Sept. 26, 1961 L. W. SHUTTS 3,001,366

COMBUSTION CHAMBER CROSSOVER TUBE

Filed May 15, 1958

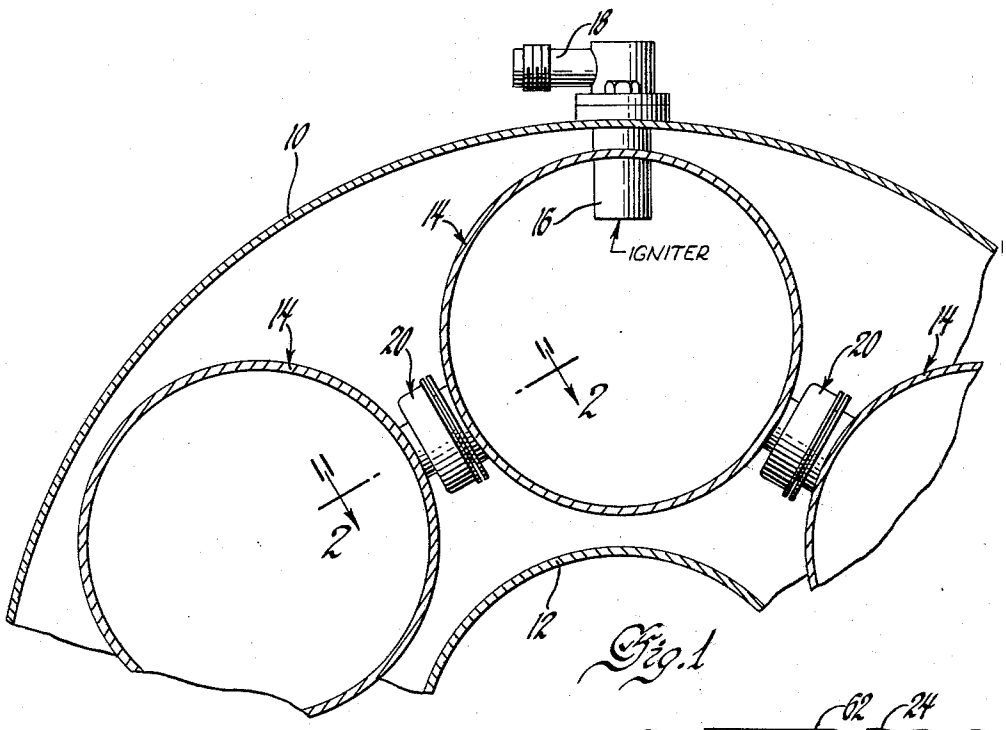


Fig. 1

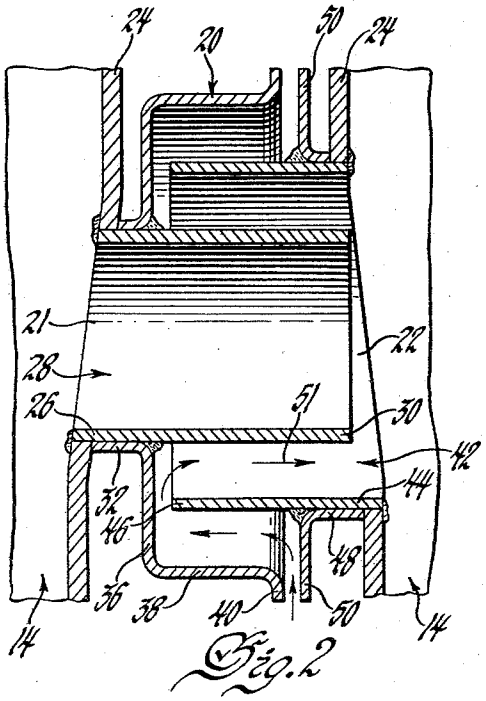


Fig. 2

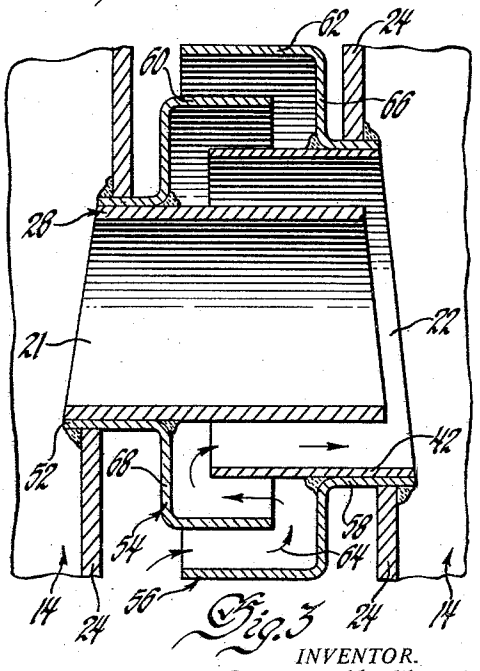


Fig. 3

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United States Patent Office 3,001,366
Patented Sept. 26, 1961

3,001,366

COMBUSTION CHAMBER CROSSOVER TUBE

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Filed May 15, 1958, Ser. No. 735,555
5 Claims. (Cl. 60—39.82)

My invention relates to combustion apparatus, particularly to such as are used in aircraft propulsion gas turbine engines, although it may be otherwise employed.

Combustion systems for gas turbine engines are of various types. One known type, to which the invention is primarily applicable, comprises a number of ducts, commonly called flame tubes or combustion liners, in which combustion is effected. These flame tubes are mounted in a combustion chamber which extends between the compressor and turbine of the engine and from which combustion air is supplied to the several flame tubes. Ordinarily, the flame tubes are disposed in a substantially parallel arrangement disposed circumferentially around the axis of the engine. Ordinarily, the combustion chamber is annular and the power output shaft of the turbine is mounted within the inner shroud of the combustion chamber.

Where a plurality of flame tubes are employed, it is the usual practice to interconnect them by tubes or sleeves commonly called crossover tubes. The principal purpose of the crossover tubes is to provide for ignition of the flame in each flame tube from the adjacent flame tube so that an ignition device is not required for each combustion space.

This invention is directed to a crossover tube and the construction of the flame tubes for reception thereof such that the application and removal of the crossover tubes and flame tubes during assembly or servicing of the engine is greatly facilitated and such that expansion or distortion of the structure due to the high temperatures prevailing is readily accommodated. These advantages are attained by a structure of remarkable simplicity and minimum weight and cost. In crossover tubes of the type mentioned, considerable wear difficulties are encountered with tubes which make mechanical contact. This invention eliminates such difficulties by providing a crossover tube made in two sections with a labyrinth interfit, thereby providing free spacing between the sections and eliminating any mechanical contact. Other objects of the invention are to improve combustion apparatus such as is used in gas turbine engines; to facilitate assembly and servicing of such engines; to provide an improved combustion chamber and crossover tube structure; and to provide a simple, efficient, and inexpensive crossover tube.

The preferred manner in which these objects are achieved and the advantages of the invention will be apparent to those skilled in the art from the appended description of the preferred embodiments of the invention.

Referring to the drawing, FIGURE 1 is a transverse section of a portion of a gas turbine combustion apparatus,

FIGURE 2 is an enlarged sectional view taken on a plane containing the axis of a crossover tube as indicated by the line 2—2 in FIGURE 1, and

FIGURE 3 is a modification of the construction of FIGURE 2.

The combustion apparatus is contained in a combustion chamber bounded by an outer casing or shroud **10** and an inner shroud **12**, these being cylindrical. The shrouds **10** and **12** may be formed of semi-cylindrical sections fixed together. The shrouds define a passage for air discharged by the compressor of a gas turbine engine, which flows axially of the casing **10**.

Mounted within the combustion chamber are a plu-

rality of flame tubes or combustion liners **14**. In the embodiment illustrated, there are six flame tubes, only a part of which are shown to avoid unnecessary duplication in the drawings. These flame tubes, which are generally cylindrical, are disposed with their axes parallel. They are formed with perforations to admit air for combustion from the outer chamber into the interior of the flame tubes and are fitted with fuel injection nozzles (not shown). The shrouds **10** and **12** and the flame tubes **14** are ordinarily made of heat resisting alloys such as stainless steel or Inconel. The combustion products are discharged from the flame tubes into a turbine (not shown). One or preferably two of the flame tubes are provided with fuel ignition devices **16** which may be of any conventional type. Ordinarily, the ignition device is mounted on the outer shroud **10** and projects into the flame tube **14**. As illustrated, the igniter is an electrical one and includes a connector **18** for a high tension circuit. Since the structure so far described is of a sort well known to those skilled in the gas turbine engine art and the details thereof are immaterial to the invention, further description is unnecessary.

Adjacent flame tubes **14** are interconnected by crossover tubes or sleeves **20** so that flame may be propagated from one combustion zone to another.

Referring to FIGURE 2 it will be seen that each of the adjacent portions of the flame tubes **14** are provided with suitable axially aligned opposed openings **21** and **22**, the opening **22** being larger than the opening **21**.

Welded to the liner **24** at the flame tube opening **21** is one end **26** of an annular or tubular section **28** of the crossover tube **20**, the other end **30** extending to the opening **22**. Surrounding end **26** adjacent opening **21** and extending therefrom is a sleeve **32** formed as shown to a cup-like shape having portions **36** and **38** perpendicular and parallel, respectively, to the axis of the tube section **28**, with a lip flange **40** as shown for a purpose to be described.

Surrounding end **30** of crossover tube section **28** is a larger tubular section **42** having one end **44** mounted within the opening **22**, with its other end **46** extending to a point adjacent the perpendicular portion **36**.

Welded to the tube section **42** adjacent opening **22** and extending therefrom is a sleeve **48** having a flange **50** extending in a direction perpendicular to the axis of the crossover tube to act as a baffle for cooperation with the lipped flanged edge **40**. As seen in FIGURE 2, the right-hand flame tube liner **24**, and flanges **50** and **40** are approximately equally spaced axially from each other, with portions **36** and **38** of sleeve **32** having a labyrinth interfit with flange **50** and tube section **42**, portion **38** overlapping both sections **42** and **28** but being laterally or radially spaced therefrom.

With this construction, the two sections **28** and **42** of the crossover tube are laterally spaced from each other without mechanical contact with the sleeves **32** and **48** having a labyrinth interfit providing an air reversal of approximately 270 degrees to restrict the flow of air to the flame tube liners. Because of this construction, any combustion chamber jacket air that enters the space between flanges **40** and **50** must follow a tortuous path as shown by the arrows **51**, flowing first in a direction perpendicular to the axis of the crossover tube, then in a direction parallel to the crossover tube axis, and finally being reversed 180 degrees to flow into the opening **22** for a total air reversal of 270 degrees. The energy of the air flow is dissipated by the air flow striking and being turned by the tube **42**, portion **36** and tube **28** to such a degree that very little air actually enters the flame tubes. This labyrinth interfit thus becomes a labyrinth-like air seal.

In the assembly of this combustion apparatus, each flame tube has secured in its adjacent opening the respec-

tive section of the crossover tube and its corresponding sleeve or portion of the labyrinth-like seal, and the two sections are merely interfitted together by telescoping tube section 28 within section 42 without any bending of the parts. The simplicity of assembly will thus be evident.

FIGURE 3 shows a modifications of the FIGURE 2 construction wherein the sleeves have a labyrinth interfit providing an air reversal of 360 degrees. In this construction, the two tubes sections 28 and 42 remain the same as previously, with the changes consisting only in the sleeve portions surrounding the tube sections. As seen in FIGURE 3, a sleeve 52 is welded to tube section 28 and the flame tube liner adjacent the opening 21 and is flared outwardly as shown to form a cup-like section 54 similar to that of FIGURE 2. Facing the open end of cup section 54 is the open end of an axially aligned larger cup-like section 56 formed integrally with a second sleeve 58 welded to tube section 42 and the flame tube liner 24 as shown. With this construction, cup-like portions 54 and 56 of sleeves 52 and 58 have a labyrinth interfit with overlapping portions 60 and 62 overlapping the tube sections. Thus, the leakage of air from the combustion chamber jacket into the liners is reduced to a minimum since any entering air must follow a tortuous path indicated by arrows 64 twice completely reversing the direction of air flow to complete a 360 degree cycle. The energy of the air flow is thus lost or dissipated to such a degree in striking the portion 66 of cup-like section 56, tube 42, portion 68 of cup-like section 54 and tube 28 that very little air enters the liner through the opening 22. In this construction, therefore, even less air flows into the combustion liners from the combustion chamber jacket compared to that of FIGURE 2, and the labyrinth interfit of the cup-like sleeve portions and tube sections forms a labyrinth-like air seal.

From the foregoing it will be seen that the crossover tubes of this invention illustrated by the embodiments of FIGURES 2 and 3 provide a labyrinth interfit connection between the flame tubes without mechanical contact permitting relative expansion or distortion of the liners because of the spacing between the crossover tube sections, while preventing too great a flow of air into the liners.

While the drawings and description describe the preferred embodiments of my invention, it will be clear to those skilled in the art that many modifications can be made therefrom without departing from the scope of the invention.

I claim:

1. A combustion apparatus comprising, in combination, means defining a compressed air chamber, a plurality of flame tubes in the chamber, and crossover tube means interconnecting adjacent flame tubes, in which each crossover tube means comprises a first tube member extending from one flame tube, a second tube member extending from an adjacent flame tube, and parts of the tube members providing an air labyrinth between the tube members, the said tube members being out of contact with each other in normal operation of the combustion apparatus to accommodate thermal distortion and minimize wear by preventing engagement of the members, and the air labyrinth restricting air flow into the crossover tube means from the compressed air chamber.

2. A combustion chamber construction comprising, an air chamber having a plurality of flame tubes therein, and crossover tube means interconnecting adjacent flame tubes, said crossover tube means comprising axially aligned tubular elements having overlapped end portions with a clearance therebetween, opposite end portions of said elements being secured each to a separate flame tube, and other means extending from each of said elements, towards each other and said overlapped ends and having portions spaced from each other and said elements to prevent contact and wear therebetween upon thermal distortion of the portions and elements, said other means together with said elements defining an air labyrinth therebetween restricting the flow of air into the interior of said elements.

3. A crossover tube comprising axially aligned tubular members having overlapped ends with a clearance therebetween, first sleeve means connected to one of said members and extending towards the adjacent member, second sleeve means secured to said adjacent member and extending towards said one of said members overlapping said first sleeve means and said members, the overlapping portions of said sleeve means and members having a clearance therebetween to prevent engagement therebetween upon thermal distortion of said members and sleeve means portions, a source of gas in communication with one of said sleeve means, the overlapping sleeve means and member portions together forming a gas labyrinth for the restrictive flow of gas through said sleeve means to the interior of said members.

4. A crossover tube as in claim 3 wherein said sleeve means includes portions comprising a number of face-to-face dished members.

5. A crossover tube comprising axially aligned tubular members having overlapped ends with a clearance therebetween, first sleeve means secured to one of said members and extending towards another of said members, second sleeve means secured to said another of said members and extending towards said first member, baffle means on said second sleeve means, said first sleeve means having a portion overlapping both of said tubular members, said sleeve means portion and members and baffle means having a clearance therebetween to prevent engagement therebetween upon thermal distortion of said members and sleeve means and baffle means, a supply of gas, and flange means on the overlapping portion of said first sleeve means cooperating with said baffle means to define a gas inlet therebetween, said overlapping sleeve means portion and said tubular members together defining a tortuous path for the restrictive flow of gas from said inlet into said members.

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