG. 11 is a perspective view. As shown in these views, the uncombusted gas flow passage R2 of the small boiler B102 according to the present embodiment is configured from an inner space in the second pipe 102 in the same manner as the small boiler B101 in the fifth embodiment. The water flow passage R3 is configured from the inner space of a plurality of fourth pipes 104 disposed at a distance from the second pipe 102 centering on the second pipe 102, and the combustion gas flow passage R1 is configured from a space surrounded by partitions 105 closing the second pipe 102 and the space between the pairs of fourth pipes 104 and fourth pipes 104.

[0060] As shown in Fig. 11, the height of the partition 105 is set to be low in comparison with the height of the second pipe 102 and the fourth pipe 104. As a result, at the upper portion of the small boiler B102, there is a space between the pairs of fourth pipes 104. Thus the space functions as a guide portion 106 for guiding the combustion gas G2 into a region on an outer side of the water flow passage R3 and opposite the combustion gas flow

passage R1.

[0061] In the same manner as the fifth embodiment, in the small boiler B102 according to the present embodiment as configured above, uncombusted gas G1 heated by heat exchange with the combustion gas G2 is ejected into the combustion gas flow passage R1 and combusted. When combustion gas G2 is newly produced, a portion of that combustion gas G2 is circulated to the rear side (the opposite side to the combustion gas passage R1) of the fourth pipe 104 through the guide portion 106. Thus, the entire periphery of the fourth pipe 104 can be heated by the combustion gas G2 and thereby enables more efficient heating of the water W. Therefore energy efficiency can be further improved.

Seventh Embodiment

[0062] Next, a seventh embodiment of the present invention will be described. In the description of the seventh embodiment, description of those sections which are the same as the fifth embodiment will be omitted or simplified.

[0063] FIG. 12 is a horizontal sectional view of the schematic configuration of a small boiler according to a seventh embodiment of the present invention. As shown in these views, the small boiler B103 according to the present embodiment includes a plurality of fins 110 that project towards the water flow passage R3 from an outer peripheral face of the first pipe 101. The fins 110 are integrally formed with the first pipe 101 and are formed from a material having superior heat transmission characteristics in the same manner as the first pipe 101.

[0064] According to the small boiler B103 in the present embodiment that has the above configuration, the fins 110 enable an increase in the heat exchanging surface area with water W flowing through the water flow passage R3 and the combustion gas G2 flowing through the combustion gas flow passage R1, and thereby enable more efficient heating of the water. Therefore energy efficiency can be further improved.

Eighth Embodiment

[0065] Next, an eighth embodiment of the present invention will be described. In the description of the eighth embodiment, description of those sections which are the same as the fifth embodiment will be omitted or simplified.

[0066] FIG. 13 is a horizontal sectional view of the schematic configuration of a small boiler B104 according to the present embodiment. As shown in the figure, the small boiler B104 according to the present embodiment is such that the first pipe 1 is configured in a star shape that is curved toward the combustion gas flow passage R1 and the water flow passage R3 at a fixed interval.

[0067] According to the small boiler B104 in the present embodiment that has the above configuration, the formation of the first pipe 101 into a star shape which is curved at a fixed interval enables an increase in the heat exchanging surface area with water W flowing

through the water flow passage R3 and the combustion gas G2 flowing through the combustion gas flow passage R1, and thereby enables more efficient heating of the water.

[0068] Although the preferred embodiments of the heat apparatus according to the present invention have been described above making reference to the attached figures, the present invention, of course, is not limited to the above embodiments. The shape or combination of each constitutive member shown in the embodiments above is merely exemplary, and various modifications based on design requirements are possible within a scope that does not depart from the spirit of the invention.

[0069] For example, in the above embodiments, a small boiler was described as an example of a heating apparatus. However the present invention is not limited in this regard, and may be applied to a boiling apparatus for heating water for the purpose of making hot water, or to an apparatus heating oil or gas. Furthermore the present invention may be applied to a large boiler, or to industrial product such as a fluidized-bed boiler using a heated powder material. Furthermore when the heating apparatus according to the present invention is applied to a recycling fluidized-bed boiler, the particle material may be transported using combustion gas.

[0070] In the first to the eighth embodiments above, the external shape and sectional shape of the first pipe 1 and 101, the second pipe 2 and 102, the third pipe 3 and 103, and the fourth pipe 4 and 104 are merely exemplary, and may be configured in an arbitrary manner.

[Industrial Applicability]

[0071] According to the present invention, a heating apparatus for heating a liquid to be heated enables stabilization of a flame in a combustion chamber and downsizing of the combustion chamber, in addition to improving energy efficiency.

Claims

1. A heating apparatus comprising a first flow passage in which uncombusted gas that contains a combustible fuel is injected from a nozzle hole that is smaller than the flame quenching distance at a flow speed to thereby enable flame maintenance is combusted, and thereby enables flow of combustion gas resulting from such combustion, and a second flow passage enabling flow of uncombusted gas supplied through the nozzle hole.
2. The heating apparatus according to claim 1, further comprising a third flow passage surrounded by the first flow passage and enabling flow of the liquid to be heated, and wherein the second flow passage is formed about the first flow passage.

3. The heating apparatus according to claim 2, wherein the third flow passage is configured from an inner space of a third pipe, the first flow passage is configured from a space sandwiched by the third pipe and the first pipe concentrically enclosing the third pipe, and the second flow passage is configured from a space sandwiched by the first pipe and the second pipe concentrically enclosing the first pipe. 5
4. The heating apparatus according to claim 3, wherein a plurality of fins is configured to project towards the first flow passage from an outer peripheral face of the third pipe. 10
5. The heating apparatus according to claim 3, wherein the third pipe is curved toward the first flow passage side and the second flow passage side at a predetermined interval. 15
6. The heating apparatus according to claim 3 comprising the second flow passage, the first flow passage formed about the second flow passage, and the third flow passage enables flow of the liquid to be heated and is formed about the first flow passage. 20
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7. The heating apparatus according to claim 6, wherein a guide portion guides the combustion gas from the first flow passage to a region opposite the first flow passage and being on an outer side of the third flow passage. 30
8. The heating apparatus according to claim 6 or claim 7, wherein the second flow passage is configured from an inner space in the second pipe, the first flow passage is configured from the space sandwiched by the second pipe and the first pipe that concentrically surrounds the second pipe, and the third flow passage is configured from the space sandwiched by the first pipe and the third pipe that concentrically surrounds the first pipe. 35
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9. The heating apparatus according to claim 6 or claim 7, wherein the second flow passage is configured from an inner space of the second pipe, the third flow passage is configured from the inner space of a plurality of fourth pipes disposed at a distance from the second pipe centering on the second pipe, and the first flow passage is configured from a space surrounded by the second pipe and the partitions closing the interval between the pairs of fourth pipes and fourth pipes. 45
50

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FIG. 1

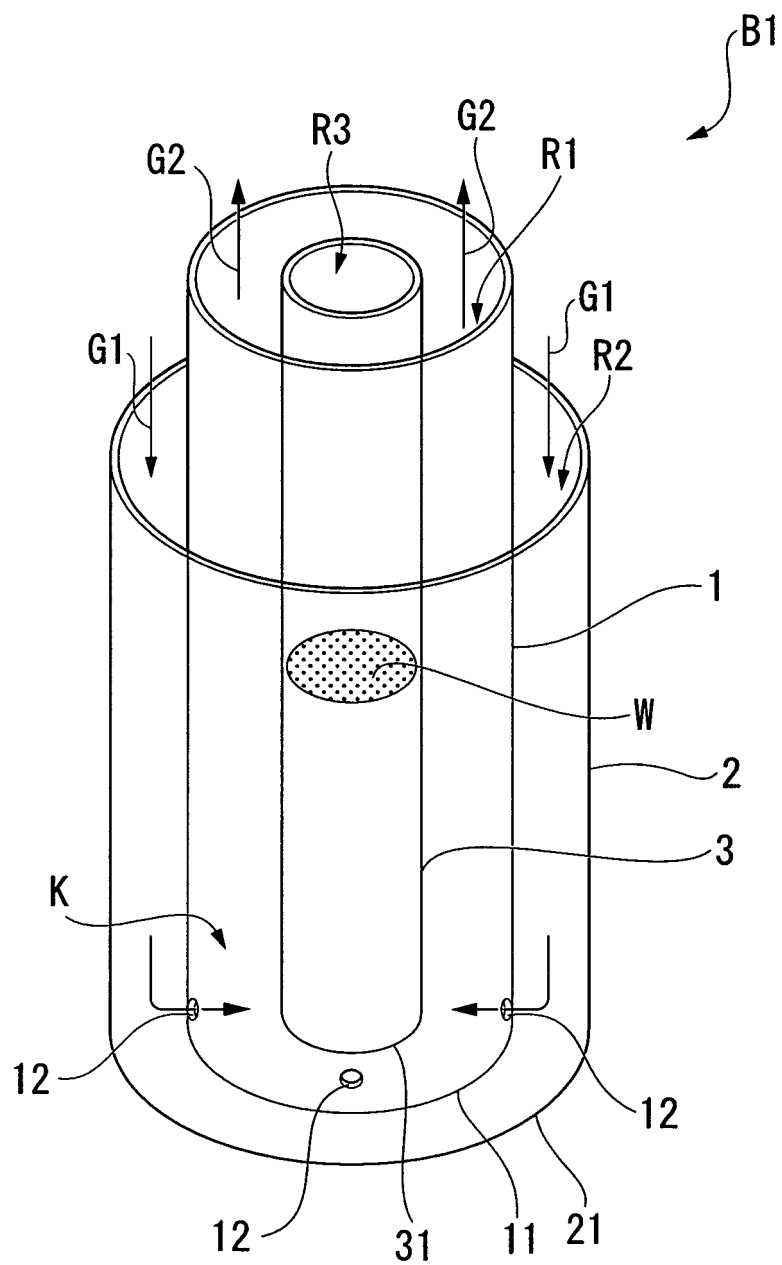


FIG. 2

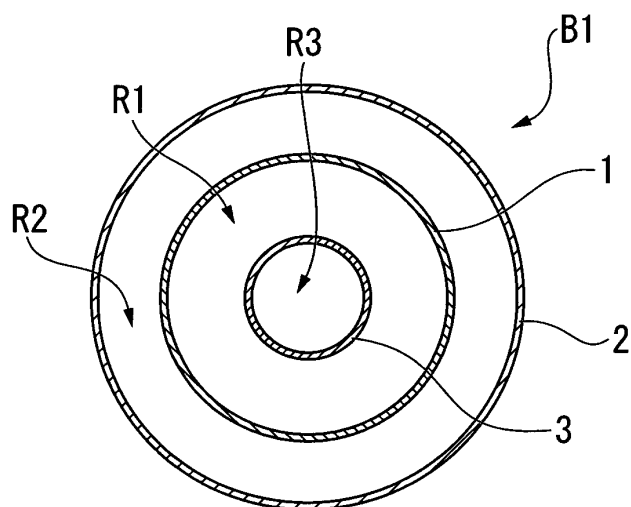


FIG. 3

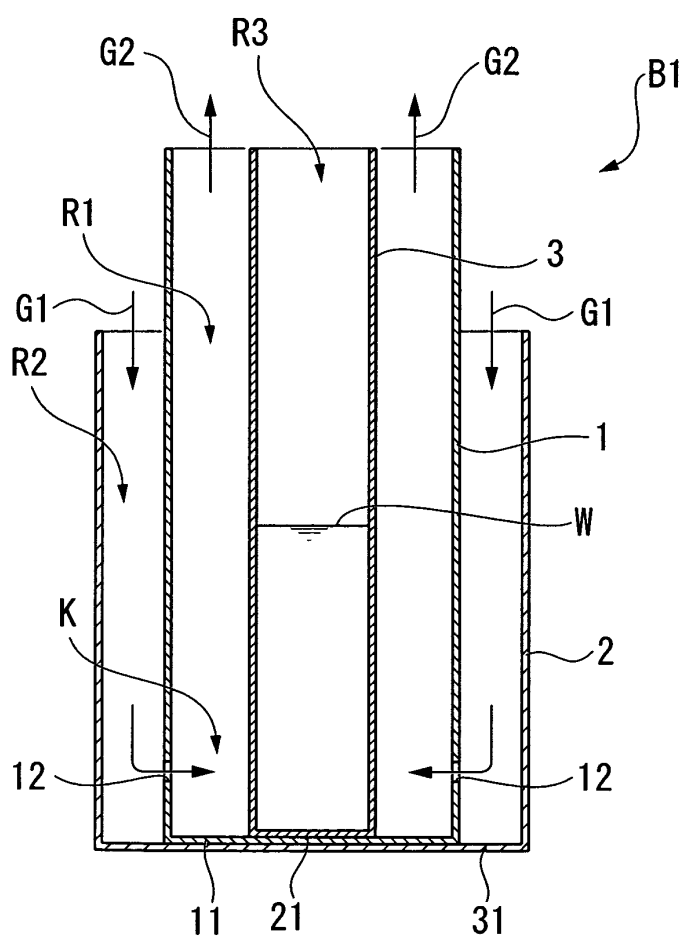


FIG. 4

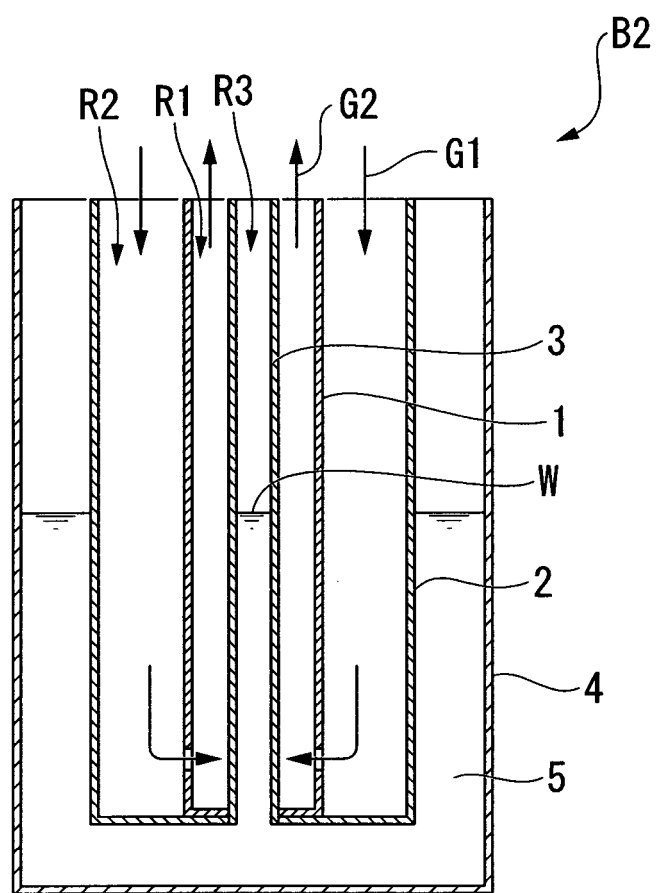


FIG. 5

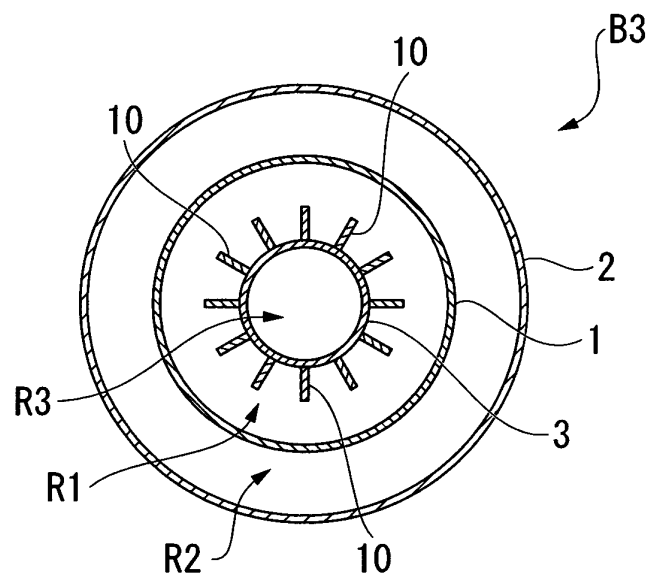


FIG. 6

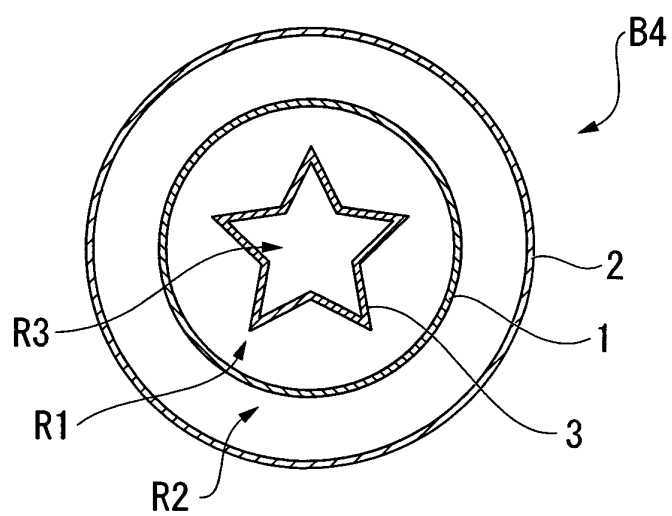


FIG. 7

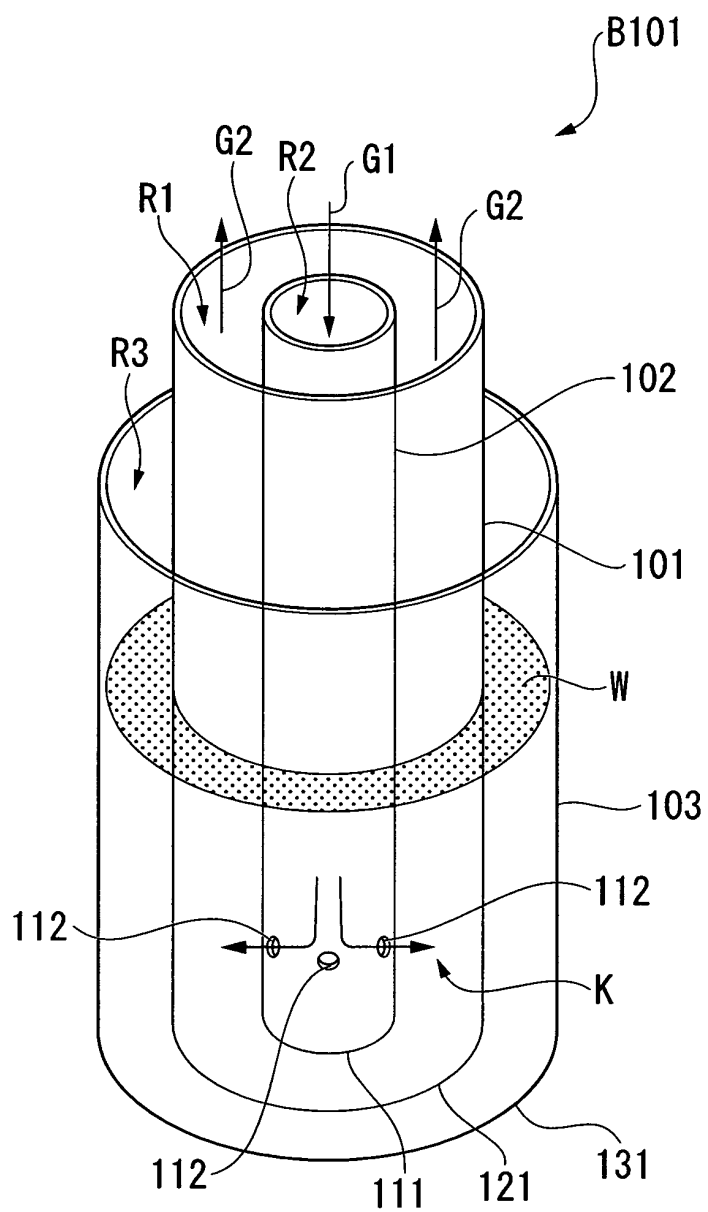


FIG. 8

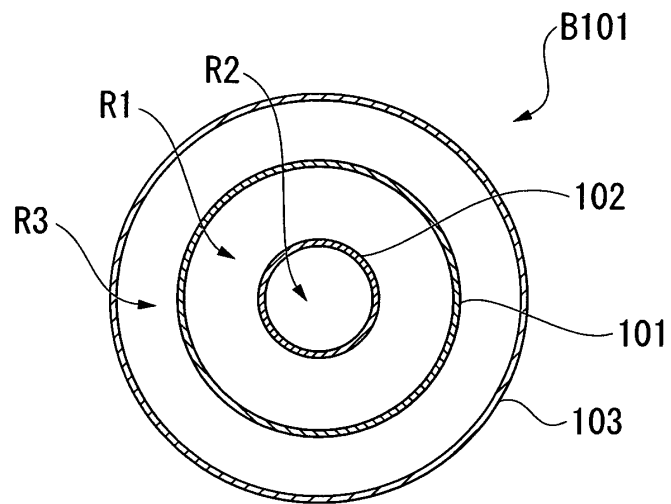


FIG. 9

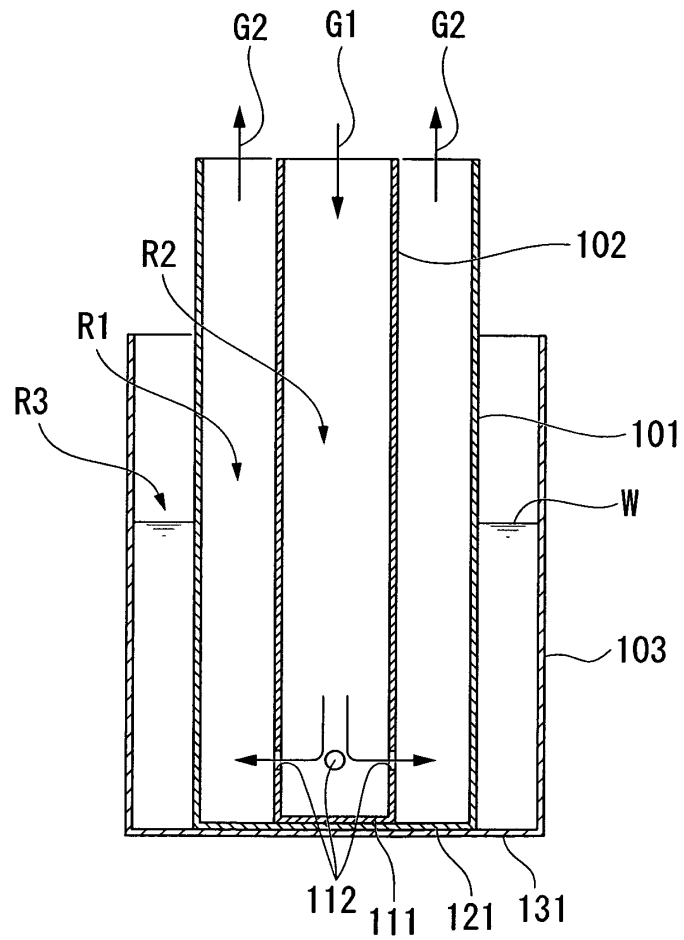


FIG. 10

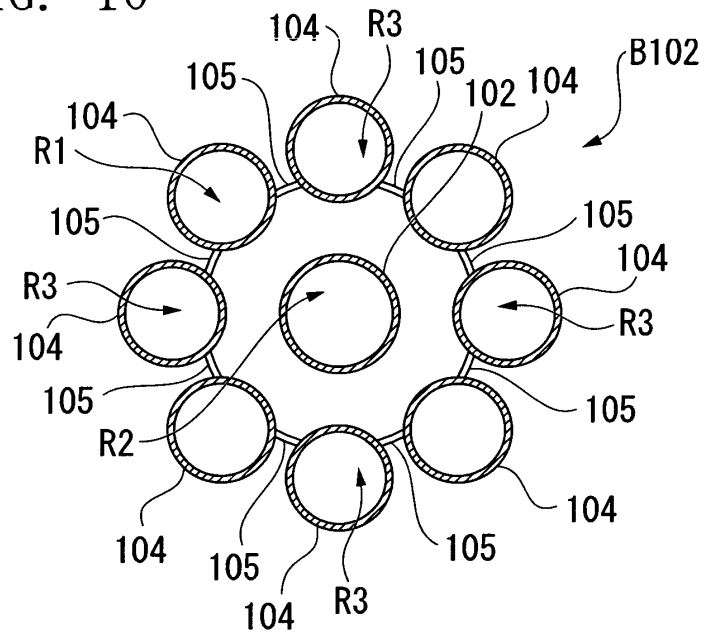


FIG. 11

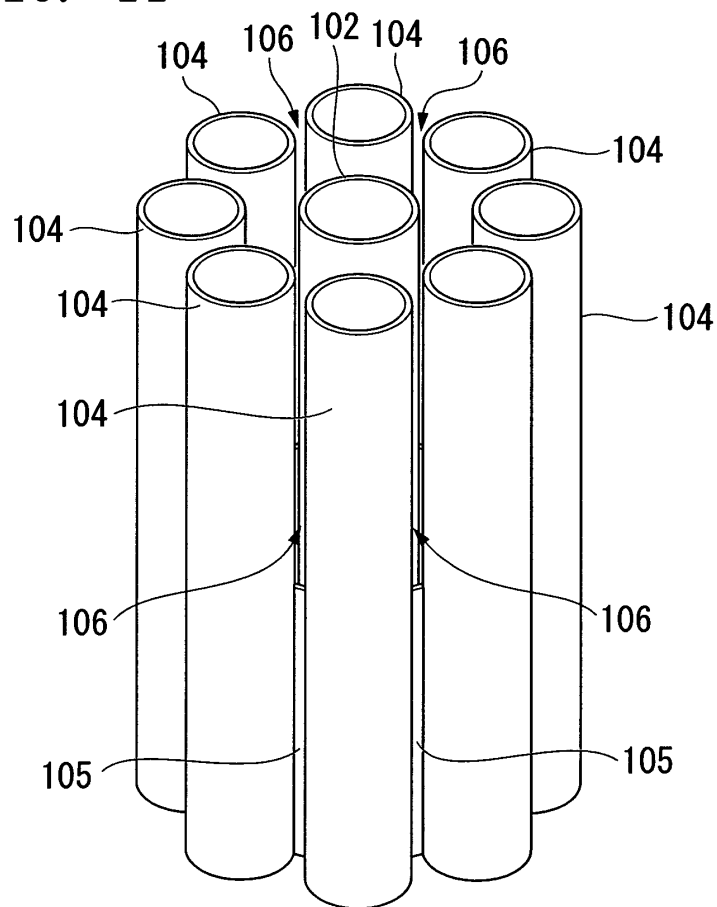


FIG. 12

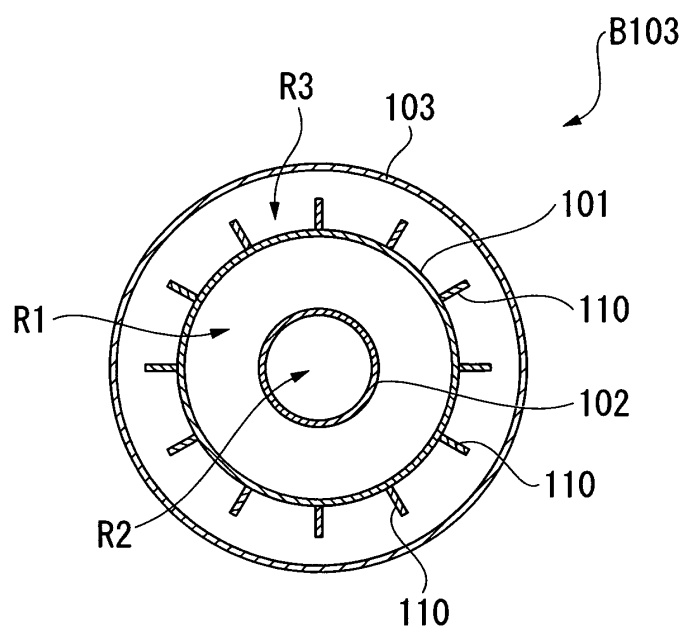
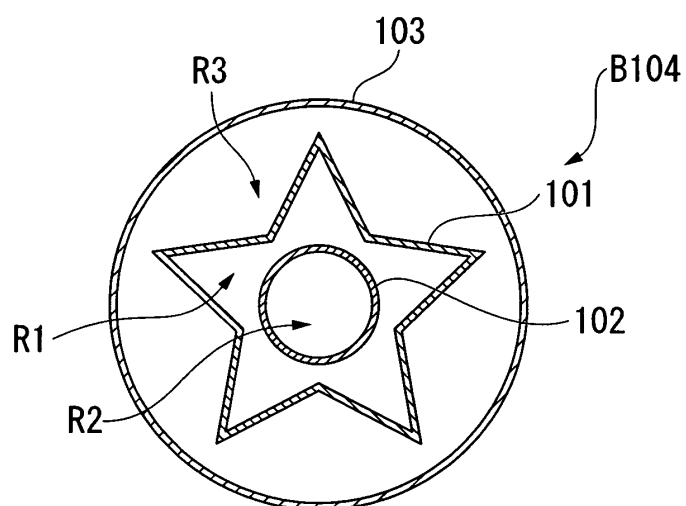


FIG. 13



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/054076

A. CLASSIFICATION OF SUBJECT MATTER F22B7/02 (2006.01) i		
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) F22B7/02		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009 Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009		
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 Y	JP 2000-28109 A (Osaka Gas Co., Ltd.), 25 January, 2000 (25.01.00), Par. Nos. [0008], [0009], [0027]; Figs. 1, 4 (Family: none)	1 2-9
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 31978/1977 (Laid-open No. 127001/1978) (Sunao Denki Kabushiki Kaisha), 09 October, 1978 (09.10.78), Fig. 1 (Family: none)	2-9
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 26 May, 2009 (26.05.09)		Date of mailing of the international search report 09 June, 2009 (09.06.09)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/054076

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 3046890 U (Siemens AG.), 07 January, 1998 (07.01.98), Fig. 3 & WO 96/7053 A & US 5979370 A1 & EP 778932 A & DE 4431185 A & DE 59502913 C & ES 2119461 T & CN 1155326 A	4
Y	JP 2007-163006 A (Samson Co., Ltd.), 28 June, 2007 (28.06.07), Fig. 2 (Family: none)	7, 9

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2008053901 A [0001]
- JP 2008053903 A [0001]
- JP 2007139358 A [0002]