United States Patent [19]

Martin

[11] **3,830,620**

[45] **Aug. 20, 1974**

[54] **GAS BURNER FOR HEAT-RECOVERY STEAM GENERATOR**

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[22] Filed: **Feb. 22, 1972**

[21] Appl. No.: **227,788**

[52] **U.S. Cl.** .... **431/350,** 432/222, 60/39.72 R

[51] **Int. Cl.** **F23d 13/24**

[58] **Field of Search** .... 263/19 A; 431/350, 180; 239/556–559; 60/39.72 R; 432/222

[56] **References Cited**

UNITED STATES PATENTS

2,193,176	3/1940	Krugler et al.	431/350
2,621,720	12/1952	Dufault	431/350
2,840,152	6/1958	Reed	431/350
3,051,464	3/1962	Yeo et al.	263/19 A
3,494,712	2/1970	Vosper et al.	263/19 A
3,574,507	4/1971	Kydd	431/350

FOREIGN PATENTS OR APPLICATIONS

1,010,504	11/1965	Great Britain	239/556

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[57] **ABSTRACT**

A gas burner comprising a straight main burner pipe with imperforate horizontal wing baffles extending diametrically therefrom. The downstream side of the pipe is formed with a number of fuel holes. Some fuel is fed directly toward an exhaust gas recirculation pattern while the remaining fuel is distributed laterally of the recirculation pattern toward an updraft of exhaust gas. A second manifold pipe having a longitudinal row of fuel distribution holes provides uniform fuel distribution in the main pipe.

6 Claims, 3 Drawing Figures

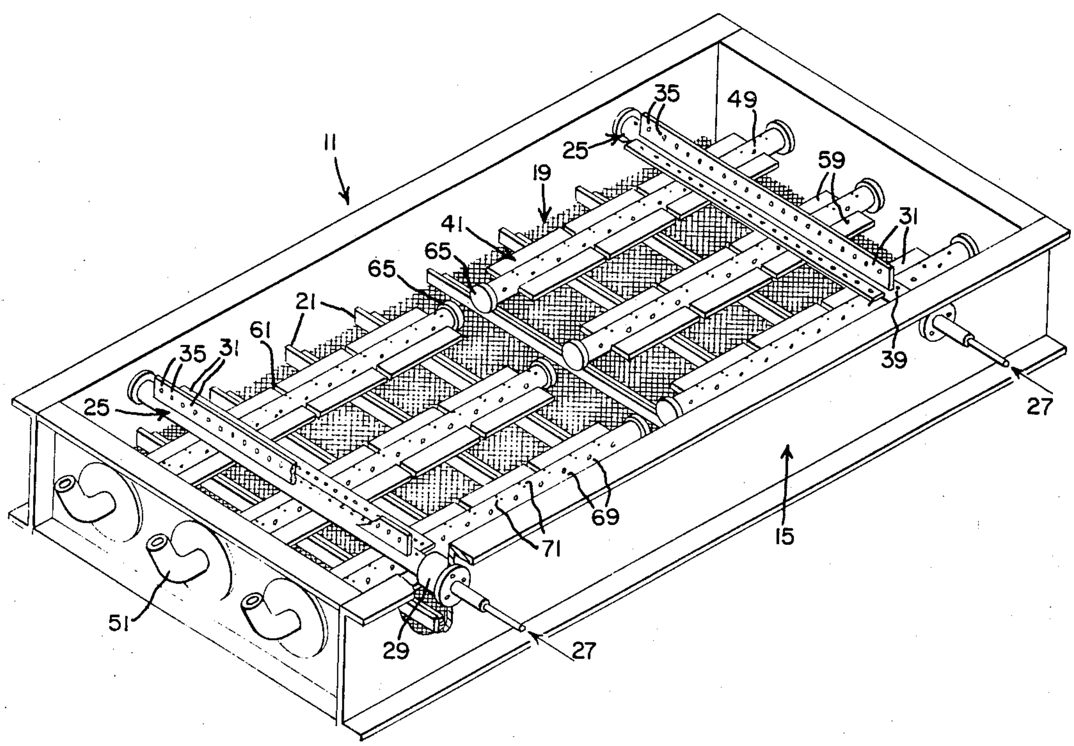


FIG. 1

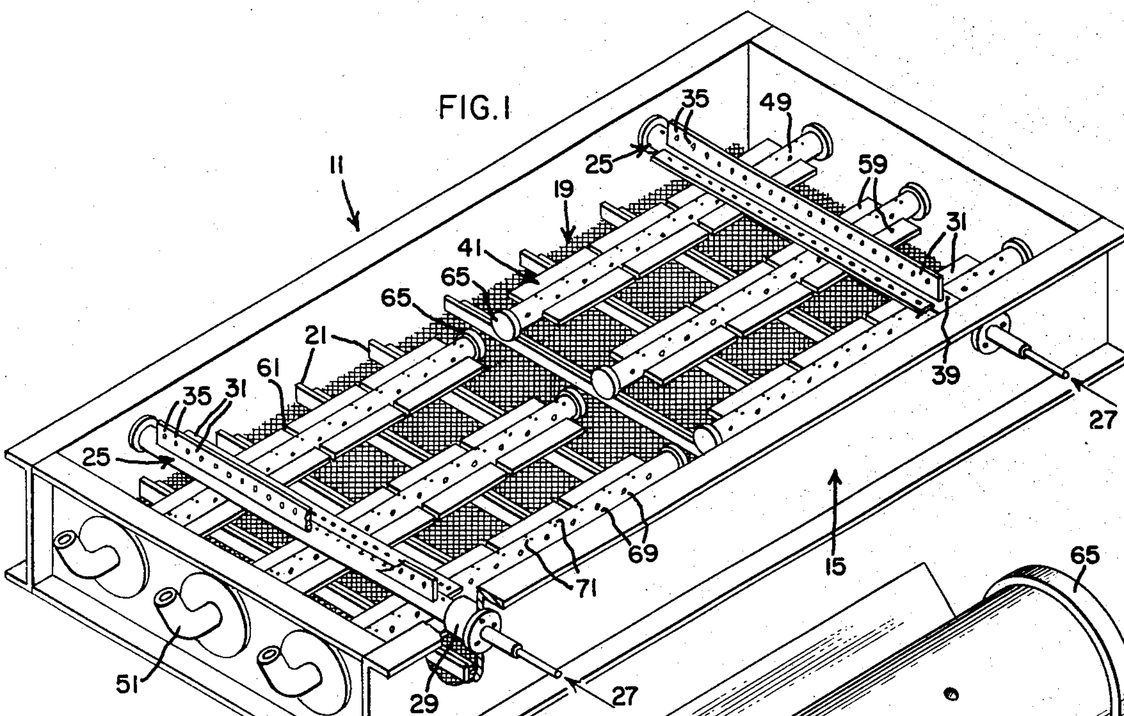
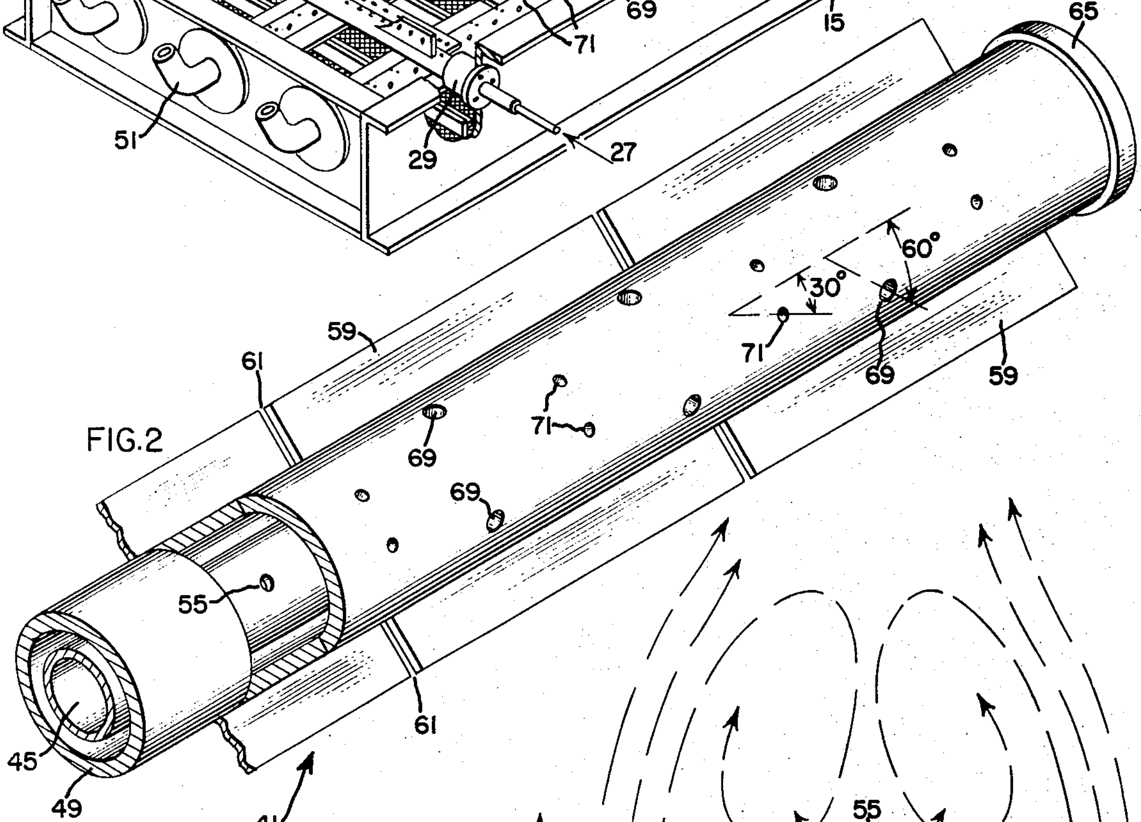


FIG. 2



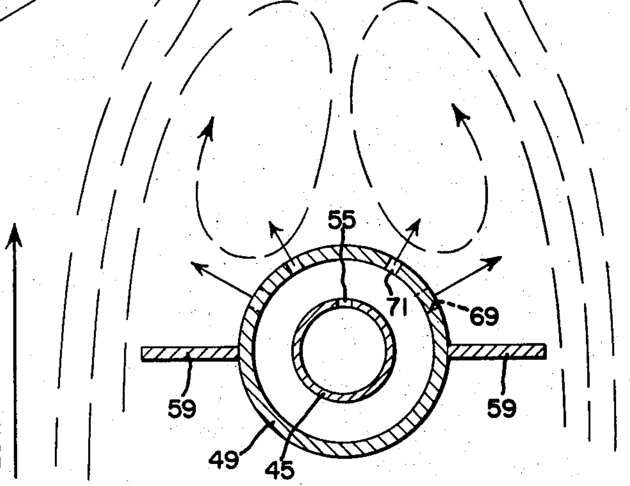


FIG. 3

GAS BURNER FOR HEAT-RECOVERY STEAM GENERATOR

BACKGROUND OF THE INVENTION

This invention relates generally to gas burners for systems in which the flow of air admitted to a combustion zone is considerably in excess of the amount required to sustain combustion and the object is to raise the temperature of the flow; and, in particular this invention relates to a gas burner used to fire a heat recovery steam generator in the exhaust duct of a gas turbine.

Gas turbine exhaust gases at 940° F may first flow upward through a bank of pre-evaporator tubes where the exhaust gas temperature is reduced to about 540° F. The gases then flow upwardly, for heating, through a horizontal burner bed or grid which comprises a number of spaced parallel main burner elements arranged along the length of the burner bed. The gases then travel vertically upward about 9 feet before passing through a bank of finned boiler tubes. In this nine foot distance it is important to burn the fuel gas from the burners completely and mix the hot products with the excess air and turbine exhaust gas which bypasses the flame, in order to achieve as uniform a temperature as possible at the boiler tubes. The fuel gas flow to the burners is controlled by regulating the fuel gas pressure to achieve an exhaust gas temperature of 1,300° F at the tubes. In addition to the main burner elements, there are pilot burner elements transversely mounted at opposite ends of the burner bed at right angles to the main burner elements. The pilot burners are ignited first, burn continuously, and eject a sheet of flame out over the downstream sides of the main burner elements.

There are a variety of operating conditions to which the burner must adjust, namely, the exhaust gases will normally be at temperatures in the range of 500° to 1,000° F., flowing upwardly with velocities in the range of 10 to 100 feet per second with oxygen contents in the range of 12 to 21 percent by volume. The burner must therefore have a high "turn-down" ratio, that is, a high ratio between maximum and minimum rates of operation. Additionally, as fuel pressure is increased, in order to meet increased heat requirements, the flame becomes unstable and tends to burn off from the burner and upwardly toward the burner tubes. This burn-off phenomena causes unequal heating of the boiler tubes and can cause damage to the system.

Some prior art solutions to the burn-off phenomena are found in patents to Yeo et al., specifically U.S. Pat. Reissue No. 25,626 issued July 28, 1964 and U.S. Pat. No. 3,178,161 issued Apr. 13, 1965. In the earlier issued patent, flame retention is provided by a pair of perforated "gutter" wings fixed to a burner pipe. Air is directed through the perforated wings and converges above the flame and gas supply to form a canopy to ensure thorough mixing, heating and combustion of the gas supply for all design ratio of operation. The latter Yeo et al patent represents an improvement in that it provided a "necked" wing burner to further contain the flames near the burner pipes.

A somewhat different approach was taken in U.S. Pat. No. 3,574,507 to Kydd, issued Apr. 13, 1971 and assigned to the assignee of the present invention. In that invention, a baffle was placed directly above a high velocity fuel jet which deflected the fuel jet laterally so as to provide a low velocity flame stabilizing region.

SUMMARY OF THE INVENTION

A gas burner for firing a heat recovery steam generator in the exhaust gas duct of a gas turbine. A burner pipe is formed with diametrically opposed horizontal wing baffles; and, includes large and small fuel jet openings respectively positioned and arranged at greater and lesser circumferential distances from the burner pipe vertical centerline. A part of the exhaust gas, due to the flat wing baffles, is directed into a recirculation zone above and downstream from the small fuel jet openings and establishes the proper conditions for flame stability. THe large fuel jet openings displaced further from the vertical centerline of the pipe, eject fuel laterally beyond the recirculation zone whereupon the fuel is caught in an updraft of exhaust gas and ignited by the stable flame. The burner pipe may contain a concentrically mounted manifold pipe with fuel distribution holes to assure uniform fuel distribution within the main burner pipe.

It is, therefore, one object of the present invention to provide an improved gas burner which will have a high "turn-down" ratio.

It is another object of the present invention to provide an improved gas burner capable of sustaining flame stability under relatively high fuel pressure conditions.

It is a further object of the present invention to provide an improved gas burner which will provide more complete fuel combustion within a specified combustion zone.

Other objects and advantages will become apparent from the following description of the invention and the novel features will be particularly pointed out hereinafter in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a burner grid of the type which may be incorporated into the exhaust duct of a gas turbine to supply heat for a heat recovery steam generator.

FIG. 2 is an isometric view of the present invention removed from the burner grid.

FIG. 3 is an end view of the present invention with arrows indicating the flow of gas turbine exhaust gases.

DETAILED DESCRIPTION OF THE INVENTION

Illustrated in FIG. 1, a burner grid **11**, of the type which may be utilized in the exhaust stack of a gas turbine and used to heat exhaust gases for firing a heat recovery steam generator or waste heat boiler, is comprised of a rectangular frame **15** which is used to support burner elements between two exhaust duct sections (not shown). A flow distribution screen **19** may be used to form a porous floor and is fixed to the rectangular frame by support beams **21** fixed traversely to opposite sides of the frame along the length thereof.

At either end of the rectangular frame there may be a transversely mounted pilot burner **25** including an ignitor **29.** Each pilot burner is connected at a gas inlet **27** to a gas supply (not shown) at one end and may be capped at the opposed end so as to form a blind burner pipe. The pilot burner may differ from the main gas burners (according ot the present invention) in that it may be an ordinary "gutter-wing" burner, according to the prior art, having a pair of divergent wings **31** including air holes **35** and a row of fuel holes **39** on the burner pipe. Since the pilot burner supplies merely the genesis of the burner conflagration, the fuel input here usually remains constant at some relatively low value. The pilot burners therefore are ignited to form a flame which is transversely propagated at either end of the rectangular frame.

The main burners **41** form the basis of this invention, and are best illustrated in FIGS. **1** and **2.** The main burners may be longitudinally oriented with respect to the burner grid and may be supported by the transverse beams **21** as well as the rectangular frame. The main burners are below or upstream of the pilot burners and are perpendicular thereto Flame propagation in the main burners is from either end of the rectangular support inwardly to approximately the middle of the rectangular frame.

The main burners are each formed from a burner pipe **49** from which extends a pair of horizontal wings **59.** The wings extend horizontally outward from the burner pipe and lie in a 180° plane with respect to one another and each wing lies at a 90° angle with respect to the vertical centerline of the burner pipe. The wings therefore lie perpendicular to the flow of turbine exhaust gas. The wings are imperforate, but are provided with periodic discontinuities or expansion slots **61** along the burner length to accommodate thermal expansion and limit thermal distortion. As an example, the width of each burner wing may be in the order of one half the diameter of the burner pipe. Each burner pipe includes a cap **65** to close one end of the burner forming thusly another blind pipe.

The downstream (with respect to the flow of gas as shown in FIG. **3**) circumference of the burner pipe **49** includes a series of large and small holes symmetrical with respect to the vertical centerline of the pipe. These include main fuel ports **69** which are the larger holes and flame stabilization ports **71** which are the smaller holes. As an example, the ratio of the diameters between the main ports and the stabilization ports may be in the order of **2** to **1.** Furhter, according to the present invention, the main fuel ports are disposed in pairs, one on each side of the vertical centerline of the burner pipe and each one port spaced a circumferential distance of 60° from the vertical centerline.

The flame stabilization holes or ports **71** (which are the smaller holes) are spaced in pairs which alternate with the main fuel ports along the burner length. The stabilization ports are each spaced **30** degrees from the vertical centerline on opposite sides of the vertical centerline.

There is a smaller diameter manifold pipe **45,** concentrically mounted within the main burner pipe **49,** and connected to a gas inlet **51.** This manifold pipe includes fuel distribution holes **55** which are formed along the top centerline of the pipe. These holes are in effect gas distribution holes occurring about once per every **3** pairs of main burner holes which assure uniform gas distribution into the burner pipe. The ratio of the mean diameter of the manifold pipe to the mean diameter of the burner pipe may be in the order of **3** to **4.**

OPERATION OF THE INVENTION

Referring now to FIG. **1,** the burner grid, which may be enlarged or reduced in size according to the size of a gas turbine exhaust duct and also according to heating requirements, receives an upward draft of gas turbine exhaust gases having varying oxygen contents and velocities. The pilot burners are fired by the ignitor and a supply of gas through gas inlet **27.** This spreads two sheets of flame across the burner grid, one at each end. These flame sheets are for igniting the main burners and produce relatively small amounts of heat. Therefore, flame stability may be achieved by adjusting the fuel gas pressure to a minimum pressure.

The main gas burners are supplied with gas fuel from the gas inlets as shown. Gas fuel is fed into the main burner pipe from the manifold pipe (FIG. **3**) in order to uniformly distribute gas into the burner pipe. Thereafter the gas is ejected from the main gas ports and the flame stabilizing ports. The exhaust gases immediately adjacent to the burner wings have a swirling motion imparted to them because of the burner wings obstructing their path. This causes an exhaust gas recirculation pattern above the burner as indicated in FIG. **3.** Fuel jets, from the flame stabilization ports, are ejected into the recirculation pattern forming a combustible mixture which is ignited by the pilot flame. Because of the recirculation pattern, fuel jets may be completely burned in a stable flame.

Meanwhile, fuel gas, issuing from the main gas ports, is ejected laterally to either side of the recirculation zone, penetrating it, until it is caught in an upward draft of turbine exhaust gases as indicated in FIG. **3.** This upward draft and the fuel carried with it forms a combustible mixture peripheral to the stable flame which now acts as a pilot flame for the main burner ports. Again, flame stability is assured for all fuel pressures and complete combustion of all fuel gases will occur.

Due to recirculating hot fuel gases above or downstream from the burner together with the hot turbine exhaust gases, the fuel within the burner pipe becomes progressively hotter as it passes down the burner pipe. This affects the distribution of fuel flowing out through the fuel ports and hence the size and stability of the flame jets. To overcome this problem, the fuel distribution manifold is inserted inside the main burner pipe as heretofore described. This internal manifold is fed with fuel gas at higher pressures up to 30 psig (or higher). A small number of fuel distribution holes in the inner pipe distributes the gas uniformly to the inside of the main burner pipe where the design pressure is around 1 psig or less. In this way uniform flames along the length of the burner are obtained.

While there has been described herein what is considered to be the preferred embodiment of the invention, other modifications will occur to those skilled in the art. The size and configuration of the fuel holes are chosen to provide the flame stability and flame spread required for the particular application. The size of the fuel holes may vary according to their distance from the vertical centerline of the burner pipe. It is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A gas burner for heating an exhaust gas flow in a vitiated air environment comprising:

an elongated gas burner pipe;

at least one pair of oppositely directed, imperforate, horizontal wing baffles attached to said burner pipe, adapted to be perpendicular to said exhaust gas flow for directing a portion of said exhaust gas flow into a recirculation pattern downstream from said burner pipe;

flame stabilization fuel ports on the downstream circumference of the burner pipe for ejecting fuel into the recirculation pattern forming a first combustible mixture; and,

main fuel ports on the downstream circumference of the burner pipe for ejecting fuel laterally beyond the recirculation pattern into the exhaust gas flow forming a second combustible mixture; said flame stabilization ports and said main fuel ports symmetrical with respect to the vertical centerline of the burner pipe; and, said flame stabilization ports circumferentially nearer the vertical centerline of the burner pipe and smaller in diameter than the main fuel ports.

2. The gas burner as recited in claim **15** wherein a fuel distribution manifold pipe, having spaced fuel holes along its length, is positioned within the burner pipe for assuring uniform distribution of gas fuel to the interior of the burner pipe.

3. The gas burner as recited in claim **15** wherein the flame stabilization ports are displaced circumferentially on the order of 30° from either side of the vertical centerline of the pipe.

4. The gas burner as recited in claim **15** wherein the main fuel ports are displaced circumferentially on the order of 60° from either side of the vertical centerline of the pipe.

5. The gas burner as recited in claim **15** wherein the width of each burner wing may be on the order of one half the diameter of the burner pipe.

6. A gas burner for heating an exhaust gas flow in a vitiated air environment comprising:

an elongated cylindrical burner pipe adapted to be transversely mounted with respect to the exhaust gas flow;

at least one pair of oppositely directed, coplanar, imperforate horizontal wing baffles attached to said burner pipe and extending radially of the burner pipe, adapted to be perpendicular to said exhaust gas flow for directing a portion of said exhaust gas flow into a recirculation pattern downstream from said burner pipe, said baffles each having a width extending from the burner on the order of one half the diameter of the burner; and,

at least two rows of fuel ports above said baffles and along the length of said burner pipe, said rows of fuel ports symmetrical with respect to the vertical centerline of said burner pipe and having an included angle in the order of 60° between said rows.

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