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24-11-89
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COMMONWEALTH OF AUSTRALIA
Patents Act 1952

P/00/001
Form 1
Regulation 9

APPLICATION FOR A STANDARD PATENT OR A STANDARD PATENT OF ADDITION

476536.

Insert full name(s) of applicant(s)

(71) We UNITED TECHNOLOGIES CORPORATION,

Insert address(es) of applicant(s)

of 1 Financial Plaza, Hartford, Connecticut 06101, U.S.A.

Insert title of invention

(54) hereby apply for the grant of a ☒ standard patent ☐ patent of addition for an invention entitled GAS TURBINE ENGINE AUGMENTOR

(tick appropriate box)

which is described in the accompanying ☐ provisional ☒ complete specification.

Insert name of actual inventor

(72) The actual inventor(s) of the said invention is/are Thomas Rush CLEMENTS and James Dale BLEVINS

Insert address for service of notices in Australia

(74) My/our address for service is SANDERCOCK, SMITH & BEADLE, 207 Riversdale Road, (P.O. Box 410) Hawthorn, Victoria, 3122 Attorney Code SA

*THESE SECTIONS ARE ONLY TO BE COMPLETED WHERE APPLICABLE:

for Convention cases only

(ONLY TO BE USED IN THE CASE OF A CONVENTION APPLICATION)

Details of basic application(s) –

(31) Number of basic application 801,642

(33) Name of Convention country in which basic application was filed U.S.A. ISO Code US

(32) Date of basic application 25th November 1985

for Divisional applications only

(ONLY TO BE USED IN THE CASE OF A FURTHER APPLICATION MADE BY VIRTUE OF SECTION 51)

(62) Number of original application

Person by whom made

for Patents of addition only

(ONLY TO BE USED IN THE CASE OF AN APPLICATION FOR A PATENT OF ADDITION)

I request that the patent may be granted as a patent of addition to the patent applied for on

(61) Application No. Patent No.

in the name of

I request that the term of the patent of addition be the same as that for the main invention or so much of the term of the patent for the main invention as is unexpired.

Insert day, month and year form signed

Dated this 21ST day of NOVEMBER 19 86

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Signature of applicant or Australian attorney

(Signature)
SANDERCOCK, SMITH & BEADLE

This form must be accompanied by either a provisional specification (Form 9 and true copy) or by a complete specification (Form 10 and true copy).

Forms 7 and 8 U.S.Serial No. 801,642

AUSTRALIA

Patents Act 1952

DECLARATION IN SUPPORT OF A CONVENTION OR NON-CONVENTION APPLICATION FOR A PATENT OR PATENT OF ADDITION

Name(s) of Applicant(s)

In support of the application made by United Technologies Corporation

Title

for a patent for an invention entitled Gas Turbine Engine Augmentor

Name(s) and address(es) of person(s) making declaration

I/We, Stephen Eli Revis of 4 Mountain View Drive, West Hartford, Connecticut 06117, United States of America

do solemnly and sincerely declare as follows:-

1. I ~~am/we are the applicant(s) for the patent~~, ~~or~~ am/~~are~~ authorised by the abovementioned applicant to make this declaration on its behalf.

2. The basic application(s) as defined by Section 141 of the Act was/~~were~~ made in the following country or countries on the following date(s) by the following applicant(s) namely:-

Country, filing date and name of Applicant(s) for the or each basic application

in United States of America on November 25 19 85
by Thomas Rush Clements and James Dale Blevins
in _____ on _____ 19 ____
by _____

3. The said basic application(s) was/~~were~~ the first application~~(s)~~ made in a Convention country in respect of the invention the subject of the application.

Name(s) and address(es) of the or each actual inventor

See reverse side of this form for guidance in completing this part

4. The actual inventor(s) of the said invention ~~is~~/are Thomas Rush Clements, 5152 Southwest Ranchito Drive, Stuart, Florida 33494, United States of America; James Dale Blevins, 571 Riverside Drive, Palm Beach Gardens, Florida 33410, United States of America

5. The facts upon which the applicant(s) is/are entitled to make this application are as follows:-
the applicant is the assignee of the actual inventors

DECLARED at East Hartford, Connecticut United States of America **this** 14 **day of** October **19**86

UNITED TECHNOLOGIES CORPORATION

Stephen Eli Revis
Assistant Patent Counsel

This form may be completed and filed after the filing of a patent application but the form must not be signed until after it has been completely filled in as indicated by the marginal notes. The

(12) PATENT ABRIDGMENT (11) Document No. AU-B-65626/86
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 593858

(54) Title
GAS TURBINE ENGINE AUGMENTOR

International Patent Classification(s)
(51)[4] F23R 003/18

(21) Application No. : 65626/86 (22) Application Date : 21.11.86

(30) Priority Data

(31) Number	(32) Date	(33) Country
801642	25.11.85	US UNITED STATES OF AMERICA

(43) Publication Date : 28.05.87

(44) Publication Date of Accepted Application : 22.02.90

(71) Applicant(s)
UNITED TECHNOLOGIES CORPORATION

(72) Inventor(s)
THOMAS RUSH CLEMENTS; JAMES DALE BLEVINS

(74) Attorney or Agent
SMITH SHELSTON BEADLE MELBOURNE

(56) Prior Art Documents
US 4423595

(57) Claim

1. An annular-shaped pilot section for a flameholder disposed in the augmentor of a gas turbine engine and said pilot section having a generally parabolic-shaped wall means defining a cavity, said parabolic-shaped wall means having a closed end portion at the fore end defining a leading edge having a generally concaved-shaped surface defining a portion of said cavity and an opened portion at the aft end for admitting fuel entrained exhaust gases, said augmentor having an axially extending centerline and said annular-shaped pilot section having a centerline in coincidence with said centerline of said augmentor, said fore end and said aft end being relative to the flow of the gas path in said gas turbine engine and an igniter disposed in said cavity, wherein the improvement comprises a slot in said wall means extending transverse to the direction of the flow of exhaust

from said gas turbine engine, and being located adjacent said leading edge, said slot being oriented perpendicular to the centerline of said annular-shaped pilot section and said slot is disposed a distance from said igniter wherein the flow of fuel enriched engine exhaust gases flowing through said slot is directed tangentially relative to said concave-shaped surface to create a vortical flow region, and said vortical flow region is located adjacent said igniter.

COMMONWEALTH OF AUSTRALIA

Form 10

PATENTS ACT 1952

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

Class 59385/86 Int. Class

Application Number:
Lodged: 65626/86

Complete Specification—Lodged:
Accepted:
Published:

Priority:

Related Art:

This document contains the amendments made under Section 49 and is correct for printing.

TO BE COMPLETED BY APPLICANT

Name of Applicant: UNITED TECHNOLOGIES CORPORATION

Address of Applicant: 1 Financial Plaza,
Hartford, Connecticut 06101,
United States of America

Actual Inventor: Thomas Rush CLEMENTS and
James Dale BLEVINS

Address for Service: SANDERCOCK, SMITH & BEADLE
207 Riversdale Road, (P.O. Box 410)
Hawthorn, Victoria, 3122

Complete Specification for the invention entitled: GAS TURBINE ENGINE AUGMENTOR

The following statement is a full description of this invention, including the best method of performing it known to me:—

Description

Gas Turbine Engine Augmentor

Technical Field

This invention relates to gas turbine power plants with augmentors and more particularly to means for improving the ignition and stabilization characteristics of the augmentor.

Background Art

As is well known, the augmentor comprises a well known flameholder consisting of a pilot section centrally supported in the housing of the augmentor and carries a plurality of radially extending gutters. A pluality of sprayrings upstream of the flameholder serves to judiciously inject fuel in the engine's exhaust to be entrained in and ignited in the aerodynamic wake of the flameholder. The pilot section is designed to provide a recirculation zone to stabilize the burning characterstics of the fuel so as to sustain combustion and to propagate the combustion around the perimeter of the flameholder.

The augmentor should be actuated at any time within the flight envelope for the aircraft's mission. It has been known that under certain aircraft operating conditions ignition and/or sustained operation has not been successful.

The typical pilot section of the augmentor is either domed or "V" shaped and the apex faces the fuel being injected by the sprayring. After the fuel entrained air flows past the aft station of the pilot

section, a portion of the fuel/air mixture migrates rearwardly relative to the flow of the engine's exhaust and recirculates inside the pilot section. The fuel entrained air is brought in close proximity to the igniter mounted in the pilot section. Unless the fuel/air mixture is within the proper proportions combustion will not ensue. It has been found that the mixture in the heretofore known designs has often been either too lean or too rich for ignition to ensue. Tests have shown that a pilot section incorporating this invention can accommodate operation over a much broader range of fuel-air mixture ratios at all operating conditions.

We have found that we can obviate the fuel/air mixture problem in the pilot section by locating an opening or slot for discretely flowing the fuel entrained air into the pilot section at a predetermined location and orientation relative to the igniter. In particular, in the dome-shaped (in cross section) pilot section the opening is located downstream of the leading edge of the flameholder but in proximity thereto. The opening is oriented so that its plane is in coincidence with the walls of the opening and is perpendicular to the engine centerline such that the flow admitted into the pilot section is tangential to the inner wall of the apex of the dome and spaced from the igniter so that the fuel/air mixture passes in proximity thereto. Tests have shown that a pilot section incorporating this invention forms a small recirculating zone adjacent the igniter and has proven to provide efficacious ignition characteristics.

By creating the circulating vortices described in the paragraphs above around the full circumference of the pilot section in accordance with this invention the stability of the pilot section can be improved. This invention contemplates, in addition to improving ignition, improving stability by locating openings as described above around the circumference of the pilot section in a plane perpendicular to the centerline of the pilot section. The openings are oriented such that the flow into the pilot section is introduced tangentially to the inside surface of the leading edge.

In certain heretofore known systems the augmentor incorporated a shroud surrounding the pilot section designed to profile the flow to achieve an improved aerodynamic recirculation zone. The shroud provided a flow path adjacent to the outer surface of the pilot section and directed the fuel entrained air in proximity to the aft end of the pilot section. Augmentors incorporating this design did not achieve the desired stability characteristics for all operating conditions.

Disclosure of Invention

An object of this invention is to provide improved ignition and stability characteristics of the pilot section of an augmentor of a gas turbine engine.

A feature of this invention is the judicious location of openings on the upstream end of the pilot section to introduce into the pilot zone a fuel/air mixture in close proximity of the igniter. The location and orientation of the opening is selected to create a vortical flow field adjacent the igniter.

An additional feature is to improve the overall stability characteristics of the pilot section by providing a plurality of openings judicially located around the circumference of the pilot section.

Other features and advantages will be apparent from the specification and claims and from the accompanying drawings which illustrate an embodiment of the invention.

Brief Description of Drawings

Figure 1 is a elevated view of the flameholder of an augmentor for a gas turbine engine.

Figure 2 is a sectional view taken along lines 2-2 of Figure 1 and showing a typical fuel sprayring.

Figure 3 is an enlarged partial plan view showing the invention.

Figure 4 is a graphical illustration showing the documented improvement in ignition capability effected by the present invention.

Figure 5 is a graphical illustration showing the results of tests in improving the stability envelope of the present invention with a typical pilot section in actual use.

Figure 6 is a partial view of the flameholder showing holes instead of slots as another embodiment of this invention.

Best Mode for Carrying Out the Invention

While the invention in its preferred embodiment is described in connection with a U-shaped or domed pilot section, and as would be understood by one skilled in the art, this invention has utility for

other configured augmentors. For the sake of convenience and simplicity only that portion of the augmentor that relates to the invention will be described, and for further details of the augmentor reference should be made to the F-100 engine manufactured by Pratt & Whitney Aircraft of United Technologies Corporation, and U.S. Patent No. 4,423,595 assigned to the same assignee as this patent application both of which are incorporated herein by reference herein.

As noted in Figs. 1 to 3, the augmentor consists of a flameholder assembly generally indicated by reference numeral 10 having a pilot section 12, igniter ports 14 and 16 and a plurality of radial gutters 18 extending radially inwardly and outwardly and circumferentially spaced around the pilot section 12.

As best seen in Fig. 2, a suitable spray ring 20 injects fuel into the engine exhaust stream indicated by arrow A whereupon the exhaust entrained fuel is directed toward the pilot section 12 as shown by the stream lines indicated by arrow B. As the exhaust entrained fuel passes the aft station 24 of the pilot section 12 the pressure pattern will cause the flow to migrate toward the igniter 26 supported in the igniter ports 16 and 14. The resulting fuel/air mixture flows over the pilot section 12 and is entrained in the aerodynamic recirculation zone 30. The recirculation brings a portion of the fuel/air mixture into close proximity of the igniter 26 and is ignited when the igniter sparks. In some situations the fuel/air mixture reaching the igniter is too lean to be ignited.

According to this invention an aperture critically located and oriented in the pilot section 12 serves to improve the ignition and stability characteristics of the augmentor 10. In one embodiment as best seen in Figs. 2 and 3 a slot 32 is formed in the wall of the pilot section extending transverse to the direction of the air flow in proximity to the leading edge 38 of the pilot section 12 so that the fore edge of slot is substantially in line with the inner surface 40 of the pilot section 12 on the back wall of leading edge 38. The slot is machined perpendicular to the engine centerline (parallel with the centerline of pilot section 12) so that it breaks through the inside surface of the pilot section 12 as nearly tangential to the surface 40 as possible.

In this configuration, exhaust entrained fuel is admitted through slot 32 whereupon a swirl is imparted thereto to form a vortical recirculating zone 42 in proximity to igniter 26. This enriches the fuel/air mixture and as is apparent no other complicated apparatus is necessary, as for example, a specialized spray bar configuration.

Another embodiment to this invention is exemplified in Fig. 6 which shows a plurality of drilled holes 44 extending laterally relative to the exhaust flow. Likewise each hole is drilled perpendicular to the engine centerline and in proximity to the inside wall 40 of leading edge 38. In either configuration the critical location and orientation is designed to produce a vortical recirculation zone adjacent the igniter.

When utilizing the slot configuration as shown in Figs. 1 to 3, it is preferred to incorporate some means for preventing the initiation of cracks. A suitable means would be by putting a sufficient radius 50 at the ends of the slot or "stop drilled".

As is exemplified in Fig. 1, a plurality of slots 32 (or drilled holes 44) may be located around the circumference of the pilot section 12 to enhance combustion stability. The ingestion of fuel/rich gas through these slots 32 or holes 44 so as to provide a plurality of the vortices (zone 42) would improve stability. The number of slots and the spacings would depend on the particular application for each augmentor.

Actual tests of the present invention in comparison with a shrouded pilot utilized in heretofore known augmentors have shown that the flameholder with the invention operates over a wider range of fuel/air ratios and altitude than a flameholder without the invention. These comparisons are illustrated in Fig. 4 comparing the ignition characteristics and Fig. 5 comparing the stability envelope characteristics.

In Fig. 4 the curve represented by the dash line C shows the range of where ignition will ensue over a given fuel air ratio for a given altitude for the shrouded pilot. Line C' shows the expanded range for ignition when the invention is employed. While the shrouded pilot gives similar results at the low end of the scale, flameholders without the shroud have not evidenced these results as shown by line C''. Hence, the flameholder utilized in the invention produces similar results in the low portion of the lean

fuel/air ratio without the encumbering hardware represented by the shroud while greatly extending the rich fuel/air and altitude ignition capability.

Figure 5 is actual test data comparing the stability characteristics of the shrouded pilot flameholer and of the flameholder incorporating the invention. Line E illustrates the stability regime of the shrouded pilot flameholder and Line E' is that for the flameholer incorporating the invention. Stability will be evidenced under all the fuel/air ratio values for a given altitude while the augmentor is operating under the respective curves.

Again, the flameholder incorporating the invention has a much extended range of operation both in terms of acceptable fuel/air ratios and in terms of altitude capability.

It should be understood that the invention is not limited to the particular embodiments shown and described herein, but that various changes and modifications may be made without departing from the spirit and scope of this novel concept as defined by the following claims.

The claims defining the invention are as follows:

1. An annular-shaped pilot section for a flameholder disposed in the augmentor of a gas turbine engine and said pilot section having a generally parabolic-shaped wall means defining a cavity, said parabolic-shaped wall means having a closed end portion at the fore end defining a leading edge having a generally concaved-shaped surface defining a portion of said cavity and an opened portion at the aft end for admitting fuel entrained exhaust gases, said augmentor having an axially extending centerline and said annular-shaped pilot section having a centerline in coincidence with said centerline of said augmentor, said fore end and said aft end being relative to the flow of the gas path in said gas turbine engine and an igniter disposed in said cavity, wherein the improvement comprises a slot in said wall means extending transverse to the direction of the flow of exhaust from said gas turbine engine, and being located adjacent said leading edge, said slot being oriented perpendicular to the centerline of said annular-shaped pilot section and said slot is disposed a distance from said igniter wherein the flow of fuel enriched engine exhaust gases flowing through said slot is directed tangentially relative to said concave-shaped surface to create a vortical flow region, and said vortical flow region is located adjacent said igniter.

2. An annular-shaped pilot section as in claim 1 wherein the flameholder includes a plurality of radially extending gutter circumferentially spaced around said pilot section wherein the improvement comprises having said slot extending between two adjacent gutters of said plurality of

gutters.

3. An annular-shaped pilot section as in claim 2 wherein said aperture is a drilled hole and a plurality of drilled holes identically oriented relative to said leading edge are circumferentially spaced about said parabolic-shaped wall means.

4. An annular-shaped pilot section as in claim 2 wherein the improvement includes a plurality of additional slots identically oriented as said slot adjacent said igniter, said plurality of additional slots cicumferentially spaced around said pilot section, each of said plurality of additional slots being dimensioned so that its lateral extent is not greater than the spacing between adjacent gutters and each of said plurality of additional slots being disposed between adjacent gutters whereby the stability characteristic of said pilot section is enhanced.

5. An annular-shaped pilot section as in claim 1 wherein said slot is comprised of spaced holes extending in a plane a predetermined distance.

6. An annular-shaped pilot section for a flameholder disposed in the augmentor of a gas turbine engine as defined in claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

DATED THIS 28th August, 1989

SMITH SHELSTON BEADLE

Fellows Institute of Patent

Attorneys of Australia.

Patent Attorneys for the Applicant

UNITED TECHNOLOGIES CORPORATION

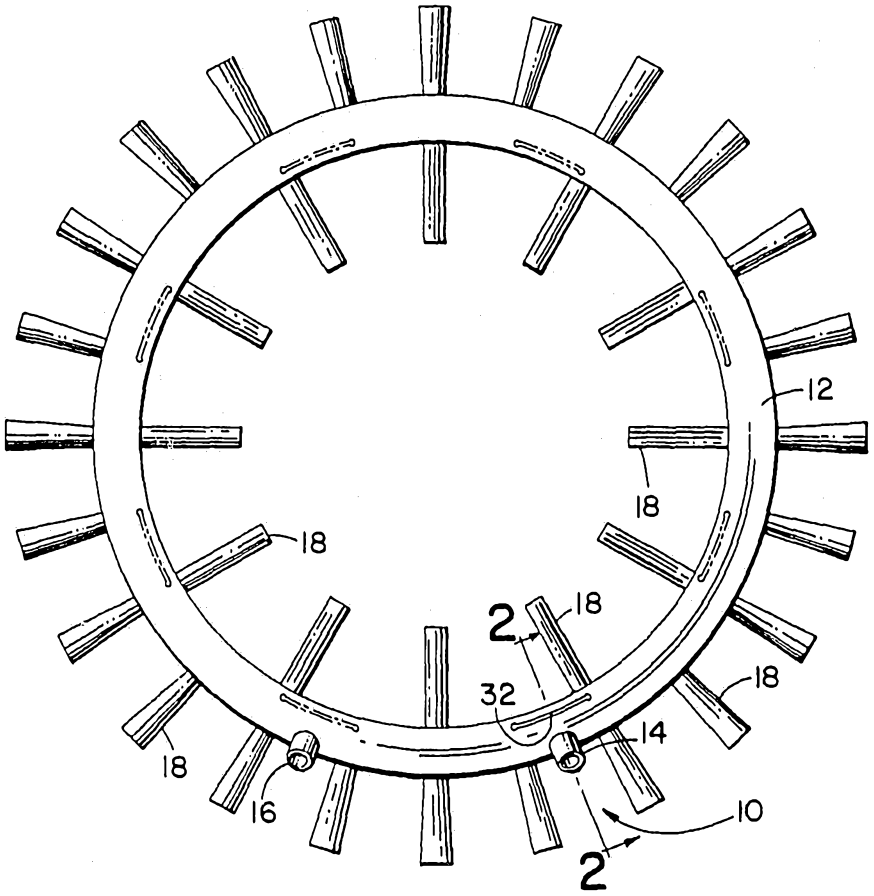

FIG. 1

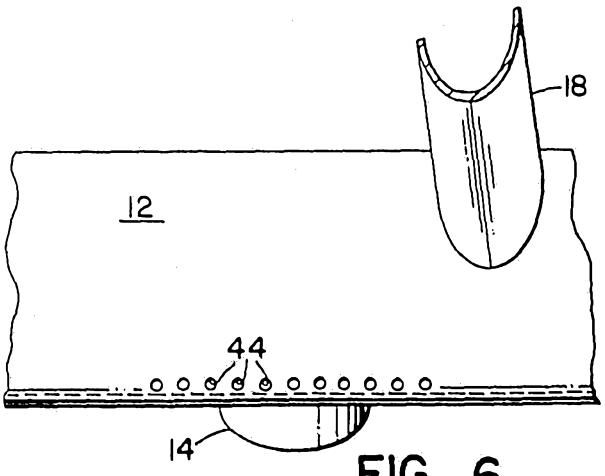

FIG. 6

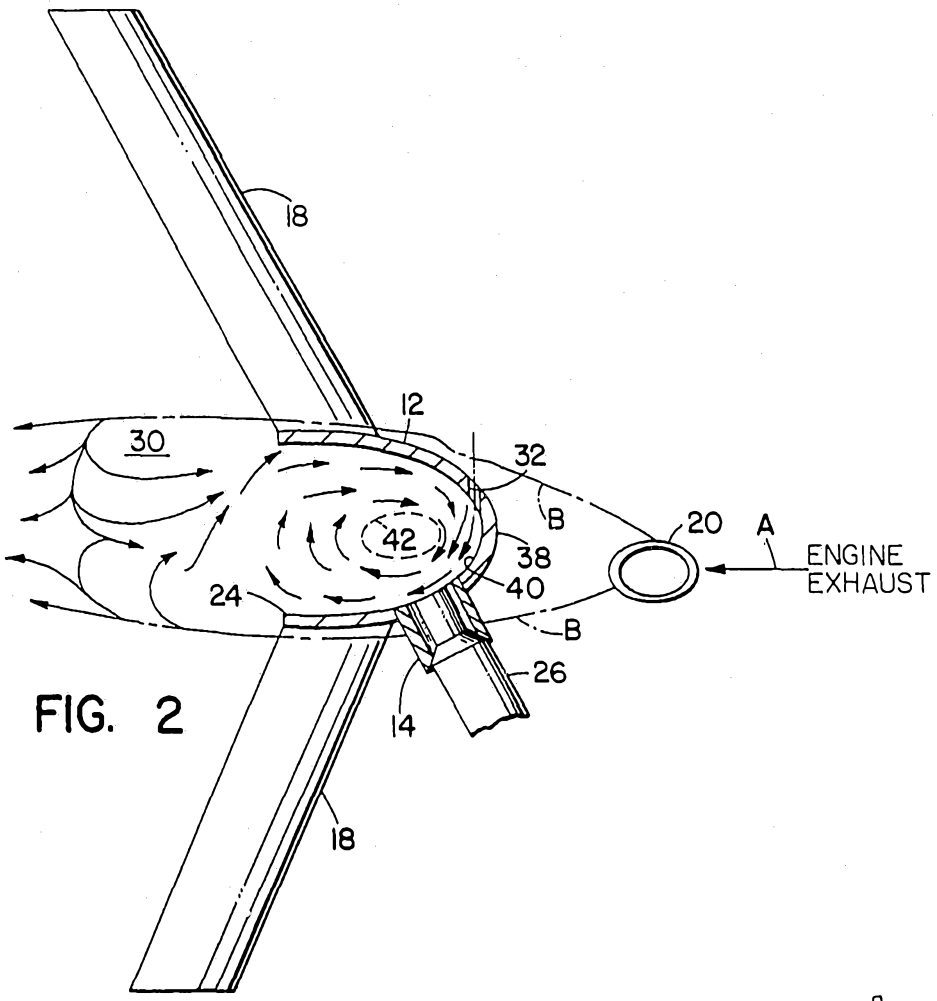
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FIG. 2

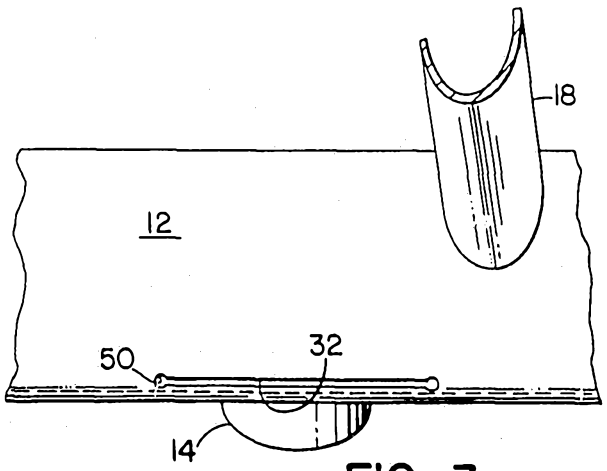
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FIG. 3

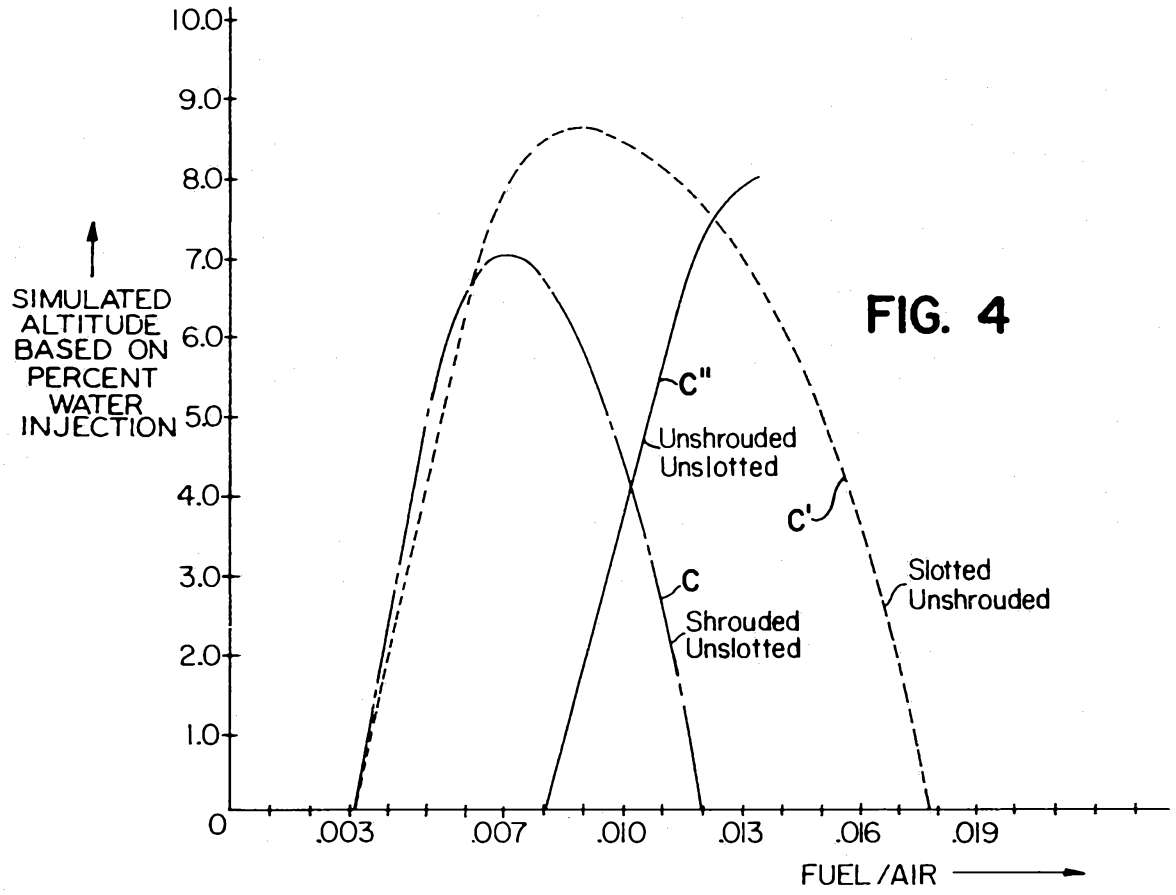
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FIG. 4

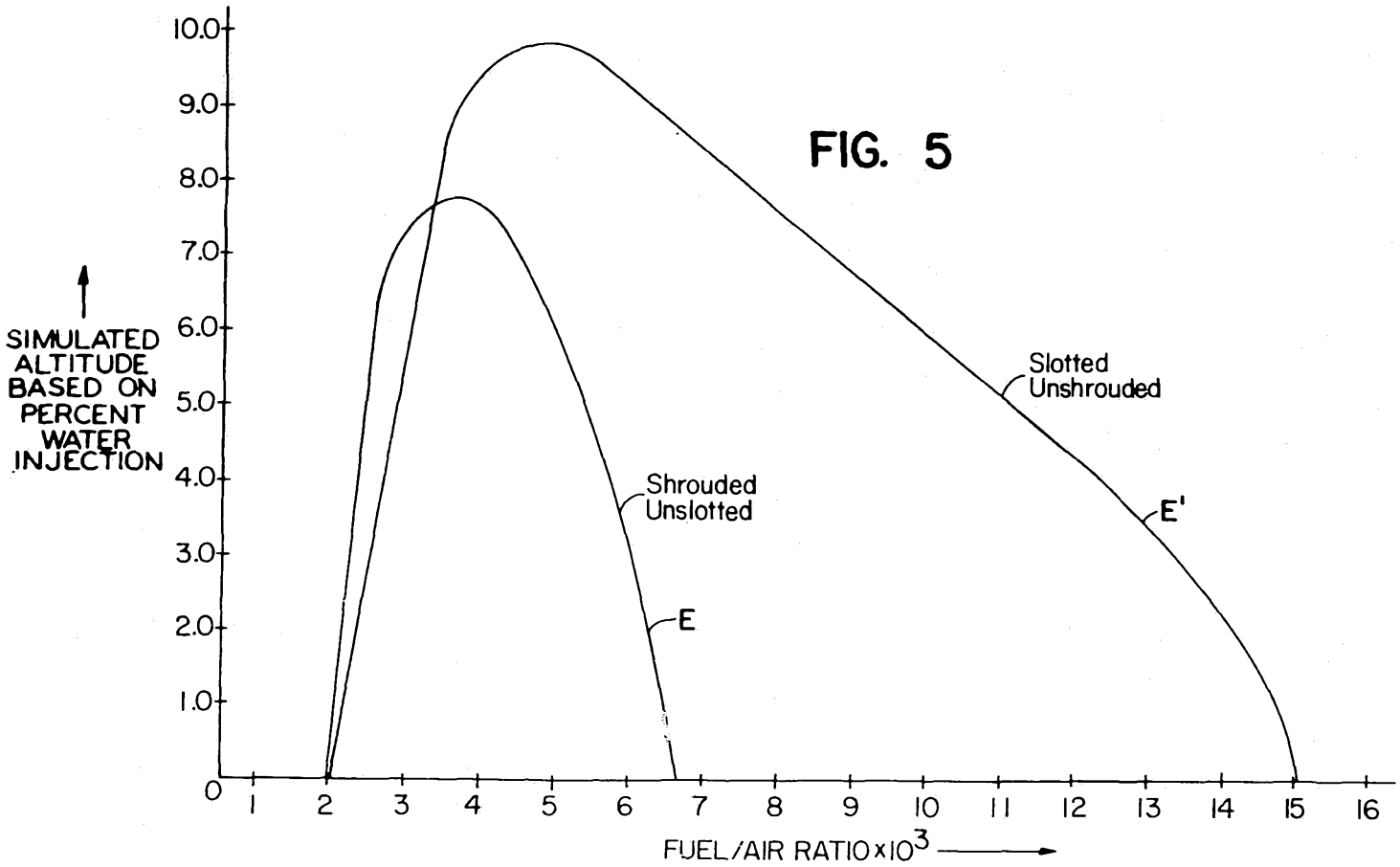

FIG. 5