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(54) **BURNER WITH LINEAR ARRAYS OF FIRE HOLES**

(57) A burner with linear arrays of fire holes, comprising at least one combustion unit, a secondary air regulation panel and a fuel gas transmission unit; the present invention uses a pattern of 2:1 repeated longitudinal arrangement of flame ports along each combustion unit and modifies the structures of the fuel gas channel and the gas regulation channel, so as to increase the burning area of the fire holes, change the burning power at the surfaces of the fire holes, and reduce the height of the burning flame at the fire holes. By using the primary air inlet openings having elongated shapes and auxiliary air inlet openings having circular shapes on the secondary air regulation panel, the combustion coefficient α_1 of the fuel is changed so that the flame is lowered and hence reduces the emissions of NO_x during thermal reaction. The present invention reduces the height of the burning flame at the fire holes, reduces the temperature of the flame, and obviously reduces the emissions of NO_x during thermal reaction of the burner. Thus, the burner of the present invention has the advantages of small load, reduced vibration and reduced noise during burning.

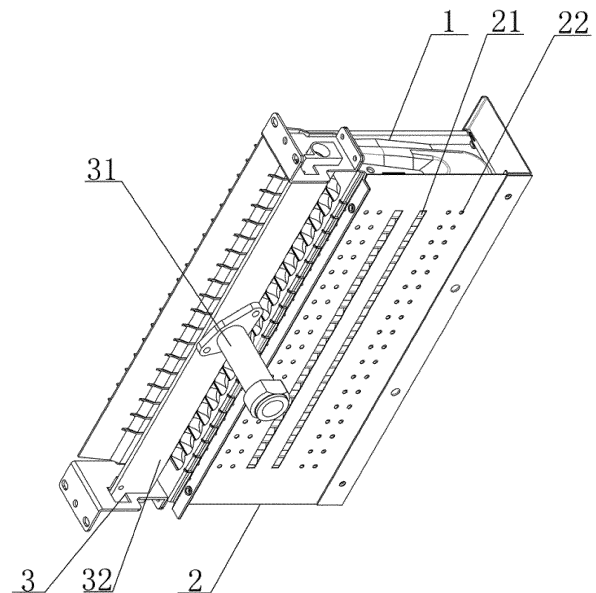


FIG. 1

Description

Technical Field

[0001] The present invention relates to technical field of gas burner, and more specifically relates to a burner with linear arrays of fire holes.

Background Art

[0002] Nitrogen oxides (NO_x) include NO , NO_2 , N_2O , N_2O_3 , N_2O_4 and N_2O_5 etc. NO_x in flue gas are mainly NO and NO_2 . NO is very toxic, and can be very easily combined with hemoglobin (Hb) in human blood, causing blood hypoxia which in turns results in central nervous system paralysis. Compared with CO , the affinity of NO with hemoglobin is about hundreds to thousands times stronger. The pollution of NO_x to the environment and its harm to the human body are well known.

[0003] The nitrogen oxides produced in the combustion process of a gas burner are mainly NO and NO_2 , and the term nitrogen oxides NO_x generally refer to these two kinds of nitrogen oxides. Loads of experimental results show that the nitrogen oxides emitted by the burner are mainly NO , accounting for about 95% on average, while NO_2 only accounts for about 5%. NO produced by general fuel combustion has two main sources: the first one is the oxidation of nitrogen in combustion-supporting air during the combustion process; and the second one is the re-oxidation of nitrides after being thermally decomposed during the combustion process. The first one is a more dominating source of NO among the described two sources, and the NO from this first source will be herein referred to as "thermally reactive NO ". The NO from the second source will be referred to as "fuel NO ". Apart from these two sources, there is a kind of "instantaneous NO " which accounts for just a small amount.

[0004] In the combustion process of most burners, NO_x are produced from gas during the combustion process. Combustion methods and combustion conditions can significantly affect the production of NO_x . Therefore, the general state during combustion can be modified to reduce the production of NO_x . Specific ways of modification includes: low flame combustion method, and increasing the combustion coefficient α_1 , etc.

[0005] A burner in the prior art has unreasonable structural designs for the flame ports causing the combustion area to be too small. According to the principle of low- NO_x combustion and according to experiments, the main source of NO_x in fuel gas is mainly thermally reactive NO_x . In order to reduce NO_x emissions in fuel gas, the height of the flame should be reduced as much as possible to lower the flame temperature, so that NO_x emissions during thermal reaction can be reduced.

[0006] Burner is a key component of the entire combustion equipment, bearing the responsibility of stable combustion of the fuel and as complete as possible combustion of the fuel. For this reason, in order to suppress

the generation of NO_x , to achieve low flame combustion, and to increase the combustion coefficient α_1 , the structure of the burner has to be contemplated.

Disclosure of the Invention

[0007] In view of the aforesaid disadvantages now in the prior art, the present invention provides a burner with linear arrays of fire holes. The present invention uses a pattern of 2:1 repeated longitudinal arrangement of flame ports along each combustion unit and modifies the structures of the fuel gas channel and the gas regulation channel, so as to increase the burning area of the fire holes, change the burning power at the surfaces of the fire holes, and reduce the height of the burning flame at the fire holes. By using the primary air inlet openings having elongated shapes and auxiliary air inlet openings having circular shapes on the secondary air regulation panel, the combustion coefficient α_1 of the fuel is changed so that the flame is lowered and hence reduces the emissions of NO_x during thermal reaction. The present invention reduces the height of the burning flame at the fire holes, reduces the temperature of the flame, and obviously reduces the emissions of NO_x during thermal reaction of the burner. Thus, the burner of the present invention has the advantages of small load, reduced vibration and reduced noise during burning.

[0008] To fulfill the above objects of the present invention, the present invention provides the following technical scheme:

A burner with linear arrays of fire holes, comprising at least one combustion unit, a secondary air regulation panel and a fuel gas transmission unit; the combustion unit is formed by punching and pressing panel boards; the combustion unit is a chamber having a composite structure comprising flame ports, a gas regulation channel and a fuel gas channel in communication with one another, wherein the flame ports are disposed on an upper surface of the combustion unit, the gas regulation channel is disposed below the flame ports, and the fuel gas channel is disposed below the gas regulation channel; the fuel gas channel has a curved shape, and comprising in sequential order a fuel gas inlet, a fuel gas mixing section and a fuel gas pressure reduction section; the secondary air regulation panel is formed by punching and pressing panel boards; the secondary air regulation panel comprises a main flat surface; one side of the main flat surface is provided with a distributor seat, and another side of the main surface is provided with at least one combustion unit seat; primary air inlet openings in elongated shapes and auxiliary air inlet openings in circular shapes are provided on the main flat surface of the secondary air regulation panel; the fuel gas transmission unit comprises a fuel gas

pipe, a distributor and a plurality of nozzles; the distributor has an elongated shape; one side of the distributor is provided with a fuel gas pipe port, and another side of the distributor is sequentially arranged with a plurality of nozzle seats; the fuel gas pipe is connected to the fuel gas pipe port of the distributor; the nozzles are sequentially arranged on the nozzle seats of the distributor respectively;

the fuel gas transmission unit is mounted on the distributor seat of the secondary air regulation panel through the distributor; a plurality of combustion units are provided, and a plurality of combustion unit seats are provided correspondingly; the combustion units are sequentially arranged on the combustion unit seats of the secondary air regulation panel respectively; also, the fuel gas inlets of the combustion units correspond to the nozzles respectively.

[0009] The gas regulation channel of the combustion unit is a rhombus-shaped chamber formed in the combustion unit where the rhombus-shaped chamber has a middle part wider than two ends thereof along a longitudinal direction of the combustion unit.

[0010] The fuel gas inlet of the fuel gas channel has a reverse taper shape towards an opening of the fuel gas inlet; the fuel gas inlet has a cross sectional shape of a circle with two flat sides.

[0011] The fuel gas mixing section of the fuel gas channel is a tapered channel with a gradually varying internal diameter along the tapered channel.

[0012] The fuel gas pressure reduction section of the fuel gas channel is a channel having a channel cross section larger than a channel cross section of the fuel gas mixing section.

[0013] The flame ports of the combustion unit are arranged longitudinally on the upper surface of the combustion unit both in double rows and in single row, wherein the flame ports arranged in double rows are main flame ports, and the flame ports arranged in a single row are regulating flame ports; the main flame ports and the regulating flame ports are arranged alternately where said double rows of main flame ports are interrupted by one regulating flame port of said single row of regulating flame ports for every arrangement of two main flame ports in each row.

[0014] The present invention uses a pattern of 2:1 repeated longitudinal arrangement of flame ports along each combustion unit and modifies the structures of the fuel gas channel and the gas regulation channel, so as to increase the burning area of the fire holes, change the burning power at the surfaces of the fire holes, and reduce the height of the burning flame at the fire holes. By using the primary air inlet openings having elongated shapes and auxiliary air inlet openings having circular shapes on the secondary air regulation panel, the combustion coefficient a_1 of the fuel is changed so that the flame is lowered and hence reduces the emissions of NO_x during thermal reaction. The present invention re-

duces the height of the burning flame at the fire holes, reduces the temperature of the flame, and obviously reduces the emissions of NO_x during thermal reaction of the burner. Thus, the burner of the present invention has the advantages of small load, reduced vibration and reduced noise during burning.

Brief Description of Drawings

[0015]

FIG. 1 is a schematic structural view of the present invention.

FIG. 2 is a schematic structural view of the fuel gas transmission unit.

FIG. 3 is a schematic structural view of a combustion unit.

FIG. 4 is a schematic structural view of the combustion unit according to viewing direction C as indicated in FIG. 3.

FIG. 5 is a schematic sectional view of FIG. 3 along line B-B.

FIG. 6 is a schematic illustration showing the present invention in operation.

Best Mode for Carrying out the Invention

[0016] With reference to FIG. 1 and FIG. 2, the present invention comprises at least one combustion unit 1, a secondary air regulation panel 2 and a fuel gas transmission unit 3.

[0017] With reference to FIG. 1 and FIG. 3, the combustion unit 1 is formed by punching and pressing panel boards; the combustion unit 1 is a chamber having a composite structure comprising flame ports 14, a gas regulation channel 15 and a fuel gas channel in communication with one another, wherein the flame ports 14 are disposed on an upper surface of the combustion unit 1, the gas regulation channel 15 is disposed below the flame ports 14, and the fuel gas channel is disposed below the gas regulation channel 15; the fuel gas channel has a curved shape, and comprising in sequential order a fuel gas inlet 11, a fuel gas mixing section 12 and a fuel gas pressure reduction section 13.

[0018] With reference to FIG. 1, the secondary air regulation panel 2 is formed by punching and pressing panel boards; the secondary air regulation panel 2 comprises a main flat surface; one side of the main flat surface is provided with a distributor seat, and another side of the main surface is provided with at least one combustion unit seat; primary air inlet openings 21 in elongated shapes and auxiliary air inlet openings 22 in circular shapes are provided on the main flat surface of the secondary air regulation panel.

[0019] With reference to FIG. 1 and FIG. 2, the fuel gas transmission unit 3 comprises a fuel gas pipe 31, a distributor 32 and a plurality of nozzles 33; the distributor 32 has an elongated shape; one side of the distributor

32 is provided with a fuel gas pipe port, and another side of the distributor 32 is sequentially arranged with a plurality of nozzle seats; the fuel gas pipe 31 is connected to the fuel gas pipe port of the distributor 32; the nozzles 33 are sequentially arranged on the nozzle seats of the distributor 32 respectively.

[0020] With reference to FIG. 1, FIG. 2 and FIG. 3, the fuel gas transmission unit 3 is mounted on the distributor seat of the secondary air regulation panel 2 through the distributor 32. A plurality of combustion units 1 are provided, and a plurality of combustion unit seats are provided correspondingly; the combustion units 1 are sequentially arranged on the combustion unit seats of the secondary air regulation panel 2 respectively; also, the fuel gas inlets 11 of the combustion units 1 correspond to the nozzles 33 respectively.

[0021] With reference to FIG. 3 and FIG. 5, the gas regulation channel 15 of the combustion unit is a rhombus-shaped chamber formed in the combustion unit where the rhombus-shaped chamber has a middle part wider than two ends thereof along a longitudinal direction of the combustion unit 1.

[0022] With reference to FIG. 3, the fuel gas inlet 11 of the fuel gas channel has a reverse taper shape towards an opening of the fuel gas inlet; the fuel gas inlet 11 has a cross sectional shape of a circle with two flat sides 111.

[0023] With reference to FIG. 3, the fuel gas mixing section 12 of the fuel gas channel is a tapered channel with a gradually varying internal diameter along the tapered channel.

[0024] With reference to FIG. 3, the fuel gas pressure reduction section 13 of the fuel gas channel is a channel having a channel cross section larger than a channel cross section of the fuel gas mixing section 12.

[0025] With reference to FIG. 3 and FIG. 4, the flame ports 14 of the combustion unit are arranged longitudinally on the upper surface of the combustion unit 1 both in double rows and in single row, wherein the flame ports arranged in double rows are main flame ports 141, and the flame ports arranged in a single row are regulating flame ports 142; the main flame ports and the regulating flame ports are arranged alternately where said double rows of main flame ports are interrupted by one regulating flame port of said single row of regulating flame ports for every arrangement of two main flame ports in each row.

[0026] The present invention is operated as follows: With reference to FIG. 1, FIG. 2, FIG. 3 and FIG. 6, when fuel gas enters through the fuel gas pipe 31 of the fuel gas transmission unit 3, the fuel gas will be distributed to each of the nozzles 33 through the distributor 32, and then the fuel gas will then be ejected by the nozzles 33 into the corresponding fuel gas inlets 11 of the corresponding fuel gas channels of the combustion units 1. As the nozzles 33 eject the fuel gas, the ejected stream of fuel gas will also drive first surrounding air into the combustion unit as well and so the fuel gas and the first surrounding air will be mixed in the fuel gas mixing section 12 to obtain a first mixed gas. The first mixed gas will

then pass through the fuel gas pressure reduction section 13 for pressure reduction so as to reduce the burning power of the first mixed gas. Subsequently, the gas regulation channel 15 (having said rhombus-shaped chamber formed in the combustion unit where the rhombus-shaped chamber has a middle part wider than two ends thereof along a longitudinal direction of the combustion unit) will balance and regulate the first mixed gas, while second surrounding air flowing through the primary air inlet openings 21 and the auxiliary air inlet openings 22 of the secondary air regulation panel 2 into the combustion unit will be mixed again with the first mixed gas at the flame ports 14 to obtain a second mixed gas. The second mixed gas is supplied for burning at the flame ports 14.

[0027] With reference to FIG. 1, FIG. 3 and FIG. 4, the flame ports 14 of the combustion unit are arranged longitudinally on the upper surface of the combustion unit 1 both in double rows and in single row, wherein the flame ports arranged in double rows are main flame ports 141, and the flame ports arranged in a single row are regulating flame ports 142; the main flame ports and the regulating flame ports are arranged alternately where said double rows of main flame ports are interrupted by one regulating flame port of said single row of regulating flame ports for every arrangement of two main flame ports in each row, thereby achieving a pattern of 2:1 repeated longitudinal arrangement of flame ports where arrangement of every two main flame ports in each row will be followed by one regulating flame port of said single row of regulating flame ports, and said one regulating flame port of said single row of regulating flame ports will be followed by another two main flame ports arranged in each row, which is then followed by another one regulating flame port of said single row of regulating flame ports, and so and so forth. As such, the arrangement of flame ports 14 according to the present invention can effectively enlarge the burning area of the fire holes.

[0028] With reference to FIG. 1, FIG. 3 and FIG. 6, the primary air inlet openings 21 and the auxiliary air inlet openings 22 are provided on the secondary air regulation panel 2. To ensure even longitudinal distribution of the second mixed gas along each combustion unit 1, a middle part of each combustion unit 1 has to be supplied with more second surrounding air, and for this purpose, the primary air inlet openings 21 having elongated shapes are provided on the secondary air regulating panel 2 corresponding to the middle part of each combustion unit 1. The auxiliary air inlet openings 22 having circular shapes are provided on the secondary air regulating panel 2 corresponding to two ends of each combustion unit 1 to supply second surrounding air in an amount slightly less than the second surrounding air supplied to the middle part of each combustion unit 1. The primary air inlet openings 21 and the auxiliary air inlet openings 22 can effectively solve the problem of uneven longitudinal distribution of second mixed gas along the flame ports 14 of each combustion unit 1 due to the prior art problem where lesser

second surrounding air is present at the middle part of each combustion unit 1 but more abundant second surrounding air is present at two ends of each combustion unit 1. Accordingly, the second mixed gas can be more completely burnt, thus lowering the height of the burning flame at the fire holes and lowering the temperature of the flame. Also, emissions of NO_x during thermal reaction of the burner are obviously reduced.

[0029] With reference to FIG. 1 and FIG. 3, the fuel gas inlet 11 having a reverse taper shape towards the opening thereof has a cross sectional shape of a circle with two flat sides 111. The two flat sides 111 reduce the width of the fuel gas inlet 11 to free some spaces which allow the plurality of combustion units 1 to be arranged more tightly. Accordingly, the plurality of combustion units can be arranged in greater density.

Claims

1. A burner with linear arrays of fire holes, **characterized in** comprising at least one combustion unit (1), a secondary air regulation panel (2) and a fuel gas transmission unit (3);

the combustion unit (1) is formed by punching and pressing panel boards; the combustion unit (1) is a chamber having a composite structure comprising flame ports (14), a gas regulation channel (15) and a fuel gas channel in communication with one another, wherein the flame ports (14) are disposed on an upper surface of the combustion unit (1), the gas regulation channel (15) is disposed below the flame ports (14), and the fuel gas channel is disposed below the gas regulation channel (15); the fuel gas channel has a curved shape, and comprising in sequential order a fuel gas inlet (11), a fuel gas mixing section (12) and a fuel gas pressure reduction section (13);

the secondary air regulation panel (2) is formed by punching and pressing panel boards; the secondary air regulation panel (2) comprises a main flat surface; one side of the main flat surface is provided with a distributor seat, and another side of the main surface is provided with at least one combustion unit seat; primary air inlet openings (21) in elongated shapes and auxiliary air inlet openings (22) in circular shapes are provided on the main flat surface of the secondary air regulation panel (2);

the fuel gas transmission unit (3) comprises a fuel gas pipe (31), a distributor (32) and a plurality of nozzles (33); the distributor (32) has an elongated shape; one side of the distributor (32) is provided with a fuel gas pipe port, and another side of the distributor (32) is sequentially arranged with a plurality of nozzle seats; the fuel

gas pipe (31) is connected to the fuel gas pipe port of the distributor (32); the nozzles (33) are sequentially arranged on the nozzle seats of the distributor (32) respectively;

the fuel gas transmission unit (3) is mounted on the distributor seat of the secondary air regulation panel (2) through the distributor (32); a plurality of combustion units (1) are provided, and a plurality of combustion unit seats are provided correspondingly; the combustion units (1) are sequentially arranged on the combustion unit seats of the secondary air regulation panel (2) respectively; also, the fuel gas inlets (11) of the combustion units (1) correspond to the nozzles (33) respectively.

2. The burner of claim 1, wherein the gas regulation channel (15) of the combustion unit (1) is a rhombus-shaped chamber formed in the combustion unit (1) where the rhombus-shaped chamber has a middle part wider than two ends thereof along a longitudinal direction of the combustion unit (1).
3. The burner of claim 1, wherein the fuel gas inlet (11) of the fuel gas channel has a reverse taper shape towards an opening of the fuel gas inlet; the fuel gas inlet (11) has a cross sectional shape of a circle with two flat sides (111).
4. The burner of claim 1, wherein the fuel gas mixing section (12) of the fuel gas channel is a tapered channel with a gradually varying internal diameter along the tapered channel.
5. The burner of claim 1, wherein the fuel gas pressure reduction section (13) of the fuel gas channel is a channel having a channel cross section larger than a channel cross section of the fuel gas mixing section (12).
6. The burner of claim 1, wherein the flame ports (14) of the combustion unit (1) are arranged longitudinally on the upper surface of the combustion unit (1) both in double rows and in single row, wherein the flame ports (14) arranged in double rows are main flame ports (141), and the flame ports arranged in a single row are regulating flame ports (142); the main flame ports (141) and the regulating flame ports (142) are arranged alternately where said double rows of main flame ports are interrupted by one regulating flame port of said single row of regulating flame ports for every arrangement of two main flame ports in each row.

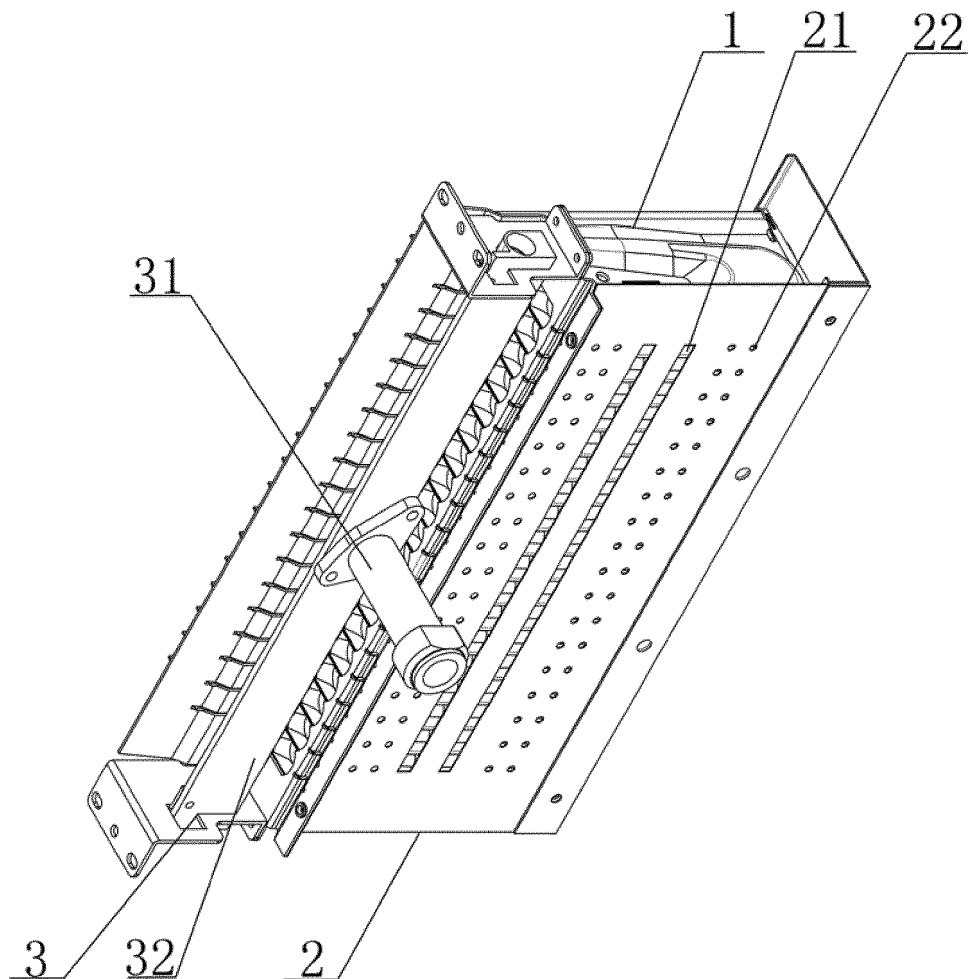


FIG. 1

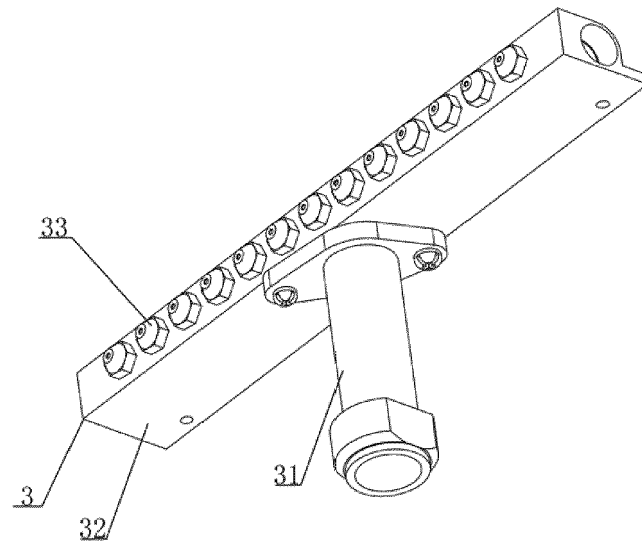


FIG. 2

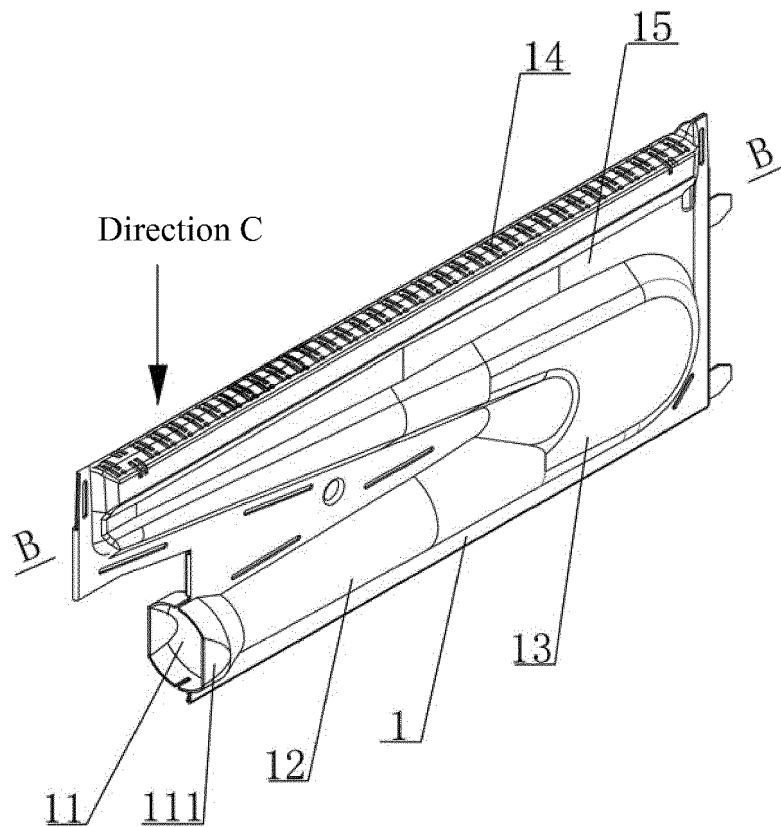


FIG. 3

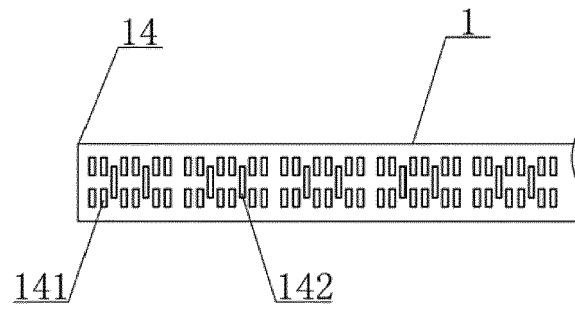


FIG. 4

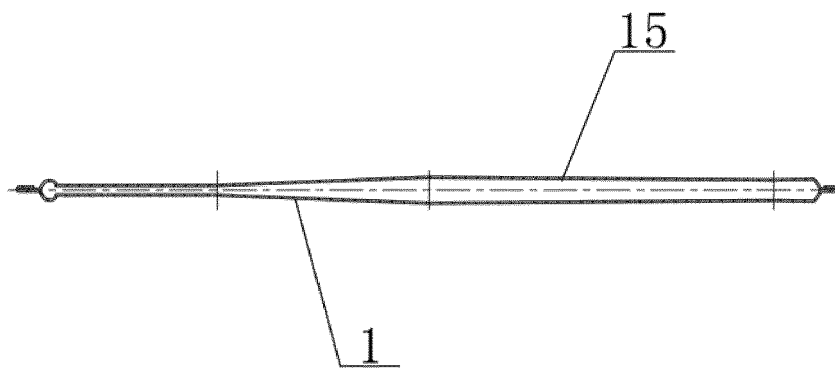
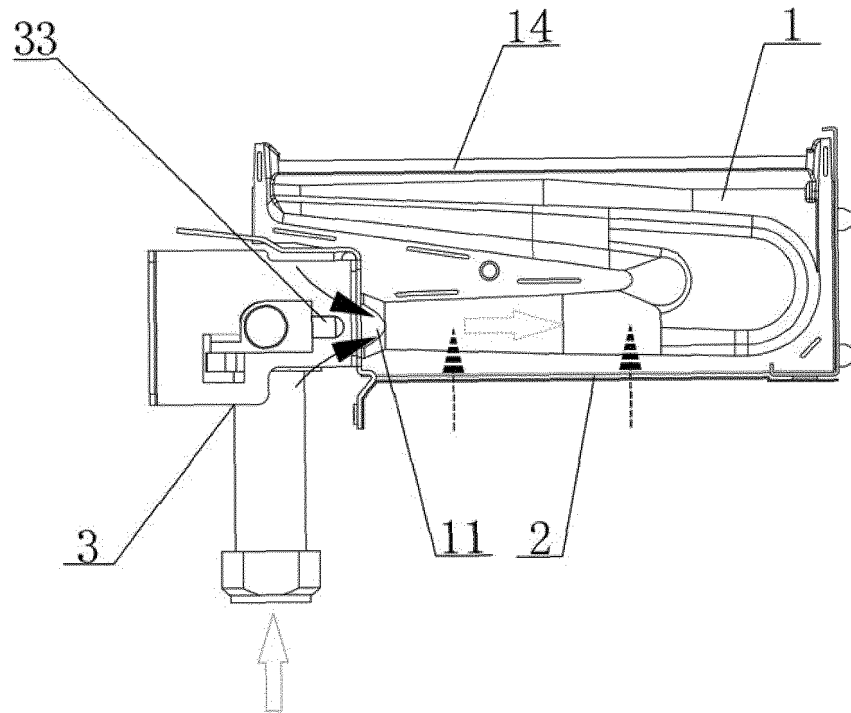


FIG. 5



In the figure :



Fuel Gas



Mixed gas



First
surrounding
air



Second
surrounding
air

FIG. 6



EUROPEAN SEARCH REPORT

 Application Number
 EP 20 20 3440

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Place of search Munich		Date of completion of the search 17 February 2021	Examiner Theis, Gilbert
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			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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