A jet burner construction, a heating apparatus utilizing the jet burner construction, and methods of making the same are provided, the jet burner construction (10) comprising a burner body (11) having a chamber (12) therein and having an inlet (13) leading to the chamber for directing fuel from a fuel source (14) therein, and an outlet (15) leading from the chamber (12) and defining an outlet opening (16) through which the fuel is adapted to issue from the chamber (12) to burn externally to the burner body (11), the outlet opening (16) having a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of the portions (46) and the central part (47) of the outlet opening (16) merge together in a turbulent manner externally of the outlet opening.
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JET BURNER CONSTRUCTION, HEATING APPARATUS UTILIZING
THE JET BURNER CONSTRUCTION, AND METHODS OF MAKING
THE SAME

Technical Field

This invention relates to a new jet burner construction and to a new heating apparatus utilizing such jet burner construction, as well as to new methods of making such a jet burner construction and such a heating apparatus.

Background Art

It is known to provide a jet burner construction comprising a burner body means having a chamber means therein and having an inlet means leading to the chamber means for directing fuel from a fuel source therein, and an outlet means leading from the chamber means and defining an outlet opening means through which the fuel is adapted to issue from the chamber means to burn externally to the burner body means. For example, see the Bryant Formula 1000 heating apparatus of the Carrier Corporation of Syracuse, New York.

Disclosure of the Invention

It is one of the features of this invention to provide a new jet burner construction which has improved fuel combustion while maintaining the desired port velocity of the fuel issuing therefrom.

In particular, prior known jet burner constructions have additional internal components therein for enhancing the fuel combustion by causing turbulence in the gas and/or air stream thereof.

However, it was found according to the teachings of this invention that such relatively expensive internal turbulence enhancers can be
eliminated from a jet burner construction if the outlet opening means is uniquely constructed and arranged so that the same has a central opening part and a plurality of spaced apart opening portions interconnected thereto and radiating outwardly therefrom, whereby the flows of fuel respectively issuing out of the portions and the central part of the outlet opening means will merge together in a turbulent manner externally of the outlet opening means for improved fuel combustion thereof.

For example, one embodiment of this invention comprises a jet burner construction comprising a burner body means having a chamber means therein and having an inlet means leading to the chamber means for directing fuel from a fuel source therein, and an outlet means leading from the chamber means and defining an outlet means through which the fuel is adapted to issue from the chamber means to burn externally to the burner body means, the outlet opening means having a central opening part and a plurality of spaced apart opening portions interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of the portions and the central part of the outlet opening means merge together in a turbulent manner externally of the outlet opening means.

Accordingly, it is an object of this invention to provide a new jet burner construction having one or more of the novel features of this invention as set forth above or hereinafter shown or described.

Another object of this invention is to provide a new method of making such a jet burner
construction, the method of this invention having one or more of the novel features of this invention as set forth above or hereinafter shown or described.

Another object of this invention is to provide a new heating apparatus utilizing such a jet burner construction, the heating apparatus of this invention having one or more of the novel features of this invention as set forth above or hereinafter shown or described.

Another object of this invention is to provide a new method of making such a heating apparatus, the method of this invention having one or more of the novel features of this invention as set forth above or hereinafter shown or described.

Brief Description of the Drawings

The features of the invention, and its technical advantages, can be seen from the following description of preferred embodiments, together with the claims and the accompanying drawings, in which:

FIG. 1 is a perspective view of the new jet burner construction of this invention;

FIG. 2 is a fragmentary top view of a plurality of the jet burner constructions of FIG. 1 arranged in a heating apparatus of this invention;

FIG. 3 is a cross-sectional view taken on line 3-3 of FIG. 1;

FIG. 4 is a fragmentary end view taken in the direction of the arrows 4-4 of FIG. 2 and illustrates the outlet ends of two of the jet burner constructions of this invention without having the fuel burning at the outlet ends thereof as illustrated in FIG. 2;

FIG. 5 is a cross-sectional view taken on
line 5-5 of FIG. 1; and

FIG. 6 is an exploded perspective view of the various parts for forming the jet burner construction of FIG. 1.

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Best Modes for Carrying out the Invention

While the various features of this invention are hereinafter illustrated and described as being particularly adapted to provide a burner construction for a jet burner construction application thereof, it is to be understood that the various features of this invention can be utilized singly or in various combinations thereof to provide a burner construction for other apparatus as desired.

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Therefore, this invention is not to be limited to only the embodiment illustrated in the drawings, because the drawings are merely utilized to illustrate one of the wide variety of uses of this invention.

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Referring now to FIGS. 1, 2 and 3, the new jet burner construction of this invention is generally indicated by the reference numeral 10 and comprises a burner body means 11 having a chamber means 12 therein and having an inlet means 13 leading to the chamber means 12 for directing fuel, such as natural or synthetic gas, from a fuel source 14 therein, and an outlet means 15 leading from the chamber means 12 and defining an outlet opening means 16 through which the fuel is adapted to issue from the chamber means 12 to burn externally to the burner body means 11 as illustrated by the flames 17 in FIG. 2.

The jet burner construction 10 of this invention is adapted to be arranged in side-by-side aligned relation with a plurality of other jet
burner constructions 10 of this invention in the manner illustrated in FIGS. 2 and 4 to be utilized in a heating apparatus that is generally indicated by the reference numeral 18 in FIG. 2, wherein each jet burner construction 10 is adapted to direct its flame 17 into an inlet end 19 of a heat tube arrangement 20 which extracts heat from that flame 17 in an efficient manner as is well known in the art. For example, see the aforementioned Bryant Formula 1000 heating apparatus of the Carrier Corporation of Syracuse, New York. Therefore, further details of the structure and of the operation of the heating apparatus 18 need not be set forth.

The jet burner construction 10 of this invention has the body means 11 thereof formed from two substantially similar sheet metal plates 21 and 22, FIG. 6, suitably stamped and shaped in the configurations illustrated in the drawings so that when the plates 21 and 22 are disposed together in face-to-face relation, flange means 23 and 24 of the plate means 22 are folded over against the plate means 21 in the manner illustrated in FIG. 1 to seal the plates 21 and 22 together, whereby the two plate means 21 and 22 readily form the body means 11 of the burner construction 10.

In one working embodiment of the jet burner construction 10 of this invention, the plate means 21 and 22 are each formed from an aluminized steel strip RMS-421 that is approximately 0.089 cm (0.035 of an inch) thick, the resulting burner body means 11 being approximately 12.7 cm (5.000 inches) in length.

The inlet means 13 of the burner body means 11 defines a substantially cylindrical wall
means 25 that has a plurality of primary air intake
openings 26 formed therethrough downstream from a
substantially circular end opening 27 in which an
orifice member 28 is disposed, the orifice member
28 having a threaded portion 29 threadedly disposed
in openings 30 formed through integral tab means 31
of the plates 21 and 22 which are bent at right
angles so as to have the openings 30 thereof
disposed in overlapping aligned relation as
illustrated in the drawings. In this manner, fuel
from the fuel source 14 is adapted to be directed
to the orifice member 28 by conduit 14', FIG. 2, to
issue out of an orifice 32 thereof into the chamber
means 12 to mix with the primary air being drawn
into the chamber means 12 through the primary air
slots 26 in a manner well known in the art so that
the air fuel mixture will pass through a venturi
portion 33 of the chamber means 12 before the same
reaches the outlet means 15 of the chamber means 12
to issue out of the outlet opening 16 in a unique
manner that will be hereinafter set forth.

The plates 21 and 22 that form the burner
body means 11 each has a pair of wing-like
extensions 34 and 35 extending outwardly therefrom
in a coplanar manner so that when the formed plates
21 and 22 are secured together by the folded over
flange means 23 and 24 to form the burner body
means 11, the cooperating extensions 34 and 35
define wing-like extensions that are generally
indicated by the reference numerals 34' and 35',
and that extend from opposed sides of the burner
body means 11 adjacent the outlet end means 15
thereof.

The wing-like extensions 34 and 35 of the
plate 21 are respectively stepped upwardly as
illustrated and have a plurality of dimples 36 formed therein to respectively engage against the surfaces 37 of the wing-like extensions 34 and 35 of the other plate 22 so as to space the facing surfaces 37 of the cooperating pairs of wing-like structures 34 and 35 from each other to define a fuel issuing slot means 38 therebetween that respectively interconnects to the chamber means 12 and the outlet opening 16 so that fuel can issue from the slot means 38 of the wing-like extensions 34' and 35' to define front end carry-over ignition flame means 39 as illustrated in FIG. 2 for multiple burner ignition propagation purposes in the apparatus 18 in a manner well known in the art so that ignition structure need be provided for only one of the jet burner constructions 10 in the apparatus 18 and the other burner constructions 10 will be ignited therefrom in a series manner as is well known in the art.

However, in order to prevent delayed ignition due to poor alignment of the burner constructions 10, the wing-like extension 34 of the plate 21 and the wing-like extension 35 of the plate 22 of each burner body means 11 is provided with tabs 40 and 41 which are disposed or stepped out of the plane of the respective wing-like extension 34 and 35 so as to provide the overlapping linked arrangement with the nonstepped tabs 40' and 41' illustrated in FIGS. 1 and 4 of the adjacent burner constructions 10 when the jet burner constructions 10 are arranged in aligned relation as illustrated. Similar tab alignment means are set forth in the U.S. patent to Riehl, No. 4,179,261, whereby this patent is being incorporated into this disclosure by this reference
The outlet end means 15 of the burner body means 11 has its wall means 42 defining a substantially cylindrical portion 43 at one end thereof and a plurality of fluted portions 44 at the outlet end 16 thereof, each flute 44 comprising a substantially U-shaped portion 45 that has an outlet opening portion 46 defined thereby and radiating outwardly from a central part 47 of the outlet means 16 and being interconnected thereto. The radiating portions 46 in one working embodiment of the burner body 11 of this invention are four in number and are disposed substantially 90° apart from the adjacent portions 46 and have outer closed ends 48 thereof defining a circular configuration that is substantially concentric to the central part 47 of the opening means 16 that also defines a substantially circular configuration.

The two portions 46 on opposite sides of the outlet opening 15 interconnect with the slot means 38 of the wing-like extensions 34' and 35' of the resulting jet burner constructions 10 so as to supply fuel thereto from the chamber means 12.

In this manner, it was found that the flows of fuel issuing out of the outlet opening means 16 at the portions 46 and central part 47 thereof merge together in a turbulent manner externally to the outlet opening means 16 to provide for improved fuel combustion while maintaining the port velocity of the fuel being injected therefrom without requiring internal turbulent enhancers as in the prior known jet burner constructions. It was also found that the resulting flame means 17 of the burner construction 10 has a distinct outer and inner mantle of the
flame characteristics which results from the improved fuel combustion.

In the one working embodiment of the jet burner construction 10 of this invention, each radiating portion 46 has the outer part 48 thereof defining a circle that is approximately 2.54 cm (1.000 inch) in diameter, with the spacing between the legs of the portion 46 being approximately 0.472 cm (0.186 of an inch), the throat of the venturi portion 33 being spaced from the inlet end opening 27 by approximately 6.761 cm (2.662 inches) and the cylindrical wall means 25 at the inlet end means 13 being approximately 3.175 cm (1.250 of an inch) in diameter. The flutes 45 begin at approximately 9.352 cm (3.682 of an inch) from the inlet opening 27 and each has the closed end 48 thereof defined by a radius that is approximately 0.236 cm (0.093 of an inch).

The jet burner construction 10 of this invention further comprises flame retainer means that is generally indicated by the reference numeral 50 and as illustrated in FIG. 6 comprises two parts 51 and 52 each having a body part 53 that is arcuate and defines opposed side edge means 54 and opposed end edge means 55 and 56. The flame retaining members 51 and 52 are so constructed and arranged that the same are respectively adapted to be disposed over the fluted portions 45 and have the ends 55 thereof correspond to or mate with the cylindrical portion 43 of the wall means 42 so as to be spot welded thereto or otherwise be secured to the burner body means 11 with the end edge means 56 thereof extending beyond the outlet opening 16 for flame retention purposes as will be hereinafter set forth. The cooperating side edge means 54 of
the members 51 and 52 permit the wing-like extensions 34' and 35' to extend therebetween in the manner illustrated in FIG. 1.

The end edge means 56 of the members 51 and 52 are beveled at 57 where the same join with the side edges 54 as illustrated.

The lower member 52 has a tab 58 extending at a right angle to the end edge means 55 thereof and is provided with a U-shaped slot 59 therein for mounting the resulting burner construction 10 to suitable support structure (not shown) in the apparatus 18 in a conventional manner.

In the one working embodiment of the jet burner construction 10 that has been previously set forth, the members 51 and 52 of the flame retaining means 50 are each formed of an aluminized steel strip RMS-421 that is approximately 0.089 cm (0.035 of an inch) thick and each has the arcuate body portion 53 thereof defined by a radius of approximately 1.283 cm (0.505 of an inch) and each is approximately 4.008 cm (1.578 of an inch long). The members 51 and 52 are so arranged on the burner body means 11 that the end edge means 56 thereof extend beyond the outlet opening 16 of the burner body means 11 approximately 0.475 cm (0.187 of an inch).

It was found that with such a flame retention means 50, the flame retention means 50 restrict the flow of induced air along the areas 60 of the minor diameter formations of the fluted arrangement and thereby tends to prevent flame blow off that would cause unburned fuel to enter into the heat exchanger tubes 20 of the heating apparatus 18, whereby combustion results of the
fuel issuing from the outlet opening 16 is greatly enhanced by the flame retention or retainer means 50.

Therefore, it can be seen that it is a relatively simple method of this invention to form the jet burner construction 10 of this invention that is adapted to operate in a manner now to be described.

As previously stated, once the jet burner construction 10 has been properly mounted in a suitable apparatus, such as the heating apparatus 18 illustrated in FIG. 2, fuel is adapted to be directed into the chamber means 12 of that burner construction 10 through suitable conduit means 14' leading from the fuel source 14 so that the same will draw primary air through the openings 26 into the chamber means 12 and pass through the venturi means 33 to issue out of the outlet end means 15 at the outlet opening means 16 thereof into the four flow paths provided by the radiating portions 46 of the opening 16 to combine with the fuel issuing out of the central part 47 of the opening 16 in a turbulent manner that can be ignited by any suitable ignition means so that the resulting flame means 17 will be directed into the inlet 19 of the heat exchanger tube 20 to have heat extracted therefrom in a manner well known in the art, the lit burner construction 10 creating the propagating side flame means 39 along the wing-like portions 34' and 35' thereof for igniting the issuing fuel from adjacent burner constructions 10 in the manner previously set forth.

As previously stated, the flame retention or retainer means 50 of this invention prevents secondary air from blowing the flame 17 off of the
outlet opening 16 as the retention means 50 completely cover the spaces 60 between the flutes 45 so that air cannot be induced along the outside of the spaces 60 between the flutes 45 for the reasons previously set forth.

Therefore, it can be seen that this invention not only provides a new jet burner construction and a new method of making the same, but also this invention provides a new heating apparatus utilizing such a jet burner construction and a new method of making the same.

While the forms and methods of this invention now preferred have been illustrated and described as required, it is to be understood that other forms and method steps can be utilized and still fall within the scope of the appended claims, wherein each claim sets forth what is believed to be known in each claim prior to this invention in the portion of each claim that is disposed before the terms "the improvement", and sets forth what is believed to be new in each claim according to this invention in the portion of each claim that is disposed after the terms "the improvement", whereby it is believed that each claim sets forth a novel, useful and unobvious invention.
CLAIMS:

1. In a jet burner construction comprising a burner body means (11) having a chamber means (12) therein and having an inlet means (13) leading to said chamber means for directing fuel from a fuel source (14) therein, and an outlet means (15) leading from said chamber means (12) and defining an outlet opening means (16) through which said fuel is adapted to issue from said chamber means (12) to burn externally to said burner body means (11), the improvement characterized in that said outlet opening means (16) has a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of said portions (46) and said central part (47) of said outlet opening means (16) merge together in a turbulent manner externally of said outlet opening means.

2. A jet burner construction as set forth in claim 1, characterized in that each said portion (46) of said outlet opening means (16) has a generally U-shaped configuration, with the closed end (48) thereof being the part thereof that is disposed the greatest distance from said central opening part (47) of said outlet opening means (16).

3. A jet burner construction as set forth in claim 2, characterized in that said central part (47) of said outlet opening means (16) has a generally circular configuration that interconnects with the open ends of said portions (46) of said outlet opening means (16).

4. A jet burner construction as set
forth in claim 1, characterized in that each said portion (46) of said outlet opening means (16) has an outer end (48) disposed the greatest distance of that said portion from said central opening means (47), said outer ends (48) of said portions (46) of said outlet opening means (16) defining a generally circular configuration that is substantially concentrically disposed about said central opening part (47) of said outlet opening means (16).

5. A jet burner construction as set forth in claim 4, characterized in that said outlet opening means (16) has four of said portions (46) radiating outwardly from said central part (47) thereof, with each said portion (46) being disposed substantially 90° from the next portion adjacent thereto.

6. A jet burner construction as set forth in claim 1, characterized in that said burner construction (10) comprises flame retainer means (50) carried by said body means (11) and having outer edge means (56) extending beyond said outlet opening means (16) of said body means (11) to restrict the flows of induced air between the flows of fuel issuing from said radiating portions (46) of said outlet opening means (16).

7. A jet burner construction as set forth in claim 6, characterized in that said burner body means (11) has wing-like extensions (34', 35') respectively disposed on opposite sides thereof for respectively interconnecting with adjacent wing-like extensions of adjacent burner constructions, said flame retaining means (50) comprising two sections (51, 52) each having like side edge means (54) facing said side edge means (54) of the other section and being separated therefrom by said wing-
like extensions (34', 35').

8. A jet burner construction as set forth in claim 7, characterized in that each said section (51, 52) of said flame retaining means (50) has two spaced apart said side edge means (54) and an arcuate intermediate portion (53) interconnecting said side edge means (54) thereof together.

9. A jet burner construction as set forth in claim 7, characterized in that said burner body means (11) is formed of two generally similar body sections (21, 22) secured together in superimposed relation and each having generally one-half of said outlet opening means (16) and one-half of said wing-like extensions (34', 35') thereon.

10. A jet burner construction as set forth in claim 9, characterized in that said wing-like extensions (34', 35') each has an elongated outlet slot means (38) interconnecting with said outlet opening means (16) and through which fuel is adapted to issue so as to burn external to said wing-like extensions (34', 35').

11. In a heating apparatus comprising a heating tube means (20) provided with an inlet (19), and a jet burner construction (10) comprising a burner body means (11) having a chamber means (12) therein and having an inlet means (13) leading to said chamber means for directing fuel from a fuel source (14) therein, and an outlet means (15) leading from said chamber means (12) and defining an outlet opening means (16) through which said fuel is adapted to issue from said chamber means (12) to burn externally to said burner body means (11) and enter said heating tube means (20) through
said inlet (19) thereof, the improvement characterized in that said outlet opening means (16) has a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of said portions (46) and said central part (47) of said outlet opening means (16) merge together in a turbulent manner externally of said outlet opening means.

12. A heating apparatus as set forth in claim 11, characterized in that each said portion (46) of said outlet opening means (16) has a generally U-shaped configuration, with the closed end (48) thereof being the part thereof that is disposed the greatest distance from said central opening part (47) of said outlet opening means (16).

13. A heating apparatus as set forth in claim 12, characterized in that said central part (47) of said outlet opening means (16) has a generally circular configuration that interconnects with the open ends of said portions (46) of said outlet opening means (16).

14. A heating apparatus as set forth in claim 11, characterized in that each said portion (46) of said outlet opening means (16) has an outer end (48) disposed the greatest distance of that said portion from said central opening means (47), said outer ends (48) of said portions (46) of said outlet opening means (16) defining a generally circular configuration that is substantially concentrically disposed about said central opening part (47) of said outlet opening means (16).

15. A heating apparatus as set forth in
claim 14, characterized in that said outlet opening means (16) has four of said portions (46) radiating outwardly from said central part (47) thereof, with each said portion (46) being disposed substantially 90° from the next portion adjacent thereto.

16. A heating apparatus as set forth in claim 11, characterized in that said burner construction (10) comprises flame retainer means (50) carried by said body means (11) and having outer edge means (56) extending beyond said outlet opening means (16) of said body means (11) to restrict the flows of induced air between the flows of fuel issuing from said radiating portions (46) of said outlet opening means (16).

17. A heating apparatus as set forth in claim 16, characterized in that said burner body means (11) has wing-like extensions (34', 35') respectively disposed on opposite sides thereof for respectively interconnecting with adjacent wing-like extensions of adjacent burner constructions, said flame retainer means (50) comprising two sections (51, 52) each having like side edge means (54) facing said side edge means (54) of the other section and being separated therefrom by said wing-like extensions (34', 35').

18. A heating apparatus as set forth in claim 17, characterized in that each said sections (51, 52) of said flame retaining means (50) has two spaced apart said side edge means (54) and an arcuate intermediate portion (53) interconnecting said side edge means (54) thereof together.

19. A heating apparatus as set forth in claim 17, characterized in that said burner body means (11) is formed of two generally similar body sections (21, 22) secured together in superimposed
relation and each having generally one-half of said outlet opening means (16) and one-half of said wing-like extensions (34', 35') thereon.

20. A heating apparatus as set forth in claim 19, characterized in that said wing-like extensions (34', 35') each has an elongated outlet slot means (38) interconnecting with said outlet opening means (16) and through which fuel is adapted to issue so as to burn external to said wing-like extensions (34', 35').

21. In a method of making a jet burner construction (10) comprising a burner body means (11) having a chamber means (12) therein and having an inlet means (13) leading to said chamber means for directing fuel from a fuel source (14) therein, and an outlet means (15) leading from said chamber means (12) and defining an outlet opening means (16) through which said fuel is adapted to issue from said chamber means (12) to burn externally to said burner body means (11), the improvement characterized by the step of forming said outlet opening means (16) to have a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of said portions (46) and said central part (47) of said outlet opening means (16) merge together in a turbulent manner externally of said outlet opening means.

22. In a method of making a heating apparatus comprising a heating tube means (20) provided with an inlet (19), and a jet burner construction (10) comprising a burner body means (11) having a chamber means (12) therein and having an inlet means (13) leading to said chamber means
for directing fuel from a fuel source (14) therein, and an outlet means (15) leading from said chamber means (12) and defining an outlet opening means (16) through which said fuel is adapted to issue from said chamber means (12) to burn externally to said burner body means (11) and enter said heating tube means (20) through said inlet (19) thereof, the improvement characterized by the step of forming said outlet opening means (16) to have a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of said portions (46) and said central part (47) of said outlet opening means (16) merge together in a turbulent manner externally of said outlet opening means.
1. In a jet burner construction comprising a burner body means (11) having a chamber means (12) therein and having an inlet means (13) leading to said chamber means for directing fuel from a fuel source (14) therein, and an outlet means (15) leading from said chamber means (12), and defining an outlet opening means (16) through which said fuel is adapted to issue from said chamber means (12) to burn externally to said burner body means (11), said outlet opening means (16) having a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of said portions (46) and said central part (47) of said outlet opening means (16) merge together in a turbulent manner externally of said outlet opening means, the improvement characterized in that said burner construction (10) comprises flame retainer means (50) carried by said body means (11) and having outer edge means (56) extending beyond said outlet opening means (16) of said body means (11) to restrict the flows of induced air between the flows of fuel issuing from said radiating portions (46) of said outlet opening
2. A jet burner construction as set forth in claim 1, characterized in that each said portion (46) of said outlet opening means (16) has a generally U-shaped configuration, with the closed end (48) thereof being the part thereof that is disposed the greatest distance from said central opening part (47) of said outlet opening means (16).

3. A jet burner construction as set forth in claim 2, characterized in that said central part (47) of said outlet opening means (16) has a generally circular configuration that interconnects with the open ends of said portions (46) of said outlet opening means (16).

4. A jet burner construction as set forth in claim 1, characterized in that each said portion (46) of said outlet opening means (16) has an outer end (48) disposed the greatest distance of that said portion from said central opening means (47), said outer ends (48) of said portions (46) of said outlet opening means (16) defining a generally circular configuration that is substantially concentrically disposed about said central opening part (47) of said outlet opening means (16).

5. A jet burner construction as set
forth in claim 4, characterized in that said outlet opening means (16) has four of said portions (46) radiating outwardly from said central part (47) thereof, with each said portion (46) being disposed substantially 90° from the next portion adjacent thereto.

6. A jet burner construction as set forth in claim 1, characterized in that said burner body means (11) has wing-like extensions (34', 35') respectively disposed on opposite sides thereof for respectively interconnecting with adjacent wing-like extensions of adjacent burner constructions, said flame retaining means (50) comprising two sections (51, 52) each having like side edge means (54) facing said side edge means (54) of the other section and being separated therefrom by said wing-like extensions (34', 35').

7. A jet burner construction as set forth in claim 6, characterized in that each said section (51, 52) of said flame retaining means (50) has two spaced apart said side edge means (54) and an arcuate intermediate portion (53) interconnecting said side edge means (54) thereof together.

8. A jet burner construction as set forth in claim 6, characterized in that said burner
body means (11) is formed of two generally similar body sections (21, 22) secured together in superimposed relation and each having generally one-half of said outlet opening means (16) and one-half of said wing-like extensions (34', 35') thereon.

9. A jet burner construction as set forth in claim 8, characterized in that said wing-like extensions (34', 35') each has an elongated outlet slot means (38) interconnecting with said outlet opening means (16) and through which fuel is adapted to issue so as to burn externally to said wing-like extensions (34', 35').

10. In a heating apparatus comprising a heating tube means (20) provided with an inlet (19), and a jet burner construction (10) comprising a burner body means (11) having a chamber means (12) therein and having an inlet means (13) leading to said chamber means for directing fuel from a fuel source (14) therein, and an outlet means (15) leading from said chamber means (12) and defining an outlet opening means (16) through which said fuel is adapted to issue from said chamber means (12) to burn externally to said burner body means (11) and enter said heating tube means (20) through said inlet (19) thereof, said outlet opening means
(16) having a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of said portions (46) and said central part (47) of said outlet opening means (16) merge together in a turbulent manner externally of said outlet opening means, the improvement characterized in that said burner construction (10) comprises flame retainer means (50) carried by said body means (11) and having outer edge means (56) extending beyond said outlet opening means (16) of said body means (11) to restrict the flows of induced air between the flows of fuel issuing from said radiating portions (46) of said outlet opening means (16).

11. A heating apparatus as set forth in claim 10, characterized in that each said portion (46) of said outlet opening means (16) has a generally U-shaped configuration, with the closed end (48) thereof being the part thereof that is disposed the greatest distance from said central opening part (47) of said outlet opening means (16).

12. A heating apparatus as set forth in claim 11, characterized in that said central part
(47) of said outlet opening means (16) has a generally circular configuration that interconnects with the open ends of said portions (46) of said outlet opening means (16).

13. A heating apparatus as set forth in claim 10, characterized in that each said portion (46) of said outlet opening means (16) has an outer end (48) disposed the greatest distance of that said portion from said central opening means (47), said outer ends (48) of said portions (46) of said outlet opening means (16) defining a generally circular configuration that is substantially concentrically disposed about said central opening part (47) of said outlet opening means (16).

14. A heating apparatus as set forth in claim 14, characterized in that said outlet opening means (16) has four of said portions (46) radiating outwardly from said central part (47) thereof, with each said portion (46) being disposed substantially 90° from the next portion adjacent thereto.

15. A heating apparatus as set forth in claim 10, characterized in that said burner body means (11) has wing-like extensions (34', 35') respectively disposed on opposite sides thereof for respectively interconnecting with adjacent wing-like extensions of adjacent burner constructions,
said flame retaining means (50) comprising two sections (51, 52) each having like side edge means (54) facing said side edge means (54) of the other section and being separated therefrom by said wing-like extensions (34', 35').

16. A heating apparatus as set forth in claim 15, characterized in that each said sections (51, 52) of said flame retaining means (50) has two spaced apart said side edge means (54) and an arcuate intermediate portion (53) interconnecting said side edge means (54) thereof together.

17. A heating apparatus as set forth in claim 15, characterized in that said burner body means (11) is formed of two generally similar body sections (21, 22) secured together in superimposed relation and each having generally one-half of said outlet opening means (16) and one-half of said wing-like extensions (34', 35') thereon.

18. A heating apparatus as set forth in claim 17, characterized in that said wing-like extensions (34', 35') each has an elongated outlet slot means (38) interconnecting with said outlet opening means (16) and through which fuel is adapted to issue so as to burn externally to said wing-like extensions (34', 35').

19. In a method of making a jet burner
construction (10) comprising a burner body means (11) having a chamber means (12) therein and having an inlet means (13) leading to said chamber means for directing fuel from a fuel source (14) therein, and an outlet means (15) leading from said chamber means (12) and defining an outlet opening means (16) through which said fuel is adapted to issue from said chamber means (12) to burn externally to said burner body means (11), said outlet opening means (16) having a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of said portions (46) and said central part (47) of said outlet opening means (16) merge together in a turbulent manner externally of said outlet opening means, the improvement characterized by the step of forming a flame retainer means (50) to be carried by said body means (11) and have outer edge means (56) extending beyond said outlet opening means (16) of said body means (11) to restrict the flows of induced air between the flows of fuel issuing from said radiating portions (46) of said outlet opening means (16).

20. In a method of making a heating apparatus comprising a heating tube means (20)
provided with an inlet (19), and a jet burner construction (10) comprising a burner body means (11) having a chamber means (12) therein and having an inlet means (13) leading to said chamber means for directing fuel from a fuel source (14) therein, and an outlet means (15) leading from said chamber means (12) and defining an outlet opening means (16) through which said fuel is adapted to issue from said chamber means (12) to burn externally to said burner body means (11) and enter said heating tube means (20) through said inlet (19) thereof, said outlet opening means (16) having a central opening part (47) and a plurality of spaced apart opening portions (46) interconnected thereto and radiating outwardly therefrom, whereby flows of fuel respectively issuing out of said portions (46) and said central part (47) of said outlet opening means (16) merge together in a turbulent manner externally of said outlet opening means, the improvement characterized by the step of forming a flame retainer means (50) to be carried by said body means (11) and have outer edge means (56) extending beyond said outlet opening means (16) of said body means (11) to restrict the flows of induced air between the flows of fuel issuing from said radiating portions (46) of said outlet opening
means (16).
INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5): F23D 14/58
U. S. CL.: 431/286

II. FIELDS SEARCHED

Minimum Documentation Searched

<table>
<thead>
<tr>
<th>Classification System</th>
<th>Classification Symbols</th>
</tr>
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<tbody>
<tr>
<td>431/286, 353, 354</td>
<td>239/597, 598, 600</td>
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<tr>
<td>126/116R, 99A</td>
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</tbody>
</table>

Documentation Searched other than Minimum Documentation

to the Extent that such Documents are Included in the Fields Searched

III. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of Document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to Claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X, Y</td>
<td>US, A, 3,506,198 (Van Der Zwaal) 14 April 1970 See the entire document</td>
<td>1-5, 11-15, 21 and 22</td>
</tr>
<tr>
<td>A</td>
<td>GB, A, 1,383,987 (DuPont) 12 Feb, 1975 See the entire document</td>
<td>1-22</td>
</tr>
<tr>
<td>Y</td>
<td>US, A, 2,682,867 (Cartter) 6 July 1954 see the entire document</td>
<td>11-15</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 1,925,183 (Forster) 5 Sept. 1933 See the entire document</td>
<td>1-22</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 4,179,261 (Riehl) 18 December 1979 see the entire document</td>
<td>1-22</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 1,344,187 (Smith) 9 February 1932 see the entire document</td>
<td>1-22</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 3,288,377 (Van De Roer) 29 November 1966 see the entire document</td>
<td>1-22</td>
</tr>
<tr>
<td>A</td>
<td>GB, A, 705,873 (Junkers) 17 March 1950 see the entire document</td>
<td>1-22</td>
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<tr>
<td>A</td>
<td>DE, A, 2,501,333 (Schutte) 17 July 1975 see the entire document</td>
<td>1-22</td>
</tr>
</tbody>
</table>

* Special categories of cited documents:

"A": document defining the general state of the art which is not considered to be of particular relevance

"E": earlier document 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

"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

"A": document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search

15 APR 1991

International Searching Authority

Signature of Authorized Officer

Carroll Doherty

Form PCT/ISA/210 (second sheet) (May 1986)
V. □ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. □ Claim numbers . . . . . . . because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claim numbers . . . . . . . because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claim numbers . . . . . . . because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. □ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This International Searching Authority found multiple inventions in this international application as follows:

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. □ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

□ The additional search fees were accompanied by applicant’s protest.
□ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (supplemental sheet (2) (Rev. 4-90))