United States Patent

Arand

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[54] **GAS TURBINE ENGINE WITH IMPROVED AFTERBURNER**

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[73] Assignee: **General Electric Company**

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[52] **U.S. Cl.** **60/261,** 60/39.31, 60/39.72
[51] **Int. Cl.** **F02k 3/08**
[58] **Field of Search** 60/261, 39.72, 39.31

[56] **References Cited**

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[57] **ABSTRACT**

The disclosure shows an afterburner for a gas turbine engine comprising fuel injectors and concentric, annular, V-shaped gutters which function as flameholders. Links are pivotally mounted at their opposite ends to the gutters and to beams. The beams are pivoted on the outer casing of the afterburner and align the pivot axes of the links and the bisectors of the gutters with the direction of hot gas flow toward the gutters in the "hot" condition of the afterburner to prevent twisting of the gutters when their material strength is weakest.

4 Claims, 5 Drawing Figures

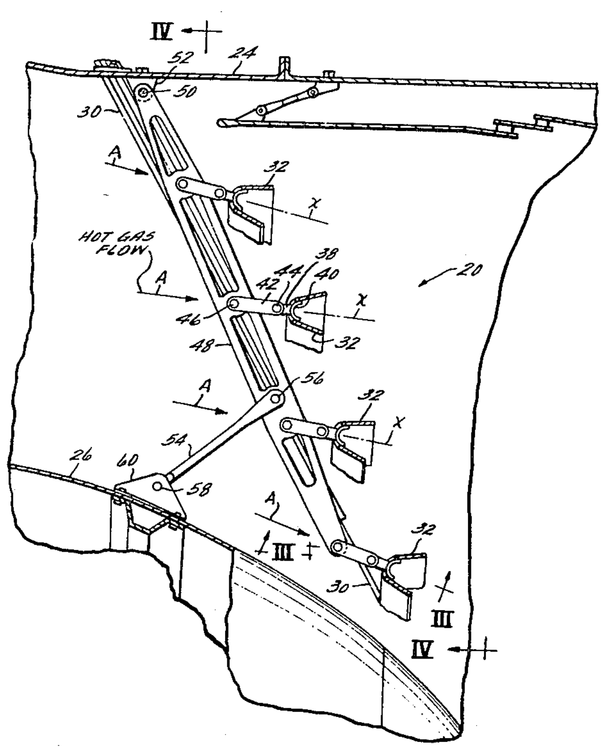

Fig 1

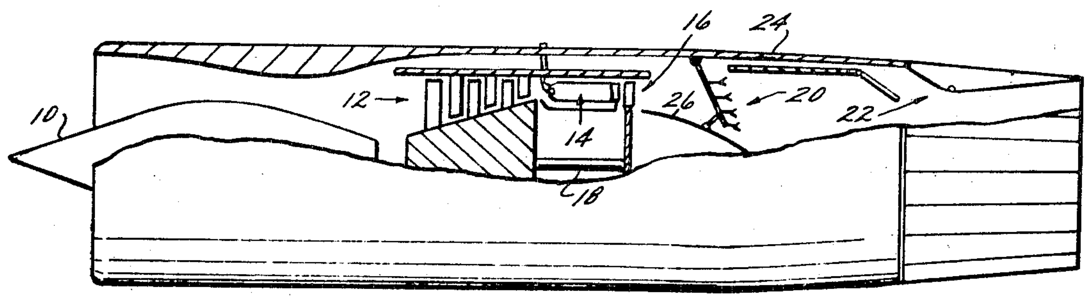

Fig 2

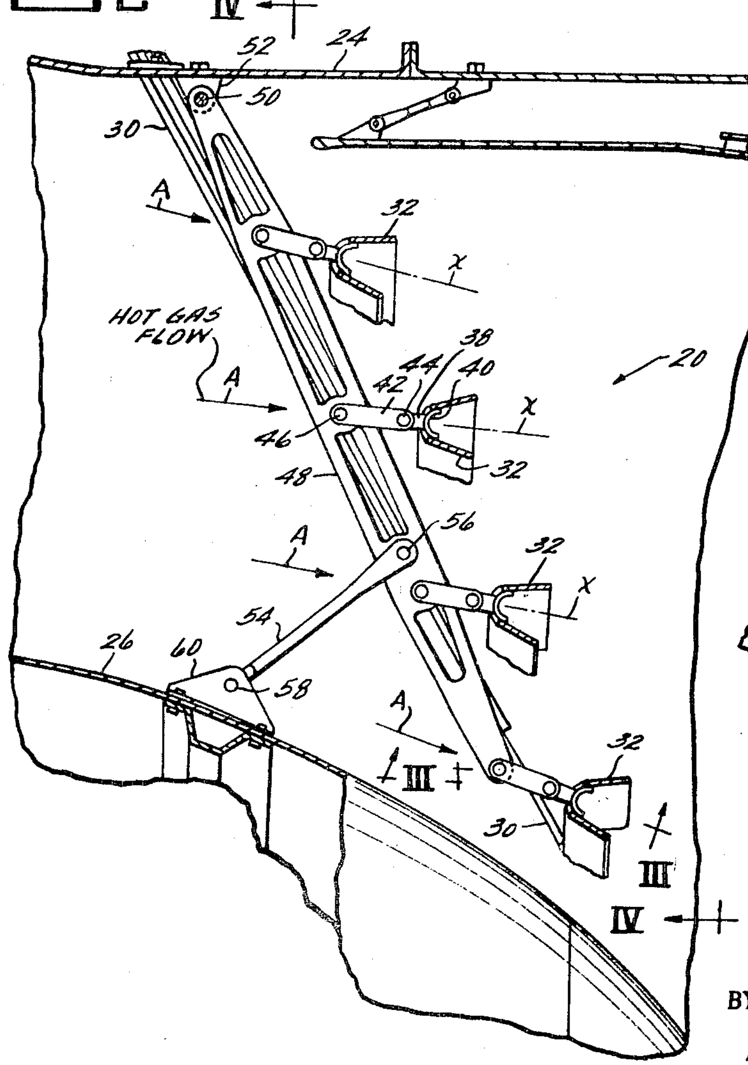

Fig 3

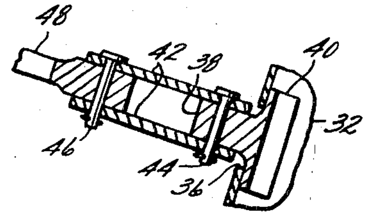

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Fig 4

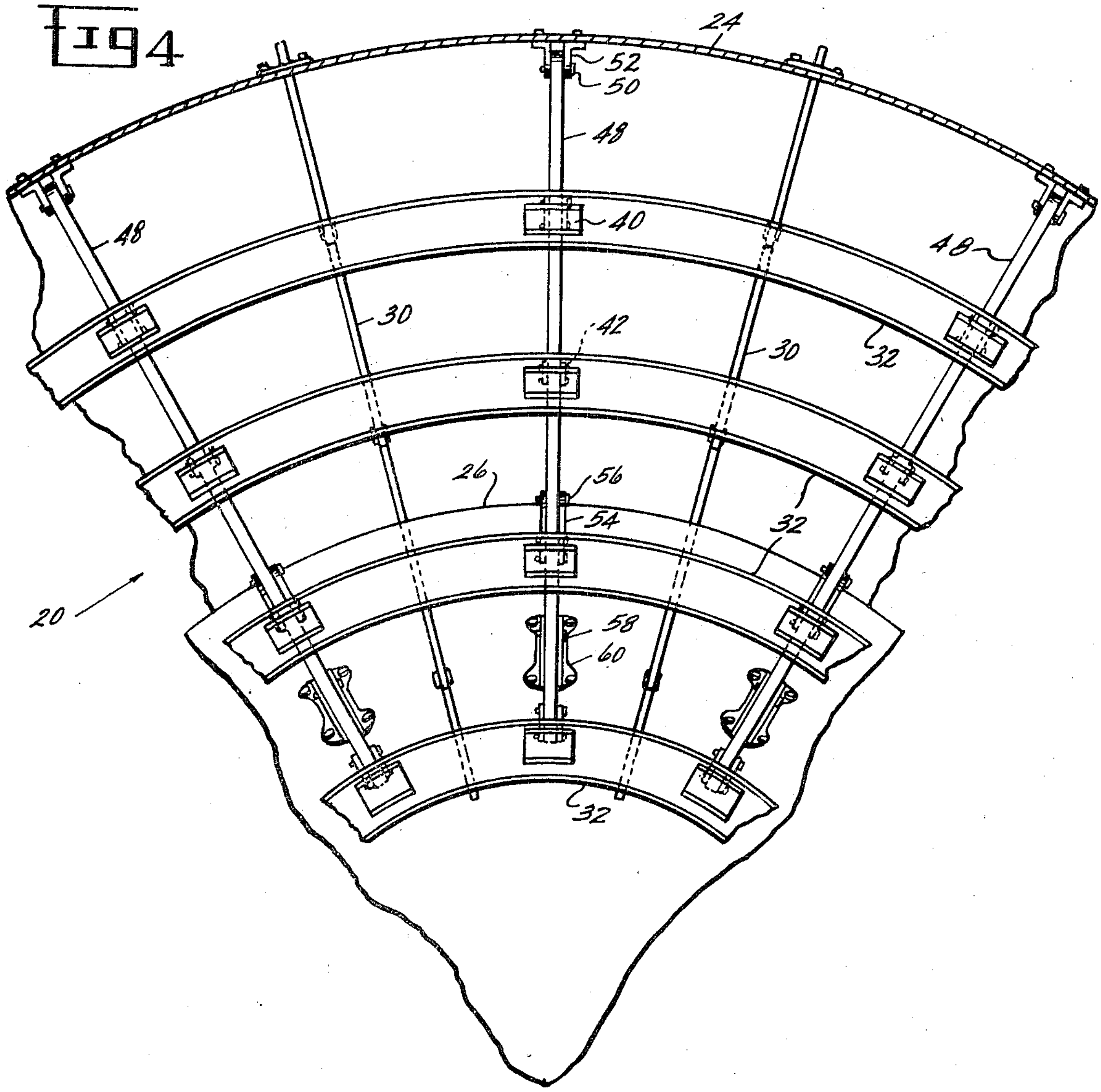

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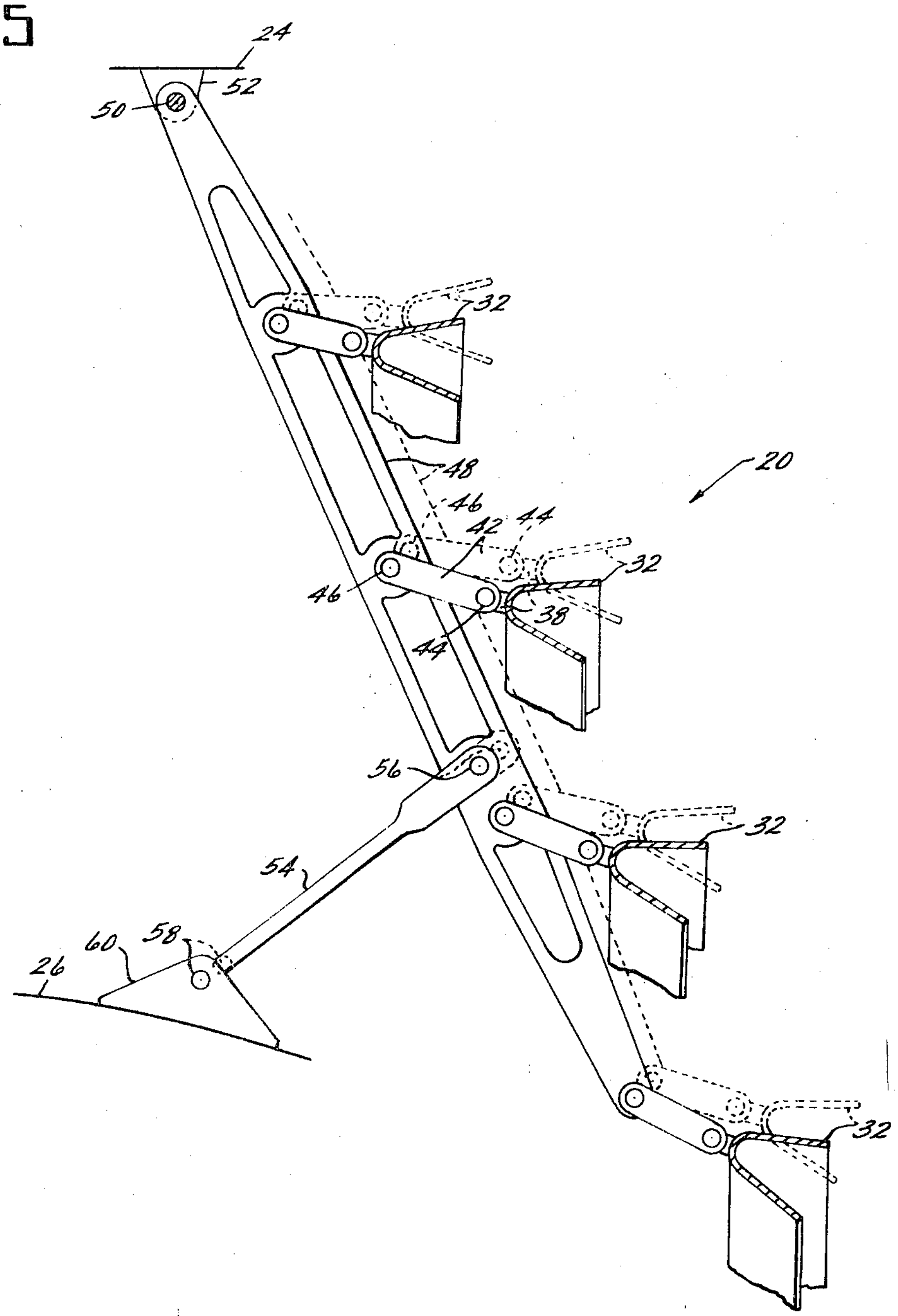
Fig 5



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GAS TURBINE ENGINE WITH IMPROVED AFTERBURNER

The invention described and claimed in the U.S. patent application herein resulted from work done under U.S. Government contract FA–SS–66–6. The U.S. Government has an irrevocable, nonexclusive license under said application to practice and have practiced the invention claimed herein, including the unlimited right to sublicense others to practice and have practiced the claimed invention for any purpose whatsoever.

The present invention relates to improvements in gas turbine engines having afterburners for augmenting the energy level of a hot gas stream to be discharged from a propulsion nozzle.

In such afterburners fuel is injected into a hot gas stream to augment its energy level. Flameholders are mounted immediately downstream of the injectors to establish a stable framefront or localized combustion zone for the augmenting fuel.

V-shaped sheet metal gutters have been found to be quite effective as flameholders. Such flameholders must operate in an area of extremely high temperature at which the strength of the gutter material is quite low. Because of the relatively thin metal sections required by weight limitations and for other reasons, flameholder gutters have been subject to bending and twisting loads which result in distortion of the gutters in relatively short periods of operation.

It has been proposed to duct cooling air to flameholder gutters to reduce their metal temperatures and thus increase their strength. This approach requires bleeding of pressurized air from the engine which reduces overall engine efficiency. It also involves complexity in the manufacture of the flameholder system.

Accordingly, the primary object of the invention is to prevent bending, twisting and other deformation of flameholder gutters in a simple, effective manner to thereby significantly increase their service life.

These ends are attained by a mounting system which, when the afterburner is in operation in its "hot" condition, aligns the bisector of the V-shaped gutter and the pivot axes of mounting links with the direction of flow of the hot gas stream toward the gutter. Preferably, the links are mounted on beams which are pivoted on the casing of the afterburner section of the engine and have pivoted links connecting their inner ends to a central casing or plug.

The above and other related objects and features of the invention will be apparent from a reading of the following description of the disclosure found in the accompanying drawings and the novelty thereof pointed out in the appended claims.

In the drawings:

FIG. 1 is a schematic showing of a gas turbine engine incorporating an afterburner for supersonic propulsion;

FIG. 2 is a partial longitudinal section showing the afterburner in greater detail in its "hot" position;

FIG. 3 is a section taken on line III—III in FIG. 2;

FIG. 4 is a section taken on line IV—IV in FIG. 2; and

FIG. 5 is a section similar to FIG. 2 showing the afterburner flameholder in a "cold" position.

FIG. 1 schematically illustrates a gas turbine engine of the type employed for supersonic flight. Air enters an inlet comprising a spike **10** and is then compressed in an axial flow compressor **12**. This compressed air supports combustion of fuel in a combustor **14** to generate a hot gas stream. The hot gas stream drives a turbine **16** which in turn, through a shaft **18**, powers the rotor of the compressor **12**. The energy level of the hot gas stream is then augmented by the combustion of further fuel in an afterburner or augmenter **20**. The augmented gas stream is then discharged from a variable area, convergent-divergent nozzle **22** to provide the necessary thrust for supersonic flight.

In subsonic flight operation the hot gas stream may or may not be augmented in the afterburner and the nozzle may be adjusted to other than the illustrated convergent-divergent configuration.

Referencing FIGS. **1** and **2** it will be noted that the hot gas stream has an annular flowpath as it enters the afterburner. This flowpath is defined by an engine casing **24** and a central plug **26** which is supported on appropriate frame structure (not shown).

The afterburner includes fuel injectors **30** (see also FIG. **4**) and flameholders in the form of annular V-shaped gutters **32**. The injectors may comprise tube bundles which are mounted in angularly spaced relation on the casing **24**. Openings in the tubes spray fuel into the hot gas stream and a stabilized flamefront or combustion zone is maintained by the gutters **32**. This type of an afterburner combustion mechanism is known per se.

The gutters **32** are preferably in the form of sheet metal fabrications having mounting lug openings **36** in their troughs or apices (FIG. 3). Mounting lugs **38** extend through the openings **36** and have wings **40** curved to match the troughs of the gutters. These wings are secured to the gutters, as by brazing. Links **42** are connected on opposite sides of each lug **38** by pins **44**. The opposite ends of each pair of links **42** are connected by pins **46** to beams **48** angularly spaced around the casing **24**. As can be seen from FIG. **4**, there is a linkage connection between each beam and each gutter.

Each of the beams **48** is pivotally mounted, at its outer end, on the casing **24** by a pin **50** and a lug **52** secured to the casing. A link **54** is connected to each beam **48**, adjacent its inner end, by a pin **56**. Each link **54** is angled in an upstream direction toward the plug **26** and is pivotally connected thereto by a pin **58** extending through a lug **60**.

The gutters **32** operate in an extremely hot environment resulting in greatly reduced load carrying capacity of the gutter material as compared with more normal lower temperature environments. The described mounting system is particularly adapted to minimize stresses on the gutters when the hot gas stream is at a maximum temperature and metal strength is at a minimum.

It will first be noted that relative radial and axial differential dimensional growth can and does occur between the casing **24** and the plug **26**. The beams **48** and the links **56** readily accommodate such growth and yet positively position the upstream ends of the links **42** in their "hot" position of minimum material strength, all without imposing any stress on the gutters which would tend to distort them in a twisting fashion. The links **42** allow differential growth of the gutters **32** relative to the beam system independently of each other, again without imposing any constraining twisting stress on the gutters in their "hot" position.

The gutters and the overall support system therefor are dimensioned (as could be done by a person skilled in the art) so that at the hottest normal operating condition the bisector of the gutter angle, line x in FIG. 2, is aligned with the axes of the associated linkage pins **44** and **46** and also aligned with the direction of hot gas stream flow toward the gutter. This means that there are no twisting forces on the gutters and the stresses thereon are reduced to the simple, minimum level imposed by the hot gas stream in the direction of flow.

FIG. **5** illustrates a "cold" position of the gutter mounting assembly within the "hot" position shown by broken lines for comparison. From this Figure it will be seen that when the described alignment of the bisector x is not maintained there is a moment arm either about the gutter relative to the axis of pin **46**, or both. In any case a twisting of the gutter occurs which imposes higher stresses on the gutter beyond the minimum stress condition, described in connection with FIG. **2**. However, higher stresses can be tolerated at such a "cold" condition due to the increased strength capabilities of the gutter material at reduced temperatures, albeit such reduced temperatures may be in excess of 1,200° F.

Various modifications of the preferred embodiment, herein described, will appear to those skilled in the art within the spirit and scope of the present inventive concepts which are to be derived solely from the following claims.

Having thus described the invention what is claimed as novel and desired to be secured by Letters Patent of the United States is:

1. A gas turbine engine comprising:

means for generating a hot gas stream,

a propulsive nozzle from which the hot gas stream is discharged, and

an afterburner for increasing the energy level of the hot gas stream immediately prior to its discharge from the propulsive nozzle, said afterburner comprising,

an outer casing,

fuel injectors within said casing,

flameholder means in the form of a plurality of concentric, annular, V-shaped gutters, each having its apex in an upstream direction toward said fuel injectors, each gutter having a bisector which extends from its apex intermediate its sides,

links pivotally connected at their downstream ends to the apexes of the gutters and spaced circumferentially therearound, the pivotal axes of said links respectively lying on the bisectors of the gutters,

mounting means pivotally connected to the upstream ends of the links and respectively aligning the pivot axes of the links and the bisector of each gutter with the direction of hot gas flow theretoward in the "hot" condition of the afterburner,

thereby eliminating any tendency to twist the gutters when their material strength is weakest.

2. A gas turbine engine as in claim 1 wherein,

the mounting means comprise a plurality of beams pivotally mounted on said outer casing and angularly spaced therearound.

3. A gas turbine engine as in claim 2 wherein,

the afterburner additionally includes an inner plug and the mounting means further includes links respectively angled from the inner end portions of said beams upstream toward said plug,

said beam links being pivotally connected at their opposite ends respectively to said beans and to said plug.

4. A gas turbine engine as in claim 2 wherein,

lugs are secured to the gutters, extend in an upstream direction and are aligned with the bisectors of said gutters and the downstream ends of the links are pivotally connected to said lugs.

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