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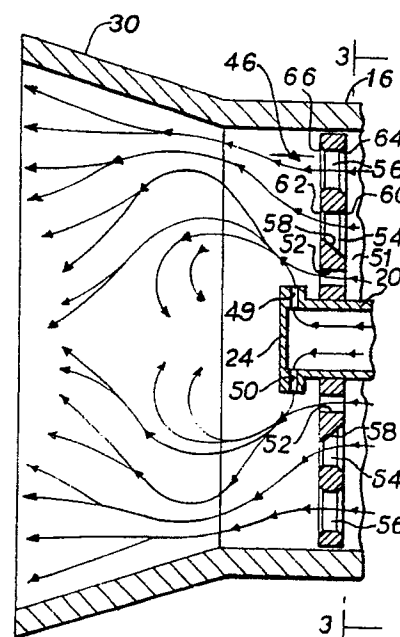
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㉙ **Flame retention plate for a burner.**

㉚ A flame retention plate (46) for a power burner (10) is designed to alter the direction of flow of air passing through openings (52, 54, 56) in the flame retention plate (46). The direction of air flow is altered by a ramped surface (58) forming a portion of each opening (54) in a ring of intermediate openings disposed between inner small openings (52) and outer large openings (56). The ramped surface (58) is oriented for directing air radially outwardly to mix with air flowing through the outer large openings (56). This action creates a partial vacuum at discharge orifices (49, 50) formed in a gas supply tube (20), with the orifices (49, 50) being disposed downstream of the flame retention plate (46), to actively suck gas out of the gas tube (20) to enhance mixing of gas with air. Highly efficient combustion of the mixed gas and air results, providing a flame close to the flame retention plate (46).

FIG. 2



This invention relates to burners, and more particularly to an improved design for a flame retention plate employed in a power gas burner such as for use in a water heater or other appliance.

Previous burner structures have been known to employ a fan-type generator at the end of an air supply tube to impart a swirling action to combustion air to facilitate mixing of air with fuel. Use of this type of structure is unsatisfactory when it is desired to obtain a high backpressure within the air supply tube. This feature provides important operating advantages as set forth in copending application Serial Number 07/382,440 filed July 19, 1989 and assigned to a common assignee as the present application. The provision of high backpressure within the air supply tube prevents flashback of the flame into the air tube. Additionally, the backpressure actively forces the combustion air through the flame retention plate.

It is an object of the present invention to provide a flame retention plate which enhances mixing of a primary air-fuel mixture with secondary combustion air. It is a further object of the invention to provide a flame retention plate structure which assists in discharging fuel from a fuel tube having lateral discharge orifices by providing a reduced or negative pressure at the fuel discharge orifices to draw fuel out of the orifices and into the stream of primary combustion air.

The flame retention plate of the invention is employed in combustion with an air tube defining an internal air flow path and a pressurized air supply means for providing pressurized air to the air flow path. A fuel supply tube extends through the air flow path and includes lateral discharge means in the form of laterally oriented orifices for discharging air into the air flow path. In accordance with the invention, a substantially planar flame retention plate is adapted for placement within the air flow path upstream of the lateral discharge orifices provided in the fuel supply tube. The flame retention plate includes a plurality of openings therethrough for outletting air from the air flow path, with the openings being arranged in a predetermined pattern and including an inner ring of relatively small openings and a plurality of relatively large outer openings. The inner ring of small openings provides primary combustion air to an area adjacent the discharge of fuel from the lateral orifices formed in the fuel supply tube, to provide a primary air-fuel mixture. The outer openings outlet secondary combustion air from the air flow path. The flame retention plate further includes means for altering the direction of flow of air through the plate for facilitating mixing of the primary air-fuel mixture with the secondary combustion air downstream of the plate.

In a preferred embodiment, the outer relatively

large openings are arranged so as to provide an outer ring of openings adjacent the outer edge of the flame retention plate and an intermediate ring of openings between the outer ring of openings and the inner ring of openings. The outer ring of openings and the intermediate ring of openings are preferably arranged in an overlapping staggered pattern to provide interlacing of air flowing therethrough downstream of the plate. In a preferred embodiment, the means for altering the flow of air through the plate comprises a ramped surface forming a portion of each opening in the intermediate ring of openings for directing air passing therethrough radially outwardly and into the path of air flowing through the outer ring of openings. The ramped surface preferably extends between the inlet side of the plate and the outlet side of the plate in a substantially linear fashion providing an outlet having a lesser area than the area of the inlet, forming a restriction at the outlet of the opening.

Additionally, the openings in the outer and intermediate rings of openings are preferably provided with means for increasing the velocity of air passing through the openings, which preferably takes the form of a chamfer provided at the inlet and outlet surfaces of the plate at each opening. The acceleration of secondary combustion air as it passes through the flame retention plate enhances downstream mixing of the secondary combustion air with primary air-fuel mixture.

The drawings illustrate the best mode presently contemplated of carrying out the invention.

In the drawings:

FIG. 1 is a perspective view with a portion broken away showing a representative burner employing a flame retention plate;

FIG. 2 is an enlarged partial sectional view showing the flame retention plate as placed at the flame end of the burner of FIG. 1; and

FIG. 3 is a partial sectional view taken generally along line 3-3 of FIG. 2.

As shown in FIG. 1, a power gas burner assembly 10 includes a control box 12, a motor and blower assembly 14, an air tube 16 and an ignition assembly including a burner head assembly 18. These components are described in copending application Serial No. 07/382,440 filed July 19, 1989 and assigned to a common assignee as the present invention, the disclosure of which is hereby incorporated by reference.

Burner head assembly 18 comprises the forward end of an ignition assembly providing a gas tube 20 which extends coaxially through air tube 16. Gas tube 20 received gas through a gas valve 22 at one end, and at burner head assembly 18 gas tube 20 is provided with an orifice cap member 24.

Blower 14 supplies pressurized air through its outlet to an air duct 26 which has its longitudinal axis disposed at an angle of 45° from the longitudinal axis of air tube 16. Air duct 26 communicates pressurized air from blower 14 to the interior of air tube 16.

Air tube 16 terminates in an end portion 28 providing an angled outwardly flared wall 30, defining a frusto-conical shape to end portion 28 of air tube 16. In a preferred embodiment, a frusto-conically shaped end extension is adapted for connection to the end of air tube 16 to facilitate assembly of the components of burner 10 shown in FIG. 1. A flange 32 is connected to air tube 16 adjacent its discharge end. A flange gasket 34 is adapted for placement adjacent flange 32, with a sealing gasket 36 adapted to secure the flared end portion 28 to air tube 16.

The ignition assembly further includes a hot surface ignitor 38 and a flame sensing rod 40, as fully disclosed in the above-referenced copending application.

A circular plate 42 is connected at the other end of air tube 16, and a mounting gasket 44 is connectable to plate 42 for securing the ignition assembly to air tube 16.

Ignitor 38 and flame sensing rod 40 are connected to a flame retention plate 46 adapted for placement at the discharge of air tube 16. Referring to FIG. 3, flame retention plate 46 includes an upper opening 47 in which ignitor 38 is normally mounted. Flame sensing rod 40 is mounted in an opening 48 in retention plate 46.

As shown in FIG. 2, retention plate 46 is placed upstream of the flared end wall 30 provided at the end of air tube 16, and gas tube 20 extends through retention plate 46. Orifice cap 24 provided at the end of gas tube 20 includes a series of laterally oriented gas discharge orifices, shown at 49, 50, which are oriented perpendicularly to the direction of flow of gas through gas tube 20.

Air tube 16 defines an internal air flow path 51 to which pressurized air from blower assembly 14 is supplied, and gas tube 20 extends through air flow path 48 in a direction coaxial therewith. The longitudinal axes of discharge orifices 49, 50 are oriented perpendicularly to the direction of movement of air through air flow path 51 for discharging gas outwardly into air flow path 51 from the interior of gas tube 20.

As noted, retention plate 46 is placed upstream of the discharge of gas from gas tube 20, acting to enclose the outlet of air tube 16 and to control the flow of air therethrough. Flame retention plate 46 has a diameter of 3.845 inches and a thickness of approximately 0.218 inches and, as shown in FIGS. 2 and 3, includes a substantially central opening 50 through which gas tube 20 extends. An inner ring

of relatively small orifices 52 is provided at the inner portion of retention plate 46, having its center coincident with the longitudinal axis of air tube 16. Inner openings 52 are relatively small in diameter, having an internal diameter of approximately 0.1935 inches.

Air passing through the inner ring of small openings 52 mixes with gas discharged from the outlets of orifices 48, 50 of gas tube 20 to provide a primary air-gas mixture.

Retention plate 46 further includes an intermediate ring of openings 54 having a relatively large diameter, and an outer ring of openings 56 also having a relatively large diameter substantially equal to that of openings 54. Openings 56 and the inlet side of openings 54 each have a diameter of approximately 0.4375 inches. In some applications, it is contemplated that the outer ring of openings 56 may be slightly larger than the intermediate ring of openings 54.

As shown in FIG. 3, the intermediate ring of openings 54 and the outer ring of openings 56 are arranged in an overlapping staggered pattern. With this construction, an interlacing of air discharged from internal flow path 51 of air tube 16 is accomplished after air passes through flame retention plate 46.

As shown in FIG. 2, each of openings 54 in the intermediate ring of openings is provided with a ramped surface 58. Ramped surface 58 is linear in cross section, extending from the inlet side of retention plate 46 to the outlet side of plate 46. Ramped surface 58 is oriented so as to direct air passing through an opening 54 radially outwardly, as shown in the representation of air passing through openings 54 in FIG. 2. This causes convergence of secondary combustion air from the intermediate ring of openings 54 with secondary air from the outer ring of openings 56.

The outward deflection of air passing through the intermediate ring of openings 54 in retention plate 46 acts to carry the primary air-gas mixture outwardly to secondary air passing through the intermediate ring of openings 54 and the outer ring of openings 56, where mixing occurs. Additionally, the outward deflection of air passing through the intermediate ring of openings 54 creates a partial vacuum at the outlets of discharge orifices 49, 50, providing negative pressure thereat to create a low turbulence area for gas to exit gas tube 20 smoothly and evenly, essentially acting to actively suck or draw gas out of discharge orifices 49, 50. This partial vacuum created by the outward deflection of air caused by ramped surfaces 58 additionally results in the air-gas mixture being drawn back towards the center of the flow area, as shown in the arrows representing air and gas flow in FIG. 2, resulting in additional turbulent mixing of air with

gas.

With the provision of ramped surfaces 58, gas from discharge orifices 49, 50 is dispersed more rapidly to the secondary outer air passing through the intermediate ring of orifices 54 and the outer ring of orifices 56 than would be accomplished if angled surfaces 58 were not present. This arrangement provides better gas and air mixing closer to flame retention plate 46, thus providing a shorter flame and more efficient combustion as a result of gas mixing with air quickly and thoroughly close to retention plate 46. Accordingly, a relatively short end portion 28 can be employed.

Angled surfaces 58 act to provide an outlet at the discharge side of plate 46 having a decreased area relative to the inlet of openings 54 at the inlet side of plate 46.

As is known, combustion of the air-gas mixture causes expansion of the mixture. Flared end wall 30 acts to contain such expansion to ensure complete combustion of the air-gas mixture. It has been found that orienting flared end wall 30 at an angle of approximately 8° to the longitudinal axis of air tube 16 results in satisfactory operation and complete combustion.

Each of openings 54 in the intermediate ring of openings is provided with a chamfer 60 at the inlet side of plate 46 and a chamfer 62 at the outlet side of plate 46. Likewise, each of openings 56 in the outer ring of openings is provided with a chamfer 64 at the inlet side of plate 46 and a chamfer 66 at the outlet side of plate 46. It is believed that chamfers 60-66 act to accelerate air as it passes through openings 54 and 56, while maintaining back pressure within internal flow path 48 of air tube 16. The resulting increase in velocity of air passing through openings 54, 56 provides additional kinetic energy at the area of convergence of air from openings 54 with air from openings 56, thus increasing the efficiency of gas and air mixing.

In high output applications, it has been found advantageous to move the mounting of flame sensing rod 40 from opening 48 to the outer opening 56 directly opposite opening 47, while maintaining ignitor 38 in position within opening 47. With this arrangement, a balanced discharge of air through retention plate 46 is achieved.

Various alternatives and embodiments are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter regarded as the invention.

Claims

1. A flame retention plate for use with a burner (10) including an air tube (16) defining an internal air flow path, means (14) for providing

pressurized air to said air flow path, and a fuel supply tube (20) including lateral discharge means (49, 50) for discharging fuel into said air flow path, said flame retention plate (46) being for placement within said air flow path upstream of said lateral discharge means (49, 50), said flame retention plate being substantially planar in form and including a plurality of openings (52, 54, 56) therethrough for outletting air from said air flow path, said openings (52, 54, 56) being arranged in a predetermined pattern and including an inner ring of relatively small openings (52) for supplying air into fuel discharged through said lateral discharge means (49, 50) to provide a primary air-fuel mixture, and a plurality of outer relatively large openings (54, 56) for outletting secondary combustion air from said air flow path, and means for altering the direction of flow through said plate (46) for facilitating mixing of said primary air-fuel mixture with said secondary combustion air downstream of said plate (46).

2. The flame retention plate of Claim 1, wherein said outer relatively large openings (54, 56) are arranged so as to provide an outer ring of openings (56) adjacent the outer edge of said plate and an intermediate ring of openings (54) located between said outer ring of openings (56) and said inner ring of openings (52).
3. The flame retention plate of Claim 2, wherein said outer ring of openings (56) and said intermediate ring of openings (54) are arranged in an overlapping staggered pattern to provide interlacing of air flowing through said outer and intermediate rings of openings downstream of said plate (46).
4. The flame retention plate of Claim 2 or 3, wherein said means for altering the direction of flow of air through said plate comprises a ramped surface (58) forming a portion of each opening (54) in said intermediate ring of openings for directing air passing through each opening (54) in said intermediate ring of openings radially outwardly and into the path of air flowing through said outer ring of openings (56), to provide negative pressure at the lateral discharge means (49, 50) of said fuel supply tube (20) to facilitate discharge of fuel therefrom, and to draw said primary air-fuel mixture toward the centre of the flow path downstream of the discharge of fuel from said fuel supply tube (20), to facilitate mixing of said primary air-fuel mixture with said secondary combustion air.

5. The flame retention plate of Claim 4, wherein the openings (54) in said intermediate ring of openings each define an inlet at one side of said plate and an outlet at the other side of said plate, and wherein said ramped surface (58) in each opening (54) in said intermediate ring of openings defines an outlet having a lesser area than said inlet to provide a restriction in each said opening.

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6. The flame retention plate of Claim 5, wherein the ramped surface (58) in each said opening (54) in said intermediate ring of openings extends linearly from the inlet side of said plate (46) to the outlet side of said plate (46).

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7. The flame retention plate as claimed in any one of Claims 2 to 6, further comprising means associated with said openings (52, 54, 56) for increasing the velocity of air passing through said openings.

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8. The flame retention plate of Claim 7, wherein said velocity increasing means comprises a chamfer (60, 62) formed in said plate (46) at each said opening (52, 54, 56) at the inlet side of said plate (46) and at the outlet side of said plate (46).

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9. A burner, comprising:

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 - an air tube (16) defining an internal air flow path;
 - pressurized air supply means (14) for providing pressurized air to said internal air flow path;
 - a fuel supply tube (20) extending through said internal air flow path and including a plurality of lateral discharge outlets (49, 50) for discharging fuel into said air flow path; and
 - a flame retention plate (46) as claimed in any one of Claims 1 to 8.

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10. A burner as claimed in Claim 9, characterized in that said air tube (16) includes a flared end portion (28) downstream of said plate (46) for facilitating mixing of primary air-fuel mixture with secondary combustion air.

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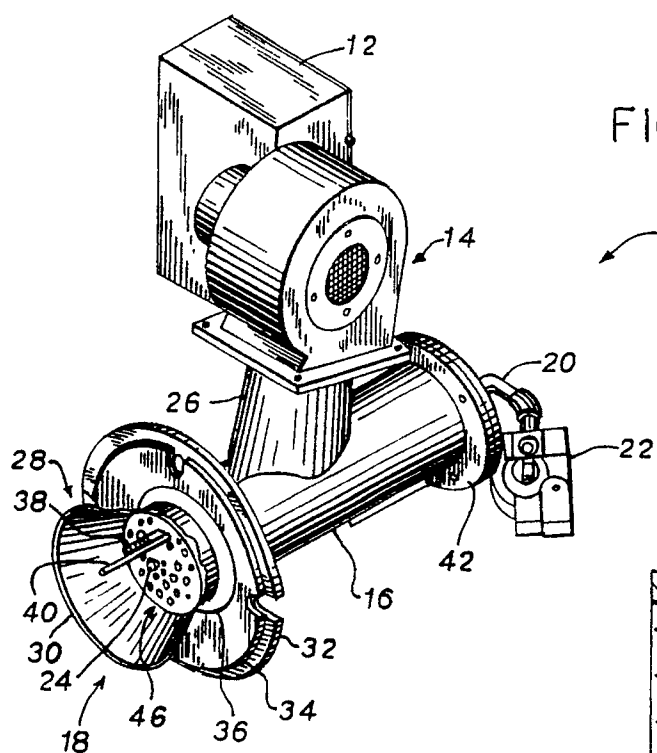


FIG. 1

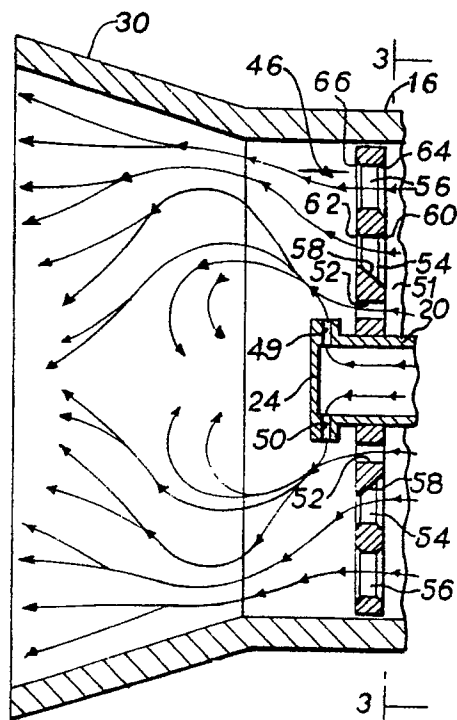
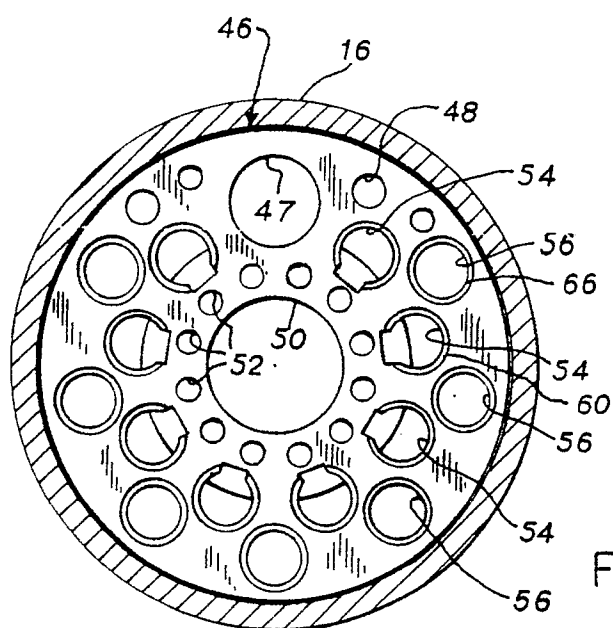
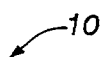


FIG. 3