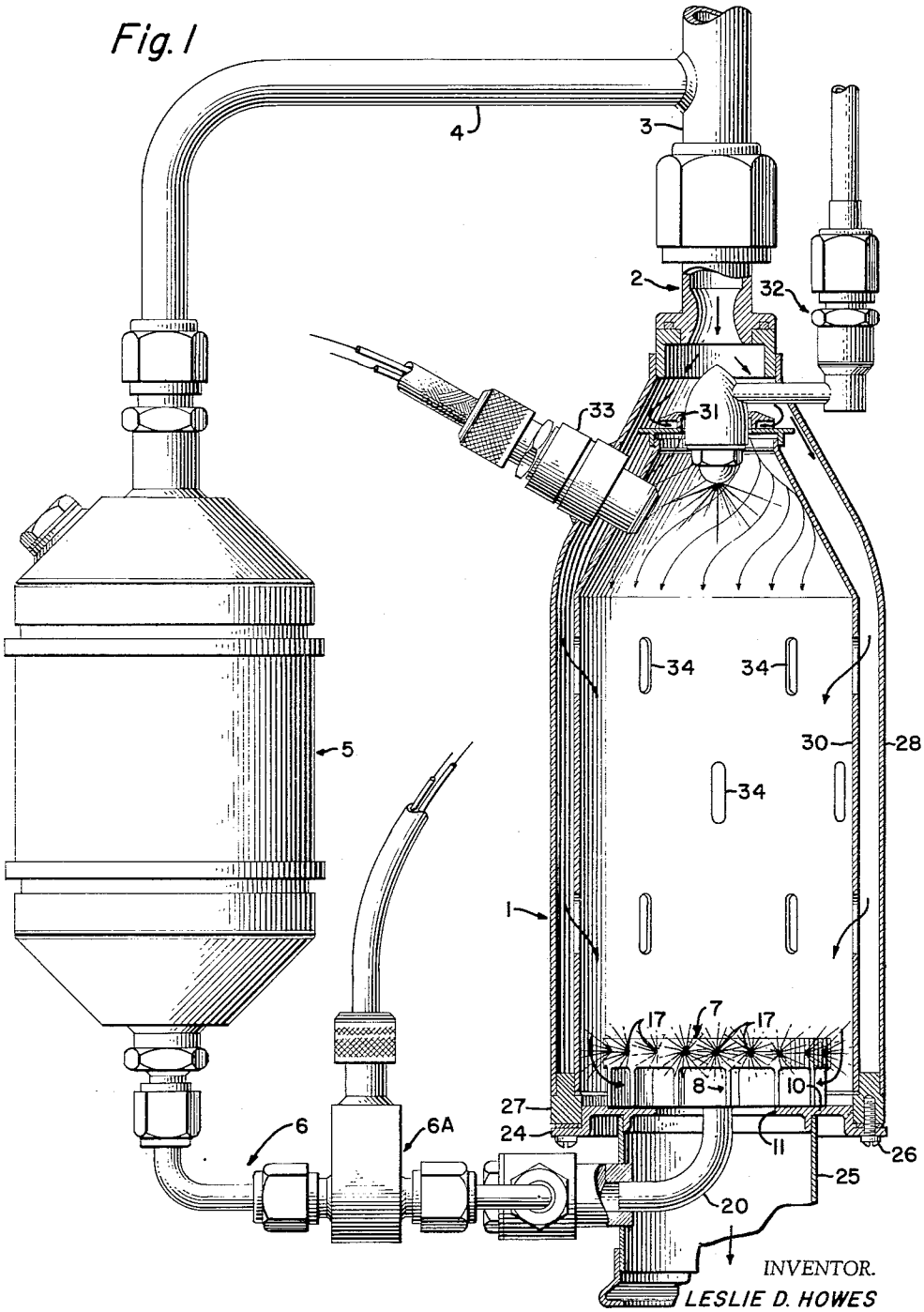
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COMBUSTOR WITH ALCOHOL-WATER INJECTION

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Fig. 1



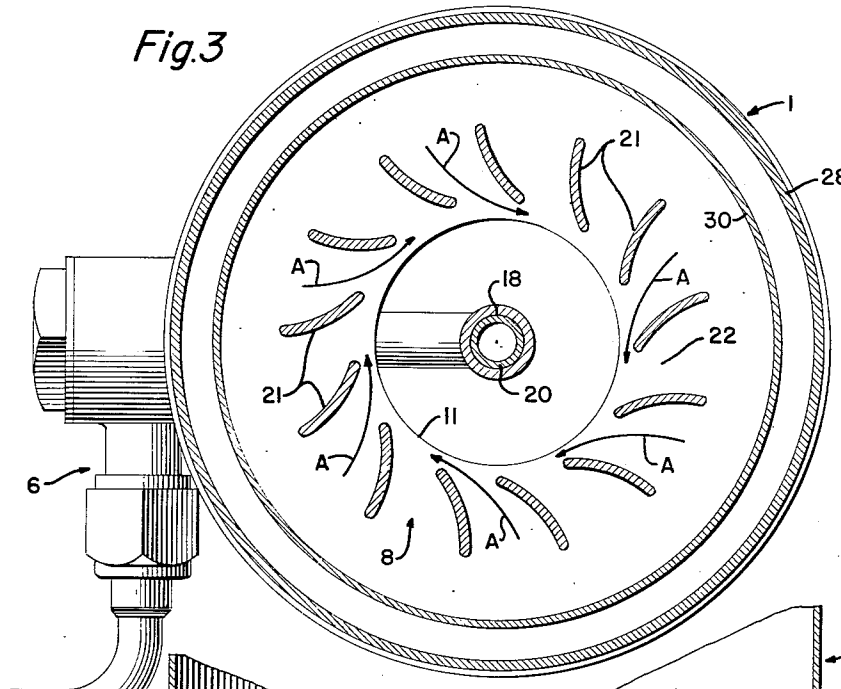

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Fig.3



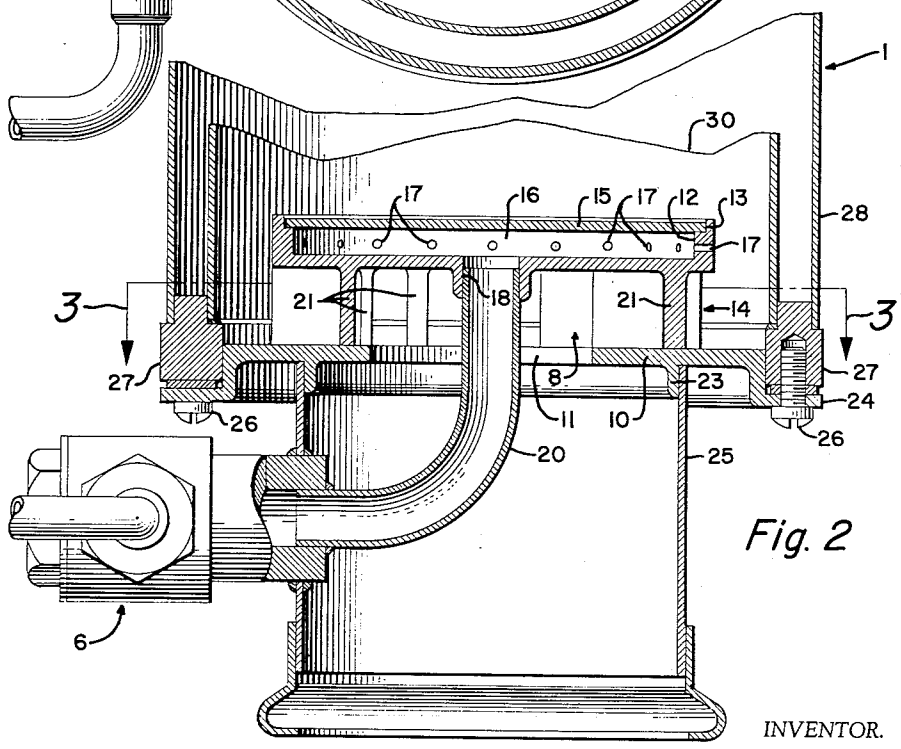




Fig. 2

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# COMBUSTOR WITH ALCOHOL-WATER INJECTION

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This invention relates generally to combustors and more particularly to gas turbine engine combustors provided with liquid coolant dispersion apparatus.

Economical use of fuel and/or the production of a stable flame pattern in the combustors of gas turbine engines requires that the combustor design and stoichiometric ratios employed cause complete vaporization and burning of the fuel somewhere in the combustor prior to its discharge therefrom. The necessary complete, rapid combustion of gas mixtures in the limited space of modern combustors results in extremely high combustor discharge temperatures, which would cause appreciable damage to the turbine blades if these gases were immediately employed unaltered.

Since the temperature of combustor discharge gases is too high for immediate use, some means must be provided for cooling this gas prior to its introduction to the turbine. The means most frequently employed is to either introduce air to the products of combustion or inject liquid coolants therein somewhere downstream of the primary flame zone. The customary manner of introducing cooling medium to the stream of hot gases usually results in either an undesirable stratified temperature profile of the combustor discharge gases or inefficient vaporization of liquid coolants, if such coolants are used.

It is, therefore, an object of the present invention to provide means for introducing one fluid to and thoroughly mixing it with another fluid for the purpose of diluting and/or cooling said second fluid.

Another object of the present invention is to provide a diffuser and swirl guide combination for installation in conduits or the like to introduce and mix a fluid issuing from said diffuser with a second fluid flowing therearound.

A further object of the present invention is to provide a diffuser and swirl guide combination for installation in gas turbine combustors to infuse a coolant with the hot gases being discharged from said combustors.

A still further object of the present invention is to provide gas turbine combustors equipped with efficient, dependable coolant-injection apparatus.

These and other objects and advantages of this invention will become apparent to persons skilled in the art from a reading of the attached description, together with the drawings, wherein:

FIGURE 1 is an overall schematic representation of a combustor with water-alcohol injection constructed in accordance with the present invention;

FIG. 2 is an enlarged fragmentary axial sectional view of part of the device shown in FIG. 1; and

FIG. 3 is a transverse horizontal sectional view taken on line 3—3 of FIG. 2.

The arrangement shown in FIG. 1 of the drawings comprises a combustor 1 provided with an inlet 2 which communicates with a source of air under pressure via an inlet conduit 3. The source of air, in this case, may be either bottled air under pressure or bleed air from a jet engine or other suitable source. A conduit 4 communicates with the inlet conduit 3 and a coolant reservoir or accumulator 5 to supply air under pressure to the latter. The reservoir 5 also communicates via a coolant passage means 6 with a diffuser 7 disposed in the outlet end of combustor 1. A swirl guide 8 is situated between the



diffuser 7 and an end cover 10 formed to include an orifice 11.

The structural details of the diffuser 7, the swirl guide 8, and the end cover 10 are more clearly shown in FIGS. 2 and 3. The diffuser 7 comprises bore 12 and a counterbore 13 formed in a piece 14. The counterbore 13 receives a disk-shaped plate 15 which is welded or brazed to piece 14 to enclose a chamber 16. A plurality of radially directed jet outlets 17 are also formed in the piece 14 and establish communication between chamber 16 and the interior of combustor 1. An inlet opening 18, disposed in the center of piece 14, forms a receptacle for a conduit 20 which is part of the coolant inlet passage 6.

The swirl guide 8 includes a plurality of vanes 21, also formed in the piece 14, which when joined to the end cover 10, define vortically directed, inwardly extending passages 22 which communicate with the interior of the combustor 1 and the orifice 11.

The end cover 10, in addition to containing orifice 11, is formed to include an axially extending flange 23 and a radially extending peripheral flange 24. The flange 23 supports a discharge conduit 25 welded or otherwise attached thereto. The flange 24 is secured by screws 26 to a support ring 27 which is welded to a housing 28 and a flame tube 30 of the combustor 1.

In operation, air under pressure is admitted to the inlet 2 via conduit 3 and to the reservoir 5 via conduit 4. Some of the air passing through inlet 2 will enter the flame tube 30 through a guide 31, passing therefrom into a spray of fuel simultaneously introduced through the fuel inlet means 32. This fuel and air mixture is ignited by a spark plug 33. The residual air, not permitted entrance through the guide 31, will flow downstream thereof through the space between the housing 28 and the flame tube 30 to enter said flame tube through openings 34 provided therein to add air to the unburned fuel as it progresses through the flame tube 30, thus causing the flame therein to extend almost the full length of said flame tube.

As the gases in the flame tube 30 pass into the outlet portion thereof, they will flow through a transverse spray of coolant, such as water or a water-alcohol mixture, issuing from the jets 17 of the diffuser 7. The coolant is introduced by automatically opening a valve 6A to allow the pressurized fluid in reservoir 5 to flow therefrom through passage 6 into diffuser 7. These droplets of coolant will thereafter be carried with the gas stream inwardly through the passages 22, in the swirl guide 8, which imparts a swift vortical movement thereto, as indicated by the flow arrows A in FIG. 3. The vortex, thus created, will centrifuge the larger fractions of coolant back into the incoming gases, causing complete vaporization thereof to increase the efficiency of the cooling process. The end cover 10 and the orice 11 are provided to hold the droplets of coolant in the region of the vortex until such vaporization is accomplished. After the combustor gases and the coolant have been thoroughly mixed in the outlet portion of the combustor 1, they are discharged through the orifice 11 and the conduit 25 to enter a turbine inlet plenum, not shown. It will be noted that introduction of the liquid coolant into the products of combustion will add appreciably to the weight flow of these gases, contributing much to the driving force thereof.

While one embodiment only of the invention has been shown and described, it should be obvious that many minor changes may be made in the construction and relation of parts to secure the introduction of the cooling medium and the swirling flow whereby the larger particles of the coolant medium will be retained in the outlet region and engaged with the guide vanes and associated parts until complete vaporization and maximum cooling results.

I claim:

1. Coolant dispersion apparatus for a combustor having an outlet adjacent one end comprising the combination of: a diffuser disposed near the outlet end of the combustor, said diffuser serving to spray a coolant into a stream of hot gases flowing through said combustor; a reservoir communicating with said diffuser to supply coolant thereto; and guide means disposed in said combustor outlet downstream of said diffuser, said guide means being formed to define a vortical passage directed perpendicularly to the axis of said combustor, such passage causing swirling movement of said hot gases and centrifuging of heavy fractions of coolant back into the incoming hot gases.

2. Coolant dispersion apparatus for a combustor having an outlet adjacent one end comprising the combination of: a diffuser disposed near the outlet end of the combustor, said diffuser being formed for injecting a coolant into the hot gases flowing through said combustor; a reservoir communicating with said diffuser to supply coolant thereto; means forming an orifice near said combustor outlet and downstream of said diffuser; and swirl guide means positioned intermediate said diffuser and said orifice, said guide means being formed to define a vortical passage directed perpendicularly to the axis of said combustor, such passage causing swirling movement of said hot gases and centrifuging the heavy fractions of coolant back into the incoming hot gases.

3. Coolant dispersion apparatus for a combustor having an outlet adjacent one end comprising the combination of: a diffuser disposed near the outlet end of the combustor, said diffuser being formed with jet outlets for injecting a coolant transversely into the hot gases flowing through said combustor; a pressurized reservoir communicating with said diffuser to provide coolant thereto; means forming an orifice near said combustor outlet and downstream of said diffuser; and swirl guide means formed to include vanes defining vortically directed passages extending inwardly between said diffuser and said orifice to cause vortical flow of said hot gases perpendicular to their original direction of flow for centrifuging the heavy fractions of coolant back into the incoming hot gases.

4. A fluid mixing apparatus comprising: a diffuser formed to receive a first fluid from a source and to disperse said fluid into a second fluid flowing past said diffuser; and swirl guide means disposed downstream of said diffuser, said swirl guide means being shaped to provide vortical passages perpendicular to the path of fluid flow past said diffuser, flow of fluids through said passages serving to centrifuge the heavier fractions of said first fluid back into the incoming fluids for further dispersion therein.

5. A fluid mixing apparatus comprising: a diffuser formed to receive a first fluid from a source under pressure, said diffuser having a plurality of radially outwardly directed jets for dispersing said first fluid into a second fluid flowing past said diffuser; a swirl guide disposed downstream of said diffuser and formed with vanes defining inwardly extending vortically directed nozzles to induce vortical flow of said fluids perpendicular to the path of flow past said diffuser, said vortical flow serving to centrifuge the heavy fractions of said first fluid back into said second fluid to secure more intimate mixing of heterogeneous fluids passing therethrough; and means forming an orifice disposed downstream of said swirl guide to restrict fluid flow from the mixing apparatus.

6. In a combustor of the type having a flame tube and an outlet, means for mixing a cooling medium with the gases generated in the combustor comprising: a hollow diffuser head disposed in the flame tube adjacent the outlet, the periphery of said head being spaced from said flame tube to provide a gas passage leading to the outlet, said head having a plurality of restricted orifices directed transversely of said gas passage; means for conducting a cooling medium under pressure to said diffuser head to be sprayed from said restricted orifices into gases flowing through said gas passage; and guide means in said passage between said diffuser head and said outlet, said guide means being shaped to impart inwardly swirling motion to the combined gases and cooling medium perpendicular to the axis of said flame tube to centrifuge the liquid fractions of said cooling medium back into the incoming gases, causing complete vaporization of said fractions prior to the exit thereof from the combustor.

7. In a combustor of the type having a flame tube and an outlet, means for mixing a cooling medium with the gases generated in the combustor comprising: a circular hollow diffuser head disposed in the flame tube and spaced therefrom to provide a gas passage extending axially and inwardly to the outlet, said head having a plurality of restricted orifices directed transversely of the axially extending portion of said gas passage; means for conducting a cooling medium under pressure to said diffuser head to be sprayed from said restricted orifices into gases flowing through said gas passage; and guide vanes provided in the inwardly extending portion of said gas passage, said guide vanes being shaped to impart a whirling motion to the combined gases and cooling medium prior to the exit thereof from the combustor.

8. In a combustor of the type having an outlet adjacent one end, means for mixing a cooling medium with the gases generated in the combustor comprising: a hollow diffuser head disposed in the combustor adjacent the outlet end thereof, said diffuser head having a plurality of radially directed restricted orifices formed therein; means for conducting a cooling medium under pressure to said diffuser head to be sprayed from said restricted orifices into gases flowing past said diffuser head; and guide means providing inwardly extending curved passages between said diffuser head and the outlet end of the combustor to impart inwardly swirling motion to the combined gases and cooling medium to centrifuge the liquid fractions of said cooling medium back into the incoming gases, causing complete vaporization thereof prior to the exit from the combustor.

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