Aug. 9, 1966 J. THURLEY ET AL 3,265,113

GAS BURNER APPARATUS

Filed Sept. 27, 1963 2 Sheets-Sheet 1

Fig. 1

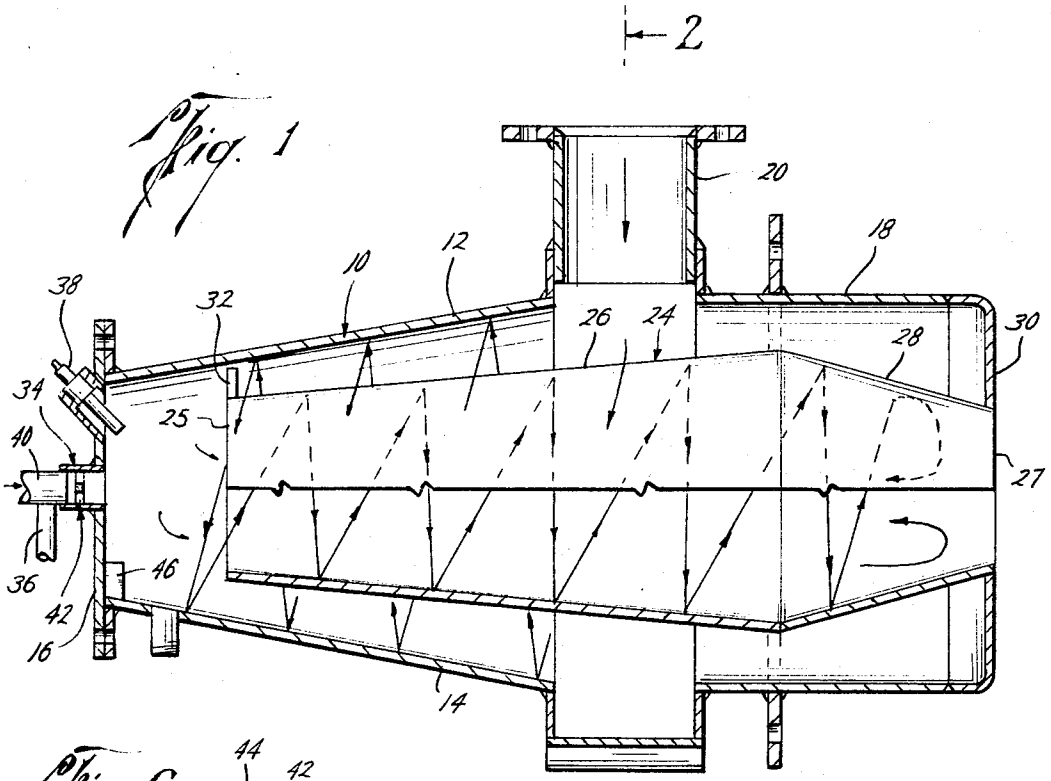


Fig. 6

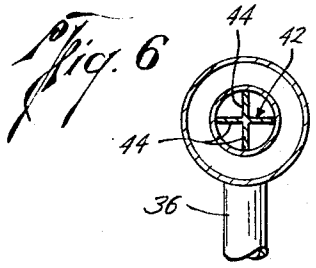
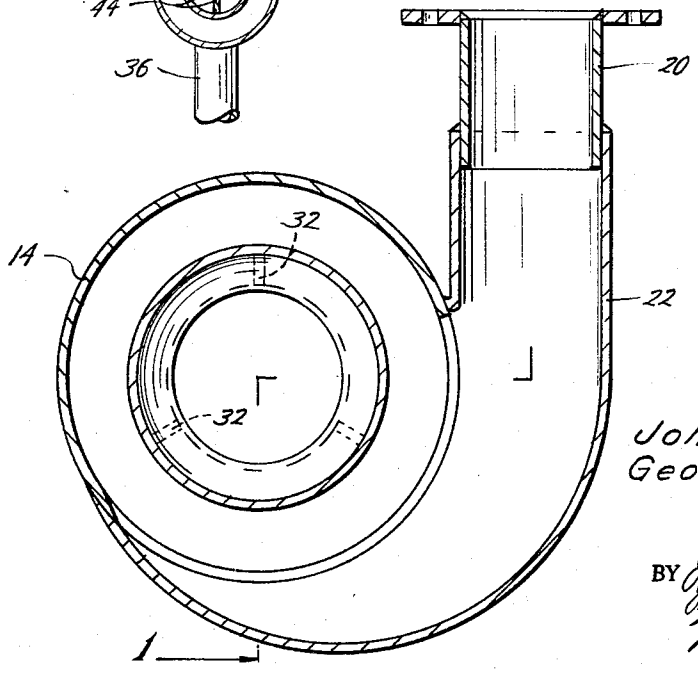


Fig. 2



John Thurley
George P. Lowry
INVENTORS

BY James F. Weiler
Jefferson D. Gilbert
William A. Stout
Paul L. DeVerter II
ATTORNEYS

Aug. 9, 1966 J. THURLEY ET AL 3,265,113

GAS BURNER APPARATUS

Filed Sept. 27, 1963 2 Sheets-Sheet 2

Fig. 3

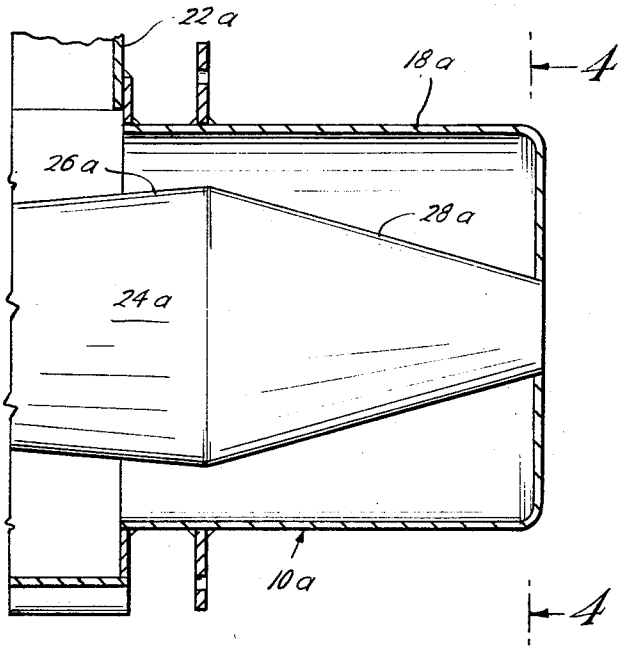


Fig. 4

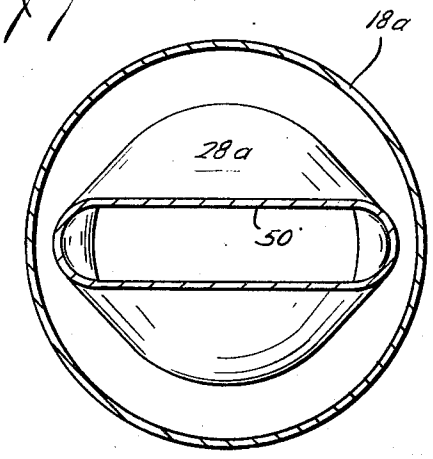
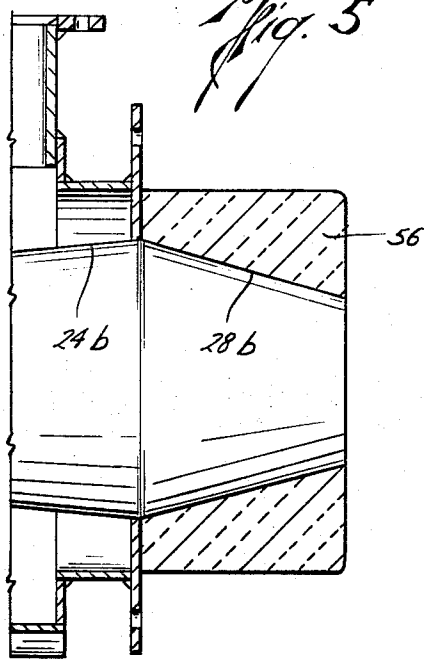


Fig. 5



John Thurley
George P. Lowry
INVENTORS

BY James F. Wiley
Jefferson O. Gilly
William G. Floyd
Paul L. DeVerter II
ATTORNEYS

United States Patent Office 3,265,113 Patented August 9, 1966

3,265,113

GAS BURNER APPARATUS

John Thurley and George P. Lowry, Oklahoma City, Okla., assignors to Black, Sivalls & Bryson, Inc., Oklahoma City, Okla., a corporation of Delaware

Filed Sept. 27, 1963, Ser. No. 312,232
9 Claims. (Cl. 158—109)

The present invention generally relates to an apparatus for mixing fluids, and more particularly, relates to a gas burning apparatus for mixing a fuel with air or oxygen for burning the combustible mixture in a comparatively small space.

In devices prior to the present invention used for the combustion of fuel a substantial amount of refractory material had to be used in order to prevent the burner from being destroyed by heat.

Therefore, a general object of the present invention is to provide a gas burner for the combustion of fuels having a high heat output capability and which requires little or no refractory lining.

A still further object of the present invention is the provision of a gas burner which provides a thorough and intimate mixing of the fuel and air and in addition provides a complete combustion of the fuel within the apparatus.

A still further object of the present invention is the provision of a gas burner apparatus which receives combustion air or oxygen tangentially from a blower and which generates a vortex at the point of fuel injection which in turn creates a low pressure area which allows the use of a low pressure fuel.

Yet a further object is the provision of a gas burner apparatus having a coaxial outer shell and inner liner wherein tangential air enters between the shell and inner liner and in which the rear of the liner is spaced from the rear of the shell by a distance at least one-half of the diameter of the inlet of the inner liner whereby the air inlet generates a vortex cooling the outside of the inner liner and provides a swirling helical vortex on the inside of the liner to cool the liner thereby allowing the use of an all metal burner except in the case of extremely high temperatures in which event a small amount of refractory material may be used at the outlet of the inner liner.

A still further object of the present invention is the provision of a gas burner which provides high heat release rates and provides a volute tangential air inlet for generating a vortex of cooling air inside and outside of an inner liner and in which the inner liner is in a diverging converging shape along the path of flow to provide complete combustion of the fuel.

A still further object of the present invention is the provision of a noise breaker plate in the gas burner adjacent the rear end to avoid the high level noise created by a high rate of air swirl in the burner.

A still further object of the present invention is the provision of a gas burner having an elongate narrow outlet whereby the outlet is shaped to provide a better heat exchange in particular applications.

Yet a further object of the present invention is the provision of a gas burner having a vortex breaker in the fuel inlet line so as to prevent the pilot light flame from being blown out by the vortex of incoming air.

Yet a still further object of the present invention is the provision of a gas burner having a coaxially spaced outer shell and inner liner both of which are frusto-conical converging toward their rear ends with the outer housing converging toward the rear at a greater angle than the angle of convergence of the inner liner.

Other and further objects, features and advantages of the present invention will be apparent from the following description of presently preferred embodiments of the

invention, given for the purpose of disclosure taken in conjunction with the accompanying drawings, where like character references designate like parts throughout the several views, and where,

FIGURE 1 is an elevational view, partly in cross-section, illustrating the preferred embodiment of the present invention,

FIGURE 2 is a cross-sectional view taken along the line 2—2 of FIGURE 1,

FIGURE 3 is a fragmentary elevational view, partly in cross-section, illustrating a modification of the present invention utilizing a narrow elongate burner outlet,

FIGURE 4 is a cross-sectional view taken along the line 4—4 of FIGURE 3,

FIGURE 5 is a fragmentary elevational view, in cross-section, illustrating a still further modification of the present invention utilizing a refractory material adjacent the outlet of the burner for use with extreme temperatures, and

FIGURE 6 illustrates the vortex breaker in the fuel inlet conduit.

Generally, the gas burner of the present invention includes a double walled structure formed by an outer shell and a coaxial inner liner, the front end of the outer shell being closed and the front end of the inner liner forming a combustion outlet. The rear end of the inner liner is located in front of the rear end of the outer shell and spaced therefrom and communicates with the annular space between the inner liner and the outer shell. A tangential combustion air or oxygen inlet is provided in the outer shell so that combustion air enters into the inner space from the tangential inlet and follows a helical path to the rear of the shell and generates a vortex at the point of fuel injection and provides a helical flow of air extending into the interior of the liner.

The shape of the internal liner in conjunction with the angular velocity imparted to the combustion air in following its helical path determines the character of the flame resulting from the combustion. In general, if the liner is convergent toward the combustion outlet, combustion will take place mainly beyond the front end of the liner. If the liner is divergent towards the combustion outlet, combustion will occur mainly within the liner. If the liner is substantially cylindrical, combustion will occur within the liner and beyond the front end thereof. In the present invention the liner includes a first section diverging towards the combustion outlet and a second section connected downstream thereto which is convergent toward the combustion outlet thereby providing a reversal of flow and insuring a thorough mixing and complete combustion of the fuel within the inner liner.

Referring now to the drawings, and particularly to FIGURE 1, the apparatus of the present invention is generally indicated by the reference numeral **10**. The gas burner **10** generally includes an outer shell **12** having a rear section **14** which is frusto-conical in shape and is closed at its rear end by a wall **16**. A front section **18** of the outer shell extends toward the front of the apparatus **10** for purposes which will be more fully discussed hereinafter. Air inlet **20** is provided connected to the outer shell **12** to provide a tangential air inlet into the shell. Preferably the air inlet is in the form of a volute shaped passageway **22** to increase the rotational flow and energy of air or oxygen entering the outer shell **12**.

Positioned interiorally of the outer shell **12** and coaxially therewith is an inner liner **24** which includes a frusto-conical section **26** coverging towards the rear end or inlet of the liner **24**. The liner **24** also includes a section **28** which is connected to the section **26** and converges towards the front of the liner **24** or liner outlet. Thus, it is noted that the liner provides a diverging-converging shape along the path of flow from its inlet **25** to

its outlet 27. The outer shell 12 includes a front wall 30 causing the air entering the inlet 20 to travel in a helical path about the exterior of and cooling the inner liner 24 and entering the rear end 25 of the liner. Suitable supporting straps 32 are provided adjacent the rear of the liner 24 for support purposes. The front end 27 of the liner 24 is connected to the end plate 30 for support.

It is noted that the rear end 25 or inlet to the liner 24 is spaced from the rear wall 16 by a substantial distance. This distance is preferably substantially equal to the diameter of the inlet 25 and must be at least as great as one-half of the diameter of the inlet 25 of the liner 24 in order that the vortex or rotational flow of air created in the outer shell may flow into the inside of and adjacent the inner liner 24 without being destroyed so as to provide a flow of air along the interior walls of the inner liner 24 for cooling purposes. This allows the burner 10 to be made entirely of metal and requires no refractory material to protect the inner liner 24 at normal burning temperatures. It is particularly noted that the outer housing 12 extends the entire length of the inner liner 24 and provides an annulus of air space in which air rotates during the burning process to cool the inner liner 24 to allow the use of an all metal type of burner.

Connected to the central portion of the end wall 16 is a burner apparatus 34 which comprises a pilot gas line 36, ignition means such as a spark plug 38 and a main gas line 40. Thus, fuel may be inserted into the burner, mixed with the incoming air and ignited to create a primary combustion zone directed into the inlet 25 of the inner liner 24. The vortex generated by the incoming air between the outer shell 12 and inner lining 24 generates a vortex at the point of fuel injection and creates a low pressure area which allows the use of a low pressure fuel, for example, six inches water column and creates rapid mixing of the fuel and air in the ignition zone. A combustion unit wherein the fuel is introduced into the low pressure vortex operates with stability over a wide range of heat output values and over a wide range of fuel-air mixture ratios.

As indicated by the flow arrows in FIGURE 1, the combustion air or oxygen flows in a helical path about the interior of the liner 24 thereby cooling the liner 24 and because of the diverging-converging shape of the liner 24 the helical flowing air creates a vortex and the combustion process flows towards the outlet 27 and is directed back or reversed into the center of the liner 24 to provide complete combustion of the fuel products and insures that combustion is completed within the liner 24. The diverging-converging shape of the inner liner provides a reverse, that is, rearward flow of combustion air and combustion products in the axial region of the front part of the liner thereby minimizing escape of unburnt fuel from the outlet 27.

As best seen in FIGURES 1 and 6, a vortex breaker 42 is provided adjacent the fuel inlet to prevent the high cyclonic velocities from blowing out the pilot flame. The vortex breaker 42 comprises a series of radially extending plates 44 positioned in the inlet fuel line 40.

In addition, since the high rate of air swirl will in some instances create an undesirable noise level in the burner 10, one or more noise plates 46 may be provided which are positioned in a radial plane of the outer shell 12 and adjacent to the rear wall 16. While the noise breaker plate tends to disturb the vortex to a small extent, they will in the case of high air velocities and noise level, reduce the noise.

In general, the greater the annular velocity imparted to the incoming combustion air during its travel towards the rear of the outer shell 12 and into the interior of the inner liner 24, the greater will be the cooling effect of such air upon the liner and the greater will be the mixing of such air with the incoming fuel. Preferably, the outer shell 12 and inner liner 24 are shaped so that the cross-sectional area of the annular space between the sections 14 and 26 decreases from a maximum area in the region of the tangential inlet and volute 22 to a minimum area at the rear end or the inlet 25 of the liner whereby the conversion of pressure energy in the combustion air to rotational kinetic energy is encouraged.

Of course, various modifications of the apparatus 10 may be provided and FIGURES 3, 4 and 5 illustrate modification of the structure according to the invention, the letters "*a*" and "*b*" being applied to the parts corresponding to those in FIGURES 1–2 and 6 for convenience of reference.

Referring now to FIGURES 3 and 4, the form of the invention is the same as that shown in FIGURES 1 and 2 with the exception that the shape of the outlet of the inner liner 24*a* is in the form of an elongate narrow outlet 50. This particular shape is desirable, instead of the circular outlet shape 27 of FIGURE 1, in providing a better heat exchange between the burner and the same devices being heated such as elongated pipes.

Referring now to FIGURE 5, the burner 10 being illustrated is substantially the same as that shown in FIGURE 1 except that a molded refractory 56 is provided about the converging section 28*b* of liner 24*b* and which may be utilized in the case of burners having extremely high temperatures.

In use, the air inlet 20 receives combustion air or oxygen tangentially from a blower (not shown) under pressure for example 20 inch water column, and the air enters the volute 22 thereby increasing the rotational energy and forming a helical path about the liner 24 towards the rear of the apparatus 10. It is noted that an air space completely surrounds the exterior of the liner 24 thereby aiding in cooling the inner liner. The helical flow of inlet air, as indicated by the arrows in FIGURE 1, creates a low pressure area at the fuel injection point which allows the use of a low pressure fuel and creates a rapid mixing of fuel and air in the ignition zone and into the interior of the lining 24. In addition, it is noted that because of the spacing of the inlet 25 of the liner 24 from the rear wall 16 that an excess air flow is created along the interior wall of the liner 24 to insure sufficient cooling of the liner and thereby provide a structure which may be composed entirely of metal. The flow of the vortex air and fuel-air mixture is directed into the liner 24 and towards the outlet 27 where due to the presence of the convergent portion 28 of the liner a further reversal of flow occurs directed rearwardly along the axis of the liner 24 thereby providing complete and thorough combustion of the fuel products.

The burner has excellent turn down stability. For example, in a typical burner, combustion may be sustained at substantially stoichiometric mixtures to produce a heat output of 10 million B.t.u. per hour, but also may be operated on a gaseous fuel with stability at low heat outputs down to 10,000 B.t.u. per hour. In addition, because of the diverging-converging shape of the liner 24 all combustion occurs prior to exhaustion from the burner and prior to contact with low temperature areas thereby preventing flame chilling.

The use of the volute 22 and the decrease in the cross-sectional area of the annular space between the sections 14 of the outer shell and section 26 of the inner liner 24 provides a conversion of pressure energy in the combustion air to rotational kinetic energy.

In addition, in the event of the high rotational velocities causing excess noise, noise plate 46 may be provided. The vortex breaker 42 may be provided in the fuel inlet to prevent the pilot light from being blown out by the air swirl.

If desired for particular applications, the narrow elongate outlet 50 as shown in FIGURES 3 and 4 may be utilized and in the event of extremely high temperatures a suitable refractory material 56 may be provided around the converging section 28*b* of the inner liner as shown in FIGURE 5.

The present invention, therefore, is well suited and adapted to attain the ends and objects mentioned herein as well as others inherent therein. While presently preferred embodiments of the invention are given for the purpose of disclosure, numerous changes in the details of construction and arrangement of parts may be made which are within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A gas burner apparatus comprising:
an outer shell having a front end and a rear end, said outer shell being frusto-conical converging toward said rear end,
an inner metal liner having a front end and a rear end, said inner liner being of a smaller diameter than said shell and including a frusto-conical section converging toward said liner rear end and including a frusto-conical section converging toward said liner front end,
said inner liner and said outer shell being coaxial, and spaced to form an air passage between said shell and said liner,
end walls at the front and rear ends of the outer shell closing said shell,
a tangential air inlet in the outer shell and spaced from the rear end thereof for admitting air for cooling said inner liner,
said liner rear being spaced a distance of at least one-half the diameter of the rear of the liner from the rear end of the outer shell whereby a portion of the air from the space between the outer shell and the liner will flow about the inside well of the liner in a helical path to cool the inside of the liner, and
means adjacent the rear of the shell for injecting fuel into said inner liner whereby fuel and air is mixed and burned in the interior of the liner.

2. The invention of claim 1 wherein the means for injecting fuel includes,
a fuel inlet tube extending through the end wall at the rear end of the shell,
a pilot burner in said tube, and
radial fins in said tube between said pilot burner and the end of the tube whereby the fins shield the pilot flame from the helical air currents adjacent said inner rear end.

3. The invention of claim 1 wherein the front end of said liner is an elongate narrow opening.

4. The invention of claim 1 including:
a plate positioned in a radially extending plane adjacent to the end wall at the rear end of the shell.

5. The invention of claim 1 wherein the tangential air inlet includes a volute shaped inlet.

6. The invention of claim 1 wherein the rear of the liner is spaced a distance substantially equal to the diameter of the rear of the liner from the rear end of the outer shell.

7. The invention of claim 1 including:
refractory insulation positioned about the section of the inner liner which converges toward said liner front end.

8. The invention of claim 1 wherein the outer shell converges toward the rear end at a greater angle than the angle of convergence of the second of said liner which converges toward the rear end.

9. The invention of claim 1 wherein the inner liner and said outer shell have their respective front ends terminating substantially in the same transverse plane.

References Cited by the Examiner

UNITED STATES PATENTS

1,791,561	2/1931	Heyn et al.	159—108 X
1,812,080	6/1931	Chapman	122—23.5
2,117,356	5/1938	Perry	158—99 X
2,242,424	5/1941	Fisher	261—79.1
2,539,165	1/1951	Saha.	
2,561,200	7/1951	Hess	158—116
2,734,560	2/1956	Harris et al.	158—1.5 X

FOREIGN PATENTS

841,876	2/1939	France.
1,225,708	2/1960	France.
476,721	5/1929	Germany.
499,657	6/1930	Germany.
822,776	10/1959	Great Britain.

FREDERICK L. MATTESON, JR., *Primary Examiner.*

JAMES W. WESTHAVER, *Examiner.*

H. B. RAMEY, *Assistant Examiner.*