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Kawaguchi

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[54] **COMBUSTION APPARATUS FOR GAS TURBINE**

[75] Inventor: **Katsuyuki Kawaguchi**, Akashi, Japan

[73] Assignee: **Westinghouse Electric Corporation**, Pittsburgh, Pa.

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **60/39.74 R**; 239/400; 239/402; 239/406

[51] **Int. Cl.** **B05b 7/10**; F02c 3/00

[58] **Field of Search** ..... 60/39.74 R, 39.74 B; 239/400, 403–406, 424.5

[56] **References Cited**

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Primary Examiner—C. J. Husar
Assistant Examiner—Robert E. Garrett
Attorney, Agent, or Firm—G. H. Telfer

[57] **ABSTRACT**

A gas turbine having a combustion chamber with a fuel nozzle is encompassed by a plurality of annular plenum chambers which are supplied with a pressurized fluid. The fluid is directed obliquely through ports toward a fuel stream being sprayed into the combustion chamber. The angle at which the fluid is directed aids in the formation of a vortex. The fluid also adds to the turbulence within the fuel vortex to reduce the carbon pollutant outflow.

4 Claims, 3 Drawing Figures

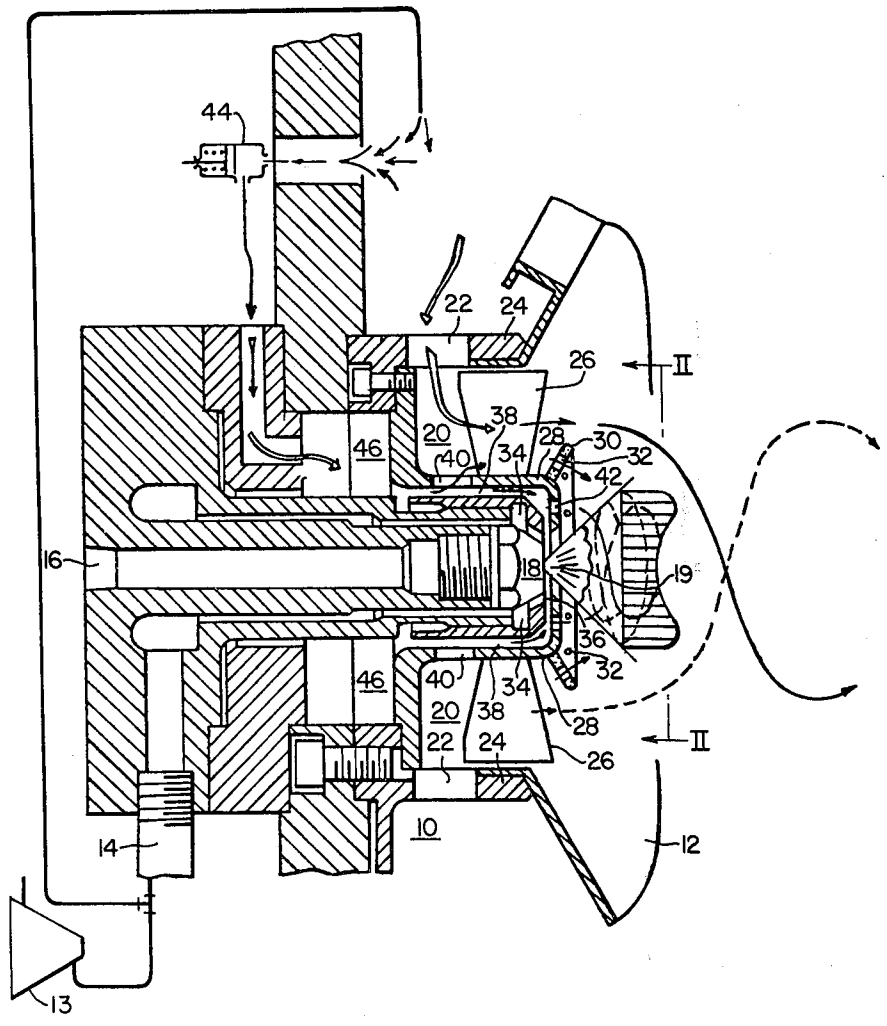

FIG. 2.

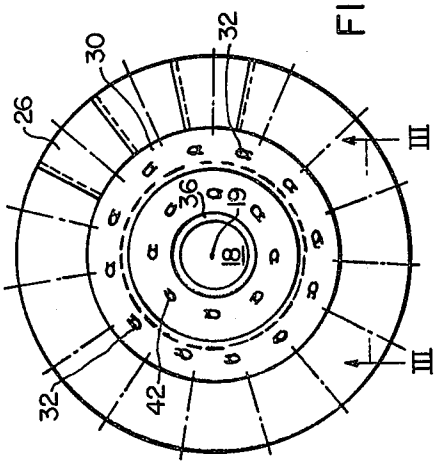

FIG. 1.

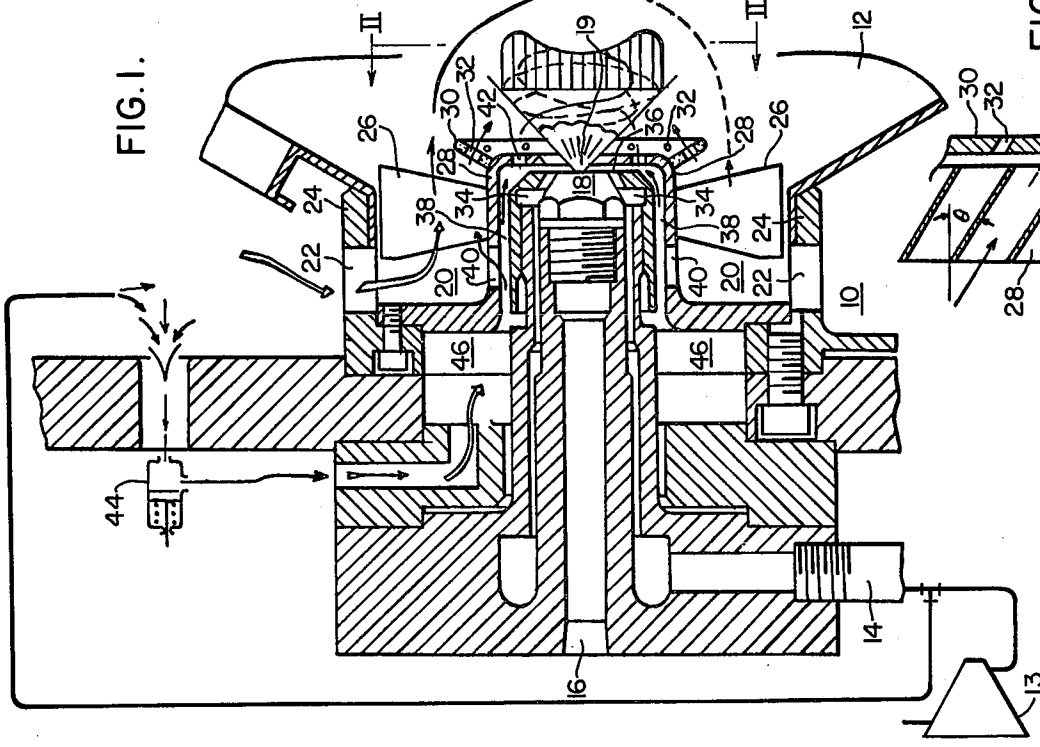

FIG. 3.

COMBUSTION APPARATUS FOR GAS TURBINE

CROSS REFERENCES TO RELATED APPLICATIONS

This invention is based on an application filed by the same inventor in Japan. The Japanese application number and its filing date is as follows:

111619/72 filed Nov. 9, 1972.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

This invention relates to combustion apparatus for a gas turbine, and more particularly to means for mixing fluid streams with the fuel to atomize, disperse or convolute the fuel to provide complete combustion thereof.

2. Prior Art:

Early arrangements of baffling and mixing of atomizing fluids and fuels have generally been concerned with increasing the thermal combustion efficiency and optimizing the temperature distribution of the products of combustion to eliminate hot spots and prevent burnout of the components in the flow path of the products of the combustion. However, with the increased interest in ecology, interest has been generated in providing a thorough mixing of the fuel and an abatement of the production of smoke and obnoxious nitrogen-oxygen compounds produced by the combustion of fuel in the gas turbine. An earlier application filed in the name of this inventor showing some prior art is U.S. Pat. No. 3,768,250.

SUMMARY OF THE INVENTION

In general, a combustion apparatus for a gas turbine, when made in accordance with this invention, comprises a fuel supply conduit having a pore in fluid communication with a combustion chamber to direct the flow of fuel to the combustion chamber, an atomizing fluid chamber having an opening disposed to direct atomizing fluid to converge with the fluid flowing into the combustion chamber, an annular chamber disposed to encircle the fuel supply conduit having one end thereof in communication with the combustion chamber, the other end being in communication with the compressor portion of the gas turbine, the annular chamber having a plurality of angularly directed vanes so disposed therein to cause air flowing therethrough to follow a vortecular path as it leaves the exit end of the annular chamber and enters the combustion chamber, and generally radially inwardly disposed and generally radially outwardly disposed angularly directed annular array of ports, through which air is passed, which aid the vortecular motion and inner turbulence of the fuel-air mixture in the combustion chamber. Each of the annular arrays of ports and the vanes direct their respective air flows generally parallel to one another, while also contributing to the generally overall convolute flow pattern.

BRIEF DESCRIPTION OF THE DRAWING

The objects and advantages of the invention will become more apparent from reading the following detailed description in connection with the accompanying drawings, in which:

FIG. **1** is a vertical sectional view of a combustion apparatus for a gas turbine made in accordance with this invention.

FIG. **2** is a view taken along lines II—II of FIG. **1**; and,

FIG. **3** is a view taken along lines III—III of FIG. **2**.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, and more particularly to FIG. **1**, wherein there is shown a combustion apparatus **10** for a gas turbine, not shown, having a combustion chamber **12**, a compressor **13**, to supply pressurized air for combustion, and a supply conduit **14** to supply atomizing fluid to atomize the fuel.

A fuel supply conduit **16** delivers fuel to a fuel supply nozzle **18** which has at least one pore or opening **19** from which fuel is sprayed into the combustion chamber **12**. An outer plenum chamber **20** encircles the combustion apparatus **10** and it is in communication with an air source through a plurality of ports **22** disposed in a cylindrical outer wall **24** of the plenum chamber **20**. A plurality of angularly directed vanes **26** are fastened to and extend generally radially outward from an inner cylindrical wall **28** of the plenum chamber **20**. The angularly directed vanes **26** are adapted to cause the air flowing through the plenum chamber **20** to follow a convolute path, directed at an angle of 30° to 35° to axis of the combustion chamber **12**, as it enters that combustion chamber. A frustoconical baffle **30** has its small diameter end fastened to the inner wall **28** of the plenum chamber **20** and has a plurality of annularly disposed ports of jets **32** angularly directed to 30° to 35° from the axis of the combustion chamber **12**. The vanes **26** and the ports **32** both direct their respective air flows generally parallel to one another. Each air flow adds to and combines with the vortecular motion of the atomizing fuel spray. The jets **32** may also direct their air flows normal to the fuel-air vortex to increase the turbulence and fuel-air mixing therein.

An inner plenum chamber **34** is provided adjacent the fuel nozzle **18** and is supplied with atomizing fluid through the atomizing conduit **14**. The atomizing fluid flows through an annular opening **36** adjacent the tip of the nozzle **18** and is directed at an angle toward the fuel converging with the fuel flowing into the combustion chamber.

An intermediate plenum chamber **38** is formed between the inner and outer annular chambers, **34** and **20**, respectively, and a plurality of ports **40** are disposed in the inner wall **28** of the outer plenum chamber **20**. The intermediate annular plenum chamber **38** is in fluid communication with the combustion chamber **12** by a plurality of angularly disposed ports or jets **42**, which may be directed at a angle of 30° to 45° with respect to the axis of the combustion chamber, the air flow therethrough being generally parallel to that vortecular air flow pattern caused by the vanes **26** and the outer array of ports **32**.

The array of vanes **26** and the angular arrays of inner and outer ports, **42**, and **32**, are shown in FIG. **2**.

The angularity of the vanes **26** and the outer ports **32** are shown in FIG. **3**. The object of this invention is to provide a combustion apparatus in which the carbon that is produced in an initial combustion zone is decreased by supplying vortex air in three steps so as widen the angle of the fuel injection cone, thereby making the fuel particle size smaller, effectively improving the ignitability of the fuel and finally shortening the length of the flame. The atomization of the fuel

is increased by the application of a swirl flow having the same vortex direction as that of the fuel injection cone. Additionally, the jetted air penetrates the fuel injection cone to provide internal turbulence and mixing thereof. As the combustion pressure increases during combustion operation, a pressure balance piston **44** admits additional air from the combustion air source, which may be a compressor, as shown in FIG. **1**, the air being passed through an annular chamber **46** disposed about the fuel supply conduit, to mix with the air in the intermediate annular chamber **38** prior to injection into the combustion chamber **12.** The air from the outer annular array of ports **32** passes into the fuel injection cone without contracting the injection cone because the air flow has its own vortecular components, and the conical angle of the vortex is increased by the air flow from the inner annular array of ports **42.** The mixing of fresh air with the circulating combustible fuel gas flow can be achieved quickly, and the combustion load factor can be increased to the state in which a stable combustion zone and fuel air ratio is effectively and highly maintained. Thus the mixture of air and fuel is sufficiently promoted and the carbon output due to incomplete combustion is reduced.

I claim:

1. A combustion apparatus for a gas turbine having a combustion chamber, a fuel supply, a compressor to supply a pressurized air for combustion, a supply of pressurized atomizing fluid to atomize the fuel, said combustion apparatus comprising:

a fuel supply nozzle having at least one port in communication with said combustion chamber and disposed to direct the flow of fuel to said combustion chamber;

an atomizing fluid chamber having walls which define at least one duct disposed to direct atomizing fluid into said combustion chamber so that it converges with fuel flowing thereto;

a plenum chamber comprised of walls disposed about said atomizing fluid chamber;

a first array of angularly arranged ports disposed through said wall of said plenum chamber and disposed about said fuel nozzle, said first array of angularly arranged ports providing jets of air to promote vortecular motion to the fuel in said combustion chamber;

a frustoconical baffle having its small diameter edge attached to said walls of said plenum chamber, said baffle being annularly disposed about said nozzle;

a second array of angularly arranged ports disposed through said baffle about said fuel nozzle, said second array of angularly arranged ports providing jets of air to promote mixing and increase vortecular motion of the combustion components;

an arcuate chamber disposed radially outwardly of said plenum chamber, said arcuate chamber having walls with inlet ports therethrough, said arcuate chamber being in communication with said compressor and said combustion chamber, and a generally radially extending array of vanes disposed across said arcuate chamber for causing the air passing therethrough to have a vortecular motion as it enters the combustion chamber;

said first and second arrays of ports and said array of vanes each directing generally the same angle to the fluid passing thereby, with respect to the axis of the combustion chamber;

said array of vanes and said first and second arrays of ports being arranged as to cause the air and fuel to follow a vortecular motion, and to increase the turbulence therein, thereby reducing the smoke generated therewith.

2. A combustion apparatus as recited in claim **1**, wherein said first array of ports have an angle betwee 30° to 45° with the axis of the combustion chamber, said second array of ports having an angle of 30° to 35° with the axis of the combustion chamber, and said array of vanes having an angle of between 30° to 35° with the axis of the combustion chamber.

3. A combustion apparatus as recited in claim **1**, wherein said first array of ports is disposed in an angular array about the downstream end of the fuel nozzle, and said second array of ports are disposed radially outwardly of the said first array of ports.

4. A combustion apparatus as recited in claim **1**, wherein said second array of ports is directed generally normal to the fuel vortex, the air passing through said second array of ports promoting turbulence and mixing of the fuel and air within the center of said vortex, thereby reducing carbon and smoke production from the combustion chamber.

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