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TURBINE COMBUSTOR

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Fig. 1

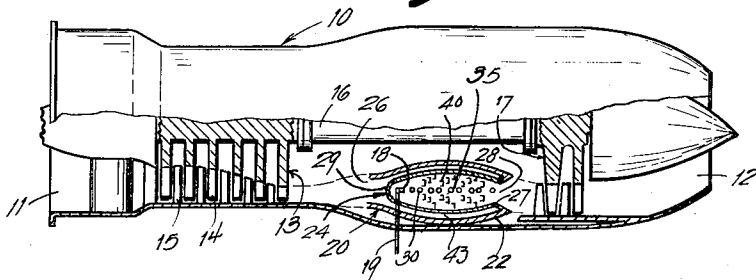


Fig. 2

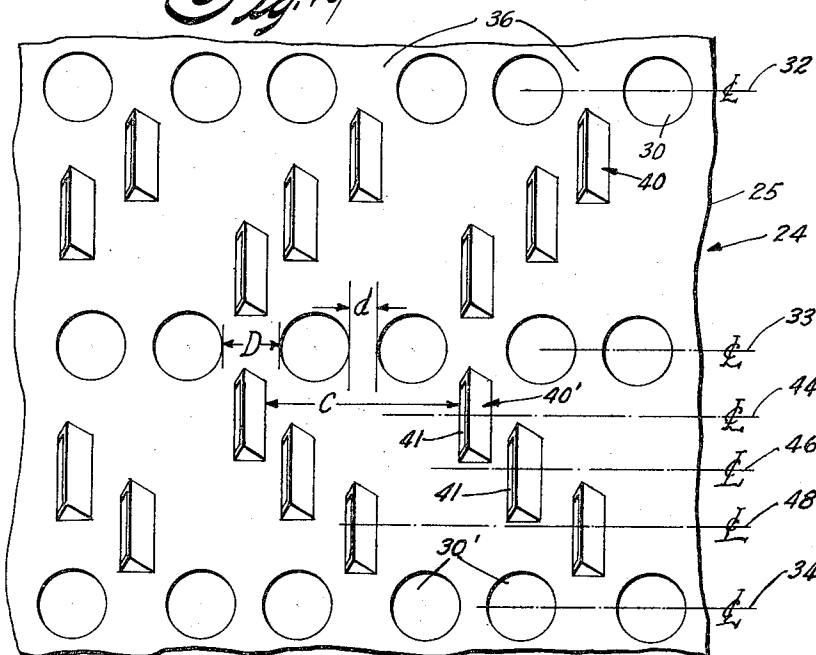
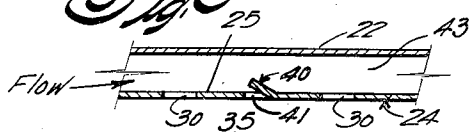


Fig. 3



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1 Claim. (Cl. 60—39.65)

This invention relates to combustion apparatus, especially combustors for gas turbines in aircraft although it may be applied to other uses.

A combustor, as used in aircraft, normally comprises an inner or flame tube in which an air-fuel mixture is burned and discharged to supply thrust for propelling the aircraft. An outer tube or casing spaced from the flame tube surrounds it to provide an annular air passage between the tubes. Air flowing in the air passage is admitted into the flame tube through a number of combustor holes in the flame tube wall for mixing and combusting with fuel. Louvers on the inner surface of the flame tube and placed between the combustor holes direct air over the tube's inner surface for cooling of the tube.

This invention is directed mainly to the arrangement of the combustor holes and louvers. Heretofore, in the design of combustors, it has been the general practise to lay out the holes in some uniform pattern, such as in axial rows wherein they were also circumferentially aligned. The holes were equally spaced from each other in their respective rows and the rows were spaced evenly where possible and were likewise aligned axially and circumferentially. This arrangement of the holes and louvers in many respects placed them extremely close to each other, especially in the case of small combustors utilizing practical sizes for holes and louvers. As a result, the combustor had poor mechanical strength in that the wall between the holes readily broke down with large circumferential cracking.

With this in mind, it is the object of this invention to provide a pattern in which there is a non-uniform axial spacing and peripheral staggering of combustor holes to effect optimum strength in a combustor.

Furthermore, it is an aim to so arrange the combustor holes so that louvers may be disposed close to combustor holes to provide improved adequate cooling in this critical area and yet permit optimum spacing of the louvers in axial rows.

It is also an object of this invention to provide a combustor in which holes and louvers are arranged in a repeating pattern which permits ease of manufacture.

Other objects will become apparent from the detailed description of the embodiment of the invention illustrated in the accompanying drawings.

As illustrated in the drawings:

FIGURE 1 is a schematic showing of a gas turbine in side elevation with portions broken away which incorporates the invention;

FIGURE 2 is an enlarged fragment of the inner tube of the combustor structure showing the arrangement of the combustor holes and louvers of the present invention as seen on its outer surface, and

FIGURE 3 is a fragmentary section through the combustor.

The gas turbine engine illustrated in FIGURE 1 comprises a tubular housing 10 having an air inlet 11 at one end and a combustion products outlet 12 at its other end. The pressure of the air entering the inlet 11 is increased by a compressor 13 having a number of blades 14 rotating between fixed blades 15. The compressor 13 is driven through a shaft 16 by a turbine 17 which is turned by the expelled gases from the combustion chamber 35 of the combustor 20. Fuel is supplied to the

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combustor by a nozzle 18 which is connected to a source of fuel (not shown) by a conduit 19. As shown in the drawing the combustor 20 has a pair of concentrically spaced sheet metal tubes, 22 and 24, each of which is opened at only one end. The outer tube or casing 22 has its open end 26 facing the compressor, whereas the open end 28 of the inner or flame tube faces the turbine.

Air from the compressor enters the outer casing 22 and passes into the flame tube 24 through a number of combustor holes 30 and louvers 40, which will be described more in detail in a subsequent portion of this description. The outer casing 22 increases in cross sectional area from its air inlet end 26 toward its center then decreases at its downstream end 27 where it is closed by a joint with the inner casing or flame tube 24. The flame tube 24 is closed at the upstream end 29 and like the outer casing increases in cross sectional area from its ends toward its middle. Although the inner tube 24 and the outer casing 22 are shown to be substantially circular in cross-section, obviously they may assume other shapes.

The construction described so far is conventional; the improvement to which this invention adverts is the means by which air is admitted into the flame tube 24 from the outer casing 22 for mixing and combusting with fuel and cooling of the flame tube wall 25. For combustion purposes air from the outer casing 22 is admitted into the combustion chamber through a number of combustor openings or holes, some of which are numbered 30, in the flame tube wall. Their number, size and shape may vary, but it is preferred, for ease of construction, that they be circular, of the same size, and of a comparatively great number which is sufficient to pass the required amount of air for combusting and yet avoid the creation of air streams that will extinguish the flame within the combustion chamber. The arrangement of the holes, as best shown in FIG. 2, is a number of rows, the center lines of some of which are indicated as the one numbered 32, that extend axially from end to end of the flame tube. In the rows, the holes have an order of repeating spaced pairs of holes 36; the axial distance D between the pairs 36, being greater than the distance d, between the holes in a pair. The exact proportion of the distances, of course depends on the conditions such as the size and length of the combustor, its pressure, the temperature, etcetera. As a matter of practise favorable results have been obtained in aircraft turbine combustors by maintaining the distance D between the pairs of holes at approximately one and one half times as large as the distance d between the holes in a pair.

The combustor hole rows 32 and 34, adjacent the row 33 are individually similar to the row 33 and have the same axial spacings d and D, between their holes and pairs of holes. In a peripheral plane, however, the holes in the adjacent rows 32 and 34 are aligned with each other but staggered with the holes in the row 33 which they flank. The pattern of the three rows 32, 33 and 34, is repeated around the flame tube 24 so that in any peripheral plane the smallest peripheral distance between combustor holes is twice that between the axial rows of holes.

The wall 25 of the flame tube 24 is formed to include a number of louvers as those indicated by 40. The louvers 40 project into the air passage 43 between the flame tube wall 25 and the outer casing 22 and are pointed in a generally upstream direction. The louvers are formed by a slitting and pressing operation as is obvious from the drawing. Air from the outer casing 22 enters the louver openings 41 and is directed along the inner surface of the flame tube 24 to form an air film (not shown) which protects the flame tube against the heat of combustion within it. There is a group of three axial rows 44, 46, and 48, of louvers between each parallel pair of rows of combustor holes, as combustor hole rows 32 and 33. Within

the louver rows, the louvers are axially equispaced as shown in FIGURE 2 by C but in peripheral planes the louvers of one axial row are staggered with those of the other rows. With respect to the combustor holes 30, the louvers 40 in the axial rows adjacent the combustor hole rows, such as louver rows 44 and 48, are approximately midway between the pairs of combustor holes, but not necessarily axially aligned with the combustor holes. The louvers of the center row of louvers, as row 46, are staggered axially with the louvers in the adjacent louver rows (44 and 48) and disposed in peripheral planes passing between or through the holes in a pair of combustor holes in one of the axial rows of combustor holes flanking the group of three louver rows; that is, louver 40' of the center row 46 is in a transverse plane that passes between combustor holes 30' and 30' of combustor hole row 34.

As in the case of the combustor holes, the conditions dictate the size, frequency of occurrence, etc. of the louvers.

From the description given it is seen that the arrangement of combustor holes permits locating louvers as close to the axial centerline of the rows of combustor holes as desired. Then although adjacent louvers thus located on any one row of combustor holes are fairly close together, the possibility of failure of the combustor due to large circumferential cracking is prevented by the axial staggering of the adjacent rows of combustor holes. The hole spacing also permits optimum axial spacing of the louvers and their location so as to cool the wall structure around all combustor holes.

In view of the many changes that could be made by those skilled in the art in the one embodiment of the invention shown and described without departing from its

spirit, it is intended that the above description, or accompanying drawings, shall be interpreted as illustrative only. The true scope of the invention is to be determined by the appended claim.

What is claimed is:

In a combustor for aircraft, a wall defining a combustion chamber having an axis, said wall having a plurality of combustor holes for the admission of air into said chamber, said holes being aligned axially in equispaced parallel, axial combustor hole rows, said sets comprising a pair of axially aligned holes, louvers for directing air over the surface of said wall for cooling it thereby, said louvers arranged to form parallel, axial louver rows, a plurality of louver rows being disposed between said combustor hole rows so that louvers in louver rows adjacent to a combustor hole row are in transverse planes passing substantially between the sets of combustor holes, and the louvers in louver rows circumferentially further removed from a row of combustor holes are in transverse planes passing between the holes in the pairs of holes of the further removed row of combustor holes wherein the distance between pairs of holes is one and one half times that between the holes in a pair and said plurality of louver rows comprises three in number, and said holes in adjacent axial combustor hole rows being staggered with respect to each other.

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