

AUGMENTOR

BACKGROUND OF THE INVENTION

5 (1) Field of the Invention

 This invention relates to turbine engines, and more particularly to turbine engine augmentors.

(2) Description of the Related Art

 Afterburners or thrust augmentors are known in the
10 industry. A number of configurations exist. In a typical configuration, exhaust gases from the turbine pass over an augmentor centerbody. Additional fuel is introduced proximate the centerbody and is combusted to provide additional thrust. In some configurations, the augmentor centerbody is integrated
15 with the turbine centerbody. In other configurations, the augmentor centerbody is separated from the turbine centerbody with a duct surrounding a space between the two. U.S. Patents 5,685,140 and 5,385,015 show exemplary integrated augmentors.

 The augmentor may feature a number of flameholder
20 elements for initiating combustion of the additional fuel. Piloting devices are used to stabilize the flame on the flameholders which, in turn, distribute the flame across the flow path around the centerbody.

25 BRIEF SUMMARY OF THE INVENTION

 Accordingly, one aspect of the invention involves a turbine engine augmentor. An augmentor centerbody may be located within a gas flowpath. An at least partially radially-extending flameholder is positioned in the flowpath
30 and may be outboard of the centerbody. A burner which may be within the centerbody has an outlet for expelling combustion products of a first pilot fuel. A pilot fuel conduit has an outlet positioned to introduce a supplemental pilot fuel to the expelled combustion products to provide a pilot flame.
35 There may be a number of such burner outlets circumferentially

arrayed about an axis of the engine and positioned to place associated pilot flames in contact with associated flameholders. The burner may have a housing and a liner within the housing. Each of the burner outlets may comprise a liner
5 outlet tube extending from the liner within a housing outlet tube extending from the housing. There may be a number of such pilot fuel conduits, each extending into the liner outlet tube of an associated one of the burner outlets. The centerbody may have a tailcone and a recessed area ahead/upstream of the
10 tailcone. The burner outlet may be positioned within the recessed area. The recessed area may be a non-annular compartment. The pilot fuel conduit outlet may be positioned within the recessed area. The pilot fuel conduit may comprise a distal end portion of a spraybar extending within the
15 flameholder.

Another aspect of the invention involves a turbine engine augmentor with a centerbody within a core flowpath of the engine. A flameholder is positioned in the core flowpath and extends radially outboard of the centerbody. A burner is
20 positioned within the centerbody. The burner has a housing, an upstream inlet for receiving oxygen-containing gas, an igniter for initiating combustion of a pilot fuel with the gas, and a foraminate liner within the housing to direct products of the combustion downstream. A number of foraminate outlet conduits
25 extend at least partially radially outward from the liner to direct the products toward the core flowpath. A number of cooling conduits each surround an associated one of the outlet conduits. A pilot fuel conduit has an outlet positioned to introduce a supplemental pilot fuel to the expelled combustion
30 products to enhance the piloting effects of the expelled products.

Another aspect of the invention is a gas turbine engine. A compressor compresses inlet air. A combustor receives
35 compressed air from the compressor and combusts a mixture of the compressed air and a fuel. A turbine extracts work from

products of the combustion to drive the compressor and discharges the products as exhaust. An augmentor is located within a path of the exhaust and has a conduit receiving bypass air and a burner combusting a first portion of the
5 bypass air. The augmentor includes a burner combusting a first portion of the bypass air with a burner fuel and discharging combustion products of the first portion and the burner fuel into the exhaust. The augmentor has an air conduit directing a second portion of the bypass air. A pilot fuel conduit directs
10 a pilot fuel and is positioned relative to the air conduit and the burner so as to permit heat from the combustion products of the first portion and the burner fuel to ignite a mixture of the pilot fuel and the second portion of the bypass air.

Another aspect of the invention involves a method for
15 operating a turbine engine augmentor. An exhaust gas is caused to flow from a turbine engine to an augmentor. Combustion of a first pilot fuel is caused to produce combustion products. A flow of the combustion products joins the exhaust gas flow. A supplemental pilot fuel is introduced to the flow of the
20 combustion products.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings,
25 and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic longitudinal sectional view of an aircraft powerplant.

30 FIG. 2 is a partial, cut-away, semi-schematic, longitudinal sectional view of an augmentor pilot system for use in the powerplant of FIG. 1.

Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

FIG. 1 shows an exemplary powerplant 20 having a central longitudinal axis 500. From upstream to downstream, the powerplant includes a turbine engine 22 having a downstream turbine exhaust case (TEC) 24. A duct extension 26 extends from the TEC 24 to join with a housing 30 of an augmentor 32. A thrust vectoring nozzle assembly 34 extends downstream from the housing 30. The augmentor 32 includes a centerbody 38 centrally mounted within the gas flow path by means of radially-extending vanes 40. Each exemplary vane 40 includes a forward/upstream structural portion and aft/downstream flameholder element 42.

The centerbody 38 is generally symmetric around the axis 500. The centerbody has a forward tip 50 from which a continuously curving convex forebody or ogive 52 extends rearward until reaching a longitudinal or nearly longitudinal transition region 54 adjacent the flameholders 42. Aft of the transition region, a tailcone surface 58 extends to an aft extremity of the centerbody.

FIG. 2 shows further details of an exemplary pilot 60 for the augmentor. The pilot includes one or more burners 62 mounted within the centerbody. In the exemplary implementation, a single burner is mounted centrally within the centerbody. The burner includes one or more upstream conduits 64 directing air from a fan duct 65 (FIG. 1) between inner and outer elements of the housing to an upstream end of a burner outer housing 66. In an exemplary implementation, the conduit(s) 64 extend radially through associated vanes 40 to direct air radially inward from the fan duct. In the exemplary implementation, the housing 66 has an upstream end to which the conduit 64 longitudinally connects, a longitudinally-extending sidewall, and a closed downstream end. The housing 66 contains a foraminate liner 70. The liner 70 has an upstream end to which an air swirler 72 is mounted, a longitudinally-extending sidewall, and a closed downstream

end. Each of one or more pilot fuel conduits 74 has a downstream outlet at the swirler 72 for delivering pilot fuel to the burner. As with the air conduit(s) 64, the pilot fuel conduit(s) 74 may extend through associated ones of the vanes or flameholders. An igniter 76 is mounted within the liner 70 and is powered via wiring 78. The wiring 78 may extend through one or more of the vanes.

In operation, a portion of the air delivered through the conduit 64 enters the liner 70 through the swirler 72. Additional portions enter through the holes in the liner, including a portion passing through the liner from an annular space 80 between the liner and housing sidewalls. A main portion of air is combusted with the fuel from the conduit 74 in response to ignition by the igniter 76. Mixture of the air and the fuel passing through the swirler may be relatively rich and leads to incomplete combustion. The air passing through the holes in the liner serves primarily to cool the liner and tends to lean out the products of the main combustion. Near the downstream end of the liner and housing, each have a circumferential array of radially-extending coaxial outlet tubes 84 and 86 having proximal inlets at the respective sidewalls of the liner and housing and distal outlets 88 and 90. In the illustrated embodiment, a distal end portion of each tube 84 protrudes beyond the outlet end 90 of the associated tube 86. As combustion products flow exiting from the liner interior proceeds through each tube 84, further air from the annular space 92 between the tube 84 and the associated tube 86 passes through holes in the tube 84. A final portion of the air originally introduced through the conduit 64 exits the annular outlet between each housing outlet tube end 90 and the associated liner outlet tube 84. In the exemplary embodiment, the outlet ends of each pair of tubes 84 and 86 are within an inboard end portion of a centerbody outlet tube 96 having an outboard outlet end 98 open at the transition region 54. The centerbody outlet tubes

96 thus define blind subannular (circular section in the exemplary embodiment) recesses or compartments into which the associated tubes 84 and 86 extend.

An additional pilot fuel conduit 100 is positioned to introduce additional fuel to the burner output. In the exemplary embodiment, this is introduced generally within the outlet tube 96. More particularly, it is introduced within an outlet end portion of the liner outlet tube 84. To achieve this, the exemplary conduit 100 penetrates the liner outlet tube 84 through an aperture 101 therein and has discharge openings 102 within the tube 84 just downstream of the outlet end 90 of the housing outlet tube 86 and just upstream of the outlet end 88 of the liner outlet tube 84. In the exemplary embodiment, the conduit 100 is formed as a distal end portion of a spraybar 103 (solid line) extending radially through an associated vane. The spraybar has, at either side, an array of circumferentially-directed nozzles 104 directing fuel into the gas flowpath around the centerbody. Air outlets and an air conduit (not shown) may also similarly be provided within each vane (e.g., as in U.S. Patent 5,685,140).

In operation, the additional pilot fuel combusts upon introduction to the burner output and generates a flame including highly reactive species (e.g., oxygen atoms and hydrocarbon fragments) which contact and flow along the flameholder in the radial outward direction igniting the augmentor fuel emitted by the nozzles 104. These species may be relatively short-lived so that similar species generated by combustion of the principal pilot fuel will have largely died out prior to reaching the flameholders.

In an exemplary method of manufacture, the burner may be preassembled and installed within the centerbody as known in the art or otherwise. The liner outlet tube 84 is preformed with the aperture 101 complementary to the shape of the conduit 100. With the vane/flameholder installed relative to the centerbody, the spraybar 103 may be installed by initially

inserting it inward and parallel to the vane/flameholder
trailing edge 106 until it reaches its broken line position.
Thereafter it may be shifted transverse to the trailing edge
106 to cause the conduit 100 to pass through the aperture 101
5 in the solid line showing. Mechanical and external plumbing
connections may, thereafter, be made.

One or more embodiments of the present invention have
been described. Nevertheless, it will be understood that
various modifications may be made without departing from the
10 spirit and scope of the invention. For example, the inventive
pilot may be applied in a retrofit or redesign of an otherwise
existing engine. In such cases, various properties of the
pilot would be influenced by the structure of the existing
engine. While illustrated with respect to an exemplary remote
15 augmentor situation, the principles may be applied to
non-remote augmentors and to augmentors wherein the burner is
located out of the centerbody (if any) and/or the supplemental
pilot fuel is introduced through the centerbody. Accordingly,
other embodiments are within the scope of the following
20 claims.

CLAIMS

What is claimed is:

1. A turbine engine augmentor comprising:
 - a gas flowpath;
 - 5 a flameholder positioned in the gas flowpath;
 - a burner having an outlet for expelling combustion products of a first pilot fuel; and
 - a pilot fuel conduit having an outlet positioned to introduce a supplemental pilot fuel to the expelled combustion
 - 10 products.
2. The augmentor of claim 1 wherein the flame holder is a first of a plurality of flameholders and the pilot fuel conduit is a first of a plurality pilot fuel conduits, each
- 15 aligned with an associated one of the plurality of flameholders.
3. The augmentor of claim 1 wherein the outlet of the burner is a first outlet of a plurality of burner outlets
- 20 circumferentially arrayed about an axis of the engine.
4. The augmentor of claim 1 further comprising a centerbody within the gas flowpath, the burner positioned within the centerbody and the flameholder positioned outboard of the
- 25 centerbody.
5. The augmentor of claim 4 wherein:
 - the burner comprises a housing and a liner within the housing; and
 - 30 each of the plurality of burner outlets comprises a liner outlet tube extending from the liner within a housing outlet tube extending from the housing.
6. The augmentor of claim 5 wherein the pilot fuel conduit
- 35 is a first conduit of a plurality of pilot fuel conduits, each

extending into the liner outlet tube of an associated one of the burner outlets.

7. The augmentor of claim 1 wherein the centerbody has a
5 tailcone and a recessed area upstream of the tailcone and wherein said outlet of said burner is positioned within said recessed area.

8. The augmentor of claim 7 wherein the recessed area is a
10 non-annular compartment.

9. The augmentor of claim 7 wherein the outlet of the pilot fuel conduit is positioned within said recessed area.

15 10. The augmentor of claim 1 wherein the pilot fuel conduit comprises a distal end portion of a spray bar extending within a vane associated with the flameholder.

11. The augmentor of claim 1 wherein said burner comprises:
20 a housing;
an upstream inlet for receiving oxygen-containing gas;
an igniter for initiating combustion of said first pilot fuel with said oxygen-containing gas;
a foraminate liner positioned within the housing to
25 direct said combustion products downstream;
a plurality of foraminate outlet conduits extending at least partially radially outward from the liner to direct said combustion products toward the gas flowpath; and
a plurality of cooling conduits, each surrounding an
30 associated one of the outlet conduits.

12. The augmentor of claim 1 wherein:
a conduit receives bypass air;
the burner combusts a first portion of said bypass air
35 with said first pilot fuel;

an air conduit directs a second portion of said bypass air; and

said pilot fuel conduit is positioned relative to said air conduit and said burner so as to permit heat from said combustion products to ignite a mixture of said pilot fuel and said second portion of said bypass air.

13. A gas turbine engine comprising:
a compressor compressing inlet air;
10 a combustor receiving compressed air from the compressor and combusting a mixture of said compressed air and a fuel;
a turbine extracting work from products of said combusting to drive the compressor and discharging said products as exhaust; and
15 the augmentor of claim 1.

14. A method for operating the augmentor of claim 1 comprising:
causing an exhaust gas flow from a turbine engine to the
20 augmentor along the gas flowpath;
causing combustion of said first pilot fuel to produce said combustion products, a flow of said combustion products joining said exhaust gas flow; and
introducing said supplemental pilot fuel to said flow of
25 said combustion products.

15. A turbine engine augmentor comprising:
a centerbody within a core flowpath of the engine;
a flameholder positioned in the core flowpath and
30 extending radially outboard of the centerbody;
a burner within the centerbody and having:
a housing;
an upstream inlet for receiving oxygen-containing gas;

an igniter for initiating combustion of a first pilot fuel with said oxygen-containing gas;

a foraminate liner positioned within the housing to direct products of said combustion downstream;

5 a plurality of foraminate outlet conduits extending at least partially radially outward from the liner to direct the products toward the core flowpath; and

a plurality of cooling conduits, each surrounding an associated one of the outlet conduits; and

10 a pilot fuel conduit having an outlet positioned to introduce a supplemental pilot fuel to the expelled combustion products.

16. The augmentor of claim 15 wherein the outlet of the burner is a first outlet of a plurality of burner outlets circumferentially arrayed about an axis of the centerbody.

17. A gas turbine engine comprising:

a compressor compressing inlet air;

20 a combustor receiving compressed air from the compressor and combusting a mixture of said compressed air and a fuel;

a turbine extracting work from products of said combusting to drive the compressor and discharging said products as exhaust; and

25 an augmentor within a path of said exhaust and having:

a conduit receiving bypass air;

a burner combusting a first portion of said bypass air with a burner fuel and discharging combustion products of said first portion of said bypass and said burner fuel into said exhaust;

30 an air conduit directing a second portion of said bypass air; and

a pilot fuel conduit directing a pilot fuel and positioned relative to said air conduit and said burner so as to permit heat from said combustion products of

said first portion of said bypass and said burner fuel to ignite a mixture of said pilot fuel and said second portion of said bypass air.

- 5 18. A method for operating a turbine engine augmentor comprising:

causing an exhaust gas flow from a turbine engine to an augmentor;

- causing combustion of a first pilot fuel to produce
10 combustion products, a flow of said combustion products joining said exhaust gas flow; and

introducing a supplemental pilot fuel to said flow of said combustion products.

- 15 19. The method of claim 18 wherein the first pilot fuel is combusted in an augmentor centerbody and wherein the flow of the combustion products exits the centerbody.

- 20 20. The method of claim 19 wherein the supplemental pilot fuel is introduced within a recess in the centerbody; and the combustion occurs in a centerbody extending generally fore-to-aft within the exhaust gas flow.