Nov. 20, 1962 C. F. HAYES 3,064,425

COMBUSTION LINER

Filed Oct. 5, 1959 2 Sheets-Sheet 1

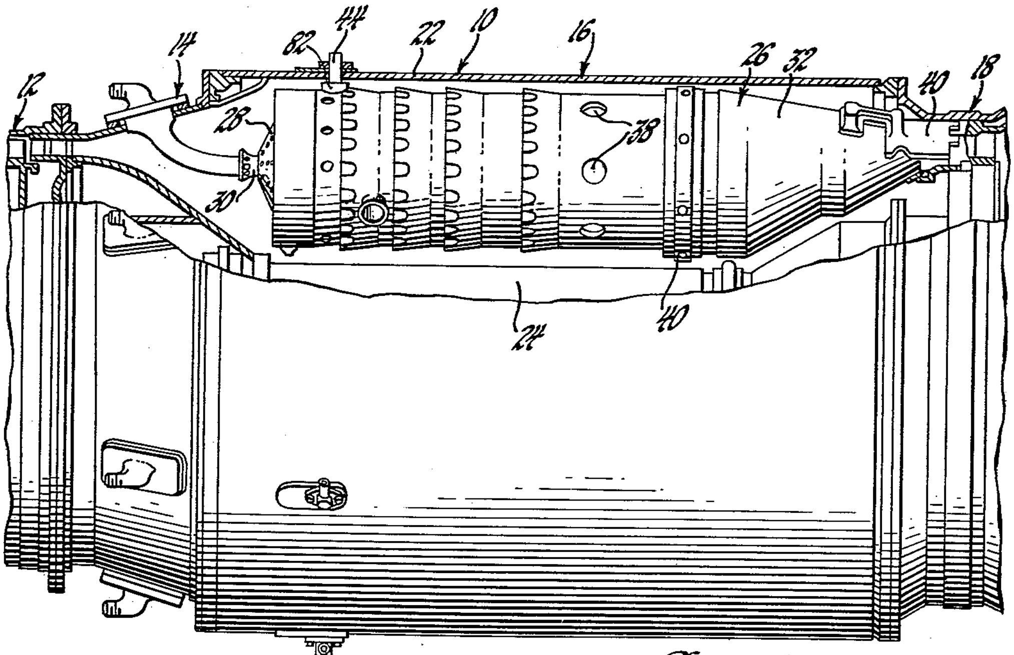

Fig. 1

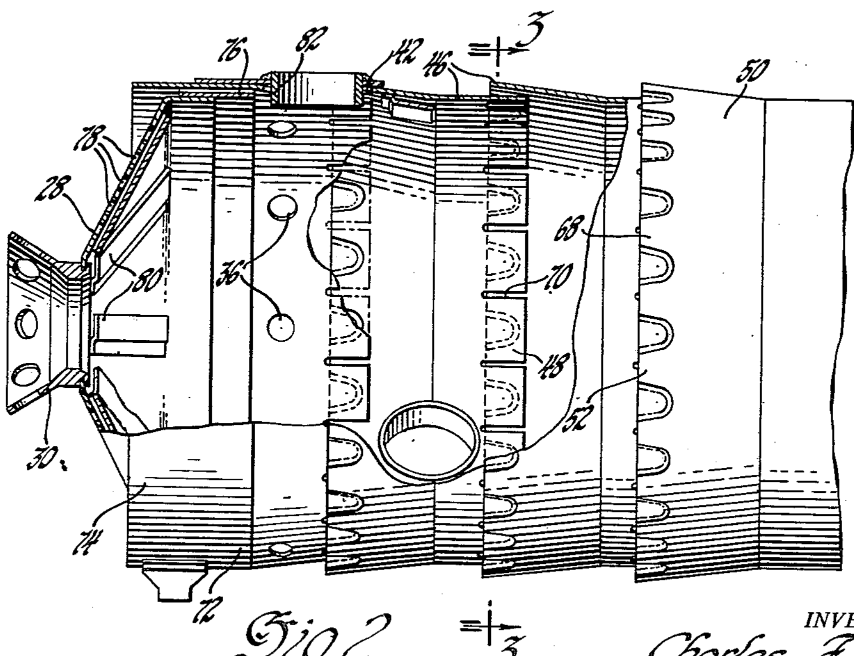

Fig. 2

INVENTOR.

Charles F. Hayes

BY

Robert E. McCallum

ATTORNEY

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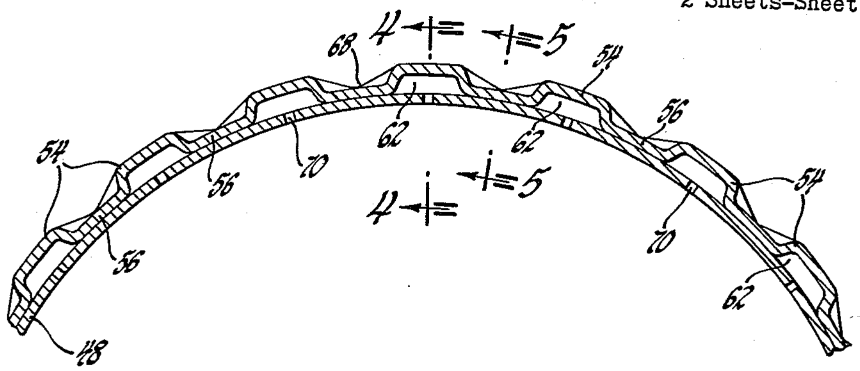

Fig. 3

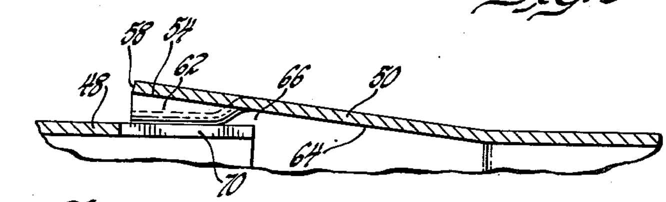

Fig. 4

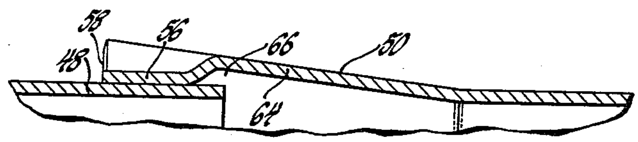

Fig. 5

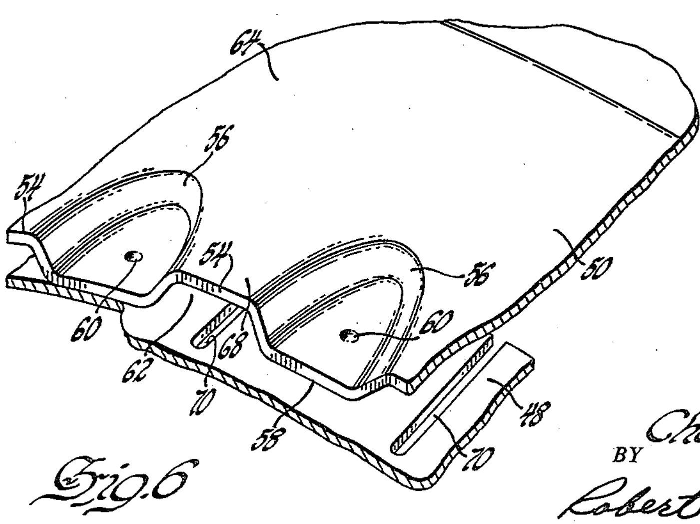

Fig. 6

INVENTOR.
Charles F. Hayes
BY
Robert E. McCollum
ATTORNEY

United States Patent Office

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COMBUSTION LINER

Charles F. Hayes, Indianapolis, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention relates to a combustion chamber construction, and more particularly, to a means for cooling the liner of a flame tube in a combustion section.

In gas turbine engines having a cannular-type combustion section, a number of annular combustion cans, liners, or flame tubes, as they are commonly called, are generally spaced around the circumference of the combustion section. One method of manufacturing these combustion cans is to telescope a number of axially aligned annular sections and spot weld them together at circumferentially spaced points along their overlapping edges. However, with this construction, hot spots often develop in the liner to the rear of the weld points or dimples due to an inadequate flow of cooling air to these areas thus causing an ultimate burn-out of the liner in this region. This invention eliminates these faults by providing circumferential corrugations on the forward or upstream edge portion of each section cooperating with the rear overlapped edge portion of an adjacent section to provide fluid flow passages therebetween having shapes to direct the flow to the liner portions directly rearwardly or downstream of the weld points.

It is therefore an object of this invention to provide a combustion liner cooling means constructed in a manner to adequately and efficiently cool the entire liner and specifically that portion immediately downstream of the weld points connecting adjacent sections together.

It is a further object of this invention to provide a combustion liner construction having adjacent liner sections formed for cooperation together to provide fluid passages therebetween tapering in a number of planes to adequately diffuse the cooling air over the greatest posisble area of the combustion liner.

Other features, objects and advantages will become apparent upon reference to the detailed description of the invention as follows, and to the drawings illustrating the preferred embodiment thereof, wherein:

FIGURE 1 is a side elevational view with parts broken away and in section of a portion of a gas turbine engine embodying the invention,

FIGURE 2 is an enlarged portion of a detail of FIGURE 1 with parts broken away and in section,

FIGURE 3 is an enlarged cross-sectional view of a detail taken on a plane indicated by and viewed in the direction of the arrows 3—3 of FIGURE 2,

FIGURES 4 and 5 are enlarged cross-sectional views of the FIG. 3 construction taken on planes indicated by and viewed in the direction of the arrows 4—4 and 5—5 of FIGURE 3,

FIGURE 6 is an enlarged perspective view of the details shown in FIGS. 3–5.

Referring now to the drawings, and more particularly to FIGURE 1, there is illustrated schematically therein a portion of a gas turbine engine 10 having a compressor 12 of the axial flow type (only the later stages of which are shown), a diffuser section 14, an annular combustion section 16, and a turbine section 18 (partially shown). Positioned within the combustion section 16, which is defined by the engine casing 22 and the shroud 24 surrounding the main shaft (not shown), are a number, preferably six, for example, of generally cylindrical combustion cans 26 equally spaced around the circumference of the combustion section. Each of the cans has at its forward end a dome 28 adapted to cooperate with a fuel nozzle 30 of

a conventional type secured to the engine casing in the diffuser section 14, and at its downwstream end a transition section 32 adapted to cooperate with the inlet to the turbine section 18. Furthermore, the cans are each provided with primary air inlet holes 36 and secondary and air dilution holes 38, as well as arcuate reinforcing members 40. The cans 26 are also each provided with an opening 42 for the insertion therein of an igniter plug 44 secured at its opposite end to the engine casing. While the number of igniter plugs illustrated correspond to the number of combustion cans, generally one or two plugs are "live," while the remaining ones are "dummy" plugs, with the propagation of the flame between the combustion cans being accomplished through the use of conventional crossover tubes.

Details of the engine beyond those already described are known in the art to which this invention pertains, are immaterial to an understanding of the invention, and do not constitute a part of this invention; consequently, further details beyond a brief description of the general operation thereof will not be given.

As shown in FIGURE 3, the air discharged from the compressor 12 is directed into the diffuser 14 wherein the air velocity is reduced, the swirl component thereof is eliminated, and the dynamic pressure energy is changed to static pressure energy to present the air to the dome of the combustion can in a uniformly distributed fashion so that it will pass thereinto, be mixed with the fuel spray supplied through the fuel nozzle 30, ignited and burned, and pass into the turbine inlet to drive the turbine (not shown), which in turn drives the turbine shaft to drive the compressor, restarting the cycle.

Referring now more particularly to the details of construction of the combustion can, and specifically to the subject matter of this invention, shown in FIGURES 2–6, it will be seen that the combustion can comprises a number of overlapping annular truncated cone sections 46 each having an axially extending slotted rear edge 48 formed integral therewith. As seen in FIGS. 3–6, the forward portion 50 of each section is formed with circumferential corrugations 52 providing axially extending alternatingly connected ridges 54 and grooves 56. The grooves 56 are substantially pointed, dimple-like indentations with a downstream pointing tip. Each of the portions 50 overlaps the rear axial edge 48 of the adjacent section in a manner to abut or contact the inner surface of the grooves 56 with the rear edge as shown at 58 in FIGURE 6. The two edges are then joined rigidly to each other by spot welding as indicated at 60.

The overlap of the two edge sections and welding them together defines an axially extending fluid passage 62 between the walls and outer radial portion of each of the ridges of the forward portions 50 and the rear edge 48 of the adjacent section for the passage therethrough into the interior of the can of cooler combustion chamber jacket air surrounding the can. This air not only provides an insulating layer of cool air between the flames in the burner can and the entire liner to prevent burn-out, but also, with particular reference to the invention, cools the areas of the liner immediately downstream of the spot welds in a manner to be described. Because of the tapering of the forward portion 50 of each section due to the truncated cone configuration, the walls of each of the ridges 54 and grooves 56 of the corrugations 52 taper radially as at 64, the taper converging with an increase in the axial distance downstream of the combustion can. As seen in FIGURE 4, each of the fluid passages has a restricted throat 66 defined by the rear edge 48 of the adjacent sections and the radial taper of portion 50 to cause an increase in the velocity of the air flow through the passage and a squeezing action or diffusion of the air in this region by a reduction in height of the volume of air.

As seem more particularly in FIGURES 1, 2, 3 and 6, the passages are each further tapered circumferentially with respect to each other, the taper **68** diverging laterally with an increase in the axial downstream direction. The quantity or volume of air entering each of the fluid passages is therefore forced out laterally or sideways as the height of the passage is diminished by the longitudinal taper to fill the area defined by the two tapers and the rear edge **48** and wash completely the walls of the grooves and ridges with cool air along the entire axial length thereof. This tapering construction therefore not only provides diverging or fan-shaped intersecting fluid flow paths to cool the portions of the liner around the welds and immediately downstream thereof thereby preventing a burn out of these portions, but also delivers air into the can to cool the entire combustion liner.

It is to be noted from the drawings that the axial length of overlap between edge **48** and portion **50** is preferably greater than the axial length of the corrugations to permit forming of the passages in a manner that absolutely makes the air expand to fill the area behind each corrugation. This overlap length will also, of course, vary as a function of the desired restriction of the throat **66** of the fluid passage, i.e., the throat area as determined by the taper angle of portion **50** and the overlap length of edges **48** and **50** will be that area providing the most efficient restriction to increase the velocity of the fluid passing through the passage to cause a diffusion thereof spreading out the flow against the walls of the ridges and grooves to completely wash them with cool air and prevent hot spots behind the welds.

As seen in FIGS. 2, 3 and 6, and as stated previously, the rear edge **48** of each section is slotted at **70** to eliminate distortion of the liner by permitting circumferential expansion or contraction thereof during thermal expansion or contraction of the liner. The slots also aid in forming the axially extending edge **48**.

While the intermediate or body portion of the combustion cans are formed by overlapping as many sections of the described configuration, as desired, as seen in FIGURE 2, the first annular section **72** of the combustion liner has an axial forward edge portion **74** cooperating with a corrugated annular spacer element **76** having secured thereto internally thereof the dome **28**. The construction of the dome as shown is known and immaterial to an understanding of the invention. Suffice it to say, however, that the dome may have a number of radially and circumferentially spaced primary air holes **78** for the admission of air therethrough, and a number of circumferentially spaced stepper swirler baffle plates **80** cooperating therewith to diffuse the primary air for better fuel-air mixing. The first section liner is also provided with the opening **42** within which a ferrule **82** is inserted and rigidly secured to the can receiving therein the igniter plug **44**.

The details of construction of the end of the can downstream of the air dilution holes **38**, and the transition end of the liner are known and may be conventional, and therefore will not be described, since they do not pertain to the present invention or vary the scope thereof. While spot welding has been described as the method of securing the overlapping sections together, it will be clear that other known methods of attachment, as long as they are consistent with the invention, may be used without departing from the scope of the invention.

To summarize, therefore, it will be seen that the volume of air admitted through the fluid passages will be squeezed laterally to wash the walls of the grooves and ridges of the corrugations with cool air, thereby completely cooling this section of the liner and providing a cooling layer of fluid between the flame of the combustion can and the liner to act as an insulator to prevent burn out thereof.

From the foregoing, it will be seen, therefore, that this invention provides a combustion can of rigid construction, and with means to cool the same effectively to prevent hot spots therein and subsequent failure thereof. This invention also provides a combustion can that can be manufactured economically and one that has a long endurance life. While the invention has been illustrated in connection with the combustion section of a gas turbine engine, it will be clear to those skilled in the art to which this invention pertains that many modifications can be made thereto without departing from the scope of the invention.

I claim:

1. A combustion liner including a number of telescopically mounted sections having overlapping portions, the walls of the overlapping portions converging radially towards each other in a downstream direction, and a plurality of circumferentially spaced dimple-like indentations formed in the wall of one portion contacting the wall of the other portion, each of the indentations converging circumferentially in a downstream direction thus defining fluid passages between the walls and indentations converging radially and diverging circumferentially in a downstream direction, the edge of one portion extending farther downstream than the downstream end of said indentations, the shape of the passages thereby causing the fluid passing therethrough to follow a fan-shaped path to effectively cool the sections.

2. A combustion liner including a number of telescopically mounted sections have overlapping portions, the walls of the overlapping portions converging radially towards each other in a downstream direction, and a plurality of circumferentially spaced dimple-like indentations formed in the wall of one portion contacting the wall of the other portion, each of the indentations converging circumferentially in a downstream direction thus defining fluid passages between the walls and indentations converging radially and diverging circumferentially in a downstream direction, the edge of one portion extending farther downstream than the down stream end of said indentations, the shape of said passages thereby effecting a squeezing action on any fluid passing therethrough causing the fluid to follow a fan-shaped path to effectively cool the sections and the points on said portion walls immediately downstream of the points of contact of said walls.

3. A combustion liner including a number of telescopically mounted sections having overlapping portions, the walls of the overlapping portions converging radially towards each other in a downstream direction, and a plurality of circumferentially spaced substantially triangle-shaped indentations formed in the wall of one portion contacting the wall of the other portions, each of the indentations converging circumferentially in a downstream direction thus defining fluid passages between the walls and indentations that converge radially and diverge circumferentially in a downstream direction, the edge of one portion extending farther downstream than the downstream end of the indentations, the shape of said passages thereby effecting a squeezing action on any fluid passing therethrough causing the fluid to follow a fan-shaped path to effectively cool the sections and the points on said portion walls immediately downstream of the points of contact of said walls.

References Cited in the file of this patent

UNITED STATES PATENTS

2,645,081	McDonald	July 14, 1953
2,670,601	Williams et al.	Mar. 2, 1954
2,884,759	Sevcik	May 5, 1959