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COMBUSTION EQUIPMENT FOR A GAS TURBINE ENGINE

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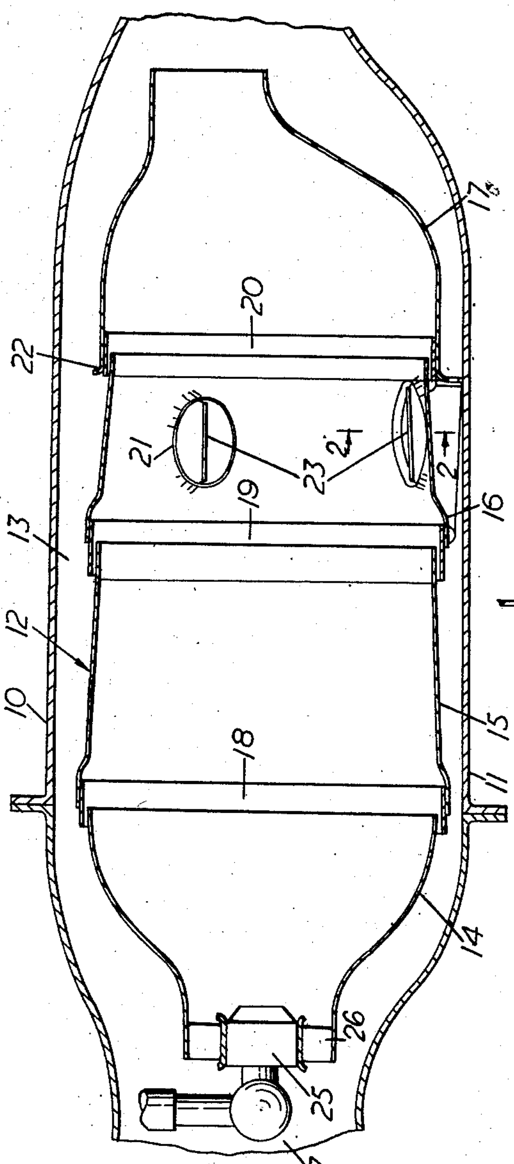

FIG. 1.

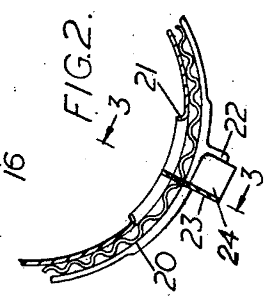

FIG. 2.

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FIG. 3.

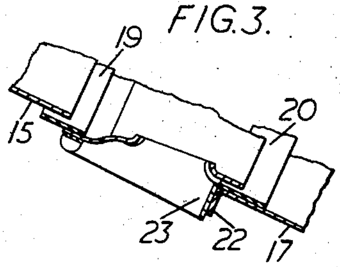


FIG. 4.

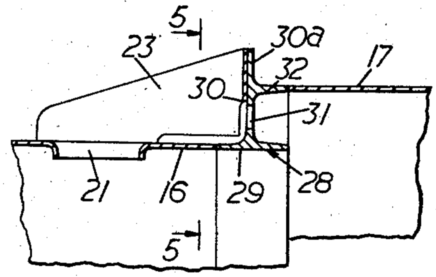
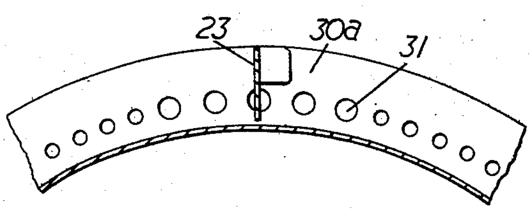


FIG. 5.



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COMBUSTION EQUIPMENT FOR A GAS TURBINE ENGINE

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This invention concerns combustion equipment for a gas turbine engine.

According to the present invention there is provided combustion equipment for a gas turbine engine comprising an air casing and a flame tube mounted therein with a space therebetween, said flame tube comprising at least two axially consecutive portions between which is disposed a cooling air transmitting member through which air may flow from said space and over the internal surface of the flame tube so as to cool the latter, said cooling air transmitting member being formed to transmit cooling air more readily in at least one localised area in which there is a restricted flow of air from said space.

The cooling air transmitting member is preferably provided with apertures of varying size, the largest apertures being disposed in said localised area or areas. Thus the cooling air transmitting member may comprise a corrugated annular strip the spaces between whose corrugations constitute the said apertures, the pitch and/or the depth of the corrugations being increased in said localised area or areas.

Preferably the flame tube is provided with holes through which air may flow from said space and into the flame tube so as to cool the products of combustion formed therein, said holes being arranged immediately upstream of the said cooling air transmitting member and being longitudinally aligned with the said localised area or areas thereof.

There may be mounted in said space at least one obstruction to air flow therethrough, said obstruction or obstructions being disposed immediately upstream of and being longitudinally aligned with the said localised area or areas of the cooling air transmitting member. Thus the obstructions may comprise flow dividing walls extending across the said holes in the flame tube. Preferably the said holes are arranged in one of said flame tube portions and the dividing walls are constituted by plates carried by the flame tube portion immediately downstream of said one portion.

It will be appreciated that by reason of the obstruction afforded by said plates to air flowing through the said space, and by reason of the withdrawal of some of this air through the said holes in the flame tube, the areas of the cooling air transmitting member which are longitudinally aligned with and are immediately downstream of said plates and holes will receive a diminished air supply. Since, however, these particular areas are formed to transmit cooling air more readily than the remaining parts of the cooling air transmitting member, the formation of hot spots in the flame tube in consequence of a shortage of cooling air will be avoided.

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

FIGURE 1 is an axial section through combustion equipment according to the present invention,

FIGURE 2 is a section taken on the line 2—2 of FIGURE 1,

FIGURE 3 is a section taken on the line 3—3 of FIGURE 2,

FIGURE 4 is an axial section through part of a modified combustion equipment according to the present invention, and

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FIGURE 5 is a section taken on the line 5—5 of FIGURE 4.

In FIGURES 1–3 there is shown a combustion equipment for a gas turbine engine comprising an annular air casing having coaxial outer and inner walls 10, 11. Within the air casing there are mounted a series of flame tubes 12 (only one of which is shown in the drawings), said flame tubes 12 being mounted side by side in the annular space 13 between the walls 10, 11.

Each of the flame tubes 12 comprises portions 14, 15, 16, 17 which are arranged successively downstream of each other. The downstream ends of the flame tube portions 14, 15, 16 are of smaller diameter than, and are mounted at, or just within, the upstream ends of the frame tube portions 15, 16, 17 respectively. Corrugated annular strips 18, 19, 20, which constitute cooling air transmitting members, are interposed between the portions 14, 15, the portions 15, 16 and the portions 16, 17 respectively.

The wall of the flame tube portion 16 is formed with a series of circumferentially spaced holes 21 through which air may pass from the space 13 into the interior of the flame tube.

The upstream end of the flame tube portion 17 is formed with a radially-outwardly extending flange 22. Extending into each of the holes 21 so as to be disposed diametrically thereof is a plate 23 which constitutes a flow dividing wall. The plate 23 has a tab 24, which is welded to the flange 22. The holes 21 are disposed just upstream of the strip 20 and, as is clearly shown in FIGURE 2, both the pitch and the depth of the corrugations in the strip 20 are increased in localised areas which are adjacent to and longitudinally aligned with the holes 21.

The upstream end of the portion 14 is provided with a fuel injector 25, the injector 25 being mounted within an annular device 26 which is adapted to impart a swirl to air passing from the inlet end 27 of the air casing and into the flame tube 12.

In operation, a part of the compressed air supplied to the inlet end 27 of the air casing passes through the device 26 so as to support the combustion of the fuel injected by the injector 25, the remainder of this air passing into the annular space 13. A portion of the air supplied to the space 13 passes between the corrugations in the strips 18, 19, 20 as so to provide the walls of the flame tube with a film of cooling air while another portion of the air supplied to the space 13 (known as "dilution" air) passes into the flame tube via the holes 21. Dilution air flowing through the holes 21 serves to cool the products of the combustion in the flame tube to a temperature acceptable to the turbine (not shown) to which the combustion products are supplied. The provision of the plates 23 across the holes 21 reduces the irregular vortex formation which otherwise tends to occur in the air passing through the holes 21 and therefore promotes air flow through these holes.

It will be appreciated that by reason of the flow of dilution air through the holes 21 and by reason of the blockage provided by the plates 23, the supply of air in the space 13 immediately downstream of the holes 21 is substantially reduced. The localised increase, however, in the pitch and depth of the corrugations in the strip 20 adjacent the holes 21 helps to ensure that there is a substantially uniform supply of film cooling air to the whole of the internal surface of the flame tube portion 17 and that no part of the said internal surface is starved of air so as to develop hot spots.

FIGURES 4 and 5 illustrate a modified embodiment of the invention in which the flame tube portions 16, 17 instead of having a corrugated annular strip 20 between them, are spaced apart by an annular strip 28.

The strip 28 has a ring-shaped part 29, which has the same diameter as, and is located against the downstream end of the flame tube portion 16. The part 29 is provided with a radially-outwardly extending web 30. The web 30, which is perforated with apertures 31, has a radially extending flange 30*a* and an axially directed circumferential flange 32 which has the same diameter as, and is located against the flame tube portion 17. The plates 23 are secured to the flange 30*a*.

As explained above, the plates 23 and holes 21 will cause a reduction in the air supply immediately downstream of these parts. In order, therefore, to compensate for this, the apertures 31 which are adjacent to and longitudinally aligned with the plates 23 are made larger than the remaining apertures 31.

We claim:

1. Combustion equipment for a gas turbine engine comprising an air casing, a flame tube mounted in said air casing with a space therebetween, said flame tube comprising at least two axially consecutive portions, a cooling air transmitting member disposed between said flame tube portions and through which air may flow from said space and axially over the internal surface of the flame tube to cool the latter, and means associated with said flame tube and disposed upstream of the cooling air transmitting member, for directing air from said space and into said flame tube, said last-mentioned means causing the air flow in the said space downstream thereof to be restricted in a localized area, said cooling air transmitting member being constructed to transmit cooling air axially over substantially the whole circumference of the said internal surface and more readily over a region of the internal surface which is aligned with said locailzed area than over other regions of the internal surface.

2. Combustion equipment for a gas turbine engine comprising an air casing, a flame tube mounted in said air casing with a space therebetween, said flame tube comprising two axially consecutive portions, a cooling air transmitting member disposed between said flame tube portions, means providing in said cooling air transmitting member a continuous series of apertures of varying size through all of which air may flow from said space and axially over the internal surface of the flame tube to cool the latter, and means associated with said flame tube and disposed upstream of the cooling air transmitting member, for directing air from said space and into said flame tube, said last-mentioned means causing the air flow in the said space downstream thereof to be restricted in a localized area, the largest of said apertures being aligned with said localized area and being constructed to transmit cooling air more readily over a region of the internal surface which is aligned with said localized area than over all other regions of the internal surface.

3. Combustion equipment for a gas turbine engine comprising an air casing, a flame tube mounted in said air casing with a space therebetween, said flame tube comprising at least two axially consecutive portions, a corrugated annular strip disposed between said flame tube portions and between whose corrugations air may flow from said space and axially over the internal surface of the flame tube to cool the latter, and means associated with said flame tube and disposed upstream of the corrugated annular strip, for directing air from said space and into said flame tube, said last-mentioned means causing the air flow in the space downstream thereof to be restricted in a localized area, the pitch of the corrugations in the said corrugated annular strip being greater in alignment with said localized area than elsewhere so that the corrugated annular strip transmits cooling air axially over the said internal surface more readily over a region of the internal surface which is aligned with said localized area than over other regions of the internal surface.

4. Combustion equipment for a gas turbine engine comprising an air casing, a flame tube mounted in said air casing with a space therebetween, said flame tube comprising two axially consecutive portions, a cooling air transmitting member disposed between said flame tube portions, means providing circumferentially spaced dilution air holes in the upstream flame tube portion, said dilution air holes being disposed immediately upstream of the cooling air transmitting member, said dilution air holes being formed to direct air from said space and into said flame tube and said dilution air hoels causing the air flow in the space downstream thereof to be restricted in a localized area, and means providing in said cooling air transmitting member a continuous series of apertures of varying size through all of which air may flow from said space and axially over the internal surface of the flame tube to cool the latter, the largest of said apertures being aligned with said localized area and being constructed to transmit cooling air axially over the said internal surface more readily over a region of the internal surface which is aligned with said localized area than over all other regions of the internal surface.

5. Combustion equipment for a gas turbine engine comprising an air casing, a flame tube mounted in said air casing with a space therebetween, said flame tube comprising two axially consecutive portions, a cooling air transmitting member disposed between said flame tube portions, means providing circumferentially spaced dilution air holes in the upstream flame tube portion, said dilution air holes being disposed immediately upstream of the cooling air transmitting member, flow dividing walls extending across said dilution air holes, said dilution air holes being formed to direct air from said space and into said flame tube, and said dilution air holes and flow dividing walls causing the air flow in the space downstream thereof to be restricted in a localized area, and means providing in said cooling air transmitting member a continuous series of apertures of varying size through all of which air may flow from said space and axially over the internal surface of the flame tube to cool the latter, the largest of said apertures being aligned with said localized area and being constructed to transmit cooling air axially over the said internal surface more readily over a region of the internal surface which is aligned with said localized area than over any other regions of the internal surface.

References Cited in the file of this patent

UNITED STATES PATENTS

2,537,033	Christensen	Jan. 9, 1951
2,658,337	Clarke	Nov. 10, 1953
2,973,624	Pierce	Mar. 7, 1961
3,019,605	Murray	Feb. 6, 1962

FOREIGN PATENTS

1,188,614	France	Mar. 16, 1959
839,009	Great Britain	June 29, 1960