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TURBINE STATOR-COMBUSTOR STRUCTURE

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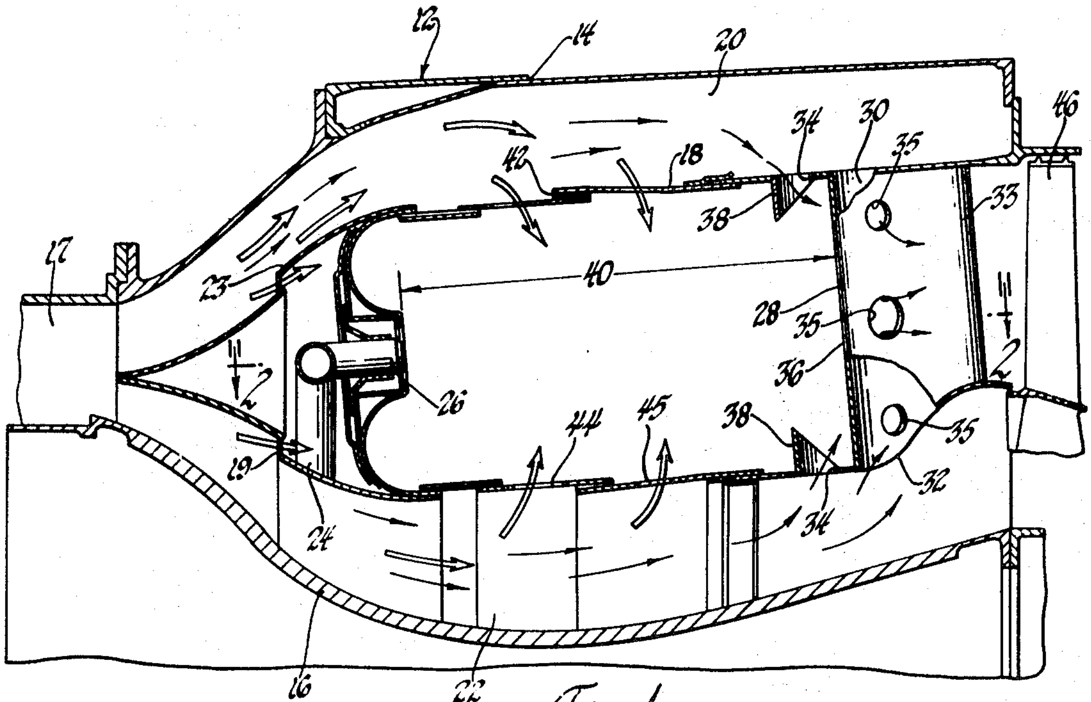

Fig. 1

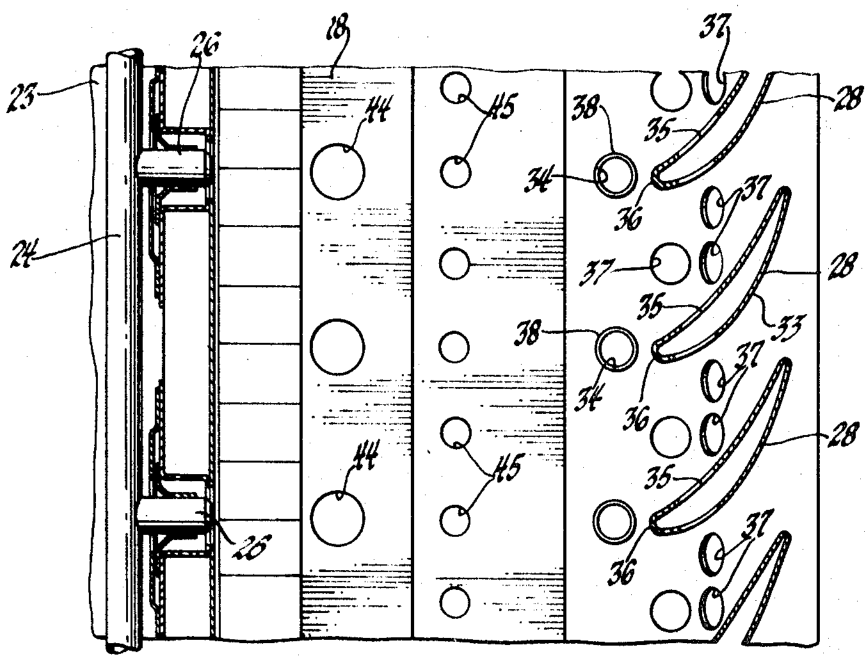

Fig. 2

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TURBINE STATOR-COMBUSTOR STRUCTURE
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ABSTRACT OF THE DISCLOSURE

A turbine stator-combustor structure in which the turbine stator vanes are integrated into an annular combustor resulting in a much shorter combination. The stator vanes are convection and film cooled while impingement cooling of the leading edges is also provided.

My invention relates generally to combustor equipment for a gas turbine engine or the like and more specifically to a turbine stator-combustor structure which is especially suitable for, but not limited to, use with a lift type gas turbine engine because of its reduced axial length.

For some time now, the feasibility of VTOL aircraft has been under study. One basic concept under study is the inclusion of lift engines vertically mounted in the aircraft which are used during take-off and landing only and are inoperable during normal flight. With the lift engine mounted vertically, it is highly desirable to reduce its axial length as much as practicable. To this end, in my invention, I have integrated a turbine inlet stator into the dilution zone of an annular combustor to decrease the axial length normally required by these components. In general, the material now available for the turbine stator or nozzle inlet vane row has a temperture limit which is far below the temperatures available from the combustion of liquid hydrocarbon fuels in air at or near the chemically correct fuel/air ratio (stoichiometric ratio). For this reason, it is necessary to include a section in the combustor in which the combustion gases are diluted with a large excess of secondary air to reduce their temperature before they reach the turbine stator. The area of the combustor in which dilution or secondary air is admitted is known as the dilution zone which heretofore has added length to the combustor and turbine inlet stator structure. In other words, without a temperature limit problem, no dilution zone would be required and the added length of the dilution zone eliminated. The temperature limit problem of the stator exists, however, and it increases as the distance between the primary combustion zone and the inlet stator decreases. Therefore, any decrease in this distance (and consequently the axial length of the structure) must take into account the temperature limit of the inlet nozzle vane stator. In my unique scheme, I utilize the dilution or secondary air in a unique manner to both decrease the temperature of the combustion gases and to give an impingement cooling effect to the vanes at their leading edges or most critical areas. In addition, air is bled from the secondary air stream to convection cool the vanes themselves—the cooling air being discharged through the vanes to provide film cooling of their outer surfaces. Because the air bleed for convection cooling flows out of the blade into the main gas stream, another advantage is realized in that the effect to engine performance of bleeding compressed air is minimized. Accordingly, the object of my invention in its broadest aspect is to provide an operable turbine stator-combustor structure for a gas turbine or the like having an axial length shorter than any available comparable structure.

Another object of my invention is to provide a relatively short combustor structure having a turbine stator

incorporated in its dilution zone, in which the hydrocarbon fuel may be efficiently burned, in which the combustion gases are cooled to a temperature which is capable of being withstood by the turbine stator and in which does not appreciably affect engine performance.

Another object of my invention is to provide turbine stator-combustor structure having a relatively short axial length and including means for convection cooling the turbine stator vanes, film cooling of their outer surfaces, and impingement cooling of their leading edges so that they can withstand the environmental temperature produced by the combustion of a stoichiometric mixture of fuel and air in the combustor.

With these and other objects in view, as will hereinafter more fully appear, and which will be more particularly pointed out in the appended claims, reference is now made to the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a section taken on a plane containing the longitudinal axis of a portion of a gas turbine engine showing an integrated turbine stator-combustor in accordance with my invention and its relationship to the engine.

FIG. 2 is a section taken along the line **2—2** of FIG. 1 and looking in the direction of the arrows.

Referring now to the drawings and more particularly to FIGS. 1 and 2, the gas turbine engine combustion portion is indicated generally at **12**. The outer casing **14** of the engine and a wall **16** mounted within it define an annular air casing which receives compressed air at inlet **17**. An annular combustor **18** mounted in the air casing and spaced from it provides outer and inner annular air passages **20** and **22**. Mounted on the forward end of the combustor **18** is a deflector **23** which proportions the air flow from inlet **17** between the air passages **19** and the annular air passages **20** and **22**. A fuel ring **24** mounted inside the deflector **23** includes a number of circumferentially spaced fuel spray nozzles **26** which protrude into the forward end of the combustor **18**.

Mounted radially across the aft end of the combustor **18** are a number of circumferentially spaced nozzle vanes **28**. These nozzle vanes are hollow and have open radially outer and inner ends **30** and **32** which are in fluid communication with the annular air passages **20** and **22**, respectively. The walls **33** providing the aerodynamic contour of the vanes have a number of apertures **35** of various size, larger ones being provided in the midportions of the vanes. Apertures **37** in the combustor inner wall admit dilution or cooling air to the area between the vanes. The circumferentially spaced apertures **34** provided in the combustor **18** adjacent the leading edges **36** of the vanes **28** have short truncated tubes **38** mounted in each aperture **34** which direct secondary air from the passages **20** and **22** into the combustor and onto the leading edge **36** of the vanes **28**.

The primary combustion section **40** is the area within the combustor between the tip of the fuel nozzles **26** and the point of admitting secondary air at the leading edges **36** of the vanes **28** through apertures **34**. The forward portion or primary combustion section **40** is fabricated from known techniques so that adequate film cooling of this area is provided by air flowing through the slots **42**. The particular combustor illustrated is of the progressive burning type so that primary air is admitted through the larger apertures **44** and smaller aperture **45** in addition to the primary air admitted through passages **19**. The progressive type burner forms no part of this invention but suffice it to say that the fuel admitted through nozzles **26** is completely burned by the time it reaches the dilution zone—sufficient air for a stoichiometeric mixture with a little excess for practical reasons being admitted through passages **19** and apertures **44** and **45**.

In operation, compressed air is proportioned by deflector **23** between passages **19** and the annular passages **20** and **22**. The air admitted through passages **19** is mixed with the fuel spray from nozzles **26** and ignited and burned. Additional air from passages **20** and **22** flows through apertures **44** and **45** to completely burn the fuel and through slots **42** to film cool the combustor inner walls. Further downstream, secondary air flows radially through the apertures **34** and is directed by the tubes **38** into the combustor and onto the vane leading edges **36**. This flow is substantial and dilutes the combustion gases. In addition, the flow has an impingement cooling effect on the leading edges **36** of the vanes **28**. Air from passages **20** and **22** also flows radially into the hollow vanes from both directions and out the apertures **35** and along their radial walls toward the aft end of the combustor structure **12**. This last-mentioned flow provides convection cooling of the vanes **28** and a film of cool air adjacent the outer surface of the vanes **28**. Dilution air may also be admitted through the apertures **37** between the vanes **28**. The flow of primary or combustion air is indicated by open arrows and the flow of secondary air is indicated by black arrows in FIG. 1. Note the vanes are convection cooled and have their exposed surface film cooled while their most critical areas, that is, their leading edges are impingement cooled by the dilution air flowing through aperture **34**. This cooling combination I have found provides adequate cooling of the vanes **28** made of presently available material with approximately 50% of the air flow while the remaining 50% of the compressed air available as primary air for combustion is adequate to support efficient combustion and yield satisfactory engine performance. The cooling of the blade in this manner also aids in presenting a temperature profile at the stator exit which is capable of being withstood by the first stage turbine **46**.

Combustors are designed from empirical data and normally the primary combustion zone **40** has a length-to-height ratio of approximately 2.5 whereas the integrated turbine stator-combustor of my invention has a primary combustion zone with a length-to-height ratio on the order of 1.5. Thus my invention provides a turbine-stator-combustor structure capable of efficient combustion and withstanding the combustion temperatures which is considerably shorter than comparable structures now available.

It should be understood, of course that the foregoing disclosure relates to only a preferred embodiment of the invention and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention.

I claim:

1. A turbine-stator-combustor for a gas turbine engine or the like comprising in combination: an annular casing, a combustor mounted in said casing and spaced radially therefrom to provide inner and outer annular air passages, a plurality of circumferentially spaced stator vanes mounted at the aft end of said combustor, said combustor having a plurality of circumferentially spaced apertures adjacent the leading edges of said vanes, truncated tubes mounted in said combustor apertures with their maximum height remote from the leading edges of said vanes, said truncated tubes extending into said combustor to direct secondary air onto said leading edges of said vanes to cool them by impingement of the secondary air.

2. The turbine-stator-combustor as defined in claim **1** wherein said stator vanes are hollow, having open inner and outer ends in fluid communication with said annular air passages, respectively, and have a plurality of apertures in their radial walls whereby secondary air is directed into said hollow blades and outwardly along the exposed surfaces of said radial walls to convection cool the said vanes and to provide a film of cool air adjacent said radial walls.

3. The turbine-stator-combustor as defined in claim **2** wherein said combustor has a plurality of apertures between said vanes.

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