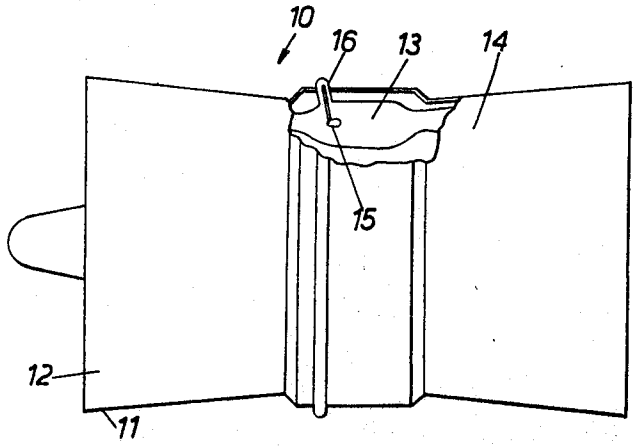
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BURNER, E.G., FOR A GAS TURBINE ENGINE COMBUSTION CHAMBER

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FIG.1



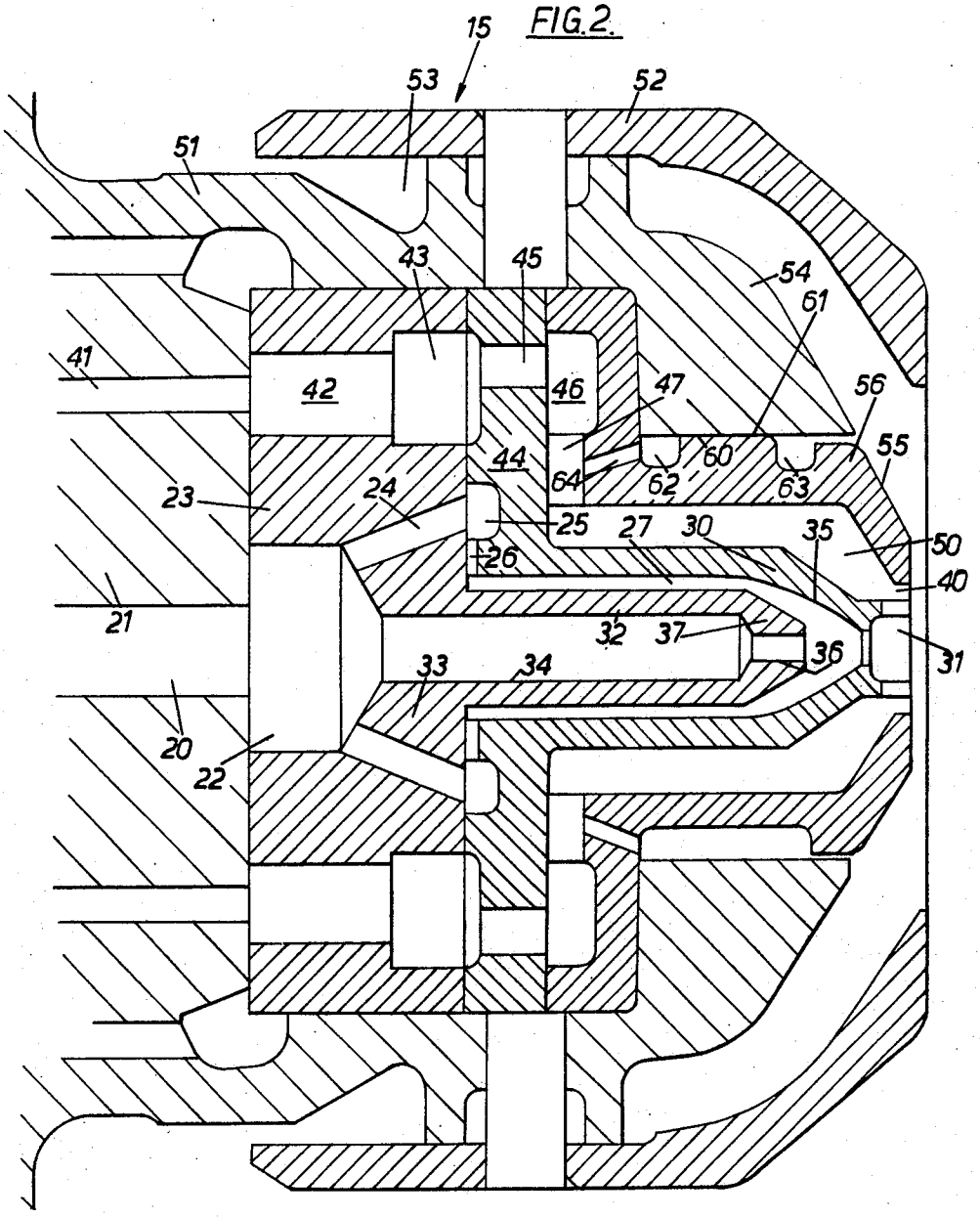
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FIG.2.



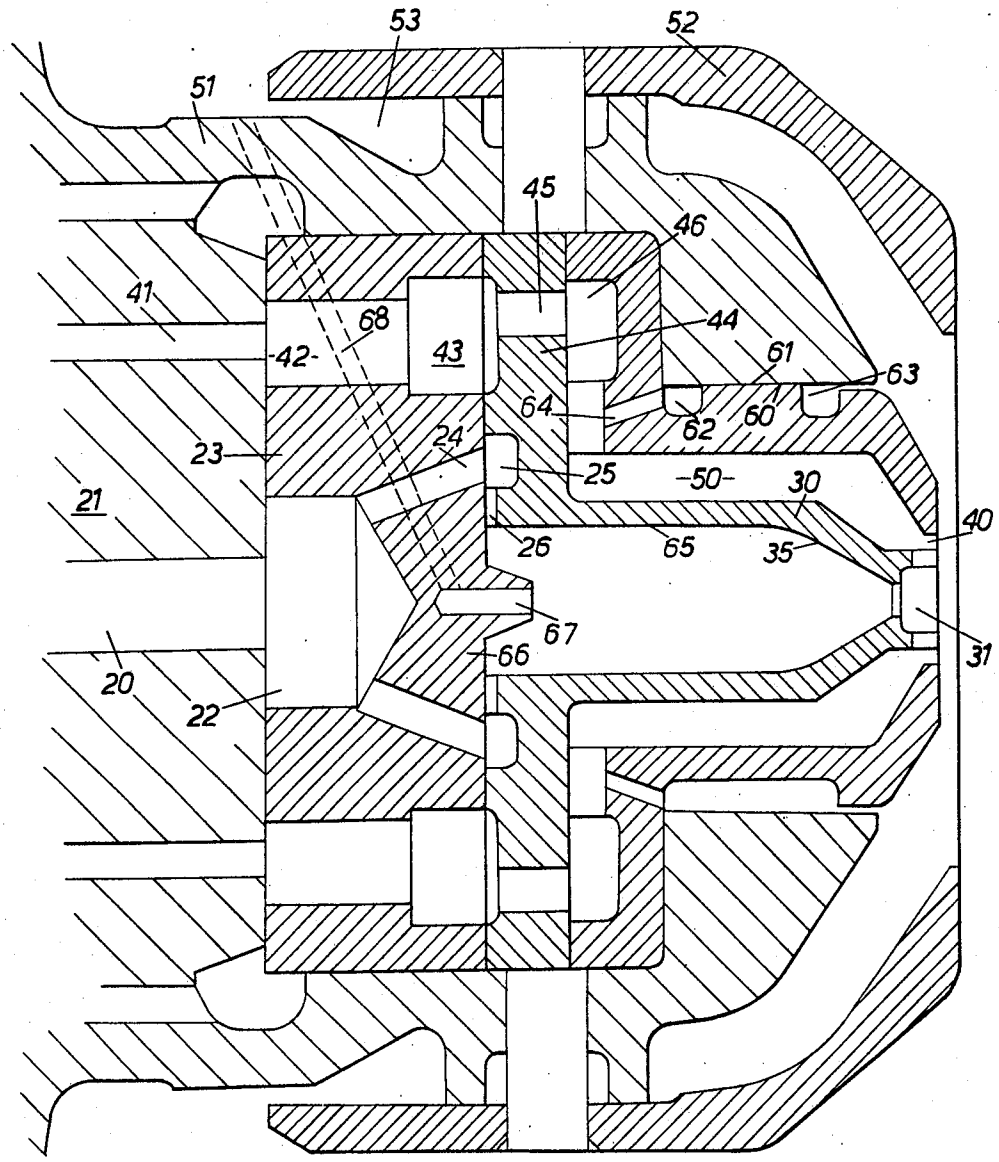
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FIG.3



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3,498,059

BURNER, E.G., FOR A GAS TURBINE ENGINE COMBUSTION CHAMBER

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U.S. Cl. 60—39.74 7 Claims

ABSTRACT OF THE DISCLOSURE

A burner has a jet orifice, a first conduit for supplying the jet orifice with an annular vortex flow of fuel, and a second conduit for supplying air liquid fuel to a hollow central region of the annular vortex to reduce the passage of combustion gases upstream through the jet orifice.

This invention concerns a burner e.g. for a gas turbine engine combustion chamber.

According to the present invention, there is provided a burner having a jet orifice, first conduit means for supplying the jet orifice with an annular vortex flow of fuel, and second conduit means for supplying a fluid to a hollow central region of the said annular vortex flow to reduce or prevent the passage of combustion gases upstream through the jet orifice.

Such combustion gases are liable to entrain carbon particles therewith, and the invention thus reduces the risk of the burner becoming carboned up.

Thus the second conduit means may communicate, at a point substantially upstream of the jet orifice, with the first conduit means to receive a supply of fuel from the latter.

The first conduit means may comprise a fuel chamber, adapted to be supplied with fuel, a fuel feed annulus, a passage or passages which lead from the fuel chamber to the fuel feed annulus, an axially extending duct leading to the jet orifice, and tangential swirl slots leading tangentially from the fuel feed annulus to the axially extending duct, the said annular vortex flow passing through the axially extending duct.

The said axially extending duct may be annular, the second conduit means communicating with either the said fuel chamber or with the said annular axially extending duct.

The said axially extending duct may have a frusto-conical portion at its downstream end, the said second conduit means supplying fuel to the centre of the said frusto-conical portion.

In an alternative arrangement, the second conduit means are formed to lead air from the exterior of the burner to the said hollow central region. In this case, the second conduit means may lead the said air to the upstream end of the axially extending duct.

The said jet orifice is preferably a pilot jet orifice which is disposed centrally of an annular main jet orifice, third conduit means being provided for supplying the main jet orifice with an annular vortex flow of fuel.

The invention also comprises a gas turbine engine combustion chamber provided with at least one burner as set forth above.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIGURE 1 is a diagrammatic view, partly in section, of a gas turbine engine having a combustion chamber provided with burners in accordance with the present invention, and

FIGURES 2 and 3 are sectional views of two alternative forms of the said burners.

In FIGURE 1 there is shown a gas turbine engine **10** having an engine casing **11** within which there are disposed, in flow series, a compressor **12**, an annular combustion chamber **13** (or an annular array of separate combustion chambers) and a turbine **14** which drives the compressor **12**.

The combustion chamber **13** is provided with burners **15** which are supplied with fuel (from a source not shown) through pipes **16**. Each of the burners **15** may be formed either as shown in FIGURE 2 or as shown in FIGURE 3.

In the FIGURE 2 embodiment, each of the burners **15** has a centrally disposed conduit **20** formed in a block **21**, the conduit **20** being adapted to be supplied with a flow of pilot fuel. The conduit **20** extends to a fuel chamber **22** which is formed in a distance piece **23**. The fuel chamber **22** communicates via a plurality of angularly spaced apart radially outwardly inclined passages **24** (or via an annular frusto-conical passage **24**) with a fuel feed annulus **25** which is disposed radially outwardly of the fuel chamber **22**. A plurality of angularly spaced apart tangential swirl slots **26** lead tangentially from and radially inwardly from the fuel feed annulus **25** to an annular axially extending duct **27**. The duct **27** is formed between a cylindrical member **30**, whose downstream end is provided with a pilot jet orifice **31**, and a sleeve member **32** which is disposed radially inwardly of the cylindrical member **30**. The arrangement is thus such that an annular vortex flow of pilot fuel passes through the duct **27** to the pilot jet orifice **31**. The downstream end of the sleeve member **32** is disposed upstream of the pilot jet orifice **31** with the result that, at the downstream end of the cylindrical member **30** and within the pilot jet orifice **31**, the said vortex flow of pilot fuel has a hollow central region radially inwardly thereof.

The sleeve **32** extends from a central portion **33** of the distance piece **23**. Alternatively, the portion **33** could of course be separate from the distance piece **23** and could be arranged to define an annular passage **24** therewith.

The sleeve **32** has an axially extending bore **34** which forms a conduit whose upstream end communicates with the fuel chamber **22**.

The downstream end of the duct **27** has a frusto-conical portion **35**, the downstream end of the bore **34** communicating with the said portion **35** by way of a hole **36** through an end wall **37** of the sleeve **32**.

The fuel which passes through the bore **34** and hole **36** thus fills at least part of the hollow central region within the annular vortex flow of fuel supplied to the pilot jet orifice **31**. Accordingly, the fuel through the bore **34** reduces or prevents the passage of combustion gases upstream through the pilot jet orifice **31**. This is desirable because if the combustion gases are allowed to pass upstream through the pilot jet orifice **31** they may carry carbon therewith which will be entrained by the fuel and can cause carboning up of the burner.

Furthermore, the flow of fuel through the bore **34** modifies the spray formed at the pilot jet orifice **31**. Thus, if it were not for the flow of fuel through the bore **34**, the spray formed by the frusto-conical portion **35** would have an outside angle which was only very slightly greater than its inside angle. The flow of fuel through the bore **34**, however, reduces the said inside angle and thus increases the difference between the latter and the said outside angle. This produces a better distribution of the fuel, and a better mixing of the fuel with the air.

The hole **36**, instead of communicating via the bore **34** with the fuel chamber **22**, could alternatively communicate with the duct **27** to receive fuel therefrom, there being

in this case a wall between the upstream end of the bore **34** and the fuel chamber **22**.

The pilot jet orifice **31** is disposed centrally of an annular main jet orifice **40**.

The block **21** has an annular conduit **41** therein through which passes a main flow of fuel, the annular conduit **41**, which is arranged concentrically about the conduit **20**, leading to an annular conduit **42** in the distance piece **23**. The annular conduit **42** leads to an annular fuel chamber **43** which is formed mainly in the distance piece **23** and partly in a radially extending flange portion **44** of the cylindrical member **30**. The portion **44** has a plurality of angularly spaced apart passages **45** therethrough whose upstream ends communicate with the annular fuel chamber **43** and whose downstream ends communicate with a fuel feed annulus **46**.

A plurality of angularly spaced apart tangential swirl slots **47** extend tangentially from the fuel feed annulus **46** and lead radially inwardly to and extend tangentially of an axially extending duct **50** which is disposed concentrically about the duct **27**. The arrangement is such that an annular vortex flow of fuel passes downstream through the duct **50** so as to be supplied to the main jet orifice **40**.

Although, however, there will be a hollow central region disposed inwardly of the annular vortex flow of fuel through the main jet orifice **40**, combustion gases will not be able to pass upstream therethrough since this hollow central region will be filled by the downstream end of the cylindrical member **30** and by the pilot fuel passing through the pilot jet orifice **31**.

The parts of the burner **15** described above are mounted within a housing member **51**. The latter is itself mounted within a casing member **52** so as to form an annular duct **53** therewith. The duct **53** is open at its upstream end to a supply of ambient air which thus passes through the duct **53** and is directed by frusto-conical surfaces **54**, **55** on the housing member **51** and on a cylindrical member **56** so as to direct the air towards the main jet orifice **40** and the pilot jet orifice **31**.

The cylindrical member **56**, which is disposed concentrically of the cylindrical member **30** and is spaced from the latter to provide the duct **50**, has an outer surface **60** which is disposed adjacent to, but very slightly spaced from, a surface **61** on the housing member **51**. The gap between the surfaces **60**, **61** extends between fuel reservoirs **62**, **63** which are formed in the cylindrical member **56**, the reservoir **62** being supplied with fuel by way of drillings **64** which communicate with the tangential slots **47**. There will thus be a thin film of fuel which will at all times, in the operation of the burner, pass from the reservoir **63** and flow downwardly over the surface **55** so as to assist in preventing the formation of carbon deposits on the latter. The passage of air over the surface **55** will assist the entrainment of this flow of fuel thereover.

In FIGURE 3 there is shown a modified burner, many of whose parts are the same as the corresponding parts of FIGURE 2, and which have therefore been given the same reference numerals. For this reason, moreover, a detailed description of FIGURE 3 will not be provided.

In the FIGURE 3 embodiment, however, the interior of the cylindrical member **30** is provided with an axially extending duct **65** which, unlike the duct **27**, is not an annular duct since no sleeve member **32** is provided in the FIGURE 3 embodiment. Moreover, the distance piece **23** is provided with a central portion **66** which, unlike the central portion **33** of the FIGURE 2 embodiment, does not have a bore extending therethrough which communicates with the fuel chamber **22**.

In the FIGURE 3 embodiment, on the contrary, the central portion **66** is formed with a conduit **67** whose downstream end communicates with the duct **65** and whose upstream end communicates with a drilling **68**. The drilling **68** extends through the distance piece **23** and through the housing member **51** so as to be open to the flow of ambient air. Accordingly, ambient air at a relatively high pressure will enter the central region of the duct **65** and will thus prevent or impede the passage of combustion gases upstream through the pilot jet orifice **31**. Thus the hollow central region of the annular vortex flow of pilot fuel is substantially filled with air at higher pressure than the combustion gases immediately outside the burner.

The drilling **68** is desirably arranged to pick up as great a dynamic head as possible. To this end, the drilling **68** may, if desired, be arranged to extend through the block **21** instead of through the housing member **51**.

We claim:

1. A burner having an unobstructed jet orifice, a fuel chamber in said burner adapted to be supplied with fuel, a fuel feed annulus, at least one passage which leads from the fuel chamber to the fuel feed annulus, an axially extending duct leading to the jet orifice, tangential swirl slots leading tangentially from the fuel feed annulus to the axially extending duct whereby an annular vortex flow having a hollow central region is, in operation, produced in the axially extending duct, and a conduit extending from said fuel chamber to said axially extending duct to supply unatomized liquid fuel to said hollow central region of the annular vortex flow.

2. A burner as claimed in claim **1** in which the conduit communicates, at a point upstream of the jet orifice, with the axially extending duct.

3. A burner as claimed in claim **1** in which the said axially extending duct is annular, and wherein the conduit communicates with the said fuel chamber.

4. A burner as claimed in claim **1** in which the said axially extending duct is annular, and the conduit communicates with the said annular axially extending duct.

5. A burner as claimed in claim **3** in which the axially extending duct has an unobstructed frusto-conical portion at its downstream end, with the said conduit means supplying fuel to the center of the said frusto-conical portion.

6. A burner as claimed in claim **1** in which the said jet orifice is a pilot jet orifice which is disposed centrally of an annular main jet orifice, and second conduit means being provided for supplying the main jet orifice with an annular vortex flow of fuel.

7. A gas turbine engine combustion chamber provided with at least one burner as claimed in claim **1**.

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