A fuel injection array for a gas turbine engine includes a plurality of bluff body injectors and a plurality of swirler injectors. A control operates the plurality of bluff body injectors and swirler injectors such that bluff body injectors are utilized without all of the swirler injectors at least at low power operation. The swirler injectors are utilized at higher power operation.
GAS TURBINE ENGINE STAGED FUEL INJECTION USING ADJACENT BLUFF BODY AND SWIRLER FUEL INJECTORS

This invention was made with government support under Contract No. NNC08CA92C by NASA. The Government has certain rights in this invention.

BACKGROUND

This application relates to a fuel injection apparatus and method for use in a gas turbine engine, where both bluff body injectors, and swirler injectors are utilized in stages.

Gas turbine engines are known, and typically include a compressor compressing air and delivering the air to be mixed with fuel in a combustion chamber, and then ignited. The amount and ratio of fuel and air which are mixed and ignited vary. At low power, a fuel/air ratio is low, and at higher power, such as take-off and cruise, the fuel/air ratio is higher. It is known to control a group of injectors in stages, with some injectors not being utilized during low power operation, and then utilized at higher power operation.

Fuel injectors are known which utilize a swirler concept. In a swirler concept, the fuel is injected into a swirling chamber, and mixed with air prior to combustion.

Another type of injector is a so-called bluff body injector, which directly injects fuel into a combustion chamber.

SUMMARY

A fuel injection array for a gas turbine engine includes a plurality of bluff body injectors and a plurality of swirler injectors. A control operates the plurality of bluff body injectors and swirler injectors such that bluff body injectors are utilized without all of the swirler injectors at least at low power operation. The swirler injectors are utilized at higher power operation.

These and other features of the present invention can be best understood from the following specification and drawings, of which the following is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically shows a gas turbine engine.
FIG. 2 schematically shows a fuel injector array according to this application.
FIG. 3 shows a portion of the FIG. 2 array.
FIG. 4 shows another portion.
FIG. 5 is a cross-sectional view along line 5-5 of FIG. 4.
FIG. 6 shows a combined operation of the FIG. 2 array.
FIG. 7 shows an alternative embodiment.
FIG. 8 is a view along line 8-8 of FIG. 7.
FIG. 9 shows another alternative embodiment.

DETAILED DESCRIPTION

A gas turbine engine 10, such as a turbofan gas turbine engine, circumferentially disposed about an engine centerline, or axial centerline axis 12 is shown in FIG. 1. The engine 10 includes a fan 14, compressor sections 15 and 16, a combustion section 18 and a turbine section 20. As is well known in the art, air compressed in the compressor 15/16 is mixed with fuel and burned in the combustor 18 and expanded in turbine 20. The turbine 20 includes rotors 22 and 24, which rotate in response to the expansion. The turbine 20 comprises alternating rows of rotary airfoils or blades 26 and static airfoils or vanes 28. In fact, this view is quite schematic, and
FIG. 7 shows another embodiment bluff body 90. As shown, the fluid pipe 92 includes a central passage 94 leading to the pilot opening 104. Side ports 96 operate as in earlier embodiments. Additional ports 98 supply fuel outwardly at a location upstream from the ports 96. Air flow 102 mixes with all of the fuel from the ports 98 and 96, and then penetrates and mixes into air passages 52 to create a well mixed fuel/air zone 100.

As can be appreciated from FIG. 8, there are a great number of ports 98, ensuring increased mixing of the fuel with air 102 and 52.

The use of the bluff body injector, and in particular the pilot opening ensures efficient and reliable combustion at the lower power operations. On the other hand, the use of the swirler injectors at higher power operation ensure reduced smoke, or NOx emissions.

At lower power operation, the amount of fuel flow in stage 2 is much greater than the amount of flow from stage 1. At mid to high power operation, the amount of fuel flow from stage 3 can be optimized for emissions and combustion dynamics. The amount of fuel flow from stage 1.

FIG. 9 shows an embodiment 200 of a swirler wherein a first supply of fuel 202 extends to a location radially outwardly of the main injection point 204 to increase the level of fuel/air mixing. Air mixes with this fuel in the swirler body, as known.

Although embodiments of this invention have been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

What is claimed is:

1. A fuel injection array for a gas turbine engine comprising:
   a plurality of bluff body injectors and a plurality of swirler injectors;
   a control for operating said plurality of bluff body injectors and said swirler injectors such that said bluff body injectors are utilized without all of the swirler injectors at least at low power operation, and said swirler injectors are utilized at higher power operation; and
   said bluff body injectors include a central flow passage leading to a pilot port communicating fuel directly into a combustion chamber, said bluff body injectors also communicate fuel into locations upstream of the combustion chamber where the fuel is mixed with air prior to it reaching the combustion chamber, and said bluff body injectors and said swirler injectors are circumferentially interspaced about a central axis.

2. The fuel injection array as set forth in claim 1, wherein said bluff body injectors are utilized along with said swirler injectors at higher power operation.

3. The fuel injection array as set forth in claim 1, wherein fuel is directed in a plurality of directions from said ports.

4. The fuel injection array as set forth in claim 1, wherein fuel is directed from said fluid supply line into said ports at a plurality of locations including locations spaced more upstream from others of said locations.

5. The fuel injection array as set forth in claim 1, wherein said swirler injectors including a fuel injector delivering fuel at a radially outer location and a radially inner location.

6. The fuel injection array as set forth in claim 1, wherein said bluff body injectors and said swirler injectors are circumferentially interspaced about a central axis.

7. The fuel injection array as set forth in claim 1, wherein said control controlling the flow of fuel to said bluff body injectors and said swirler injectors.

8. A fuel injection array for a gas turbine engine comprising:
   a plurality of bluff body injectors and a plurality of swirler injectors;
   a control for operating said plurality of bluff body injectors and said swirler injectors such that said bluff body injectors are utilized without all of the swirler injectors at least at low power operation, and said swirler injectors are utilized with said bluff body injectors at higher power operation;
   said bluff body injectors include a central flow passage leading to a pilot port communicating fuel directly into a combustion chamber, said bluff body injectors also communicate fuel into locations upstream of the combustion chamber where the fuel is mixed with air prior to it reaching the combustion chamber, and said bluff body injectors and said swirler injectors are circumferentially interspaced about a central axis.

9. The fuel injection array as set forth in claim 8, wherein a fuel supply line leads into said central flow passage, and ports extend from said fuel supply line to locations on opposed sides of said central flow passage to intermix with air flowing along said opposed sides.

10. The fuel injection array as set forth in claim 9, wherein fuel is directed in a plurality of directions from said ports.

11. The fuel injection array as set forth in claim 9, wherein fuel is directed from said fluid supply line into said ports at a plurality of locations including locations spaced more upstream from others of said locations.

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