July 15, 1969 A. J. POOLE 3,455,641

BURNER THROAT

Filed March 26, 1968 2 Sheets-Sheet 1

FIG. 1

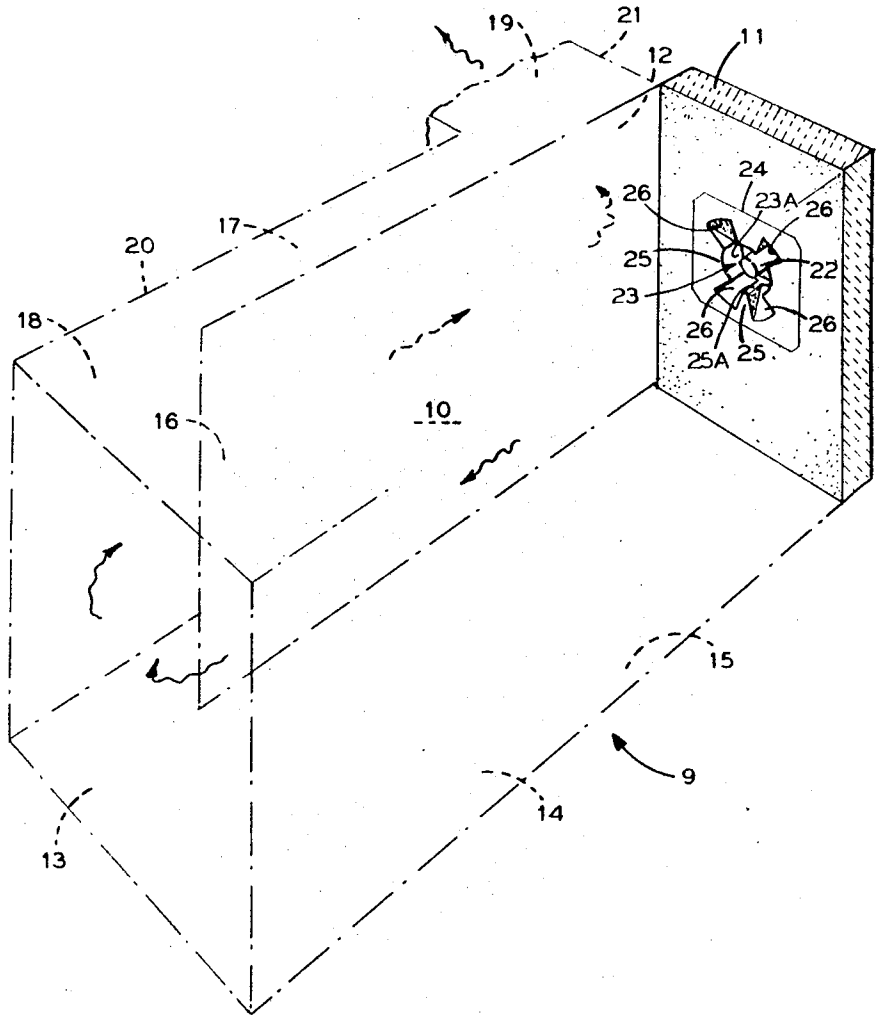

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FIG. 2

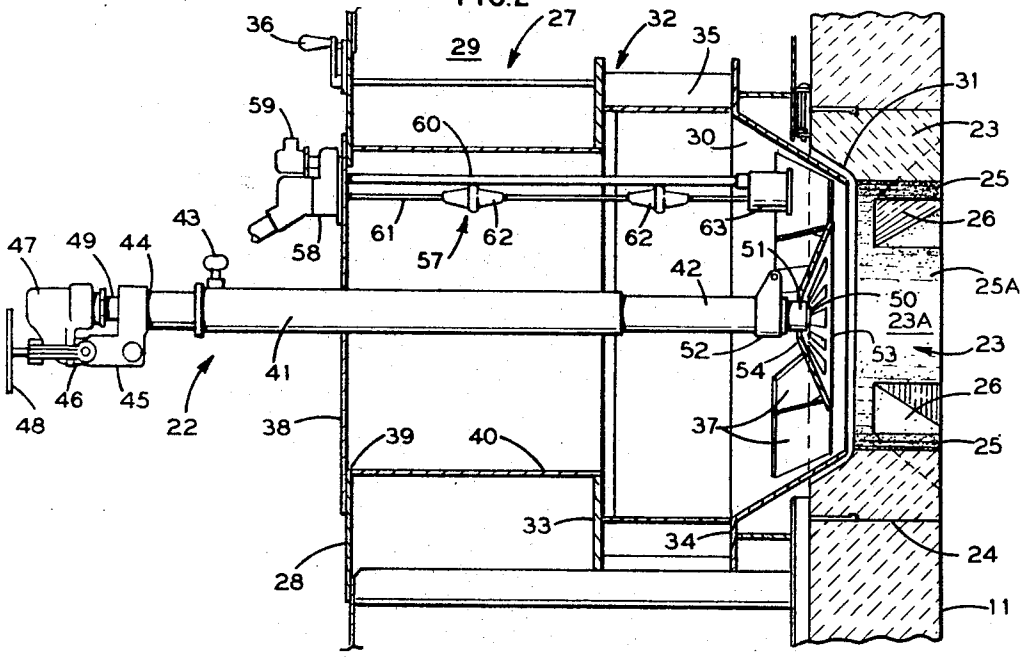
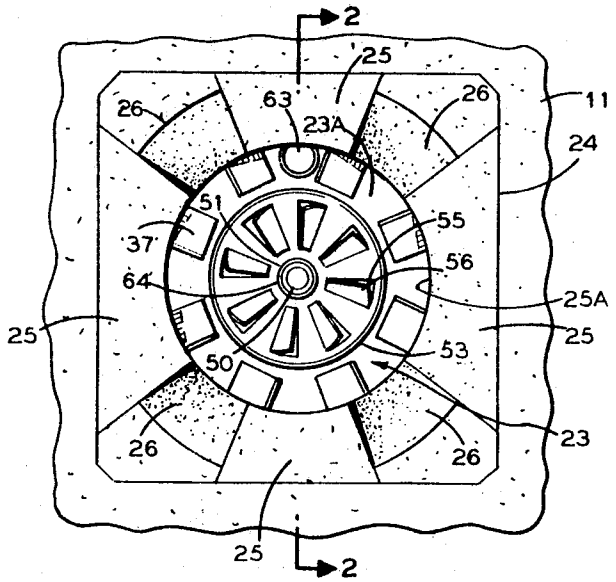


FIG. 3



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BURNER THROAT

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ABSTRACT OF THE DISCLOSURE

A circular burner throat having an inner periphery formed of axially-oriented surfaces alternately spaced with flared surfaces. The axially-oriented surfaces are selectively arranged to constrain the burner flame and to project it in an axial direction so as to preclude impingement on the side walls of the combustion chamber where there is insufficient clearance between the burner throat and the floor, roof and side walls of the combustion chamber. The flared surfaces are disposed where there is ample clearance. The combination of flared and axially-oriented surfaces maintains the throat pressure drop within acceptable limits. The irregular contour and sharp transitions formed by the alternating flared and axially-oriented throat surfaces promote turbulence and the mixing of fuel and air.

The invention relates generally relates generally to liquid fuel burners and more particularly to an improved burner throat for controlling the flame pattern in a furnace combustion chamber.

The modern trend has been toward the shop fabrication of small and medium sized steam generators. Due to the restrictions imposed by transportation facilities these boilers have been limited as to their height and width dimensions, so that capacity increases can only be obtained by lengthening the unit to permit installation of additional heating surface. These limitations have resulted in the steam generators having long and relatively narrow furnace chambers. These units are usually equipped with fuel burners discharging through circular type throats which are flared in the direction of the combustion chamber. The mixing of fuel and air is primarily accomplished by imparting a rotational component of movement to the incoming combustion air through the adjustment of register doors, with consequent short, bushy flame and a tendency for the flame to expand in a radial direction.

With every increase in the steam generating output of these boilers, there has been a corresponding increase in the capacity of the fuel burners and in effect a resultant decrease in the desired lateral clearances between the burner throat and the roof, floor and side walls due to the aforementioned limitations in height and width dimensions. The combination of higher fuel inputs and reduced burner throat to side wall clearances has aggravated the problem of flame impingement resulting in the formation of heavy coke deposits on the side walls of the furnace combustion chamber. These deposits, if allowed to accumulate, will interfere with the efficient burning of the fuel and may necessitate a shutdown of the unit for cleaning. Moreover, continued severe impingement has been known to cause hot spots which proved damaging to both tubes and boiler casing.

It is the primary object of this invention to eliminate flame impingement on the roof, floor and side walls of the furnace combustion chamber. The invention accomplishes this by providing a burner throat whose inner periphery consists of alternately spaced axially-oriented and flared surfaces selectively arranged so that the axially-oriented portions will act to constrain the flame and project it in an axial direction, thereby eliminating impingement where burner throat to side wall clearances are insufficient or marginal, while the flared surfaces positioned where there is ample clearance will allow the flame to expand in a radial direction.

Another object of this invention is to combine the low air pressure drop characteristic of a flared surface with the flame pattern control characteristic of the axially-oriented surface to provide a burner throat which, while eliminating flame impingement, will also retain a commercially acceptable air pressure drop value.

A further object of this invention is to improve the efficiency of the unit by reducing the excess air required for complete combustion of the fuel. This is accomplished through increased turbulence and better mixing of fuel and air caused by abrupt flow pattern transitions resulting from the alternating flared and axially-oriented throat surfaces.

In the drawings:

FIG. 1 is a diagrammatic perspective of the burner and furnace chamber associated with the present invention.

FIG. 2 is a sectional side view of the burner assembly including the burner throat taken along line 2—2 of FIG. 3.

FIG. 3 is a view looking toward the inside of the burner wall of FIG. 1.

In the illustrated embodiment disclosed in the drawings, the burner assembly is shown as adapted for liquid fuel and applied to a furnace having a refractory wall wherein the burner port is provided with a refractory throat of the special configuration which characterizes the invention. It should be understood, however, that the invention is equally applicable for burners using solid or gaseous fuel.

Referring to FIG. 1, the boiler setting 9 shown therein is provided with a furnace chamber 10 of rectangular cross section which includes burner wall 11, furnace side walls 12 and 14, rear wall 13, floor 15 and roof 16. Extending alongside furnace chamber 10 is gas pass 17 containing convection heat absorbing surface (not shown) which is separated from the furnace and formed by side wall 12 and boiler side wall 20 and communicates with the furnace through passage 18 formed between the end of side wall 12 and rear wall 13. The other end of gas pass 17 is provided with an outlet passage 19 formed between the end of boiler side wall 20 and end wall 21, for discharging combustion gases generated in the furnace chamber 10 to a suitable stack (not shown) after they have traversed the length of the gas pass. A burner 22 is arranged to fire through a refractory burner throat 23 formed in the part 24 of the burner wall 11. All of the above-mentioned walls with the exception of the burner wall 11 are lined with steam generating tubes (not shown). The burner wall 11 is preferably formed of refractory thereby eliminating the need for costly, intricate tube bending to accommodate the throat 23, however, this is not intended as a limitation and should the need arise, the invention would be equally applicable to a tubular type burner wall.

The circular burner throat 23 is formed with frusto-conical refractory segments 25 projecting radially inward at spaced positions about the periphery of the throat 23 with their small ends 25A forming an opening 23A about and adjacent to the liquid fuel burner 22, the opening 23A

being of uniform cross-sectional area along at least a major portion of its axial length. The sides of the frusto-conical segments 25 cooperate with the throat 23 to form channels 26 flaring outwardly in the direction of the furnace chamber. In the illustrated embodiment, the burner throat 23 is shown with four frusto-conical segments 25 alternately spaced with flared channels 26. The four channels extend along radial lines to respective corners formed by the side walls 12 and 14 and burner wall 11, while the four radially extending frusto-conical segments extend along radial lines generally normal to the respectively adjacent furnace side walls 12 and 14, the floor 15 and roof 16. The flared channel sections 26 permit the flame to widen at will where there is adequate clearance as between the diagonal corners of the furnace and the burner throat. The frusto-conical segments 25 constrain the flame where there is marginal or insufficient clearance as between the burner throat and the furance side walls, floor and roof of the illustrated embodiment. Flared channel sections 26 are used whenever clearance permits in order to keep the air pressure drop across the burner throat within acceptable limits. The sharp irregularity of the burner throat contour resulting from the abrupt transition between a frusto-conical segment and the adjoining channels promotes turbulence and the better mixing of air and burning fuel.

Referring to FIG. 2, the liquid fuel burner 22 is shown in a partially retracted position for the sake of clarity. The burner 22 is mounted centrally of a circular type burner assembly 27 which is in alignment with burner throat 23 and extends into port 24 formed in a portion of burner wall 11. The burner throat 23 is made from a suitable refractory material and includes alternately spaced flared channels 26 and frusto-conical segments 25 the small ends 25A of which form the openings 23A.

Spaced outwardly from the burner wall 11 and extending substantially parallel thereto is the burner outer casing 28 which cooperates with the burner wall to form a windbox 29 to facilitate the flow of combustion air from a forced draft fan (not shown) to the burner port 24. An air entrance means in the form of a hollow truncated cone 30 centrally positioned immediately adjacent to the exterior side of port 24 directs combustion air into the burner throat 23. In the illustrated embodiment, the air directing cone 30 converges toward the entrance of port 24 and a portion of it extends into recess 31 formed at the inlet of throat 23. The combustion air is directed to the cone 30 from an air register 32 having an outer wall 33 and inner wall 34, the inner wall being connected to the directing cone 30. It will be noted that within the confines of the walls 33 and 34, the air register is provided with adjustable air doors 35 suitably controlled by operator means 36 to impart a whirling motion to the air. This effect is further augmented by a plurality of vanes 37 in cone 30 so that the air discharging from the register 32 tends to form a whirling, turbulent stream of air which hugs the inner periphery of the burner throat 23.

A circular cover plate 38 closes an access opening 39 in the casing 28 and a cylindrical housing 40 extends inwardly from the circumferential periphery of access opening 39 through the windbox 29 to the outer wall 33 of the air register 32. The circular cover 38 supports a central sleeve member 41 through which there extends a distance piece 42 forming part of the fuel burner assembly 27. The distance piece 42 is axially adjustable along the central axis of burner 22 and can be locked into a selected position with the bolt 43. The inlet end 44 of the distance piece 42 is threaded to receive the yoke assembly 45 which is connected to the liquid fuel and atomizing steam lines (not shown). The discharge end 46 of the yoke 45 connects to the atomizer assembly 47 for the through passage of fuel and atomizing steam. A leak-proof fit between yoke 45 and atomizer 47 is achieved by introducing a gasket (not shown) between the mating surfaces and applying pressure with locking device 48. Barrel tube 49 is connected at its inlet end to atomizer assembly 47 and at its outlet end to sprayer plate 50 and retaining cap 51. Attached to support ring 52 at the distal end of distance piece 42 is an impeller deflector 53 in the shape of a truncated cone, concentrically disposed about the longitudinal axis of the liquid fuel burner 22. An ignition device 57 is provided for lighting the main fuel and includes the electrical junction box 58, fuel intake chamber 59, fuel conduit 60, electric lead 61, insulators 62 and ignition chamber 63.

Referring to FIG. 3, the portion of burner wall 11 shown therein includes port 24 and burner throat 23, and has flared channels 26 spaced alternately with frusto-conical segments 25 whose small ends 25A form the opening 23A. Impeller 53 and directional vanes 37 are concentrically arranged about the axis of the burner throat. The impeller 53 is provided with a series of equally spaced air openings 55 and air deflector vanes 56 and a central port 64 to allow passage of sprayer plate 50 and cap 51. Ignition chamber 63 is positioned to discharge a lighting flame through the annular space between the impeller 53 and cone 30.

The geometric pattern of alternate frusto-conical segments and flared channels shown in the drawings is not intended as a limitation, but rather represents only one of many possible arrangements with respect to the relative size and location of the contoured portions.

In operation, combustion air from windbox 29 is admitted to circular burner assembly 27 through air register doors 35 which are adjusted to impart a whirling motion to the air. Cone plate 30 directs the air into the opening 23A and vanes 37 are used to augment the whirling motion of the air. The firing position (not shown) of liquid fuel burner 22 requires that distance piece 42 be inserted in the direction of the furnace chamber 10 thereby positioning impeller 53 with its leading edge in the same plane as the small end of recess 31. Steam or air is used to atomize the fuel prior to its discharge from sprayer plate 50 in the form of a conical-shape mist. The fuel spray mixes with the incoming combustion air and is lighted from a flame produced by ignition device 57. The ignition device operates only for the short interval required to light the main flame. After light-off, ignition of the main flame becomes self-sustaining and will generally occur within the dished contour of the impeller. The flame is projected through the burner throat where its shape is regulated to eliminate impingement. The frusto-conical segments 25 will act to constrain the flame and to guide it in an axial direction where throat to side wall clearances are inadequate or marginal. The use of flared channels 26 alternately spaced with frusto-conical segments 25 keeps the burner throat pressure drop within acceptable limits and promotes turbulence and the better mixing of air and burning fuel.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In combination with a furnace chamber having a burner wall, a circular burner throat in the burner wall, a burner in the central portion of the throat, said throat formed with frusto-conical refractory segments projecting radially inward at spaced positions along the periphery of the throat with their small ends forming an opening about and adjacent to the burner of uniform circular cross-section along at least a major portion of its axial length and with their sides cooperating with the throat to form channels flaring in the direction of the furnace.

2. The combination according to claim 1 wherein the furnace chamber includes side walls connected to the burner wall, and the throat has at least two segments opposed to each other and extending generally normal to the side walls.

3. The combination according to claim 1 wherein the furnace chamber is of rectangular cross-section and the

throat has four channels extending along radial lines to the corners formed by the side and burner walls.

4. The combination according to claim 3 wherein the burner wall is upright.

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