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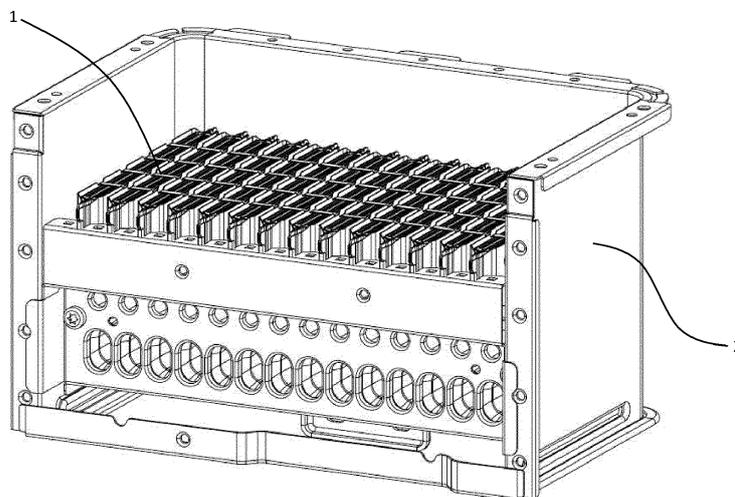
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(54) **BURNER UNITS AND GAS-FIRED WATER HEATING APPLIANCE USING THE SAME**

(57) The present invention discloses a burner unit including a first combustion portion and a second combustion portion. The first combustion portion extends in a lengthwise direction and including a number of first fire holes arranged along a widthwise direction perpendicular to the lengthwise direction for providing one of fuel-rich flames and fuel-lean flames. The second combustion portion extends in the lengthwise direction and including a number of second fire holes disposed on both sides of

the first fire holes in the widthwise direction for providing the other of the fuel-rich flames and the fuel-lean flames. A first interval width is defined between the number of first fire holes in the widthwise direction. In this way, a separate flame can be formed on each of the first fire holes, thereby increasing the overall surface area of the flames and facilitating heat dissipation to reduce the combustion temperature, thus contributing to the reduction of nitrogen oxide emissions.



**Fig. 1**

**Description**FIELD OF THE INVENTION

5 **[0001]** The present invention relates to the field of combustion appliance, and more particularly to a burner unit and a gas-fired water heating appliance using the burner unit.

BACKGROUND OF THE INVENTION

10 **[0002]** Gas-fired water heating appliance, such as gas water heaters or gas fired boilers, those typically include gas burners, heat exchangers, and combustion chambers that contain burners and heat exchangers. The burners often include a number of burner units arranged side by side, and each of the units has a gas-air mixing channel in which gas and air are mixed and passed to a fire hole disposed at the top of the units to be ignited in the combustion chamber to generate heat. The heat can be used to heat the water passing through the heat exchanger so that the heated water can be discharged for drinking, bathing, or space heating.

15 **[0003]** Burners generate exhaust gas during combustion and the exhaust gas is discharged to the atmosphere. The exhaust gases usually contain toxic compounds, like carbon monoxide (CO) and nitrogen oxides (NOx). Nowadays, people pay more attention to domestic gas appliances in the emissions of harmful gases, and a lot of measures have been adopted to reduce emissions of CO, however, no enough attention has been paid for the NOx emissions.

20 **[0004]** A lot of studies show that, nitrogen oxides is more toxic than carbon monoxide, and long-term emissions of NOx may cause acid rain and photochemical smog. Currently various measures for decreasing the generation of NOx in burners of combustion apparatus have been developed and utilized, for example, burners applying rich-lean combustion technique.

25 **[0005]** The basic principle of rich-lean combustion is to make part of the gas to be burnt with not enough air, that is, fuel-rich combustion, and the other part of the gas is burnt with an excess of air, that is, the fuel-lean combustion. In both cases, the stoichiometric ratio of fuel-air mixture deviates from the theoretical stoichiometric ratio of fuel and air when completely combusted. The low concentration of oxygen in the fuel-rich flame results in the primary combustion temperature is lower than that at theoretical stoichiometric ratio, which leads to a low generation of nitrogen oxides; while the fuel-lean flame has a high concentration of oxygen, and the lack of fuel gas also reduces the primary combustion temperature, thereby reducing the nitrogen oxides emissions and finally reducing the total nitrogen oxides. At the same time, there is a secondary combustion in the process of rich-lean combustion. The secondary combustion is carried out on the products of the primary combustion after the primary combustion being completed. Since the products of the primary combustion contain a large amount of gases such as carbon dioxide and water, which results in the temperature of the secondary reaction zone and the concentration of oxygen are both lower, thereby suppressing the formation of nitrogen oxides. Therefore, both the primary combustion and the secondary combustion can effectively inhibit the formation of nitrogen oxides. The burner for rich-lean combustion is shown in European Patent Publication EP 0 587 456 B1.

35 **[0006]** ErP regulation (Commission Regulation (EU) No 814/2013) requires that, from 26 September 2018 emissions of nitrogen oxides of conventional water heaters using gaseous fuels shall not exceed 56 mg/kWh. Nevertheless, according to the test of the burner as shown in the above-mentioned European patent, the emissions of nitrogen oxides of the burner exceed 70 mg/kWh, which obviously can not meet the emission requirements of the ErP regulation. In view of this, it is necessary to improve the existing burner so that it can meet the requirements of the ErP regulation to be implemented.

SUMMARY OF THE INVENTION

45 **[0007]** It is an object of present invention to provide a burner unit which can increase the heat dissipation area of a flame and thereby effectively reducing the emissions of nitrogen oxides.

**[0008]** It is another object of present invention to provide a gas-fired water heating appliance employing the above burner units.

50 **[0009]** According to one aspect of the present invention there is provided a burner unit including a first combustion portion and a second combustion portion. The first combustion portion extends in a lengthwise direction and including a number of first fire holes arranged along a widthwise direction perpendicular to the lengthwise direction for providing one of fuel-rich flames and fuel-lean flames. The second combustion portion extends in the lengthwise direction and including a number of second fire holes disposed on both sides of the first fire holes in the widthwise direction for providing the other of the fuel-rich flames and the fuel-lean flames. A first interval width is defined between the number of first fire holes in the widthwise direction.

55 **[0010]** In one embodiment, the first combustion portion is made of a metal sheet plate, and the first interval width is larger than the thickness of the sheet plate.

[0011] In a preferred embodiment, the first interval width is more than twice the thickness of the sheet plate.

[0012] Preferably, a second interval width larger than the first interval width is defined between the first fire hole and the second fire hole in the widthwise direction.

5 [0013] Preferably, the first combustion portion includes a first burning head having a pair of vertical plates extending in a vertical direction and a flat plate connected between the pair of vertical plates, and the first fire holes are longitudinally disposed in the flat plate.

[0014] Preferably, the first interval width is defined in the flat plate and disposed beside the first fire hole along the widthwise direction.

10 [0015] Preferably, the first combustion portion further includes a second burning head with the structure as same as that of the first burning head, and the first and the second burning heads are symmetrically arranged, wherein part of the plurality of first fire holes are disposed between the first and the second burning heads.

[0016] Preferably, another part of the number of first fire holes disposed in the first and the second burning heads are spaced along the lengthwise direction; and a number of spaced ribs disposed on the vertical plates at two opposite sides of the first and the second burning heads to divide the space between the first and the second burning heads into the part of the number of first fire holes.

[0017] Preferably, the vertical plates of the first and the second burning heads disposed opposite to each other are further provided with a number of turbulators disposed among the number of spaced ribs; and the vertical plates of the first and the second burning heads disposed away from each other extend plainly.

20 [0018] Preferably, the burner unit further includes a main body and a shell covering the upper half of the main body; and the main body is provided at its longitudinal end with a first air inlet and a second air inlet located above the first air inlet; wherein the first air inlet is in communication with the first fire hole for supplying a first fuel-air mixture and the second air inlet is in communication with the second fire hole for supplying a second fuel-air mixture.

[0019] Preferably, the second fire hole is disposed between the first combustion portion and the shell, and the shell is provided with a number of convex protrusions located near the second fire holes and arranged at intervals in the lengthwise direction.

[0020] According to another aspect of the present invention there is provided a gas-fired water heating appliance having a burner including a number of aforementioned burner units arranged side by side and a heat exchanger absorbing the heat generated by the number of burner units and transfers the heat to water flowing therethrough.

30 [0021] Compared with the state of art, the present invention has the advantages that: as a first interval width is defined between the first fire holes in the widthwise direction, a separate flame can be formed on each of the first fire holes, thereby increasing the overall surface area of the flames and facilitating heat dissipation to reduce the combustion temperature, thus contributing to the reduction of nitrogen oxide emissions.

#### BRIEF DESCRIPTION OF THE DRAWINGS

35 [0022] For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic perspective view of a burner in accordance with one embodiment of present invention;

40 Fig. 2 is a schematic perspective view of a burner unit employed in the burner as shown in Fig. 1;

Fig. 3 is an exploded perspective view of the burner unit as shown in Fig. 2;

45 Fig. 4 is an exploded perspective view of a burning head of the burner unit as shown in Fig. 3;

Fig. 5 is a schematic perspective view of the burner unit as shown in Fig. 2, in which part of the burner unit is cut off;

50 Fig. 6 is a schematic cross-sectional view of the burner unit as shown in Fig. 2;

Fig. 7 is a top view of the burner unit as shown in Fig. 2;

55 Fig. 8 is a schematic plan view of a gas-fired water heating appliance in accordance with one embodiment of present invention, wherein a front cover of the appliance is removed to show its internal structure.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Reference will now be made to the drawing figures to describe the preferred embodiments of the present

invention in detail. However, the embodiments can not be used to restrict the present invention. Changes such as structure, method and function obviously made to those of ordinary skill in the art are also protected by the present invention.

5 [0024] Gas water heaters and gas boilers could be fired with combustible gas, such as natural gas, city gas, liquefied petroleum gas, methane, etc., thereby supplying hot water and/or heating living space for domestic sanitary usage and heating purpose. The embodiments to be described below take a gas water heater as an example, however, the present invention is not limited to this, and it can also be applied on gas boilers.

10 [0025] First referring to Fig. 8, a gas water heater 100 in accordance with one embodiment of present invention, includes a housing, and a burner, a heat exchanger 51, an air supply fan 52, and a flue hood 53 accommodated in the housing, and an inlet tube, an outlet tube, and a gas supply pipe extending out of the housing.

15 [0026] The housing may be composed of a number of plates, such as a front plate, a back plate, a top plate, a bottom plate, and a pair of side plates. The heat exchanger 51 is generally placed above the burner. The heat exchanger may include multiple heat absorbing fins and a heat absorbing pipe passing through the multiple heat absorbing fins. The heat absorbing pipe communicates with the inlet tube and the outlet tube. Fuel gas and air mixture is burnt in a casing of the burner, and combustion exhaust gas of the burner pass through the fins of the heat exchanger with the generated heat interchanging with water passing through the heat absorbing pipe, then heated hot water passes through the outlet tube for domestic sanitary usage, like drinking, showering, or bathing.

20 [0027] The air supply Fan 52 is provided at a lower portion of the housing, which is operated to supply outside air to the burner as combustion air, also, force the flue gas to be discharged outdoors. The flue hood 53 is placed upon the heat exchanger 51 for collecting flue gas containing carbon monoxide and nitrogen oxides, and then the flue gas is discharged to the outdoors through discharging ducts (not shown).

[0028] Fig. 1 shows a burner in accordance with one embodiment of present invention. The burner includes a casing 2 and a number of burner units 1 arranged side by side in the casing.

25 [0029] With reference to Fig. 2 and Fig. 3, the burner unit 1 can made of metallic sheet plates and has a main body 10, burning heads 20 received in the main body, and a shell 30 substantially covering the upper half of the main body. The main body 10 is generally in the shape of a vertical blade, and an elongated receiving portion 13 is disposed at the upper portion of the main body 10, in which a receiving cavity 131 is defined for receiving the combustion heads 20. The main body 10 is provided at a lower position of one longitudinal end thereof with a first air inlet 11, and a first fuel-air mixing chamber 111 communicated between the first air inlet 11 and the receiving cavity 131. The main body 10 is also provided at the longitudinal end with a second air inlet 12 located above the first air inlet 11, and a second fuel-air mixing chamber 121 communicated with the second air inlet. A number of through holes 1211 are provided at a rear portion of the second fuel-air mixing chamber 121.

30 [0030] The shell 30 has a pair of side plates 31 that extend in a lengthwise direction. As shown in FIG. 5, a cylindrical cavity 32 is defined in the side plates 31 to cover the second fuel-air mixing chamber 121. A number of strips are provided at the top of the shell 30 and straddle the pair of side plates 31 to restrict the burning head 20 within the receiving cavity 131 of the main body. The shell 30 is formed with a number of concave depressions 312 spaced along the lengthwise direction at the upper portion thereof for abutting against outer walls of the receiving portion 13 of the main body and defining gap therebetween. The shell is also provided with a number of convex protrusions 311 spaced along the lengthwise direction at the upper portion thereof for abutting against the corresponding protrusions on the adjacent burner units so as to prevent the shell from being deformed due to the combustion at a high temperature.

35 [0031] Refer to Figs. 4 to 7, in the present embodiment, the burning heads 20 include a first burning head and a second burning head which are formed in the same structures and are symmetrically arranged. Since the structures of the two burning heads are the same, only one of them will be described in details hereinafter. The first burning head is stamped and bent from a metallic sheet plate and formed with a pair of vertical plates 21, 23 extending in a vertical direction and a flat plate 22 connected between the tops of the pair of vertical plates. In this embodiment, a number of fire holes 221 longitudinally extending are defined in the flat plate 22 at intervals. As shown in Fig. 4, a number of spaced ribs 231 protruded on the vertical plates 23 of the first and the second burning heads opposite to each other to divide the space between the first and the second burning heads into a number of pieces in the lengthwise direction, and the number of pieces corresponds to the fire holes 211 of the first and second burning heads in a widthwise direction perpendicular to the lengthwise direction. Moreover, the above vertical plates of the first and the second burning heads disposed opposite to each other are further provided with a number of turbulators (232) disposed among the number of spaced ribs 231. Furthermore, the vertical plates of the first and the second burning heads disposed away from each other extend plainly.

40 [0032] As shown in Figs. 2 and 5, the burner units has a first air inlet 11 and a second air inlet 12 for being passed through by fuel-air mixtures with different stoichiometric ratio. Gas supplied from a fuel supply device (not shown) and the primary air pass through the first air inlet 11 at a predetermined ratio. The first fuel-air mixing chamber 111 is formed with a venturi tube portion adjacent to the first air inlet 11. The Venturi tube is used for sucking fluid flows through a length of tube of varying diameter. As the principles and configurations of Venturi tubes are well-known to those skilled in the art, the applicant will not repeat them here. The incoming fuel gas and air are mixed thoroughly when passing through

the first mixing chamber 111 to generate a first fuel-air mixture, which then flows into the flow passage defined by the vertical plates 21, 23 and finally burns at the fire holes 231. In this embodiment, the burning heads 20 form a first combustion portion, and the fire holes disposed at the top thereof form first fire holes 221 for burning the first fuel-air mixture to generate one of fuel-rich flames and fuel-lean flames, and this flame type is related to the stoichiometric ratio of the first fuel-air mixture. Similarly, gas supplied from the fuel supply device and the primary air pass through the second air inlet 12 at another predetermined ratio, and enter the gap between the shell 31 and the receiving portion 13 of the main body through the through holes 1211 after sufficiently mixing in the second mixing chamber 121, and finally burn at the fire holes. This burning area at the top of the gap constitutes a second combustion portion, wherein the number of fire holes separated by the recesses 312 constitute second fire holes 223 for burning the second fuel-air mixture to generate the other of the fuel-rich flames and the fuel-lean flames. As such, the flame type is related to the stoichiometric ratio of the second fuel-air mixture.

**[0033]** As mentioned above, the first fuel-air mixing chamber 111 and the second fuel-air mixing chamber 121 of the burner unit 1 are used to provide fuel-air mixtures with different fuel-to-air stoichiometric ratio, such as rich fuel-air mixture and lean fuel-air mixture. The term "rich fuel-air mixture" as used herein refers to a mixture of too-rich fuel and primary air compared to the stoichiometric ratio of fuel and air when completely combusted, in which case the coefficient of the primary air is smaller and the flames of combustion are fuel-rich flames; in contrast, a "lean fuel-air mixture" refers to a mixture of too-lean fuel and primary air compared to the stoichiometric ratio of fuel and air when completely combusted, in this case, the coefficient of the primary air is larger and the flames of combustion are fuel-lean flames. In the present embodiment, the fuel is natural gas, and a lean fuel-air mixture is formed in the first fuel-air mixing chamber 111, and accordingly, the flames formed on the first fire holes 221 is fuel-lean flames; while a rich fuel-air mixture is formed in second fuel-air mixing chamber 121, and accordingly, the flames formed on the second fire holes 223 are fuel-rich flames.

**[0034]** As shown in Figs. 6 and 7, in this embodiment, the first fire holes 221 include three rows of longitudinally extending holes respectively provided in the flat plates 22 of the first and second burning heads, and the space between the vertical plates 23 of the first and the second burning heads. A first interval width is defined between the first fire holes 221 in the widthwise direction, so that a separate flame can be formed on each of the first fire holes 231, thereby increasing the overall surface area of the flames and facilitating heat dissipation to reduce the combustion temperature, thus contributing to the reduction of nitrogen oxide emissions. The first interval width is more than the thickness of the metal sheet plate forming the combustion heads, and preferably, the first interval width is more than twice the thickness of the sheet plate in order to prevent the flames generated on the fire holes from mixing with each other. In present embodiment, the first interval width is greater than three times of the thickness of the sheet plate, which is achieved by a side portion 222 of the flat plates 22 beside the first fire hole 221 in the widthwise direction. Similarly, a second interval width is formed between the first fire hole 221 and the second fire hole 223 in the widthwise direction, and the second interval width is larger than the first interval width, the size of which equals to the width of the other side portion 224 of the flat plates 22 beside the first fire hole 221 plus the thickness of the sheet plate forming the receiving portion 13 of the main body.

**[0035]** The table below shows test results for the gas water heater as described in the above embodiments, and the results are measured according to the requirements of the nitrogen oxide emission test (chapter 6.9.3) required in the European standard for gas water heaters (EN 26 : 2015), and the test conditions are:

Designation: G20;  
 Ambient temperature: 24.1°C;  
 Barometric pressure: 1021 mbar;  
 Relative humidity: 9.7 H<sub>2</sub>O/kg;  
 Water temperature at inlet: 10.0°C, water temperature at outlet: 40.0°C;  
 Q<sub>max</sub> or Q<sub>average</sub> for range rating boiler: 31.00 kW, Q<sub>min</sub>: 5 kW;

EP 3 343 105 A1

	Designation	Calorific Value [MJ/m <sup>3</sup> ]	CO <sub>2</sub> max. [%]	Density		Load [kW]	CO <sub>2</sub> [%]	CO 0% O <sub>2</sub> [ppm]	NO <sub>x</sub> cor. 0% O <sub>2</sub> [ppm]		
				Stand.	Meas.						
5	1	G20	34.02	11.7	0.555	0.555	31.15	6.40	299	60	Pn
10	2	G20	34.02	11.7	0.555	0.555	21.65	5.60	138	33	70%Pn
	3	G20	34.02	11.7	0.555	0.555	15.86	5.05	95	21	50%Pn
	4	G20	34.02	11.7	0.555	0.555	5.06	2.09	97	25	1min
15											

[0036] As can be seen from the above table, NO<sub>x</sub> emission is 60 ppm at an actual load Q<sub>1</sub> = 31.15 kW that is close to the rated power; NO<sub>x</sub> emission is 33 ppm at an actual load Q<sub>2</sub> = 21.65 kW that is approximately 70% of the rated power; NO<sub>x</sub> emissions is 21 ppm at an actual load Q<sub>3</sub> = 15.86 kW that is close to 50% of the rated power; and NO<sub>x</sub> emission is 25 ppm at an actual load Q<sub>4</sub> = 5.06 kW that is close to the minimum power. Thus, according to the weight values defined in chapter 6.9.3.2 of the European Standard (EN 26 : 2015), i.e., 0.10 for Q<sub>2</sub>, 0.45 for Q<sub>3</sub>, and 0.45 for Q<sub>4</sub>. Thus, the NO<sub>x</sub> emissions on instantaneous water heaters with adjustable output: NO<sub>x</sub> = 0.10 x 33 + 0.45 x 21 + 0.45 x 25 = 24 ppm. Finally, according to the NO<sub>x</sub> conversion calculation mentioned in Annex K of the Standard, the NO<sub>x</sub> emission value for second family gases G20 is: 24 x 1.764 = 42.336 mg/kWh, which obviously satisfies the ErP regulation that requires nitrogen oxide emissions of conventional water heaters using gaseous fuels should not exceed 56 mg/kWh.

[0037] It is to be understood, however, that even though numerous, characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosed is illustrative only, and changes may be made in detail, especially in matters of number, shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broadest general meaning of the terms in which the appended claims are expressed.

Claims

1. A burner unit (1), characterized in that the burner unit comprises:

a first combustion portion extending in a lengthwise direction and including a plurality of first fire holes (221) arranged along a widthwise direction perpendicular to the lengthwise direction for providing one of fuel-rich flames and fuel-lean flames;

a second combustion portion extending in the lengthwise direction and including a plurality of second fire holes (223) disposed on both sides of the first fire holes in the widthwise direction for providing the other of the fuel-rich flames and the fuel-lean flames; wherein

a first interval width is defined between said plurality of first fire holes (221) in the widthwise direction.

2. A burner unit according to claim 1, characterized in that the first combustion portion is made of a metal sheet plate, and said first interval width is larger than the thickness of the sheet plate.

3. A burner unit according to claim 2, characterized in that the first interval width is more than twice the thickness of the sheet plate.

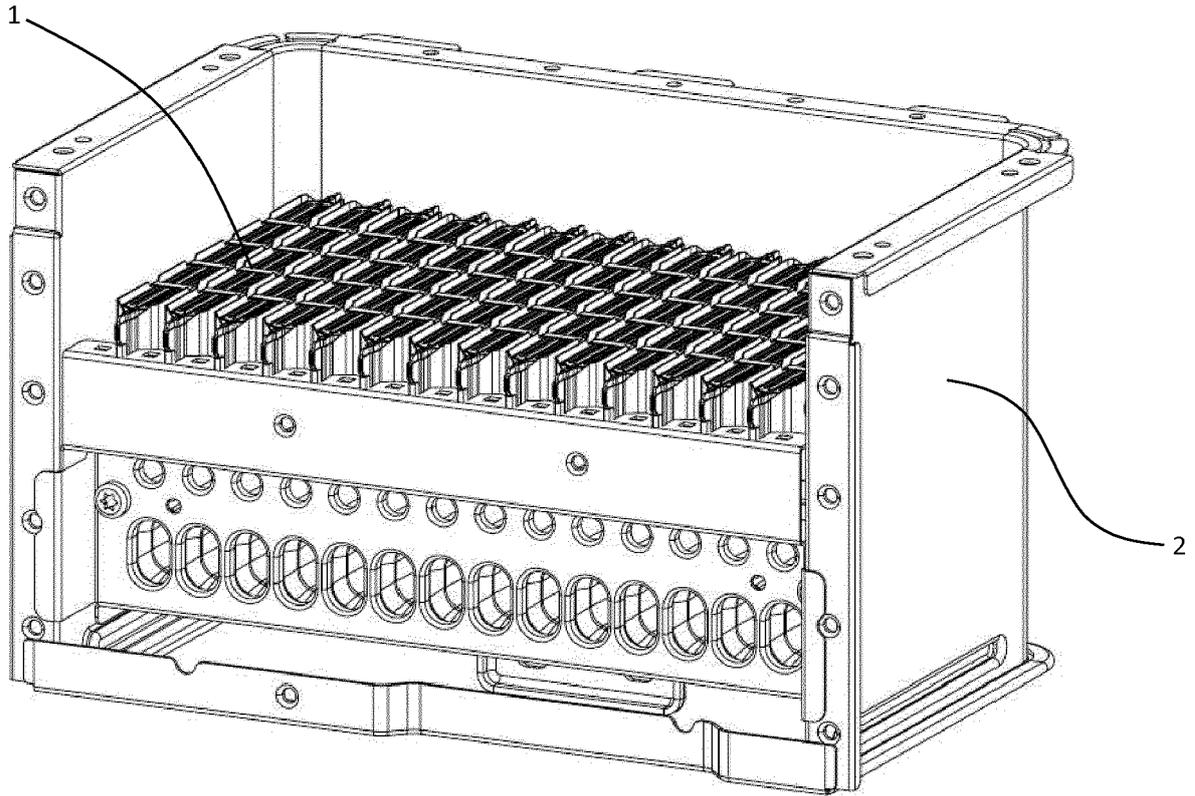
4. A burner unit according to claim 1, characterized in that a second interval width larger than the first interval width is defined between the first fire hole (221) and the second fire hole (223) in the widthwise direction.

5. A burner unit according to claim 1, characterized in that the first combustion portion includes a first burning head having a pair of vertical plates (21, 23) extending in a vertical direction and a flat plate (22) connected between said pair of vertical plates, and the first fire holes are longitudinally disposed in the flat plate.

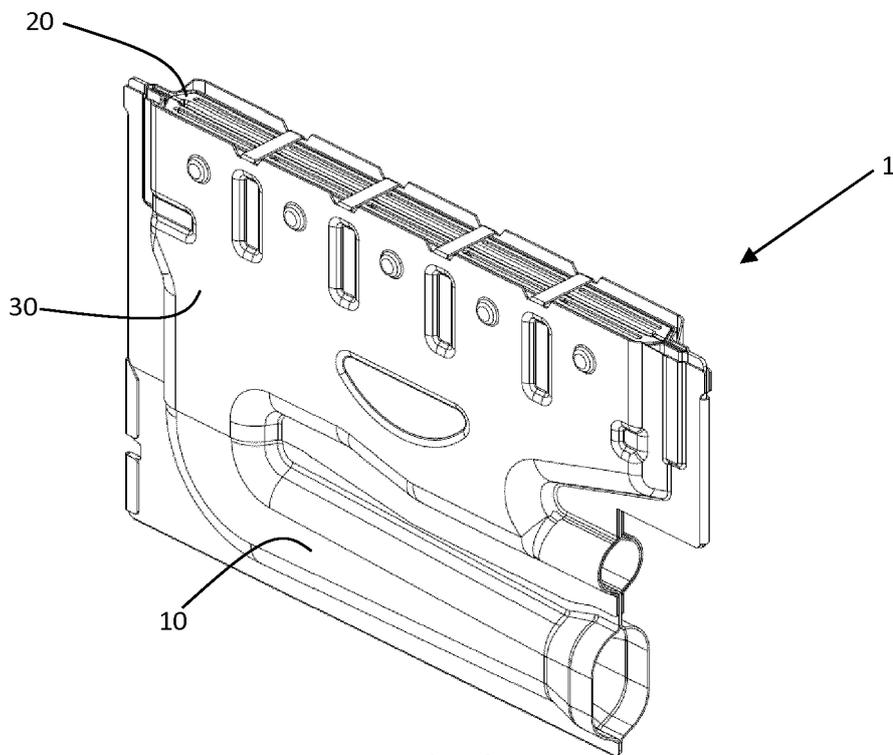
6. A burner unit according to claim 5, characterized in that said first interval width is defined in the flat plate (22) and

disposed beside the first fire hole (221) along the widthwise direction.

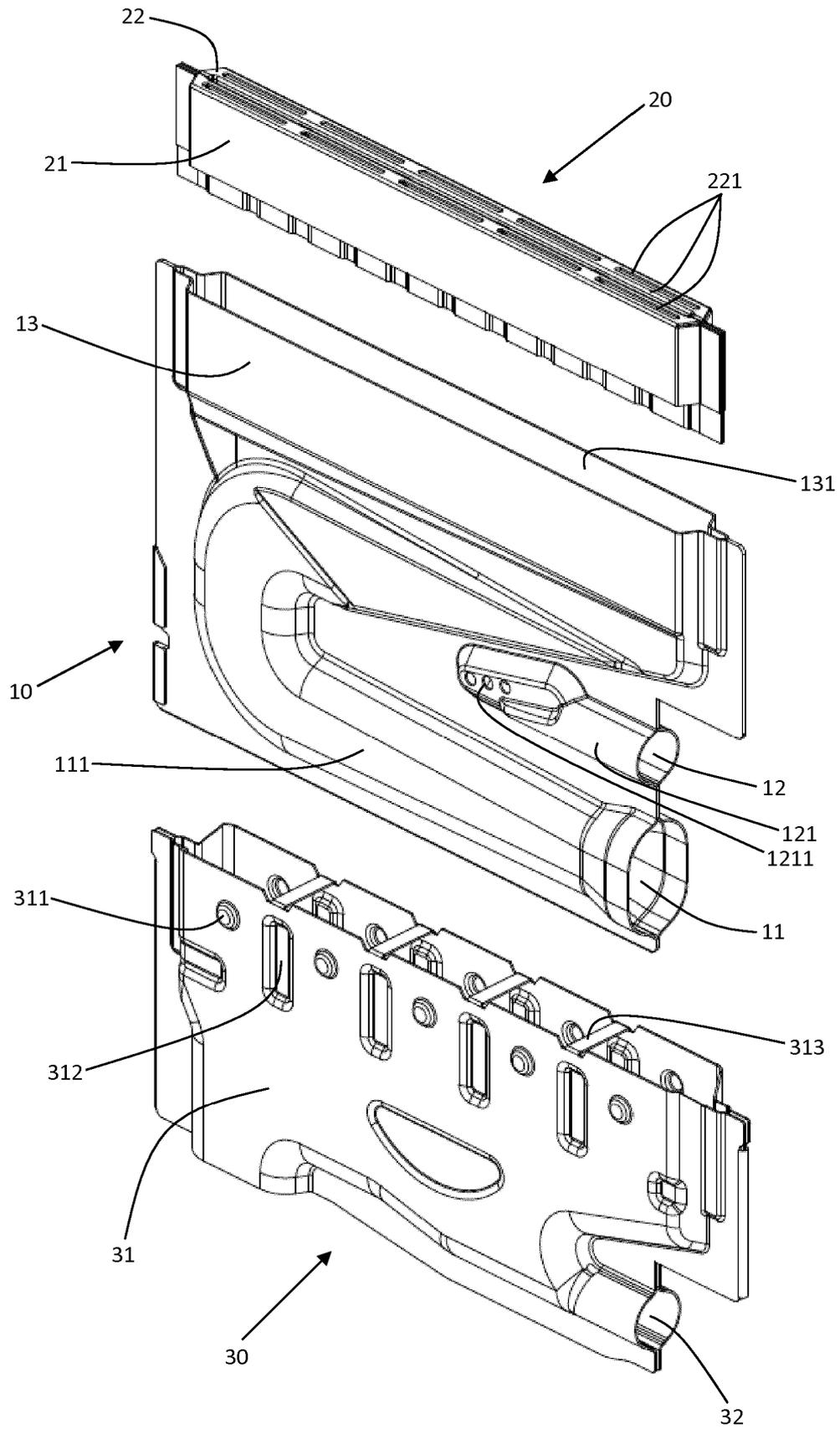
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7. A burner unit according to claim 5, **characterized in that** said first combustion portion further comprises a second burning head with the structure as same as that of the first burning head, and the first and the second burning heads are symmetrically arranged, wherein part of the plurality of first fire holes (221) are disposed between the first and the second burning heads.
- 10
8. A burner unit according to claim 7, **characterized in that** another part of the plurality of first fire holes (221) disposed in the first and the second burning heads are spaced along the lengthwise direction; and a plurality of spaced ribs (231) disposed on the vertical plates (23) at two opposite sides of the first and the second burning heads to divide the space between the first and the second burning heads into said part of the plurality of first fire holes.
- 15
9. A burner unit according to claim 8, **characterized in that** the vertical plates of the first and the second burning heads disposed opposite to each other are further provided with a plurality of turbulators (232) disposed among said plurality of spaced ribs (231); and the vertical plates of the first and the second burning heads disposed away from each other extend plainly.
- 20
10. A burner unit according to claim 1, **characterized in that** the burner unit further comprises a main body (10) and a shell (30) covering the upper half of the main body; and the main body is provided at its longitudinal end with a first air inlet (11) and a second air inlet (12) located above the first air inlet; wherein the first air inlet is in communication with the first fire hole for supplying a first fuel-air mixture and the second air inlet (12) is in communication with the second fire hole (223) for supplying a second fuel-air mixture.
- 25
11. A burner unit according to claim 10, **characterized in that** the second fire hole (223) is disposed between the first combustion portion and the shell, and said shell is provided with a plurality of convex protrusions (311) located near the second fire holes and arranged at intervals in the lengthwise direction.
- 30
12. A gas-fired water heating appliance (100), **characterized in that**, said appliance comprises:  
a burner comprising a plurality of burner units (1) according to any of claims 1 to 11 and arranged side by side; and  
a heat exchanger (51) absorbs the heat generated by said plurality of burner units and transfers the heat to water flowing therethrough.
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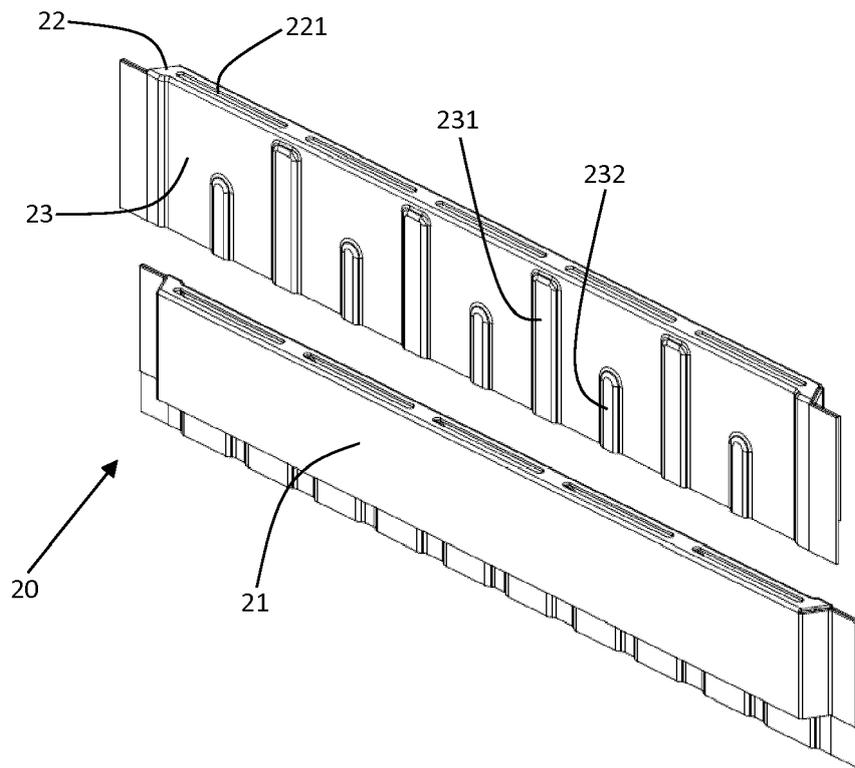
**Fig. 1**



**Fig. 2**



**Fig. 3**



**Fig. 4**

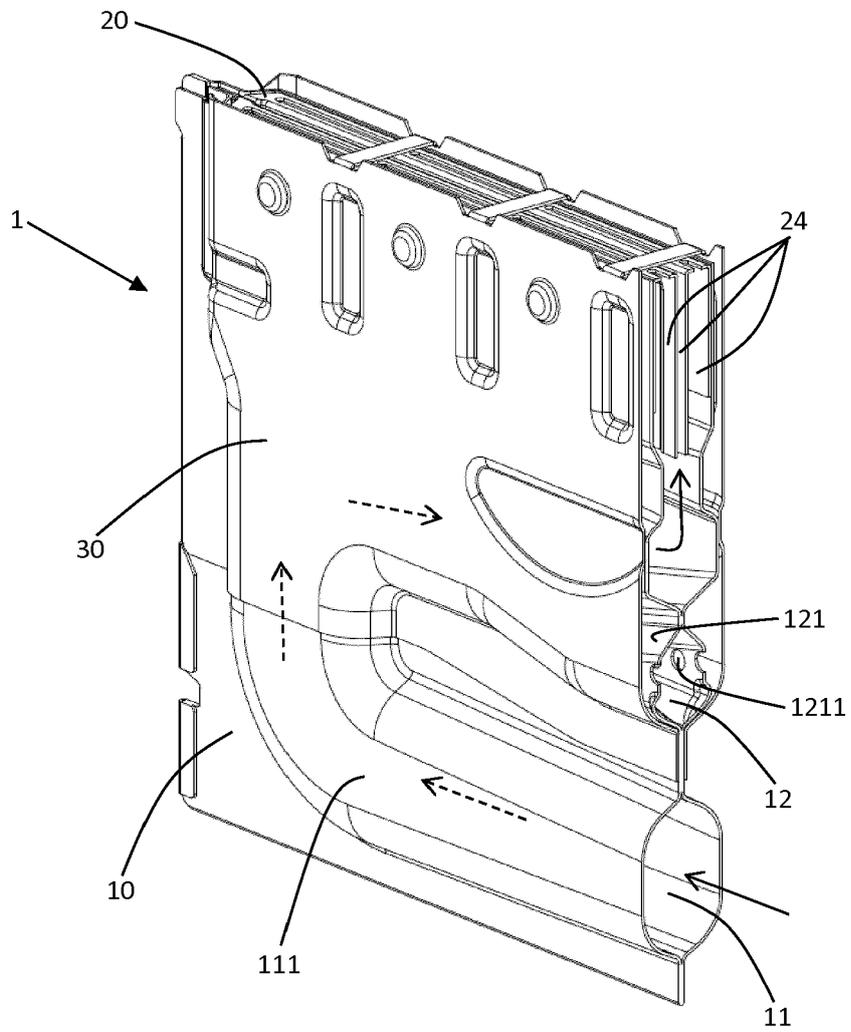
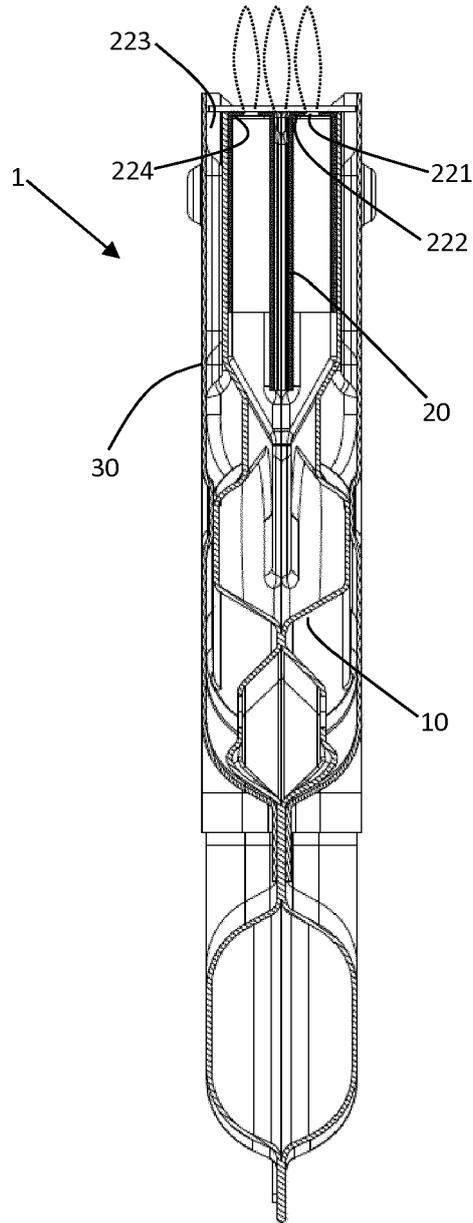
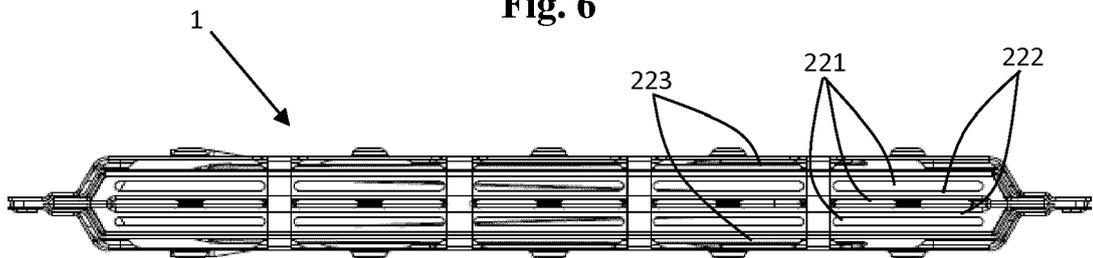


Fig. 5



**Fig. 6**



**Fig. 7**

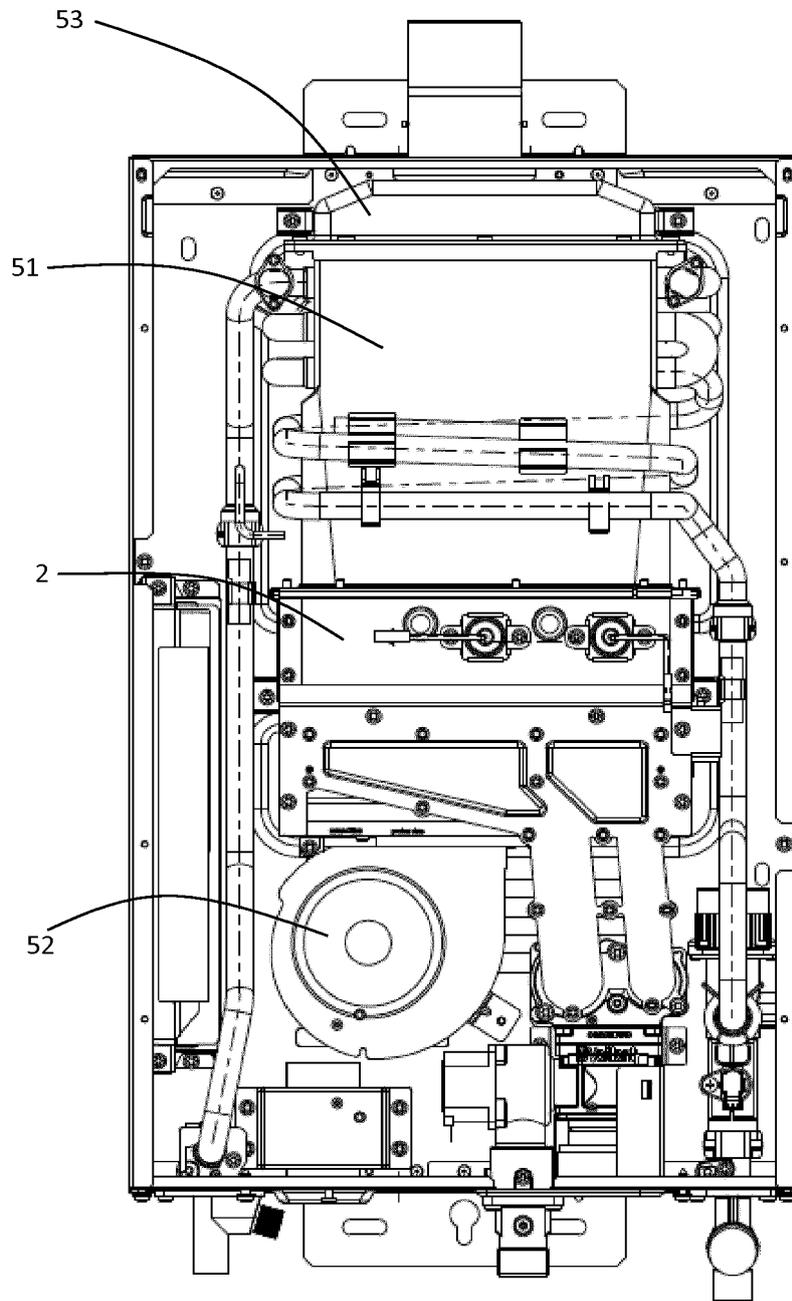


Fig. 8



EUROPEAN SEARCH REPORT

Application Number  
EP 17 20 8762

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 2013/171576 A1 (AKIYAMA TAKASHI [JP] ET AL) 4 July 2013 (2013-07-04) * paragraph [0048] - paragraph [0074]; figures 1-23 *	1-4, 10-12 5	INV. F23D14/58 F23D14/04
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			TECHNICAL FIELDS SEARCHED (IPC)
			F23D
The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>19 April 2018</b>	Examiner <b>Theis, Gilbert</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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