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RADIANT TUBE HEATERS

Filed April 10, 1963

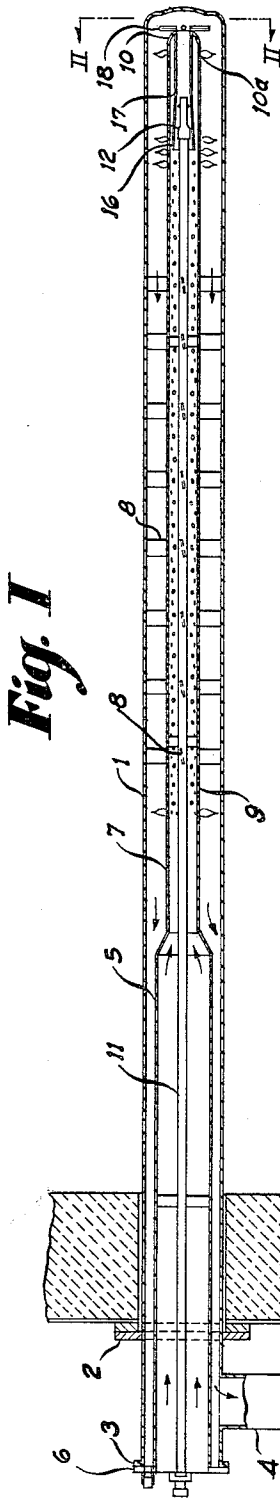

Fig. I

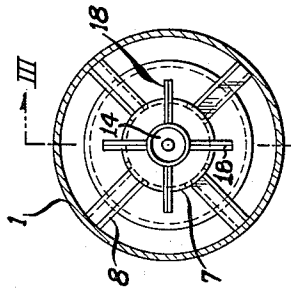

Fig. II

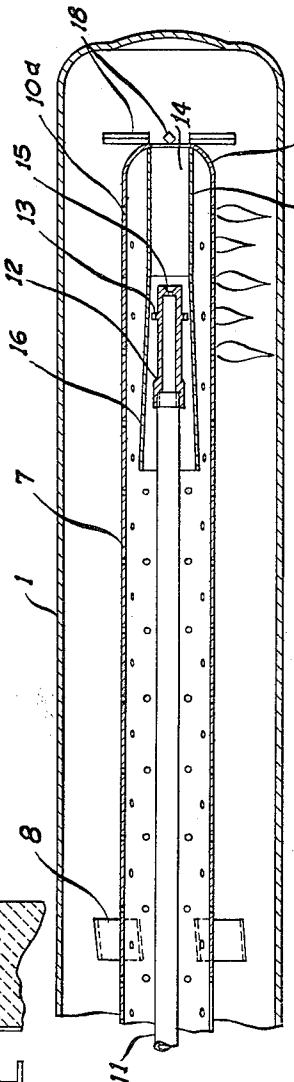

Fig. III

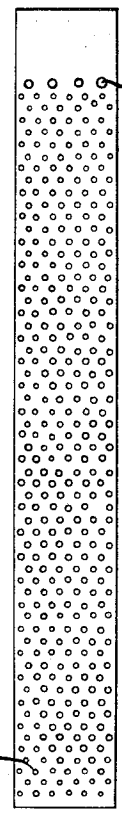

Fig. IV

Fig. V

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# RADIANT TUBE HEATERS

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This invention relates to radiant tube heaters of the type where a tubular housing having its outer wall in heat exchange relation with a gas or liquid to be heated and in which the heating element is self-contained within the tubular housing. In a former application serially numbered 199,184 filed May 31, 1962, we have disclosed apparatus for heating air or liquids utilizing a plurality of radiant heating tubes and the present application is a continuation-in-part thereof. We have found that in the use of radiant tubes for heating liquids, the outer tube is constantly exposed to the low temperature of the liquid or fluid being heated and under these conditions it is difficult to maintain a stable flame because the temperature of the flame is reduced by radiation to the outer tube which remains relatively cold. Among other things, we have found that turbulence of the gas and air mixture returning in the space between the air tube and the outer tube or housing blows out the unstable burner flame at the tip or closed end of the air tube and variation of premix ratios of air and gas merely results in explosive puffs at the light-up that blows the flames out. In accordance with the present invention these difficulties are overcome by the use of a mixing tube between the tip of the heater and the pre-mix cone with a baffle bar arrangement to provide laminar flow of the pre-mixed fuel over the closed end of the mixing tube to eliminate turbulence that would affect the stability of the burner flames at the tip of the radiant tube.

The invention further contemplates a greater annular space along a portion of the air tube to cause impingement of the flames emanating adjacent the air tubes on the inner wall of the outer housing to obtain better heat transfer.

We have found that by the utilization of fins on the air tube, some of which also function as spacers between the air tube and outer housing, the air tube is heated up rapidly and maintains a temperature suitable for propagating and maintaining the burner flames.

It is a general object of this invention to provide an improved radiant tube heater with a pre-mixing cone and mixing tube and directing the flow of gaseous fuels over the end and between an air tube and heater housing in a manner to eliminate turbulence at the closed end of the tube and obtain efficient burning characteristics throughout the length of the heating zone from the first burner hole adjacent the closed end to the last burner hole in the air tube.

The invention will become more apparent from a consideration of the accompanying drawings constituting a part hereof in which like reference characters designate like parts and in which:

FIGURE 1 is a vertical section partially in elevation taken longitudinally of a radiant tube heater embodying the principles of this invention;

FIGURE 2 is a cross section taken on the line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged vertical section of a portion of the heater shown in FIGURE 1;

FIGURE 4 is a diagrammatic view of a template for drilling burner holes; and,

FIGURE 5 is an end view of the template of FIGURE 4.

With reference to the figures of the drawing, the numeral 1 designates an outer tube or heater housing having mounting flanges 2 and 3 and having a waste gas outlet connection 4. These housings may be of any suitable length such as 12 to 15 feet and are of suitable diameter as for example 6 inches. They are made of suitable alloy metal such as stainless steel to withstand the firing temperatures and the contaminants of the gases or liquids with which they come in contact. Disposed within the heater housing 1 is an air tube 5, FIGURE 2, having a flange 6 for mounting within the housing 1, the air tube 5 being constricted for the major portion of its length to a reduced section generally designated by the numeral 7, FIGURE 2 to provide a suitable combustion space between the air tube and heater housing. Spacers 8*a* and fins 8 are welded to the outer surface of the air tube 7, the spacers 8*a* being of a diameter to contact the inner wall of the housing 1 to which they may be welded. The fins 8 are skewed and are welded to the tube 7 as shown in FIGURE 1 of the drawing, there being angularly spaced spacers and fins as shown in FIGURE 2 of the drawing in sufficient number to aid in quick heating of the air tube 7 and maintain a temperature suitable for propagating and maintaining the burner flames.

Holes or perforations 9 are drilled around the tube between the spacers and fins as shown in the template of FIGURE 4. The holes are ⅛ of an inch in diameter and the initial holes 10*a* adjacent the tip or closed end of the tube are approximately 1" from the end of the air tube where the rounded bottom 10 begins. There are no drill holes in the enlarged portion 5 of the air tube, which is wiped by the hot products of combustion passing from the burner and at the right in the annular space between the air tube and the outer housing wall to preheat the air that is drawn into and flows through the air tube.

As shown in FIGURE 3, the fuel pipe 11 is provided with a cast alloy spud 12. This spud is provided with a flange 13 and is disposed in a premix cone 16 of FIGURE 3, the fuel tube 11 being adjustably mounted so that the flange 13 can be moved axially to meter the air flow by varying the degree of opening between the outside of the flange and the premix cone to thereby vary the ratio of air and fuel passing out of the opening 14 at the end 10 of the air tube. The alloy spud 12 is provided with an opening 15 through which the gaseous fuel from pipe 11 enters the premix cone 16. A mixing tube designated by the numeral 17 forms an extension of the premix cone 16 and this tube extends to the end of the rounded tube bottom 10 of air tube section 7.

One of the features of the invention is the use of the baffle elements or bars 18, FIGURES 2 and 3, which are of square shape and welded to the rounded bottom 10 with the V-shaped sides in line with the opening 10*a*, as shown in FIGURES 2 and 3. As shown on the template in FIGURE 4, there are four holes 10*a* approximately an inch away from the edge of the rounded bottom 10 and the V edges of the baffle bars 18 are in line with these openings 10*a*, there being four openings and four bars. The V-shaped baffles streamline the flow of the premix as it passes from the end opening 14 into the annular space between the air tube 7 and the outer housing 1 and causes laminar flow of the premix on the outside of the air tube for a distance corresponding to the length of the mixing tube 17 and premix cone 16, thereby avoiding turbulence that would cause the flame emitted from the openings 9 and 10*a* to be subject to explosive or pulsating puffs.

As the products of combustion pass rearwardly, they heat up the spacers and fins 8 which helps to stabilize the burner flames propagated around the holes 9 and in-

tensify the heat radiating to the wall of the outer housing **1**. As shown in FIGURE 1, the housing **1** extends through a wall **1***a* which may be either a horizontal partition or a vertical wall as shown so that the tubular housing **1** will either be suspended vertically, as shown in our former application, or it may be disposed horizontally and supported by suitable brackets at its extended end. As in our former application, a multiple of such tubes may be used in a housing to provide adequate capacity for heating the air or liquid with which they come in contact.

Because of the rounded end of the air tube resulting in the laminar flow and because of the streamlining of the premix with the initial burner holes **10***a* by baffle bars **18**, turbulence and flame instability is eliminated during the initial period of firing when the tube is cold and the burner flames are propagated from the very tip at the end of the air tube to the enlarged portion **5** of the air tube.

Although one embodiment of the invention has been herein illustrated and described, it will be evident to those skilled in the art that various modifications may be made in the details of construction without departing from the principles herein set forth.

We claim:

**1.** In a radiant tube heater a tube-like housing closed at one end and connected to a vent outlet at the other end, an air tube disposed in said housing extending substantially the full length of the housing and spaced a substantial distance from the wall of said housing and from the closed end thereof to form a combustion area, a pre-mix cone disposed within said air tube and a mixing tube forming an extension of said pre-mix cone extended to the closed end of the air tube, a fuel pipe disposed in said air tube and extending into the pre-mix cone, a spud mounted on the end of the fuel pipe having a restricted end opening and having a flange disposed therearound to constitute a valve that controls the air flow through the pre-mix cone into the mixing tube, the location of the flange within the tapered wall of said cone determining the ratio of air and fuel supplied to the combustion area, baffle bars mounted to extend radially outward from the end of the air tube, said bars being square in cross section with a pair of V-shaped edges thereof pointing oppositely in the axial direction of the mixing tube and being disposed in the path of the fuel and air pre-mix as it passes from the end of the mixing tube around the outside of the closed end of the air tube in the space between the outer housing and air tube to cause laminar flow of the pre-mix along a substantial distance of the closed outside surface of the air tube from the end thereof, said air tube having burner holes throughout a constricted portion of said tube, some of said burner holes adjacent the closed end of the air tube being in alignment with said baffle members to be shielded thereby and eliminate turbulence and flame instability from the flow of the pre-mix from the mixing tube into the combustion area.



**2.** A radiant tube heater as set forth in claim **1** in which each of said baffle bars are aligned with a burner hole and are secured to a rounded end of the air tube beyond the outlet of the premix tube.

**3.** A radiant tube heater as set forth in claim **1** in which skew shaped fins are integrally formed on the outer wall of the air tube in the path of the premix air and fuel and the products of combustion to divert the flow thereof and spacers extending from the air tube to the inner wall of said housing to conduct heat to the air tube and stabilize the burner flames propagated around the burner holes.


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