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Reed et al.

[11] **3,857,672**

[45] **Dec. 31, 1974**

[54] **TRI-FUEL BURNER FOR PROCESS GASES**

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[52] **U.S. Cl.** **431/353,** 431/173, 431/174

[51] **Int. Cl.** **F23d 15/02**

[58] **Field of Search** ..... 431/173, 174, 353, 5, 202; 122/7 D; 23/277 C

[56] **References Cited**

UNITED STATES PATENTS

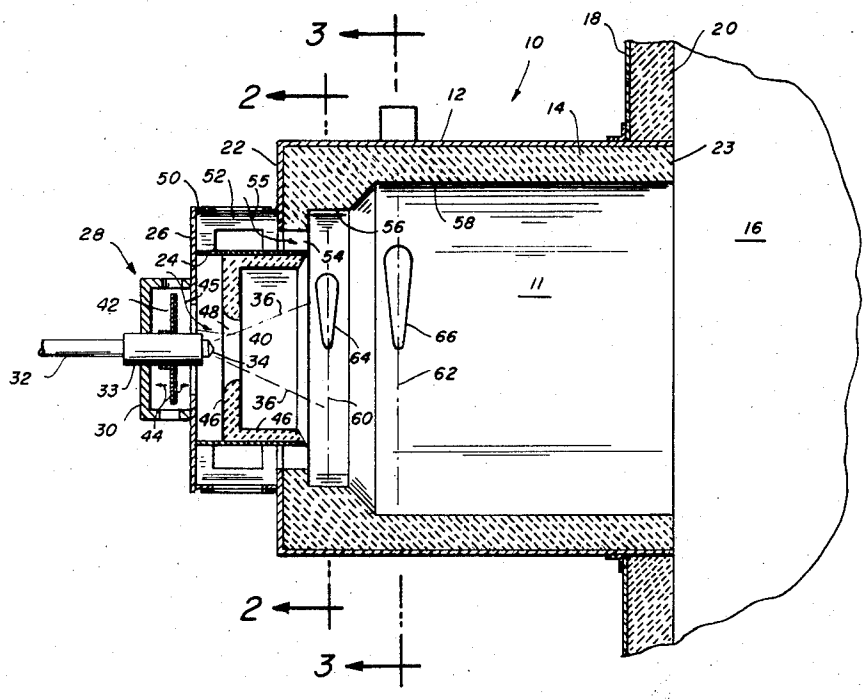
3,105,540	10/1963	Hardgrove	431/173 X
3,106,955	10/1963	Flasskamp et al.	431/173 X
3,195,608	7/1965	Voorheis et al.	431/5 X
3,244,220	4/1966	Kloecker	431/5 X

Primary Examiner—Edward G. Favors

[57] **ABSTRACT**

This abstract describes a type of burner in which gaseous or liquid fuel is used to provide a high temperature environment, with excess air, into which a low heat value "lean" gas can be introduced to be burned. It comprises a cylindrical housing lined with refractory, having a closed end and an open end, adapted to be inserted into a furnace wall. Liquid fuel burner means can be inserted into the closed end and/or gaseous fuel can be introduced in a tangential rotary manner, with excess combustion air introduced through ports in the closed end of the housing. Combustion of these fuels provides a high temperature gaseous environment into which the lean gas can be introduced, in a tangential manner, downstream, so that the lean gas will be burned with the excess air provided.

4 Claims, 3 Drawing Figures



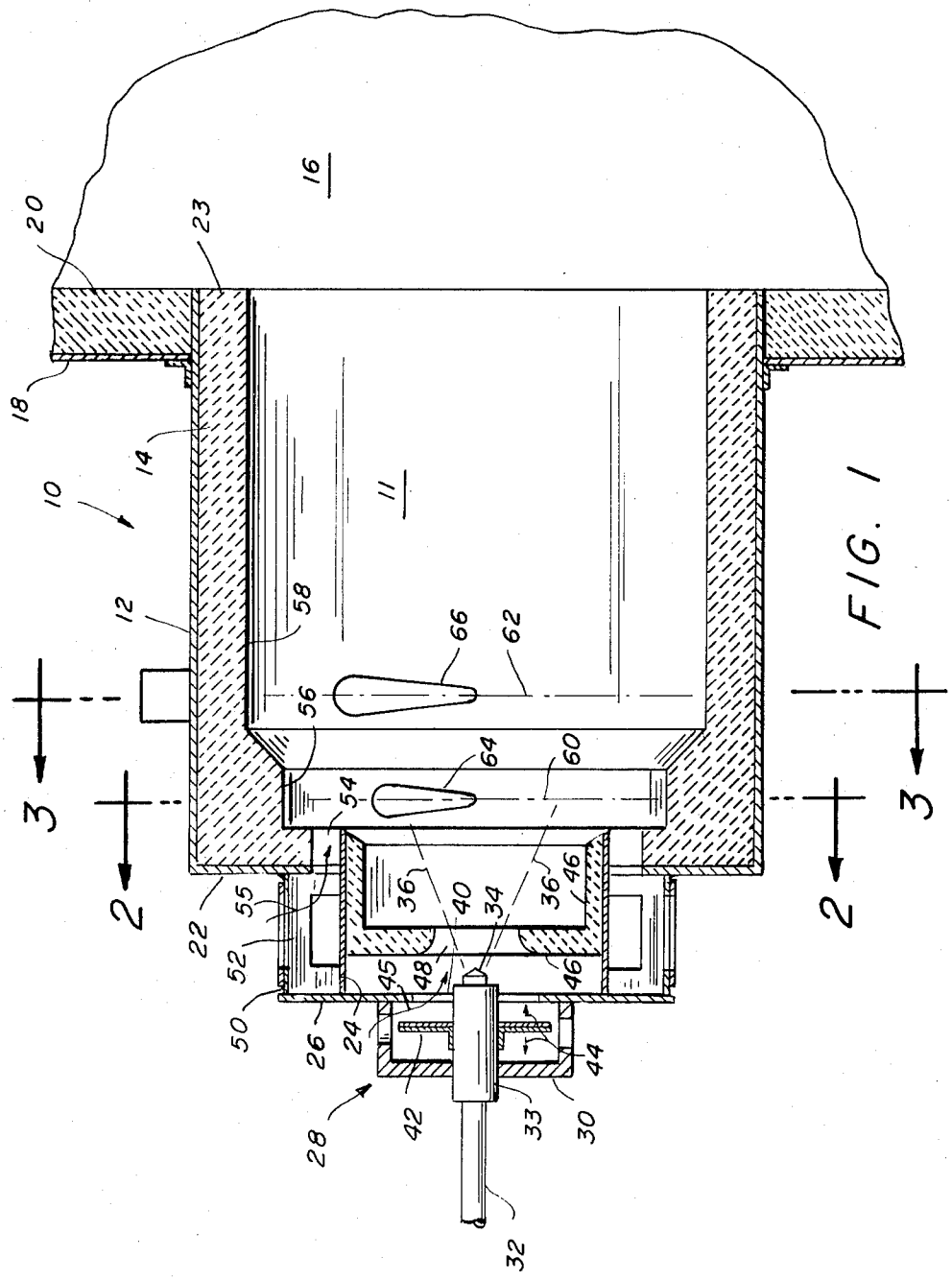

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FIG. 1

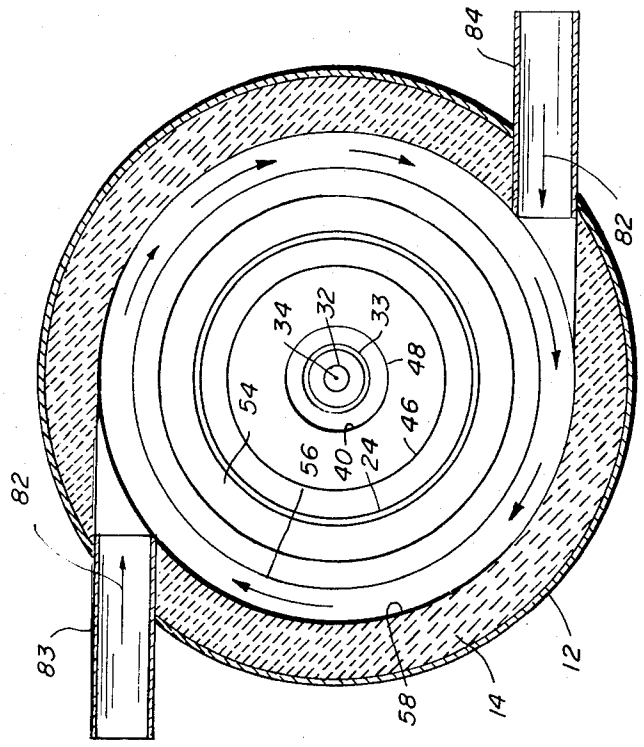

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FIG. 3

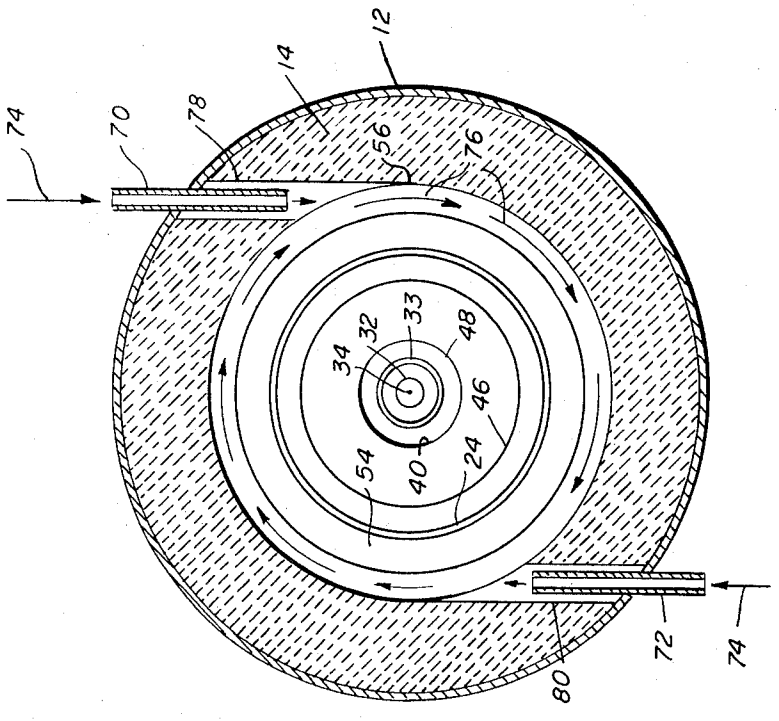

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FIG. 2

TRI-FUEL BURNER FOR PROCESS GASES

BACKGROUND OF THE INVENTION

Because of the national energy crisis, and also because of increasing fuel costs there is great demand for the safe and stable burning of "lean" process gases which have insufficient heat value for combustion by themselves. Since some of these gases also have considerable sensible heat it is advantageous to provide some way of economically burning the lean gases to utilize both their chemical and their sensible heat.

It is typical of many industries, but particularly typical of the carbon black industry, for example, to produce great volumes of lean gases which have calorific values so low that they are not capable of self-supported burning despite possession of appreciable sensible heat. There is authoritative disagreement as to the minimum calorific value of the gas which will permit safe and stable self-burning, but such a minimum figure is in the order of 70 Btu/cu ft, lower heat value, (LHV). Burning of lean gas of this heat value is possible, but only with some difficulty. Also, it must be burned in a zone which has been preheated significantly, through burning of a standard fuel, such as coal, oil or hydrocarbon gas.

The lean gases in this case have calorific value ranging from 10 Btu/cu ft LHV to 60 Btu/cu ft LHV plus some sensible heat content in some cases, and no sensible heat content in other cases. The calorific values are indicated as lower heat values, because this is the sensible heat value and is thus recoverable, whereas the higher heating value of fuel includes the latent heat for vaporization of any water formed by the combustion of hydrogen. Hydrogen is typically a component of lean gases. Also, CO, NH_3, H2S, COS, CS_2, carbon and hydrocarbons. Inert components may be N_2, H_20, A, $C0_2$ and others. Safe and stable burning of lean gases, as in this case, requires simultaneous firing of easily burned fuel for a portion of the heat demand, to supply heat to force burning (rapid burning) of the lean gases, and the fuel demand for such heat is according to the characteristics of the lean gases, with fuel demand increasing as the calorific value of the lean gases decreases.

Because of fuel supply problems, it is preferred that there be provision for more than a single easily burned fuel. In this invention there is provision for the burning of hydrocarbon gases as one easily burned fuel, or liquid fuel, as required by supply and operational problems, where the liquid fuel may be oil or any easily burned liquid.

This invention lies in the field of gas burners. More particlarly, it is concerned with means for burning gases which have such a low heat value that they are not capable of combustion without additional input of heat. Still more particularly, this invention concerns a burner for the combustion of lean process gases by the imposition of heat and excess air from the combustion of gaseous or liquid fuel.

Although the prior art shows burners in which fuel is burned to provide a hot flame and into which lean gases can be introduced, they do not show the particular advantages of this invention.

SUMMARY OF THE INVENTION

It is a primary object of this invention to provide a burner in which liquid or gaseous fuel can be burned to provide the high temperature environment, with excess air, for the complete combustion of a low heat value gas introduced into the burner.

This and other objects are realized and the limitations of the prior art are overcome in this invention in which the burner comprises a circular cylindrical metal housing with refractory lining. A first end of the housing is closed and the second end is adapted to be attached to the wall of a furnace for the utilization of the heat value of the gases burned. The lean gases are introduced through one or a plurality of nozzles arranged tangential to the inner surface of the lining, in a plane, which is intermediate the closed and open ends of the burner. Either or both liquid fuel and gaseous fuel may be burned in the burner between the closed end of the plane of introduction of the lean gas.

Liquid fuel can be burned in a liquid fuel burner mounted in an axial opening at the closed end of the burner. This liquid fuel burner has means for the introduction of primary combustion air and liquid fuel and provides an expanding spray of burning droplets of liquid in the direction toward the plane of introduction of the lean gas. Additional combustion air openings are provided through an annular port **54** the diameter of the circle being greater than the diameter of the liquid fuel burner. The combustion air passes through the port axially to the plane of introduction of the lean gases. The tangential introduction and the helical rotary motion of the lean gas provides a turbulent mixing with the incoming air from the ports, which in the environment of the hot flame from the liquid burner provides full and complete combustion of the lean gases.

Means are also provided for the introduction of fuel gas in a tangential rotary motion at a plane intermediate between the closed end of the burner and the plane of the lean gas introduction. Thus, liquid fuel and/or gaseous fuel can be used to provide the high temperature environment for the combustion of the lean gas.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. **1** represents a vertical cross section of one embodiment of this invention.

FIGS. **2** and **3** represent transverse cross sections taken at planes **2—2** and **3—3** of FIG. **1.**

Referring now to the drawings and in particular to FIG. **1** there is shown by the numeral **10** a tri-fuel burner for the combustion of low heat value gases. The burner **10** comprises a circular cylindrical metal housing **12** which is adapted for attachment to the outer wall **18** of a furnace **16.** The furnace has refractory lining **20** and the burner has a refractory lining **14.** The first end of the burner **10** is closed off by wall **22.** There is an opening in the wall **22** in which is supported a liquid fuel burner **28,** which comprises a liquid fuel supply pipe **32** and nozzle **34.** The liquid is supplied under pressure so that an expanding stream of droplets of liquid fuel, indicated generally by the lines **36,** are injected into the burner. Means not shown but well known in the art, are utilized for igniting the streams of droplets to provide a hot turbulent flame which is injected into the space **11** of the burner **10.** The pipe **32** is supported in a cylindrical pipe **33** which is mounted in a framework **30** supported by metal plate **26.** Cylin-

drical plate **24** is attached to the end wall **26** of the burner. The cylinder **33** is supported by the framework **30** made of steel strips. Thus there is ready access of air up to openings **48** and **40.** The opening **40** in the plate **26** admits air to partially burn the droplets of oil. Slidable diaphragm means **42** are provided on the tube **33** so that by motion in accordance with the arrows **44** more or less air can be provided through the opening **40** in accordance with arrow **45.** A refractory regenerative tile **46** is provided surrounding the flow of liquid droplets, which flow through an opening **48.** The regenerative tile is described in U.S. Pat. No. 3,711,243. It serves to provide a high temperature zone for the continual ignition of the droplets of fuel as they are injected into the burner and to force quick availability of heat from the liquid fuel. The air entering in accordance with arrow **45** supplies only part of the combustion air for the liquid fuel. The remaining air passes through an annular port **54** arranged around the outside of the cylindrical member **24.** This air is guided by a structure **50** which has an air register **52** to control the amount of secondary air which enters the combustion space **11** through the annular ports **54.** The secondary combustion air through ports **54** flow partly because of the injection of the fuel through the orifices **34** inducing such flow or by other well known means to produce in the space **11** a lower pressure than the ambient pressure outside of the burner, which will force flow of combustion air in accordance with arrows **55** through the annular port **54.**

The inner surface of the refractory lining has a first diameter **56** associated with a plane **60** and a second larger diameter surface **58** associated with the plane **62,** and which also carries toward the second end **23** of the burners and to the furnace **16.** Hydrocarbon fuel gas is injected through the openings **64,** in a tangential flow, to bear against and flow along the surface **56.** The air entering through the annular opening **54** flows along the edge of the circularly flowing fuel gas, and mixes with it, so that it can be burned in the form of a helical flow of hot combustion gases, which flows axially toward the furnace **16.**

The lean gases are introduced through a series of ports **66** so that they flow tangential to the cylindrical surface **58** and are mixed with the excess air coming in through the annular port **54** and the high temperature products of combustion of either, or both, the fuel gas in the plane **60** or the expanding cone of burning droplets of liquid fuel.

FIG. **2** is a transverse section along the plane **2—2** of FIG. **1,** and shows the fuel gas flowing in accordance with arrows **74** through tubes **70** and **72** in appropriate openings **78** and **80** through the wall **12** and the refractory **14.** The direction of flow is tangential to the surface **56** which is larger in diameter than the diameter of the annular port **54** through which the combustion air enters.

In FIG. **3** is shown a similar cross section, taken along the plane **3—3** of FIG. **1,** which is the plane **62,** in which the lean gas is introduced into the burner. Here the lean gases shown by arrows **82** are introduced through nozzles **83** and **84** tangential to the circular surface **58** to provide a rotary helical type of motion. The hot gases provided either by the liquid fuel burner **28,** or the tangentially introduced fuel gas carrying excess air provided through the port **54,** are intimately mixed with the lean gas and promote the complete combustion thereof. While in FIGS. **2** and **3** we show two inlets, there can be one or more for each gas.

While FIGS. **2** and **3** show the tangential introduction of the fuel gas and the lean gas in the same rotary direction, that is, clockwise in the plane of the drawings, they can be in the same rotary direction or in opposite directions. That is, they can flow concurrent or contracurrent.

In this description there is shown a tri-fuel burner which is required to produce a selected heat rate through the burning of lean gas with either easily burned gaseous fuel or liquid fuel.

In the sense of heat supply for forced rapid burning of the lean gases, either with or without reference to more than a single easily burned fuel, the means for gaseous fuel burning is novel. It is new and previously unobvious. This arrangement, in combination with the regenerative tile for enhancing the burning of the liquid fuel, in the absence of gaseous fuel burning, is new and unique since air delivery is identical in that only a portion of total air demand is supplied by air delivery means indicated as primary or oil air (arrow **45**) which is a fraction of the total air demand for the liquid fuel.

When the burner is operated with gaseous fuel the gas air register **52** must be open, but the oil air register may be either opened or closed. The oil air register must be open, however, when liquid fuel is being burned, for early initiation of liquid fuel burning. The primary air for the initial oil burning is not a significant portion of total air supply for complete burning, since the secondary or gas air is capable of complete and total air supply.

While the 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 embodiments 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.

What is claimed:

1. A burner for the forced burning of low heat value gases comprising:

a. a cylindrical metal housing with horizontal axis and refractory lining, said housing closed at a first end and adapted to be attached to a furnace wall at a second end, said refractory lining having three steps of diameter;

b. combustion air inlet means for the longitudinal introduction of combustion air at a first diameter through an annular port in said closed end;

c. fuel gas introduction means for the tangential introduction of fuel gas under pressure at a second, larger diameter, axially displaced from said combustion air inlet means; and

d. lean gas introduction means for the tangential introduction of low heat value gas at a third, larger diameter, displaced axially from said fuel gas introduction means, said third diameter continuing for the remaining length of said housing.

2. The burner as in claim **1** including liquid fuel burner means on the first end of said housing, at its axis, said liquid fuel burner including primary combustion air means.

3. The burner as in claim 1 in which the rotary direction of introduction of said fuel gas is the same as the rotary direction of introduction of said low heat valve gas.

4. The burner as in claim 1 in which the rotary direction of introduction of said fuel gas is opposite to the rotary direction of introduction of said low heat value gas.

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