

[54] **COMBUSTION LINER**

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[22] Filed: **Feb. 25, 1972**

[21] Appl. No.: **229,411**

[52] U.S. Cl. **60/39.65, 60/39.66**

[51] Int. Cl. **F02c 7/18**

[58] Field of Search **60/39.65, 39.23,**
60/39.29, 39.66

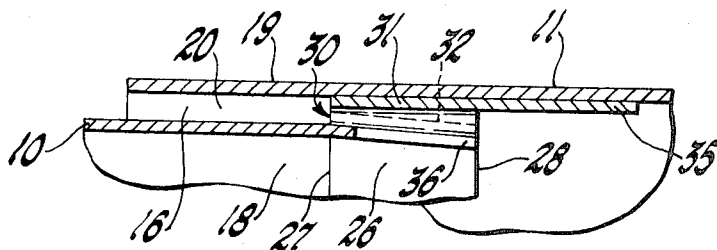
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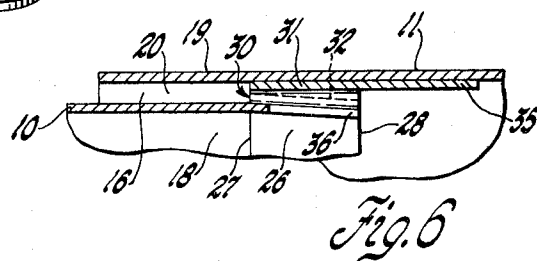
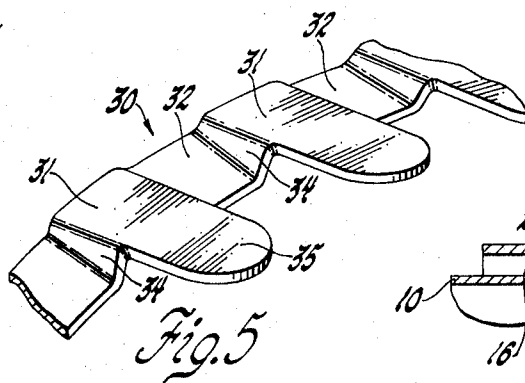
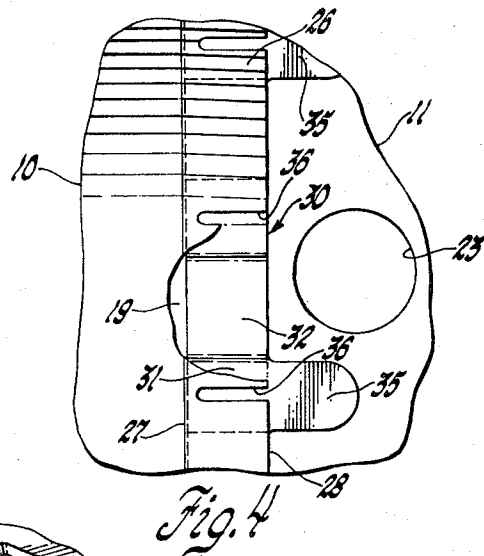
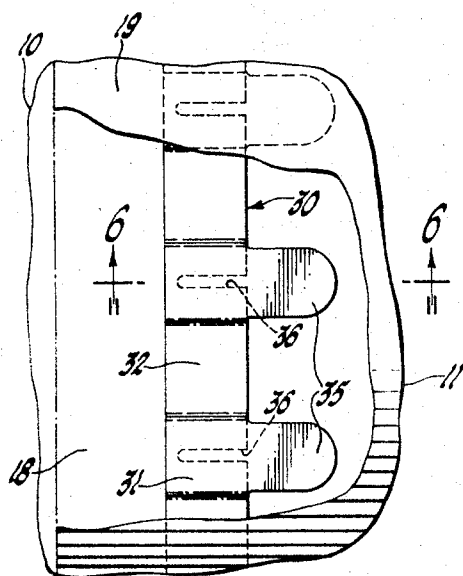
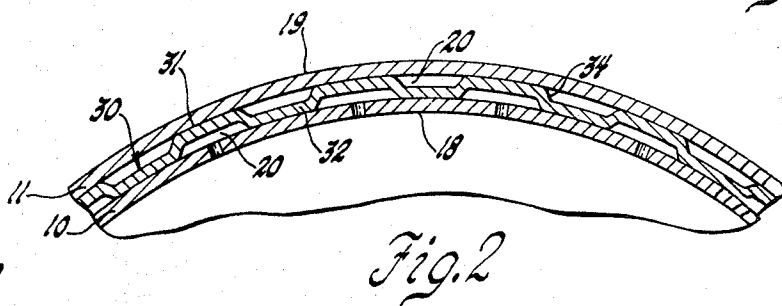
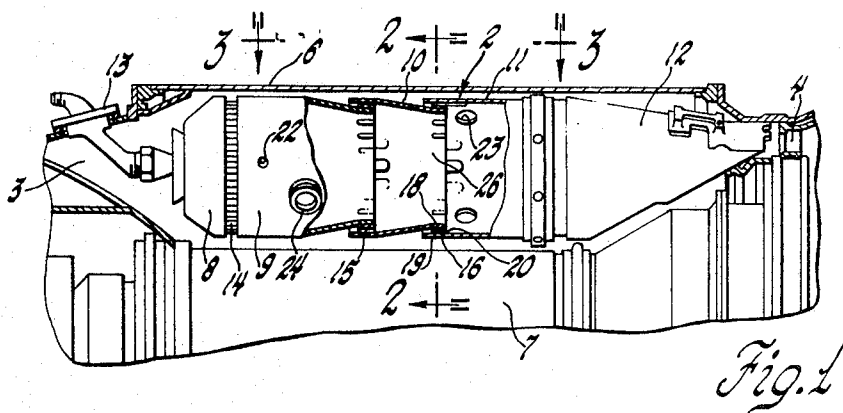
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[57] **ABSTRACT**

A gas turbine combustion liner has successive wall sections which define between them entrances for film cooling air which flows rearwardly along the inside of the liner in the same direction as the combustion products. The forward liner section is telescoped within the rearward one, and the rear portion of the forward liner section is tapered inwardly so that the gap between the two diverges radially in the direction of flow to diffuse the air flowing through the film cooling entrance. The overlapping portions of the liners are joined by a zigzag strip which is tapered to conform to the divergence of the passage walls, alternate lands of the strip being fixed by spot welding and brazing to the inner section and the lands between these having tabs extending from them which are spot welded and brazed to the outer liner section.

3 Claims, 6 Drawing Figures





COMBUSTION LINER

Our invention is directed to improving combustion liners such as are used in gas turbine engine combustion chambers. The principal objects of our invention are to improve the flow of film cooling air into such chambers by diffusing the flow and to provide a highly suitable structure of a combustion liner to achieve such diffusion. A further object is to provide combustion chamber structure which is light in weight, strong and rugged, and readily assembled.

Stated briefly, in its preferred embodiment, our invention involves the provision of tapered zigzag strips disposed between diverging overlapping sections of a combustion liner to fix the sections together and to cooperate with the overlapping sections in providing a diverging entrance for film cooling air. Further, in its preferred form our invention involves provision of a zigzag strip having tabs extending from the lands which lie adjacent one of the joined walls to facilitate assembly of the structure.

The nature of our invention and its advantages will be more clearly apparent to those skilled in the art from the succeeding detailed description of the preferred embodiment and the accompanying drawings thereof.

FIG. 1 is a general view of a gas turbine combustion apparatus including a combustion liner embodying the invention.

FIG. 2 is a greatly enlarged partial cross sectional view taken on the plane indicated by the line 2—2 in FIG. 1.

FIG. 3 is a partial enlarged view of the exterior of the combustion liner with parts cut away and in section, as indicated by the line 3—3 in FIG. 1.

FIG. 4 is a partial enlarged view of the interior of the liner, with parts cut away.

FIG. 5 is a partial axonometric view of a corrugated joining strip.

FIG. 6 is an enlarged fragmentary sectional view taken on the plane indicated by the line 6—6 in FIG. 3.

FIG. 1 illustrates the installation of a combustion liner embodying the invention in a gas turbine engine of known type such as the military T56 turboprop engine (Allison Model 501), the installation being generally as described in Tomlinson U.S. Pat. No. 3,064,424 and Hayes U.S. Pat. No. 3,064,425, both issued Nov. 20, 1962. The flame tube or combustion liner 2 of FIG. 1 is mounted between a compressor outlet diffuser 3 through which air enters the combustion apparatus and a turbine nozzle 4 through which the combustion products from the flame tube flow into a turbine (not illustrated). The combustion apparatus is bounded by an outer wall or case 6 and an inner wall 7, these defining between them an annular space within which a number, preferably six, of such combustion liners are mounted in generally parallel relation.

Each liner includes, in the direction of flow from its forward end to its outlet, a dome 8, wall sections 9, 10, and 11, and a transition section 12. The transition section is telescopically mounted on the turbine nozzle and the dome 8 is supported by a fuel nozzle 13 fixed in the outer wall of the engine. Fuel introduced by the nozzle, after being ignited, burns continuously in the air flowing into the liner 2 from the engine compressor. In the illustrated structure, an entrance for film cooling air to scour the interior of dome 8 and forward wall section 9 is indicated at 14. As shown, this is a structure

in accordance with that described in the Tomlinson patent referred to above. This is immaterial to the present invention, which is concerned with the structure for introduction of film cooling air into the liners illustrated at 15 between liner sections 9 and 10 and at 16 between liner sections 10 and 11. These may be essentially identical, so our present description will be confined to the air entrance 16 between sections 10 and 11.

It will be noted that section 10 has a marginal portion 18 and that section 11 has a cylindrical forward marginal portion 19 lying radially outward from and spaced from the marginal portion 18. A film cooling air entrance 20 is defined between these two marginal portions. Because of the convergence of the rear end of portion 18, this air entrance diverges in the direction of air flow through it into the interior of the liner. The air thus introduced, after being diffused in the entrance passage, flows along the inner surface of wall 11 to shield the wall from the hot combustion products and ultimately is mixed with the combustion products flowing from the combustion liner into the turbine.

Air for combustion and dilution, in addition to that introduced through the entrances 14, 15, and 16, is admitted to the liner through the dome 8 by openings not illustrated here, through a ring of primary combustion air holes 22 in the section 9, and through four dilution air holes 23 in the section 11. The spigot 24 is for cross connection to an adjacent combustion liner.

In operation of the combustion chamber, fuel is sprayed from the nozzle 13 into the upstream or dome end of the combustion liner, and combustion takes place largely in the upstream end of the liner, being completed as the gas flows through the liner. Film cooling air entering through the entrance 15 or 16 flows over the downstream marginal portion of a section of the liner and inside the immediately downstream section, thus cooling to some extent the downstream end of one liner section by convection cooling and cooling the downstream section through which it flows by film cooling; that is, by isolating the liner wall from the hot combustion gases to a large extent as well as by heat transfer from the liner wall to the film cooling air. The film cooling air may be employed in part in the combustion and may also serve as dilution air. A considerable quantity of dilution air is admitted through the holes 23 to reduce the temperature of the combustion products to a value tolerable to the turbine.

With this background, we may now consider in detail the preferred arrangement of the liner wall to provide structure conforming to the invention and attain the advantages of the invention.

Referring to FIGS. 2 through 6, it will be seen that the upstream marginal portion 19 of the liner section 11 extends a substantial distance over the downstream marginal portion 18 of the liner section 10 to define the film air entrance 20. In a particular embodiment, in which the liner is nearly six inches in diameter, the overlap of the marginal portions is about one inch. The thickness of the metal of the sections 10 and 11 is about 0.040 inch and the initial width of the radial gap between them about 0.070 inch. The initial portion of the air entrance 20 is of substantially constant area. However, the downstream end 26 of section 10, beginning at the line 27 in FIG. 6 and continuing to the edge 28, tapers to provide a diverging downstream or exit portion of the air entrance. This convergence of the mar-

ginal portion 18 is such that the width of the gap between the adjacent liner sections increases by about 0.030 inch in this terminal portion of the inlet. This serves to provide the increasing area of the passage and diffusion of the air entering, reducing its velocity.

The tapered end 26 of the section 10, which forms part of its marginal portion, is fixed to section 11 by a zigzag metal joining strip 30 which has outer lands 31 and inner lands 32 alternating around its circumference, these being joined by diverging or tapered risers 34. The zigzag strip is formed in a suitable die from a metal strip and, in the embodiment illustrated, has twenty-two corrugations around its circumference. The metal of the strip is necessarily stretched to some extent in this forming operation. The specific strip described is about 0.030 inch thick. The lands 31 are extended in the downstream direction to provide tabs 35 generally coplanar with the lands so as to lie in contact with the inner surface of section 11. The terminal edge of section 10 has 22 slits 36 formed in it to prevent thermal stress cracking at the edge of the liner section.

The taper of the joining strip 30 is such as to fit the surfaces to which it is to be attached. In the assembly of the liner, the strip 30 is fitted over the tapered portion 26 of the liner section 10 and fixed by spot welding between the lands 32 and the wall of section 10. Section 11 is then slipped over the joining strip and fixed to it by spot welding between the tabs 35 and the wall section 11. The joining is completed by a brazing operation which brazes lands 32 to the inner section and tabs 35 and lands 31 to the radially outer section. The effective width of the air passage between the liner sections through the corrugated joining strip in the particular embodiment increases from about 0.040 inch radial dimension at the forward edge to about 0.070 inch radial dimension at the rear edge, allowing for the thickness of the joining strip 30. As illustrated in FIG. 4, tabs 35 are omitted at some locations on the strip 30 so that they do not interfere with entry of dilution air through the openings 23.

The dimensions recited above are, of course, merely illustrative and may be varied, depending upon the dimensions and other operating parameters of a particular combustion liner. In the particular case illustrated the dimensions of the entrance between sections 9 and 10 are the same as those between sections 10 and 11 which have been described in detail.

It should be apparent from the foregoing that we have provided a structure which is readily fabricated, has a high degree of structural integrity, and is very well suited to achieve the object of diffusing and decelerating the air entering through the film air entrances so that it enters with a velocity consonant with that of the combustion products, minimizing turbulence and mixing, and enhancing the film cooling action of the air.

The detailed description of the preferred embodiment of the invention for the purpose of explaining the principles thereof is not to be considered as limiting or restricting the invention, since many modifications may be made by the exercise of skill in the art.

We claim:

1. A combustion liner for a gas turbine combustion apparatus or the like comprising two wall sections disposed successively in the direction of gas flow through the liner, with the adjacent marginal portions of the sections overlapping longitudinally of the liner and spaced radially of the liner to define an entrance for film cooling air into the liner between the said portions, the said marginal portions diverging radially of the liner in the direction of film cooling air flow to provide a diverging diffusing passage to reduce the velocity and increase the static pressure of the film cooling air as it flows through the entrance, and comprising a zigzag joining strip fixed to both adjacent wall sections having alternating inner and outer lands conforming to the surfaces of the respective marginal portions and having risers diverging in the direction of cooling air flow joining alternate lands.

2. A combustion liner for a gas turbine combustion apparatus or the like comprising two wall sections disposed successively in the direction of gas flow through the liner, with the adjacent marginal portions of the sections overlapping longitudinally of the liner and spaced radially of the liner to define an entrance for film cooling air into the liner between the said portions, the radially inner wall section converging radially toward its edge so that the said marginal portions diverge radially of the liner in the direction of film cooling air flow to provide a diverging diffusing passage to reduce the velocity and increase the static pressure of the film cooling air as it flows through the entrance, and comprising by a corrugated joining strip fixed to both adjacent wall sections having alternating inner and outer lands conforming to the surfaces of the respective marginal portions and having risers diverging in the direction of cooling air flow joining alternate lands.

3. A combustion liner for a gas turbine combustion apparatus or the like comprising two wall sections disposed successively in the direction of gas flow through the liner, with the adjacent marginal portions of the sections overlapping longitudinally of the liner and spaced radially of the liner to define an entrance for film cooling air into the liner between the said portions, the said marginal portions diverging radially of the liner in the direction of film cooling air flow to provide a diverging diffusing passage to reduce the velocity and increase the static pressure of the film cooling air as it flows through the entrance, and comprising by a zigzag joining strip fixed to both adjacent wall sections having alternating inner and outer lands conforming to the surfaces of the respective marginal portions and having risers diverging in the direction of cooling air flow joining alternate lands, the joining strip including tabs generally coplanar extending from alternate lands so as to project beyond the overlapping marginal portions, the tabs being fixed to one of the wall sections, and the lands disposed between the tabs being fixed to the other wall section.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,751,910 Dated August 14, 1973

Inventor(s) Ralph B. Sweeney, John M. Vaught, Albert J. Verdouw

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 56, after the period delete "cooling".

Column 4, line 32 and line 48, delete "by".

Signed and sealed this 18th day of December 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents