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(54) **COMBUSTOR AND GAS WATER HEATER HAVING SAME**

(57) A burner and a gas water heater with the burner are provided. A burner casing (11) is provided with a first rich burning flame port (118) and a second rich burning flame port (119). A flow-adjustment device (14) defines a first blind passage (116) and a 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 flow-adjustment device 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 flow-adjustment device (14) are denoted by H1, and a height difference between the top surface of the outer side wall of the first rich burning flame port (118) and the top surface of the flow-adjustment device and a height difference between the top surface of the outer side wall of the second rich burning flame port (119) and the top surface of the flow-adjustment device (14) are denoted by H2, in which H2≥H1.

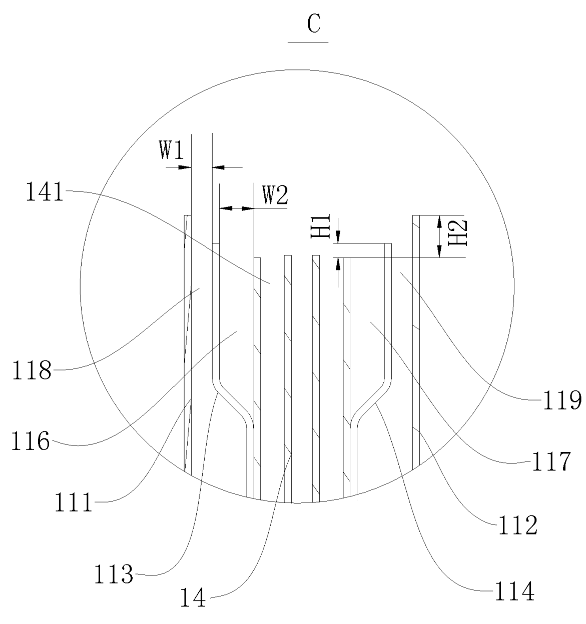


Fig. 8

EP 3 460 326 A1

Description

FIELD

[0001] The present disclosure relates to a field of house appliance, and more particularly to a burner and a gas water heater with 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 burning 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] The present disclosure seeks to solve at least one of the problems existing in the related art to at least some extent. To this end, a burner is provided by the present disclosure, the burner may reduce emission of nitrogen oxides in fume and reduce environment pollution.

[0004] The present disclosure further provides a gas water heater with the burner.

[0005] The burner according to a first aspect of embodiments of the present disclosure includes at least one burning unit, the burning unit includes a burner casing, in which the burner casing has a first rich burning cavity, a second rich burning cavity and a lean burning cavity therein, and the burner casing thereon is provided with a rich burning injection inlet in communication with the first rich burning cavity and the second rich burning cavity, a lean burning injection inlet in communication with the lean burning cavity, a first rich burning flame port in communication with the first rich burning cavity, a second rich burning flame port in communication with the second rich burning cavity and a lean burning opening in communication with the lean burning cavity; a flow-adjustment device, arranged in the lean burning opening and provided with a plurality of lean burning flame ports in communication with the lean burning cavity, in which the first rich burning flame port and the second rich burning flame port are located at two sides of the plurality of lean burning flame ports respectively. A first blind passage and a second blind passage are defined between the flow-adjustment device and two side walls of the lean burning opening respectively, the first blind passage is located between the first rich burning flame port and the plurality of lean burning flame ports, and the second blind passage is located between the second rich burning flame port and the plurality of lean burning flame ports.

[0006] 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 is higher than a top surface of the flow-adjustment device, a top surface of an outer side wall of the first rich burning flame port is flush with that of the second rich burning flame port and is 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 flow-adjustment 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 flow-adjustment device are denoted by HI, and a height difference between the top surface of the outer side wall of the first rich burning flame port and the top surface of the flow-adjustment device and a height difference between the top surface of the outer side wall of the second rich burning flame port and the top surface of the flow-adjustment device are denoted by H2, in which H2≥H1.

[0007] In the burner according to embodiments of the present disclosure, the first rich burning flame port and the second rich burning flame port of the burning unit are located at two sides of the plurality of lean burning flame ports respectively, so as to form the stable flame structure having the lean burning flame in the middle and the rich burning flames at both sides, thereby reducing the flame temperature and controlling emission of the nitrogen oxides in the fume after the burning. The height difference between the top surface of the outer side wall of the first blind passage and the top surface of the flow-adjustment device and the height difference between the top surface of the outer side wall of the second blind passage and the top surface of the flow-adjustment device are denoted by HI, and the height difference between the top surface of the outer side wall of the first rich burning flame port and the top surface of the flow-adjustment device and the height difference between the top surface of the outer side wall of the second rich burning flame port and the top surface of the flow-adjustment device are denoted by H2, in which H2≥H1, thereby controlling stability of flow at the rich burning flame ports and the lean burning flame port, further improving the stability of the burning flame and further reducing emission of nitrogen oxides in fume.

[0008] In addition, the burner according to embodiments of the present disclosure further includes the following additional technical features.

[0009] According to some embodiments of the present disclosure, a maximum width of the first blind passage and a maximum width of the second blind passage are equal and denoted by W2, and a maximum width of the first rich burning flame port and a maximum width of the second rich burning flame port are equal and denoted by W1, and W2≥W1.

[0010] According to some embodiments of the present disclosure, a distance between two outer side walls of the flow-adjustment device is denoted by W3 and a height of the flow-adjustment device is denoted by H, in which, W3/H=0.03~0.30.

[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 burning 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 burning injection inlet is denoted by Φ_R, in which Φ_R/Φ_S=0.5~0.8.

[0012] According to some embodiments of the present disclosure, a ratio of the amount of air to that of fuel gas in theory for complete burning of fuel gas is denoted by Φ_S, and a mixture ratio of the amount of air to that of fuel gas at the lean burning injection inlet is denoted by Φ_L, in which Φ_L/Φ_S =1.5~2.0.

[0013] According to some embodiments of the present disclosure, the burner casing includes: a first lean burning casing portion and a second lean burning casing portion, in which the first lean burning casing portion and the second lean burning casing portion are connected together and define the lean burning cavity and the lean burning opening together, and the flow-adjustment device is arranged between the first lean burning casing portion and the second lean burning casing portion and located at the lean burning opening; and a first rich burning casing portion and a second rich burning casing portion, in which the first rich burning casing portion is connected to the first lean burning casing portion and is located outside of the first lean burning casing portion, the first rich burning casing portion and the first lean burning casing portion together define the first rich burning cavity and the first rich burning flame port, the second rich burning casing portion is connected to the second lean burning casing portion and located outside of the second lean burning casing portion, the second rich burning casing portion and the second lean burning casing portion define the second rich burning cavity and the second rich burning flame port together.

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

[0015] Optionally, the burner casing further includes a lean burning injector, connected to the first lean burning casing portion and the second lean burning casing portion, in which the lean burning injection inlet is arranged on the lean burning injector; and a rich burning injector, connected to the first rich burning casing portion and the second rich burning casing portion and in communication with the first rich burning cavity and the second rich burning cavity, in which the rich burning injector is located above the lean burning injector and the rich burning injection inlet is arranged on the rich burning injector.

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

[0017] Optionally, a sectional area S3 of a gas jet port of the rich burning nozzle and a sectional area S4 of a gas jet port of the lean burning nozzle satisfy: S3/S4=0.25~0.65.

[0018] Optionally, the burner further includes a primary air adjusting plate arranged in front of the rich burning injector port and the lean burning injector port so as to adjust an amount of injection air.

[0019] Optionally, the burner further includes a secondary air adjusting plate arranged below the burning unit, in which 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.

[0020] According to some embodiments of the present disclosure, a plurality of burning units are provided and arranged along a width direction of the burning unit.

[0021] According to a second aspect of embodiments of the present disclosure, the gas water heater having the burner of the above embodiments is provided.

[0022] As the burner 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 burner 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.

[0023] 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

[0024]

Fig. 1 is a schematic view of a burning unit of a burner according to an embodiment of the present disclosure from an angle.

Fig. 2 is a schematic view of a burning unit of a burner according to an embodiment of the present disclosure from another angle.

Fig. 3 is a sectional view taken along line A-A in Fig. 2.

Fig. 4 is a top view of a burning unit of a burner according to an embodiment of the present disclosure.

Fig. 5 is an exploded view of a burning unit of a burner according to an embodiment of the present disclosure.

Fig. 6 is a schematic view of a burning unit of a burner according to another embodiment of the present disclosure.

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

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

Reference numerals:

[0025]

1: burning unit;

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

12: lean burning injector, 121: lean burning injection inlet;

13: rich burning injector, 131: rich burning injection inlet;

14: flow-adjustment device, 141: lean burning flame port;

15: rich burning nozzle;

16: lean burning nozzle;

17: connecting slat.

DETAILED DESCRIPTION

[0026] 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.

[0027] In the specification, it is to be understood that terms such as "lateral," "length," "width," "thickness," "upper," "lower," "front," "rear," "left," "right," "vertical," "horizontal," "top," "bottom," "inner," and "outer," 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 disclosure be constructed or operated in a particular orientation.

[0028] 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 disclosure, the term "a plurality of' means two or more than two, unless specified otherwise.

[0029] In the present disclosure, 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.

[0030] A burner according to embodiments of the present disclosure will be described with reference to drawings in the following.

[0031] Referring to Figs. 1-8, the burner according to embodiments of the present disclosure may include at least one burning unit 1, each burning unit 1 includes a burner casing 11 and a flow-adjustment device 14.

[0032] The burner casing 11 defines a first rich burning cavity 1111, a second rich burning cavity 1121 and a lean burning cavity 1141 therein. The burner casing 11 is provided with a rich burning injection inlet 131 in communication with the first rich burning cavity 1111 and the second rich burning cavity 1121, a lean burning injection inlet 121 in communication with the lean burning cavity 1141, a first rich burning flame port 118 in communication with the first rich burning cavity 1111, a second rich burning flame port 119 in communication with the second rich burning cavity 1121 and a lean burning opening 115 in communication with the lean burning cavity 1141 thereon.

[0033] The flow-adjustment device 14 is arranged in the lean burning opening 115 and the flow-adjustment device 14 is provided with a plurality of lean burning flame ports 141 in communication with the lean burning cavity 1141, the first rich burning flame port 118 and the second rich burning flame port 119 are located at two sides of the plurality of lean burning flame ports 141 respectively. A first blind passage 116 and a second blind passage 117 may be defined between the flow-adjustment device 14 and two side walls of the lean burning opening 115 respectively, the first blind passage 116 is located between the first rich burning flame port 118 and the plurality of lean burning flame ports 141, and the second blind passage 117 is located between the second rich burning flame port 119 and the plurality of lean burning flame ports 141.

[0034] In other words, the burner may include one or more burning units 1, for example, the burner may include a plurality of burning units 1, the plurality of burning units 1 are arranged side by side and are arrayed along a width direction of the burning unit 1. The width direction refers to a left-right direction shown in Fig. 5 and Fig. 7. Each burning unit 1 includes the burner casing 11 and the flow-adjustment device 14, the flow-adjustment device 14 is arranged in the burner casing 11.

[0035] The burner casing 11 defines the first rich burning cavity 1111 therein, the second rich burning cavity

1121 and the lean burning cavity 1141 therein. The burner casing 11 is provided with the rich burning injection inlet 131, the lean burning injection inlet 121, the first rich burning flame port 118, the second rich burning flame port 119 and the lean burning opening 115 thereon. The rich burning injection inlet 131 is configured to introduce air for the rich burning and the lean burning injection inlet 121 is configured to introduce air for the lean burning. Referring to Fig. 1-Fig. 3 and Fig. 6, the rich burning injection inlet 131 is located above the lean burning injection inlet 121.

[0036] The rich burning injection inlet 131 is in communication with the first rich burning cavity 1111 and the second rich burning cavity 1121, the first rich burning cavity 1111 is in communication with the first rich burning flame port 118, the second rich burning cavity 1121 is in communication with the second rich burning flame port 119, the lean burning injection inlet 121 is in communication with the lean burning cavity 1141, as well the lean burning cavity 1141 is in communication with the lean burning opening 115.

[0037] In this way, the air is introduced in from the rich burning injection inlet 131 and is mixed with fuel gas to form rich burning gas, the rich burning gas after being mixed may enter the first rich burning cavity 1111 and the second rich burning cavity 1121, then be led to the first rich burning flame port 118 and the second rich burning flame port 119 respectively. The air introduced in by the lean burning injection inlet 121 is mixed with the fuel gas to form lean burning gas which flows to the lean burning cavity 1141 then. Referring to Figs. 5-8, the flow-adjustment device 14 is arranged in the lean burning opening 115, the flow-adjustment device 14 is provided with the plurality of lean burning flame ports 141, the lean burning cavity 1141 is in communication with the plurality of lean burning flame ports 141, and the lean burning gas may be led to the plurality of lean burning flame ports 141.

[0038] Referring to Fig. 4, Fig. 5, Fig. 7 and Fig. 8, the first rich burning flame port 118 and the second lean burning flame port 141 are arranged at two sides of the lean burning opening 115 respectively, the plurality of lean burning flame ports 141 are located between the first rich burning flame port 118 and the second rich burning flame port 119. In this way, a structure having a middle configured to be the lean burning flame ports 141 and two sides configured to be the rich burning ports may be formed at the top of each burning unit 1. That is to say, the burning unit 1 may allow a flame structure having a lean flame in the middle and rich flames at the two sides during the burning, so that stability of the flame may be improved, and temperature of the burning flame may be reduced, controlling emission of nitrogen oxides in fume.

[0039] As shown in Fig. 7 and Fig. 8, the flow-adjustment device 14 is arranged in the lean burning opening 115 and is connected to the two side walls of the lean burning opening 115. The flow-adjustment device 14 defines the first blind passage 116 and the second blind passage 117 with the two side walls of the lean burning opening 115 respectively, nether the first blind passage 116 nor the second blind passage 117 is in communication with the lean burning cavity 1141. The first rich burning flame port 118 may be spaced apart from the plurality of lean burning flame ports 141 by means of the first blind passage 116, and the second rich burning flame port 119 may be spaced apart from the plurality of lean burning flame ports 141 by means of the second blind passage 117, thereby the flame structure being more stable, the emission of nitrogen oxides in fume being effectively controlled.

[0040] 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 flow-adjustment device 14. A top surface of an outer side wall of the first rich burning flame port 118 is flush with that of the second rich burning 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 flow-adjustment 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 flow-adjustment device 14 are denoted by H1, and a height difference between the top surface of the outer side wall of the first rich burning flame port 118 and the top surface of the flow-adjustment device 14 and a height difference between the top surface of the outer side wall of the second rich burning flame port 119 and the top surface of the flow-adjustment device 14 are denoted by H2, in which $H2 \geq H1$, thereby controlling stability of the flow at the rich burning flame ports and the lean burning flame port 141, further improving the stability of the burning flame and further reducing emission of nitrogen oxides in fume.

[0041] Thus, in the burner according to embodiments of the present disclosure, the first rich burning flame port 118 and the second rich burning flame port 119 of the burning unit 1 are located at two sides of the plurality of lean burning flame ports 141 respectively, so as to form the stable flame structure having the lean burning flame in the middle and the rich burning flames at two sides, thereby reducing the flame temperature and controlling emission of the nitrogen oxides in the fume after the burning.

[0042] A height difference between the top surface of the outer side wall of the first blind passage 116 and the top surface of the flow-adjustment 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 flow-adjustment device 14 are denoted by H1, and a height difference between the top surface of the outer side wall of the first rich burning flame port 118 and the top surface of the flow-adjustment device 14 and a height difference between the top surface of the outer side wall of the second rich burning flame port 119 and the top surface of the flow-adjustment device 14 are denoted by H2, in which H2≥H1, thereby controlling stability of the flow at the rich burning flame ports and the lean burning flame port 141, further improving the stability of the burning flame and further reducing emission of nitrogen oxides in fume.

[0043] In some embodiments of the present disclosure, 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 burning flame port 118 and the maximum width of the second rich burning flame port 119 are equal and denoted by W1, in which W2≥W1, thereby further ensuring the structural stability of the burning flames. Specifically, with reference to Fig. 7 and Fig. 8, the maximum width of the first rich burning flame port 118 refers to the maximum width of a narrow side of the first rich burning flame port 118 along a left-right direction, the maximum width of the second rich burning flame port 119 refers to the maximum width of a narrow side of the second rich burning 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 burning flame port 118 and the second rich burning 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 burning flame port 118 and the second rich burning flame port 119.

[0044] In some embodiments of the present disclosure, the maximum width of the lean burning flame port 141 may be denoted by W3, a height of the rectifying device 14 may be denoted by H, in which W3/H=0.03~0.30. 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 burning flame ports 141 are formed at a top of each finedraw-type passage. In which, the maximum width W3 of the lean burning 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=0.05~0.20. Thereby the structure stability of the rich burning flames and the lean burning flames may be further ensured.

[0045] In some embodiments of the present disclosure, a ratio of the amount of air to that of the fuel gas in theory for complete burning 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 burning injection inlet 131 may be denoted by Φ_R, in which, Φ_R/Φ_S=0.5~0.8.

[0046] Φ_R/Φ_S refers to a primary air ratio of the rich burning. By controlling the primary air ratio of the rich burning, the fuel gas and the air are fully mixed and have a good burning ratio, fuel gas can sufficiently burned during rich burning, so as to form the stable flame structure and reduce the emission of nitrogen oxides in fume.

[0047] In some embodiments of the present disclosure, the ratio of the amount of air to that of the fuel gas in theory for complete burning 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 burning injection inlet 121 may be denoted by Φ_L, in which, Φ_L/Φ_S=1.5~2.0.

[0048] Φ_R/Φ_S refers to a primary air ratio of the lean burning. By controlling the primary air ratio of the rich burning and the lean burning, so that the fuel gas and the air are fully mixed and have a good burning ratio, fuel gas can sufficiently burned during lean burning, so as to form the stable flame structure and reduce the emission of nitrogen oxides in fume.

[0049] In some embodiments of the present disclosure, as shown in Fig. 5, Fig. 7 and Fig. 8, the burner casing 11 may include a first lean burning casing portion 113, a second lean burning casing portion 114, a first rich burning casing portion 111 and a second rich burning casing portion 112. The first lean burning casing portion 113 and the second lean burning casing portion 114 are connected together and define the lean burning cavity 1141 and the lean burning opening 115. The flow-adjustment device 14 is arranged between the first lean burning casing portion 113 and the second lean burning casing portion 114 and located at the lean burning opening 115.

[0050] The first rich burning casing portion 111 is connected to the first lean burning casing portion 113 and is located outside of the first lean burning casing portion 113. The first rich burning casing portion 111 and the first lean burning casing portion 113 define the first rich burning cavity 1111 and the first rich burning flame port 118 together. The second rich burning casing portion 112 is connected to the second lean burning casing portion 114 and located outside of the second lean burning casing portion 114. The second rich burning casing portion 112 and the second lean burning casing portion 114 define the second rich burning cavity 1121 and the second rich burning flame port 119 together.

[0051] As shown in Fig. 7 and Fig. 8, the first rich burning flame port 118 and the second rich burning flame port 119 are located at two sides of the lean burning opening 115 respectively. The flow-adjustment device 14 is arranged at the lean burning opening 115 and is provided with the plurality of lean burning flame ports 141. The plurality of lean burning flame ports 141 are arranged at the top of the flow-adjustment device 14. The first rich burning flame port 118 and the second rich burning flame port 119 are located at two sides of the plurality of lean burning flame ports 141 respectively, thereby facilitating formation of the stable flame structure having the lean burning flame in the middle and the rich burning flames at two sides, so as improving the stability of the flames, reducing the temperature of flames and reducing the emission of nitrogen oxides.

[0052] Advantageously, the burner casing 11 may further include a plurality of connecting slats 17. Two ends of each connecting slat 17 are connected to the first rich burning casing portion 111 and the second rich burning casing portion 112 respectively. The plurality of connecting slats 17 divide each of the first rich burning flame port 118, the second rich burning flame port 119 and the lean burning flame port 141 into a plurality of segments. Thus, the lean burning flame and the rich burning flame may be divided into a plurality of segments, thereby increasing a heat dissipation area of the flame and reducing the flame temperature.

[0053] Optionally, the burner casing 11 may further include a lean burning injector 12 and a rich burning injector 13. The lean burning injector 12 is connected to the first lean burning casing portion 113 and the second lean burning casing portion 114. The lean burning injection inlet 121 is arranged on the lean burner. The rich burning injector 13 is connected to the first rich burning casing portion 111 and the second rich burning casing portion 112 and is in communication with the first rich burning cavity 1111 and the second rich burning cavity 1121. The rich burning injector 13 is located above the lean burning injector 12, and the rich burning injection inlet 131 is arranged on the rich burning injector 13. Thus, the fuel gas and the introduced air may be led to the first rich burning cavity 1111 and the second rich burning cavity 1121 through the rich burning injector 13, the fuel gas and the air are mixed in the first rich burning cavity 1111 and the second rich burning cavity 1121, and the mixed gas is led to the first rich burning flame port 118 and the second rich burning flame port 119. At the same time, the fuel gas and the introduced air may be led to the lean burning cavity 1141 through the lean burning injector 12, the fuel gas and the air may be mixed in the lean burning cavity 1141 and the mixed gas and air may be led to the lean burning flame port 141.

[0054] In some embodiments of the present disclosure, the burning unit 1 may further include a rich burning nozzle 15 and a lean burning nozzle 16. The rich burning nozzle 15 may be configured to provide the rich burning injection inlet 131 with the fuel gas and the lean burning nozzle 16 may be configured to provide the lean burning injection inlet 121 with the fuel gas. The rich burning nozzle 15 is in communication with the rich burning injector 13 port and the lean burning nozzle 16 is in communication with the lean burning injection inlet 121. Thus, the fuel gas may be injected into the rich burning injection inlet 131 through the rich burning nozzle 15. The fuel gas is mixed with the air introduced by the rich burning injector 13 and is led to the first rich burning cavity 1111 and the second rich burning cavity 1121. The fuel gas may be injected into the lean burning injection inlet 121 through the lean burning nozzle 16. The fuel gas is mixed with the air introduced by the lean burning injector 12 and is led to the lean burning cavity 1141.

[0055] Optionally, a sectional area S3 of a gas jet port of the rich burning nozzle 15 and a sectional area S4 of a gas jet port of the lean burning 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 burning nozzle 15 is 0.25~0.65 percent of the sectional area of the gas jet port of the lean burning nozzle 16. Thus, by designing the ratio of the sectional area of the gas jet port of the rich burning nozzle 15 to that of the lean burning nozzle 16, the ratio of the amount of fuel gas to that of the air for the rich burning and the lean burning may be controlled, so that the amount of air introduced by the lean burning injection inlet 121 and the amount of fuel gas injected by the lean burning nozzle 16, as well as the amount of air introduced by the rich burning injection inlet 131 and the amount of fuel gas injected by the rich burning nozzle 15 could have a good ratio, thereby the rich burning and the lean burning being more sufficient, and the emission of nitrogen oxides being reduced.

[0056] Optionally, the burner may further include a primary air adjusting plate, the primary air adjusting plate is arranged in front of the rich burning injection inlet 131 and the lean burning injection inlet 121 so as to adjust an amount of injection air. Thus, the amount of air introduced in the rich burning injection inlet 131 and the lean burning injection inlet 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 burning injection inlet 131 and the proportion of the amount of air to the fuel gas at the lean burning injection inlet 121 being further controlled.

[0057] Furthermore, the burner may further include a secondary air adjusting plate, the secondary air adjusting plate is arranged below the burning 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 arranged in front of the rich burning injection inlet 131 and the lean burning injection inlet 121 to adjust the amount of injection air, the secondary air adjusting plate is arranged below the burning unit 1 to adjust the air amount in a burning 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 burner flows to the rich burning injection inlet 131 and the lean burning injection inlet 121 through the pressure balancing chamber 21, so that primary air entering the rich burning injection inlet 131 and the lean burning injection inlet 121 is more evenly, so as to improve the burning effect.

[0058] A specific embodiment of the burner 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.

[0059] As shown in Figs. 1-8, the burner according to embodiments of the present disclosure may include the plurality of burning units 1, the primary air adjusting plate and the secondary air adjusting plate, in which the plurality of burning units 1 are arranged side by side along the width direction of the burning unit 1.

[0060] Specifically, each burning unit 1 includes the burner casing 11, the flow-adjustment device 14, the rich burning injector 13, the lean burning injector 12, the rich burning nozzle 15 and the lean burning nozzle 16. As shown in Fig. 5, Fig. 7 and Fig. 8, the burner casing 11 includes the first lean burning casing portion 113, the second lean burning casing portion 114, the first rich burning casing portion 111 and the second rich burning casing portion 112. The first lean burning casing portion 113 and the second lean burning casing portion 114 are connected together and define the lean burning cavity 1141 and the lean burning opening 115. The flow-adjustment device 14 is arranged between the first lean burning casing portion 113 and the second lean burning casing portion 114 and located at the lean burning opening 115.

[0061] The first rich burning casing portion 111 is connected to the first lean burning casing portion 113 and is located outside of the first lean burning casing portion 113. The first rich burning casing portion 111 and the first lean burning casing portion 113 define the first rich burning cavity 1111 and the first rich burning flame port 118 together. The second rich burning casing portion 112 is connected to the second lean burning casing portion 114 and located outside of the second lean burning casing portion 114. The second rich burning casing portion 112 and the second lean burning casing portion 114 define the second rich burning cavity 1121 and the second rich burning flame port 119 together.

[0062] The first rich burning flame port 118 and the second rich burning flame port 119 are located at two sides of the lean burning opening 115 respectively. The flow-adjustment device 14 is arranged at the lean burning opening 115 and is provided with the plurality of lean burning flame ports 141. The plurality of lean burning flame ports 141 are arranged at the top of the flow-adjustment device 14. The first rich burning flame port 118 and the second rich burning flame port 119 are located at two sides of the plurality of lean burning flame ports 141 respectively, thereby facilitating formation of the stable flame structure having the lean burning flame in the middle and the rich burning flames at two sides, so as improving the stability of the flames, reducing the temperature of flames and reducing the emission of nitrogen oxides.

[0063] The lean burning injector 12 is connected to the first lean burning casing portion 113 and the second lean burning casing portion 114. The lean burning injection inlet 121 is arranged on the lean burner. The rich burning injector 13 is connected to the first rich burning casing portion 111 and the second rich burning casing portion 112 and is in communication with the first rich burning cavity 1111 and the second rich burning cavity 1121. The rich burning injector 13 is located above the lean burning injector 12, and the rich burning injection inlet 131 is arranged on the rich burning injector 13. Thus, the fuel gas and the introduced air may be led to the first rich burning cavity 1111 and the second rich burning cavity 1121 through the rich burning injector 13, the fuel gas and the air are mixed and led to the first rich burning flame port 118 and the second rich burning flame port 119. At the same time, the fuel gas and the introduced air may be led to the lean burning cavity 1141 through the lean burning injector 12, the fuel gas and the air may be mixed led to the lean burning flame port 141.

[0064] The rich burning nozzle 15 may be configured to provide the rich burning injection inlet 131 with the fuel gas and the lean burning nozzle 16 may be configured to provide the lean burning injection inlet 121 with the fuel gas. The rich burning nozzle 15 is in communication with the rich burning injector 13 port. The lean burning nozzle 16 is in communication with the lean burning injection inlet 121. Thus, the fuel gas may be injected into the rich burning injection inlet 131 through the rich burning nozzle 15. The fuel gas is mixed with the air introduced by the rich burning injector 13 and is led to the first rich burning cavity 1111 and the second rich burning cavity 1121. The fuel gas may be injected into the lean burning injection inlet 121 through the lean burning nozzle 16. The fuel gas is mixed with the air introduced by the lean burning injector 12 and is led to the lean burning cavity 1141.

[0065] The sectional area S1 of the rich burning injection inlet 131 and the sectional area S2 of the lean burning injection inlet 121 satisfy: $S1/S2=0.20\sim0.40$. The sectional area S3 of the gas jet port of the rich burning nozzle 15 and the sectional area S4 of the gas jet port of the lean burning 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 burning injection inlet 131 and the ratio of the amount of air to that of fuel gas at the lean burning injection inlet 121 may be controlled, and then the primary air ratio of the rich burning and the primary air ratio of the lean burning may be further controlled.

[0066] The ratio of the amount of air to that of fuel gas in theory for a complete burning 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 burning injection inlet 131 may be denoted by Φ_R, and the mixture ratio of the amount of air to that of fuel gas at the lean burning injection inlet 121 may be denoted by Φ_L. The primary air ratio of the rich burning 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 burning is configured to be Φ_L/Φ_S and satisfies: $\Phi_L/\Phi_S=1.5\sim2.0$. Therefore, by designing the ratio of the area of the port of rich burning injection inlet 131 to that of the lean burning injection inlet 121, and designing the ratio of the sectional area of the gas jet port of the rich burning nozzle 15 to that of the lean burning nozzle 16, the primary air ratio of the rich burning and the lean burning can be controlled, so that the fuel gas and the air are mixed fully and have a good burning proportion, so as forming the stable flame structure and reducing the emission of nitrogen oxides in fume.

[0067] As shown in Fig. 7 and Fig. 8, the first blind passage 116 and the second blind passage 117 may be defined between the flow-adjustment device 14 and two side walls of the lean burning opening 115 respectively, the first blind passage 116 is located between the first rich burning flame port 118 and the plurality of lean burning flame ports 141, and the second blind passage 117 is located between the second rich burning flame port 119 and the plurality of lean burning flame ports 141.

[0068] 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 flow-adjustment device 14. The top surface of the outer side wall of the first rich burning flame port 118 is flush with the top surface of the outer side wall of the second rich burning 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 flow-adjustment 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 flow-adjustment device 14 are denoted by H1, and the height difference between the top surface of the outer side wall of the first rich burning flame port 118 and the top surface of the flow-adjustment device 14 and the height difference between the top surface of the outer side wall of the second rich burning flame port 119 and the top surface of the flow-adjustment 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 burning flame port 118 and the maximum width of the second rich burning 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 flow at the rich burning flame ports and the lean burning flame port 141, further improving the stability of the burning flame.

[0069] The maximum width of the lean burning flame port 141 may be denoted by W3, and the height of the flow-adjustment 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 burning flame and the lean burning flame may be further ensured.

[0070] The primary air adjusting plate may be arranged in front of the rich burning injection inlet 131 and the lean burning injection inlet 121 of each burning unit 1, so as to adjust the amount of injection air. Thus, the amount of air introduced from the rich burning injection inlet 131 and the lean burning injection inlet 121 of each the burning 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 burning injection inlet 131 and the proportion of the amount of air to that of fuel gas at the lean burning injection inlet 121 being further controlled.

[0071] The secondary air adjusting plate is arranged below the burning unit 1 to adjust the amount of air in the burning 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 burning injection inlet 131 and the lean burning injection inlet 121 through the pressure balancing chamber, so that primary air entering the rich burning injection inlet 131 and the lean burning injection inlet 121 is more evenly, so as to improve the burning effect.

[0072] Thus, in the burner according to embodiments of the present disclosure, the first rich burning flame port 118 and the second rich burning flame port 119 of the burning unit 1 are located at two sides of the plurality of lean burning flames 141, so as to form the stable flame structure having the lean burning flame in the middle and the rich burning flame at the two sides, reducing the flame temperature and controlling emission of the nitrogen oxides in the fume after the burning. Moreover the sectional area S1 of the rich burning injection inlet 131 and the sectional area S2 of the lean burning injection inlet 121 of the burner satisfy: $S1/S2=0.20\sim0.40$, and the sectional area S3 of the gas jet port of the rich burning nozzle 15 and the sectional area S4 of the gas jet port of the lean burning nozzle 16 satisfy: $S3/S4=0.25\sim0.65$. The structure of the burner casing 11 and the primary air ratio of the rich burning and the lean burning are defined, thereby achieving a good proportion of the air introduced by the rich burning injection inlet 131 and the lean burning injection inlet 121 to the fuel gas, and further controlling the structural stability of the burning flame and reducing the emission of nitrogen oxides.

[0073] In addition, a gas water heater having the burner according to the above embodiments is further provided by the present disclosure.

[0074] As the burner 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 burner according to the above embodiments, the temperature of the flame may be reduced and the emission of nitrogen oxides in fume of the gas water heater may be reduced.

[0075] In the present disclosure, 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 second feature, or just means that the first feature is at a height lower than that of the second feature.

[0076] Reference throughout this specification to "an embodiment," "some embodiments," "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 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.

[0077] 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 burner comprising at least one burning unit, the burning unit comprising:

   a burner casing defining a first rich burning cavity, a second rich burning cavity and a lean burning cavity therein, wherein the burner casing is provided with a rich burning injection inlet in communication with the first rich burning cavity and the second rich burning cavity, a lean burning injection inlet in communication with the lean burning cavity, a first rich burning flame port in communication with the first rich burning cavity, a second rich burning flame port in communication with the second rich burning cavity and a lean burning opening in communication with the lean burning cavity thereon; and

   a flow-adjustment device, arranged in the lean burning opening and provided with a plurality of lean burning flame ports in communication with the lean burning cavity, wherein the first rich burning flame port and the second rich burning flame port are located at two sides of the plurality of lean burning flame ports respectively, a first blind passage and a second blind passage are defined between the flow-adjustment device and two side walls of the lean burning opening respectively, the first blind passage is located between the first rich burning flame port and the plurality of lean burning flame ports, and the second blind passage is located between the second rich burning flame port and the plurality of lean burning flame ports;

   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 is higher than a top surface of the flow-adjustment device, a top surface of an outer side wall of the first rich burning flame port is flush with that of the second rich burning flame port and is 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 flow-adjustment 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 flow-adjustment device are denoted by H1, and a height difference between the top surface of the outer side wall of the first rich burning flame port and the top surface of the flow-adjustment device and a height difference between the top surface of the outer side wall of the second rich burning flame port and the top surface of the flow-adjustment device are denoted by H2, wherein $H2 \geq H1$.

2. The burner according to claim 1, wherein a maximum width of the first blind passage and a maximum width of the second blind passage are equal and denoted by W2, and a maximum width of the first rich burning flame port and a maximum width of the second rich burning flame port are equal and denoted by W1, wherein $W2 \geq W1$.

3. The burner according to claim 1, wherein a distance between two outer side walls of the flow-adjustment device is denoted by W3 and a height of the flow-adjustment device is denoted by H, wherein $W3/H=0.03\sim0.30$.

4. The burner according to claim 1, wherein a ratio of the amount of air to that of fuel gas in theory for complete burning 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 burning injection inlet is denoted by Φ_R, wherein $\Phi_R/\Phi_S=0.5\sim0.8$.

5. The burner according to claim 1, wherein a ratio of the amount of air to that of fuel gas in theory for complete burning of fuel gas is denoted by Φ_S, and a mixture ratio of the amount of air to that of fuel gas at the lean burning injection inlet is denoted by Φ_L, wherein Φ_L/Φ_S =1.5~2.0.

6. The burner according to any one of claims 1-5, wherein the burner casing comprises:

a first lean burning casing portion and a second lean burning casing portion, wherein the first lean burning casing portion and the second lean burning casing portion are connected together and define the lean burning cavity and the lean burning opening, and the flow-adjustment device is arranged between the first lean burning casing portion and the second lean burning casing portion and located at the lean burning opening; and
a first rich burning casing portion and a second rich burning casing portion, wherein the first rich burning casing portion is connected to the first lean burning casing portion and located outside of the first lean burning casing portion, the first rich burning casing portion and the first lean burning casing portion define the first rich burning cavity and the first rich burning flame port together, the second rich burning casing portion is connected to the second lean burning casing portion and located outside of the second lean burning casing portion, the second rich burning casing portion and the second lean burning casing portion define the second rich burning cavity and the second rich burning flame port together.

7. The burner according to claim 6, wherein the burner casing further comprises:
a plurality of connecting slats, wherein two ends of each connecting slat are connected to the first rich burning casing portion and the second rich burning casing portion respectively, and the plurality of connecting slats divide each of the first rich burning flame port, the second rich burning flame port and the lean burning flame port into a plurality of segments.

8. The burner according to claim 6, wherein the burner casing further comprises:

a lean burning injector, connected to the first lean burning casing portion and the second lean burning casing portion, wherein the lean burning injection inlet is arranged on the lean burning injector; and
a rich burning injector, connected to the first rich burning casing portion and the second rich burning casing portion and in communication with the first rich burning cavity and the second rich burning cavity, wherein the rich burning injector is located above the lean burning injector and the rich burning injection inlet is arranged on the rich burning injector.

9. The burner according to any one of claims 1-5, wherein the burning unit further comprises:

a rich burning nozzle configured to provide the rich burning injection inlet with the fuel gas and corresponding to the rich burning injector port; and
a lean burning nozzle configured to provide the lean burning injection inlet with the fuel gas and corresponding to the lean burning injector port.

10. The burner according to claim 9, wherein a sectional area S3 of a gas jet port of the rich burning nozzle and a sectional area S4 of a gas jet port of the lean burning nozzle satisfy: S3/S4=0.25~0.65.

11. The burner according to claim 9, further comprising a primary air adjusting plate arranged in front of the rich burning injector port and the lean burning injector port so as to adjust an amount of injection air.

12. The burner according to claim 11, further comprising a secondary air adjusting plate arranged below the burning unit, wherein 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.

13. The burner according to any one of claims 1-5, wherein a plurality of burning units are provided and arranged along a width direction of the burning unit.

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

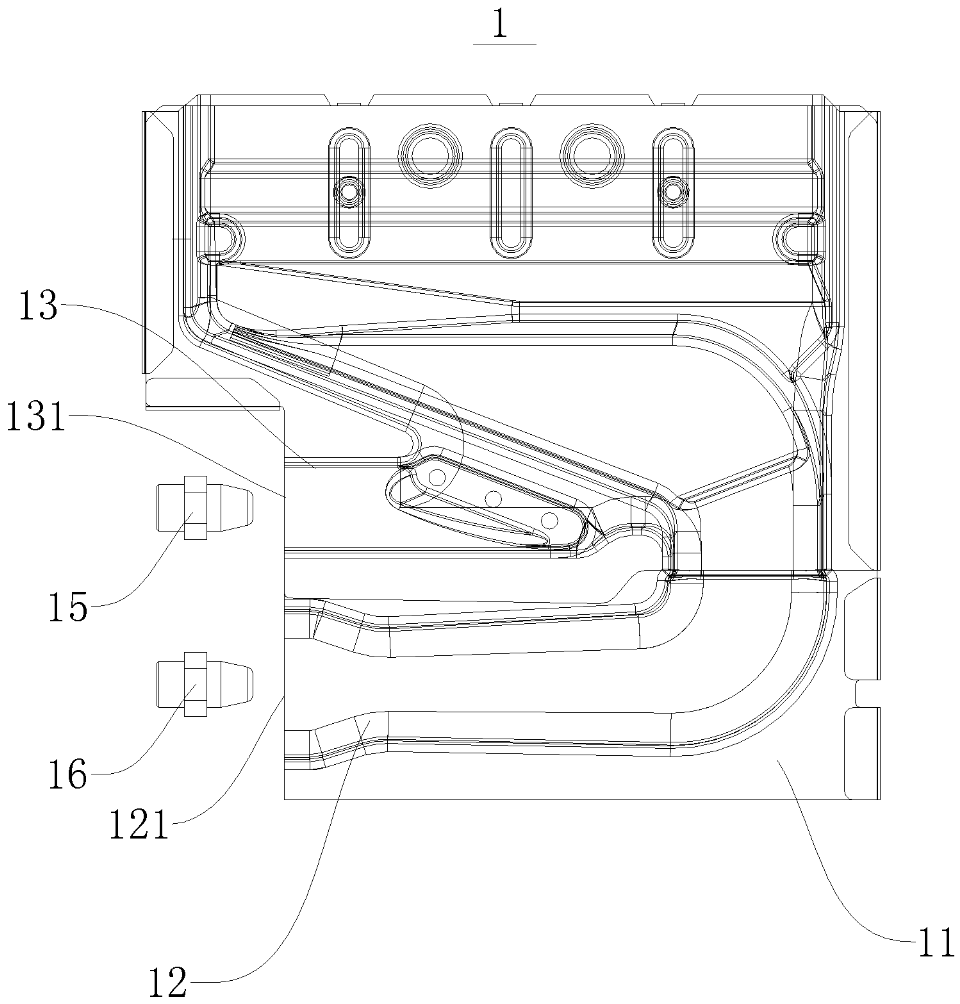


Fig. 1

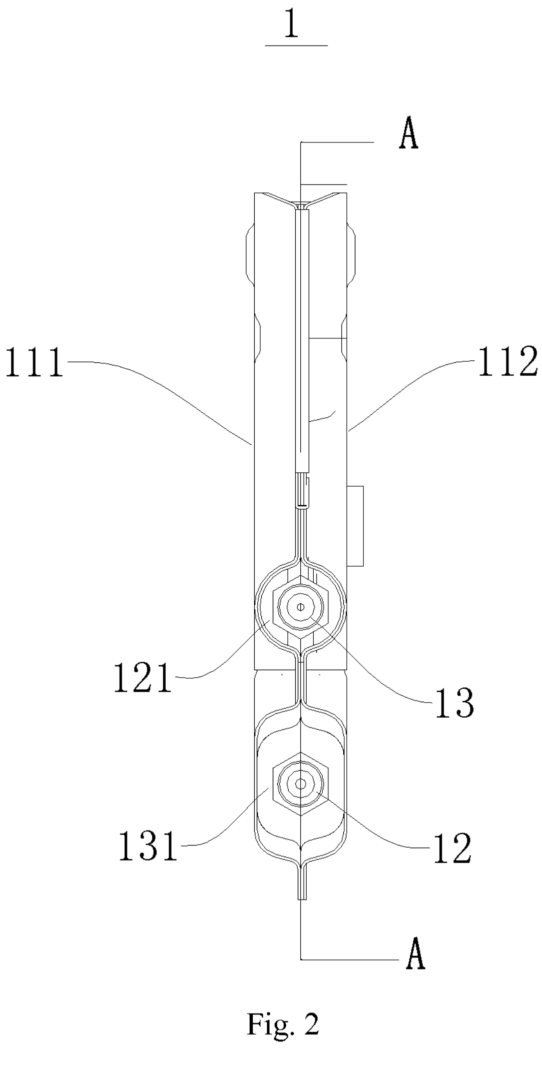


Fig. 2

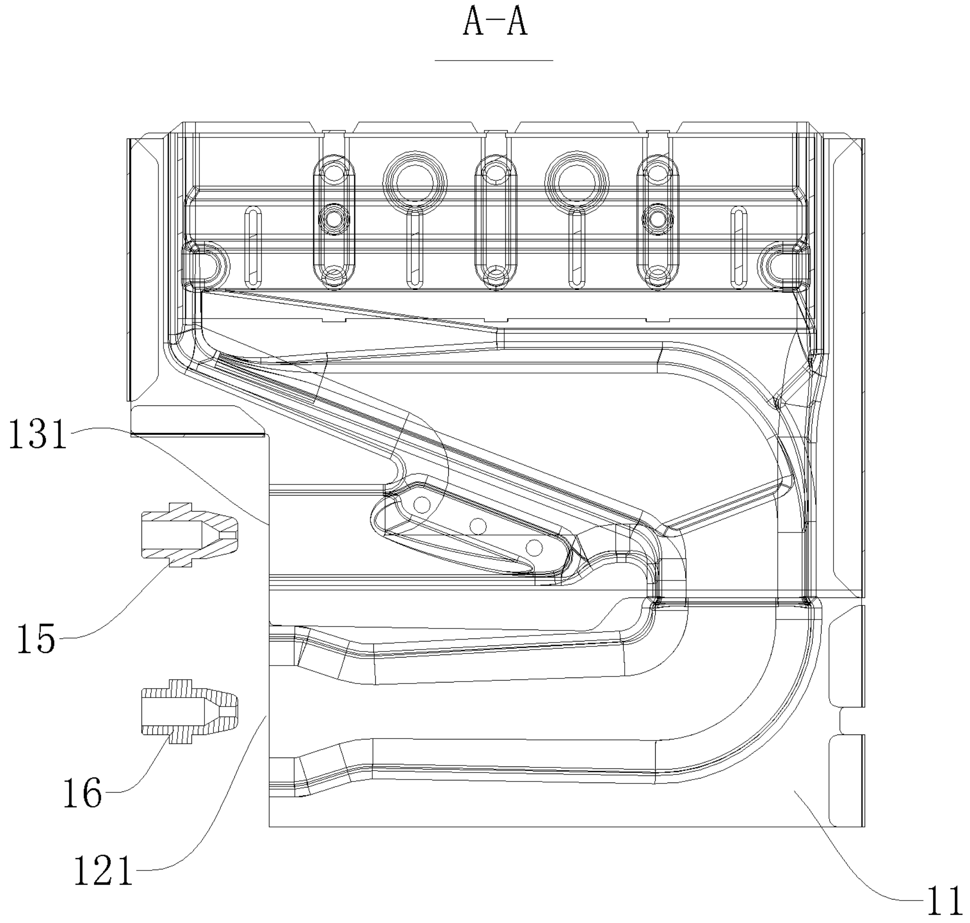


Fig. 3

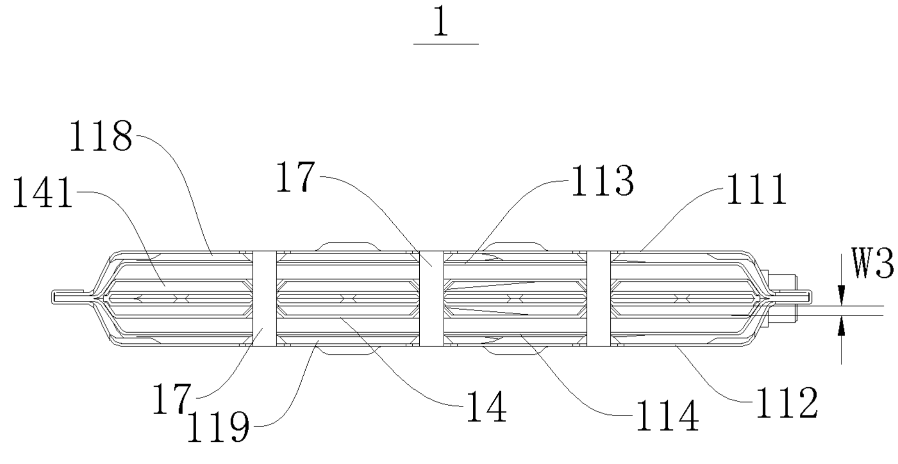


Fig. 4

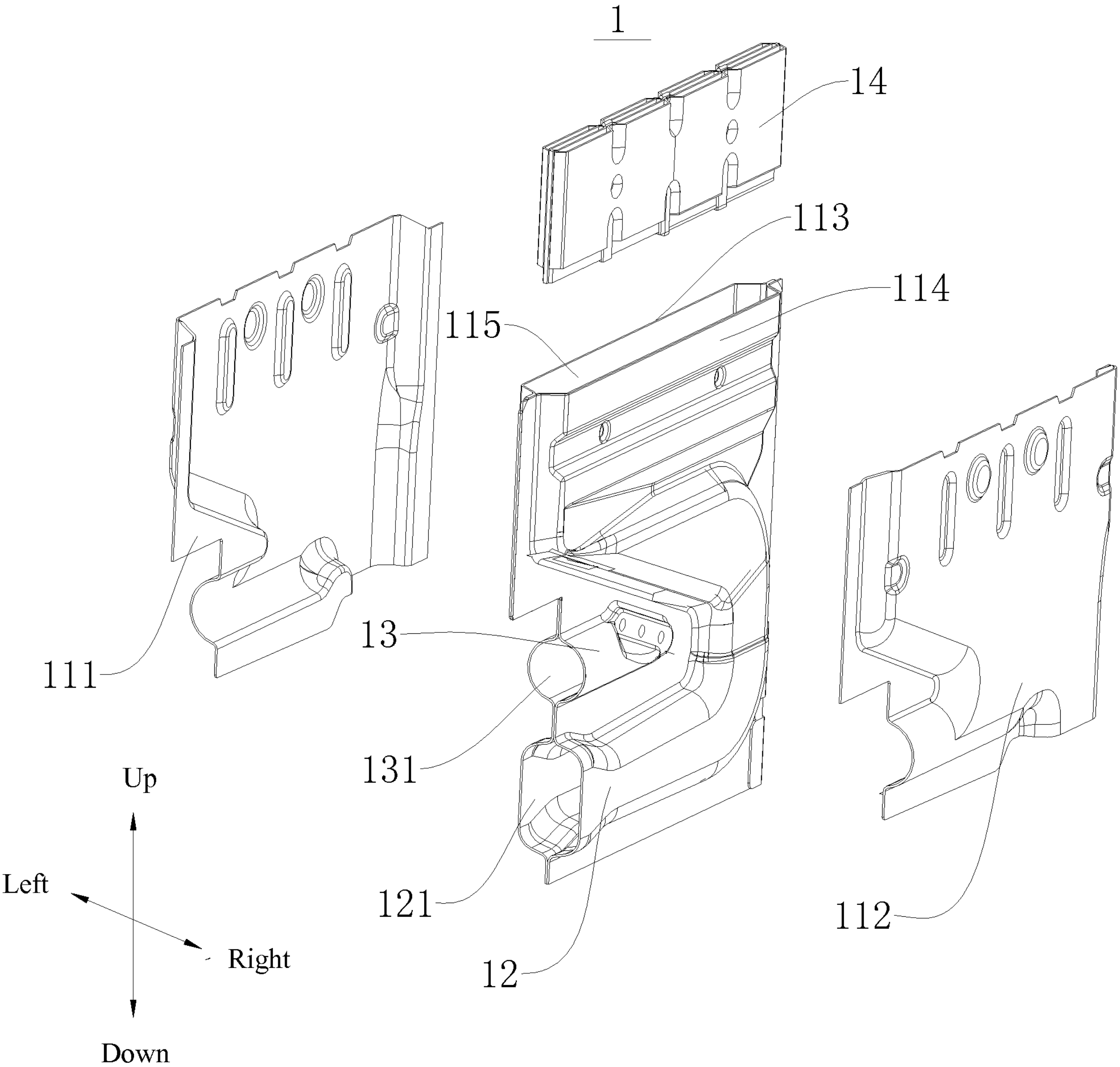


Fig. 5

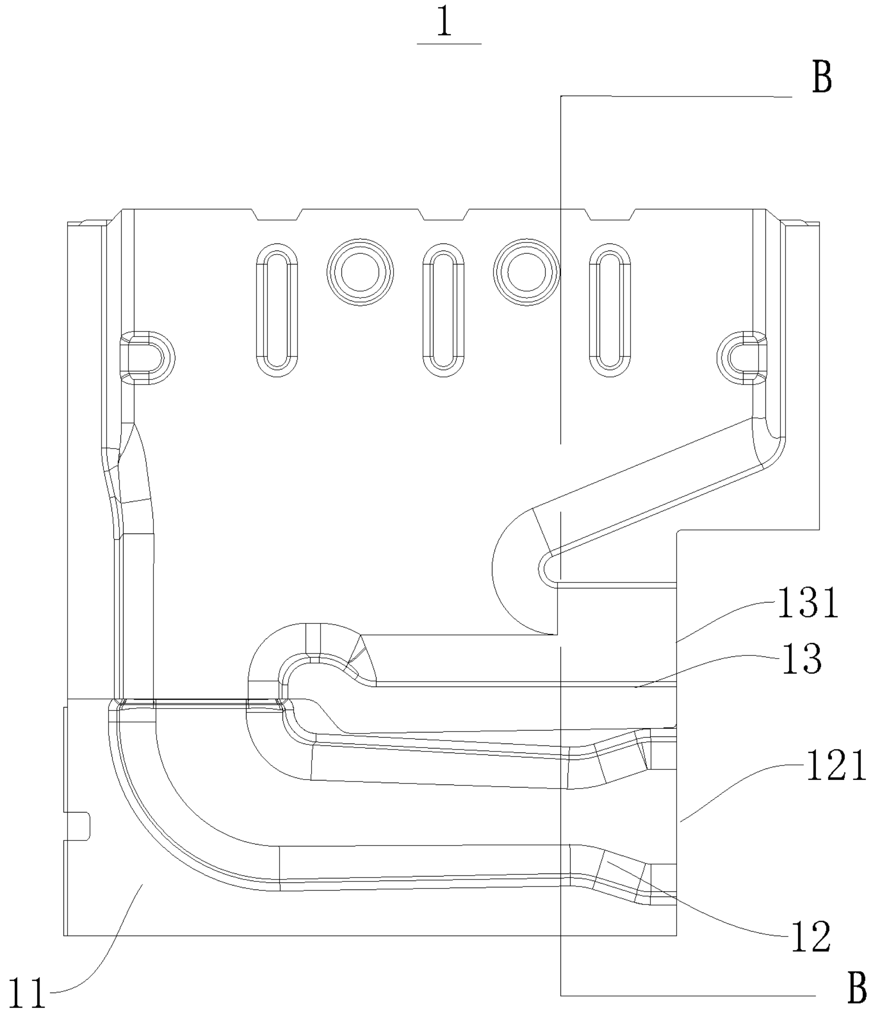
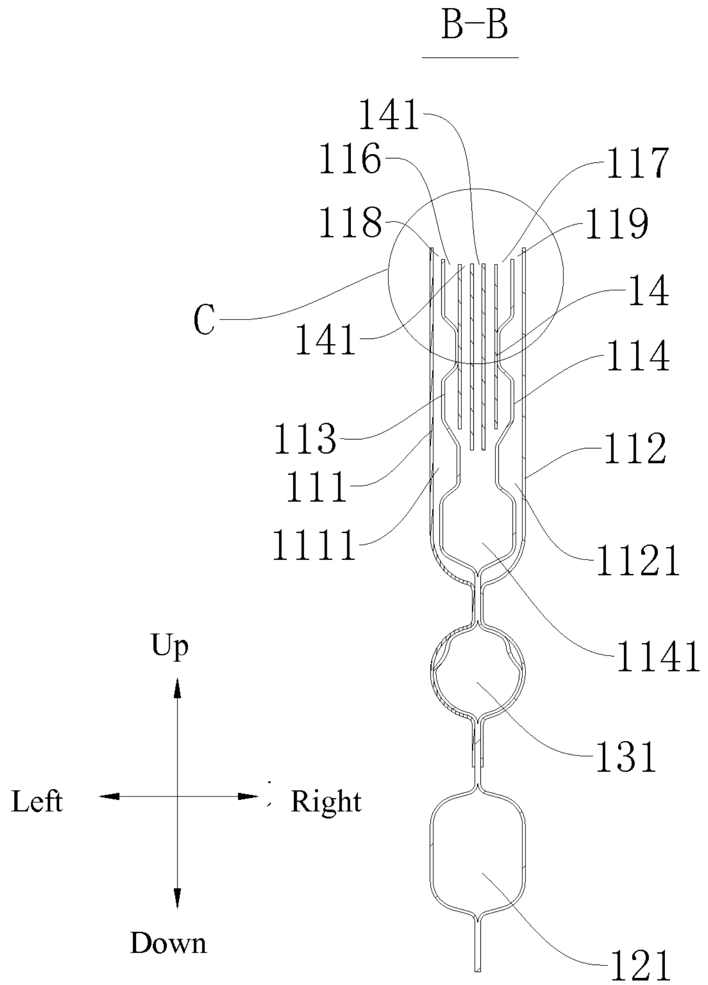


Fig. 6


B-B
141
116
117
118
119
C
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114
113
112
111
1111
1121
1141
Up
131
Left
Right
Down
121

Fig. 7

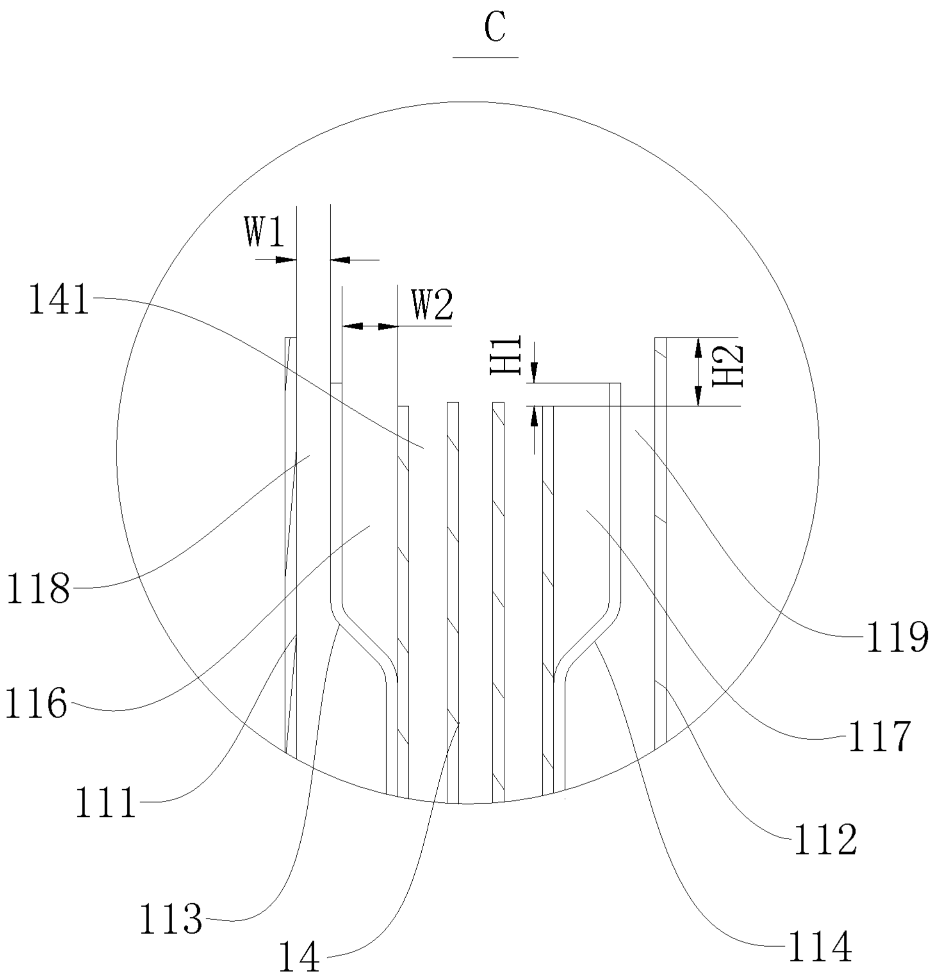

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/079169

A. CLASSIFICATION OF SUBJECT MATTER

F23D 14/08 (2006.01) i; F23D 14/62 (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, F23C 99, 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)

CPRSABS; CNTXT; VEN; CNKI: 燃烧器, 整流, 浓, 淡, 宽度, 高度, NOx, 引射, combust+, burner, rich, lean, gas, width, height, inject+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012244482 A1 (HOMMA, T. et al.), 27 September 2012 (27.09.2012), description, paragraphs [0019]-[0031], and figures 1-5	1-14
X	JP 2013205000 A (NORITSU KK), 07 October 2013 (07.10.2013), description, paragraphs [0016]-[0028], and figures 1-17	1-14
X	JP 2010261615 A (PALOMA KOGYO KK), 18 November 2010 (18.11.2010), description, paragraphs [0018]-[0051], and figures 1-8	1-14
A	CN 102537962 A (NORITZ CORPORATION), 04 July 2012 (04.07.2012), entire document	1-14
A	CN 205480981 U (TAIWAN SAKURA CORPORATION), 17 August 2016 (17.08.2016), entire document	1-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"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	Date of mailing of the international search report
01 August 2017	31 August 2017

Name and mailing address of the ISA
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Facsimile No. (86-10) 62019451

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/079169

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
US 2012244482 A1	27 September 2012	JP 2012202585 A	22 October 2012
		JP 5646380 B2	24 December 2014
		US 9091436 B2	28 July 2015
JP 2013205000 A	07 October 2013	JP 5673965 B2	18 February 2015
JP 2010261615 A	18 November 2010	JP 5300579 B2	25 September 2013
CN 102537962 A	04 July 2012	US 2012156629 A1	21 June 2012
		US 9115891 B2	25 August 2015
		CN 102537962 B	03 June 2015
		JP 5625869 B2	19 November 2014
		JP 5626098 B2	19 November 2014
		CN 102650428 B	12 August 2015
		CN 102650428 A	29 August 2012
		JP 2012229830 A	22 November 2012
		JP 2012127595 A	05 July 2012
CN 205480981 U	17 August 2016	None	

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