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COOLING MEANS FOR COMBUSTION CHAMBER CROSS IGNITION TUBES

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Fig. 1.

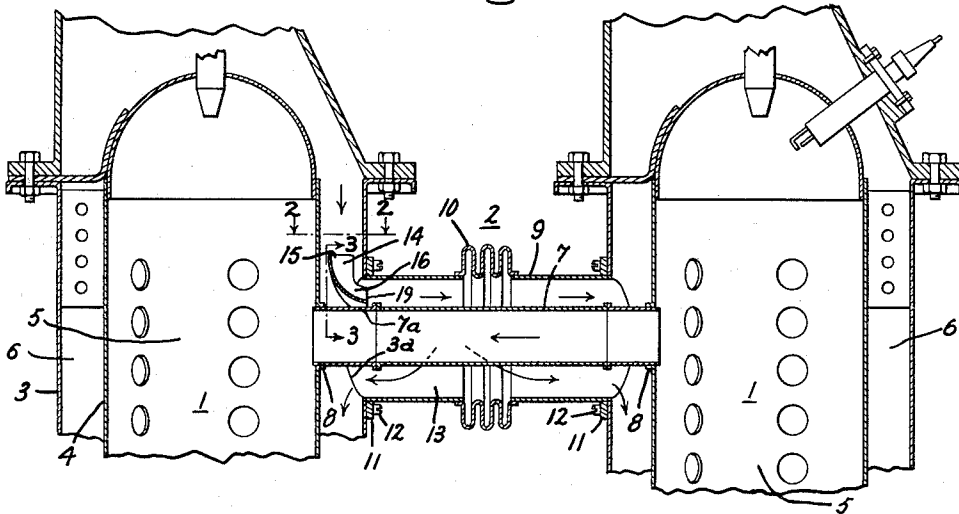


Fig. 2.

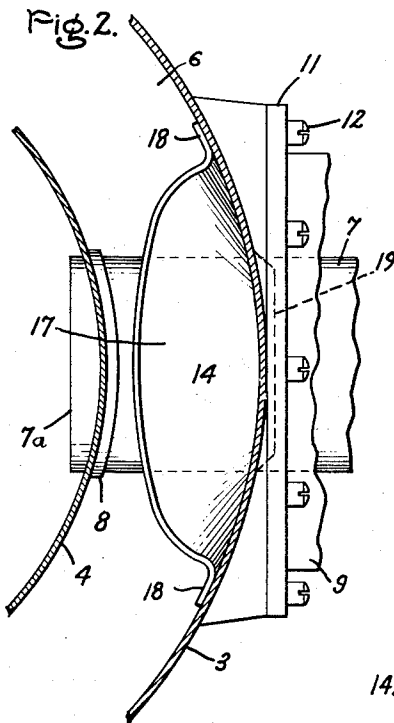


Fig. 3.

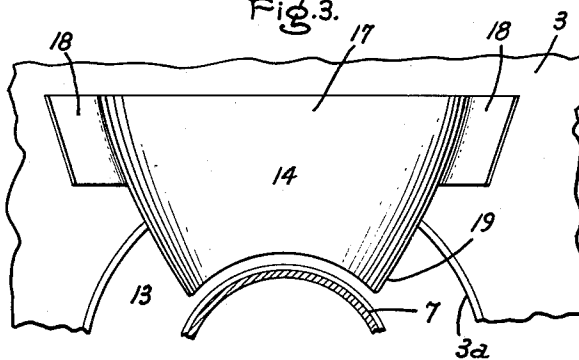
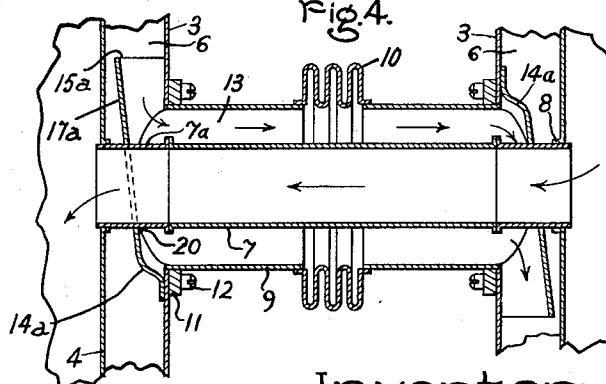


Fig. 4.



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COOLING MEANS FOR COMBUSTION CHAMBER CROSS IGNITION TUBES

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5 Claims. (Cl. 60—39.37)

This invention relates to combustion chambers and particularly to an improved means for cooling cross ignition tubes for such combustion chambers.

In the design of gas turbine power plants, particularly for aircraft use, it has been customary to provide a plurality of combustion chambers connected in parallel flow relation in order to obtain adequate combustion space and at the same time minimize weight and the space occupied by such a power plant. In order to guard against possible pressure unbalance that might otherwise exist in individual combustion chambers, it has been customary to provide means connecting the interiors of the several combustion chamber casings. Such an arrangement also tends to insure that ignition, when initiated, is initiated simultaneously in all combustion chambers and also permits the use of only one or two ignition plugs in one or two of the combustion chambers. In starting, burning starts first in the combustion chamber or chamber having an ignition plug, and from this or these combustion chambers, the other combustion chambers are quickly ignited by the flame passing through connecting tubes. A combustion chamber arrangement and cross-ignition tube arrangement of this type is described with greater particularity in Patent No. 2,432,359 granted December 9, 1947, upon an application of Dale D. Streid.

In connection with recent efforts to improve certain operating characteristics of power plants of the type described, it became desirable to increase the cross sectional area of the cross-ignition tubes. It was found that when the cross sectional areas of the cross-ignition tubes were increased, the inner connecting tube of the cross-ignition tube system was often subjected to temperatures of the order of 3000° F. Obviously, the best of presently known metals would have an extremely short life if subjected to such service because of rapid deterioration at such temperatures.

Accordingly, it is an object of the present invention to provide an improved cross-ignition tube arrangement which is relatively simple and inexpensive to manufacture and in which adequate cooling of critical parts is provided to obtain reasonable life expectancy of such parts.

Other objects and advantages will be apparent from the following description taken in connection with the accompanying drawing in which Fig. 1 is a partial sectional view of two combustion chambers and their cross-ignition means provided with an improved cooling arrangement in accordance with the invention; Fig. 2 is a partial sectional view taken in the direction of arrows 2—2 of Fig. 1; Fig. 3 is a view partly in section taken in the direction of arrows 3—3 of Fig. 1; and Fig. 4 is a modified embodiment of the arrangement shown in Fig. 1.

Referring now to Fig. 1, two combustion chambers are indicated generally at 1 connected together by a cross-ignition tube arrangement indicated generally at 2. Combustion chambers 1 comprise an outer casing 3 and an inner liner 4 defining an elongated combustion zone 5. Combustion chambers 1 are of the type more particularly described in the above-mentioned Streid patent wherein

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casing 3 and liner 4 are in spaced relation to form an air supply passage 6. It is often customary to connect a plurality of combustion chambers 1 in parallel flow relation to a compressor (not shown) which supplies air for cooling purposes and for purposes of combustion in a manner also disclosed in the above-mentioned Streid patent.

In aircraft service where weight is of considerable importance, it is highly desirable to avoid providing separate ignition means for each individual combustion chamber 1 and, also, where the products of combustion are utilized as motive fluid for driving a turbine as is also disclosed in the above-mentioned Streid patent, it is desirable to provide passage means interconnecting all combustion zones 5 in order to minimize any pressure unbalance which may tend to occur between individual combustion zones 5. This is accomplished by the provision of the cross-ignition means 2 comprising an inner conduit 7 for establishing communication between adjacent combustion zones 5. Ordinarily, conduit 7 is a loose piece, that is, the end portions thereof are merely inserted in telescope fashion into an eyelet portion 8 provided in each of adjacent liners 4. The fit between conduit 7 and eyelet portions 8, while intended to be a reasonably close fit, is a slip fit rather than one which is completely tight so that under certain conditions, flame from one of the combustion zones 5 may find its way past the eyelet portion 8 and the outer surface of conduit 7. In order to guard against this eventuality and also to provide a positive means for preventing leakage of air from passageways 6 to the atmosphere, an outer casing 9 is provided.

Casing 9, which includes a flexible bellows 10, surrounds the greater portion of conduit 7 and is connected to the casings 3 of adjacent combustion chambers. Casing 9 may be connected to casings 3 in a number of different ways which will be apparent to those skilled in the art. As illustrated in the drawings, casing 9 is provided with flanges 11 at the end portions thereof for connection to casings 3 by means of threaded fastenings 12.

With only the structure thus far described, it will be seen that conduit 7 and casing 9 cooperate to form a passageway 13 which also surrounds the greater portion of conduit 7 and communicates with air supply passageway 6 in both combustion chambers so that conduit 7 is substantially surrounded by a layer of air at relatively low temperature. However, it has been found that this surrounding layer of air is not always adequate to protect conduit 7 against extremely rapid deterioration which has been found to be due to surges of flame through conduit 7 so that its walls are subjected to temperatures of the order of 3000° F. It has been found that such flame surges will occur when extremely low pressure differences exist adjacent combustion zones 5, that is, with pressure differences of only a few inches of water.

I have found that adequate protection against the harmful effects of such flame surges is effected by the provision of an air scoop 14 having an entrance opening 15 facing in the direction of air flow in passageway 6 and spaced in relation to passageway 13 to form a discharge opening 16 for directing a portion of the air flowing through passageway 6 through passageway 13. According to a simple embodiment of the invention, scoop 14 is suitably formed from a piece of sheet metal to form a central scoop portion 17 with tab portions 18 at each end of the scoop portion 17. Air scoop 14 is secured to casing member 3 in any convenient manner, for example, by welding tab portions 18 to the walls of casing 3 with edge portion 19 of scoop portion 17 extending beyond opening 3a in the walls of casing 3. In this way edge portion 19 cooperates with a portion of casing wall 3 and

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opening 3a to form opening 16 through which cooling air is directed into passageway 13 from scoop 14.

In operation, with air flowing at relatively high velocity in passageways 6, there would be no tendency for any flow of cooling air parallel to the axis of conduit 7 through passageway 13 if scoop 14 were not provided because the local pressures at the extremities of passageway 13 would be substantially balanced. With the provision of my scoop means for converting at least a portion of the velocity head of the high velocity air flowing in the left-hand passageway 6 as shown in Fig. 1 into pressure energy, this velocity head is thereby made available for creating a pressure difference across the extremities of passageway 13 and thus will cause a flow of cooling air therethrough. From an inspection of the cross-sectional view of air scoop 14 as shown in Fig. 1, it will be apparent that the flow area of the scoop decreases more or less uniformly as the air passes from opening 15 to opening 16 so that this air is discharged at relatively high velocity into passageway 13. Since the air in the right-hand passageway 6 of Fig. 1 flows past the right-hand end of passageway 13 at high velocity, the static pressure at the right-hand end of passageway 13 will be somewhat lower than the static pressure plus the velocity head of the air flowing through opening 16, the pressure difference being sufficient to insure a positive and steady flow of cooling air over the surfaces of conduit 7 and thus protect it against the deteriorating effect of high-temperature flame surges.

A modified embodiment of the invention is illustrated in Fig. 4 wherein like parts bear the same notation previously employed and scoop 14 is replaced by a modified scoop 14a. As the high velocity air stream from passageway 6 flows past conduit 7, in a system not employing scoops, the local static pressure in the immediate vicinity of and at the upstream side of conduit 7 will increase to some value greater than the average static pressure in passageway 6. The local static pressure at the downstream side of conduit 7 will be less than the local pressure at the upstream side thereof and may be less than the average value of static pressure within passageway 6. Accordingly, scoop 14a is provided with a scoop portion 17a and tab portions 18a similar to those previously described. In addition, however, scoop portion 17a has an opening 20 therein to receive and fit closely around conduit 7. Therefore, when scoop 14a is secured to the wall of casing 3 in the manner previously described and with conduit 7 projecting through opening 20, scoop 14a forms a scroll-like casing around conduit 7a. Scoop 14a cooperates with the wall of left-hand casing 3 to form an inlet opening 15a, but the annular space formed between casing 9 and conduit 7, in other words, the opening 3a in casing 3 forms the discharge opening through which cooling fluid is supplied to passageway 13.

I prefer to utilize two scoops 14a, one having opening 15a facing in an upstream direction with respect to the flow in passageway 6 and the other having opening 15a facing in a downstream direction in the adjacent passageway 6 in the manner shown in Fig. 4. It will be noted that the flow area of scoop 14a decreases more or less uniformly from opening 15a to the annular discharge opening formed by conduit 7 extending through opening 3a of casing 3. In this way, full advantage can be taken of the previously described pressure distribution in order to insure a fairly uniform flow of cooling air through passageway 13.

Operation is as described in connection with the previous embodiment of the invention except that instead of merely allowing the cooling flow from passageway 13 to pass directly into right-hand passageway 6, this cooling flow is collected from passageway 13 by a similar scoop member 14a and discharged in a downstream direction into the right-hand passageway 6.

Thus it will be seen that the invention provides a means for adequately cooling cross-ignition tubes for combustion chambers so that such tubes will have a reason-

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able life expectancy, it is relatively easy to manufacture and to apply either to new combustion chamber designs or to previously existing combustion chambers. While a particular embodiment of the invention has been illustrated and described, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention and it is intended to cover in the appended claims all such changes and modifications that come within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a combustion apparatus, at least two separate combustion chambers each having an inner liner forming a combustion zone and an outer casing surrounding the liner and spaced therefrom to form a fluid passageway, first conduit means supported by adjacent liners and establishing communication between adjacent combustion zones, second conduit means spaced from and surrounding the first conduit means and connected to adjacent casings to establish communication between the passageways of adjacent combustion chambers, and a dished wall surrounding a portion of said first conduit means within and secured to the casing of at least one combustion chamber between the casing and the liner and adjacent the second conduit means to form in co-operation with said casing a first opening facing upstream with respect to the flow in the passageway including said dished wall and for directing a portion of the fluid from said passageway into the space between said first and second conduit means.

2. In a combustion apparatus, at least two separate combustion chambers each having an inner liner forming a combustion zone and an outer casing surrounding the liner and spaced therefrom to form a fluid passageway, first conduit means supported by adjacent liners and establishing communication between adjacent combustion zones, second conduit means spaced from and surrounding the first conduit means and connected to adjacent casings to establish communication between the passageways of adjacent combustion chambers, and a dished wall within and secured to the casing of at least one combustion chamber between the casing and the liner and adjacent the second conduit means with spacing between one end of said dished wall and said casing forming a first opening facing upstream with respect to the flow in the passageway including said dished wall with a second end portion of said dished wall spaced from said second conduit means to form a second opening for discharging fluid therefrom in a direction generally axial with respect to said second conduit means.

3. In combustion apparatus, at least two combustion chambers each having an inner liner forming a combustion zone and an outer casing surrounding the liner and spaced therefrom to form a fluid passageway, conduit means connected to adjacent liners and establishing communication between adjacent combustion zones, a scoop member surrounding a portion of said conduit means between said liner and said outer casing of at least one combustion chamber and having an opening facing upstream in the associated fluid passageway, a casing coaxial with and spaced from said conduit means, said scoop discharging fluid between said conduit and said casing across the exterior surface of said conduit means and in a direction generally axial with respect to said conduit means.

4. In combustion apparatus, at least two combustion chambers each having an inner liner forming a combustion zone and an outer casing surrounding the liner and spaced therefrom to form a first fluid passageway, first conduit means connected to adjacent liners and establishing communication between adjacent combustion zones, second conduit means spaced from and surrounding the first conduit means and connected to adjacent outer casings to form an annular fluid passageway between said first fluid passageways of adjacent combustion chambers,

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a dished wall having an opening therein adapted to receive and fit closely around said first conduit means when said wall is secured to one of said outer casings and within the first fluid passageway to form in cooperation with said outer casing a second opening for receiving fluid from said passageway.

5. In a combustion apparatus, at least two combustion chambers each having an inner liner forming a combustion zone and an outer casing surrounding the liner and spaced therefrom to form a first annular fluid passageway, first conduit means connected to adjacent liners and establishing communication between adjacent combustion zones, second coaxial conduit means spaced from and surrounding the first conduit means and connected to adjacent outer casings to form a second annular fluid passageway in communication with said first passageway, a pair of dished walls each having a first opening therein adapted to receive and fit closely around said first conduit means when said walls are secured to the outer casings adjacent both ends of the second conduit means and with-

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in the first passageways to form a pair of scroll-like casings each surrounding a portion of the first conduit means and forming in cooperation with said outer casings second openings in said first passageways, the second opening associated with one of said scroll-like casings facing in an upstream direction in said first passageway and the second opening associated with the other of said scroll-like casings facing in a downstream direction in an adjacent first passageway.

References Cited in the file of this patent

UNITED STATES PATENTS

2,404,335	Whittle	July 16, 1946
2,437,385	Halford	Mar. 9, 1948
2,445,114	Halford	July 13, 1948
2,525,207	Clarke	Oct. 10, 1950
2,546,432	Darling	Mar. 27, 1951
2,580,962	Sédille	Jan. 1, 1952