CHAMBERLESS HIGH INTENSITY BURNER
EMPLOYING AUXILIARY AIR FLOW

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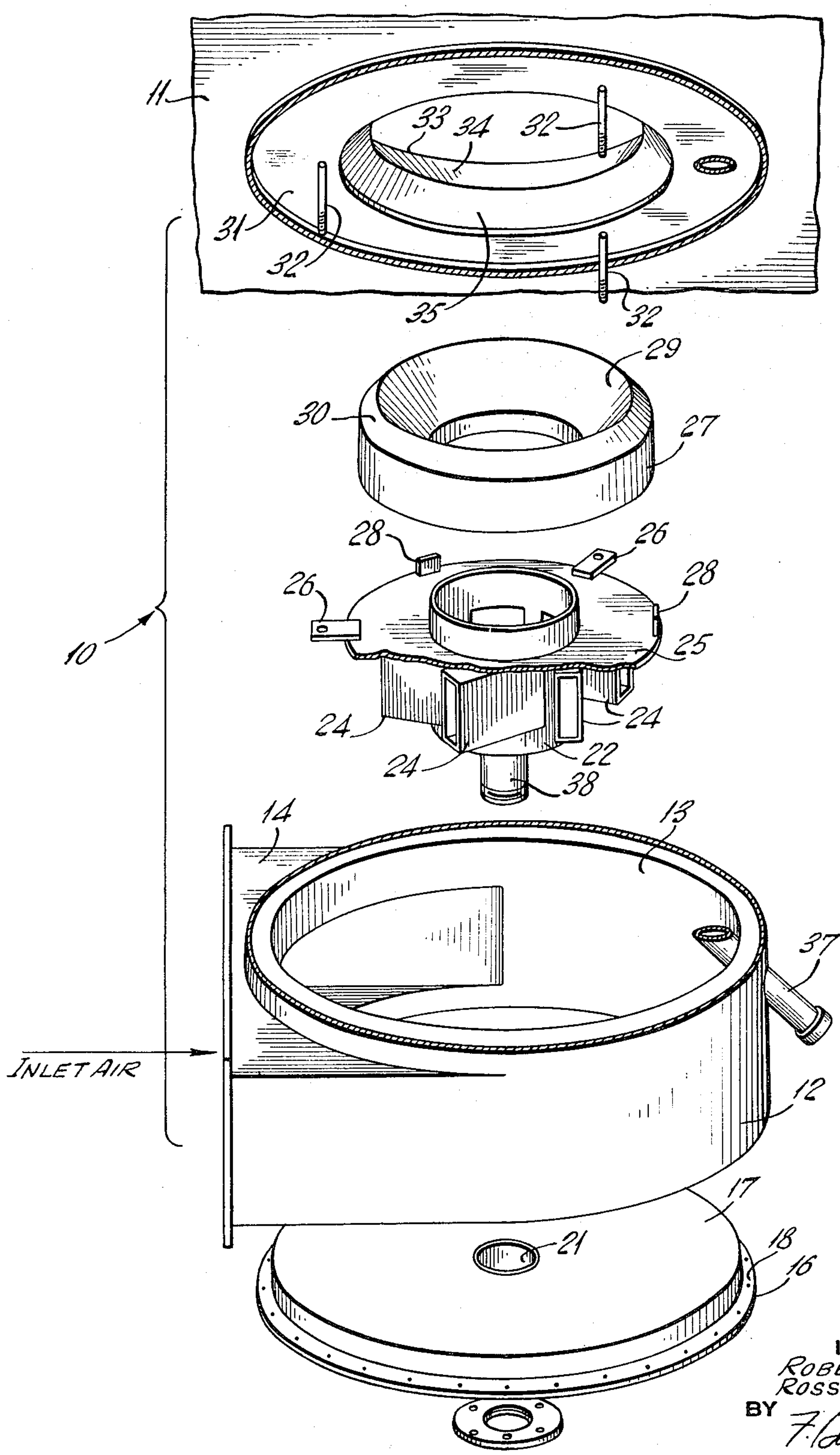
Fig. 1.



INVENTORS
ROBERT P. GUERRE
ROSS R. RULAND
BY
ATTORNEY

Fig. 2.

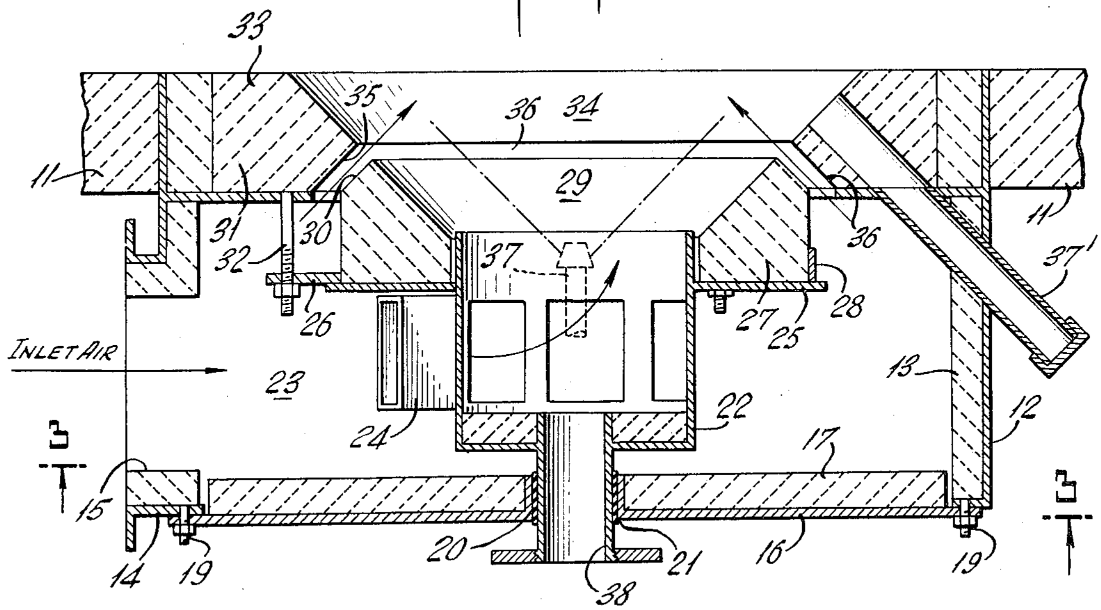
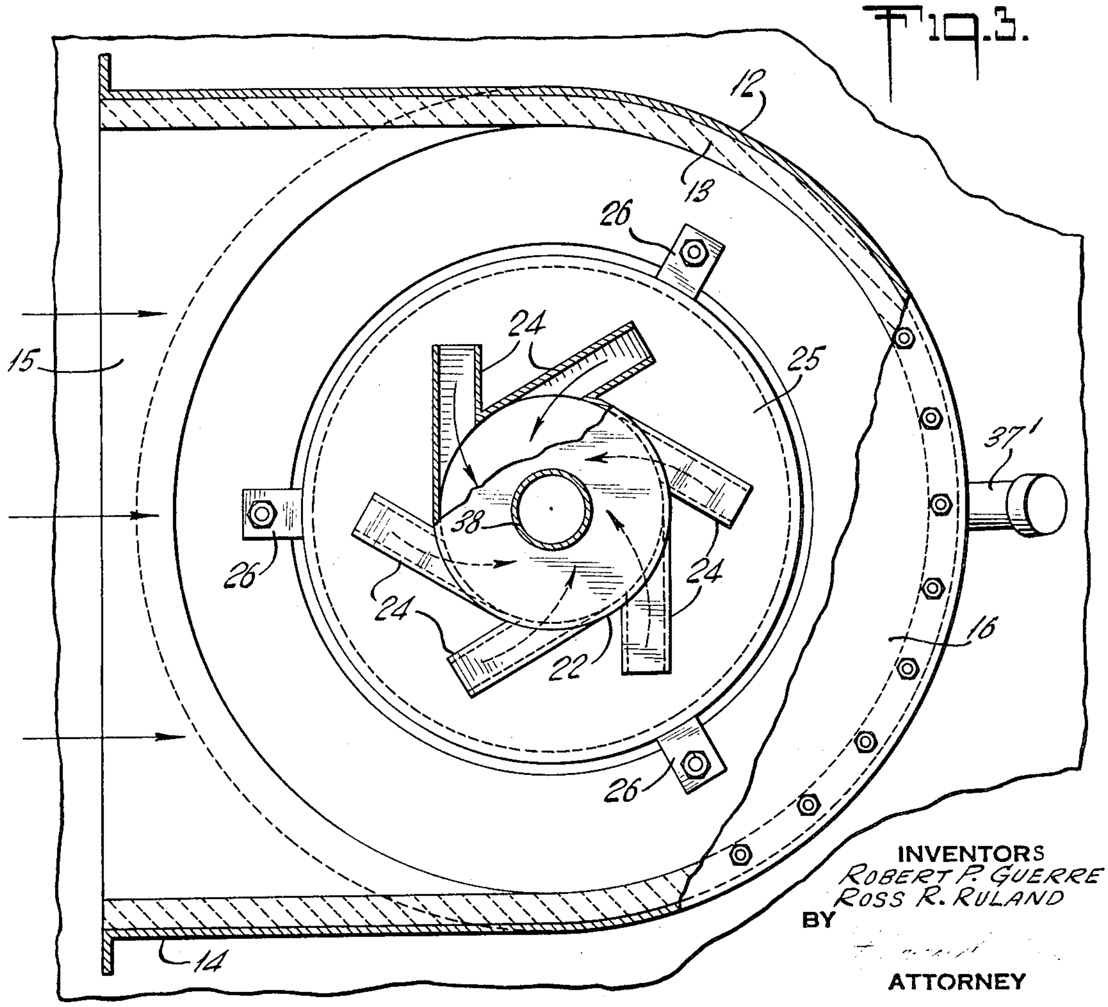


Fig. 3.



INVENTORS
ROBERT P. GUERRE
ROSS R. RULAND
BY

ATTORNEY

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Fig. 4.

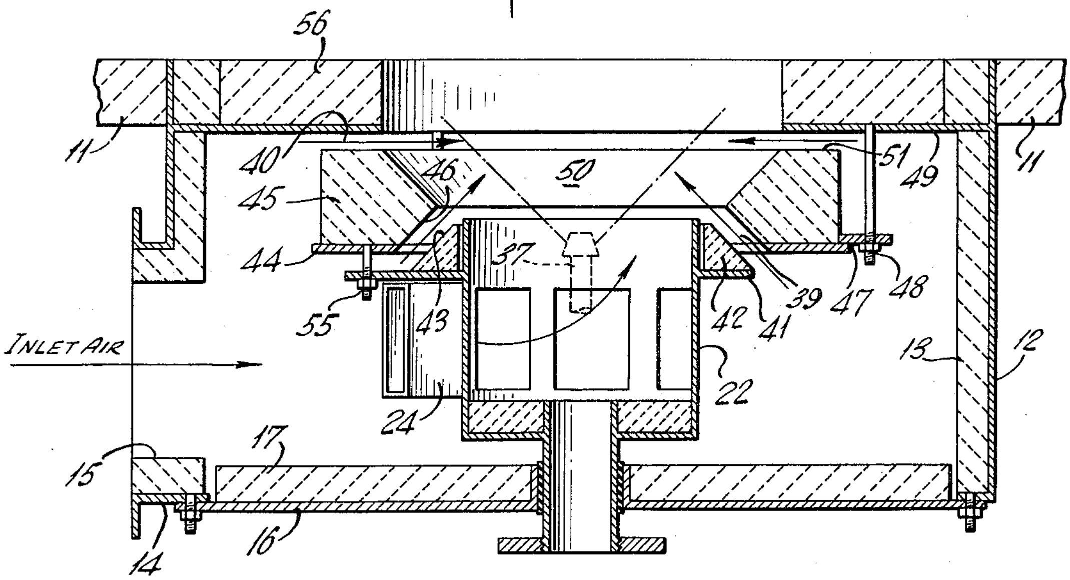
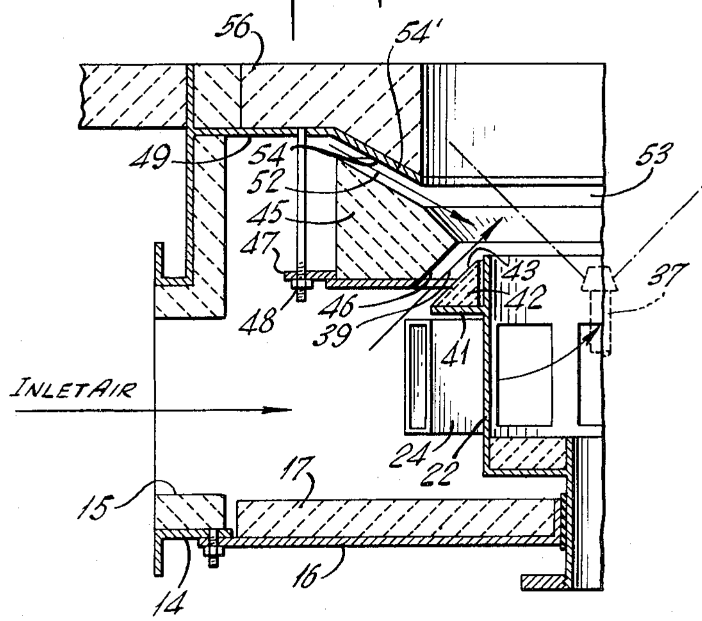


Fig. 5.



INVENTORS
ROBERT P. GUERRE
ROSS R. RULAND
BY
ATTORNEY

United States Patent Office

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CHAMBERLESS HIGH INTENSITY BURNER EMPLOYING AUXILIARY AIR FLOW

Robert P. Guerre, Dover, and Ross R. Ruland, Hopatcong, N.J., assignors to Esso Research and Engineering Company

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U.S. Cl. 431—182 15 Claims

ABSTRACT OF THE DISCLOSURE

A chamberless, high intensity burner especially suited for the incineration and combustion of contaminated fuels and waste streams by achieving a high, concentrated degree of mixing and, therefore, a high temperature, in a relatively small but structurally unconfined volume. The device utilizes the principal of vortex air flow from swirling air jets to achieve a high degree of recirculation local to the point of fuel injection, together with one or more coaxially-oriented annular-shaped streams of air to provide intimate mixing of fuel and air as well as to shape, control and contain the flame envelope. Utilizing the air required for combustion in this manner eliminates the need for a refractory-lined chamber which otherwise would be required to confine the combustion process in order to generate the extreme temperatures sometimes required for complete incineration. The burner is, of course, not limited to such applications, but offers particular advantage where contaminants are present in the fuel and which are incompatible with or otherwise destructive to mechanically formed combustion chambers.

BACKGROUND OF THE INVENTION

Field of the invention

In general the present invention relates to high intensity burners and more particularly to a novel and improved burner construction which eliminates the necessity for a combustion chamber.

Description of prior art

Typical prior art high intensity construction burner constructions generally include a combustion chamber which is required to contain and confine the burning process to achieve a high degree of mixing and completeness of combustion. The heated walls of the combustion chamber aid in the combustion process by radiating heat from the chamber walls back toward the flame. These walls contain and shape the flame by restricting the tendency of the gases to expand and limiting the flames radial expansion.

The known prior art believed most pertinent to the present invention comprises a burner construction wherein an auxiliary air flow is employed for cooling purposes only, that is, to cool or wash the combustion chamber walls. Such prior art constructions are not designed so that the auxiliary air flows aid in the combustion, but merely function to create a boundary layer of cool air along the chamber walls. In such typical prior art constructions there is a relatively high excessive amount of air in comparison to the amount needed to burn fuel and thus, combustion is economically undesirable.

SUMMARY OF THE INVENTION

The present invention relates to a novel and improved burner construction, and more particularly, to a chamberless, high intensity burner especially suited for combustion by achieving a high concentrated degree of mixing and therefore, a high temperature in a relatively small but structurally unconfined volume wherein the principle of vortex air flow is employed to achieve a high degree of recirculation local to the point of fuel injection.

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In accordance with the present invention there is provided a novel and improved construction for a high intensity burner wherein the need for a combustion chamber is completely eliminated by virtue of the employment of auxiliary air stream flow to control, contain and shape the flame envelope and simultaneously provide adequate turbulences for the required air/fuel mixing. Thus, the burner is constructed and arranged such that the inlet air stream flows in predetermined precise part through the swirl chamber while the remaining portion of the inlet air stream flows through one or more auxiliary passageways or gaps provided so that the secondary or auxiliary air flow will shape the flame inwardly to control its expansion, restrain the limits of flame expansion and to keep the contaminated fuels off the small amount of refractory surrounding the gap so as to maintain the integrity of the refractory. The momentum of the air flow through the gap is sufficient to enable it to mix with the fuels so that complete combustion is achieved within a short distance relative to the point of fuel injection, thereby to provide a relatively superior, shorter flame which obtains a reduction in flame impingement. Throughout this disclosure the term "primary" air flow is intended to mean that air closest to the fuel supply. The terms "secondary" and "tertiary" are intended to define the proximity of the auxiliary air flow(s) relative to the fuel supply. The important characteristic to keep in mind throughout this invention is that the gap air flow must be the dominant factor, that is, it must be sufficiently strong to resist expansion of the vortex flow, which according to the present invention functions to stabilize the flame and tip only. Thus, it is apparent that at least fifty percent (50%) of the air flow must be through the gap(s).

In one embodiment of the invention preferably only a single auxiliary air flow is required to obtain the desired flame quality. The primary air flow is utilized to create a vortex flow region in the immediate vicinity of the fuel supply, which may comprise an oil or gas gun. This characteristic of the burner is essential for good flame quality and stability, especially when utilizing heavy oils. The remainder of the inlet air flow enters through an annular gap disposed about the vortex air flow inducing means to control the limit of expansion of the flame and to create the desired pattern of hot gas/flame envelope and thus, the burner requires no combustion chamber. Although either preheated or ambient inlet air may be employed, by using the former a relatively small amount of gap air flow bounces off the fuel rich mixture it is designed to intersect with, thus obtaining the desired combustion and permitting the use of a single air gap only. According to the present invention the refractory material which is located below the air gap is subjected to a vortex wash plus a substoichiometric air/fuel ratio (that is, a fuel rich mixture) so that the temperature thereof is relatively low so as to obtain relatively little heat release along its surface and therefore, the refractory has a relatively high life expectancy even when relatively bad fuels are employed. The vortex wash aids in cooling the refractory surface and is insufficient to obtain combustion until the air/fuel mixture is contacted by the auxiliary air flow. Typical of the advantages flowing from such an arrangement, as previously described, include superior combustion relative to most available burners and the lack of the necessity for a refractory combustion chamber, which means that even under the worst conditions, a nonexistent refractory cannot be deleteriously affected. In general, the overall construction is simplified since it is not as sensitive to aerodynamic ratios as is true in prior art situations discussed heretofore.

A second embodiment, which also is chamberless and utilizes air stream momentum to shape the flame envelope, includes an auxiliary air flow comprising multiple auxiliary air streams in addition to the primary vortex air flow produced through the usual vortex air flow inducing means. In this embodiment either ambient or preheated inlet air may be used in combination with multiple auxiliary air flows. The use of either ambient or preheated inlet air may be dictated by prevailing conditions and the consequent costs involved in either situation. Naturally, when employing ambient air the cost involved for provinding a preheater which would be required in the case of using preheated inlet air is eliminated, and thus, the economics are substantially reduced.

Accordingly, it is a primary object of the present invention to provide a novel chamberless high intensity burner construction.

Another object of the present invention is to provide a novel and improved high intensity burner construction which retains the advantages of present day superior high intensity burners, while eliminating the need for a combustion chamber by utilizing the principle of air stream momentum to control and contain the flame envelope.

A further object of the present invention is to provide a completely chamberless high intensity burner construction which utilizes a predetermined portion of the inlet air flow to create a vortex flow region in the immediate vicinity of the fuel supply and includes at least one annular gap located proximate the vortex region to provide a passageway for an auxiliary air flow to control the limit of expansion of the flame.

Still yet a further object of the present invention is to provide a novel construction for a burner comprising a chamberless high intensity burner which utilizes preheated air at a velocity required to mix in connection with an auxiliary air stream for providing the denied combustion, as well as the control and containment of the flame envelope.

A further object of the present invention is to provide a novel construction for a chamberless high intensity burner which utilizes non-preheated air in connection with auxiliary air flow to control and contain the flame envelope.

Having in mind the above and other objects that will be evident from an understanding of this disclosure, the invention comprises the construction and arrangement as illustrated in the presently preferred embodiments of this invention which is hereinafter set forth in such detail as to enable those skilled in the art readily to fully understand the function, operation, construction and advantages of it when read in conjunction with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of one embodiment of a chamberless high intensity burner constructed and arranged in accordance with the present invention;

FIG. 2 is a cross-sectional view of the burner of FIG. 1 taken substantially along the vertical centerline thereof;

FIG. 3 is a cross-sectional view taken substantially on the line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view similar to that of FIG. 2, illustrating a second embodiment of the present invention which employs multiple auxiliary air flow; and

FIG. 5 is a modification of the second preferred embodiment illustrated in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Having reference to the drawings wherein similar parts are designated by like reference numerals, FIGS. 1 through 3 illustrate in detail a first preferred embodiment of the present invention. In FIG. 1 there is shown a chamberless high intensity burner generally designated **10** maintained in a furnace floor or wall **11** by suitable welds or brackets (not shown) and which comprises a cylindrical open-ended burner casing **12** made of carbon steel construction and lined internally with a block type insulation **13** secured to the interior of the casing **12** by a suitable insulation adhesive. In the case of usual preheated air the insulation **13** provides protection against a person inadvertently touching the hot casing. The casing **12** includes a radially disposed air duct **14** for providing an inlet opening **15** to receive the air flow designated by the arrow, which may be ambient or preheated, the latter of which may be supplied by conventional means (not shown) such as a standard air preheater or other suitable type of conventional preheater.

The casing **12** is provided at its bottom with a cover plate **16**. A block insulation **17** is secured to the interior surface of the cover plate **16**. The cover plate **16** extends radially outward of the insulation **17** to provide a flange **18** which facilitates mounting of the cover plate **16** to the burner casing **12** by means of nuts and bolts generally designated **19**, as shown in FIG. 2. The cover plate **16** is formed with a central opening **20** having a packing sleeve **21** disposed therein for mounting air flow inducing means including a swirl jet casing **22**, which is of conventional construction in an air inlet plenum chamber **23**, for receiving the inlet air flow. The air flow from the plenum chamber flows in two directions, one flow being tangential through the tangentially arranged air ducts **24** whereupon the tangential air flow through the swirl chamber **22** is changed to include an axial direction component of vortex air flow, and the other being a gap air flow described hereinafter. The swirl chamber **22** is mounted conventionally as best illustrated in FIGS. 2 and 3, which also illustrate the general nature of the air flow pattern. The swirl chamber **22** includes an upper radially extending annular seat or support plate **25** having circumferentially spaced apertured mounting lugs **26** extending radially outward thereof. An annular primary burner tile **27** made of a suitable, high temperature castable refractory material seats on the mounting plate **25** of the swirl chamber and may be secured thereto by a suitable refractory cement and restrained radially by peripherally disposed metal clips **28** welded to the plate **25**. The upper surface of the primary burner tile **27** has a substantially pyramidal shape comprising an inner outwardly sloping surface **29** joined to form an apex with an outer inwardly sloping surface **30**. A centrally open annular floor plate **31** is provided with downward extending threaded bolts **32** for engaging corresponding ones of the apertured mounting lugs **26** to mount the floor plate **31** at a distance which is adjustable relative to the seat **25** and thus, the primary burner tile **27** also is vertically adjustable. Conventional nuts thread on the threaded portion of the bolts extending through the lugs **26**. The floor plate **31** has secured theerto by a suitable refractory cement, a secondary annular burner tile **33**, also made of a high temperature castable refractory material. The tile **33** has an inner anular surface of pyramidal shape comprising an upper annular surface **34** having a slope substantially similar to and coplanar with the surface **29** and a bottom or lower annular surface **35** whose slope is parallel with that of the surface **30** and is disposed in spaced parallel relation to the surface **30** as shown in FIG. 2. When mounted as shown in FIG. 2 the surfaces **35** and **30** form a continuous uniform annular air gap **36**. The width of the gap or auxiliary air passageway **36** may be adjusted by changing the vertical disposition of the seat **25** relative to the floor plate **31**. By closing the air gap the velocity of the auxiliary air flow may be controlled, that is, made greater by closing the gap or lessened by making the gap wider.

In operation, as previously discussed, a predetermined precise portion of the preheated inlet air flow enters through the air ducts **24** of the swirl chamber **22**, for example 25 to 50 percent, which comprises the primary air flow and creates a strong vortex flow which forces the hot gases to recirculate back to the fuel spray, which enters through the fuel gun shown in part schematically in dotted lines by reference character 37, thus heating it and aiding in combustion. The remaining 50 to 75 percent of the inlet air flow enters through the continuously uniform annular air gap 36 defined by the refractory surfaces 30 and 35. This auxiliary or secondary air flow shapes the flame inwardly to maintain the contaminated fuels off the surrounding refractory material, and further produces a high turbulent zone for mixing the fuel and air to achieve complete combustion within a relatively short distance of the fuel gun. Thus, the vortex air flow achieves a high degree of recirculation local to the point of fuel injection together with one or more coaxially disposed annular-shaped streams of air to provide intimate mixing of fuel and air, as well as to shape, control and contain the flame envelope. Thus, the air flow through the annular gap 36 controls the limit of expansion of the flame and creates the desired pattern of hot gas/flame envelope. The fuel supply may comprise conventional means 37, such as a center fired gas gun unit or a standard oil gun. Also, the burner is provided with the usual pilot guide tube (not shown) and pilot light-off tube 37'. Extending through the central opening 20 of the cover plate 16 is a bottom flanged gun guide tube 38 received in the sleeve 21.

In the event that the previously described preferred embodiment utilizes preheated air, the temperature range of the air should be about 500–750° F. Since the air is the main force in this burner construction, its flow must be maintained in a substantailly uniform manner. Essentially this means that any obstruction such as coke deposit, refractory pieces or low pressure may cause an unbalancing of the flame and thereby create further overheating or additional deposits to one side or the other of the burner so that eventually the entire burner may fail. Accordingly, the present burner has been constructed and arranged so that nothing interferes with the air flow. It is most desirable to maintain the annular gap 36 uniform as any non-symmetry will cause the flame to lean more so toward the favored side.

FIG. 4 differs from the heretofore described burner construction of FIGS. 1 to 3 in the auxiliary air flow arrangement. As shown a first portion of the inlet air flow is directed through the swirl jets 24 circumferentially arranged about the swirl chamber casing 22, while secondary and tertiary portions are directed through uniform annular air gaps 39 and 40. The swirl chamber casing 22 is provided with a radially extended annular flange or shelf 41 to support an annular refractory material 42 having an outer downward sloping side 43. The swirl chamber casing shelf 41 also adjustably carries a primary annular plate 44 for supporting a second annular refractory material 45 having an inner pyramidal surface comprising a lower surface 46 disposed in spaced parallel relation relative to the surface 43 of the refractory material 42 so as to define the first annular gap 39 which directs the auxiliary air flow upward at an angle relative to a horizontal plane. The width of the gap 39 is adjustable by means of the mounting means 55 comprising nuts and bolts, the latter of which extend down from the plate 44 through radially extended lugs formed with the shelf 41. The primary support plate 44 is provided with radially extending flanges or lugs 47 for receiving mounting means 48 comprising nuts and bolts, the latter of which extend downward from a floor plate 49. The refractory material 45 further comprises an upper, outwardly sloping surface 50 and an uppermost horizontally disposed surface 51. The upper disposed horizontal surface 51 together with the floor support plate 49 forms the second annular gap 40 for directing a tertiary portion of the inlet air flow in a direction substantially perpendicular to the flame. This arrangement may be referred to as a "triple air injection system" for controlling the flame envelope completely and providing the air necessary for complete combustion within a few feet of the fuel gun. Of course it is recognized that under certain conditions the horizontal air gap alone may suffice. A centrally open annular refractory material 56 seats securely on top of the floor plate 49 to bring the overall burner to a height coplanar with that of the furnace floor 11.

The embodiment shown in FIG. 5 is a modification of that illustrated in FIG. 4. The only difference between these constructions resides in the disposition of the second annular gap and as illustrated in FIG. 5, the second gap designated 52 is constructed and arranged so that it directs the second auxiliary air flow in a downward direction. To achieve this the upper surface 53 of the refractory material 45 slopes downward relative to the horizontal and so does the corresponding portions 54 and 54' of the floor plate 49 and the refractory material 56 located directly above to obtain the desired disposition of the air gap 52. This second air flow intersects with the first auxiliary air flow directed through the annular air gap 39 to precisely mix the fuel and air in the best possible combination of momentum and stoichoimetry.

Thus, there has been provided a burner construction that obviates the need for a combustion chamber, while simultaneously providing for substantially improved flame performance. Although there has been disclosed herein a preferred construction and arrangement, it should be understood that such disclosure is intended to be representative of the preferred embodiments only and that various changes may be made therein without departing from the clear teachings of the present invention. For example, although various arrangements of air gaps have been described and illustrated, it also is within the scope of this invention to employ vertical or horizontal disposed air gaps, the latter of which provides for excellent control of flame expansion and most desirable mixing, but has one fault in that it reduces the effective volume for combustion relative to a vertical disposed air gap. By varying the heat release, air pressure and gap thickness, one possibly could achieve similar results with either arrangement comprising a single air gap or a plurality of air gaps ranging from a horizontal air gap to an air gap disposed at substantially 45° relative to the horizontal, and to obtain substantially longer flames the air gap may be disposed from substantially 45° relative to the horizontal to a vertical air gap. Accordingly reference should be made to the following appended claims in determining the full scope of the invention.

Having thus set forth the nature of the invention, what is claimed herein is:

1. A chamberless staged-air vortex burner for use in the burning of fuels and adapted to be mounted in a furnace wall having an opening therein comprising in combination, burner casing means having an air inlet adapted for receiving an inlet air flow, air induction chamber means having an outlet and being mounted within said burner casing for receiving a predetermined portion of said inlet air flow and producing an uninterrupted helical vortex primary air flow from said outlet, refractory means mounted in said casing about said chamber outlet, said refractory means including a substantially divergent surface extending outward from the periphery of said outlet to a plane common with the outer surface of said furnace wall, air gap means adapted to receive the remaining portion of said inlet air flow, said air gap means comprising at least one air gap of substantially uniform annular configuration extending through said refractory means and located between said outlet and the plane of said outer surface of said furnace wall in which said burner is to be mounted, said one air gap being angularly disposed relative to the axis of said primary air flow for projecting secondary air flow in a convergent direction toward the primary air flow axis to contain the flame envelope and obtain precise flame control and intimate mixing of fuel and air proximate the point of fuel injection.

2. A vortex burner according to claim **1** including a plurality of substantially uniform annular air gaps.

3. A votrex burner according to claim **1** wherein said inlet air flow comprises preheated air.

4. A vortex burner according to claim **1** wherein said one air gap is angularly disposed to provide convergent upward air flow in an outward direction relative to said chamber outlet.

5. A vortex burner according to claim **2** wherein said one air gap is disposed to provide outward converging air flow and a second air gap is constructed and arranged to provide converging air flow in a perpendicular direction relative to said primary air flow axis.

6. A vortex burner according to claim **2** wherein a second air gay is constructed and arranged to provide upward air flow relative to said chamber outlet.

7. A vortex burner according to claim **2** wherein said one air gay is disposed to provide an outward converging air flow and a second air gap is constructed and arranged to provide an inward air flow relative to said chamber outlet.

8. A vortex burner according to claim **1** including means for selectively adjusting the width of said one air gap.

9. A vortex burner according to claim **1** wherein said burner is constructed and arranged such that said air induction means is adapted to receive substantially 25 to 50 percent of said inlet air flow and said air gap means is adapted to receive the remaining portion of said inlet air flow.

10. A chamberless staged-air vortex burner for use in the burning of fuels and adapted to be mounted in a furnace wall having an opening therein comprising in combination, burner casing means having an air inlet adapted for receiving an inlet air flow, air induction chamber means having an outlet and mounted within said burner casing for receiving a predetermined portion of said inlet air flow and producing an uninterrupted helical vortex primary air flow from said outlet, refractory means mounted in said casing about chamber outlet, said refractory means including a substantially divergent surface

extending outward from the periphery of said outlet to a plane common with the outer surface of said furnace wall, air gap means adapted to receive the remaining portion of said inlet air flow, said air gap means comprising at least one air gap of substantially uniform annular configuration extending through said refractory means and located between said outlet and the plane of said outer surface, said one air gap being angularly disposed relative to the plane of said outer surface for projecting secondary air flow in an outward direction relative to said outlet of said induction chamber for containment of the flame envelope, whereby intimate mixing of fuel and air is obtained proximate the point of fuel injection.

11. A vortex burner according to claim **10** including a plurality of substantially uniform annular air gaps.

12. A vortex burner according to claim **11** wherein at least one of said plurality of air gaps is angularly disposed relative to the axis of said primary air flow for projecting secondary air flow in a convergent direction toward the primary air flow axis.

13. A vortex burner according to claim **1** wherein said one air gap is located at substantially 45° relative to the axis of said primary air flow.

14. A vortex burner according to claim **1** wherein said one air gap is disposed in substantially parallel relationship relative to the plane of said outer surface of said furnace wall in which said burner is to be mounted.

15. A vortex burner according to claim **1** wherein said one air gap is disposed angularly relative to the plane of said outer surface of said furnace wall.

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EDWARD G. FAVORS, Primary Examiner