# United States Patent

**Carlisle**

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[54] **FUEL INJECTOR FOR A GAS TURBINE ENGINE**


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[51] **Int. Cl.**...............................................**F02g 1/00**

[58] **Field of Search**........239/419.5, 422, 424, 424.5, 239/428, 428.5, 432, 518, 524; 60/39.74 R, 39.72 R



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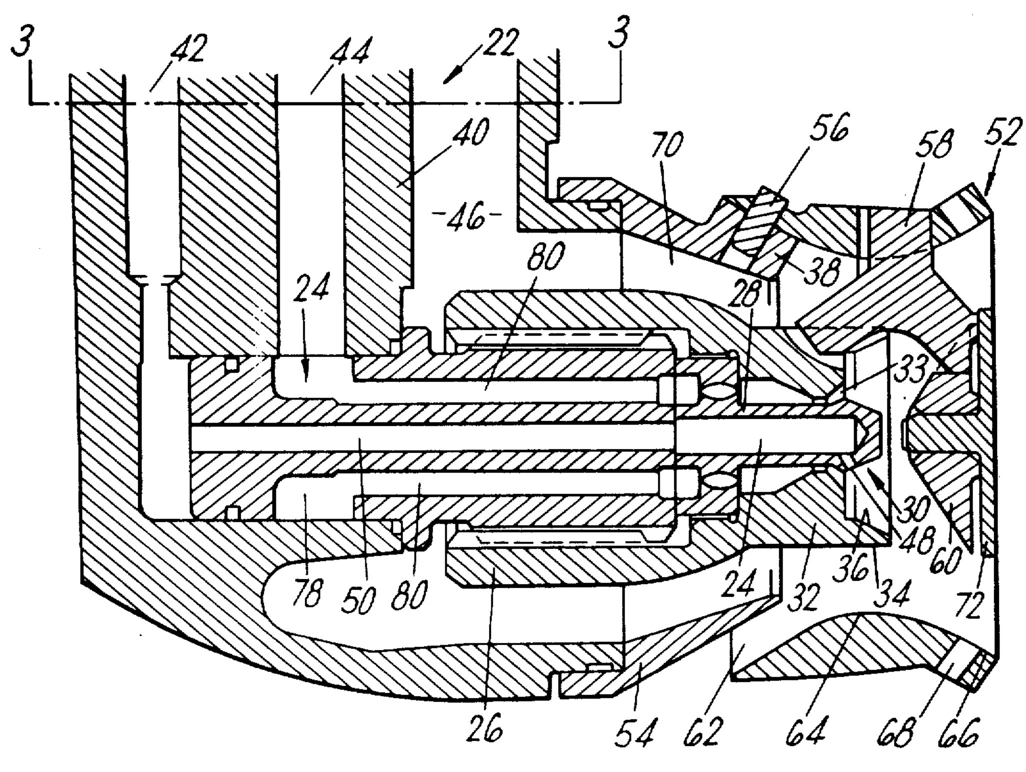
[57] **ABSTRACT**

A fuel injector for a gas turbine engine is arranged to be capable of supplying both liquid and gaseous fuels. The fuel injector has a central member which has a plurality of liquid fuel ducts having respective nozzles, a cowl surrounds the central passage and defines therewith an annular gaseous fuel passage, a baffle is mounted on the cowl downstream of the liquid fuel nozzles and deflecting face is provided inside the cowl. The fuel emitted from the nozzles is arranged to pass between the cowl and the baffle and the fuel emitted from the central one of the nozzles is arranged to impinge upon the deflecting face. A flow of high pressure air is arranged to flow through a passage defined by the shroud and the cowl and flow into the passage defined by the cowl and the central member.

**8 Claims, 3 Drawing Figures**

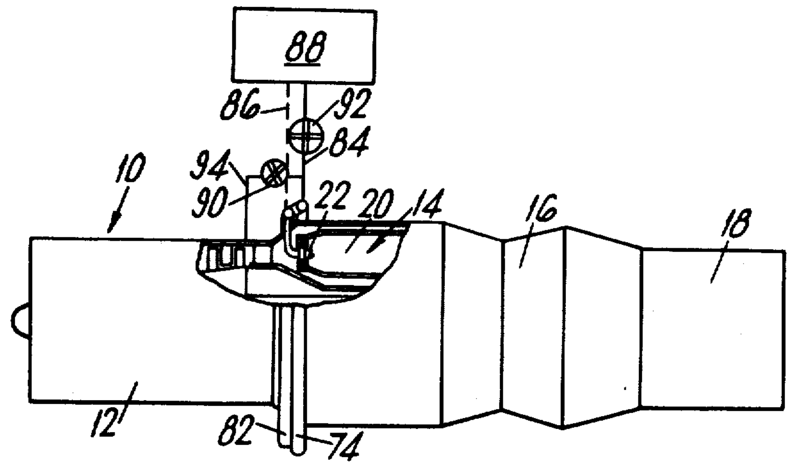



FIG. 1

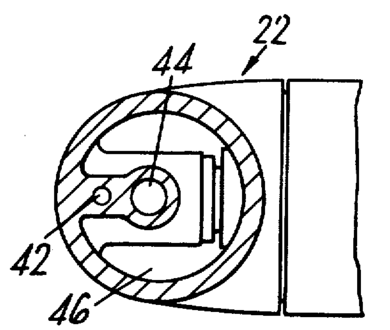



FIG. 3

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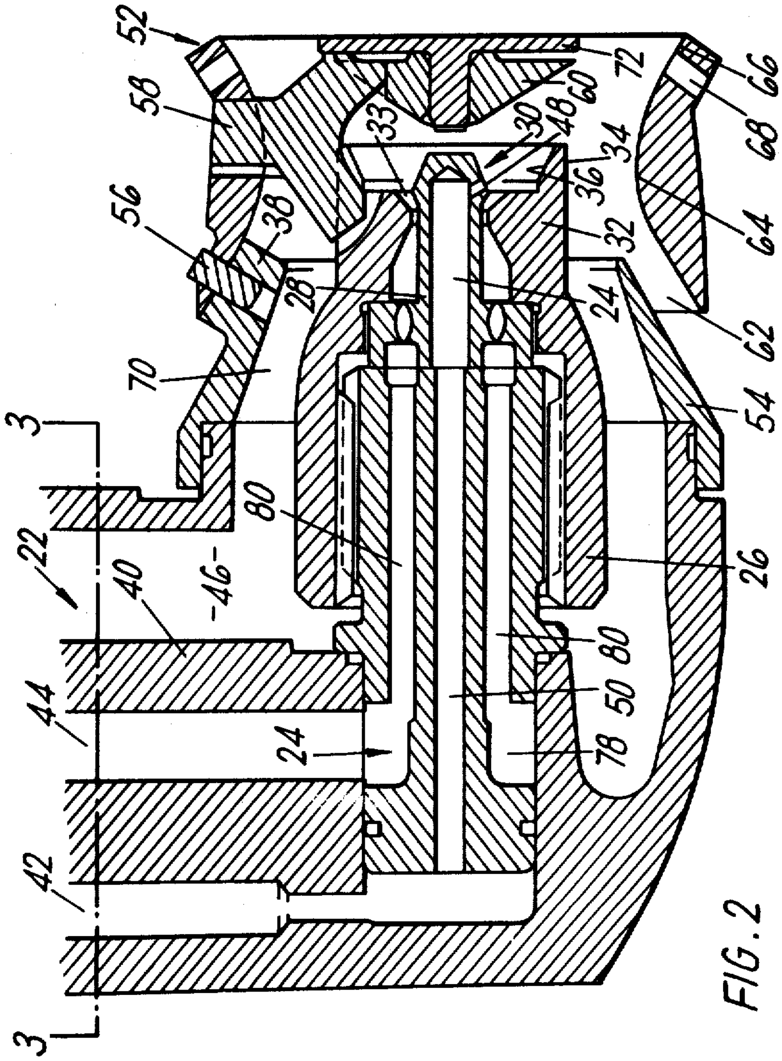

FIG. 2

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## FUEL INJECTOR FOR A GAS TURBINE ENGINE

This invention concerns a fuel injector for a gas turbine engine.

According to the present invention, there is provided a fuel injector for a gas turbine engine comprising a central member having a plurality of fuel ducts terminating in respective nozzles and adapted to be connected to respective fuel supply means, a shroud member mounted in a spaced relationship about the member and forming an annular fuel passage therewith, a cowl member mounted in spaced relationship about the central member and defining an annular flow passage therewith, baffle means supported by the cowl member and disposed downstream of the nozzles and deflector means coaxial with and disposed within the cowl member, the fuel emitted by the nozzles being arranged to pass between the cowl member and the baffle means, the fuel emitted by the central one of said nozzles being arranged to impinge upon the deflector means, and a flow of high pressure being arranged to flow through a passage defined by the shroud member and the cowl member into the passage defined by the cowl member and the central member.

It will be appreciated that in a fuel injector according to the present invention, the risk that a nozzle which is not in use at any particular time will carbon up is reduced by reason of the fact that the fuel from the remaining nozzle or nozzles is carried away therefrom by the said flow of air, while the provision of the deflector means widens the range of fuel spray angles produced by the injector.

Preferably the outermost nozzle is a gaseous fuel nozzle, the other nozzle or nozzles being liquid fuel nozzles.

There may be, in the central member a relatively small central liquid fuel duct and nozzle for use in pilot fuel combustion which are concentrically surrounded by a relatively large annular liquid fuel duct and nozzle for use in main fuel combustion.

The deflector means is preferably secured to or formed integrally with the radially outer wall of the annular liquid fuel nozzle, and may have a frustoconical deflection surface which is coaxial with the nozzles and which diverges towards the baffle means.

The baffle means preferably comprises a member having a substantially conical surface the axis of which is common with the axis of the nozzles and the apex of which is disposed towards the nozzles.

Preferably the member has a plate secured to its downstream end which plate serves as a heat sink for the prevention of carbon deposits on the member.

The downstream end of the cowl member may be convergent in a downstream direction at least a portion of the cowl member may be convergent in a downstream direction.

Preferably the downstream end of the cowl is apertured to permit a flow of high pressure air to pass therethrough and into the passage.

The fuel supply means are preferably controllable to permit simultaneous supply of gaseous fuel to the outermost nozzle and liquid fuel to the other nozzle or nozzles.

There may be provided valve means associated with the gaseous fuel nozzle for selectively connecting the latter to its respective fuel supply means or to a source of high pressure air.



The invention also comprises a gas turbine engine provided with a fuel injector as set forth above.

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

FIG. 1 is a diagrammatic view, partly in broken-away section, of a gas turbine engine provided with a fuel injector according to the present invention;

FIG. 2 is a broken away sectional view on a larger scale of the fuel injector shown in FIG. 1; and

FIG. 3 is a section taken on the line 3—3 of FIG. 2.

Referring to the drawings, a gas turbine engine **10** comprises in flow series one or more compressors **12**, combustion equipment **14**, and one or more turbines **16**, the turbine exhaust gases being directed to atmosphere through an exhaust duct **18** which may terminate in a jet nozzle.

The combustion equipment **14** comprises a plurality of angularly spaced apart flame tubes **20**, each of the flame tubes being provided at its upstream end with a fuel injector **22**.

Each fuel injector **22** (FIG. **2**) comprises a central body consisting of a member **24** having a nut **26** secured to its downstream end the central body and the nut in combination, retaining a nozzle member **28** in position. The nozzle member **28** has a relatively small, centrally disposed nozzle **30** for the so-called "pilot" fuel, the nozzle **30** being concentrically surrounded by a relatively large annular nozzle **32** for the so-called "-main" fuel which passes through an annular aperture **33** the "pilot" and"main" fuels in this preferred embodiment being liquid fuels. The radially outer wall of the nozzle **32** has an axially extended portion **34** which is provided with a frusto-conical deflecting surface **36** formed on its internal surface. The nozzle **32** is itself concentrically surrounded by a nozzle **38** which in operation emits gaseous fuel. The central member **24** is secured to a substantially L-shaped fuel feed arm **40** in which are located respective fuel supply ducts **42**, **44** and **46**.

The nozzle **30** is constituted by three equi-angularly spaced apart drillings **48** whose axes are inclined at an angle of about 70° to the axis of the member **24** and intersect the deflecting surface **36**. The drillings **48** communicate at their upstream ends with a pilot fuel passage **50** in the member **24** and communicate at their downstream ends with the interior of a hollow annular cowl **52**. The axially extending limb of the fuel feed arm **40** has a shroud **54** brazed to its downstream end, and the shroud **54** supports by means of dowels **56** the cowl **52** so that the latter is radially spaced from the nozzle **38**. The cowl **52** carries three equi-angularly spaced supporting members **58**, each of which is substantially Y-shaped in section and is secured, e.g. by brazing, to a substantially conical baffle member **60** to support the latter. The cowl **52** has an open upstream end **62** which defines with the external surface the shroud **54** an annular air inlet. The cowl **52** converges from its upstream end **62** to an intermediate point **64** which is substantially co-planar with the downstream end of the nozzle **30**; the cowl **52** then diverges from the intermediate point **64** to an open downstream end **66** which is provided with throughgoing apertures **68** which communicate with the flow passage **70** defined between the central body **24** and nut **26** on the one hand and the shroud **54** and the cowl **52** on the other hand.

The baffle member 60 is disposed inwardly of the downstream end 66 of the cowl 52, and the axis of its conical surface substantially coincides with the axis of the nozzles 30, 32, 38, with the apex of the cone being disposed towards the nozzle 30.

The downstream end of the baffle member 60 has a metallic heat shield member 72 secured thereto. It will be appreciated that this member 72 is in operation exposed to the internal temperature of the flame tube and will thus transmit heat to the conical baffle member 60 to a sufficient extent to prevent any accumulation of carbon deposits thereon.

Air which has been compressed by the compressor or compressors 12 is in operation forced through the cowl 52.

The arrangement is such that the apex angle of the substantially conical spray of fuel emitted by the nozzle 32 is determined by the shape of the nozzle 32 and the necessity for clearing the baffle member 60, and is typically about 90°. This angle is very suitable for normal running of the engine 10, but is too large to provide good weak burning stability of good light-up and light-round properties (i.e. weak extinction can easily occur, and combustion does not start readily in a flame tube 20 and then spread readily to the adjacent flame tubes 20). However, the "pilot" fuel emitted from the drillings 48 impinges upon the deflecting surface 36 and is deflected thereby into a substantially conical spray having an apes angle of about 70°, which is sufficient to clear the baffle member 60 owing to the radius of the deflecting surface 36 and which substantially eliminates the above mentioned weak burning and lighting problems.

The deflecting surface 36 on the portion 34 could, if desired, be replaced by separate deflector means (not shown) suitably mounted within the cowl 52.

The passage of gas fuel and/or liquid fuel through the cowl 52 takes place simultaneously with a flow of air through the cowl 52, the said flow of air through the cowl 52 not only effecting atomization of the fuel but also helping to ensure that the fuel is burned away from the nozzles 30, 32, 38. Thus, carboning up of any of the nozzles 30, 32, 38 which happens to be out of action at any particular time is reduced. The baffle member 60 assists in atomizing the fuel, the fuel and air being directed into a desired direction between the baffle member 60 and the downstream end 66 of the cowl 52.

The gas fuel passage 46 communicates at one end with the flow passage 70, and at the other end with a gas manifold 74 (FIG. 1). The liquid fuel ducts 42 and 44 respectively communicate with a pilot fuel passage 76, via an annular chamber 78, and with the main fuel passage 80. Both the liquid ducts 42, 44, communicate with a liquid fuel manifold 82 (FIG. 1) so as to receive fuel therefrom.

The manifolds 72, 82 are connected by respective lines 84, 86 to a dual fuel control unit 88 which has means (not shown) for enabling gaseous fuel and liquid fuel to be used either simultaneously or separately from each other.

It has been found, however, that when the fuel injector 22 is operated on liquid fuel along, the problem arose that liquid fuel sometimes splashed back into the gas fuel passage 70 wherein it spontaneously ignited. This spontaneous ignition can, of course, damage the injector structure and has to be prevented. Furthermore, in operation, the prevailing pressures in the various combustion chambers of a given engine are not always equal, and this gives rise to the possibility of hot combustion products flowing back into the gas fuel passage 70 of an injector of a relatively high pressure combustion chamber and from there, via the gas fuel manifold 82 into a relatively low pressure combustion chamber. This is clearly undesireable.

These problems are overcome according to the illustrated embodiment of this invention by the provision of a pair of shut-off valves 90, 92 (FIG. 1) connected to the gas fuel line 84. The valve 90, 92 are so arranged that when one is open the other one is shut and vice-versa. The valve 90 is disposed in a line 94 which connects the gas fuel line 84 with a source of compressed air which in the illustrated embodiment is tap-off from the outlet of the compressor 12. The valve 92 is upstream of the connection between the lines 84 and 94 and is disposed in the gas fuel line 84.

In operation, when liquid fuel only is being burnt, the gas fuel supply is shut off by means of the valve 92, while the valve 90 is opened to supply a continuous flow of compressed air from the line 94 to the gaseous fuel nozzle 38 by way of the line 84, the gas manifold 74 and the passage 46.

What we claim is:

1. In a turbine engine having a fuel injector of the type including a central member having a plurality of concentric nozzles, a shroud mounted about a first portion of said central member and spaced radially therefrom to define an annular fuel passage between said central member and said shroud, means for supplying fuel to each of said nozzles and said fuel passage, an annular cowl member mounted about a second portion of said central member and spaced radially therefrom the define an annular flow passage therebetween downstream of said fuel passage, baffle means supported by said cowl member and disposed downstream of said nozzles, said plurality of concentric nozzles including at least one fuel nozzle having an outlet means for spraying fuel at a predetermined angle into said flow passage at least one other fuel nozzle having an outlet means for spraying fuel into said flow passage, the improvement comprising deflector means disposed coaxially with respect to said nozzles and within said cowl for deflecting the spray from said one other fuel nozzle so that fuel sprayed from said one other fuel nozzle will enter said flow passage at an angle that is less than said predetermined angle.

2. A fuel injector according to claim 1 in which the central member has a central liquid fuel duct of relatively small cross-sectional area terminating at a nozzle for use in pilot fuel combustion which is concentrically surrounded by an annular liquid fuel duct of relatively large cross-sectional area terminating at a nozzle for use in main fuel combustion.

3. A fuel injector according to claim 2 in which the deflector means is secured to the peripheral wall of the annular liquid fuel nozzle.

4. A fuel injector according to claim 1 in which the deflector means has an internal frusto-conical deflecting surface which is coaxial with the nozzles and which diverges towards the baffle means.

5. A fuel injector according to claim 1 in which said fuel passage formed between the shroud member and said central member is a gaseous fuel nozzle.

6. A fuel injector according to claim 1 which the baffle means comprises a member having a substantially conical surface, the axis of which is common with the axis of said nozzles and the apex of which is disposed towards said nozzles.

7. A fuel injector according to claim 6 in which the member has a plate secured to its downstream end which serves as a heat sink for the prevention of carbon deposits on the member.

8. A fuel injector as claimed in claim 1 in which said cowl member has a first portion which converges in the downstream direction and a second portion downstream of said first portion which diverges in the downstream direction.

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