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[54] **VARIABLE GEOMETRY COMBUSTORS**

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[52] **U.S. Cl.** **60/39.23,** 60/39.32, 60/39.65

[51] **Int. Cl.** **F02c 7/18**

[58] **Field of Search** 60/39.32, 39.31, 60/39.65, 39.23

[56] **References Cited**

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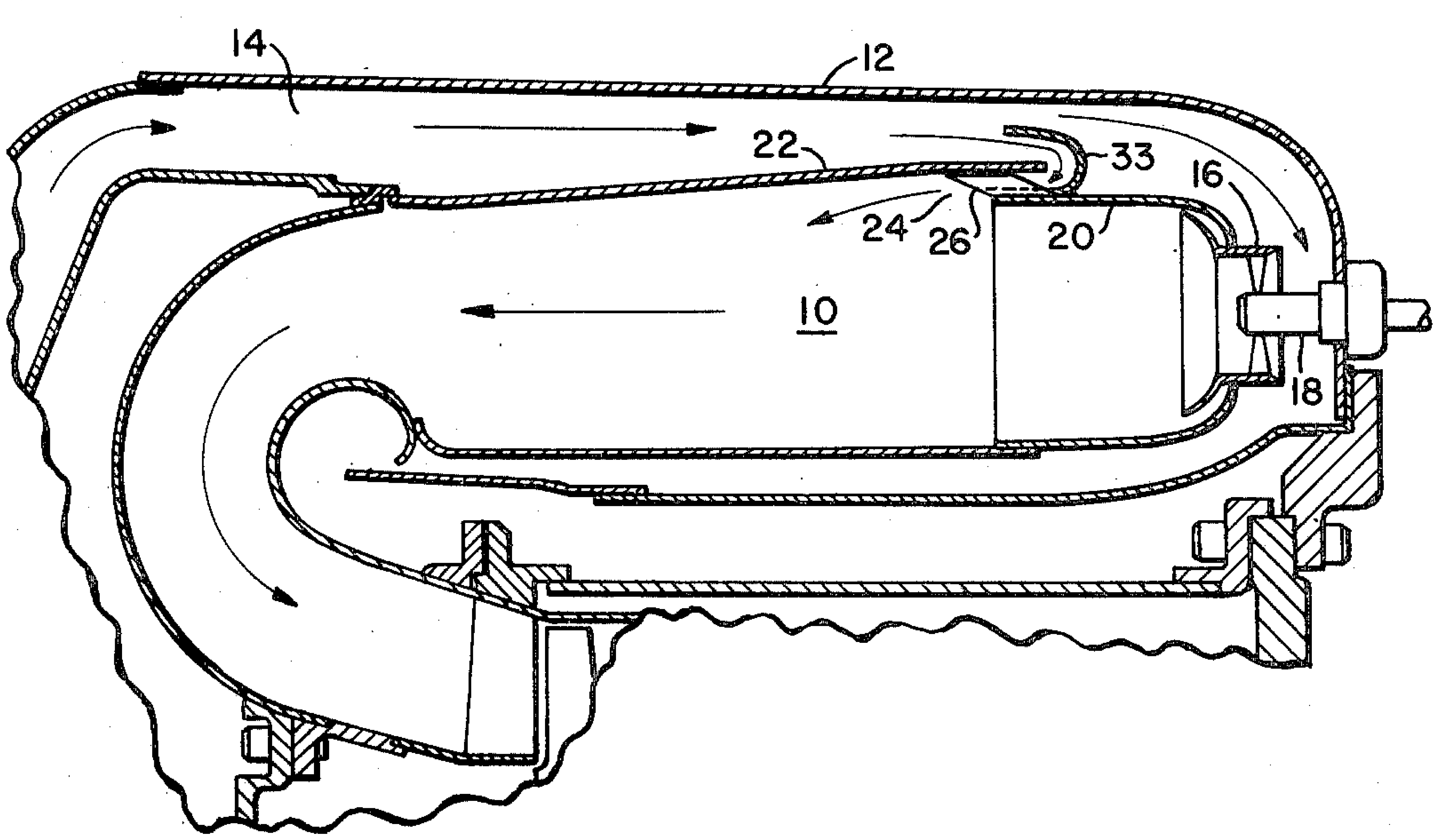
[57] **ABSTRACT**

The combustion chamber for a gas turbine engine is constructed of a plurality of spaced telescoping sections, the gap between the sections providing an inlet for the introduction of cooling air. A flexible joint is provided between the overlapping portions of the telescoped sections permitting each section to expand and contract with low constraint. This results in a change in the size of the air inlet gap, and thus controls the amount of air introduced to the combustor under varying operating conditions. In one embodiment the joint comprises a plurality of circumferentially disposed flexible wiggle strips welded at one end to one section and at the other end to the other section. In another embodiment the joint takes the form of a plurality of circumferentially disposed flexible Z-section spacers.

9 Claims, 5 Drawing Figures



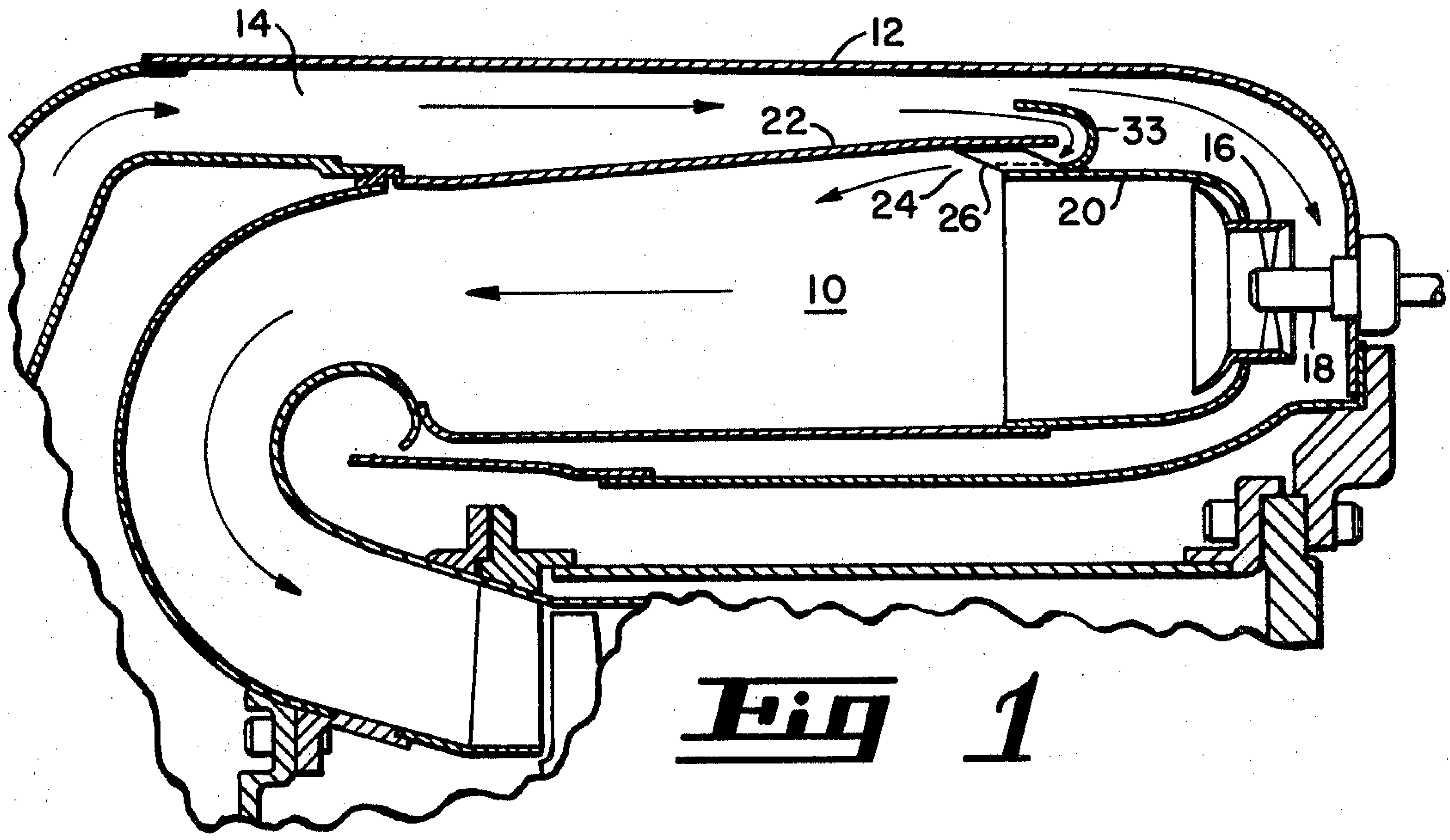


Fig 1

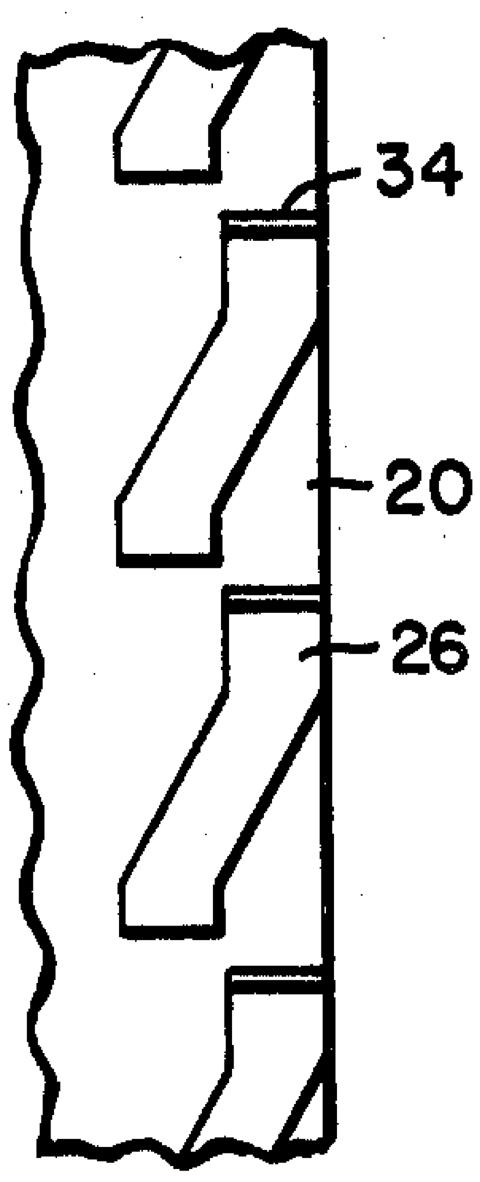


Fig 2

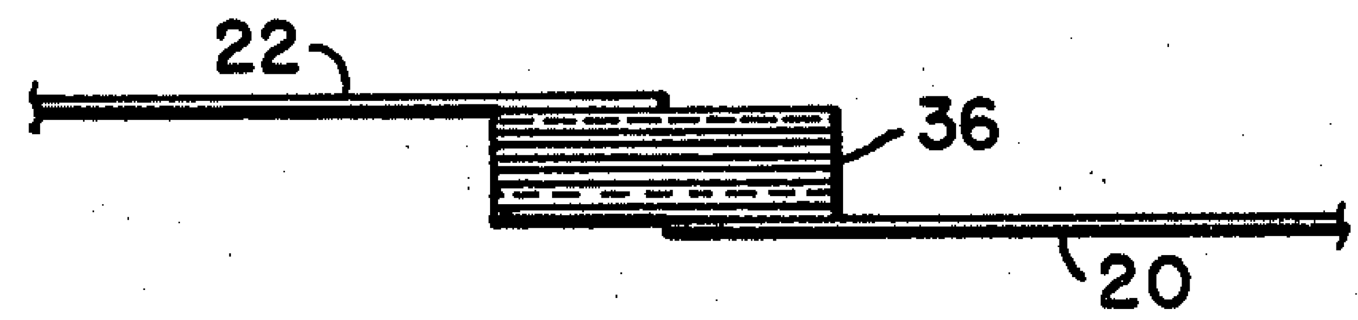


Fig 4

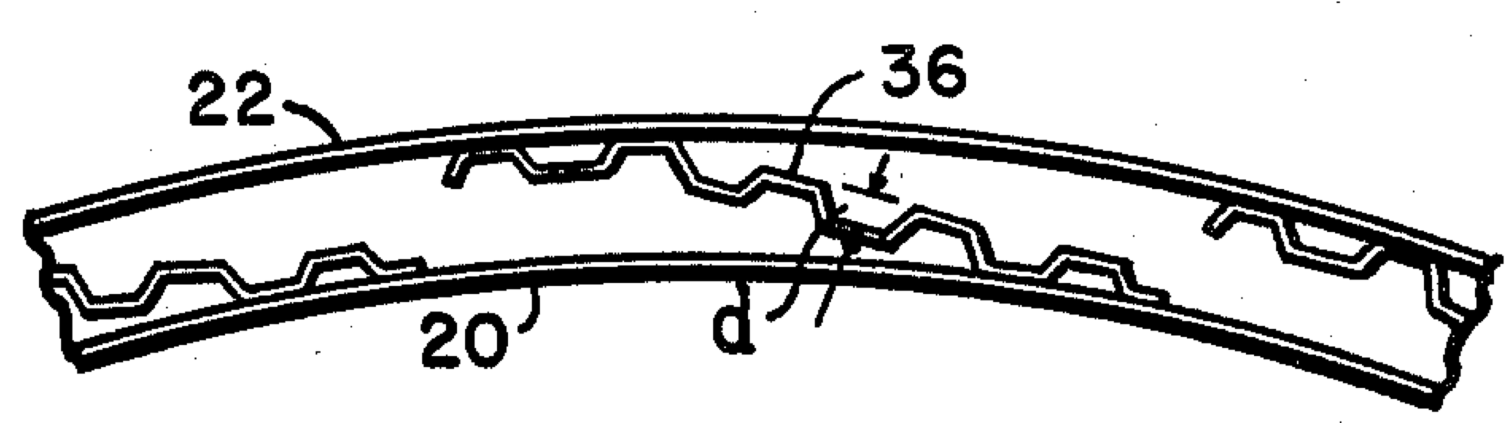


Fig 5

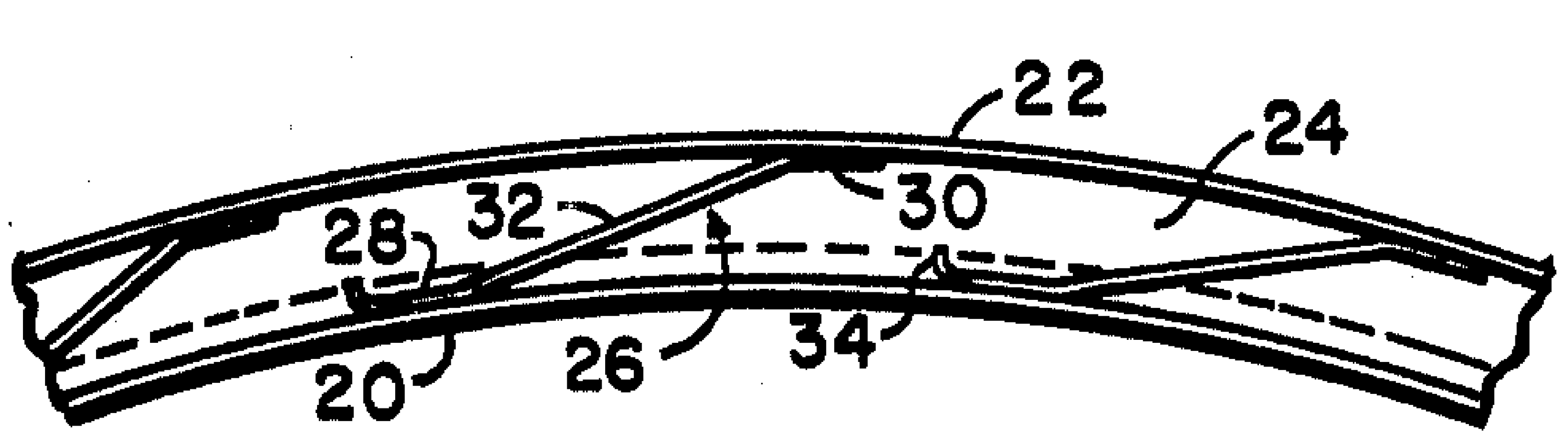


Fig 3

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VARIABLE GEOMETRY COMBUSTORS

BACKGROUND OF THE INVENTION

Until recently most combustor designs have been based on good cold starting performance without consideration of exhaust emissions at maximum power condition. However, recent changes in the law regarding pollution of the environment require that combustors be designed so that minimum exhaust emissions result.

From a technical point of view the requirement for good cold starts and low exhaust emissions are diametrically opposite. A good cold start requires a fuel rich primary combustion zone whereas minimum exhaust emissions at maximum power require a fuel lean primary combustion zone. These opposing requirements suggest the need for variable geometry. The present invention provides a variable geometry combustor which changes the cooling air inlet area as a function of temperature, thereby varying the percentage of air that enters the primary combustion zone as a function of temperature.

In addition to the problems concerning pollution, the gas turbine combustor must be mechanically constructed so as to accommodate the various forces resulting from large temperature differences. Prior art combustors which are constructed of telescoping sections are provided with rigid joints between the sections. Generally the rigid joints provide a spacing so that cooling air can be admitted to the combustion chamber. A large percentage of combustor failures occur within these joints because of the very large forces resulting from the temperature differences between the inner and outer combustor sections. The variable geometry, as provided in accordance with this invention, eliminates the rigid joint between the telescoping sections and thereby eliminates the strains due to temperature differences between the sections. Thus, the flexible joint provided by this invention automatically controls the spacing between the two sections as a function of temperature and thereby controls the amount of air admitted to the various combustion zones; and in addition the flexible joint reduces the strains on the combustor due to temperature differences.

THE DRAWINGS

FIG. 1 is a longitudinal section of a combustor constructed in accordance with this invention;

FIG. 2 is a section taken through the line 2—2 in FIG. 1;

FIG. 3 is an end view of a portion of the combustor;

FIG. 4 is a cross-sectional view of another embodiment of this invention; and

FIG. 5 is an end view of the portion of the combustor shown in FIG. 4.

THE FIRST EMBODIMENT

In the embodiment of this invention illustrated in FIGS. 1–3 we show an annular reverse flow combustor **10** positioned within a casing **12** of a gas turbine engine. The space **14** between the combustor **10** and the casing **12** provides a path for compressed air exiting from the compressor and diffuser (not illustrated) and supplied to the primary combustion zone through conventional swirlers **16.** Fuel is supplied in a conventional manner through a plurality of annularly spaced nozzles **18** (only one is shown).

The combustor **10** is comprised of at least two telescoping sections **20** and **22** with a radial gap **24** between the sections providing a cooling air inlet at an intermediate or dilution zone of the combustor. The two sections **20** and **22** are interconnected and spaced by means of a flexible joint **26.** As better seen in FIGS. 2 and 3, the joint **26** comprises a Z-section spacer having an end **28** spotwelded to the combustor section **20** and an end **30** spotwelded to the combustor section **22** and a central section **32.** The Z-section spacer is provided with a rigid radial lip **34.** The section **32** extends circumferentially and axially so that a wide degree of flexibility between the sections is permitted. An annular air scoop **33** is welded to the periphery of section **20** to direct cooling air into the gap **24.**

Generally speaking, the illustrated variable geometry technique consists in the introduction of a degree of flexibility between the sections **20** and **22** of the combustor walls which are at different temperatures due to the introduction of cooling air into an intermediate combustion or dilution zone. The introduction of such cooling air causes a temperature discontinuity between the sections **20** and **22** so that the inner section **20** becomes hotter than the outer section **22.** This causes inner section **20** to expand more than outer section **22** and results in the flexing of the Z-section spacer so that the gap **24** between the sections **22** and **20** decreases as the combustor heats up.

Thus, under cold starting conditions the gap **24** is at a maximum determined by the dimensions of the telescoping sections **20** and **22** under cold conditions. Under fully heated conditions the gap **24** is reduced to the size of the lip **34** which defines the minimum air gap. This means that under cold starting conditions a maximum amount of air is bypassed through the gap **24** and away from the main combustion zone, thereby causing a fuel rich mixture at starting. Under hot operating conditions, however, a minimum amount of air is bypassed from the main combustion zone, and therefore there is a fuel lean mixture in the primary combustion zone. This condition results in better engine performance both at starting temperatures and at hot operating temperatures.

THE SECOND EMBODIMENT

In a second embodiment of the invention illustrated in FIGS. 4 and 5, the joint between the two sections **20** and **22** takes the form of a wiggle strip **36.** This joint comprises a short length of corrugated sheet metal with the corrugations disposed axially for rigidity in that direction but permitting flexibility in a radial direction. This is accomplished by welding a length of corrugation at one end to the section **20** and at the other end to the section **22.** As in the previous embodiment, the inner section **20,** which is subjected to more heat than the outer section **22,** expands to a greater degree than the outer section **22** and reduces the gap between the sections to a minimum determined by the depth *d* of the corrugation.

Various modifications of this invention will become apparent to persons skilled in the art and are within the intended scope of the invention. For example, the flexible joints may take may other forms, the Z-section spacer **26** and the wiggle strip **36** not being the only possible configurations. A simple straight section extending circumferentially may be effective under certain circumstances. In addition, while the illustrated embodiments provide for the introduction of less dilutant air as the liner wall heats up, the reverse can also be accomplished by providing variable geometry at a primary combustion zone. However, such a modification would only be made under special circumstances where such operation was required.

SUMMARY OF THE INVENTION

In summary, this invention results in a variable geometry air inlet by providing a flexible joint between two combustor sections, thereby permitting the inner hotter section to expand more than the outer section and changing the gap between the sections as a function of operating temperatures. Minimum air gaps are established by providing positive stops or limits for the closing thereof.

We claim:

1. A combustor comprising: first and second radially spaced, longitudinally overlapping telescoping sections, the space between said sections providing an inlet for the admission of air to the interior of said sections; and a plurality of elongated circumferentially extending joints between said sections, one end of each of said joints being connected to one of said sections, the other end of said joints being connected to the other of said sections, each of said joints being radially flexible to permit the relative radial expansion of the inner of said sections with respect to the outer of said sections.

2. The invention as defined in claim **1** wherein said joint is provided with means for limiting the minimum size of said air gap.

3. The invention as defined in claim **1** wherein said joint comprises an elongated sheet metal strip, one end of which is welded to one section, the other end of which is welded to the other of said sections, said strip extending both axially and circumferentially.

4. The invention as defined in claim **3** wherein said strip is provided with a rigid radially inwardly extending projection, said projection limiting the minimum dimension of said gap.

5. The invention as defined in claim **1** wherein said joint is a corrugated strip, the corrugations extending axially to provide rigidity in an axial direction and flexibility in a radial direction, the base of the corrugation at one end of said strip being welded to one of said sections, the base of the corrugation at the other end of said strip being welded to the other of said sections, the depth of said corrugations providing a minimum gap between said sections.

6. A combustor comprising: an upstream section and a downstream section, said upstream section being telescoped into said downstream section and being radially spaced therefrom, the overlapping ends of said sections being interconnected by a plurality of flexible joints, one end of each of said joints being connected to one of said sections, the other end of said joints being connected to the other of said sections each of said flexible joints being constructed and arranged to permit the radial expansion of said upstream section with respect to said downstream section when said sections are heated, whereby the space between said sections is varied as a function of temperature, and a positive stop for limiting the minimum space between said sections.

7. The invention as defined in claim **6** wherein each of said joints comprises an elongated flexible strip, said strip being circumferentially extended between said sections, one end being connected to one of said sections, the other end being connected to the other of said sections.

8. The invention as defined in claim **7** wherein said strip is corrugated, the depth of said corrugations providing said positive stop.

9. The invention as defined in claim **6** wherein said positive stop is a radially extending lip at one end of said strip.

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