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COMBUSTION CHAMBER CROSSOVER TUBE

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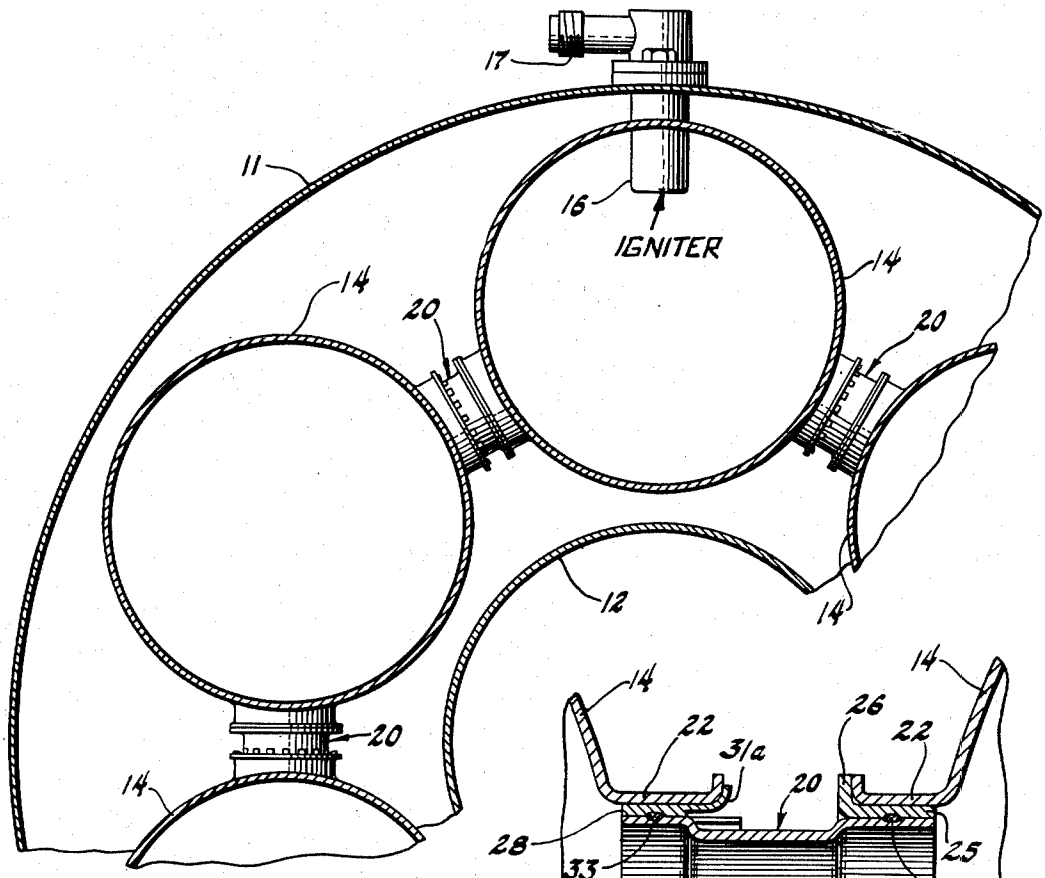

Fig. 1

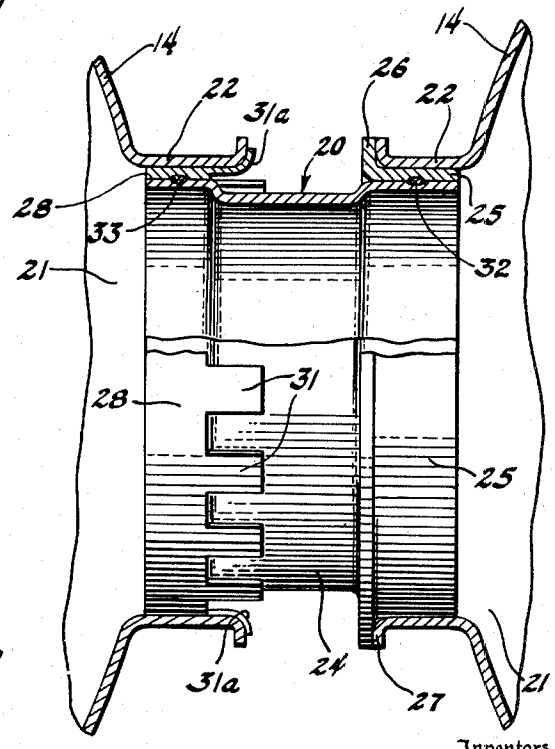

Fig. 2

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COMBUSTION CHAMBER CROSSOVER TUBE

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Our 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 our 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 combustion chambers or flame tubes are employed, it is the usual practice to interconnect the flame tubes 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. The principal 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 embodiment of the invention.

Referring to the drawing, Figure 1 is a transverse section of a portion of a gas turbine combustion apparatus, and Figure 2 is an enlarged sectional view taken on a plane containing the axis of a crossover tube.

The combustion apparatus is contained in a combustion chamber bounded by an outer casing or shroud 11 and an inner shroud 12, these being cylindrical. The shrouds 11 and 12 may be formed of semicylindrical 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 11.

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 11 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 11 and projects into the flame tube 14. As illustrated, the igniter is an electrical one and includes a connector 17 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 noted that the flame tubes are formed with openings 21 which are so located that the openings 21 of adjacent flame tubes are opposed and are axially aligned. Each flame tube is formed with a flange or boss 22 around the opening 21, the flange being provided to receive the crossover tube 20. The crossover tube comprises a sleeve 24 of heat resisting metal which is slightly reduced in diameter in the intermediate portion thereof. One end of the sleeve 24 has mounted thereon a flanged collar 25, the cylindrical portion of which is dimensioned for an easy sliding fit into the flange 22 of the flame tube. The flange 26 of the collar 25 defines a shoulder which may engage a flange 27 at the outer end of the boss 22 of the flame tube. At the other end of the sleeve 24 a castellated sheet metal ring 28 is fixed. The castellations of the ring provide a number of tabs 31 which, before installation of the crossover tube, lie in the same cylindrical surface as the body of the ring 28 and slightly spaced from the reduced diameter portion of the sleeve 24. The ring 28 is dimensioned for a sliding fit in the boss 22 of a flame tube. The rings 25 and 28 are fixed on the sleeve 22 by seam welding, as indicated at 32 and 33 respectively.

When the combustion apparatus is assembled, the crossover tube is held in place by bending outwardly one or more of the tabs 31 as indicated by 31*a* at the top and bottom of Figure 2 to provide a locating shoulder. The reduced diameter of the central part of sleeve 24 makes it easy to pry up the tabs.

The significance of the invention may be best appreciated in connection with a consideration of the problem involved in assembly and disassembly of the engines. The flame tubes 14 must be inserted and removed individually so that it is important to have a crossover tube structure which makes it easy to assemble or disassemble them. In the assembly of the engine, before any of the tabs 31 are bent out, the crossover tube 20, as shown in Figure 2, may be inserted into the left-hand flame tube in Figure 2 until the flange 26 engages the boss of the left-hand flame tube. In this position of the crossover tube, the right-hand end of the tube is out of the way of the right hand flame tube, which may be moved into place either longitudinally of the engine or radially of the engine without interference from the crossover tube. When both flame tubes are in place, the

crossover tube is slid to the right to the position illustrated in Figure 2 and the tab or tabs 31*a* are bent out completing the assembly. All of the crossover tubes are assembled in the same manner. To remove a flame tube, it it necessary only to bend inwardly the previously bent tabs so that the crossover tube can again be pushed into one flame tube so as to clear the other. Even if this releasing of the tabs should break the tabs, another pair of tabs may be used for holding the crossover tube in place when the device is reassembled.

The fit of the crossover tube in the flame tubes may be made as loose as desired. Any desired amount of looseness of the crossover tube for movement longitudinally of its own axis may be provided to accommodate expansion or distortion of the flame tubes.

It is believed that the advantages of the invention will be apparent to those skilled in the art from the foregoing. Many modifications of structure may be made within the principles of the invention, which are illustrated but not limited by the foregoing description of the preferred embodiment.

We claim:

1. A combustion apparatus comprising, in combination, means defining a chamber adapted to be supplied with air; a plurality of flame tubes in the chamber, adjacent flame tubes being provided with open opposed coaxial sockets for receiving a crossover tube to interconnect the flame tubes, the sockets being disposed to provide a gap therebetween; and a crossover tube adapted for insertion in the opposed sockets extending between the flame tubes, the crossover tube comprising a sleeve of length greater than the said gap, a shoulder thereon spaced from one end of the sleeve by a distance less than the gap, so that when the other end of the sleeve is inserted in a flame tube the sleeve clears the adjacent flame tube, and means providing an abutment against one of the flame tubes when the shoulder is lodged against the other flame tube to hold the crossover tube against displacement after assembly.

2. A combustion apparatus comprising, in combination, means defining a chamber adapted to be supplied with air; a plurality of flame tubes in the chamber, adjacent flame tubes being provided with open opposed coaxial sockets for receiving a crossover tube to interconnect the flame tubes, the sockets being disposed to provide a gap therebetween; and a crossover tube adapted for insertion in the opposed sockets extending between the flame tubes, the crossover tube comprising a sleeve of length greater than the said gap, a shoulder thereon spaced from one end of the sleeve by a distance less than the gap, so that when the other end of the sleeve is inserted in a flame tube the sleeve clears the adjacent flame tube, and means providing at least one tab on the sleeve between the shoulder and the said other end, the tab being adapted to be bent outwardly to form an abutment against one of the flame tubes when the shoulder is lodged against the other flame tube to hold the crossover tube against displacement after assembly.

3. A combustion apparatus as recited in claim 2 in which the last recited means provides a plurality of the said tabs.

4. An apparatus comprising, in combination, first and second tubes and a crossover sleeve interconnecting the tubes, the tubes being provided with opposed spaced openings and the sleeve being mounted so as to extend into the openings and extend therebetween to provide communication between the tubes, the sleeve including means providing a fixed shoulder thereon to limit the depth of insertion thereof into the first tube and means providing at least one tab deformable outwardly from the sleeve to limit the depth of insertion thereof into the second tube, the shoulder and tab thus serving to locate and fix the sleeve in a position interconnecting the tubes.

5. An apparatus comprising, in combination, first and second tubes and a crossover sleeve interconnecting the tubes, the tubes being provided with opposed spaced openings and the sleeve being mounted so as to extend into the openings and extend therebetween to provide communication between the tubes, the sleeve including means providing a fixed shoulder thereon to limit the depth of insertion thereof into the first tube and means providing a plurality of tabs deformable outwardly from the sleeve to limit the depth of insertion thereof into the second tube, the shoulder and tabs thus serving to locate and fix the sleeve in a position interconnecting the tubes, the tabs being spaced from the sleeve in their original position to facilitate deformation thereof.

6. An apparatus as recited in claim 4 in which the distance of the said shoulder from one end of the sleeve is less than the distance between the said openings.

7. A crossover tube comprising a sleeve, a shoulder thereon spaced from one end of the sleeve, and means on the sleeve providing a number of tabs on the sleeve between the shoulder and the other end of the sleeve, the tabs extending away from the said other end and toward the shoulder and being adapted to be sent outwardly to form an abutment.

8. A crossover sleeve including means providing a fixed shoulder thereon and means on the sleeve providing a plurality of tabs deformable radially from the sleeve, the tabs being spaced radially from the sleeve in their original position to facilitate deformation thereof.

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