Feb. 10, 1970 R. R. VOSPER ET AL 3,494,712

DUCT BURNER

Filed July 1, 1968 2 Sheets-Sheet 1

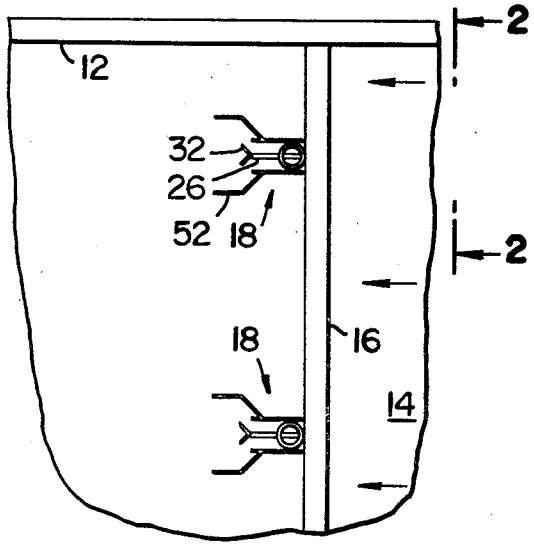

FIG_1

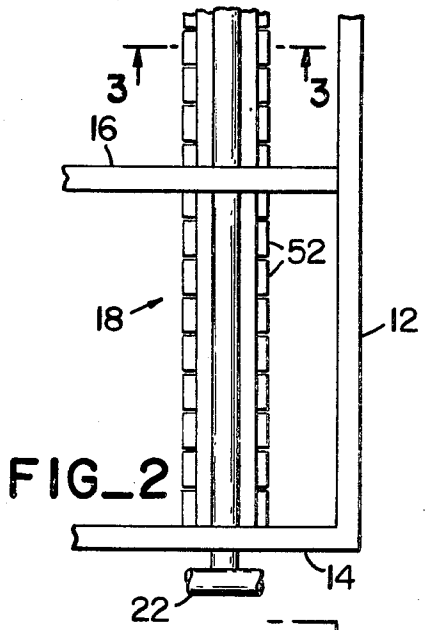

FIG_2

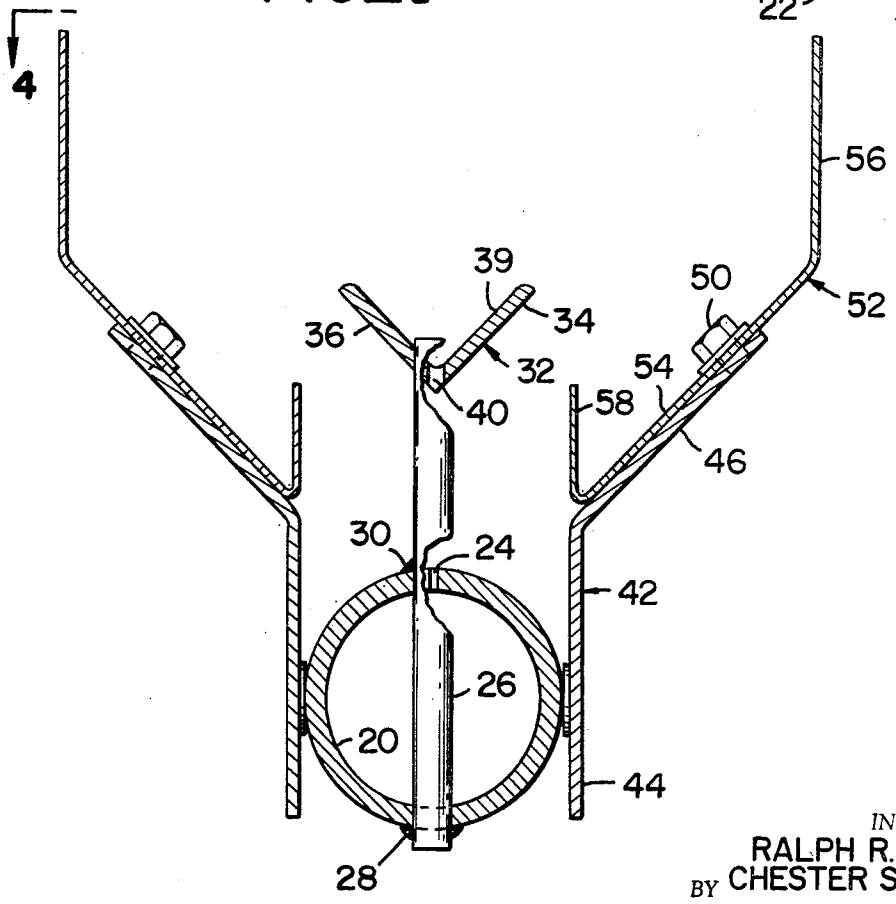

FIG_3

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DUCT BURNER

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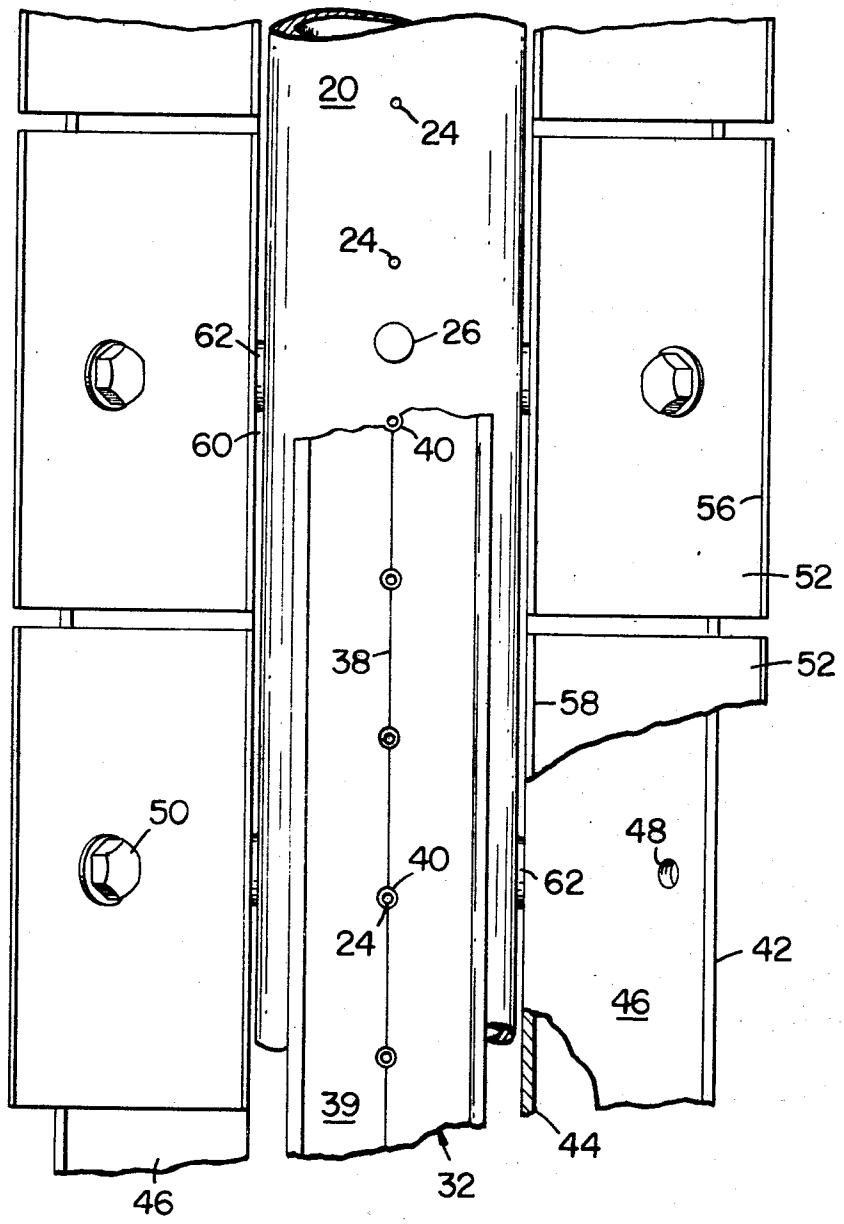

FIG_4

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DUCT BURNER

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U.S. Cl. 431—171 7 Claims

ABSTRACT OF THE DISCLOSURE

A burner for placement in an air duct for heating air moving through such duct. The burner has structure for forming two combustion zones: a first zone of small extent that is shielded from the main airstream and a second zone in the airstream at which the preponderance of combustion occurs. The boundary between the zones is formed by an impervious member that defines an orifice; a gas jet having a diameter greater than the orifice is directed at the orifice and a small amount of gas is "peeled" off to supply fuel to the first combustion zone.

This invention relates to a burner for heat production and more particularly to a burner particularly adapted for placement in an air duct to heat air flowing in the duct.

The present invention provides a burner for operation in a stream of air that is moving at high speed; the invention solves in an efficient and novel manner the principal problem inherent in such environment, the problem of retaining the flame at the burner over a wide operating range.

Sustaining a flame in an environment of rapidly moving air is difficult because the flame has a tendency to move downstream with the air flow. Moreover, the flame is subject to be blown out at low rates of fuel input and/or high rates of air flow. The problems are obviated by the present invention in that the present invention provides a gas jet and a member defining an orifice in alignment with the gas jet, which orifice has a smaller diameter than the gas jet. Accordingly, two combustion zones are formed; one at the upstream side of the member in which the orifice is formed and the other downstream of such member. An air deflector is provided to shield the first-mentioned combustion zone from the main stream of air so that continuous combustion is maintained there. The main heat producing flame is formed on the downstream side of the plate in which the orifice is formed, the flame always being fixed with respect to the orifice forming member because the position of the sustaining flame is at all times held constant.

The principal object of the present invention is to provide a burner for placement in a stream of fast-moving air, which burner is adapted to assure total combustion adjacent to burner, rather than downstream thereof, for all ranges of air flow and combustible gas input to the burner. This object is achieved in the present invention by providing a burner structure that assures retention of the flame at the burner structure at all times, even when the combustible gas inflow rate is very low and the rate of air movement past the burner is very high.

Another object is to provide a burner of the type mentioned above that is operable over a large turndown range, independent of the rate of air flow movement past the burner. This object is achieved by providing a burner in which two combustion zones are defined. In one zone the flame is substantially shielded from the main air stream; in the other zone the flame is directed outwardly for mixture with the airstream so as to give up heat to the passing air. Because the flame in the first-mentioned

zone is shielded, it sustains the second flame should the second flame experience a tendency to be blown out during operation.

In the preferred form of the present invention one or more elongate gas pipes is mounted in a duct that constrains moving air therein. The pipe is formed with a plurality of gas outlet openings at the downstream side of the pipe. Parallel to the pipe and spaced therefrom is a plate, which plate has a row of orifices that correspond to the gas outlet openings. The diameters of the gas outlet openings and the corresponding orifices are relatively proportioned so that the major portion of the gas emanating from each opening passes through the orifice and a minor portion is "peeled" off from the gas jet when the jet impinges on the member in which the orifice is formed. A deflector is fixed to the gas pipe so that the main stream of air is excluded from the region behind the plate at which the "peeled off" gas is burned. A small amount of air is bled into such region so that the gas that has been "peeled off" from the gas jet emanating from the opening continuously burns adjacent the rear face of the member in which the orifice is formed.

A further object of the present invention is to provide a burner that can be installed conveniently in existing ducts. Achievement of this object is made possible because the entire burner structure is mounted on an elongate pipe that can be conveniently installed in existing ducts. Moreover, the burner of the present invention is extremely versatile in that plural pipes can be installed in a duct to increase the capacity of the burner.

These and other objects will be more apparent after referring to the following specification and accompanying drawings in which:

FIG. 1 is a plan view of a fragment of an air duct having installed therein a burner according to the present invention;

FIG. 2 is an elevation view taken generally along line 2—2 of FIG. 1 and looking downstream of the air duct;

FIG. 3 is a cross-sectional view at enlarged scale taken along line 3—3 of FIG. 2; and

FIG. 4 is an elevation view taken along line 4—4 of FIG. 3.

Referring more particularly to the drawings, reference numeral **12** indicates the sidewall of an air duct and reference numeral **14** indicates the bottom wall of such duct. Such ducts exist in many industrial applications for conveying air, typically ambient air, to a furnace or chamber or the like. For supporting the structure of the present invention, one or more horizontal supports **16** is installed within the duct in spanning relation between sidewall **12** and the opposite sidewall, not shown. Secured to support members **16** and extending vertically within the air duct are plural burner assemblies **18**. Two such burner assemblies are shown in FIG. 1 disposed in spaced apart relation so that there is substantial space therebetween to afford air flow through the duct.

Each burner assembly **18** includes a central gas pipe **20** that connects to a gas source, such as a gas feed manifold **22**, seen fragmentarily in FIG. 2 to reside below wall **14**. Along the length of pipe **20** are formed plural gas 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** and spaced at suitable intervals along pipe **20** are studs **26** that are secured to the pipe by weldments at **28** and **30**. At the downstream end of each stud **26** is mounted an air impervious 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** therein, which orifices are equal in number and spacing to fuel openings **24** in pipe **20**. The spacing between member **32** and gas pipe **20**, as well as the relative diameters of gas opening **24** and orifice **40** are established so that the gas jet emanating from opening **24** has a diameter slightly larger than orifice **40**.

Gas emanating from fuel opening **24** will form a jet that will have a diameter at a distance downstream of the fuel opening equal to the distance of orifice **40**, larger than the orifice so that a portion of the gas will flow along the upstream surfaces of member **32** and the preponderance of the gas will flow through the orifice. Accordingly a small flame will originate in the volume upstream of member **32** and a large flame will originate downstream of the member. The two flames will merge at the outer edges of air impervious member **32**.

For shielding the flame against the airstream so as to prevent extinguishment of the flame by the fast moving stream of air, a shielding structure most clearly seen in FIG. 3 is provided. Attached to each side of pipe **20** is a mounting plate **42** that has an upstream longitudinally extending portion **44** and a downstream diverging portion **46**. The plates are formed with holes **48** for receiving therethrough threaded fasteners **50** that secure air deflector vanes **52** onto plates **42**. As seen in FIGS. 2 and 4, 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 air flow. The central web has a hole for receiving threaded fastener **50** therethrough. As seen most clearly in FIG. 3, inner flange **58** defines in connection with portion **44** of plate **42** a volume upstream of air impervious member **32** that is protected from the main airstream. Combustion air is admitted or bled to such volume through spaces or slits **60** (see FIG. 4) between gas pipe **20** and plates **42**, the slits being formed by spacers **62** that are interposed between the pipe and the plates.

In operation the apparatus of present invention is disposed transversely of the direction of airflow in the air duct. Gas is supplied through manifold **22** to individual gas pipes **20** at a rate proportional to the output temperature desired. Gas flowing through pipes **20** issues through the openings **24** to form gas jets directed at orifices **40** in air impervious members **32**. Light-off is achieved by conventional pilot light structures at the bottom of respective pipes **20**. Combustion exists in two zones: a first zone behind air impervious member **32** and a second zone downstream of the member and downstream of the burner assembly. Combustion in the first zone is supported by a small quantity of air bled through the slits **60**; the amount of air is not sufficient to blow the flame out in such first zone. The flame in the first zone is directed divergently outwardly around the sides of angle member **32** and is guided adjacent the outer edges of plates **34** and **36** by flanges **58**. Consequently even should the flame downstream of the burner be subjected to a rapidly moving stream of air, the flame upstream of air impervious member **32** will be retained at burner **18**. Contributing to the flame retention at high rates of operation is the gas that is maintained behind angle member **32** in the first zone as a consequence of a certain amount of gas being "peeled off" by the relative size of gas opening **24** and orifice **40**. Combustion in the first volume is thus continuous and is substantially independent of operation downstream of the burner unit.

The outwardly diverging vanes **52** also contribute to the retention of the flame at the burner unit in that the air is deflected from direct impingement adjacent orifice **40**. The slits **60** however assure that sufficient combustion air is provided adjacent the opening **24** and the orifice **40** to achieve continuous combustion.

Gas jets formed by passage of gas through orifices **40** at the downstream or concave surface of the air impervious member tend to create a low pressure volume adjacent the orifices. The low pressure causes turbulance adjacent the orifices which in turn enhances mixture between gas emanating from the orifice and the surrounding air stream.

Thus it will seem that the present invention provides a duct burner that has excellent flame retention characteristics, even at high operating rates. The construction of the apparatus and particularly the divergent disposition of vanes **52** in cooperation with the air bleed slits **60** assists in effecting retention of the flame at the burner rather than at some location downstream. Moreover, a duct burner according to this invention can be readily installed in existing ducts.

Although one embodiment of the present invention has been shown and described, it will be obvious that other adaptations and modifications can be made without departing from the true spirit and scope of the invention.

What is claimed is:

1. A burner for placement in an airstream that flows from an upstream direction to a downstream direction comprising a rigid member having an air-impervious surface facing the upstream direction, said member defining a passage therethrough that has an inlet end in said surface extending toward the upstream direction and an outlet end extending toward the downstream direction, means for directing at said inlet end a gas jet that has a dimension transversely of the inlet end greater than the inlet end so that a minor portion of the gas in the jet flows along said surface and a major portion of the gas enters said passage, and means upstream of said gas jet directing means for shielding said inlet opening from the airstream, said shielding means including means forming a bypass air path to supply a sufficient amount of air adjacent said surface to sustain combustion of the minor portion of gas flowing therealong.

2. A burner according to claim **1** wherein the said rigid member defines a concave face on the downstream side thereof, said outlet end residing in said face so that a low pressure volume is formed adjacent said outlet end to enhance mixing of the gas with air.

3. A burner according to claim **1** wherein said rigid member comprises first and second elongate plates conjoined along longitudinal edges thereof and relatively angularly oriented to form a concave face downstream thereof, said passage being formed through said member at the intersection of said plates and bisecting the angle formed between said plates.

4. A burner according to claim **1** wherein said gas jet directing means comprises a cylindrical pipe mounted adjacent said rigid member in spaced relation thereto, said pipe having formed therein a radially extending opening in alignment with said inlet end of said passage.

5. A burner according to claim **1** wherein said shielding means comprises first and second deflector plates mounted on opposite sides of said rigid member, said deflector plates extending from a site upstream of said gas jet directing means to a site downstream of said rigid member, said deflecting plates diverging in a downstream direction.

6. A burner according to claim **1** wherein said gas jet directing means comprises an elongate pipe having at least one hole therethrough at the downstream side thereof, and wherein said shielding means comprises first and second deflector plates secured to opposite sides of said pipe and diverging in the downstream direction, spacer means being disposed intermediate said pipe and said deflectors to form said bypass air path therebetween.

7. A burner for placement in an airstream that flows

from an upstream direction to a downstream direction comprising first and second elongate plates joined together along longitudinal edges thereof in angularly oriented relation, said plates being disposed in said airstream with the joined edges toward the upstream direction and the plates diverging from the joined edges in the downstream direction, a passage formed in said plates at the region of joinder, said passage having an inlet and extending toward the upstream end and an outlet end extending toward the downstream end, means for directing at said inlet end a gas jet that has a dimension transversely of the inlet end greater than the inlet end so that a major portion of the gas enters said passage and a minor portion of the gas flows along the outer surfaces of said plates, and means upstream of said gas jet directing means for shielding said inlet opening from the airstream, said

shielding means including means forming a bypass air path to supply a sufficient amount of air adjacent the outer faces of said plates to sustain combustion of the minor portion of gas flowing therealong.

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EDWARD G. FAVORS, Primary Examiner

U.S. Cl. X.R.

263—19; 239—432