

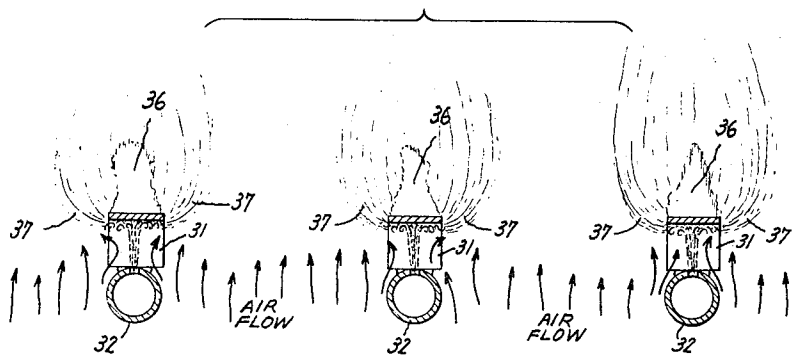
[72] Inventor **Paul H. Kydd**
Scotia, N.Y.
[21] Appl. No. **846,548**
[22] Filed **July 31, 1969**
[45] Patented **Apr. 13, 1971**
[73] Assignee **General Electric Company**

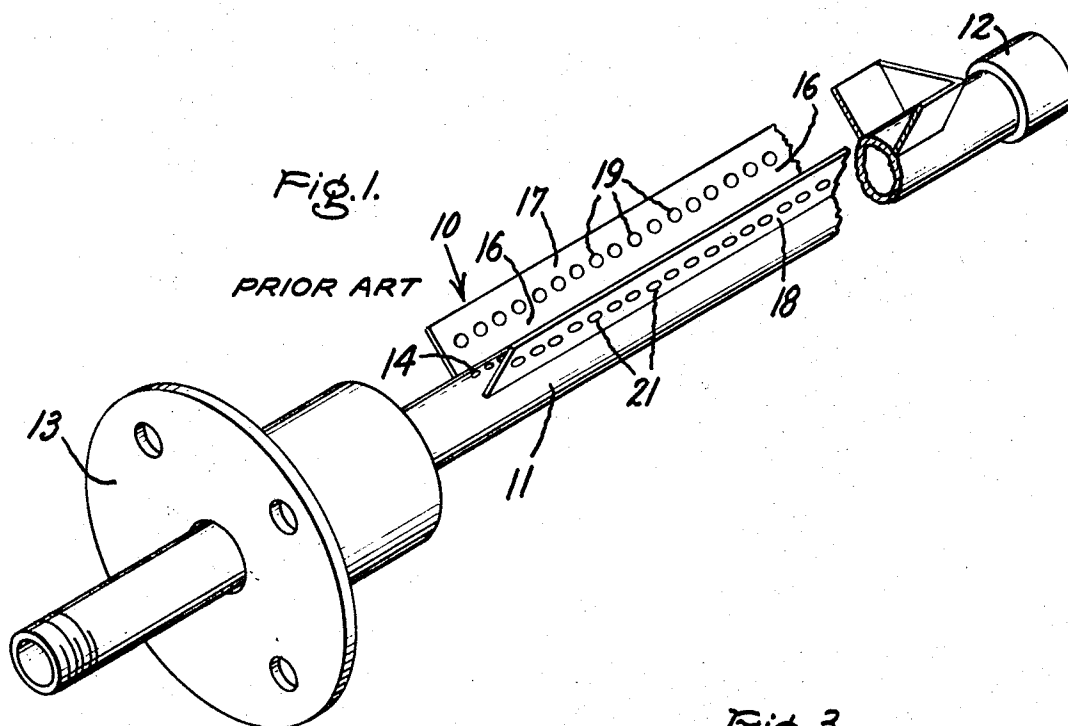
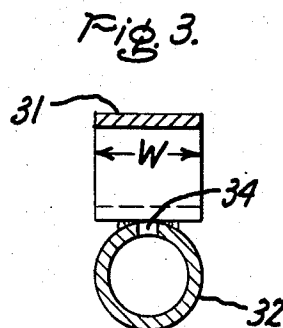
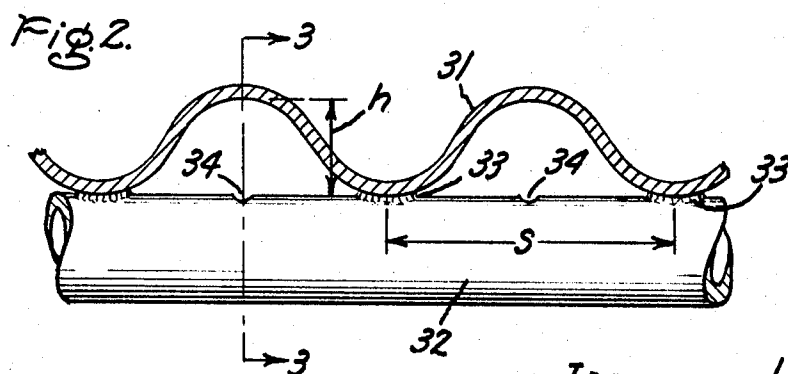
References Cited			
UNITED STATES PATENTS			
3,176,465	4/1965	Colley	60/39.72
3,269,115	8/1966	Nelson	60/39.72X
3,393,516	7/1968	Markowski.....	60/39.72X

Primary Examiner—Carroll B. Dority, Jr.
Attorneys—Richard R. Brainard, Paul A. Frank, Charles T. Watts, Leo I. Ma Lossi, Frank L. Neuhauser, Oscar B. Waddell and Joseph B. Forman

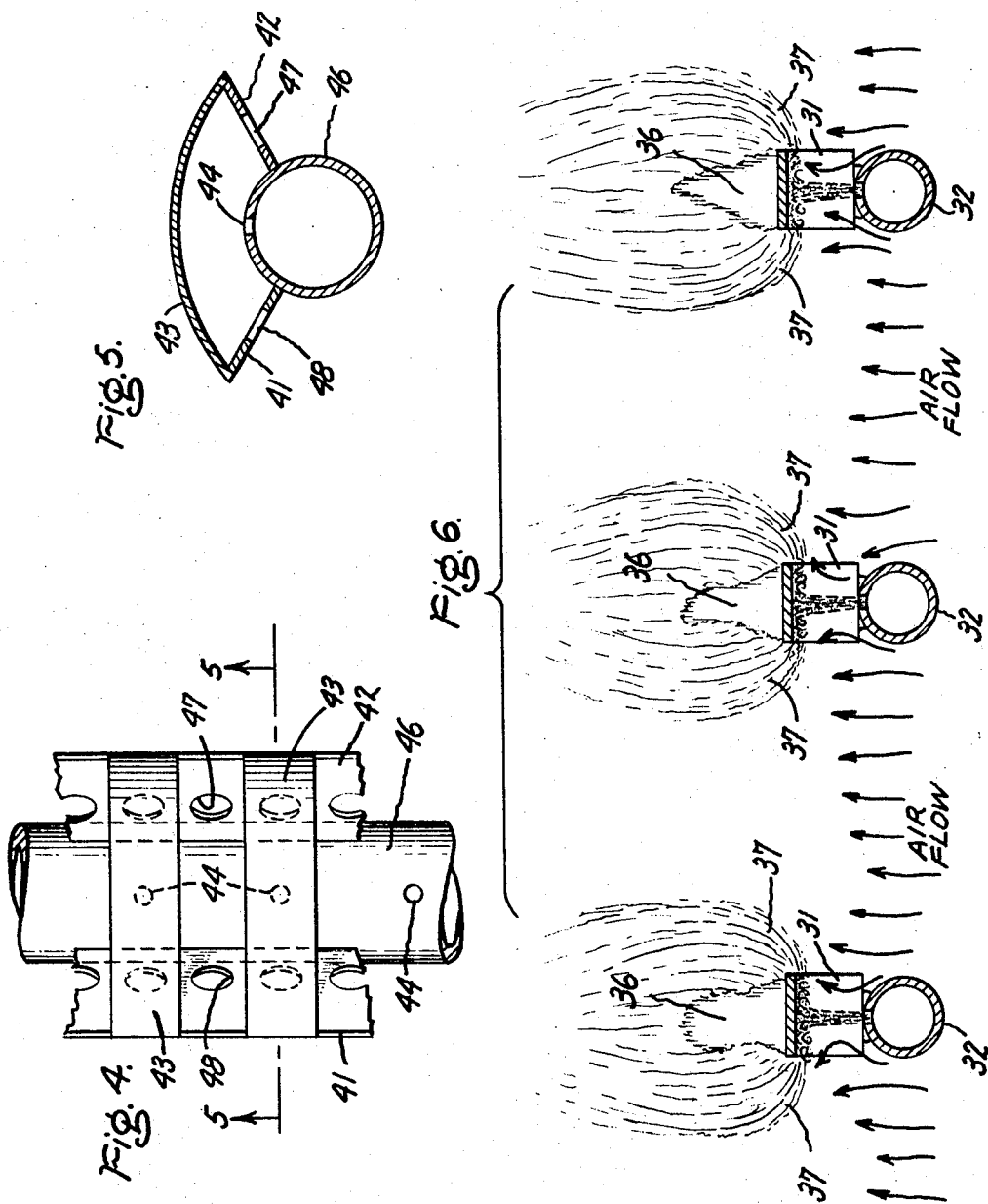
[54] **AIR/FUEL MIXING AND FLAME-STABILIZING
DEVICE FOR FLUID FUEL BURNERS**
5 Claims, 6 Drawing Figs.
[52] U.S. Cl..... **431/350,**
60/39.72, 263/19
[51] Int. Cl..... **F23d 13/24**
[50] Field of Search..... 60/39.72;
431/350; 263/19 (A)

ABSTRACT: Baffle means are located in the paths of fluid fuel streams issuing at high velocity from a plurality of jet orifices in an elongate burner pipe. These downstream baffles significantly laterally deflect the fuel streams and result in both the promotion of fuel/air mixing and the provision of low-velocity flame-stabilizing regions.





Inventor:
Paul H. Kydd,
by Leo S. Masoni
His Attorney.



Inventor:
Paul M. Kydd,
by *Leo J. Marconi*
His Attorney.

AIR/FUEL MIXING AND FLAME-STABILIZING DEVICE FOR FLUID FUEL BURNERS

BACKGROUND OF THE INVENTION

The use of fluid fuel burners broadly encompasses two types of application: (a) equipment in which the amount of air admitted to the combustion system is at most only slightly larger than that required to sustain combustion and (b) systems in which the flow of air admitted to the combustion system is considerably in excess of the amount required to sustain combustion and the object is to raise the temperature of the flow. Gas burners for firing industrial and domestic heating equipment is an example of the first type of application, while the burner for a fired exhaust heat-recovery steam generator (used in conjunction with a gas turbine) is an example of the second type of application.

This invention is primarily of interest for the latter type of application and, when the term "air" is employed herein, both normal air and oxygen-containing gas streams are encompassed.

The problems encountered with the latter type of burner application differ in many respects from those encountered in the former type. Examples of difficult, but desirable, conditions to achieve and maintain in the presence of grossly excessive airflows are: (a) operating with a short flame length (about 1-2 feet) with jet orifices having diameters in excess of 0.050 inches; (b) providing acceptable fuel/air mixing; (c) operating with positive flame retention and stable combustion at air velocities from 1,500 to 6,000 f.p.m., and (d) adjusting to a wide range of fuel flows.

One example of prior-art solutions to the above problems is described in U.S. Pat. No. 3,051,464, Yeo et al., wherein an array of spaced air jets is provided adjacent a gas supply means, the air jets having varying air-supplying capacity such that a greater or lesser portion of the air jet array contributes to the combustion depending upon the amount of gas supplied. The air jets are located in at least one mixing wall flanking the gas supply means. Flame retention is accomplished by the provision of shielded eddy pockets adjacent certain ports for the discharge of gaseous fuel, called ignitor ports, as distinguished from main gas ports. These eddy pockets are in part defined by projections, which extend into paths of the fuel gas streams leaving the ignitor ports, but not the main gas ports from which the gas streams flow unimpeded. As described in the Yeo et al. specification, it is necessary to supply various raw gas or gas/air mixtures to the burner to vary the stage of operation. For example, at "high fire operation" either raw gas or a rich gas/air mixture is supplied. For "minimum and low rates of operation" the burner ports are supplied with a combustible mixture of gas and air containing all or substantially all the air required for combustion. This requirement of premixing of fuel gas and air poses a distinct problem. It is inconvenient to mix fuel gas and external air for admission to a burner and fuel cannot be mixed with hot air sources, such as hot turbine exhaust air.

In contrast to the Yeo et al. mixture, which is used for fluid fuel-burning operations in the presence of great excesses of air, U.S. Pat. No. 3,037,553, Jackson, describes a gas burner for heating equipment specifically designed to operate without any excess flow of air and to provide for close proportioning of the air/gas mixture. Un-aerated gas jet streams exiting at high velocity from the burner pipes strike a gas-impingement structure consisting of bars disposed within an air injection duct. This combined structure is provided to break up the gas jet streams and aerate the gas. The air injection duct permits the ejected gas to induce the proper airflow for combustion to pass therethrough and is apparently relied upon to provide a zone of relatively low-velocity flow for gas ignition and flame propagation. Although the gas jet streams are high-velocity flows, the airstream must not have any significant velocity, because of the construction disclosed. Therefore, there is no indication that the combination of gas-impingement and air-injection duct structures would function in the presence of

high-velocity airflows. Further, this combined structure is not suitable for use in applications in which a wide range of fuel flows and fuel jet velocities are encountered.

What is needed in the art is a mechanically simple and rugged burner construction with a turndown ratio of at least 5:1 with which un-aerated fluid fuel may be burned with a short, nonluminous flame with positive flame retention in the presence of great excesses of air having velocities ranging up to 6,000 f.p.m.

SUMMARY OF THE INVENTION

The instant invention solves the above-mentioned need and, in addition, enables the utilization of larger fuel jet orifices having diameters in the 0.050 inches-0.150 inches range, thereby increasing the capability of the burner to combust "dirty" fuel, a major problem in the field. These objectives are attained by placing flame-holding baffle structures of significant lateral dimension downstream of the jet orifices to provide significant lateral deflection of each fluid fuel stream whereby the desired fuel/air mixing is achieved and a low-velocity flame-stabilizing region is provided thereover for each flame. In addition, the lateral spread of the baffles into the airstream provides a more uniform flame temperature distribution.

BRIEF DESCRIPTION OF THE DRAWING

The exact nature of this invention as well as objects and advantages thereof will be readily apparent from consideration of the following specification relating to the annexed drawing in which:

FIG. 1 is a perspective view showing a single burner element with a pair of flame-holder wings affixed thereto representative of the prior art;

FIG. 2 is an elevational view of the preferred construction of the gas burner/flame-holder unit of the instant invention;

FIG. 3 is a sectional view taken on line 3-3 of FIG. 2;

FIG. 4 is a plan view of a modification of the prior-art gas burner device to embody the flame holders of the instant invention;

FIG. 5 is a sectional view taken on line 5-5 of FIG. 4; and

FIG. 6 is a sectional view through an array of the burners of FIGS. 2, 3 showing the flame profiles and low-velocity regions provided by the instant invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A single prior-art burner/flame-holder unit 10 is shown in FIG. 1, which in its simplest construction includes hollow cylindrical tube 11 closed at one end by cap 12 and open at the opposite end thereof for connection to a source (not shown) of fluid fuel, such as gas or vaporized oil. A typical mounting plate arrangement 13 is employed to mount the burner unit 10 so that it projects into a combustion chamber.

Jet orifices, or ports, 14 located at intervals along the length of fuel tube 11 admit fluid fuel into the trough-shaped mixing space 16 defined by diverging flame-holder webs 17, 18 provided with a plurality of apertures 19, 21, respectively, spaced longitudinally thereof. Apertures 19, 21 direct air from the passing stream into mixing volume 16 in distinct jets providing a multitude of small "combustors" distributed along the burner length.

It has been shown that by replacing the flame-holder wings 17, 18 of the prior-art burner 10 (FIG. 1) with a single undulating metal strip 31 extending along fuel tube 32 (FIGS. 2 and 3) and welded (or otherwise attached) to the top of tube 32, a more effective burner unit is produced. The points of attachment 33 are located midway between fuel orifices 34 with flame-holder strip 31 arched over each orifice 34 as shown. This distance s and h may each vary from about 2 inches to about 6 inches. The width w of flame-holder strip 31 will range from about three-fourths inch to about 1½ inches and the orifice size may range from about 0.050-0.150 inches in diameter.

These relatively large orifice diameters facilitate the utilization of gaseous or vaporized fuels containing such impurities as particulate matter and substances, which would form soot in the fuel tubes 32, if not passed by the orifices. Ordinarily, such large orifice sizes must be avoided, because the discharged fuel is not adequately mixed with the air before it is burned. With the construction in FIGS. 2 and 3 each issuing stream of fuel is deflected as it impinges upon wavy flame-holder strip 31 being forced to move laterally a significant distance in order to pass beyond flame holder 31. In traversing this path the fuel becomes thoroughly mixed with the air streaming by tube 32 as may be seen in FIG. 6.

In addition to promoting mixing of the fuel with air, strips 31 provide low-velocity wake regions 36 along most of the upper surface thereof in which the flame can stabilize, while the lateral spread of the burning gas regions 37 results in a more uniform flame temperature distribution. The strips 31 must provide an imperforate transversely extending width of at least three-fourth inches in order to produce a large enough wake for flame stabilization.

The spacing center-to-center of fuel tubes 32 (FIG. 6) may range from about 9 inches—18 inches. Using such an arrangement the flames remain stabilized in the presence of airflows ranging as high as 6,000 f.p.s. to produce increases in air temperature as required ranging from 100° to as high as 1,000° F. or even higher. There is, of course, no need to induce airflow and the cooling effect of the airflow minimizes oxidation of the flame-holder strips 31.

A second embodiment is shown in FIGS. 4 and 5 wherein the prior-art wing structures 41, 42 are relied upon, not as flame holders, but as supports for the transversely extending spaced baffle flame holders 43 arching over the fuel orifices 44 in fuel tube 46. In the construction shown, an added set of wing apertures 47, 48 is located in the space between adjacent flame holders 43, but the critical aspect of this invention is the juxtaposition of flame holders 43 and fuel orifices 44, whereby the emerging gaseous or vaporized fuel strikes the undersurface of the bafflelike flame holder and is deflected laterally to each side in order to continue on its way.

Low-velocity regions (not shown) occur over the upper surfaces of flame holders 43 in the same manner as is illustrated in FIG. 6 for the simpler preferred construction of FIGS. 2 and 3 and flame stabilization results in the same manner. The distance from orifice 44 to the underside of flame holder 43 may be 1½ inches—3 inches. With this distance set at the higher end of this range greater mixing between air and fuel can occur before impingement on the baffle 43. Conversely with this distance set at the lower end of this range, less air/fuel mixing can occur.

The burner construction of this invention may be disposed in the airstream with the fuel tube extending vertically, horizontally or at some other desired angle to the horizontal so long as the orifice side of the fuel tube faces downstream.

The invention has particular applicability to a heat-recovery steam generator used in conjunction with a gas turbine

wherein a bank, or banks, of burners according to this invention are disposed in a stack or duct-receiving exhaust gases from the gas turbine. The purpose of the burner system, which must operate under a wide range of conditions, is to raise the temperature of the large flow of turbine exhaust air through a controlled temperature rise and provide a uniform temperature in the discharged airflow.

Although all baffles shown are rectangular in transverse section, they could be formed as V-shaped (or convex) in cross section so long as the point of the V-shape (or the convex surface) is placed upstream. The imperforate transverse dimension seen by the gas flow must, of course, remain at least about three-fourth inch in order to provide the minimum size wake for flame stabilization and to give the added benefit of lateral spreading of the hot gases.

I claim:

1. In an apparatus for heating a gas stream by the combustion of fluid fuel wherein the gas stream supports the combustion process and flows past the burner construction at velocities of the order of 1,500 to 6,000 f.p.m., fluid fuel is emitted from the burner, mixes with the gas stream, is burned and thereby heats the gas stream, the improvement comprising:

- a. a hollow elongate burner body;
- b. a row of spaced fuel orifices extending along and penetrating the wall of said burner body on the downstream portion of said wall;
- c. at least one baffle strip located downstream of said burner body, mounted spaced therefrom and supported thereby having as opposite major surfaces thereof:

1. an upstream imperforate laterally extending major surface area facing and in register with each of said orifices for laterally spreading all fluid fuel flow impinging thereon into the adjacent high-velocity airflow for passage around said baffle strip; and
2. a downstream laterally extending major surface area facing downstream from said orifices for maintaining thereon a physically unconfined low-velocity flame-stabilizing region, said baffle strip extending substantial distances transversely to the direction in which fuel flow emanates from said burner body.

2. The improvement recited in claim 1 in which the baffle strip extends along the burner body in a wavy configuration and is connected directly thereto.

3. The improvement recited in claim 1 in which a separate baffle strip is mounted over each fuel orifice.

4. The improvement recited in claim 3 in which a plurality of baffle strips are connected to a pair of wing structures extending along and attached to the burner body, said wing structures having apertures therethrough for the passage of air.

5. The improvement recited in claim 1 in which the downstream major surface area is at least about three-fourth inch in least dimension.