

[54] AIR AUGMENTED DUCT BURNER

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[58] Field of Search **23/277 C**, 2 C; 431/5, 171, 431/202, 347, 350; 110/8 A

[56] References Cited

UNITED STATES PATENTS

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[57]

ABSTRACT

A burner assembly for placement in a gas stream having an insufficient oxygen content to enable the ignition of fuel injected into the gas stream. An auxiliary air duct is placed adjacent the burner and a passageway that is separated from the gas stream is formed between the burner and the air duct to supply the burner with sufficient oxygen and permit ignition of the fuel.

4 Claims, 3 Drawing Figures

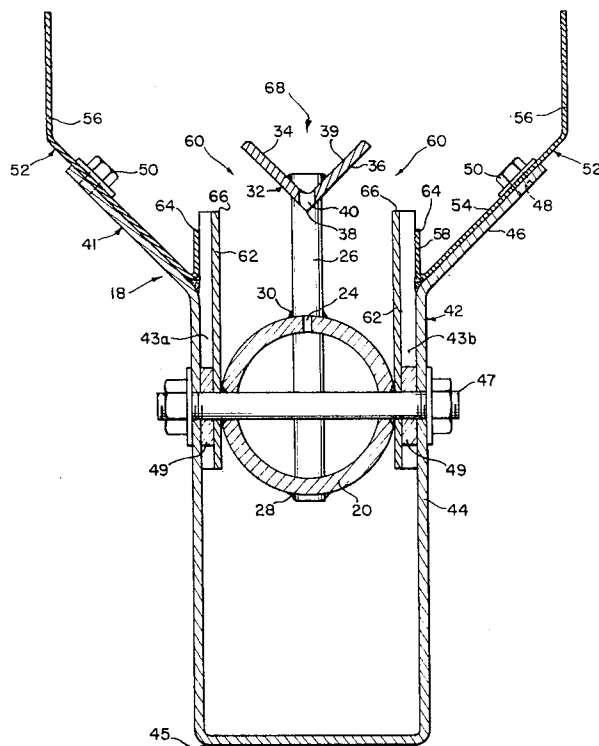


FIG. 1

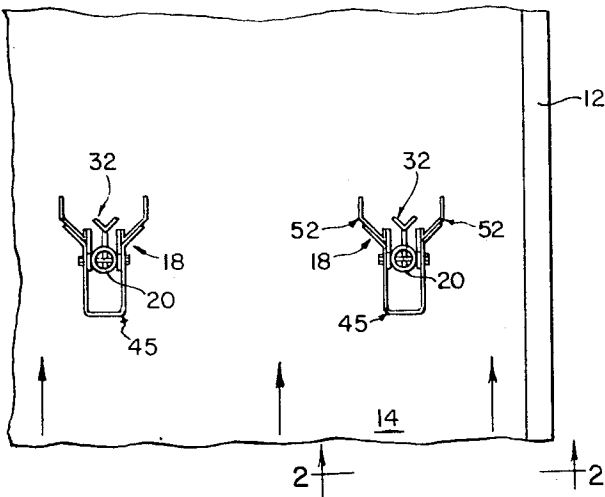


FIG. 2

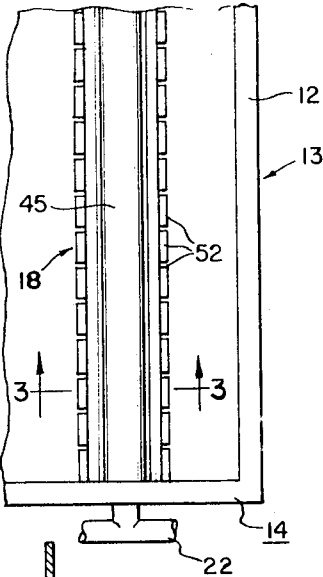
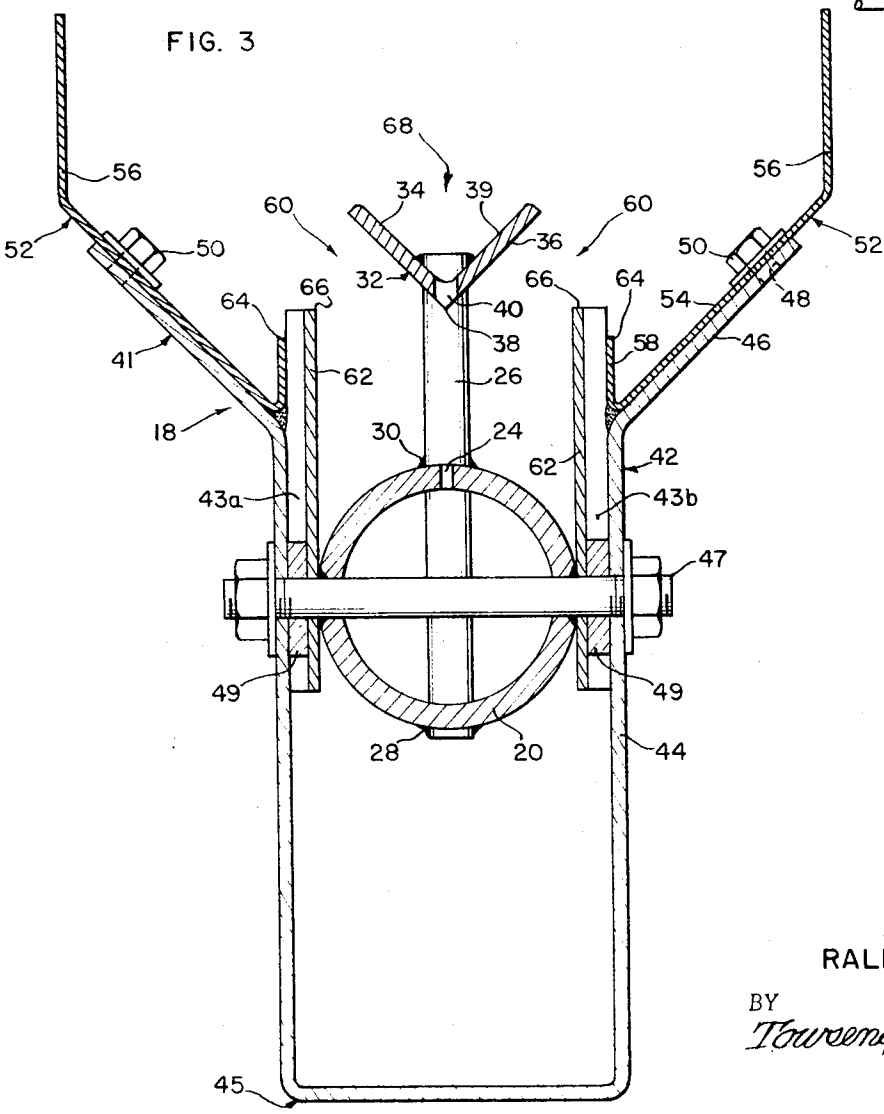


FIG. 3



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AIR AUGMENTED DUCT BURNER

BACKGROUND OF THE INVENTION

It is now common to incinerate gases, such as industrial waste gases from ovens, ventilated areas, drying chambers, or incompletely combusted exhaust gases from motors, boilers, and the like to remove air pollutants before the gases are discharged to the atmosphere. Frequently, such gases contain insufficient oxygen and/or combustible substances to enable their self-ignition or to support complete combustion. However, if the gas stream temperature is sufficiently raised (up to 1,500° F. and more) incineration of the combustible pollutants in the gas stream takes place by oxidation of the pollutants in the oxygen present in the gas stream even if the pollutant and/or oxygen concentration is insufficient to sustain a continuous incineration at lower temperature.

It is therefore necessary to raise the gas stream temperature to the desired incineration temperature. This can be done with heat exchangers or by igniting a fuel injected into the gas stream. The former method is relatively inefficient and expensive in operation. Fuel injected into the gas stream, on the other hand, does not ignite at the frequently encountered low levels of oxygen concentration in the gas stream even though there might be a total oxygen content sufficient for the complete oxidation of all pollutants and the fuel.

It has heretofore been difficult and/or costly to heat such low oxygen content gases to the desired incineration temperature to trigger the above referred to incineration through oxidation at high temperature. Consequently, prior art gas stream heating methods involve substantial energy consumption and, therefore, substantial operating costs. Moreover, they require equipment that is relatively complicated and expensive to construct and install.

SUMMARY OF THE INVENTION owned now U.S.

The present invention provides means for mixing fuel injected into a low oxygen content gas stream with a limited amount of air or oxygen to ignite the fuel and oxidize at least a portion of the fuel. This raises the gas stream temperature sufficiently to cause the oxidation of any remaining fuel and of the pollutants with the oxygen present in the gas stream. Although the present invention can be employed with conventional in-stream or duct burners of any desired construction, it is particularly well adapted for use in conjunction with duct burners described and claimed in the commonly owned copending patent application bearing Ser. No. 741,495 filed July 1, 1968, now Pat. No. 3,494,712, for a Duct Burner, the disclosure of which is incorporated herein by reference.

Briefly, the present invention provides a burner having a fuel ejecting means disposed in the gas stream and adapted to direct the fuel in the downstream direction. Air duct means carry air and include an outlet for discharging the air into a passageway extending from the outlet towards the ejected fuel to admix the air with the ejected fuel so that a flame can be maintained in the burner in spite of the low oxygen content of the gas stream.

For the purposes of this specification and the appended claims, the term "air" includes other gases having a relatively high oxygen content.

It is presently preferred to employ the present invention in conjunction with gas burners of the type disclosed in the above-referenced copending patent application. Such gas burner includes an air impervious surface that prevents flame-out and retains the flame at the burner. The present invention provides an air passageway that directs the air flow to a region closely adjacent the air impervious surface of a flame retention member facing towards the air duct. This prevents a flame-out of the burner from a failure to mix the fuel with the air stream from the air duct before the fuel moves past the flame retention member. Furthermore, introduction of the air adjacent the flame retention member and remote from the fuel supply structure in the burner prevents a premature ignition of the fuel while in the burner which can result in exces-

sive heating of the burner components and may damage the burner.

The present invention enables the in-stream or direct heating of low oxygen containing gases to a sufficient temperature to cause oxidation of combustible materials in the gas stream. To this end, the invention provides a direct airtight connection between the burner and the air duct. The direct connection between the burner and the air duct confines air introduced through the air duct to a region adjacent the burner so as to prevent mixture of the fuel and/or the injected air with the gas stream. Consequently, lowering of the oxygen concentration at the burner is avoided so that fuel ignition is assured with a minimum amount of additional air. The total volume of fuel, gas and air that must be heated is thus kept to a minimum. Fuel consumption and operating costs are thereby also kept to a minimum.

Since the mixture of the fuel and the air flow from the air duct can be closely controlled and adjusted when necessary, only an amount of air sufficient to assure fuel ignition and the desired temperature increase need be injected. This enables the use of the burner assembly of the present invention under variable gas flow rates and/or with gases having differing chemical compositions without requiring replacement of the burner assembly each time operating conditions change. Additionally, since a given burner can operate under widely differing conditions, inventories can be significantly reduced, thereby further contributing to the economies provided by the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary plan view of a duct for a low oxygen containing gas stream having fuel burners constructed in accordance with the present invention;

FIG. 2 is a fragmentary elevational view and is taken on line 2—2 of FIG. 1; and

FIG. 3 is an enlarged cross-sectional plan view of the fuel burner and is taken on line 3—3 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, reference numeral 12 indicates the sidewall of a duct 13 and reference numeral 14 indicates the bottom wall of such duct. Such ducts exist in many industrial applications for conveying exhaust gases and the like from a furnace, a drying chamber or the like to the atmosphere. Plural burner assemblies 18 extend vertically within the duct and are suitably secured to support members (not shown) within the duct or to the duct itself. Two such burner assemblies are shown in FIG. 1 disposed in spaced-apart relation so that there is substantial space therebetween to afford gas flow through the duct.

Referring to FIG. 1 through 3, each burner assembly 18 includes a central gaseous fuel pipe 20 that connects to a gaseous fuel source, such as a gas manifold 22, seen fragmentarily in FIG. 2 to reside below wall 14. Along the length of pipe 20 are formed plural fuel outlet openings 24 which are spaced from one another along the pipe at intervals so as to insure flame propagation along the length of the pipe.

As can be seen in FIG. 3, fuel openings 24 extend radially of pipe 20. Extending in a direction parallel to fuel openings 24, positioned between the fuel openings and spaced at suitable intervals along pipe 20, are studs 26 that are secured to the pipe by weldments 28 and 30. At the downstream end of each stud 26 is mounted an air impervious flame retention member 32, exemplified in the drawing by an angle formed by plates 34 and 36 joined centrally along longitudinal edges thereof at 38. As can be seen most clearly in FIG. 3, air impervious member 32 defines on the downstream side thereof a concavity 39.

Member 32 is formed with orifices 40 which are equal in number and spacing to fuel openings 24 in pipe 20. The spacing between member 32 and fuel pipe 20, as well as the relative diameters of fuel opening 24 and orifice 40, are established so that the fuel jet emanating from opening 24 has a diameter slightly larger than that of orifice 40.

Fuel ejected from fuel openings 24 form jets that have diameters, at a distance downstream of the fuel opening equal to the distance of orifice 40, that are larger than the orifice so that a portion of the fuel flows along the upstream surfaces of member 32 and the preponderance of the fuel flows through the orifice. Accordingly, a small flame originates in the space upstream of member 32 and a large flame originates downstream of the member. The two flames merge at the outer edges of air impervious member 32.

For shielding the flame against the gas stream in duct 13 so as to prevent extinguishment of the flame by a fast moving stream and to prevent entrance of the gas stream into the space surrounding member 32, a shielding structure 41, most clearly seen in FIG. 3, is provided. The shielding structure is defined by mounting plates 42, each having an upstream longitudinally extending portion 44 and a downstream diverging portion 46, and by vanes 52. The shielding structure is spaced from the periphery of fuel pipe 20 to define airflow passages 43a and 43b extending from an air duct or conduit 45 to the downstream side of the fuel pipe. The air duct can be integrally constructed with the upstream portion of 44 of the mounting plate as shown in FIG. 3 or it can be separately attached thereto (not shown) with suitable fasteners. This latter construction can be employed to adapt air stream burners such as disclosed in the above referred to copending patent application for use in gas streams having a low oxygen content.

Substantially horizontally disposed transverse studs 47 are welded to the fuel pipe and serve to mount the shielding structure. Spacers 49 maintain a spacing between mounting plates 42 and the fuel pipe and thereby form the air flow passages 43a and 43b.

The mounting plates 42 are formed with holes 48 for receiving therethrough threaded fasteners 50 that secure the deflector vanes 52 onto the plates. As seen in FIG. 2, vanes 52 can be made of relatively short segments so as to permit thermal expansion along the axial direction of the apparatus.

Each deflector vane 52 has a central web 54, an outer flange 56 extending downstream of the web, and an inner flange 58 that extends generally parallel with the direction of gas flow in duct 13. The central web has a hole for receiving threaded fastener 50 therethrough. As seen most clearly in FIG. 3, inner flange 58 and portion 44 of plate 42 define a combustion zone 60 upstream of air impervious member 32 that is separated from the gas stream. Air is admitted to the combustion zone through air flow passages 43a and 43b between fuel pipe 20 and plates 42.

To provide a controlled air flow in passageways 43a and 43b, air guide plates 62 are placed between the outer surfaces of fuel pipes 20 and the sides of spacers 49 facing the fuel pipe. The air guide plates thus form a continuous air flow passage and separate the air flow from the fuel admitted through openings 24 in pipe 20 so that the point of contact between the fuel and the air, and, therefore, the point where combustion takes place is controlled. It is presently preferred that the air guide plates extend a substantial distance past the free ends 64 of deflector vane flange 58 towards air impervious member 32 as illustrated in FIG. 3. The free ends 66 of the air guide plates are preferably positioned so that actual combustion of the air-fuel mixture on both the upstream and the downstream sides of the air impervious member is assured. Premature ignition through mixture of the fuel and air in the vicinity of the fuel pipe 20, which can result in excessive heating of the structural members of the burner assembly 18 and can lead to its damage, is prevented.

Air duct 45 extends through bottom wall 14 or the top wall (not shown) of gas duct 13 and is connected to a source of air or like gas having a sufficient oxygen content. Air thus flows from an air source via ducts 45 and air flow passages 43a and 43b to combustion zone 60. The quantity of air flowing to the combustion zone can be controlled by regulating the air supply pressure or by adjusting the spacing between shielding structure 42 and guide plates 62. This can be done by replacing spacers 49 or by providing suitable conventional means for

adjusting the usable cross section of air passageways 43a and 43b.

In operation burner assemblies 18 of present invention are disposed transversely of the direction of the gas flow in duct 13. Fuel is supplied through manifold 22 to individual fuel pipes 20 at a rate proportional to the desired heat energy output of the burner. Fuel flowing through pipes 20 issues through openings 24 to form gas jets directed at orifices 40 in air impervious members 32. Light-off is achieved by conventional pilot light structures (not shown) at the bottom of respective pipes 20. Combustion exists in two zones: the first zone 60 behind air impervious member 32 and a second combustion zone 68 downstream of the member and downstream of the burner assembly. Combustion in both zones is supported by air flowing through air passages 43a and 43b. The flame in the first zone is directed divergently outwardly around the sides of angle member 32.

The total amount of air entering the combustion zones is adjusted so that ignition of the fuel emitted through openings 24 is maintained and the temperature of the gas stream in duct 13 is raised to about the incineration temperature. Oxidation of unburned fuel and of the combustible pollutants in the gas stream takes place downstream of burner assemblies as a result of their oxidation with the oxygen in the gas stream.

From the above description, it is apparent that the present invention provides an efficient burner for the instream heating of gases having a low oxygen content. It is ideally suited for use in conjunction with the duct burner disclosed in the above referenced copending patent application which can be placed in high speed gas streams while permitting regulation of the flame size in the burner without the danger of flame blowout due to the high speed gases in the duct. However, the present invention is not limited for use in conjunction with such burner and it can be used with any duct burner in which the necessary oxygen for fuel ignition cannot be drawn from the gas stream in the duct.

I claim:

1. Apparatus for heating a gas stream that contains combustible materials and oxygen, the oxygen content of the gas stream being insufficient to permit ignition of fuel injected into the gas stream, the apparatus comprising: at least one conduit extending across the gas stream for introducing fuel from the conduit into the gas stream at points distributed over a substantial length of the conduit, an air supply duct disposed in and separated from the gas stream, means defining an air passageway from the duct to the fuel discharged from the conduit, the passageway extending substantially continuously over the substantial length of the conduit to provide a homogeneous air flow towards discharged fuel, means for regulating the quantity air flowing through the passageway, and means for separating the gas stream from the discharged fuel and the air flow to permit at least initial admixture of the fuel and the air only, whereby the fuel-air mixture can be ignited and admixed with the gas stream to heat the gas stream.

2. In a burner of the type adapted for placement in a gas stream having an insufficient oxygen content to enable continuous ignition of fuel injected into the gas stream, the gas stream flowing in a downstream direction, the burner including a plurality of rigid members spaced across the gas stream, each member having an air impervious surface facing the upstream direction, the members defining spaced apart openings therethrough that are distributed over an effective, flame sustaining length of the surface, each opening having an inlet end in the surface facing in the upstream direction and an outlet end facing in the downstream direction, means for directing at said inlet ends fuel jets that have a dimension transversely of the inlet ends greater than the inlet ends so that a minor portion of the fuel in the jets flows along the surface and the major portion of the fuel enters the openings, and means upstream of the fuel jet directing means for shielding the inlet openings from the gas stream, the improvement comprising: an air duct disposed upstream of each air impervious surface, and means forming a passageway for directing a substantially

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homogeneous air flow from each air duct towards the corresponding impervious surface over the effective length of the surface, the last mentioned means preventing admixture of the air flow and the gas stream upstream of the impervious surfaces.

3. A burner according to claim 2 including means for vary-

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ing the volumetric air flow in the passageways.

4. A burner according to claim 2 wherein the last-mentioned means defines a continuous passageway from the air duct to adjacent the air impervious surface.

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