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Goodnight et al.

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[54] **BURNER FOR GASEOUS FUELS IN REDUCED OXYGEN AND/OR SIGNIFICANT VELOCITY ATMOSPHERE**

[75] Inventors: **Hershel Goodnight; John S. Zink; Robert D. Reed,** all of Tulsa, Okla.

[73] Assignee: **John Zink Company,** Tulsa, Okla.

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[52] **U.S. Cl.**.....**431/286,** 60/39.72 R, 431/171, 431/350

[51] **Int. Cl.**.....**F23l 19/04**

[58] **Field of Search**.....431/8, 171, 180, 431/351, 350, 354; 263/19 A; 60/39.72 R, 39.74

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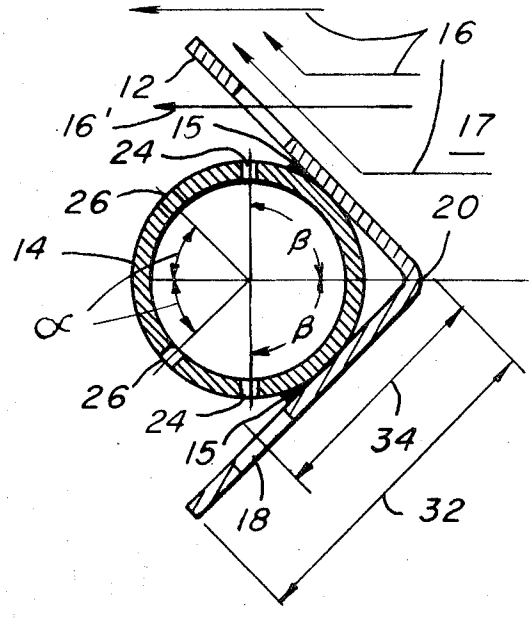
Primary Examiner—Carroll B. Dority, Jr.

Attorney—Head & Johnson

[57] **ABSTRACT**

This invention describes a burner system for burning gaseous fuels in an atmosphere containing oxygen less than that of air and/or in an atmosphere of significant flow velocity. It comprises one or more burner-baffle arrays which may be mounted singly, or in spaced parallel arrangement across the flow of said oxidizing atmosphere. Each array includes longitudinally spaced V-shaped angular baffles placed with the convex surface toward the gas flow. A gaseous fuel conduit connects with the concave downstream side of the baffle within the V angle formed by the side walls. Fuel gas inlet ports are spaced along the length of the conduit. Openings are provided in the walls of the baffles, spaced in direct relation to the positions of said ports.

14 Claims, 5 Drawing Figures



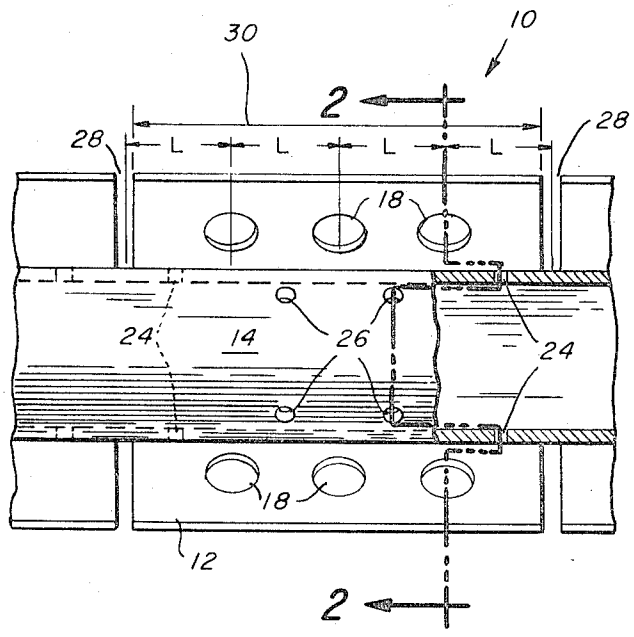


FIG. 1

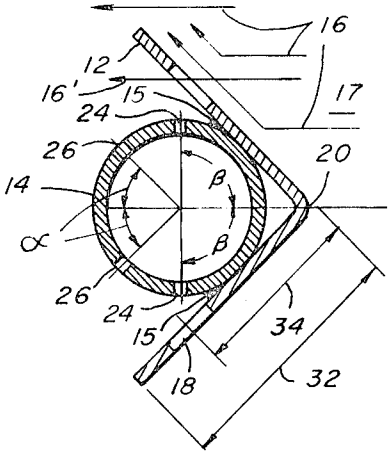


FIG. 2

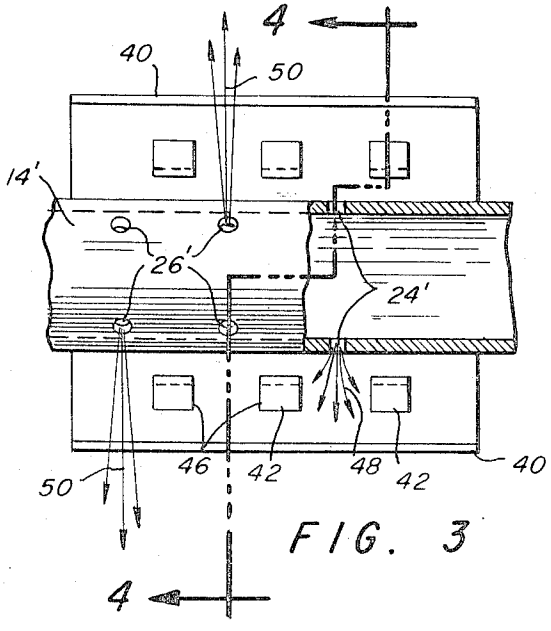


FIG. 3

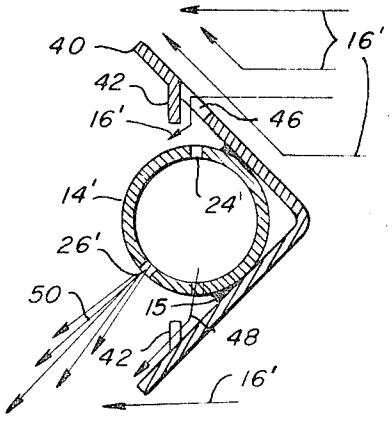


FIG. 4

INVENTORS.
HERSHEL GOODNIGHT
JOHN S. ZINK
BY ROBERT D. REED

Head & Johnson

ATTORNEYS

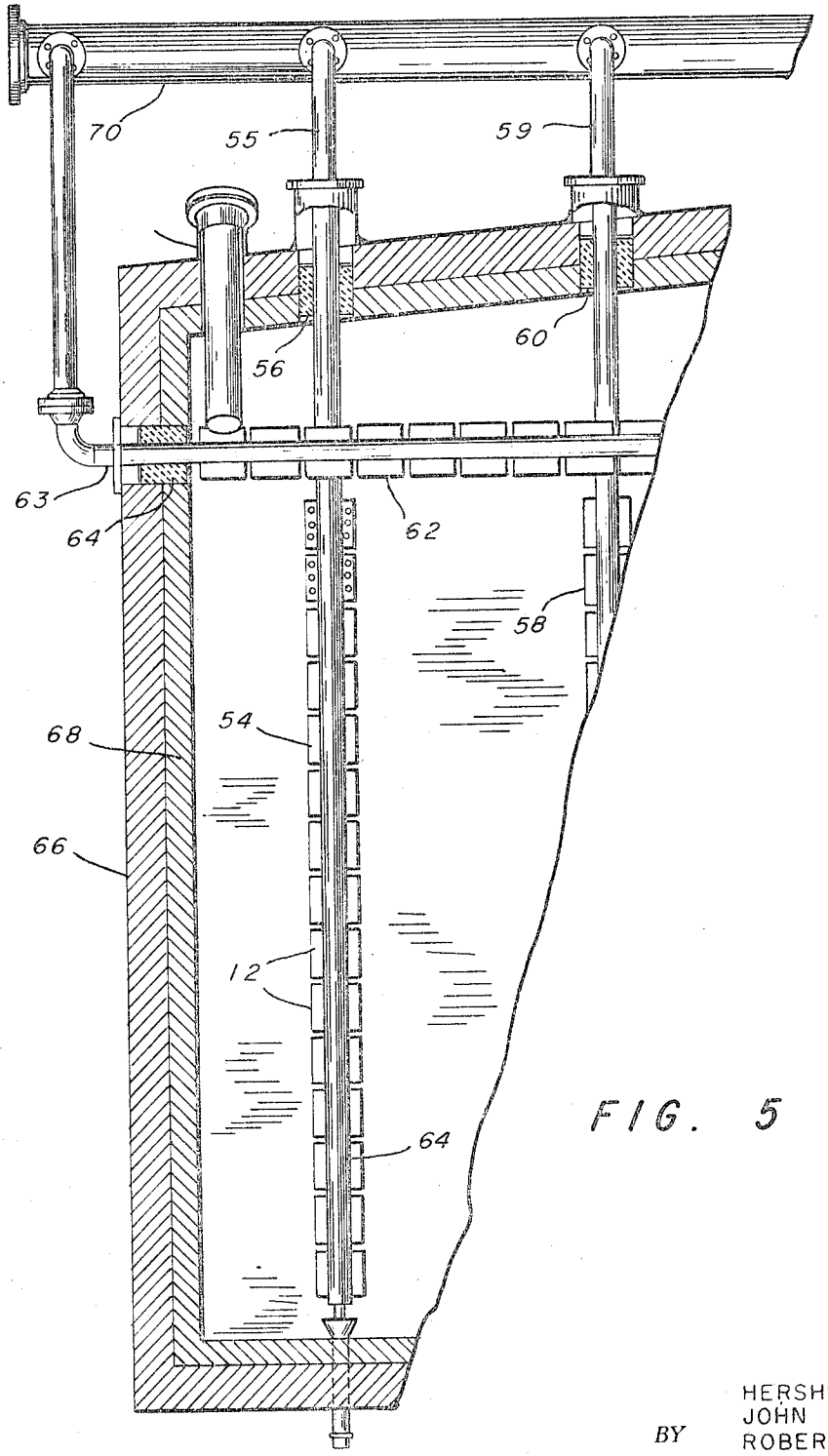


FIG. 5

INVENTORS.
HERSHEL GOODNIGHT
JOHN S. ZINK
ROBERT D. REED
BY
Head & Johnson
ATTORNEYS

BURNER FOR GASEOUS FUELS IN REDUCED OXYGEN AND/OR SIGNIFICANT VELOCITY ATMOSPHERE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is in the field of gaseous fuel burners for use with oxidizing gases to provide heated gases at specified temperatures.

More particularly this invention is related to a burner system for promoting the combustion of a fuel gas in an oxidizing atmosphere which contains oxygen in an amount less than that of air (on a mole percent basis) and which atmosphere has appreciable and significant flow velocity.

2. Description of the Prior Art

Most modern fuel burning systems that provide heat for boilers and the like utilize air as the combustion supporting gas in which the percentage of oxygen is about 20 percent.

On the other hand, there are many power generating devices that produce exhaust gases which may have temperature of up to 1000° F., and which carry substantial amounts of sensible heat. Normally these gases (such as exhausts from internal combustion engines and gas turbines, etc.) are exhausted to the atmosphere, with a consequent waste of the heat contained in the gases. Attempts have been made, in the past, to utilize these exhaust gas gases as oxidizing atmospheres to burner assemblies where combustion of fuel gas can raise the temperatures of 2000° and higher, where the heat can be used to greater advantage.

In general, great difficulty has been observed in burning gaseous fuels under these conditions. The difficulty has been that the reduced oxygen content does not permit as hot a flame, and the high flow velocity tends to cool and/or blow out the flame.

SUMMARY OF THE INVENTION

These difficulties in the prior art systems are overcome in this invention by:

a. providing an angular baffle upstream of the burner pipe or conduit. This can take the form of a 90° angle structure with the outer vertex side directed upstream into the oxidizing gas flow. The fuel inlet pipe is in the inner vertex space or the downstream side of the baffle. This tends to shield the fuel ports in the pipe from the blast of the moving oxidizing atmosphere. Openings are provided along the walls of the baffle to feed preferred amounts of the oxidizing atmosphere into the downstream side of the baffle.

b. a first series of ports or orifices, designated as ignition ports, for the purpose of igniting the gas, are spaced along the pipe. The streams of gas discharging from the ignition ports are directed toward the walls of the baffle where they are diverted to provide intimate fuel gas mixing with the atmosphere in the relative quiescent zone inside the V of the baffle.

c. a second series of ports or orifices, designated as firing ports, are directed downstream at about a 45° angle from the centerline or a 90° included angle for the purpose of carrying the flame outwardly to the sides of the baffle into the flowing atmosphere. Even though the streams of gas issuing from these firing ports may occasionally be broken up and the flames extinguished by the flowing atmosphere, there is a volume of burning gas in the shelter of the baffle, fed from the ignition ports, which serve as pilot flames for all of the firing jets of gas. Thus a continuous burning of gas is possible.

The objective of this invention is therefore to provide a burner system for the burning of fuel gas in a rapidly moving oxidizing atmosphere or in rapidly moving atmospheres that contain less than about 20 percent oxygen, on a mole basis, yet enough oxygen to support adequate combustion.

These and other objects and a better understanding of the principles of the invention will be apparent from the following description taken in conjunction with the attached drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** show, respectively, elevation and sectional views of one embodiment of this invention.

FIGS. **3** and **4** show, respectively, elevation and sectional views of a modification of the embodiment of FIGS. **1** and **2**.

FIG. **5** shows a partial sectional view, looking upstream, utilizing a plurality of longitudinal burners of the type illustrated in FIGS. **1** through **4**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates one embodiment of this invention looking in an upstream direction. It comprises a baffle-conduit system indicated generally by the numeral **10**. It includes a V-shaped baffle **12**, in which the outer convex or vertex is directed upstream into the flow **16** of the oxidizing atmosphere **17**. The V shaped baffle **12** is comprised of an angle structure preferably of an included angle of about 90°. The fuel pipe or conduit **14** is set into the inside of the V (on the downstream side of the baffle) and held by such means as welds **15**. When made in this way in long lengths, there is a tendency for the assembly to twist and distort under forces of expansion and contraction. For this reason it is preferred to make the baffle in a plurality of short lengths **30**, with spaces **28** in between. An example of the dimensions **30** and **28** are 5 ¾ and ¼ inches respectively. The baffle may have webs or walls of width **32**, which may, as an example, be of the order of 4 inches wide.

A plurality of openings are provided in the walls of the baffle to permit a preferred amount of the oxidizing atmosphere **17** to pass through the openings into the sheltered (downstream) side of the baffle. These openings **18** may be round as in FIG. **1** or square as in FIG. **3**, or other shapes with substantially equal effectiveness. A typical size of round opening **18** would be ¾ inch diameter spaced a distance **34** (typically 3 inches) from the outer vertex **20** of the baffle **12**.

A plurality of openings **18** usually equally spaced apart a distance L, and also spaced a distance L on each side of the centerline of the gap **28**. A typical number of openings would be **3**, as shown, spaced apart a distance $L = 1\ ½$ inches. It is seen that the slot or space **28** between each of the segments **12** of the baffle serves, in effect, as another opening like **18** to pass oxygen containing gas to the back of the V.

The gas supply pipe or conduit **14** is drilled with a plurality of openings or ports divided into "ignition" ports **24** and "firing" ports **26**, based on their angular

relation. The firing ports **26** are directed outwardly-downstream of the assembled burner and provide a high velocity concentrated stream of fuel gas **50** that extends out beyond the edges of the baffle. Here the stream of gas (and flame, when the stream is ignited) is subjected to the high velocity stream of atmosphere gas **16** which tends to buffet and interrupt the flame, which must be maintained or continually reignited. The firing ports are nominally provided at angles α on each side of the axis of the baffle. The angle α may vary from 45° to 60°.

The maintenance of flame or reignition is taken care of by having a standby or pilot flame within the protected walls of the V of the baffle. This standby flame is created by the ignition ports **24**. These are drilled into the gas pipe at angles B to the baffle axis, which angles may typically be 80°–90°. The gas issuing from the ignition ports strikes the walls of the V and are splayed outwardly, mixing with the atmosphere **16'** passing through the openings **18** on each side. Thus, the inside of the V forms a protected burning area where part of the fuel may be burned and which provides a steady flame from which the gas issuing through the firing ports maintains continuous ignition.

FIGS. **3** and **4** show a modification of FIGS. **1** and **2**. The principle difference lies in the square openings **46** rather than the round opening **18**. These square openings may be clean cut. However, it is preferable to cut only three sides to form a diversion lip **42** which can be bent inward toward the inside of the V. This provides a better mixing of the air **16'** passing through the opening with the gas issuing from the ignition ports **24'**.

The ignition ports **24'** are placed between and service two adjacent firing ports. Thus there are twice as many firing ports as ignition ports. All ports are spaced apart along the pipe by the distance L which is the spacing of the openings in the baffle. And the ports are positioned on the centerlines between the openings **18**.

In FIGS. **3** and **4** is shown in schematic form the different ways that the gas stream flows from the ignition and firing ports. The gas **48** issuing from ports **24'** strikes the leg **40** of the baffle and is splayed out so as to contact and mix with the oxidizing atmosphere **16'** passing through the openings **46**. The gas issuing from ports **26'**, on the other hand, is directed almost parallel to the walls **40**, extends out beyond the walls **40** where it contacts the main flowing stream of oxidizing gas **16'**.

In FIG. **5** is an elevation view, looking upstream, of a typical furnace or combustion chamber in which the burners of this invention would be used. It comprises an outer wall **66** lined with refractory material **68**. Mounted across oxidizing atmosphere flow path are a plurality of parallel burners **54, 58**, etc. These burners are supplied with gas to their pipes **64** from a manifold **70**, through pipes **55, 59**, etc. The pipes **55, 59**, etc. are sealed through openings in the wall with ceramic material **56, 60**. A burner **62** is set on top of, and across, the burners **54, 58** at their ends. This burner is fed with gas from the manifold through pipe **63**. This burner **62** is ignited by means of an ignition pilot (not shown but well known in the art) that is inserted through the pipe **72** sealed through the wall of the furnace.

In operation, the flow of oxidizing atmosphere would be substantially horizontal issuing, for example, from a turbine as exhaust across the burners. The gas in burner **62** is ignited by the pilot through pipe **72**. The gas issuing from the ignition ports in burner **62** would provide a stable flame to ignite the gas in each of the parallel burners **54, 58**, etc. so that a complete area of flame will fill the area between burners substantially across the stream of oxidizing atmosphere.

While this invention has been described with a certain degree of particularity, it is manifest that many changes may be made in the details of construction and the arrangement of components. It is understood that the invention is not to be limited to the specific embodiment set forth herein by way of exemplifying the invention, but the invention is to be limited only by the scope of the attached claim or claims, including the full range of equivalency to which each element or step thereof is entitled. For example, although the invention has been particularly described relative to burning fuel gas in oxidizing atmosphere having oxygen in amounts less than that of air (on a mole percent basis) and wherein the atmosphere is moving at a significant velocity this is not to be limiting. The burner of this invention is capable of use with other oxidizing gas or air which is moving at a significant velocity. Typical of such velocity is that sufficient to maintain combustion and yet provide the needed heat. Usually at least a velocity of twenty feet per second is satisfactory.

What is claimed:

1. A burner system for burning fuel gas in an oxidizing atmosphere containing oxygen in an amount less than that of air and where said atmosphere has a significant flow velocity; comprising:

a. at least one elongated angular baffle means in the path of said flowing atmosphere, the convex side facing said flow, to angularly divert said flow into two angular paths, a plurality of spaced openings in the walls of said baffle, whereby part of said atmospheric flow passes through said openings from the upstream to the downstream side of said baffle;

b. a fuel gas supply conduit means positioned in the downstream concave side of said baffle, the axis of said conduit substantially parallel to the walls of said baffle;

c. a plurality of ignition ports angularly and linearly spaced along said conduit means to direct the flow of said fuel gas against the inner wall of said baffle; and

d. a plurality of firing ports angularly and linearly spaced along said conduit means to direct the flow of said fuel gas into the angular paths of flow of said atmosphere.

2. The system as in claim **1** including a plurality of the baffle-and-conduit means in parallel relation in a single plane.

3. The system as in claim **2** including at least one baffle-and-conduit means placed across said plurality of baffle-and-conduit means and substantially perpendicular thereto.

4. The system as in claim **1** in which the angle included between the walls of said baffle is substantially 90°.

5. The system as in claim **1** in which said conduit is welded to said baffle means, and in which said baffle means comprises a plurality of short lengths of baffle, spaced apart along said conduit.

6. The system as in claim 5 in which there are a plurality of openings in each wall of said short lengths of baffle equally spaced apart.

7. The system as in claim 1 in which said ignition ports are positioned in pairs at an angle in the range of 80° to 90° to the diameter of said conduit which passes through the vertex of said baffle.

8. The system as in claim 1 in which said firing ports are positioned in pairs at an angle in the range of 45° to 60° to the diameter of said conduit which passes through the apex of said baffle, to direct said fuel gas outwardly and downstream of said baffle.

9. The system as in claim 1 in which said ports in said conduit are positioned in planar pairs, in equal angular position with respect to the diameter of said conduit passing through the apex of said baffle, and equally spaced along said conduit between each pair, there being one pair of ignition ports between each two pairs of firing ports.

10. The system as in claim 9 in which said ignition and firing ports are spaced longitudinally on the centerlines between said openings in said lengths of baffle.

11. The system as in claim 1 in which the openings in the walls of said baffle are round openings.

12. The system as in claim 1 in which the openings in the walls of said baffle are parallelogram shaped openings.

13. The system as in claim 12 including a diversion lip extending on the downstream side of said baffle over said openings and toward the centerline of said baffle.

14. A burner system for burning fuel gas in an oxidizing atmosphere of significant flow velocity comprising:

a. at least one elongated angular baffle means in the path of said flowing atmosphere, the convex side facing said flow, to angularly divert said flow into two angular paths, a plurality of spaced openings in the walls of said baffle, whereby part of said atmospheric flow passes through said openings from the upstream to the downstream side of said baffle;

b. a fuel gas supply conduit means positioned in the downstream concave side of said baffle, the axis of said conduit substantially parallel to the walls of said baffle;

c. a plurality of ignition ports angularly and linearly spaced along said conduit means to direct the flow of said fuel gas against the inner wall of said baffle; and

d. a plurality of firing ports angularly and linearly spaced along said conduit means to direct the flow of said fuel gas into the angular paths of flow of said atmosphere.

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