United States Patent [19]

Zink et al.

[11] **3,749,548**

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[54] **HIGH INTENSITY BURNER**

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[21] Appl. No.: **157,121**

[52] **U.S. Cl.** **431/158,** 431/115, 431/183

[51] **Int. Cl.** **F23r 1/02**

[58] **Field of Search** 431/158, 353, 183, 431/115, 116, 9

[56] **References Cited**

UNITED STATES PATENTS

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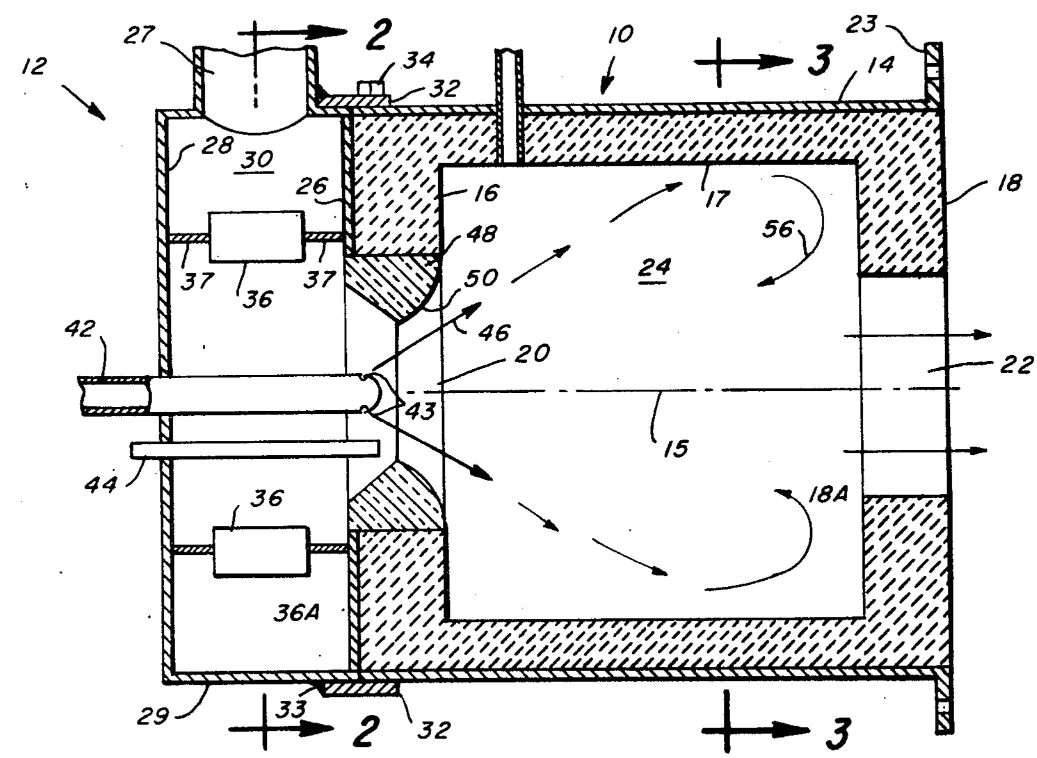
[57] **ABSTRACT**

A combustion chamber is provided in the form of a cylindrical chamber with a circular inlet opening in a first end wall and a circular outlet opening in the second end wall. Air enters under pressure into a circular plenum with a plurality of angular vanes or nozzles adapted to give the air flow a tangential motion, forming a helical vortex of flow into the chamber. Fluid fuel is sprayed into the chamber in the form of a wide-angle conical surface, where it is mixed with the air and burned. The helical flow combined with the restriction of the second end wall of the outlet provides long residence time and complete combustion of the fuel-air mixture.

5 Claims, 6 Drawing Figures



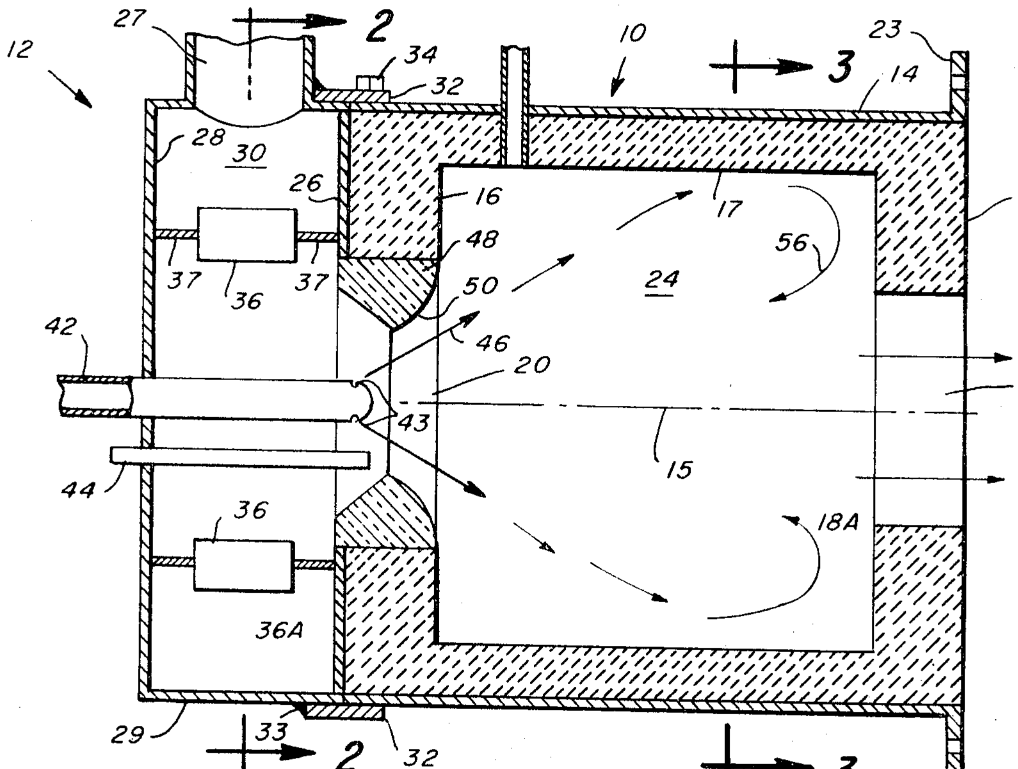


FIG. 1

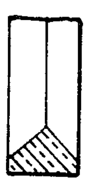


FIG. 4

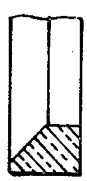


FIG. 5

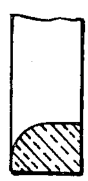


FIG. 6

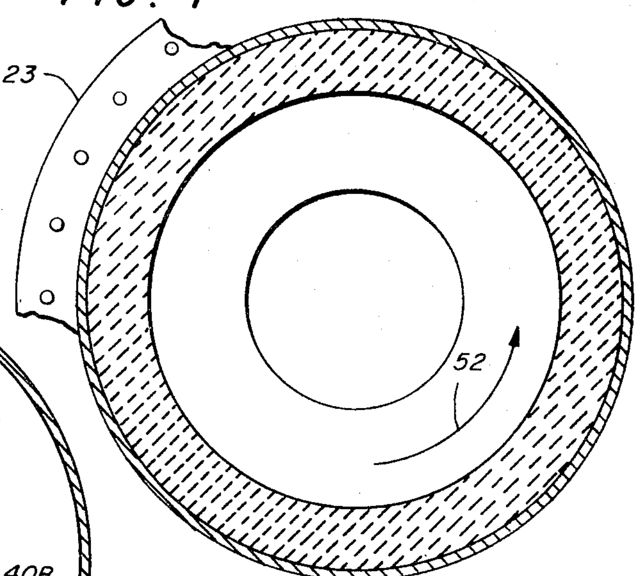


FIG. 3

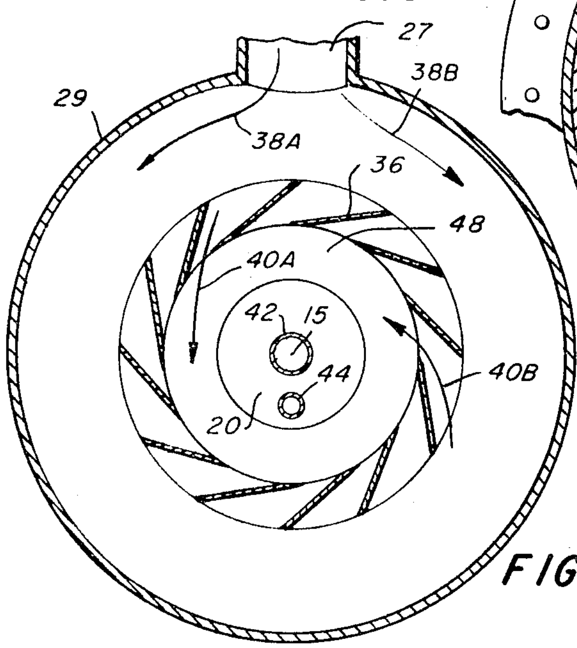


FIG. 2

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HIGH INTENSITY BURNER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is in the field of fluid fuel combustion chambers, and particularly those in which the air and fuel are intimately mixed so as to form substantially "flameless" combustion at the exit of the chamber. More particularly this invention is concerned with a combustion chamber designed to provide long residence time of the fuel-air mixture so that there will be complete combustion with a minimum of excess air, and a minimum production of polluting products of combustion.

2. Description of the Prior Art

In the burning of fluid fuels, the problem is to provide sufficient oxygen for complete combustion of the carbon and hydrogen in the fuel to carbon dioxide and water, without either insufficient, or excess air, which might deliver undesirable pollutants into the atmosphere. To get this type of burning, the factors of flame temperature and residence time are of primary importance. The longer the residence time provided, the lower the temperature required, and vice versa. Increasing the temperature or the residence time both increase cost. Others in the art, such as U.S. Pat. No. 3,476,494 have taught increased residence time within a combustion chamber by providing an angular fillet at the inlet, the included angle of which approximates that of the fuel spray angle. Such structures as taught do not provide sufficient residence for complete combustion especially the destruction of exotic fuels such as carbon tetrachloride.

SUMMARY OF THE INVENTION

In this invention pressure-velocity flow of fuel and air is controlled in such a way as to provide long residence time. This is accomplished in two ways; (a) the air or other combustion supporting gas travels a helical path inside the combustion chamber, and (b) the presence of the end wall at the outlet end of the combustion chamber serves to cause recirculation of the air toward the inlet end, before it is finally discharged through the outlet opening. The longer path of flow of the air-fuel mixture provides longer residence time, while the recirculation provides better mixing of the air and fuel. Together, these improvements provide more complete combustion with less excess air than is the case with prior art combustion chambers.

It is therefore an important object of this invention to provide a combustion chamber with optimum mixing of fluid fuel and air and long residence time of the fuel-air mixture, to the end that complete combustion will be effected with a minimum of excess air.

These and other objects and advantages of the invention will become apparent and the invention will be more fully understood from the following description taken in conjunction with the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a side elevation in section of one embodiment of the invention.

FIG. 2 shows a sectional view along the line 2—2 of FIG. 1.

FIG. 3 shows a sectional view along the line 3—3 of FIG. 1.

FIGS. 4, 5, 6 illustrate alternate configurations of ceramic tile for the combustion chamber inlet opening.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 is shown a vertical cross-section through the combustion chamber, generally indicated by the numeral 10. The incoming combustion air plenum is generally indicated by the numeral 12.

The combustion chamber comprises a cylindrical shell 14 with axis 15. The shell is composed of or lined on its interior wall 17 with high temperature refractory or ceramic material, as is well known in the art. The chamber 10 has two end walls 16 and 18, also lined. There is an inlet opening 20 through which the air and fuel enter the chamber, and an outlet opening 22, through which the hot products of combustion leave the chamber. A flange 23 is provided for fastening the combustion chamber 10 to a boiler or other structure where the combustion products can be utilized. A preferred value of diameter of the outlet opening 22 is approximately one-half the diameter of the inner surface 17 of the chamber although this is not limiting.

The air inlet plenum 12 is an axially short cylinder of substantially the same diameter as the shell 14, and fastened to the shell, such as by welding or flange 32 and bolts 34. The plenum comprises an inner wall 26 with a central opening to match that of wall 16, and an outer wall 28. A plurality of vanes 36 are supported between the walls 26, 28 by means such as cylinders 37. These vanes typically are shorter than the length of the plenum and are arranged in a circle about axis 15, and are tilted so as to impart a tangential motion to the air. A fuel conduit 42 is placed on the axis 15, and has a circle of orifices 43 arranged so as to spray out fuel along a conical surface in space, as indicated by arrows 46. Either liquid or gaseous fuels may be used. An ignition means or pilot light 44 may be provided.

The central opening 20 in wall 16 has an annular ceramic tile 48, adapted to fit the opening. This has an outwardly expanding surface 50 to guide the air flow into an expanding helical vortex.

OPERATION OF THE PREFERRED EMBODIMENT

Air entering the plenum 12 is under a selected pressure from pump or blower means, not shown. It flows through inlet 27 in accordance with arrows 38A, 38B circumferentially around the circle of vanes 36. The air flows between the vanes in accordance with arrows 40A, 40B, creating a circumferential flow which, as it moves axially through opening 20, expands into a helix 52. The length of path of the air flow in the helix is, of course, much greater than the axial length of the chamber, and thus the residence time of the fuel-air mixture will be greater than if the flow were axial.

Since the vanes are shorter than the length of the plenum chamber, there will be a substantially uniform pressure around the periphery of the chamber, and the tangential flow of air between the vanes 40A, 40B, will be uniform around the axis 15, thus providing a balanced value of air to fuel ratio.

The presence of the surface 18A of the wall 18 causes a re-entrant or recirculation flow 56 and a recirculation of the burning fuel-air mixture before it finally flows out of the opening 22. This recirculation causes a longer residence time, as well as added mixing of the fuel and air. This balanced value of fuel-air mixture, combined with the mixing in the helical vortex, the recirculation flow, and the long residence time, provide all the conditions for efficient and complete burning which makes possible the use of a minimum of excess air, and thus a minimum of pollutants in the effluent gases. Also the long residence time permits the burning of refractory fuels and the oxidation of difficult-to-react materials.

In the design the entry **20** diameter is always the least. The outlet **22** is predicated on tolerable pressure loss for discharge of the desired volume, but is always less than the diameter of the inner wall **17** to form the recirculation baffle. In determining the inner wall diameter the particular fuels to be processed must be considered relative to the required volume demanded for residence time. A minimal time of about 0.5 seconds is typical.

While the vanes **36** are shown as extending only part way across the length of the plenum, they can, of course, be extended from wall to wall, as shown in dashed line **36A**.

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. For example, other inlet tile **48** details such as shown in the partial sectional views of FIGS. **4, 5** and **6** may be utilized.

The outlet **22**, although preferably coaxial with the inlet, can be offset or non-coaxial to the inlet. Further, outlet **22** may be circular or non-circular.

What is claimed:

1. A combustion chamber for use with fluid fuels and adapted for complete combustion with a minimum of excess air, comprising:

a. a refractory-lined cylindrical chamber having an axis, and having refractory-lined end walls, substantially plane and perpendicular to said axis, a first single clear circular opening in a first end wall for the entry of fuel and combustion air, a second opening in the second wall for the outflow of hot products of combustion;

b. an inlet air plenum coaxial with and contiguous with said first opening, a plurality of vanes, uniformly spaced in a circle concentric with said axis, said vanes angled so as to impart a tangential motion to the incoming air, all of said incoming air adapted to flow through said vanes and through said first opening into said chamber in the form of a helical vortex;

c. fluid fuel supply means including a supply conduit along said axis and an orifice assembly including a plurality of orifices directed so as to spray fuel in the form of a conical surface concentric with said axis, into said chamber; and

d. means to ignite the air-fuel mixture entering said chamber;

whereby a helical vortex of air and burning fuel will swirl into the combustion chamber transversing a helical path of length greater than the length of said chamber, and providing a residence time great enough to permit complete combustion of said fuel with a minimum of excess air.

2. The combustion chamber as in claim **1** including a refractory, annular ring lining for said first opening, the internal surface of said ring having an outwardly expanding conical surface toward said chamber.

3. The combustion chamber as in claim **1** in which the diameter of the opening in said second wall is substantially equal to one-half the diameter of said chamber.

4. The combustion chamber as in claim **1** in which said fluid fuel is a gas.

5. The combustion chamber as in claim **1** in which said fluid fuel is a liquid.

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