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COMBUSTION TUBE BURNER

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This invention relates to an apparatus and method for burning fuel and particularly to a burner for heat-exchange tubes adapted to be heated by the passage of hot combustion gases therethrough and radiate heat from their outer surfaces.

Tube burners as constructed heretofore have been characterized by certain objections. In the first place, they have only a relatively narrow range of turn-down, i. e., the burners do not operate satisfactorily when the fuel flow is reduced much below the optimum value. In the second place, the possible variation in the length of the flame is small. It is also difficult to control accurately the ratio of fuel and air, especially when operating on reduced rates of fuel flow, and under these circumstances carbon is deposited in the form of soot.

I have invented a burner particularly adapted to heat-exchange tubes, which overcome the aforementioned objections to burner tubes as previously used. In a preferred embodiment of the invention, I supply secondary air to one end of a heat-exchange tube and distribute it substantially uniformly over the greater portion of the sectional area thereof. I also supply a mixture of air and fuel at a point spaced from the point of introduction of the secondary air and adjacent the bottom of the tube. This mixture, on ignition, rises through the stream of secondary air and combustion with the fuel is thus completed. The apparatus includes a burner head having fuel and air chambers and a mixer tube extending from the head into the burner tube. The details of the structure and operation will be explained hereinafter with reference to the accompanying drawing illustrating the preferred embodiment. In the drawing,

Fig. 1 is a vertical, axial section through a burner tube having the invention incorporated therein;

Fig. 2 is a transverse sectional view taken substantially along the plane of line II—II of Fig. 1; and

Fig. 3 is a view similar to Fig. 1 showing a modification.

Referring now in detail to the drawing, and for the present to Figs. 1 and 2, a combustion tube 10 is disposed in a generally horizontal position or constitutes a substantially horizontal portion of a tube having other portions disposed at an angle thereto. While the invention is applicable to combustion tubes regardless of their particular use, it has particular utility in connection with the heat-exchange tubes installed in metallurgical or ceramic furnaces. Such tubes, if not horizontal throughout, frequently have a horizontal portion traversing the furnace wall and it is this portion of such tubes which I designate by the numeral 10.

A burner head 11 is disposed at the end of the tube 10 and is preferably cylindrical in cross section to conform to the shape of the tube. The head has a transverse partition 12 dividing it into an air chamber 13 and a fuel chamber 14. A perforated plate 15 overlies the open end of the head 11 adjacent the end of the tube 10. The plate 15 has holes or ports 16 for supplying air to the tube 10 in a plurality of commingling streams distributed over the major portion of the sectional area of the tube. An inlet 17 in the head 11 communicates with the chamber 13. An air-supply pipe 18 extends to the inlet 17 and an orifice plate 19 is disposed over the inlet 17. A fuel-supply pipe 20 extends into an inlet 21 communicating with the fuel chamber 14. A nozzle tube 22 extends through the partition 12 and the plate 15 and has an orifice 23 in its discharge end whereby fuel flows from the chamber 14 into the tube 10.

The fuel flowing through the orifice 23 is confined in a mixer tube 24 extending forwardly from the plate 15 adjacent the bottom of the tube 10. The tube 24 circumscribes a small area of the plate 15 near the bottom thereof. Holes 25 in the plate 15 located in said area permit air to flow from the chamber 13 into the tube 24 so that the fuel and air are mixed in passing through the latter.

A transverse baffle 26 extends across the bottom of the tube 10 and around the mixer tube 24 to confine the air flowing from the chamber 13 directly to the tube 10, to an area generally above the mixer tube 24. The baffle 26 has spacer fingers 27 adapted to engage the interior of the tube 10. The mixer tube 24 extends through suitable openings in the baffle and is thereby supported at its outer end. The mixer tube 24 may conveniently be welded at its inner end to the plate 15.

When air and fuel are supplied under pressure to the supply pipes 18 and 20 respectively, the air flows through the orifice in the plate 19, the inlet 17, and the holes 16 in the plate 15. This secondary air flows axially along the tube 10, being distributed somewhat uniformly over the greater portion of the sectional area thereof but prevented from flowing along the bottom of the tube by the baffle 26. Air also flows from the chamber 13 through the holes 25 into the tube 24 and there mixes with fuel flowing through the nozzle tube 22 from the chamber 14. The mixture of primary air and fuel passes along the length of the mixer tube 24. On ignition of the issuing mixture, initial combustion occurs but this is not complete because of the relatively limited amount of primary air supplied through the holes 25. The flame issuing from the mixer tube 24, however, tends to rise and in doing so, is intimately mixed with substantially all the secondary air

supplied to the tube 10 through the holes 16. Combustion of the fuel thus continues until fully completed and the hot combustion products flow on through the tube 10 until they reach the discharge end thereof.

Fig. 3 illustrates a modification which is similar in all respects to that shown in Figs. 1 and 2 except that it is designed particularly for fast burning fuel having a relatively short flame and is therefore provided with a refractory screen 28 in the discharge end of the mixer tube, to prevent back-firing through the latter. The other parts of the modification correspond generally with the structure of Figs. 1 and 2 and are designated by the same reference numerals with a prime affixed.

The invention is characterized by numerous advantages. Perhaps the most important is that the flame resulting from partial combustion of the primary air and the fuel is caused to rise through substantially the entire body of the stream of secondary air. The length of the flame may be accurately controlled over a relatively wide range, being determined by the ratio of primary air to secondary air. This may be varied by substituting for the plate 15, other plates having holes 16 and 25 of different numbers and sizes. The length of the flame is increased by decreasing the percentage of primary air and vice versa. The location of the mixer tube 24 adjacent the bottom of the tube 10 and the use of the baffle 26 prevent the cloudy flame observed on low turn-down of burners in which the primary air and fuel are supplied adjacent the center of the stream of secondary air. This latter type of combustion results in soot deposits which are avoided by my invention because of the complete mixture between the fuel and all the secondary air and the avoidance of stratification between rich and lean layers of combustible

Since all the the air for combustion is supplied through the orifice in the plate 19, it must be supplied under positive pressure and the same is true of the fuel since it passes from the chamber 14 to the mixer tube through the nozzle tube 22 of reduced sectional area. The fuel and air may thus be proportioned in any desired ratio throughout the entire range of turn-down by any suitable type of proportioning device. Since the fuel and air are supplied under pressure, it is not necessary to employ an eductor at the discharge end of the combustion tube. This simplifies the apparatus and permits the use of the combustion products for preheating, drying, or the like.

Although I have illustrated and described but a preferred embodiment with a modification of the structure, it will be understood that changes in the apparatus disclosed may be made without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. The combination with a combustion passage of a transverse plate therein having a plurality of ports distributed substantially uniformly over the entire transverse section of the passage except a small portion adjacent the bottom thereof for supplying air along the passage in commingling streams, a tube extending from said plate into the combustion passage for supplying fuel thereto solely through said small portion, whereby said fuel on combustion ascends through substantially all said air, and means preventing the flow of said air through the portion of the sectional area of the combustion passage immediately adjacent said relatively small portion.

2. The combination with a combustion passage, 75

of an air chamber adjacent an end of the passage, a transverse plate between the chamber and passage having a plurality of ports distributed substantially uniformly over the section of the passage and adapted to supply commingling air streams longitudinally of the passage, a tube extending from said plate into said passage for supplying fuel through a small portion of the sectional area of the passage adjacent the bottom thereof, at a point spaced longitudinally of said passage from said end, and a baffle spaced from said plate preventing the flow of air immediately adjacent said small portion of the sectional area of the passage.

3. Means for supplying fuel and air to a combustion tube comprising an air chamber at one end of the tube overlying the greater portion of the tube section, a plate between said chamber and said tube having holes therethrough distributed over said section, a mixer tube extending into said combustion tube from the lower portion of said plate and circumscribing a small area thereof, holes through the plate in said area admitting air from said chamber to said mixer tube, and fuel-supply means communicating with said mixer tube.

4. Means for supplying fuel and air to a combustion tube comprising an air chamber at one end of the tube overlying the greater portion of the tube section, a plate between said chamber and said tube having holes therethrough distributed over said section, a mixer tube extending into said combustion tube from the lower portion of said plate and circumscribing a small area thereof, holes through the plate in said area admitting air from said chamber to said mixer tube, fuel-supply means communicating with said mixer tube, and a baffle in said combustion tube adjacent the discharge end of the mixer tube, said baffle extending over the lower portion of the section of the combustion tube.

5. Fuel and air supply means for a combustion tube comprising a burner head at one end of the tube, a transverse partition dividing said head into an air chamber adjacent the tube and a fuel chamber spaced therefrom, a wall between the air chamber and said tube having holes therethrough distributed over the sectional area of the tube, a mixer tube extending into said combustion tube from said wall and circumscribing a small area thereof, holes through said wall within said area adapted to admit air to the mixer tube, said mixer tube being located toward the bottom of the combustion tube, and a connection between said fuel chamber and said mixer tube.

6. Fuel and air supply means for a combustion tube comprising a burner head at one end of the tube, a transverse partition dividing said head into an air chamber adjacent the tube and a fuel chamber spaced therefrom, a wall between the air chamber and said tube having holes therethrough distributed over the sectional area of the tube, a mixer tube extending into said combustion tube from said wall and circumscribing a small area thereof, holes through said wall within said area adapted to admit air to the mixer tube, said mixer tube being located toward the bottom of the combustion tube, a connection between said fuel chamber and said mixer tube, and a transverse baffle in said combustion tube adjacent the end of the mixer tube and overlying the portion of the sectional area of the combustion tube immediately adjacent and on each side of the mixer tube.

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