Lewis

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for
Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,581,492

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : NA

NASA Patent Case No. : LEW-10286-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:
Yes ☐ No ☑

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

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Enclosure
Copy of Patent cited abov

FACILITY FORM 602

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PATENTED JUN 1 1971 3,581,492

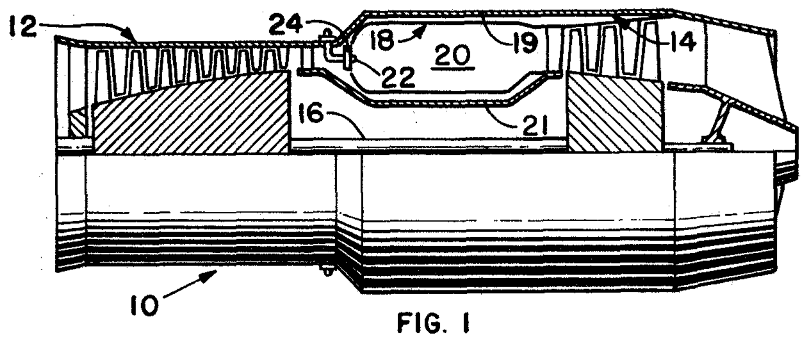

FIG. 1

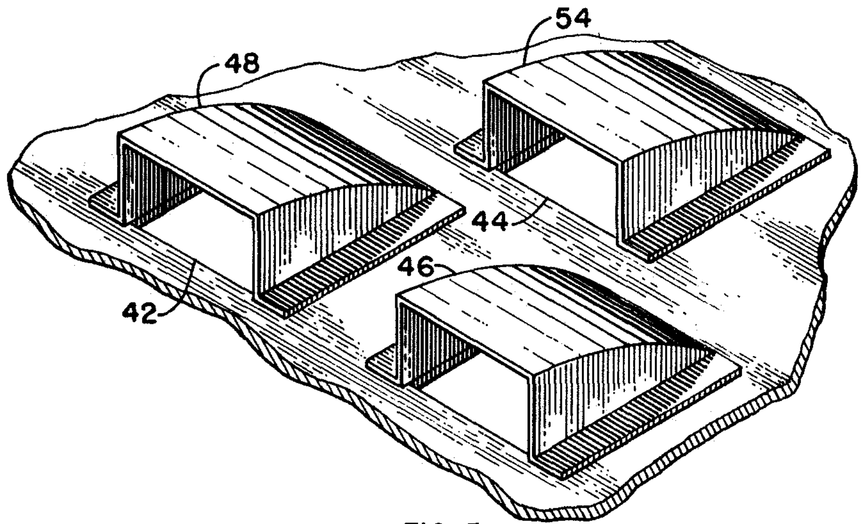

FIG. 5

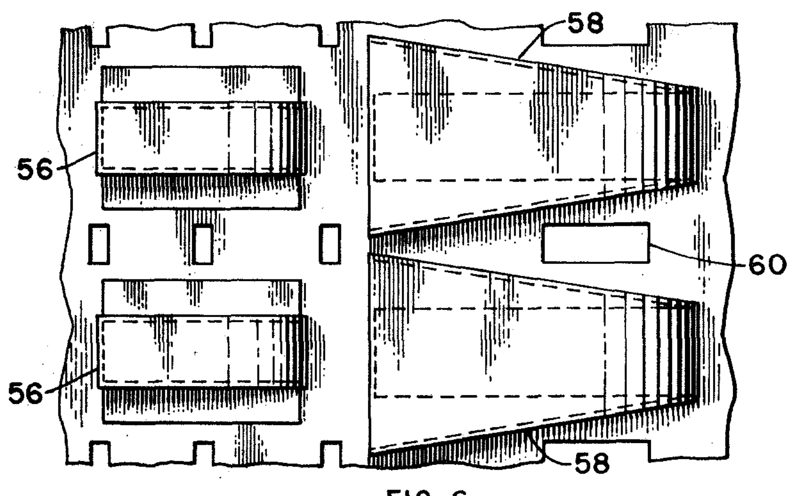

FIG. 6

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PRIOR ART COMBUSTOR

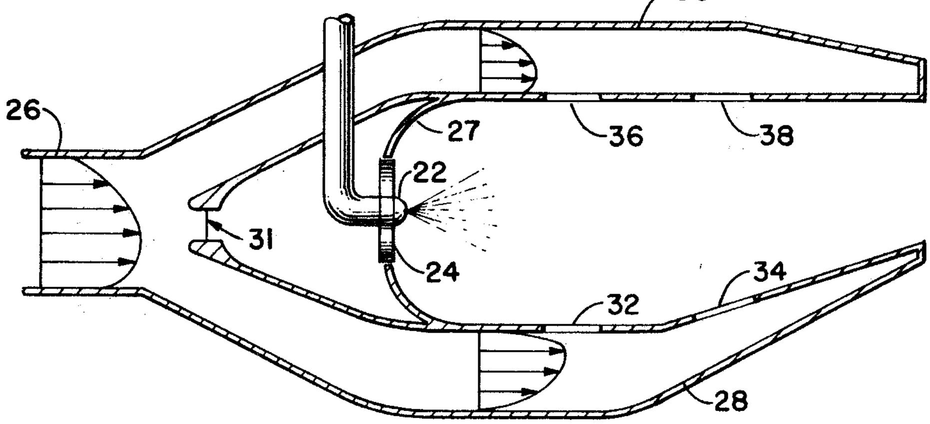

FIG. 2

SIDE ENTRY COMBUSTOR

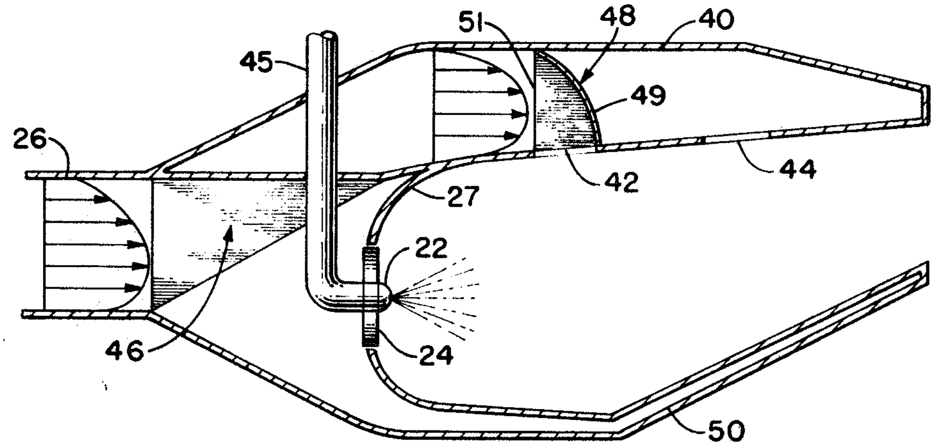

FIG. 3

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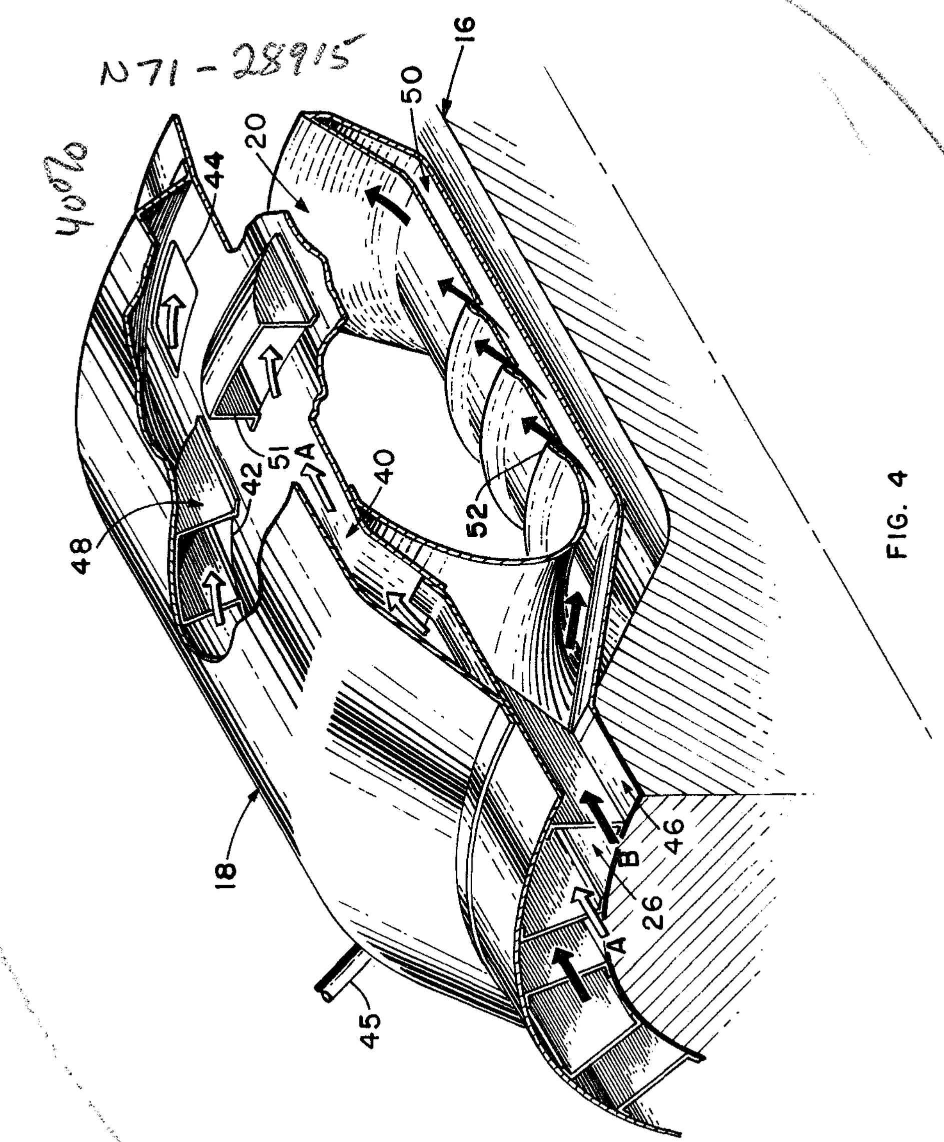

FIG. 4

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United States Patent

[11] 3,581,492

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[21] Appl. No 839,994
[22] Filed July 8, 1969
[45] Patented June 1, 1971
[73] Assignee The United States of America as represented by the Administrator of the National Aeronautics and Space Administration

[54] **GAS TURBINE COMBUSTOR**
8 Claims, 6 Drawing Figs.

[52] U.S. Cl. 60/39.36, 60/39.65, 431/352
[51] Int. Cl. F02c 3/06
[50] Field of Search 60/39.36, 39.65; 431/352

[56] **References Cited**

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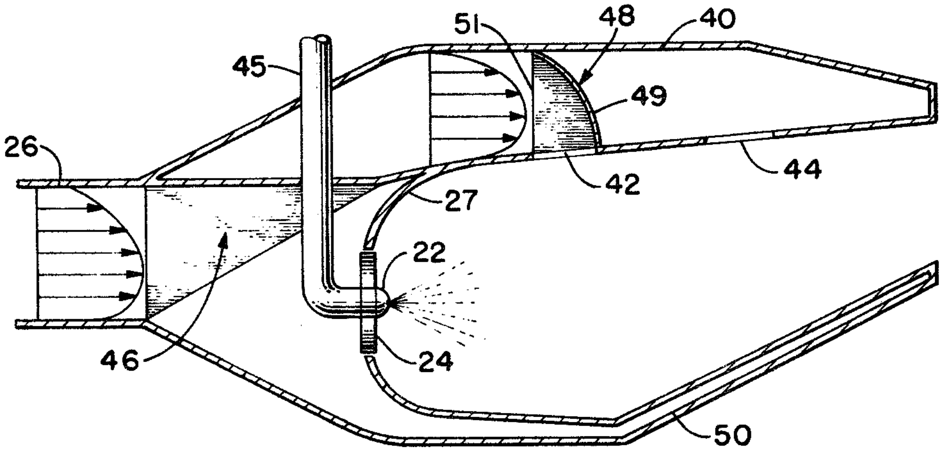
ABSTRACT: Maintaining performance in a gas turbine combustor during periods of airflow distortion. A diffuser duct is between a liner forming the combustor and a housing surrounding the liner. Entry ports in the combustor liner have scoops which extend the full height of the diffuser duct to maintain the proper airflow distribution regardless of inlet airflow distortion.

SIDE ENTRY COMBUSTOR



GAS TURBINE COMBUSTOR

ORIGIN OF THE INVENTION

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention is concerned with maintaining good performance in a gas turbine combustor during periods of airflow distortion. The invention is particularly directed to providing the proper airflow through each entry port even if the radial flow profile from the compressor is distorted.

Certain combustion problems have been encountered in gas turbine engines due to flow distortions caused by acceleration, deceleration, off design operation of the engine or local environmental conditions. The problems have become critical in advanced engines which operate near the maximum capability of the materials from which the engine is constructed.

SUMMARY OF THE INVENTION

These problems have been solved in a gas turbine combustor construction in accordance with the present invention wherein air from the compressor is ducted into a single annular diffuser that is adjacent the combustion chamber. The velocity profile across the duct reflects the velocity profile at the compressor exit.

Air is admitted into the combustion chamber through entry ports in a predetermined pattern. A scoop is attached to each entry port, and each scoop extends completely to the full height of the diffuser duct. In this manner the mass flow through the scoop and into the combustion chamber is always proportional to the mass flow from the compressor. Even if the radial flow profile from the compressor becomes inverted, the airflow into each port will remain the same. Thus the combustion chamber will contain the same fuel air distribution which assures that no hot temperature streaks will occur due to local decrease in airflow.

OBJECTS OF THE INVENTION

It is, therefore, an object of the present invention to maintain good performance in a gas turbine combustor with no local overheating during periods of flow distortion caused by acceleration, deceleration, off-design operation, and local environmental conditions.

Another object of the invention is to accommodate flow distortions of air to a gas turbine combustor so that the engine can be operated near the maximum capability of the materials.

These and other objects of the invention will be apparent from the specification which follows and from the drawings wherein like numerals are used throughout to identify like parts.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an axial quarter section view of a typical gas turbine engine showing the relative positions of its various components;

FIG. 2 is an enlarged sectional view of a prior art combustor;

FIG. 3 is an enlarged sectional view of a combustor constructed in accordance with the present invention;

FIG. 4 is a perspective view of a combustor constructed in accordance with the invention;

FIG. 5 is a perspective view of a portion of a combustor illustrating an alternate embodiment of the invention; and

FIG. 6 is a plan view of still another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings there is shown in FIG. 1 a gas turbine engine 10 having a compressor 12 and a turbine 14 mounted on a spindle 16. A combustor 18 enclosed by a housing 19 is positioned between the compressor 12 and the turbine 14. Air from the compressor 12 is heated in the combustor 18 and then directed through the turbine 14 in a manner well known in the art.

One form of combustor has a torus-shaped chamber 20 between the housing 19 and an inner casing 21 which encircles the spindle 16. Fuel for combustion is injected into the chamber 20 through a plurality of nozzles 22. Swirlers 24 may be used with the nozzles 22 for improved combustion.

The prior art combustor 18 is shown in greater detail in FIG. 2. Air from the compressor 12 flows through an inlet passage 26 toward a liner 27. This airflow is divided between an inner duct 28 and an outer duct 30. The duct 28 is in the form of an annulus between the inner casing 21 and the liner 27. The outer duct 30 comprises the annular space between the housing 19 and the liner 27.

A portion of the air in the inlet passage 26 is also directed to the swirlers 24 through snouts 31. The compressed air in the inner duct 28 is admitted into the combustion chamber 20 through suitable ports 32 and 34. In like manner, compressed air in the outer duct 30 passes through ports 36 and 38.

The arrows in the inlet passage 26 illustrate a distorted radial air flow profile. The arrows in the ducts 28 and 30 show the resulting distortions of the radial air profiles in these ducts. As a result of these profile distortions the amount of air entering the combustion chamber 20 through the ports 32, 34, 36, and 38 will not be the same as with a uniform inlet airflow profile. Consequently, combustion problems occur which may produce local overheating.

A side entry combustor constructed in accordance with the present invention in which air for the combustion process enters substantially from a single annulus is shown in FIG. 3. Here again compressed air from the compressor 12 flows through an inlet passage 26 toward a liner 27. This air then passes into an annular diffuser duct 40 that is adjacent to the combustion chamber 20 between the liner 27 and the housing 19. The radial air profile across the diffuser duct 40 shown by the arrows in FIG. 3 will reflect the radial air profile at the compressor exit in the passage 26.

Air from the diffuser duct 40 is admitted into the combustion chamber 20 in a predetermined entry pattern through primary entry ports 42 and secondary entry ports 44 in the liner 27. Fuel is supplied to the nozzles 22 from pipes 45. A portion of the air in the inlet passage 26 is directed to the swirlers 24 at the nozzles 22 through inlet diffusers 46.

An important feature of the invention is the provisions of scoops 48 at the primary entry ports 42. The scoops 48 extend to the full height of the diffuser duct 40 from the liner 27 to the housing 19. Each scoop 48 has an open front which faces toward the flowing air. A curved backwall 49 on each scoop 48 extends outward from the downstream edge of each primary entry port 42 the full height of the duct 40 to the housing 19. Vertical sidewalls 51 extend from opposite edges of each primary port 42 to the curved backwall 49. If desired, the wall 49 may be a straight plate which extends diagonally from the downstream edge of the port 42 to the housing 19 opposite the upstream edge of the same primary port.

In this manner the mass flow through each scoop 48 and into the combustion chamber 20 is always proportional to the mass flow from the compressor. Even if the radial flow profile shown by the arrows in FIG. 3 from the compressor becomes inverted the airflow into each primary entry port 42 will remain the same. Thus the combustion chamber 20 will have the same fuel air distribution which, in turn, will assure that no hot temperature streaks will occur due to local decreases in airflow.

The operation of the side entry combustor shown in FIG. 3 is illustrated in greater detail in FIG. 4. The combustion chamber 20 encircles the spindle 16 which mounts the compressor at one end and the turbine at the other. Fuel passes through pipes 45 and is injected into the chamber 20 through nozzles as previously described.

Compressed air from the compressor enters the diffuser duct **40** as shown by the arrows A. A portion of this air is intercepted by the scoops **48** at the primary entry port **42**. These scoops **48** direct this intercepted air into the combustion chamber **20**. Still another portion of the air enters the combustion chamber **20** through the secondary ports **44**.

A small amount of air passes through the inlet diffusers **46** into a cooling duct **50** as shown by the arrow B. This cooling air passes through cooling apertures **52** into the combustion chamber **20**. The remaining air from the diffusers passes to the swirlers **24** which surround the nozzles **22**.

DESCRIPTION OF ALTERNATE EMBODIMENTS

In the alternate embodiment shown in FIG. **5** scoops **54** are provided at each of the secondary ports **44**. The scoops **54** likewise extend to the full height of the diffuser duct **40**.

In the embodiment shown in FIGS. **4** and **5** the secondary ports **44** are staggered relative to the primary entry ports **42**. The embodiment shown in FIG. **6** has the primary and secondary ports aligned. Each primary port is provided with a scoop **56** that is aligned with another scoop **58** on the secondary port. As seen in FIG. **6** the secondary scoop **58** is larger than the primary scoop **56** to obtain the proper proportioning of the air.

The embodiment shown in FIG. **6** also provides a set of secondary ports **60** which are staggered relative to the primary entry ports. This results in combinations of entry ports which may be sized to suit desired combustor performance. When scoops are attached to entry ports, the scoops extend to the full height of the diffuser duct.

While several embodiments of the invention have been shown and described it will be appreciated that various structural modifications may be made without departing from the spirit of the invention or the scope of the subjoined claims. For example, it is contemplated the secondary ports **44** may be staggered with respect to the primary ports **42** as shown in FIG. **5** yet have different size scoops as shown in FIG. **6**. Whatever the arrangement all the scoops must extend to the full height of the diffuser duct to obtain at all times correct proportional amount of air which is to be used for combustion purposes. This amount of air is independent of the compressor outlet radial velocity profile.

We claim:

1. A combustor for a gas turbine engine of the type having a compressor and a turbine mounted on a spindle, said combustor comprising

a curved liner forming a torus-shaped chamber encircling said spindle between said compressor and said turbine, said liner having a plurality of spaced ports therein, each of said ports having an upstream edge toward said compressor and a downstream edge away from said compressor;

means for injecting fuel into said torus-shaped chamber,

a housing surrounding said liner and spaced therefrom to form an annular diffuser duct, said duct being in communication with said compressor for receiving compressed air therefrom whereby compressed air is admitted to said torus-shaped chamber through said ports, and

a plurality of scoops in said diffuser duct adjacent some of said ports and substantially surrounding said lines for intercepting a portion of the flow of compressed air, each of said scoops having a pair of spaced sidewalls extending from said liner toward said housing, a backwall connecting the outermost edges of each of said pairs of sidewalls whereby the space between the sidewalls at adjacent ports is substantially unobstructed to the flow of compressed air, said backwall extending the full height of said diffuser duct from said downstream edge of said port to said housing substantially opposite the upstream edge of said port, and an open front between said sidewalls extending from said upstream edge of said port to said housing whereby the mass airflow through said open front and adjacent port into said combustion chamber is proportional to the mass flow in said diffuser duct.

2. Apparatus as claimed in claim **1** wherein the ports are in at least two adjacent rows, one of said rows being upstream from the other,

primary entry ports being in said one row, and

secondary entry ports being in said other row.

3. Apparatus as claimed in claim **2** including scoops on the primary entry ports.

4. Apparatus as claimed in claim **2** including scoops on the secondary entry ports.

5. Apparatus as claimed in claim **2** wherein the primary entry ports and secondary entry ports are aligned in the direction of airflow.

6. Apparatus as claimed in claim **2** wherein the primary entry ports and the secondary entry ports are staggered in the direction of the airflow.

7. Apparatus as claimed in claim **1** wherein backwall portion of the scoop comprises

a member curving outwardly from said downstream edge of the adjacent port to the housing.

8. Apparatus as claimed in claim **1** wherein the backwall portion of the scoop comprises

a substantially straight member extending diagonally outward from said downstream edge of the adjacent port to a housing substantially opposite the upstream edge of said port.