United States Patent

[11] 3,630,651

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[21] Appl. No. **37,230**
[22] Filed **May 14, 1970**
[45] Patented **Dec. 28, 1971**

[73] Assignee **The United States of America as represented by the Secretary of the United States Air Force**

[54] **DUAL VORTEX BURNER**
9 Claims, 6 Drawing Figs.

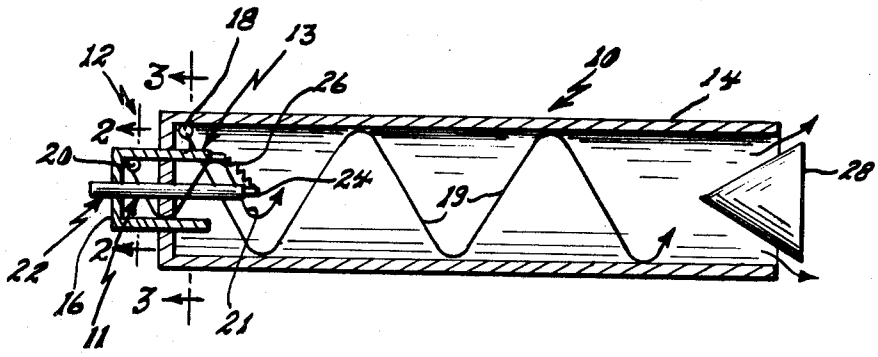
[52] **U.S. Cl.** **431/173,** 431/353
[51] **Int. Cl.** **F23c 5/18**
[50] **Field of Search** 239/404; 431/173, 353, 157, 9, 347, 160

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ABSTRACT: A dual vortex gaseous burner having a vortex tube, a separator tube, a pair of vortex chambers and an igniter. An oxidizer is injected tangentially through a jet in one of the vortex chambers forming a primary vortex between the separator tube and the vortex tube wall, while a fuel is injected tangentially through a jet in the other vortex chamber forming a secondary vortex between the igniter and the separator tube. An electric spark from the igniter produces ignition of the oxidizer and fuel at the boundary between the two vortices.



DUAL VORTEX BURNER

BACKGROUND OF THE INVENTION

This invention relates generally to gaseous fuel burners and, more particularly to a gaseous fuel burner utilizing a dual vortex for the purpose of heating tubes used as infrared radiators.

Heretofore, gaseous fuel burners utilized an axial combustion system. Such a system, although dependable had many drawbacks in use. For example, the heat release per unit volume in the axial combustion system was insufficiently high for many of the present day requirements in gaseous fuel burners. Also, heat transfer to the tube walls of an axial combustion system falls short of the standards set forth in today's operating environment. Many attempts have been made to increase the efficiency of such axial combustion burners; however, to date none have proved to be successful.

SUMMARY OF THE INVENTION

The dual vortex gaseous burner of this invention overcomes all the problems heretofore encountered and as set forth hereinabove.

The gaseous fuel burner of this invention employs a dual vortex changer which has been developed for the purpose of heating tubes used as infrared radiators. The burner of this invention combines a high heat release per unit volume with a high rate of heat transfer to the tube surface, thus making it possible to heat tubes to very high temperatures. Surface temperatures in excess of 2,000° C. have been attained with beryllium oxide tubes fired with propane and oxygen.

In this invention the oxidizer gas is injected tangentially through a jet and forms a primary vortex which flows in the annulus formed by a vortex tube on the outside and a separator tube on the inside. The fuel gas is injected tangentially through a jet forming a secondary vortex which flows inside the separator tube. The fuel and oxidizer vortices rotate in the same direction. An electric spark from spark igniter produces ignition of the combustion reaction which takes place at the boundary between the two vortices. A conical end restriction is required to prevent the influx of products of combustion and surrounding air into the negative pressure region at the axis of the tube. The energy in the products of combustion is transferred to the tube wall by forced convection.

The heat release per unit volume of the vortex tube of this invention and the heat transfer to the tube wall are roughly 10 times as great as can normally be expected with an axial combustion system using the same fuel and oxidizer. Heating densities of 18.75 M^2 btuh/ft.^{3} are achieved with propane and air as compared to 1 to 2 M^2 btuh/ft.^{3} normally achieved with an axial combustion system. Heat released on the order of 40 M^2 btuh/ft.^{3} have been achieved with propane and oxygen and higher heat released are possible.

The only limitation on the vortex gaseous burner of this invention is the ability of the tube material to withstand the high temperatures and heat fluxes. Heat transfer to the tube wall by the products of combustion is very effective in the instant invention because the flow is concentrated at the tube wall and the relative velocities between the products and the tube wall are high (on the order of several hundred feet per second). Also because of the spiral path of the flow, the residence time of the gas in the tube is much higher for a given relative velocity than could be obtained with axial flow through the tube. Heat transfer coefficients between the vortex and the tube wall on the order of 100 btuh/ft.^{2}/°F. are indicated. The coefficient for the same level of output in an axial flow mode would be on the order of 10 btuh/ft.^{2}/°F. Furthermore, the burner of this invention has good stability over a wide range of inputs. It has been fired with fuel and oxidizer pressures of from 1 to 30 p.s.i.g. and wider ranges are believed possible. Also, the burner can be used in any application requiring a compact high performance burner which can operate on a gaseous fuel.

It is therefore an object of this invention to provide a dual vortex gaseous fuel burner which releases extremely high heat per unit volume.

It is another object of this invention to provide a dual vortex gaseous fuel burner which exhibits very effective heat transfer to the tube wall.

It is still another object of this invention to provide a dual vortex gaseous fuel burner which has extremely good stability.

It is a further object of this invention to provide a dual vortex gaseous fuel burner which is economical to produce and which utilizes conventional, currently available components that lend themselves to standard mass-producing manufacturing techniques.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

DESCRIPTION OF THE DRAWING

FIG. 1 represents a side elevational view of the dual vortex gaseous fuel burner of this invention partially in cross section and placing specific emphasis on the location of the vortex chambers, with the proportions of the vortex burner elements being enlarged for clarity;

FIG. 2 is a cross-sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 1;

FIG. 4 is a side elevational view of a modified end restriction of this invention shown in cross section;

FIG. 5 is a side elevational view of the oxidizer injector vortex chamber of this invention drawn substantially to scale; and

FIG. 6 is a side elevational view of the fuel injector vortex chamber of this invention drawn substantially to scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference is now made to FIG. 1 of the drawing wherein a side elevational view of the dual vortex gaseous burner or radiator **10** of this invention is shown in cross section. It should be noted that the elements making up the gaseous burner **10** of this invention as shown in FIGS. 1–3 are drawn in an enlarged manner in order to better display their specific relationship with one another.

The gaseous burner **10** of the present invention utilizes a dual injection system **12** made up of a pair of concentric vortex chambers **11** and **13** which are clearly shown in FIGS. **5** and **6**. The vortex chambers **11** and **13** inject a fuel and oxidizer respectively, into a vortex tube **14** made of any suitable material such as inconel, LT-1 or beryllium oxide such that they form concentric vortices which merge together inside the vortex tube **14**. A small tube **16**, called the separator tube, keeps the two vortices separated until well inside the tube **14**.

As shown in FIGS. 1—3 an oxidizer such as air or pure oxygen is injected by any conventional injection system tangentially through a jet or line **18** (see FIG. **5**) and forms the primary vortex **19** which flows in the annulus formed by the vortex tube **14** on the outside and the separator tube **16** formed on the inside. The fuel such as propane, acetylene or hydrogen is injected by any conventional injection system through tangential jet or line **20** (see FIG. **2**) forming a secondary vortex **21** flowing inside the separator tube **16**. At the end of the separator tube the two vortices **19** and **21** merge together gradually.

Still referring to FIG. 1, an igniter **22** is mounted within the vortex chamber **11** and is used to ignite the oxidizer and fuel at the point where they merge. The igniter **22** may be in the form of a flame; however, better results are obtained with an electrical igniter **22** made up of an electrode **24** and a Tesla coil **26**. The igniter electrode **24** is made of any suitable Nichrome wire cemented into an alumina tube with the Tesla coil **36** capable of putting out a 25,000 volt 60-cycle spark.

A conical end restriction **28** is required and mounted at the end of the vortex tube **14**. This end restriction **28** prevents the influx of products of combustion and surrounding air into the negative pressure region at the axis of the tube **14**. FIG. **4** discloses a modified end restriction **30** which is liquid cooled.

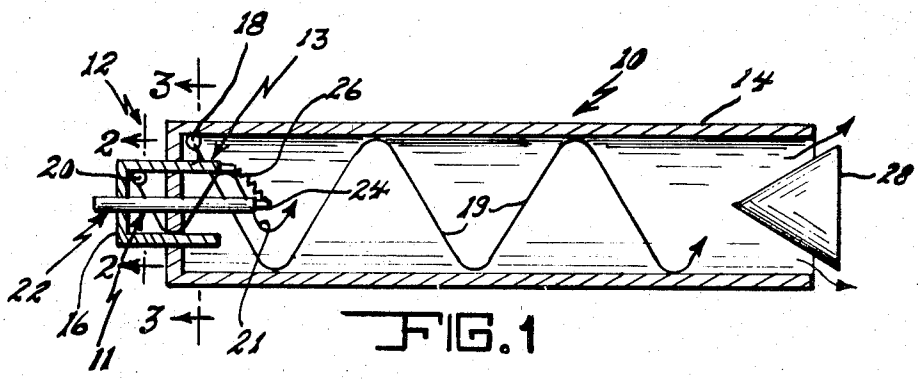


FIG. 1

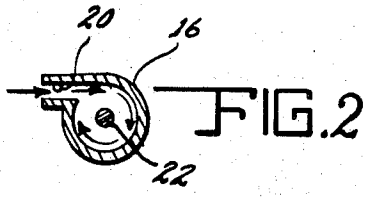


FIG. 2

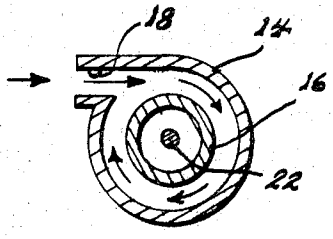


FIG. 3

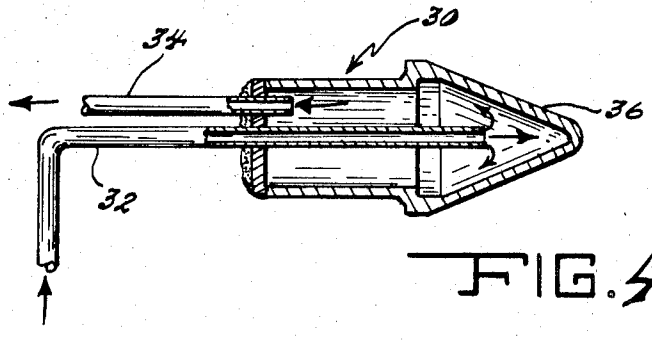


FIG. 4

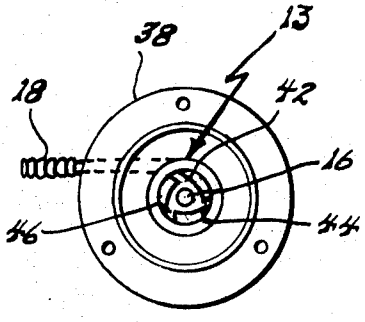


FIG. 5

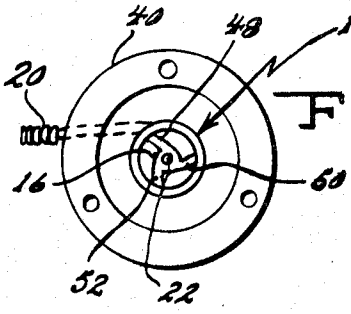


FIG. 6

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