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A. H. LABASTIE ETAL
COMBUSTOR CONSTRUCTION WITH MEANS FOR
PREVENTION OF HOT STREAKS
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Fig 1

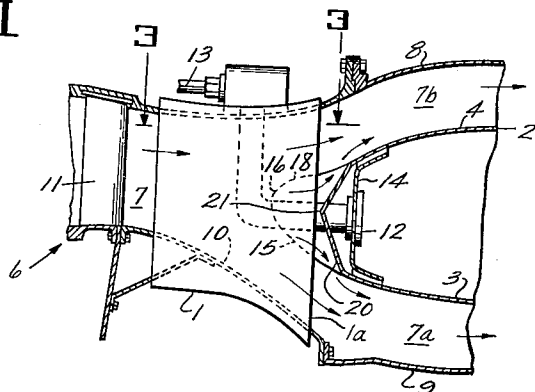


Fig 2

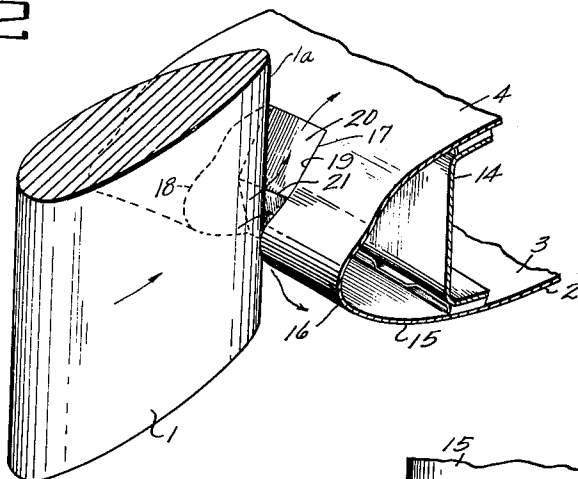
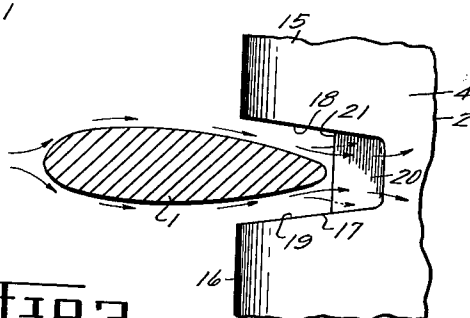


Fig 3



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COMBUSTOR CONSTRUCTION WITH MEANS FOR PREVENTION OF HOT STREAKS

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4 Claims. (Cl. 60—39.66)

This invention relates to combustor constructions, and particularly to an improved combustor construction having means for prevention of hot streaks therein.

In a conventional gas turbine engine, an axial flow air compressor delivers compressed air through a diffusing section to a fuel combustor. The flow path for the compressed air is formed between concentric spaced-apart stationary casing members, and it is convenient to support an inner one of the casing members by means of a plurality of circumferentially-spaced radially extending struts, which are secured at their extremities to the casings. However, in the interest of minimizing the axial length of the engine, the diffuser section is given as short an axial length as is feasible for performance of its function, with the result that the struts must be located in close proximity to the leading edge of the combustor. We have found in practice that such location of the supporting struts causes the wakes which form downstream of the struts to establish an uneven distribution of air flow over the leading surfaces of the combustor, thus producing hot streaks in the combustor directly downstream of the struts, where there is an inadequate flow of air for cooling purposes.

It is the object of this invention to provide a combustor construction with improved means for reducing wake formation by supporting struts located upstream of the combustor, to prevent the development of hot streaks on the leading surfaces of the combustor.

This and other objects and advantages of our invention will become apparent from the following detailed description.

Briefly stated, in accordance with one aspect thereof, we carry out our invention by forming indentations or "saddles" in the leading surfaces of a combustor to cause the scooping of a substantial flow of air into the saddles, and by locating the trailing edges of struts located upstream of the combustor in spaced-apart proximity to the saddles. The flow of air scooped by the saddles sweeps the area behind the struts, and reduces the effect of turbulent wake-formation downstream of the struts. The loss of axial velocity associated with wake-formation is thus reduced, with the result that an increased flow of cooling air occurs over the leading surfaces of the combustor downstream of the struts.

The air scooped into the saddle is forced to flow radially outwardly and inwardly therefrom by means of a baffle portion formed at the axially downstream end of the saddle, thus cooling the leading surfaces of the combustor downstream of the strut. This construction forces sufficient cooling air to flow into the saddle to effectively prevent the formation of hot streaks on the leading surfaces of the combustor.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which we regard as our invention, it is believed that the invention will be better understood from the following description taken in connection with the accompanying drawing, in which:

FIG. 1 is an elevation in section of a portion of a gas turbine engine made according to our invention;

FIG. 2 is a pictorial view of a cutaway portion of the strut and combustor of FIG. 1; and

FIG. 3 is a view taken along line 3—3 in FIG. 1, looking in the direction of the arrows.

Referring to the drawing, an illustrative embodiment of our invention is shown in a strut 1, having a trailing edge 1a, and a combustor 2. The combustor may be cylindrical or toroidal in form, to provide a conventional "cannular" or "annular" combustion system, respectively. For purposes of illustration, combustor 2 is shown as an annular system, comprising circumferentially spaced apart inner and outer annular walls 3 and 4, respectively. These elements are incorporated in a gas turbine engine generally designated 6, in which an annular air flow path 7 is formed between an outer annular casing 8 and an inner annular casing 9 which are circumferentially spaced apart. In a conventional manner, a compressor (not shown) supplies compressed air to a diffuser portion 10 formed between casings 8 and 9, exhausting thereto through a plurality of circumferentially spaced flow-straightening vanes 11 which extend across the passage 7. Subsequent to diffusion of the compressed air, it is delivered to combustor 2, flowing in the directions generally designated by the arrows. In a well known manner, fuel is injected into the interior of combustor 5 by means of a nozzle 12 from fuel supply means 13 located exteriorly of casing 8. Compressed air received from diffuser 10 is caused to flow into the interior of combustor 2 through suitable openings (not shown) in order to effect combustion of the fuel injected therein.

Combustor 2 includes a dome 14 partially enclosing the combustion space, and a cowl portion 15 extending upstream for even division of the air flow into inner and outer portions of the air passage, designated 7a and 7b respectively. Cowl 15 terminates in a nose 16, and partially comprises the leading surfaces of combustor 2. Subsequent to combustion in combustor 2, the hot gases are exhausted to a turbine (not shown) and discharged to provide a useful thrust reaction, in a manner well known in the art. No further description of the engine construction, which in itself forms no part of the present invention, is believed necessary.

In carrying out our invention, we form cowl 15 with an indentation or "saddle" 17 for each strut 1, and locate the trailing edge 1a of the vane in axially-spaced proximity to this indentation. In the preferred embodiment shown, the trailing edge of the vane 1 is axially inset into the saddle 17. As shown, saddle 17 is formed with a pair of circumferentially spaced apart walls 18 and 19 extending with a component of direction generally radial to passage 7 and converging in a downstream direction, and terminates in a baffle portion 20 extending generally transversely to the direction of flow. We prefer to form baffle 20 with a V-shaped cross-section forming an apex 21 extending in a direction lying in the plane of FIG. 3, so as to obtain division of the air stream in saddle 17 into air passages 7a and 7b, with a minimum disturbance of flow. Walls 18 and 19 are spaced circumferentially of the combustor from strut 1 to provide for the collection in the saddle of a substantial flow of air, and baffle 20 is spaced downstream from trailing edge 1a of the strut to provide for flow of the scooped air radially inwardly and outwardly over the surfaces of inner and outer walls 3 and 4, respectively.

The position of the strut, inset into the saddle, causes the area behind the strut to be swept by air scooped into the saddle, reducing the effect of turbulent wake-formation and consequent loss of axial velocity of the air, and thus produces an increased flow of cooling air for the combustor surfaces directly downstream from the strut. This construction is effective to prevent the formation of hot streaks in the combustor surfaces due to wake formation behind the strut. The relative dimensions and loca-

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tion of the baffle, saddle and strut are determined such as to maintain an adequate cooling air flow over the trailing edges of the strut and over the surfaces of baffle 20 and walls 3 and 4.

It is not necessary to the invention that the trailing edge 1a of the strut be axially inset into the saddle as in the preferred embodiment shown; the trailing edge 1a may be spaced axially upstream of the nose 16, provided that it is located with sufficient proximity to the saddle to render the flow of air scooped by the saddle operative to reduce the formation of a turbulent wake and the resulting loss of axial velocity downstream of the strut. In any event we have discovered that to reduce turbulent wake formation, the peripheral spacing of the strut 1 from the walls 18 and 19 of the cowl 15 must be in excess of one and one half percent (1½%) of the strut width. Spacing greater than two and one half percent (2½%) of the strut width, however, provides little additional improvement.

It will be apparent from the foregoing description that we have provided an improved combustor construction with means for preventing the formation of hot streaks therein, which would otherwise be induced by the presence of a strut immediately upstream of the combustor. While we have shown and described a particular embodiment of our invention, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention. We intend in the appended claims to cover all such changes and modifications.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A combustor construction for a gas turbine engine comprising, in combination; an inner casing and an outer casing circumferentially spaced apart to form an annular fluid passage therebetween, at least one vane extending radially across said passage, a combustor mounted in said air passage and extending downstream from said vane with respect to the direction of fluid flow in said passage, an upstream end of said combustor formed with an indentation, said vane located in axially and circumferentially spaced apart proximity to said indentation by an amount not less than one and one half percent (1½%) or substantially greater than two and one half percent (2½%) of the width of said vane, such that a flow of fluid is scooped into said indentation from said passage to flow downstream of said vane through said indentation to oppose the formation of a turbulent wake downstream of said vane thereby inhibiting the formation of hot streaks along said combustor.

2. A combustor construction for a gas turbine engine comprising, in combination; an inner casing and an outer casing circumferentially spaced apart to form an annular fluid passage therebetween, at least one vane formed with a trailing edge and extending radially across said passage, a combustor mounted in said air passage and extending downstream from said vane with respect to the direction of fluid flow in said passage, an upstream end of said combustor formed with an indentation, said trailing edge of said vane located in circumferentially and axially spaced apart proximity to said indentation by an amount of not less than one and one half percent (1½%) or substantially greater than two and one half percent

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(2½%) of the width of said vane, such that a flow of fluid is scooped into said indentation from said passage to flow around and downstream of said trailing edge of said vane through said indentation to oppose the formation of a turbulent wake downstream of said vane thereby inhibiting the formation of hot streaks along said combustor.

3. A combustor construction for a gas turbine engine comprising, in combination; an inner casing and an outer casing circumferentially spaced apart to form an annular fluid passage therebetween, at least one vane formed with a trailing edge and extending radially across said passage, a combustor mounted in said air passage and extending downstream from said vane with respect to the direction of fluid flow in said passage, an upstream end of said combustor formed with an indentation, said trailing edge of said vane axially inset into said indentation in circumferentially and axially spaced apart relation thereto by an amount not less than one and one half percent (1½%) nor substantially greater than two and one half percent (2½%) of the width of said vane, such that a flow of fluid is scooped into said indentation from said passage to flow around and downstream of said trailing edge of said vane through said indentation to oppose the formation of a turbulent wake downstream of said vane thereby inhibiting the formation of hot streaks along said combustor.

4. A combustor construction for a gas turbine engine comprising, in combination; an inner casing and an outer casing circumferentially spaced apart to form an annular fluid passage therebetween, at least one vane extending radially across said passage, an annular combustor mounted in said air passage and extending downstream from said vane with respect to the direction of fluid flow in said passage, said combustor formed with a nose at the upstream end thereof, said nose formed with an indentation, said indentation comprising a pair of spaced apart walls extending with a component of direction generally radial to said passage, said indentation further comprising a baffle portion extending transversely to the general direction of fluid flow through said passage and joining said walls at the downstream ends thereof, said vane located in spaced apart relation to said walls and in axially spaced apart relation to said baffle portion by an amount not less than one and one half percent (1½%) nor substantially greater than two and one half percent (2½%) of the width of said vane, such that a flow of fluid is scooped into said indentation from said passage to flow around and downstream of said vane to oppose the formation of a turbulent wake downstream of said vane thereby inhibiting the formation of hot streaks along said combustor.

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