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(54) **BURNER AND GAS WATER HEATER PROVIDED WITH SAME**

(57) A combustor and a gas water heater having the same are provided, wherein the combustor includes at least one combustion unit (1) comprising a combustor shell (11) and a rectifying device (14), the combustor shell (11) is provided with a rich combustion injection port (131), a lean combustion injection port (121), a first rich combustion flame port (118), a second rich combustion flame port (119) and a lean combustion opening (115), wherein a sectional area S1 of the rich combustion injection port (131) and a sectional area S2 of the lean combustion injection port (121) satisfy: $S1/S2=0.20\sim0.40$.

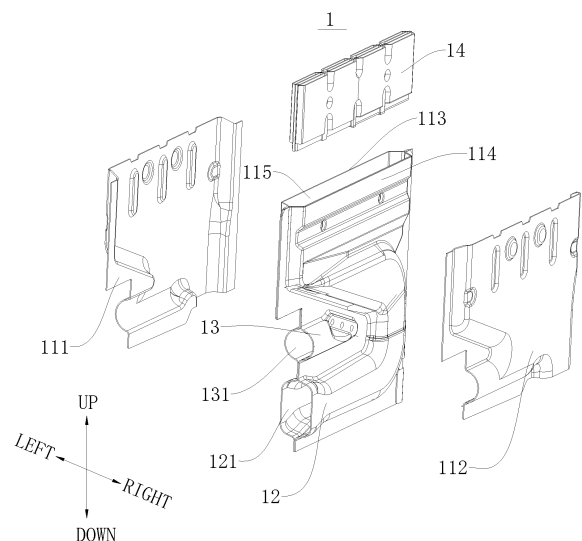


Fig. 5

Description

FIELD

[0001] The present disclosure relates to a technical field of household appliances, and more particularly to a combustor and a gas water heater having the same.

BACKGROUND

[0002] As ecological environment is increasingly deteriorating, human suffers more and more severe harm. People attach more and more attention to air pollution. All industries are responding to the national call to conduct energy conservation and emission reduction. With a rapid development of urban fuel gas, a gas water heater is becoming more and more popular with people as it is convenient and efficient. However, in existing gas water heaters, as combustion of the fuel gas will produce harmful gas inevitably and especially the content of nitrogen oxides in fume is high, which cause severe environmental pollution.

SUMMARY

[0003] Embodiments of the present disclosure seek to solve at least one of the problems existing in the related art to at least some extent. To this end, a combustor is provided by the present disclosure, the combustor may reduce emission of nitrogen oxides in fume and reduce environment pollution.

[0004] A gas water heater having the combustor is further provided by the present disclosure.

[0005] The combustor according to a first aspect of embodiments of the present disclosure includes at least one combustion unit, the combustion unit includes a combustor shell, in which the combustor shell has a first rich combustion cavity, a second rich combustion cavity and a lean combustion cavity therein, and the combustor shell thereon is provided with a rich combustion injection port in communication with the first rich combustion cavity and the second rich combustion cavity, a lean combustion injection port in communication with the lean combustion cavity, a first rich combustion flame port in communication with the first rich combustion cavity, a second rich combustion flame port in communication with the second rich combustion cavity and a lean combustion opening in communication with the lean combustion cavity; a rectifying device, disposed in the lean combustion opening and provided with a plurality of lean combustion flame ports in communication with the lean combustion cavity, in which the first rich combustion flame port and the second rich combustion flame port are located at two sides of the plurality of lean combustion flame ports respectively; in which, a sectional area S1 of the rich combustion injection port and a sectional area S2 of the lean combustion injection port satisfy: $S1/S2=0.20\sim0.40$.

[0006] In the combustor according to embodiments of

the present disclosure, the first rich combustion flame port and the second rich combustion flame port of the combustion unit are located at two sides of the plurality of lean combustion flame ports respectively, so as to form the stable flame structure having the lean combustion flame in the middle and the rich combustion flames at both sides, thereby reducing the flame temperature and controlling emission of the nitrogen oxides in the fume after the combustion. In which the sectional area S1 of the rich combustion injection port and the sectional area S2 of the lean combustion injection port satisfy: $S1/S2=0.20\sim0.40$, achieving a good mixture proportion of the air introduced by the rich combustion injection port to the fuel gas and a good mixture proportion of the air introduced by the lean combustion injection port to the fuel gas, so as further controlling the structural stability of the combustion flame and reducing the emission of nitrogen oxides.

[0007] In addition, the combustor according to embodiments of the present disclosure further includes the following additional technical features:

According to some embodiments of the present disclosure, a first blind passage and a second blind passage are defined between the rectifying device and two side walls of the lean combustion opening respectively, in which the first blind passage is located between the first rich combustion flame port and the plurality of lean combustion flame ports, and the second blind passage is located between the second rich combustion flame port and the plurality of lean combustion flame ports.

[0008] Optionally, a top surface of an outer side wall of the first blind passage is flush with a top surface of an outer side wall of the second blind passage and higher than a top surface of the rectifying device, a top surface of an outer side wall of the first rich combustion flame port is flush with a top surface of an outer side wall of the second rich combustion flame port and higher than the top surface of the outer side wall of the first blind passage and the top surface of the outer side wall of the second blind passage, a height difference between the top surface of the outer side wall of the first blind passage and the top surface of the rectifying device and a height difference between the top surface of the outer side wall of the second blind passage and the top surface of the rectifying device are denoted by H1, and a height difference between the top surface of the outer side wall of the first rich combustion flame port and the top surface of the rectifying device and a height difference between the top surface of the outer side wall of the second rich combustion flame port and the top surface of the rectifying device are denoted by H2, wherein $H2 \geq H1$.

[0009] Optionally, the maximum width of the first blind passage and the maximum width of the second blind passage are equal and denoted by W2, the maximum width of the first rich combustion flame port and the maximum width of the second rich combustion flame port are equal and denoted by W1, in which $W2 \geq W1$.

[0010] According to some embodiments of the present

disclosure, the maximum width of the lean combustion flame port is denoted by W_3 and a height of the rectifying device is denoted by H , in which, $W_3/H=0.03\sim 0.30$.

[0011] According to some embodiments of the present disclosure, a ratio of the amount of air to that of fuel gas in theory for complete combustion of fuel gas is denoted by Φ_S and a mixture ratio of the amount of air to that of fuel gas at the rich combustion injection port is denoted by Φ_R , wherein $\Phi_R/\Phi_S=0.5\sim 0.8$.

[0012] According to some embodiments of the present disclosure, the ratio of the amount of air to that of fuel gas in theory for complete combustion of fuel gas is denoted by Φ_S , a mixture ratio of the amount of air to that of fuel gas at the lean combustion injection port is denoted by Φ_L , wherein $\Phi_L/\Phi_S=1.5\sim 2.0$.

[0013] According to some embodiments of the present disclosure, the combustor shell comprises:

a first lean combustion shell portion and a second lean combustion shell portion, wherein the first lean combustion shell portion and the second lean combustion shell portion are connected together and define the lean combustion cavity and the lean combustion opening together, and the rectifying device is disposed between the first lean combustion shell portion and the second lean combustion shell portion and located at the lean combustion opening; and a first rich combustion shell portion and a second rich combustion shell portion, wherein the first rich combustion shell portion is connected to the first lean combustion shell portion and is located outside of the first lean combustion shell portion, the first rich combustion shell portion and the first lean combustion shell portion together define the first rich combustion cavity and the first rich combustion flame port, the second rich combustion shell portion is connected to the second lean combustion shell portion and located outside of the second lean combustion shell portion, the second rich combustion shell portion and the second lean combustion shell portion define the second rich combustion cavity and the second rich combustion flame port together.

[0014] Optionally, the combustor shell further includes a plurality of connecting slats, in which two ends of each connecting slat are connected to the first rich combustion shell portion and the second rich combustion shell portion respectively, and the plurality of connecting slats divide each of the first rich combustion flame port, the second rich combustion flame port and the lean combustion flame port into a plurality of segments.

[0015] Optionally, the combustor shell further includes a lean combustion injector, connected to the first lean combustion shell portion and the second lean combustion shell portion, in which the lean combustion injection port is disposed on the lean combustion injector; and a rich combustion injector, connected to the first rich combustion shell portion and the second rich combustion

shell portion and in communication with the first rich combustion cavity and the second rich combustion cavity, in which the rich combustion injector is located above the lean combustion injector and the rich combustion injection port is disposed on the rich combustion injector.

[0016] According to some embodiments of the present disclosure, the combustion unit further includes a rich combustion nozzle configured to provide the rich combustion injection port with the fuel gas and corresponding to the rich combustion injection port; and a lean combustion nozzle configured to provide the lean combustion injection port with the fuel gas and corresponding to the lean combustion injection port.

[0017] Optionally, a sectional area S_3 of a gas jet port of the rich combustion nozzle and a sectional area S_4 of a gas jet port of the lean combustion nozzle satisfy: $S_3/S_4=0.25\sim 0.65$.

[0018] According to some embodiments of the present disclosure, a plurality of combustion units are provided and arranged along a width direction of the combustion unit.

[0019] According to a second aspect of embodiments of the present disclosure, the gas water heater having the combustor of the above embodiments is provided.

[0020] As the combustor according to the above embodiments of the present disclosure has the above technical effects, hence the gas water heater according to embodiments of the present disclosure also has the above technical effects. That is to say, the gas water heater according to embodiments of the present disclosure is provided with the combustor according to the above embodiments, thereby the stability of flame structure may be improved, the temperature of the flame may be reduced and the emission of nitrogen oxides in fume of the gas water heater may be reduced.

[0021] Additional aspects and advantages of embodiments of present disclosure will be given in part in the following descriptions, become apparent in part from the following descriptions, or be learned from the practice of the embodiments of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1 is a schematic view of a combustion unit of a combustor according to embodiments of the present disclosure from a perspective;

Fig. 2 is a schematic view of a combustion unit of a combustor according to embodiments of the present disclosure from another perspective;

Fig. 3 is a cross sectional view along a line A-A shown in Fig. 2;

Fig. 4 is a top view of a combustion unit of a combustor according to embodiments of the present disclosure;

Fig. 5 is an exploded view of a combustion unit of a combustor according to embodiments of the present

disclosure;

Fig. 6 is a schematic view of a combustion unit of a combustor according to another embodiment of the present disclosure;

Fig. 7 is sectional view along a line B-B shown in Fig. 6;

Fig. 8 is an enlarged view of a portion C shown in Fig. 7.

Reference numerals:

[0023]

1: combustion unit;

11: combustor shell, 111: first rich combustion shell portion, 1111: first rich combustion cavity, 112: second rich combustion shell portion, 1121: second rich combustion cavity, 113: first lean combustion shell portion, 114: second lean combustion shell portion, 1141: lean combustion cavity, 115: lean combustion opening, 116: first blind passage, 117: second blind passage, 118: first rich combustion flame port, 119: second rich combustion flame port;

12: lean combustion injector, 121: lean combustion injection port;

13: rich combustion injector, 131: rich combustion injection port;

14: rectifying device, 141: lean combustion flame port;

15: rich combustion nozzle;

16: lean combustion nozzle;

17: connecting slat.

DETAILED DESCRIPTION

[0024] Reference will be made in detail to embodiments of the present disclosure. The embodiments described herein with reference to drawings are explanatory, illustrative, and used to generally understand the present disclosure. The embodiments shall not be construed to limit the present disclosure.

[0025] In the specification, it is to be understood that terms such as "central," "longitudinal," "lateral," "length," "width," "thickness," "upper," "lower," "front," "rear," "left," "right," "vertical," "horizontal," "top," "bottom," "inner," "outer," "clockwise," and "counterclockwise" should be construed to refer to the orientation as then described or as shown in the drawings under discussion. These relative terms are for convenience of description and do not require that the present invention be constructed or operated in a particular orientation.

[0026] In addition, terms such as "first" and "second" are used herein for purposes of description and are not intended to indicate or imply relative importance or significance or to imply the number of indicated technical features. Thus, the feature defined with "first" and "second" may comprise one or more of this feature. In the description of the present invention, "a plurality of" means

two or more than two, unless specified otherwise.

[0027] In the present invention, unless specified or limited otherwise, the terms "mounted," "connected," "coupled," "fixed" and the like are used broadly, and may be, for example, fixed connections, detachable connections, or integral connections; may also be mechanical or electrical connections; may also be direct connections or indirect connections via intervening structures; may also be inner communications of two elements, which can be understood by those skilled in the art according to specific situations.

[0028] A combustor according to embodiments of the present disclosure will be described with reference to drawings in the following.

[0029] Referring to Figs. 1-8, the combustor according to embodiments of the present disclosure may include at least one combustion unit 1, each combustion unit 1 includes a combustor shell 11 and a rectifying device 14.

[0030] The combustor shell 11 defines a first rich combustion cavity 1111, a second rich combustion cavity 1121 and a lean combustion cavity 1141 therein. The combustor shell 11 is provided with a rich combustion injection port 131 in communication with the first rich combustion cavity 1111 and the second rich combustion cavity 1121, a lean combustion injection port 121 in communication with the lean combustion cavity 1141, a first rich combustion flame port 118 in communication with the first rich combustion cavity 1111, a second rich combustion flame port 119 in communication with the second rich combustion cavity 1121 and a lean combustion opening 115 in communication with the lean combustion cavity 1141 thereon. The rectifying device 14 is disposed in the lean combustion opening 115 and the rectifying device 14 is provided with a plurality of lean combustion flame ports 141 in communication with the lean combustion cavity 1141, the first rich combustion flame port 118 and the second rich combustion flame port 119 are located at both sides of the plurality of lean combustion flame ports 141 respectively, in which, a sectional area S1 of the rich combustion injection port 131 and a sectional area S2 of the lean combustion injection port 121 satisfy: $S1/S2=0.20\sim0.40$.

[0031] In other words, the combustor 100 may include one or more combustion units 1, for example, the combustor 100 may include a plurality of combustion units 1, the plurality of combustion units 1 are arranged side by side and are arrayed along a width direction of the combustion unit 1. The width direction refers to a left-right direction shown in Fig. 5 and Fig. 7. Each combustion unit 1 includes the combustor shell 11 and the rectifying device 14, the rectifying device 14 is disposed in the combustor shell 11.

[0032] The combustor shell 11 defines the first rich combustion cavity 1111, the second rich combustion cavity 1121 and the lean combustion cavity 1141 therein. The combustor shell 11 is provided with the rich combustion injection port 131, the lean combustion injection port 121, the first rich combustion flame port 118, the second

rich combustion flame port 119 and the lean combustion opening 115 thereon. The rich combustion injection port 131 is configured to introduce air for the rich combustion and the lean combustion injection port 121 is configured to introduce air for the lean combustion. Referring to Fig. 1- Fig. 3 and Fig. 6, the rich combustion injection port 131 is located above the lean combustion injection port 121.

[0033] The rich combustion injection port 131 is in communication with the first rich combustion cavity 1111 and the second rich combustion cavity 1121, the first rich combustion cavity 1111 is in communication with the first rich combustion flame port 118, the second rich combustion cavity 1121 is in communication with the second rich combustion flame port 119, the lean combustion injection port 121 is in communication with the lean combustion cavity 1141, as well the lean combustion cavity 1141 is in communication with the lean combustion opening 115.

[0034] In this way, the air is introduced in from the rich combustion injection port 131 and is mixed with fuel gas to form rich combustion gas, the rich combustion gas after being mixed may enter the first rich combustion cavity 1111 and the second rich combustion cavity 1121, then be led to the first rich combustion flame port 118 and the second rich combustion flame port 119 respectively. The air introduced in by the lean combustion injection port 121 is mixed with the fuel gas to form lean combustion gas which flows to the lean combustion cavity 1141 then. Referring to Figs. 5-8, the rectifying device 14 is disposed in the lean combustion opening 115, the rectifying device 14 is provided with the plurality of lean combustion flame ports 141, the lean combustion cavity 1141 is in communication with the plurality of lean combustion flame ports 141, and the lean combustion gas may be led to the plurality of lean combustion flame ports 141.

[0035] Referring to Fig. 4, Fig. 5, Fig. 7 and Fig. 8, the first rich combustion flame port 118 and the second lean combustion flame port 141 are disposed at both sides of the lean combustion opening 115 respectively, the plurality of lean combustion flame ports 141 are located between the first rich combustion flame port 118 and the second rich combustion flame port 119. In this way, a structure having a middle configured to be the lean combustion flame ports 141 and two sides configured to be the rich combustion ports may be formed at the top of each combustion unit 1. That is to say, the combustion unit 1 may allow a flame structure having a lean flame in the middle and rich flames at the two sides during the combustion, so that stability of the flame may be improved, and temperature of the combustion flame may be reduced, controlling emission of nitrogen oxides in fume.

[0036] The sectional area of the rich combustion injection port 131 is denoted by S1, the sectional area of the lean combustion injection port 121 is denoted by S2, S1 and S2 may satisfy: $S1/S2=0.20\sim0.40$, that is to say, the sectional area S1 of the rich combustion injection port

131 is 0.20-0.40 percent of the sectional area S2 of the lean combustion injection port 121. Thus, the amount of air introduced by the rich combustion injection port 131 and the lean combustion injection port 121 may be controlled, moreover the mixture proportion of the air introduced by the rich combustion injection port 131 to the fuel gas and the mixture proportion of the air introduced by the lean combustion injection port 121 to the fuel gas are good, so as to control the primary air ratio of the rich combustion or the lean combustion. The primary air ratio refers to a ratio of the proportion of the amount of air to that of fuel gas when the fuel gas is mixed with the air in advance, to the proportion of the amount of air to that of fuel gas in theory for a complete combustion of fuel gas. Thereby the stability of the flame structure may be improved effectively, so as to further reduce the emission of nitrogen oxides in fume and reduce the environment pollution.

[0037] Thus, in the combustor according to embodiments of the present disclosure, the first rich combustion flame port 118 and the second rich combustion flame port 119 of the combustion unit 1 are located at two sides of the plurality of lean combustion flame ports 141 respectively, so as to form the stable flame structure having the lean combustion flame in the middle and the rich combustion flames at both sides, thereby reducing the flame temperature and controlling emission of the nitrogen oxides in the fume after the combustion. In which the sectional area S1 of the rich combustion injection port 131 and the sectional area S2 of the lean combustion injection port 121 satisfy: $S1/S2=0.20\sim0.40$, achieving good mixture proportion of the air introduced by the rich combustion injection port 131 to the fuel gas and good mixture proportion of the air introduced by the lean combustion injection port 121 to the fuel gas, so as further controlling the structural stability of the combustion flame and reducing the emission of nitrogen oxides.

[0038] In some embodiments of the present disclosure, a first blind passage 116 and a second blind passage 117 may be defined between the rectifying device 14 and two side walls of the lean combustion opening 115 respectively, the first blind passage 116 is located between the first rich combustion flame port 118 and the plurality of lean combustion flame ports 141, and the second blind passage 117 is located between the second rich combustion flame port 119 and the plurality of lean combustion flame ports 141. As shown in Fig. 7 and Fig. 8, the rectifying device 14 is disposed in the lean combustion opening 115 and is connected to the two side walls of the lean combustion opening 115. The rectifying device 14 defines the first blind passage 116 and the second blind passage 117 with the two side walls of the lean combustion opening 115 respectively, neither the first blind passage 116 nor the second blind passage 117 is in communication with the lean combustion cavity 1141. The first rich combustion flame port 118 may be spaced apart from the plurality of lean combustion flame ports 141 through the first blind passage 116, and the

second rich combustion flame port 119 may be spaced apart from the plurality of lean combustion flame ports 141 through the second blind passage 117, thereby the flame structure being more stable, the emission of nitrogen oxides in fume being effectively controlled.

[0039] Optionally, as shown in Fig. 8, a top surface of an outer side wall of the first blind passage 116 is flush with a top surface of an outer side wall of the second blind passage 117 and is higher than a top surface of the rectifying device 14. A top surface of an outer side wall of the first rich combustion flame port 118 is flush with that of the second rich combustion flame port 119 and is higher than the top surface of the outer side wall of the first blind passage 116 and the top surface of the outer side wall of the second blind passage 117. A height difference between the top surface of the outer side wall of the first blind passage 116 and the top surface of the rectifying device 14 and a height difference between the top surface of the outer side wall of the second blind passage 117 and the top surface of the rectifying device 14 are denoted by H1, and a height difference between the top surface of the outer side wall of the first rich combustion flame port 118 and the top surface of the rectifying device 14 and a height difference between the top surface of the outer side wall of the second rich combustion flame port 119 and the top surface of the rectifying device 14 are denoted by H2, in which $H2 \geq H1$, thereby facilitating control of stability of the air flow at the rich combustion flame ports and the lean combustion flame port 141, further improving the stability of the combustion flame.

[0040] Preferably, H2 and H1 may satisfy $H2 > H1$, thereby further ensuring the stability of the flames at the lean combustion flame port 141 and the rich combustion flame ports, reducing the emission of nitrogen oxides in fume.

[0041] Advantageously, as shown in Fig. 8, the maximum width of the first blind passage 116 and the maximum width of the second blind passage 117 may be equal and denoted by W2, the maximum width of the first rich combustion flame port 118 and the maximum width of the second rich combustion flame port 119 are equal and denoted by W1, in which $W2 \geq W1$, thereby further ensuring the structural stability of the combustion flames. Specifically, with reference to Fig. 7 and Fig. 8, the maximum width of the first rich combustion flame port 118 refers to the maximum width of a narrow side of the first rich combustion flame port 118 along a left-right direction, the maximum width of the second rich combustion flame port 119 refers to the maximum width of a narrow side of the second rich combustion flame port 119 along the left-right direction. The maximum width of the first blind passage 116 and the maximum width of the second blind passage 117 refer to the maximum widths of narrow sides of the first blind passage 116 and the second blind passage 117 along the left-right direction respectively. The maximum widths of narrow sides of the first blind passage 116 and the second blind passage 117 are equal and configured to be W2, the maximum widths of narrow sides

of the first rich combustion flame port 118 and the second rich combustion flame port 119 are equal and configured to be W1, the maximum widths W2 of narrow sides of the first blind passage 116 and the second blind passage 117 are larger than or equal to the maximum widths W1 of narrow sides of the first rich combustion flame port 118 and the second rich combustion flame port 119.

[0042] In some embodiments of the present disclosure, the maximum width of the lean combustion flame port 141 may be denoted by W3, a height of the rectifying device 14 may be denoted by H, in which $W3/H = 0.03 \sim 0.30$. Specifically, as shown in Fig. 4 and Fig. 5, the rectifying device 14 may include a plurality of rectifying plates. The plurality of rectifying plates define a plurality of finedraw-type passages therebetween. The plurality of lean combustion flame ports 141 are formed at a top of each finedraw-type passage. In which, the maximum width W3 of the lean combustion flame port 141 refers to the maximum width of a narrow side of a top opening of each finedraw-type passage along the left-right direction, a height H of the rectifying device 14 refers to the height of each finedraw-type passage, preferably, $W3/H = 0.05 \sim 0.20$. Thereby the structure stability of the rich combustion flames and the lean combustion flames may be further ensured.

[0043] In some embodiments of the present disclosure, a ratio of the amount of air to that of the fuel gas in theory for complete combustion of fuel gas may be denoted by Φ_S , a mixture ratio of the amount of air to that of the fuel gas at the rich combustion injection port 131 may be denoted by Φ_R , in which, $\Phi_R/\Phi_S = 0.5 \sim 0.8$. Φ_R/Φ_S refers to a primary air ratio of the rich combustion. By designing a port area ratio of the rich combustion injection port 131 to the lean combustion injection port 121, the primary air ratios of the rich combustion and the lean combustion may be adjusted, so that the fuel gas and the air are fully mixed and have a good combustion ratio, so as to form the stable flame structure and reduce the emission of nitrogen oxides in fume.

[0044] In some embodiments of the present disclosure, the ratio of the amount of air to that of the fuel gas in theory for complete combustion of fuel gas may be denoted by Φ_S , a mixture ratio of the amount of air to that of the fuel gas at the lean combustion injection port 121 may be denoted by Φ_L , in which, $\Phi_L/\Phi_S = 1.5 \sim 2.0$. Φ_L/Φ_S refers to a primary air ratio of the lean combustion. By designing a port area ratio of the rich combustion injection port 131 to the lean combustion injection port 121, the primary air ratios of the rich combustion and the lean combustion may be adjusted, so that the fuel gas and the air are fully mixed and have a good combustion ratio, so as to form the stable flame structure and reduce the emission of nitrogen oxides in fume.

[0045] In some embodiments of the present disclosure, as shown in Fig. 5, Fig. 7 and Fig. 8, the combustor shell 11 may include a first lean combustion shell portion 113, a second lean combustion shell portion 114, a first rich combustion shell portion 111 and a second rich com-

bustion shell portion 112. The first lean combustion shell portion 113 and the second lean combustion shell portion 114 are connected together and define the lean combustion cavity 1141 and the lean combustion opening 115. The rectifying device 14 is disposed between the first lean combustion shell portion 113 and the second lean combustion shell portion 114 and located at the lean combustion opening 115.

[0046] The first rich combustion shell portion 111 is connected to the first lean combustion shell portion 113 and is located outside of the first lean combustion shell portion 113. The first rich combustion shell portion 111 and the first lean combustion shell portion 113 define the first rich combustion cavity 1111 and the first rich combustion flame port 118 together. The second rich combustion shell portion 112 is connected to the second lean combustion shell portion 114 and located outside of the second lean combustion shell portion 114. The second rich combustion shell portion 112 and the second lean combustion shell portion 114 define the second rich combustion cavity 1121 and the second rich combustion flame port 119 together.

[0047] As shown in Fig. 7 and Fig. 8, the first rich combustion flame port 118 and the second rich combustion flame port 119 are located at two sides of the lean combustion opening 115 respectively. The rectifying device 14 is disposed at the lean combustion opening 115 and is provided with the plurality of lean combustion flame ports 141. The plurality of lean combustion flame ports 141 are disposed at the top of the rectifying device 14. The first rich combustion flame port 118 and the second rich combustion flame port 119 are located at two sides of the plurality of lean combustion flame ports 141 respectively, thereby facilitating formation of the stable flame structure having the lean combustion flame in the middle and the rich combustion flames at both sides, so as improving the stability of the flames, reducing the temperature of flames and reducing the emission of nitrogen oxides.

[0048] Advantageously, the combustor shell 11 may further include a plurality of connecting slats 17. Two ends of each connecting slat 17 are connected to the first rich combustion shell portion 111 and the second rich combustion shell portion 112 respectively. The plurality of connecting slats 17 divide each of the first rich combustion flame port 118, the second rich combustion flame port 119 and the lean combustion flame port 141 into a plurality of segments. Thus, the lean combustion flame and the rich combustion flame may be divided into a plurality of segments, thereby increasing a heat dissipation area of the flame and reducing the flame temperature.

[0049] Optionally, the combustor shell 11 may further include a lean combustion injector 12 and a rich combustion injector 13. The lean combustion injector 12 is connected to the first lean combustion shell portion 113 and the second lean combustion shell portion 114. The lean combustion injection port 121 is disposed on the lean combustor 100. The rich combustion injector 13 is con-

nected to the first rich combustion shell portion 111 and the second rich combustion shell portion 112 and is in communication with the first rich combustion cavity 1111 and the second rich combustion cavity 1121. The rich combustion injector 13 is located above the lean combustion injector 12, and the rich combustion injection port 131 is disposed on the rich combustion injector 13. Thus, the fuel gas and the introduced air may be led to the first rich combustion cavity 1111 and the second rich combustion cavity 1121 through the rich combustion injector 13, the fuel gas and the air are mixed in the first rich combustion cavity 1111 and the second rich combustion cavity 1121, and the mixed gas is led to the first rich combustion flame port 118 and the second rich combustion flame port 119. At the same time, the fuel gas and the introduced air may be led to the lean combustion cavity 1141 through the lean combustion injector 12, the fuel gas and the air may be mixed in the lean combustion cavity 1141 and the mixed gas and air may be led to the lean combustion flame port 141.

[0050] In some embodiments of the present disclosure, the combustion unit 1 may further include a rich combustion nozzle 15 and a lean combustion nozzle 16. The rich combustion nozzle 15 may be configured to provide the rich combustion injection port 131 with the fuel gas and the lean combustion nozzle 16 may be configured to provide the lean combustion injection port 121 with the fuel gas. The rich combustion nozzle 15 is in communication with the rich combustion injector 13 port and the lean combustion nozzle 16 is in communication with the lean combustion injection port 121. Thus, the fuel gas may be injected into the rich combustion injection port 131 through the rich combustion nozzle 15. The fuel gas is mixed with the air introduced by the rich combustion injector 13 and is led to the first rich combustion cavity 1111 and the second rich combustion cavity 1121. The fuel gas may be injected into the lean combustion injection port 121 through the lean combustion nozzle 16. The fuel gas is mixed with the air introduced by the lean combustion injector 12 and is led to the lean combustion cavity 1141.

[0051] Optionally, a sectional area S3 of a gas jet port of the rich combustion nozzle 15 and a sectional area S4 of a gas jet port of the lean combustion nozzle 16 could satisfy: $S3/S4=0.25\sim0.65$. That is to say, the sectional area of the gas jet port of the rich combustion nozzle 15 is 0.25-0.65 percent of the sectional area of the gas jet port of the lean combustion nozzle 16. Thus, by designing the ratio of the sectional area of the gas jet port of the rich combustion nozzle 15 to that of the lean combustion nozzle 16, the ratio of the amount of fuel gas to that of the air for the rich combustion and the lean combustion may be controlled, so that the amount of air introduced by the lean combustion injection port 121 and the amount of fuel gas injected by the lean combustion nozzle 16, as well as the amount of air introduced by the rich combustion injection port 131 and the amount of fuel gas injected by the rich combustion nozzle 15 could have a good ratio,

thereby the rich combustion and the lean combustion being more sufficient, and the emission of nitrogen oxides being reduced.

[0052] Optionally, the combustor may further include a primary air adjusting plate, the primary air adjusting plate is disposed in front of the rich combustion injection port 131 and the lean combustion injection port 121 so as to adjust an amount of injection air. Thus, the amount of air introduced in the rich combustion injection port 131 and the lean combustion injection port 121 may be adjusted through the primary air adjusting plate, thereby a proportion of the amount of air to the fuel gas at the rich combustion injection port 131 and the proportion of the amount of air to the fuel gas at the lean combustion injection port 121 being further controlled.

[0053] Furthermore, the combustor may further include a secondary air adjusting plate, the secondary air adjusting plate is disposed below the combustion unit 1, and the primary air adjusting plate extends downwardly and defines a pressure balancing chamber between the primary air adjusting plate and the secondary air adjusting plate. Specifically, the primary air adjusting plate is disposed in front of the rich combustion injection port 131 and the lean combustion injection port 121 to adjust the amount of injection air, the secondary air adjusting plate is disposed below the combustion unit 1 to adjust the air amount in a combustion chamber, a lower end of the primary air adjusting plate extends downwardly and defines the pressure balancing chamber between the primary air adjusting plate and the secondary air adjusting plate. In this way, air flow produced by an air blower of the combustor flows to the rich combustion injection port 131 and the lean combustion injection port 121 through the pressure balancing chamber 21, so that primary air entering the rich combustion injection port 131 and the lean combustion injection port 121 is more evenly, so as to improve the combustion effect.

[0054] A specific embodiment of the combustor according to embodiments of the present disclosure will be described in detail with reference to drawings in the following. It should be noted that, the following description is just explanatory and could not be construed to limit the present disclosure.

[0055] As shown in Figs. 1-8, the combustor according to embodiments of the present disclosure may include the plurality of combustion units 1, the primary air adjusting plate and the secondary air adjusting plate, in which the plurality of combustion units 1 are arranged side by side along the width direction of the combustion unit 1.

[0056] Specifically, each combustion unit 1 includes the combustor shell 11, the rectifying device 14, the rich combustion injector 13, the lean combustion injector 12, the rich combustion nozzle 15 and the lean combustion nozzle 16. As shown in Fig. 5, Fig. 7 and Fig. 8, the combustor shell 11 includes the first lean combustion shell portion 113, the second lean combustion shell portion 114, the first rich combustion shell portion 111 and the second rich combustion shell portion 112. The first lean

combustion shell portion 113 and the second lean combustion shell portion 114 are connected together and define the lean combustion cavity 1141 and the lean combustion opening 115. The rectifying device 14 is disposed between the first lean combustion shell portion 113 and the second lean combustion shell portion 114 and located at the lean combustion opening 115.

[0057] The first rich combustion shell portion 111 is connected to the first lean combustion shell portion 113 and is located outside of the first lean combustion shell portion 113. The first rich combustion shell portion 111 and the first lean combustion shell portion 113 define the first rich combustion cavity 1111 and the first rich combustion flame port 118 together. The second rich combustion shell portion 112 is connected to the second lean combustion shell portion 114 and located outside of the second lean combustion shell portion 114. The second rich combustion shell portion 112 and the second lean combustion shell portion 114 define the second rich combustion cavity 1121 and the second rich combustion flame port 119 together.

[0058] The first rich combustion flame port 118 and the second rich combustion flame port 119 are located at two sides of the lean combustion opening 115 respectively. The rectifying device 14 is disposed at the lean combustion opening 115 and is provided with the plurality of lean combustion flame ports 141. The plurality of lean combustion flame ports 141 are disposed at the top of the rectifying device 14. The first rich combustion flame port 118 and the second rich combustion flame port 119 are located at two sides of the plurality of lean combustion flame ports 141 respectively, thereby facilitating formation of the stable flame structure having the lean combustion flame in the middle and the rich combustion flames at both sides, so as improving the stability of the flames, reducing the temperature of flames and reducing the emission of nitrogen oxides.

[0059] The lean combustion injector 12 is connected to the first lean combustion shell portion 113 and the second lean combustion shell portion 114. The lean combustion injection port 121 is disposed on the lean combustor 100. The rich combustion injector 13 is connected to the first rich combustion shell portion 111 and the second rich combustion shell portion 112 and is in communication with the first rich combustion cavity 1111 and the second rich combustion cavity 1121. The rich combustion injector 13 is located above the lean combustion injector 12, and the rich combustion injection port 131 is disposed on the rich combustion injector 13. Thus, the fuel gas and the introduced air may be led to the first rich combustion cavity 1111 and the second rich combustion cavity 1121 through the rich combustion injector 13, the fuel gas and the air are mixed and led to the first rich combustion flame port 118 and the second rich combustion flame port 119. At the same time, the fuel gas and the introduced air may be led to the lean combustion cavity 1141 through the lean combustion injector 12, the fuel gas and the air may be mixed led to the lean com-

bustion flame port 141.

[0060] The rich combustion nozzle 15 may be configured to provide the rich combustion injection port 131 with the fuel gas and the lean combustion nozzle 16 may be configured to provide the lean combustion injection port 121 with the fuel gas. The rich combustion nozzle 15 is in communication with the rich combustion injector 13 port. The lean combustion nozzle 16 is in communication with the lean combustion injection port 121. Thus, the fuel gas may be injected into the rich combustion injection port 131 through the rich combustion nozzle 15. The fuel gas is mixed with the air introduced by the rich combustion injector 13 and is led to the first rich combustion cavity 1111 and the second rich combustion cavity 1121. The fuel gas may be injected into the lean combustion injection port 121 through the lean combustion nozzle 16. The fuel gas is mixed with the air introduced by the lean combustion injector 12 and is led to the lean combustion cavity 1141.

[0061] The sectional area S1 of the rich combustion injection port 131 and the sectional area S2 of the lean combustion injection port 121 satisfy: $S1/S2=0.20\sim0.40$. The sectional area S3 of the gas jet port of the rich combustion nozzle 15 and the sectional area S4 of the gas jet port of the lean combustion nozzle 16 could satisfy: $S3/S4=0.25\sim0.65$. Thus, the ratio of the amount of air to that of fuel gas at the rich combustion injection port 131 and the ratio of the amount of air to that of fuel gas at the lean combustion injection port 121 may be controlled, and then the primary air ratio of the rich combustion and the primary air ratio of the lean combustion may be further controlled.

[0062] The ratio of the amount of air to that of fuel gas in theory for a complete combustion of fuel gas may be denoted by Φ_S , the mixture ratio of the amount of air to that of fuel gas at the rich combustion injection port 131 may be denoted by Φ_R , and the mixture ratio of the amount of air to that of fuel gas at the lean combustion injection port 121 may be denoted by Φ_L . The primary air ratio of the rich combustion is configured to be Φ_R/Φ_S and satisfies: $\Phi_R/\Phi_S=0.5\sim0.8$, the primary air ratio of the lean combustion is configured to be Φ_L/Φ_S and satisfies: $\Phi_L/\Phi_S=1.5\sim2.0$, so that the fuel gas and the air are mixed fully and have a good combustion proportion, so as forming the stable flame structure and reducing the emission of nitrogen oxides in fume.

[0063] As shown in Fig. 7 and Fig. 8, the first blind passage 116 and the second blind passage 117 may be defined between the rectifying device 14 and two side walls of the lean combustion opening 115 respectively, the first blind passage 116 is located between the first rich combustion flame port 118 and the plurality of lean combustion flame ports 141, and the second blind passage 117 is located between the second rich combustion flame port 119 and the plurality of lean combustion flame ports 141.

[0064] The top surface of the outer side wall of the first blind passage 116 is flush with the top surface of the

outer side wall of the second blind passage 117 and is higher than the top surface of the rectifying device 14. The top surface of the outer side wall of the first rich combustion flame port 118 is flush with the top surface of the outer side wall of the second rich combustion flame port 119 and is higher than the top surface of the outer side wall of the first blind passage 116 and the top surface of the outer side wall of the second blind passage 117. The height difference between the top surface of the outer side wall of the first blind passage 116 and the top surface of the rectifying device 14 and the height difference between the top surface of the outer side wall of the second blind passage 117 and the top surface of the rectifying device 14 are denoted by H1, and the height difference between the top surface of the outer side wall of the first rich combustion flame port 118 and the top surface of the rectifying device 14 and the height difference between the top surface of the outer side wall of the second rich combustion flame port 119 and the top surface of the rectifying device 14 are denoted by H2, the maximum width of the first blind passage 116 and the maximum width of the second blind passage 117 are equal and may be denoted by W2, the maximum width of the first rich combustion flame port 118 and the maximum width of the second rich combustion flame port 119 are equal and may be denoted by W1, in which $H2\geq H1$, $W2\geq W1$, thereby facilitating control of stability of the air flow at the rich combustion flame ports and the lean combustion flame port 141, further improving the stability of the combustion flame.

[0065] The maximum width of the lean combustion flame port 141 may be denoted by W3, and the height of the rectifying device 14 may be denoted by H, in which, $W3/H=0.03\sim0.30$, and preferably, $W3/H=0.05\sim0.20$, thereby the structural stability of the rich combustion flame and the lean combustion flame may be further ensured.

[0066] The primary air adjusting plate may be disposed in front of the rich combustion injection port 131 and the lean combustion injection port 121 of each combustion unit 1, so as to adjust the amount of injection air. Thus, the amount of air introduced from the rich combustion injection port 131 and the lean combustion injection port 121 of each the combustion unit 1 may be adjusted through the primary air adjusting plate, thereby the proportion of the amount of air to that of fuel gas at the rich combustion injection port 131 and the proportion of the amount of air to that of fuel gas at the lean combustion injection port 121 being further controlled.

[0067] The secondary air adjusting plate is disposed below the combustion unit 1 to adjust the amount of air in the combustion chamber, the primary air adjusting plate extends downwardly and defines a pressure balancing chamber between the primary air adjusting plate and the secondary air adjusting plate. The air flow produced by the air blower of the gas water heater flows to the rich combustion injection port 131 and the lean combustion injection port 121 through the pressure balancing

chamber, so that primary air entering the rich combustion injection port 131 and the lean combustion injection port 121 is more evenly, so as to improve the combustion effect.

[0068] Thus, in the combustor according to embodiments of the present disclosure, the first rich combustion flame port 118 and the second rich combustion flame port 119 of the combustion unit 1 are located at two sides of the plurality of lean combustion flames 141, so as to form the stable flame structure having the lean combustion flame in the middle and the rich combustion flame at the both sides, reducing the flame temperature and controlling emission of the nitrogen oxides in the fume after the combustion. Moreover the sectional area S1 of the rich combustion injection port 131 and the sectional area S2 of the lean combustion injection port 121 of the combustor satisfy: $S1/S2=0.20\sim0.40$, and the sectional area S3 of the gas jet port of the rich combustion nozzle 15 and the sectional area S4 of the gas jet port of the lean combustion nozzle 16 satisfy: $S3/S4=0.25\sim0.65$. The structure of the combustor shell 11 and the primary air ratio of the rich combustion and the lean combustion are defined, thereby achieving a good proportion of the air introduced by the rich combustion injection port 131 and the lean combustion injection port 121 to the fuel gas, further controlling the structural stability of the combustion flame and reducing the emission of nitrogen oxides.

[0069] In addition, a gas water heater having the combustor according to the above embodiments is further provided by the present disclosure.

[0070] As the combustor according to the above embodiments of the present disclosure has the above technical effects, hence the gas water heater according to embodiments of the present disclosure also has the above technical effects. That is to say, the gas water heater according to embodiments of the present disclosure is provided with the combustor according to the above embodiments, thereby the stability of flame structure may be improved, the temperature of the flame may be reduced and the emission of nitrogen oxides in fume of the gas water heater may be reduced.

[0071] In the present invention, unless specified or limited otherwise, a structure in which a first feature is "on" or "below" a second feature may include an embodiment in which the first feature is in direct contact with the second feature, and may also include an embodiment in which the first feature and the second feature are not in direct contact with each other, but are contacted via an additional feature formed therebetween. Furthermore, a first feature "on," "above," or "on top of" a second feature may include an embodiment in which the first feature is right or obliquely "on," "above," or "on top of" the second feature, or just means that the first feature is at a height higher than that of the second feature; while a first feature "below," "under," or "on bottom of" a second feature may include an embodiment in which the first feature is right or obliquely "below," "under," or "on bottom of" the sec-

ond feature, or just means that the first feature is at a height lower than that of the second feature.

[0072] Reference throughout this specification to "an embodiment," "some embodiments," "one embodiment," "another example," "an example," "a specific example," or "some examples," means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. Thus, the appearances of the phrases such as "in some embodiments," "in one embodiment," "in an embodiment," "in another example," "in an example," "in a specific example," or "in some examples," in various places throughout this specification are not necessarily referring to the same embodiment or example of the present disclosure. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples.

[0073] Although explanatory embodiments have been shown and described, it would be appreciated by those skilled in the art that the above embodiments cannot be construed to limit the present disclosure, and changes, alternatives, and modifications can be made in the embodiments without departing from spirit, principles and scope of the present disclosure.

Claims

1. A combustor comprising at least one combustion unit, the combustion unit comprising:

a combustor shell, wherein the combustor shell defines a first rich combustion cavity, a second rich combustion cavity and a lean combustion cavity therein, and the combustor shell is provided with a rich combustion injection port in communication with the first rich combustion cavity and the second rich combustion cavity, a lean combustion injection port in communication with the lean combustion cavity, a first rich combustion flame port in communication with the first rich combustion cavity, a second rich combustion flame port in communication with the second rich combustion cavity and a lean combustion opening in communication with the lean combustion cavity thereon; and

a rectifying device, disposed in the lean combustion opening and provided with a plurality of lean combustion flame ports in communication with the lean combustion cavity, wherein the first rich combustion flame port and the second rich combustion flame port are located at two sides of the plurality of lean combustion flame ports respectively;

wherein a sectional area S1 of the rich combustion injection port and a sectional area S2 of the

lean combustion injection port satisfy:
 $S1/S2=0.20\sim0.40$.

2. The combustor according to claim 1, wherein a first blind passage and a second blind passage are defined between the rectifying device and two side walls of the lean combustion opening respectively, wherein the first blind passage is located between the first rich combustion flame port and the plurality of lean combustion flame ports, and the second blind passage is located between the second rich combustion flame port and the plurality of lean combustion flame ports.
3. The combustor according to claim 2, wherein a top surface of an outer side wall of the first blind passage is flush with a top surface of an outer side wall of the second blind passage and higher than a top surface of the rectifying device, a top surface of an outer side wall of the first rich combustion flame port is flush with a top surface of an outer side wall of the second rich combustion flame port and higher than the top surface of the outer side wall of the first blind passage and the top surface of the outer side wall of the second blind passage, a height difference between the top surface of the outer side wall of the first blind passage and the top surface of the rectifying device and a height difference between the top surface of the outer side wall of the second blind passage and the top surface of the rectifying device are denoted by $H1$, and a height difference between the top surface of the outer side wall of the first rich combustion flame port and the top surface of the rectifying device and a height difference between the top surface of the outer side wall of the second rich combustion flame port and the top surface of the rectifying device are denoted by $H2$, wherein $H2 \geq H1$.
4. The combustor according to claim 2, wherein the maximum width of the first blind passage and the maximum width of the second blind passage are equal and denoted by $W2$, and the maximum width of the first rich combustion flame port and the maximum width of the second rich combustion flame port are equal and denoted by $W1$, wherein $W2 \geq W1$.
5. The combustor according to claim 1, wherein the maximum width of the lean combustion flame port is denoted by $W3$ and a height of the rectifying device is denoted by H , wherein $W3/H=0.03\sim0.30$.
6. The combustor according to claim 1, wherein a ratio of the amount of air to that of fuel gas in theory for complete combustion of fuel gas is denoted by Φ_S and a mixture ratio of the amount of air to that of fuel gas at the rich combustion injection port is denoted by Φ_R , wherein $\Phi_R/\Phi_S=0.5\sim0.8$.

7. The combustor according to claim 1, wherein the ratio of the amount of air to that of fuel gas in theory for complete combustion of fuel gas is denoted by Φ_S , a mixture ratio of the amount of air to that of fuel gas at the lean combustion injection port is denoted by Φ_L , wherein $\Phi_L/\Phi_S=1.5\sim2.0$.

8. The combustor according to any one of claims 1-7, wherein the combustor shell comprises:

a first lean combustion shell portion and a second lean combustion shell portion, wherein the first lean combustion shell portion and the second lean combustion shell portion are connected together and define the lean combustion cavity and the lean combustion opening, and the rectifying device is disposed between the first lean combustion shell portion and the second lean combustion shell portion and located at the lean combustion opening; and

a first rich combustion shell portion and a second rich combustion shell portion, wherein the first rich combustion shell portion is connected to the first lean combustion shell portion and located outside of the first lean combustion shell portion, the first rich combustion shell portion and the first lean combustion shell portion define the first rich combustion cavity and the first rich combustion flame port together, the second rich combustion shell portion is connected to the second lean combustion shell portion and located outside of the second lean combustion shell portion, the second rich combustion shell portion and the second lean combustion shell portion define the second rich combustion cavity and the second rich combustion flame port together.

9. The combustor according to claim 8, wherein the combustor shell further comprises:

a plurality of connecting slats, wherein two ends of each connecting slat are connected to the first rich combustion shell portion and the second rich combustion shell portion respectively, and the plurality of connecting slats divide each of the first rich combustion flame port, the second rich combustion flame port and the lean combustion flame port into a plurality of segments.

10. The combustor according to claim 8, wherein the combustor shell further comprises:

a lean combustion injector, connected to the first lean combustion shell portion and the second lean combustion shell portion, wherein the lean combustion injection port is disposed on the lean combustion injector; and

a rich combustion injector, connected to the first rich combustion shell portion and the second

rich combustion shell portion and in communication with the first rich combustion cavity and the second rich combustion cavity, wherein the rich combustion injector is located above the lean combustion injector and the rich combustion injection port is disposed on the rich combustion injector. 5

11. The combustor according to any one of claims 1-7, wherein the combustion unit further comprises: 10

a rich combustion nozzle configured to provide the rich combustion injection port with the fuel gas and corresponding to the rich combustion injection port; and 15
a lean combustion nozzle configured to provide the lean combustion injection port with the fuel gas and corresponding to the lean combustion injection port. 20

12. The combustor according to claim 11, wherein a sectional area S3 of a gas jet port of the rich combustion nozzle and a sectional area S4 of a gas jet port of the lean combustion nozzle satisfy: $S3/S4=0.25\sim0.65$. 25

13. The combustor according to any one of claims 1-7, wherein a plurality of combustion units are provided and arranged along a width direction of the combustion unit. 30

14. A gas water heater comprising the combustor according to any one of claims 1-13. 35

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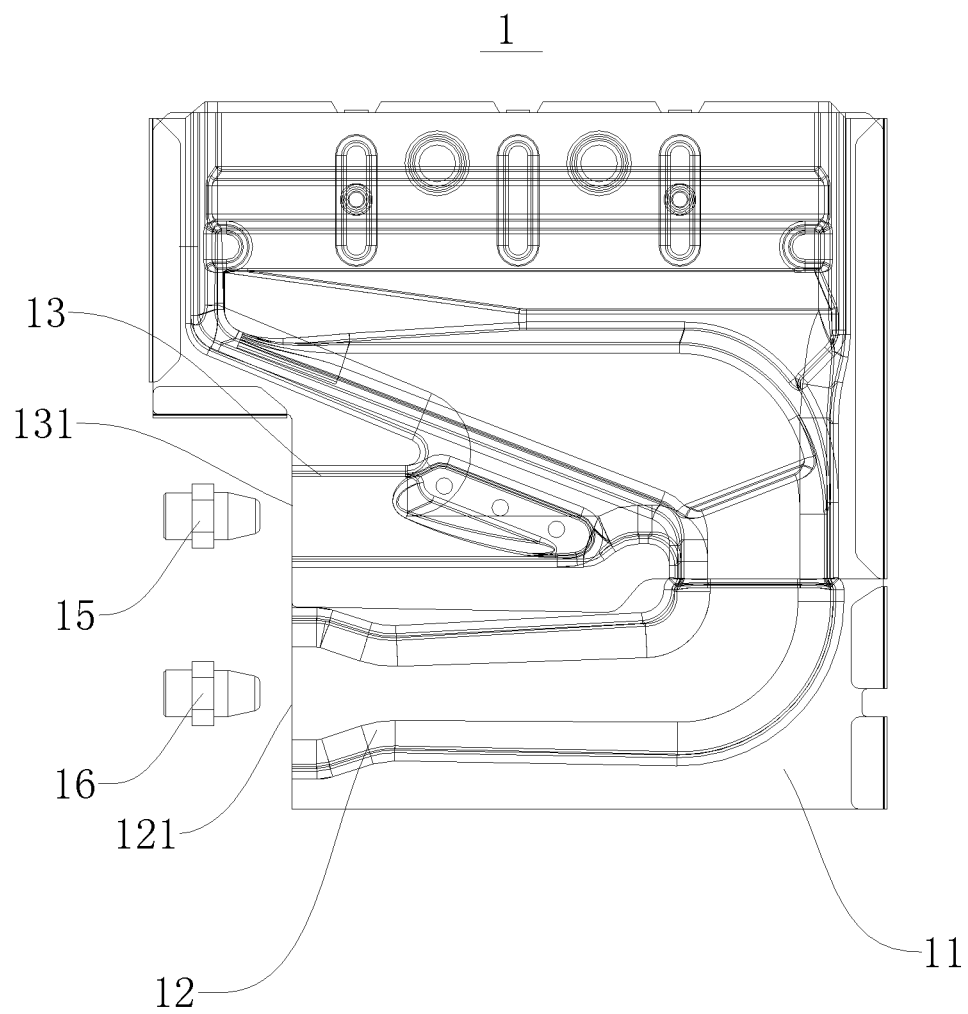


Fig. 1

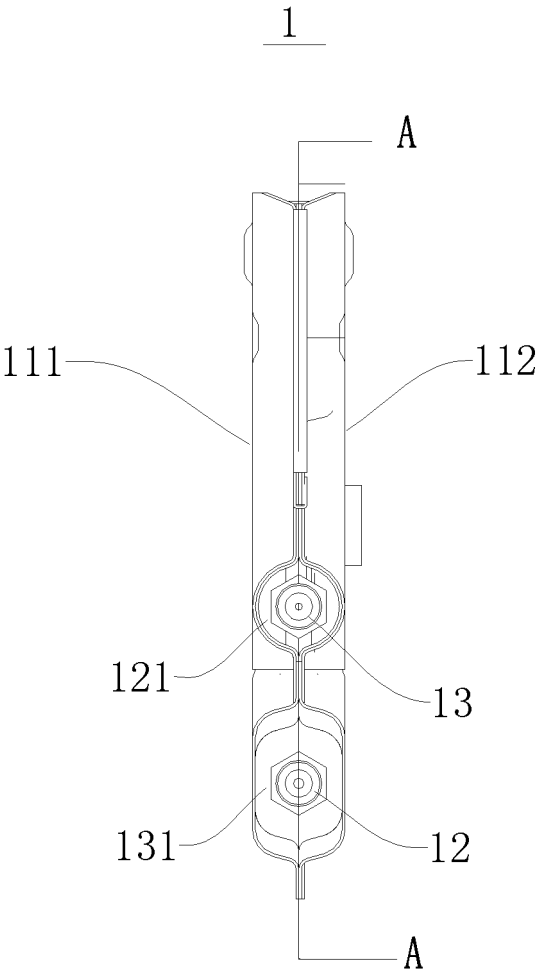


Fig. 2

A-A

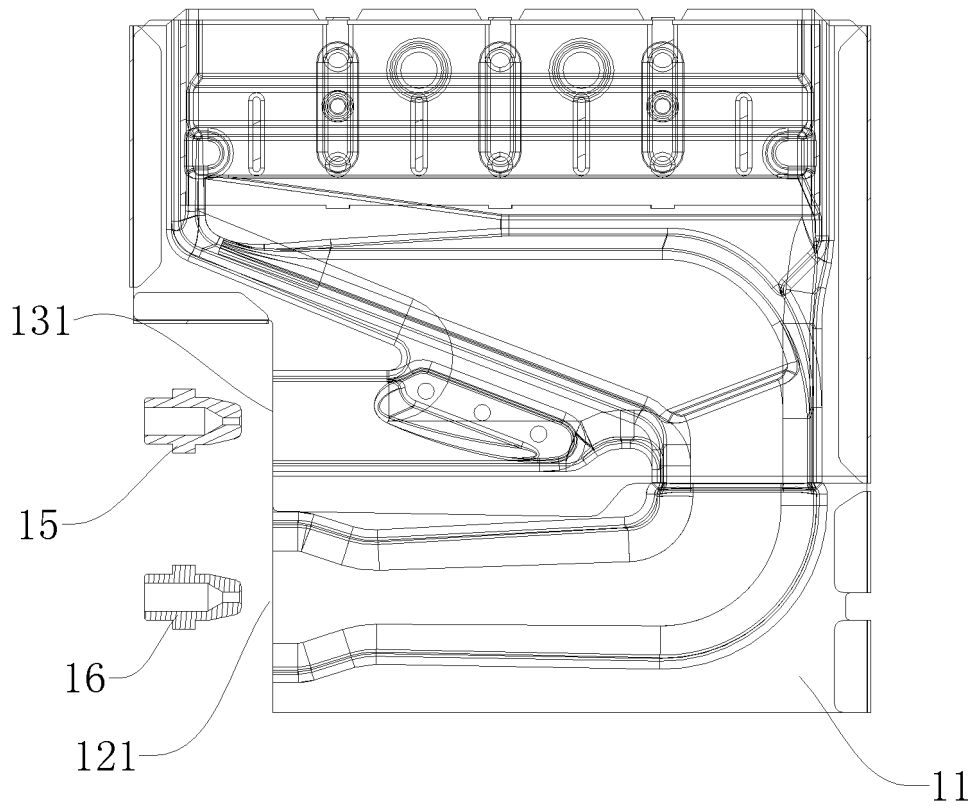


Fig. 3

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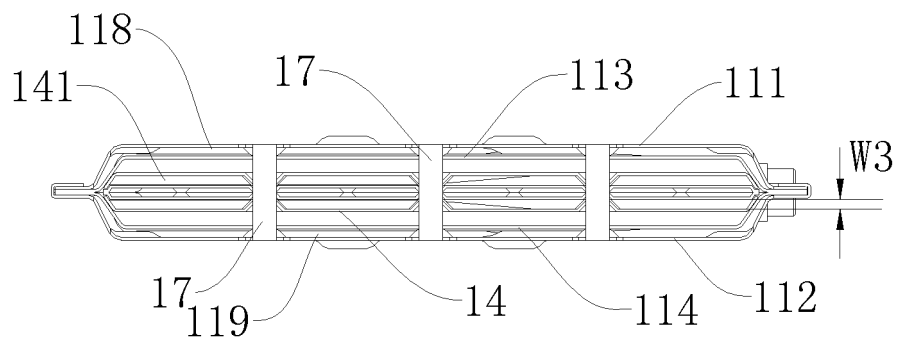


Fig. 4

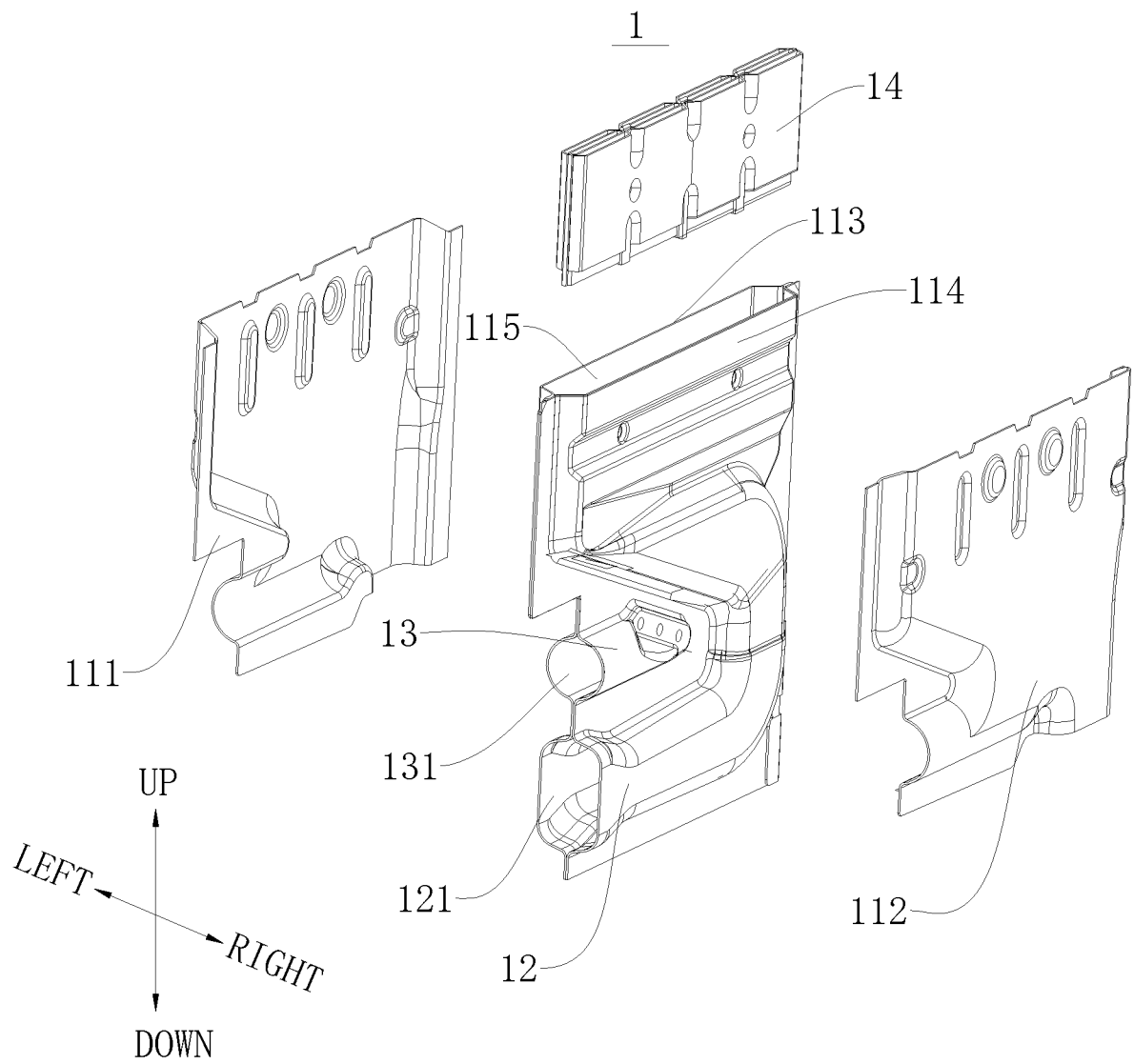


Fig. 5

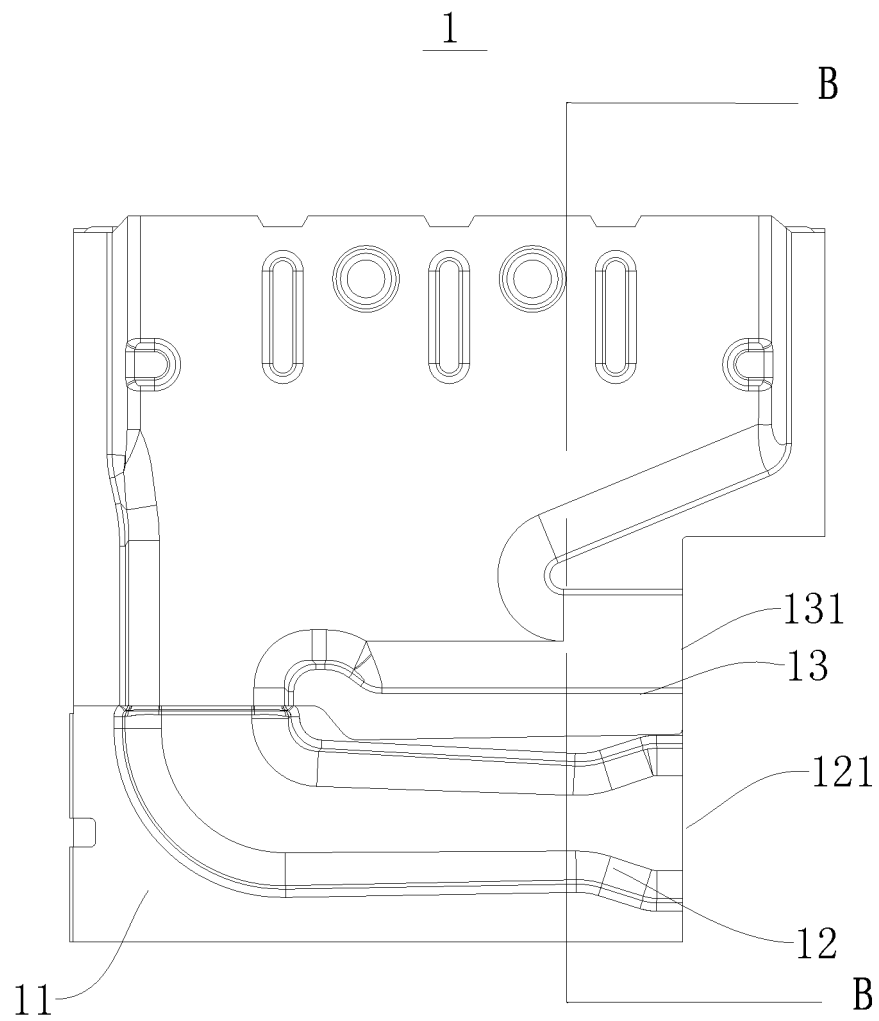


Fig. 6

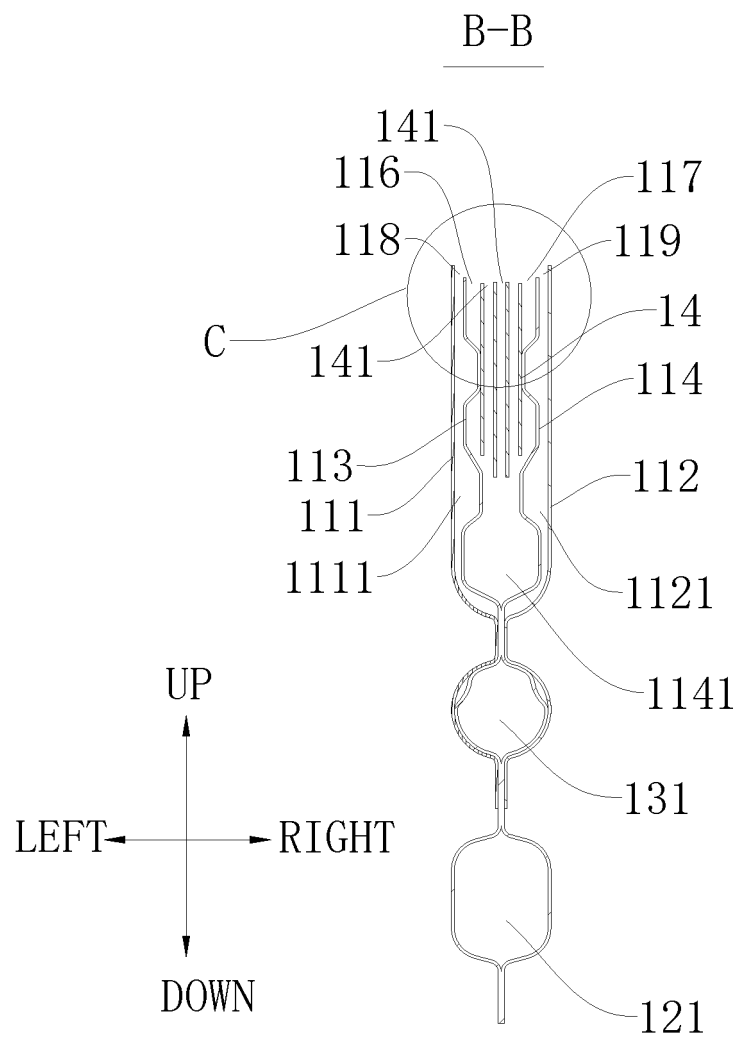


Fig. 7

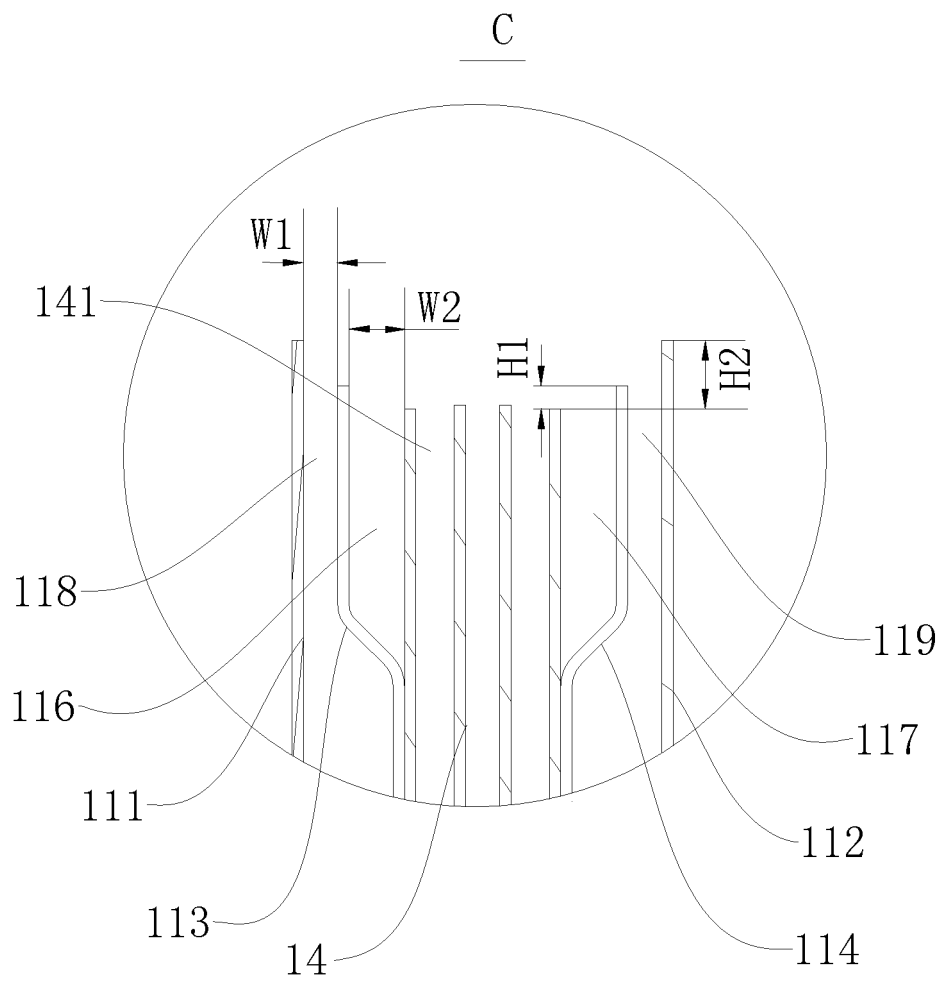


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/108091

A. CLASSIFICATION OF SUBJECT MATTER

F23D 14/04 (2006.01) i; F23D 14/64 (2006.01) i; F23D 14/60 (2006.01) i; F24H 1/12 (2006.01) i; F24H 9/18 (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)

F23D 14; F24H 1; F24H 9

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

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

CNABS, CNTXT, SIPOABS, DWPI, CNKI: 浓, 淡, 燃烧器, 整流, 分开, 分配, 盲道, 隔开, 间隔, 热水器, rich, lean, dense, light, distribute, flow, gas, blind, partition

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 205351315 U (WH MEDIA KITCHEN & BATH APPLIANCES MFG CO., LTD.), 29 June 2016 (29.06.2016), description, paragraphs [0030]-[0051], and figures 1-6	1-10, 12-14
Y	CN 205351315 U (WH MEDIA KITCHEN & BATH APPLIANCES MFG CO., LTD.), 29 June 2016 (29.06.2016), description, paragraphs [0030]-[0051], and figures 1-6	11
Y	JP 2007064503 A (NORITSU KK), 15 March 2007 (15.03.2007), description, paragraph [0051], and figure 4	11
A	CN 205351733 U (WH MEDIA KITCHEN & BATH APPLIANCES MFG CO., LTD. et al.), 29 June 2016 (29.06.2016), entire document	1-14
A	CN 102809155 A (NORITZ CORPORATION), 05 December 2012 (05.12.2012), entire document	1-14
A	CN 205279094 U (WH MEDIA KITCHEN & BATH APPLIANCES MFG CO., LTD.), 01 June 2016 (01.06.2016), entire document	1-14
A	JP 2007163043 A (PALOMA KOGYO KK), 28 June 2007 (28.06.2007), entire document	1-14

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

☒ See patent family annex.

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“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

10 July 2017

Date of mailing of the international search report

11 August 2017

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Haidian District, Beijing 100088, China
Facsimile No. (86-10) 62019451

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Telephone No. (86-10) 62089896

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/108091

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	JP 4350696 B2 (RINNAI CORP.), 21 October 2009 (21.10.2009), entire document	1-14
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Form PCT/ISA/210 (continuation of second sheet) (July 2009)

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US 2015184849 A1	02 July 2015	None	

Form PCT/ISA/210 (patent family annex) (July 2009)