



US 20090175721A1

(19) **United States**

(12) **Patent Application Publication**
Ohri et al.

(10) **Pub. No.: US 2009/0175721 A1**

(43) **Pub. Date: Jul. 9, 2009**

(54) **COMBUSTOR SPRING CLIP SEAL SYSTEM**

Publication Classification

(76) Inventors: **Rajeev Ohri**, Winter Springs, FL (US); **Plum Boonsuan**, Orlando, FL (US)

(51) **Int. Cl.**
F01D 25/24 (2006.01)
(52) **U.S. Cl.** **415/214.1**

(57) **ABSTRACT**

Correspondence Address:
SIEMENS CORPORATION
INTELLECTUAL PROPERTY DEPARTMENT
170 WOOD AVENUE SOUTH
ISELIN, NJ 08830 (US)

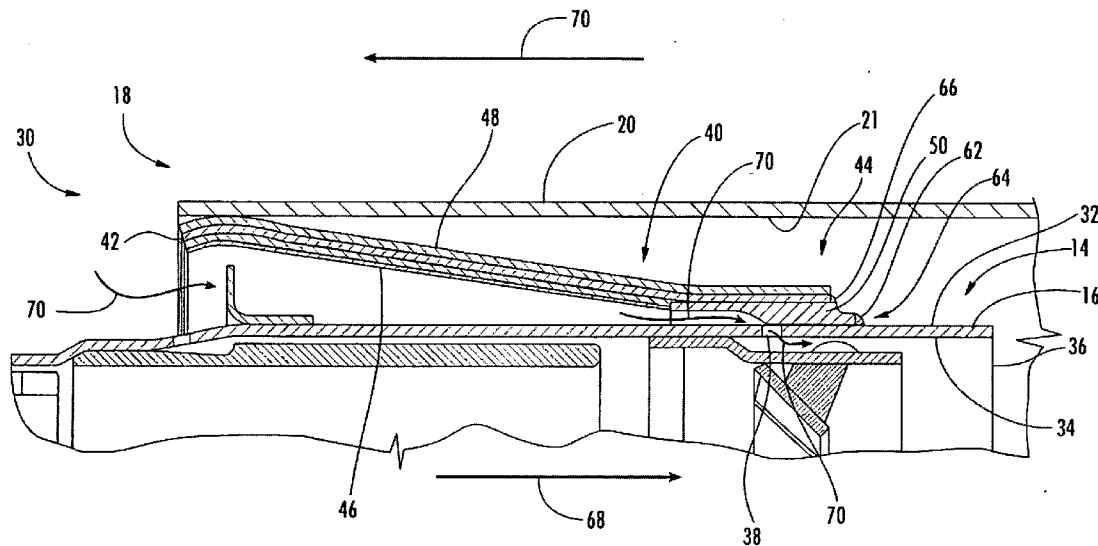
Aspects of the invention are directed to a sealing system for the interface between a combustor liner and transition duct. The system includes a spring clip seal. A first end of the spring clip seal operatively engages the inner peripheral surface of the transition duct. A second end of the spring clip seal is indirectly attached to the liner by an insert disposed therebetween. The spring clip seal can be attached to the insert by any kind of welding process that does not involve melting of the spring clip seal and the insert, such as fillet welding. The insert and the liner can be attached in a similar manner. Because fillet welds are relatively easy to cut, the spring clip, insert and liner can be separated without the need for cutting any of these individual components. Thus, the system can facilitate the repair, disassembly and reassembly of the interface.

(21) Appl. No.: **12/406,308**

(22) Filed: **Mar. 18, 2009**

Related U.S. Application Data

(63) Continuation of application No. 11/418,065, filed on May 4, 2006, now Pat. No. 7,524,167.



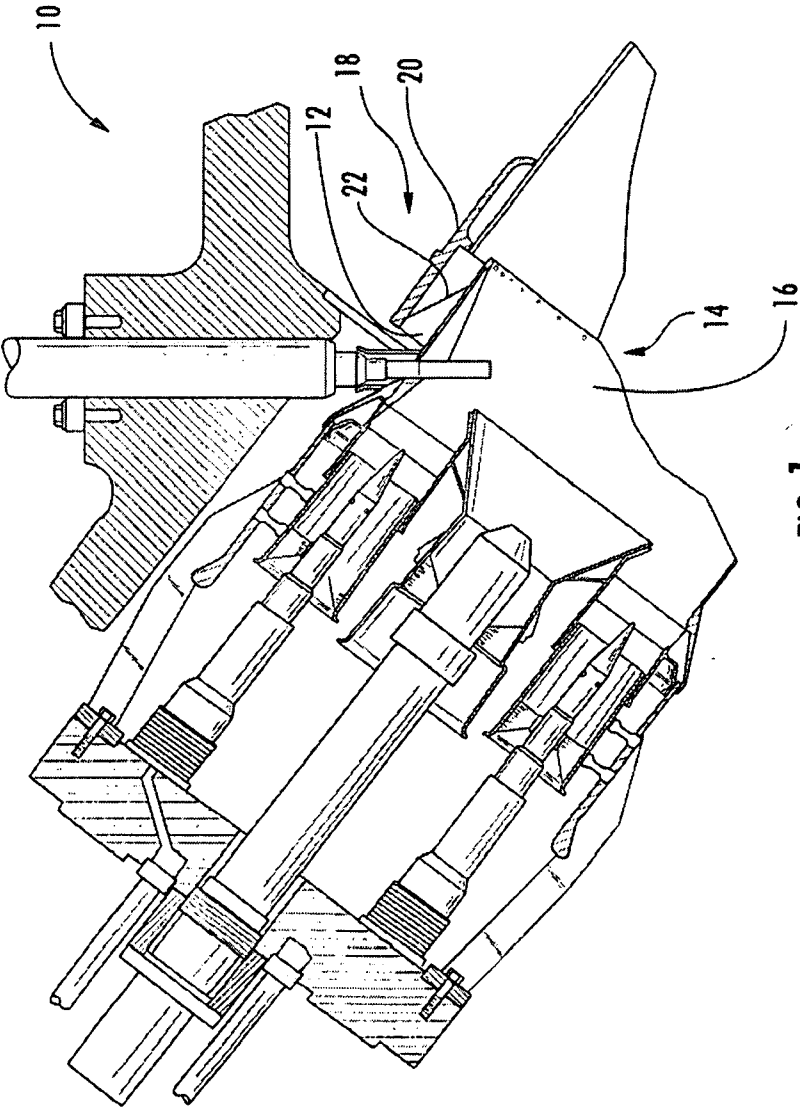


FIG. 7
(PRIOR ART)

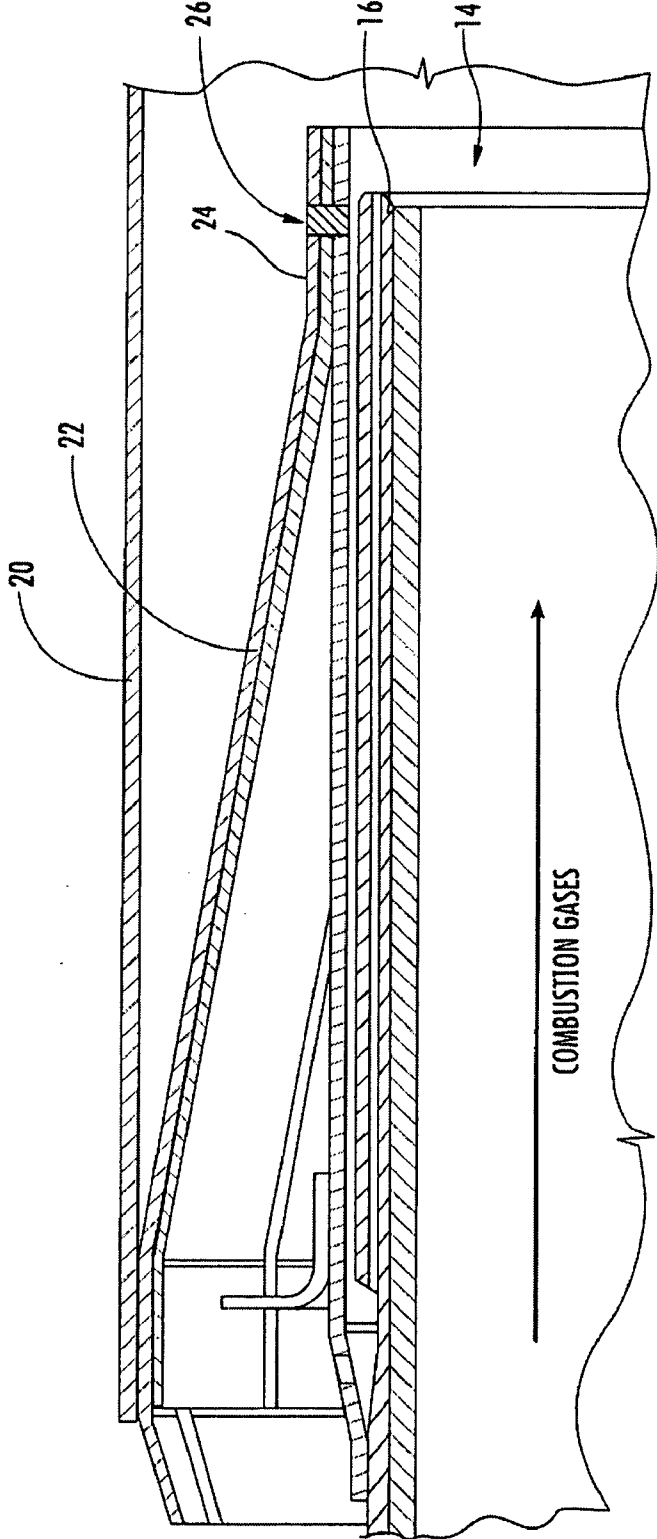


FIG. 2
(PRIOR ART)

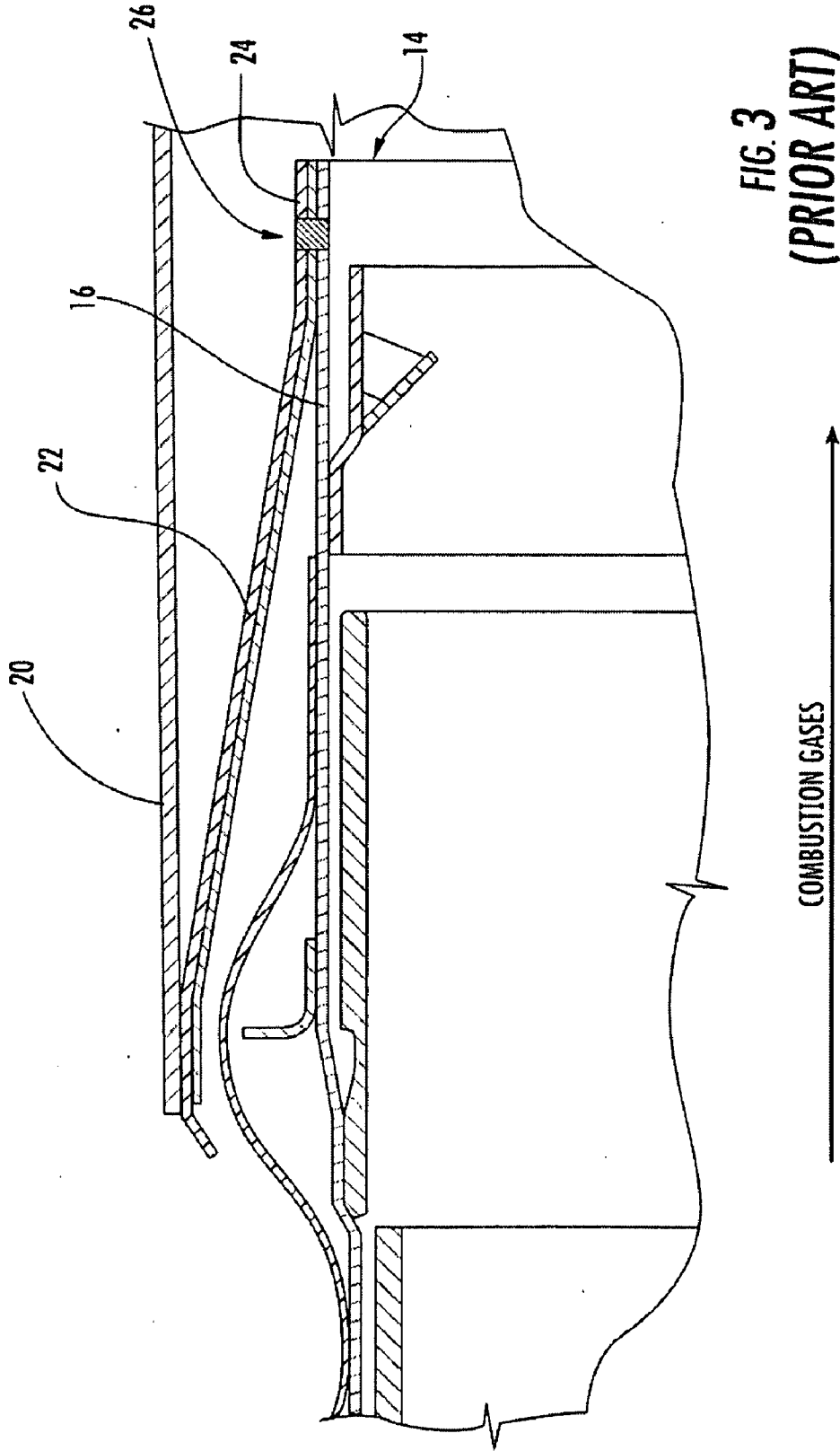


FIG. 3
(PRIOR ART)

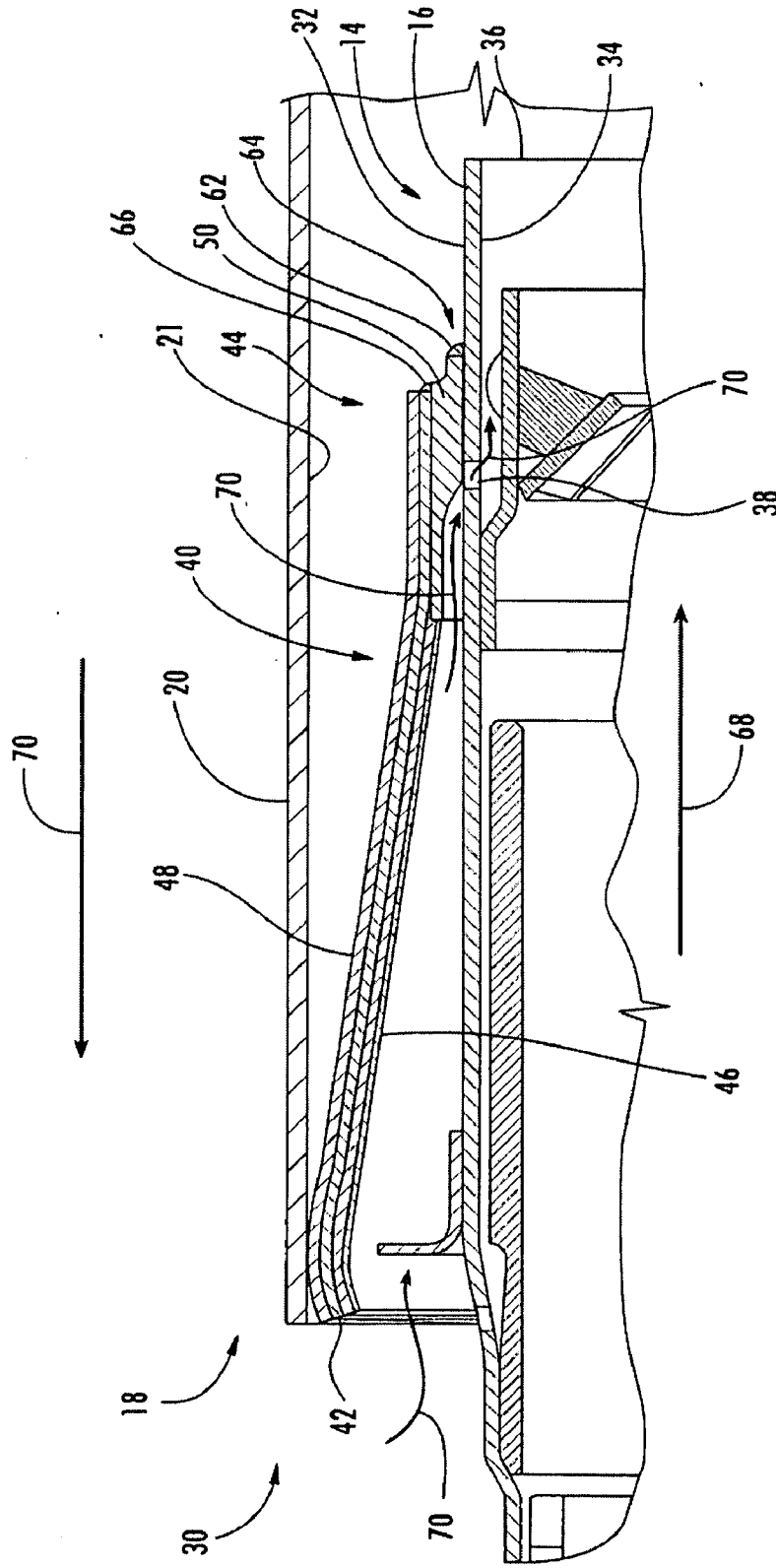
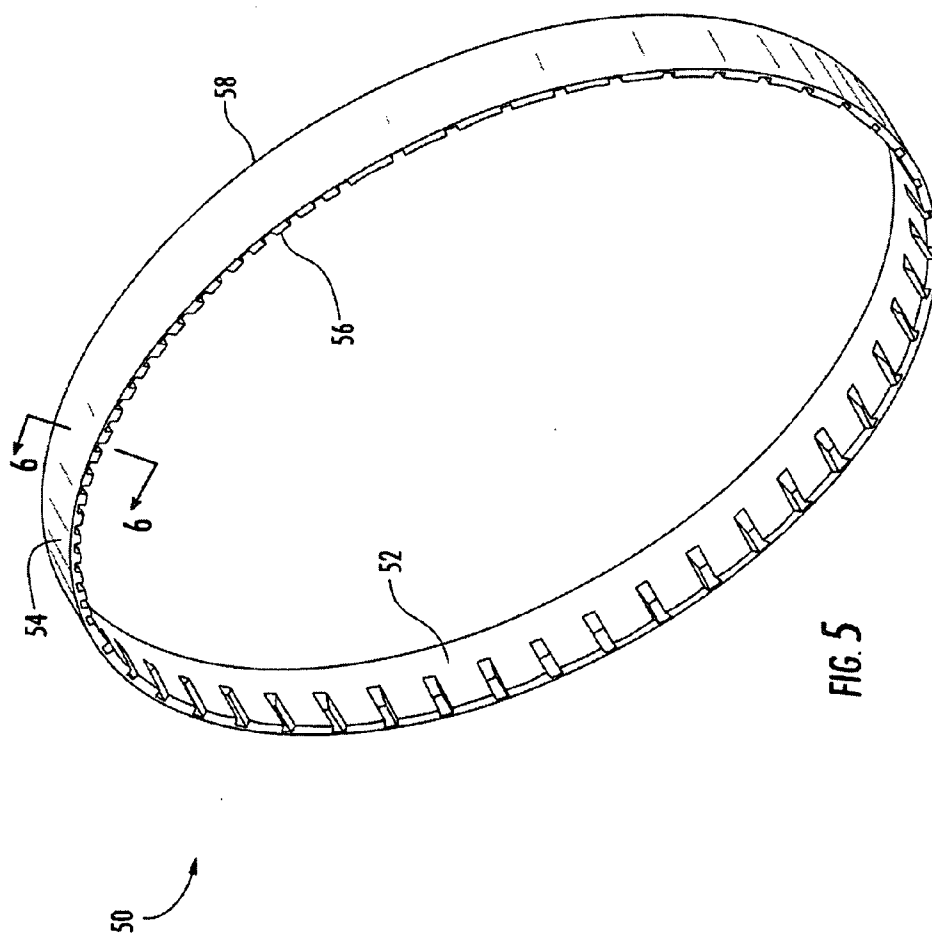


FIG. 4



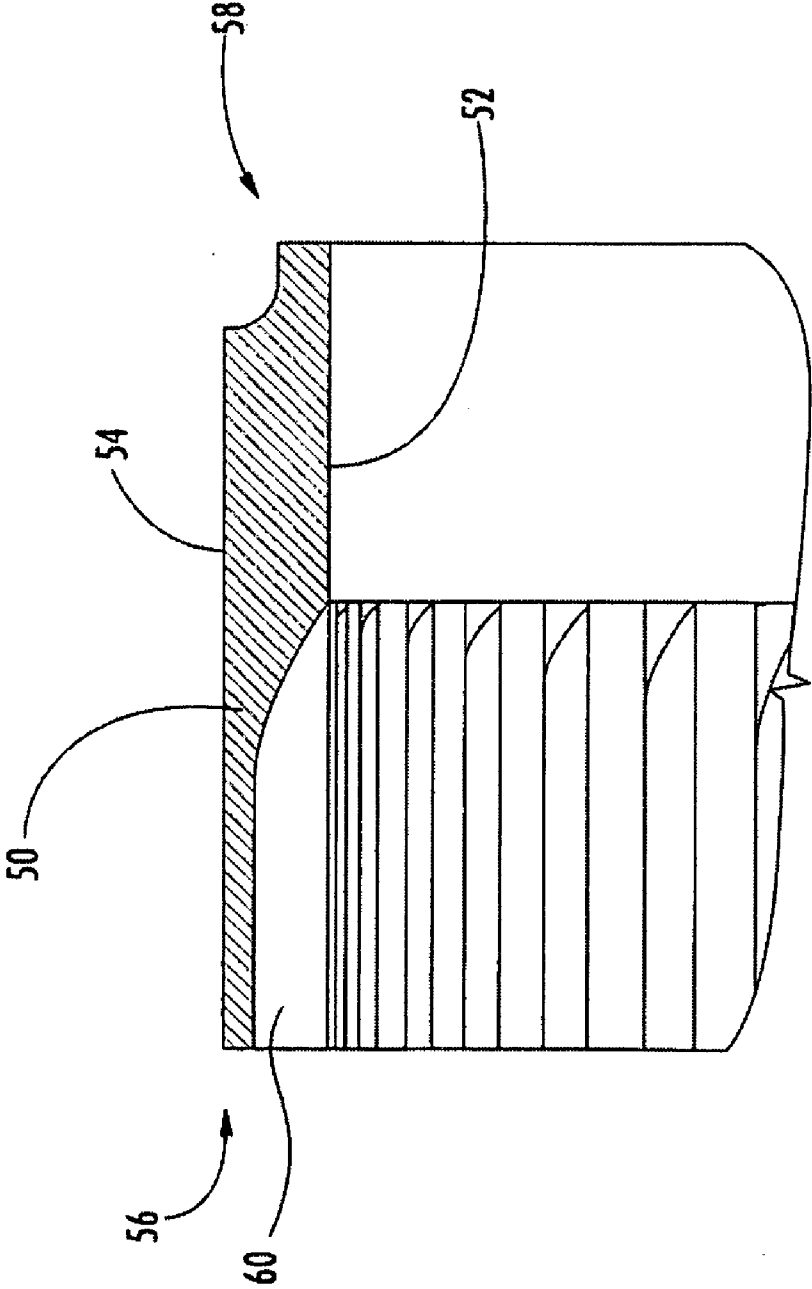


FIG. 6

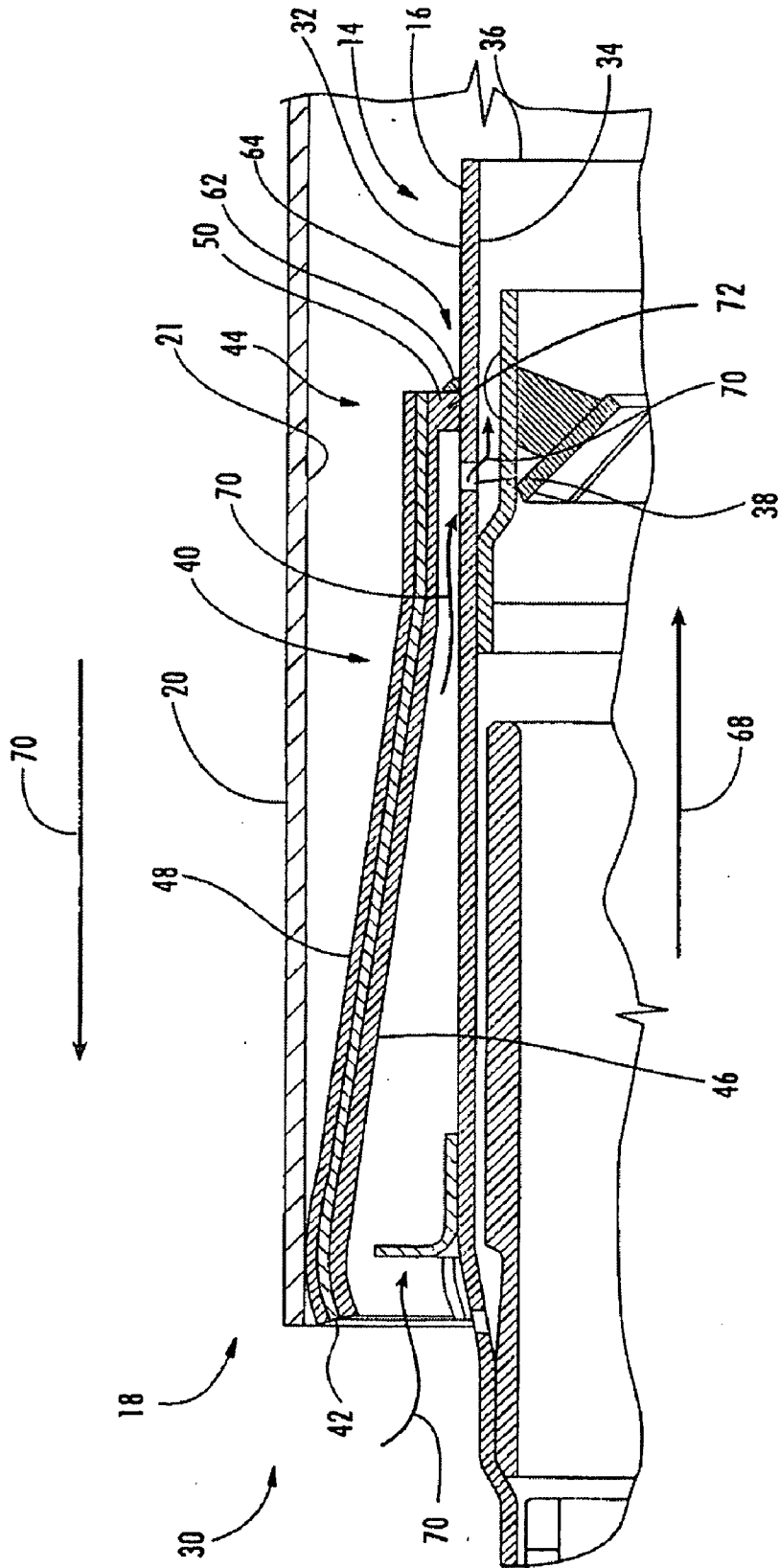


FIG. 7

COMBUSTOR SPRING CLIP SEAL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of U.S. patent application Ser. No. 11/418,065, filed May 4, 2006.

FIELD OF THE INVENTION

[0002] The invention relates in general to turbine engines and, more particularly, to a sealing system for a turbine engine.

BACKGROUND OF THE INVENTION

[0003] FIG. 1 shows an example of a portion of the combustor section 10 of a turbine engine. Turbine engine performance can be adversely affected by fluid leakages that can occur in the combustor flow path. One area in which such leakage can occur is the annular gap 12 defined between the exit region 14 of the combustor liner 16 and the inlet region 18 of the transition duct 20. As is known, the annular gap 12 can be sealed by the use of a spring clip seal 22. Such seals 22 are generally cylindrical cones that taper from a first diameter to a second, smaller diameter. The first diameter of the spring clip seal 22 is operatively positioned against the transition duct 20, and the second, smaller diameter is fixedly attached to a combustor liner 16. The spring clip seal 22 can accommodate relative movement between the combustor liner 16 and the transition duct 20 while maintaining a seal.

[0004] Over the life of the engine, the combustor liner 16 and/or the spring clip seal 22 may require service or repair due to wear or other issues. However, known spring clip sealing systems can actually impede the repair process, causing extended downtime.

[0005] One of the known spring clip sealing systems is shown in FIG. 2. The second diameter 24 of the spring clip seal 22 is fixed to the liner 16 by spot welds 26. However, spot welding causes a portion of both the liner 16 and the seal 22 to melt to form the weld joint. Consequently, the spring clip seal 22 cannot be easily removed. A portion of the liner 16 including its exit region 14 must be cut along with the spring clip seal 22 in order to remove the spring clip seal 22. During reassembly, the cut spring clip 22 and liner exit region 14 must be rewelded, making the process time consuming and raising concerns of structural integrity.

[0006] FIG. 3 shows another known spring clip sealing system. Again, the second diameter 24 of the spring clip 22 is fixed to the liner 16 by spot welds 26. The repair of such a system is difficult because one or more components can obstruct access to the spot weld joint 26. As a result, there is no way that a new spring clip 22 can be attached without cuffing the liner 16 apart. Again, the disassembly and reassembly of the interface becomes time-consuming and difficult.

[0007] Thus, there is a need for a spring clip system that can facilitate the repair, assembly and/or disassembly of the liner-transition duct interface.

SUMMARY OF THE INVENTION

[0008] Aspects of the invention are directed to a turbine engine sealing system. The system includes a liner, a spring clip seal and a spacer. The liner has an outer peripheral surface and an exit end. The spring clip seal has an inner peripheral surface and an outer peripheral surface. The spring clip seal

tapers from a first end that has a first diameter to a second end that has a second diameter, which is smaller than the first diameter.

[0009] The spacer is disposed between and operatively engages each of the second end of the spring clip seal and the outer peripheral surface of the liner. The spacer is attached to outer peripheral surface of the liner. In one embodiment, the spacer can be attached to the outer peripheral surface of the liner by at least one fillet weld. In such case, the fillet weld can extend substantially continuously about an interface defined between engaging portions of the liner and the spacer. The second end of the spring clip seal is spaced from the outer peripheral surface of the liner. Further, the second end of the spring clip seal can be spaced axially upstream from the exit end of the liner.

[0010] In one embodiment, the spacer can be a protrusion that extends from the second end of the spring clip seal. The protrusion and the second end of the spring clip seal can be unitary. In another embodiment, the spacer can be an insert formed separately from the second end of the spring clip seal. In such case, the second end of the spring clip seal can be attached to the insert by at least one fillet weld. The fillet weld can extend substantially continuously about an interface between the spring clip seal and the insert. The liner can include a plurality of passages extending through and about the liner proximate the exit end. The insert can include a plurality of notches. Each notch can be in fluid communication with a respective one of the passages. Thus, air from the combustor flow path can enter the passages.

[0011] In another respect, turbine engine sealing system according to aspects of the invention includes a liner, a spring clip seal and a separately-formed insert. The liner has an outer peripheral surface and an exit end. The spring clip seal has an inner peripheral surface and an outer peripheral surface. The spring clip seal tapers from a first end at a first diameter to a second end at a second diameter that is smaller than the first diameter. The second end of the spring clip seal can be spaced axially upstream from the exit end of the liner. The insert is disposed between the second end of the spring clip seal and the outer peripheral surface of the liner.

[0012] The second end of the spring clip seal is attached to the insert by a first fillet weld, and the insert is attached to outer peripheral surface of the liner by a second fillet weld. The first fillet weld can extend substantially continuously about an interface between engaging portions of the second end of the spring clip seal and the insert. The second fillet weld can extend substantially continuously about an interface between engaging portions of the outer peripheral surface of the liner and the insert. The insert can have an upstream end and a downstream end. The downstream end of the insert can be attached to outer peripheral surface of the liner by the second fillet weld.

[0013] The liner can include a plurality of passages extending through and about the liner proximate the exit end. The insert can include a plurality of notches. Each notch can be in fluid communication with a respective one of the passages. Thus, air from the combustor flow path can enter the passages.

[0014] Aspects of the invention are further directed to a method of attaching a spring clip seal. The method includes the step of providing a liner that has an outer peripheral surface and an exit end. A spring clip seal is formed. The spring clip seal has an inner peripheral surface and an outer peripheral surface. The spring clip seal tapers from a first end at a first diameter to a second end at a second diameter, which

is smaller than the first diameter. In addition, a spacer is formed. The steps of forming the spring clip seal and the spacer can be performed together such that the spacer and the spring clip seal are unitary.

[0015] The spacer is positioned so as to operatively engage both the second end of the spring clip seal and the outer peripheral surface of the liner. A first weld joint is formed to attach the spacer to the outer peripheral surface of the liner. The first weld joint is formed such that the spacer and the liner do not melt. In one embodiment, the step of forming the first weld joint can be performed by fillet welding.

[0016] In one embodiment, the spacer can be an insert formed separately from the spring clip seal. In such case, the method according to aspects of the invention can further include the step of forming a second weld joint to attach the spacer to the outer peripheral surface of the liner. The second weld joint forming step can be performed in such a way that the spacer and the liner do not melt. For example, the second weld joint can be formed by fillet welding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a cross-sectional view of a portion of the combustor section of a known turbine engine, showing a spring clip seal operatively positioned between the exit end of the combustor basket and the inlet to the transition.

[0018] FIG. 2 is a close-up cross-sectional view of one known spring clip seal system.

[0019] FIG. 3 is a close-up cross-sectional view of another known spring clip seal system.

[0020] FIG. 4 is a close-up of a spring clip seal system according to aspects of the invention.

[0021] FIG. 5 is an isometric view of an insert according to aspects of the invention.

[0022] FIG. 6 is a cross-sectional view of the insert according to aspects of the invention, viewed from line 6-6 in FIG. 5.

[0023] FIG. 7 is a close-up view of an alternative spring clip seal system according to aspects of the invention, showing a spring clip seal adapted for direct engagement with the outer peripheral surface of the liner.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0024] Embodiments of the present invention are directed to a spring clip seal system that can minimize the difficulties experienced with the repair, assembly and/or disassembly of prior spring clip seal systems. A system according to aspects of the invention can involve the attachment of a spring clip seal to a liner in a manner that can facilitate the separation of the spring clip seal from the liner, such as by using a welding process that does not require the base material of the spring clip seal and the liner to be melted to form the weld joint. Ideally, such a system would not appreciably affect the aerodynamic performance in the region. Embodiments of the invention will be explained in the context of one possible system, but the detailed description is intended only as exemplary. Embodiments of the invention are shown in FIGS. 4-7, but the present invention is not limited to the illustrated structure or application.

[0025] FIG. 4 shows one spring clip seal system 30 according to aspects of the invention. The system 30 can be used at the interface between the inlet region 18 of the transition duct 20 and the outlet region 14 of the combustor liner 16. Preferably, the system 30 does not require modifications to be made

to the liner 16 and the transition duct 20. The transition duct can have an inner peripheral surface 21. The liner 16 is a generally tubular component having an outer peripheral surface 32, an inner peripheral surface 34, and an exit end 36. A plurality of passages 38 extend through the wall of the liner 16 near the exit end 36.

[0026] The sealing system 30 according to aspects of the invention includes a spring clip seal 40. The seal 40 can be generally conical, tapering from a first end 42 having a first diameter to a second end 44 having a second, smaller diameter. However, other conformations are possible. The spring clip seal 40 can have an inner peripheral surface 46 and an outer peripheral surface 48. The spring clip seal 40 can be a single unitary piece, or it can comprise a plurality of nested housings.

[0027] The outer peripheral surface 48 of the first end 42 of the spring clip seal 40 can operatively engage the inner peripheral surface 21 of the transition duct 20. The second end 44 of the spring clip seal 40 according to aspects of the invention can be operatively attached to the liner 16 in a way that can facilitate the subsequent separation and removal of the spring clip seal 40. According to aspects of the invention, the second end 44 of the spring clip seal 40 is separated from the outer peripheral surface 32 of the liner 16 by a spacer. The spacer can operatively engage the second end 44 of the spring clip seal 40 and the outer peripheral surface 32 of the liner 16.

[0028] In one embodiment, the spacer can be an insert 50 that is interposed between the second end 44 of the spring clip seal 40 and the liner 16. Thus, the second end 44 of the spring clip seal 40 can be indirectly attached to the liner 16. One embodiment of an insert 50 according to aspects of the invention is shown in FIGS. 5-6. The insert 50 can be substantially ring-shaped. The insert 50 can have an inner peripheral surface 52 and an outer peripheral surface 54. In addition, the insert 50 can also include an upstream end 56 and a downstream end 58. The insert 50 can be a single unitary piece, or it can be made of a plurality of segments that are circumferentially abutted and connected so as to form a ring. The insert 50 can be made of any suitable material including, for example, HAST-X.

[0029] The insert 50 can include a plurality of notches 60 therein. The notches 60 can be formed in the insert 50 so as to begin at the upstream end 56. The notches 60 can extend toward but terminate before the downstream end 58. In addition, the notches 60 can open to the inner peripheral surface 52 of the insert 50. The notches 60 can have any shape and are preferably configured so as to minimize stress concentrations. The notches 60 can be substantially identical to each other, but at least one of the notches 60 can be different from the other notches 60 in one or more respects.

[0030] The notches 60 can be spaced about the insert 50 in various ways. Ideally, the notches 60 are positioned to correspond to locations of the passages 38 in the liner 16. In one embodiment, the notches 60 can be substantially equally spaced about the insert 50. In some instances, the notches 60 can be provided at an unequal spacing in one or more areas about the insert 50.

[0031] According to aspects of the invention, the insert 50 can be attached to the liner 16 in a way that does not involve the melting of the base material of the liner 16 and/or the insert 50. For instance, a weld material can be deposited at the engaging portions of the liner and the insert to form a weld joint. In one embodiment, the insert 50 can be attached to the liner 16 by a fillet weld 62. More specifically, the downstream

end **58** of the insert **50** can be fillet welded to the outer peripheral surface **32** of the liner **16** proximate the exit end **36**. Preferably, the fillet weld **62** extends continuously around an interface **64** defined between the engaging portions of the liner **16** and the insert **50**, such as a 360 degree fillet weld. However, aspects of the invention include embodiments in which the liner **16** and the insert **50** are attached by intermittent fillet welds. It should be noted that the term "fillet weld" and variants thereof may connote a specific cross-sectional geometry of the weld (i.e., triangular) and of a particular arrangement of the pieces being joined (i.e., at right angles), but aspects of the invention are not limited to any particular cross-sectional geometry of the weld or arrangement of the components being joined.

[0032] While the above discussion has been directed to fillet welds, the liner **16** and the insert **50** can be joined by other types of welds, preferably welds that are relatively thin and do not involve melting of the liner **16** and the insert **50**. When the insert **50** is attached to the liner **16**, the notches **60** in the insert **50** can be in fluid communication with the passages **38** in the liner **16**.

[0033] The first end **42** of the spring clip seal **40** can be operatively positioned against the inner peripheral surface **21** of the transition duct **20**. The second end **44** of the spring clip seal **40** can contact the outer peripheral surface **54** of the insert **50**. The second end **44** of the spring clip seal **40** can be attached to the insert **50** in a way that does not involve the melting of the base material of the insert **50** and/or the spring clip seal **40**, such as by a fillet weld **66**. The above discussion of the attachment between the insert **50** and the liner **16** applies equally to the attachment to the insert **50** and the spring clip seal **40**. In one embodiment, the second end **44** of the spring clip seal **40** can be attached at or near the downstream end **58** of the insert **50**. Preferably, the second end **44** of the spring clip seal **40** is axially spaced from the exit end **36** of the liner **16**.

[0034] There are other ways in which the second end **44** of the spring clip seal **40** can be operatively attached to the liner **16**. In one embodiment, the second end **44** of the spring clip seal **40** can be adapted to be directly attached to the liner **16**. To that end, the spacer can be one or more protrusions **72** extending from the second end **44** of the spring clip seal **40**, as shown in FIG. 7. The protrusion **72** can be unitary with the second end **44** of the spring clip seal **40**; that is, the protrusion **72** and the second end **44** can be a single piece. The protrusion **72** can extend continuously about the entire inner peripheral surface **46** of the spring clip seal **40**. The protrusion **72** can also extend substantially radially inward from the inner peripheral surface **46** of the spring clip seal **40**. The protrusion **72** can be attached to the liner **16** by any of the processes discussed above, including fillet welds **62**. The protrusion can be configured so that it does not block any of the passages **38** in the liner **16**.

[0035] The above-described system can facilitate the repair of the combustor liner **16** and/or spring clip seal **22**, as may be required over the life of the engine. As noted above, fillet welds can be used to join the spring clip seal **40** and the insert **50** and to join the insert **50** and the liner **16**. Such welds are relatively easy to cut using any suitable technique. Thus, the spring clip seal **40**, insert **50** and liner **16** can be separated from each other without the need for cutting any of these individual components, as was necessary with prior spring clip sealing systems. As a result, component life can be extended and the frequency of repair can be reduced. Further,

the time and labor cost associated with the repair, disassembly and reassembly process can be reduced.

[0036] Further, it should be noted that there have been instances of the second end of known spring clip seals being burned during engine operation. Such burning can be attributed to the location of the second end of the seals, which may extend substantially to or even beyond the exit end **36** of the liner **16**. Consequently, the second end resides close to the hot combustion gas flow. However, the spring clip seal cannot simply be shortened because of the second end of the seal would cover the passages **38** in the liner **16**. According to aspects of the invention, the axial length of the spring clip seal **40**, measured from the first end **42** to the second end **44**, can be shortened so that the second end **44** terminates at or near the passages **38** in the liner **16**. However, the passages **38** are not obstructed because the insert **50** keeps the second end **44** off of the outer peripheral surface **32** of the liner **16**. The second end **44** can be spaced upstream from the exit end **36** of the liner **16** and, therefore, away from the combustion gas path. The remoteness of the second end **44** can minimize the potential for burning.

[0037] It will be appreciated that the above-described system **30** can have little or no impact on the aerodynamic performance of the transition duct-liner interface. The system **30** can direct fluid flow to the passages **38** in the liner **16** while preventing hot combustion gases **68** in the liner **16** from leaking into the combustor air path **70**. In addition, the spring clip seal **40** can prevent leakage of compressed air **70** into the combustion gas path **68**. The notches **60** in the insert **50** can permit an appropriate amount of the air **70** to enter the passages **38** in the liner **16**.

[0038] The foregoing description is provided in the context of one possible spring clip seal system. Thus, it will of course be understood that the invention is not limited to the specific details described herein, which are given by way of example only, and that various modifications and alterations are possible within the scope of the invention as defined in the following claims.

What is claimed is:

1. A turbine engine sealing system comprising:

a liner having an outer peripheral surface and an exit end;
a spring clip seal having an inner peripheral surface and an outer peripheral surface, the spring clip seal tapering from a first end having a first diameter to a second end having a second diameter that is smaller than the first diameter; and

a spacer disposed between and operatively engaging each of the second end of the spring clip seal and the outer peripheral surface of the liner, the spacer being attached to outer peripheral surface of the liner, whereby the second end of the spring clip seal is spaced from the outer peripheral surface of the liner.

2. The system of claim 1 wherein the spacer is attached to the outer peripheral surface of the liner by at least one fillet weld.

3. The system of claim 2 wherein the fillet weld extends substantially continuously about an interface defined between engaging portions of the liner and the spacer.

4. The system of claim 1 wherein the second end of the spring clip seal is spaced axially upstream from the exit end of the liner.

5. The system of claim 1 wherein the spacer is a protrusion extending from the second end of the spring clip seal, and wherein the protrusion and the second end of the spring clip seal are unitary.

6. The system of claim 1 wherein the spacer is an insert formed separately from the second end of the spring clip seal.

7. The system of claim 6 wherein the second end of the spring clip seal is attached to the insert by at least one fillet weld.

8. The system of claim 7 wherein the fillet weld extends substantially continuously about an interface between the spring clip seal and the insert.

9. The system of claim 6 wherein the liner includes a plurality of passages extending through and about the liner proximate the exit end, and wherein the insert includes a plurality of notches, wherein each notch is in fluid communication with a respective one of the passages, whereby air from the combustor flow path can enter the passages.

10. A turbine engine sealing system comprising:
a liner having an outer peripheral surface and an exit end;
a spring clip seal having an inner peripheral surface and an outer peripheral surface, the spring clip seal tapering from a first end having a first diameter to a second end having a second diameter that is smaller than the first diameter; and
a separately-formed insert disposed between the second end of the spring clip seal and the outer peripheral surface of the liner, the second end of the spring clip seal being attached to the insert by a first fillet weld, and the insert being attached to outer peripheral surface of the liner by a second fillet weld.

11. The system of claim 10 wherein the second fillet weld extends substantially continuously about an interface between engaging portions of the outer peripheral surface of the liner and the insert.

12. The system of claim 10 wherein the second end of the spring clip seal is spaced axially upstream from the exit end of the liner.

13. The system of claim 10 wherein the liner includes a plurality of passages extending through and about the liner proximate the exit end, and wherein the insert includes a plurality of notches, wherein each notch is in fluid commu-

nication with a respective one of the passages, whereby air from the combustor flow path can enter the passages.

14. The system of claim 10 wherein the first fillet weld extends substantially continuously about an interface between engaging portions of the second end of the spring clip seal and the insert.

15. The system of claim 10 wherein the insert has an upstream end and a downstream end, wherein the downstream end of the insert is attached to outer peripheral surface of the liner by the second fillet weld.

16. A method of attaching a spring clip seal comprising the steps of:

- providing a liner having an outer peripheral surface and an exit end;
- forming a spring clip seal having an inner peripheral surface and an outer peripheral surface, the spring clip seal tapering from a first end having a first diameter to a second end having a second diameter that is smaller than the first diameter;
- forming a spacer;
- positioning the spacer on the outer peripheral surface of the liner so that the spacer operatively engages each of the second end of the spring clip seal and the outer peripheral surface of the liner; and
- forming a first weld joint to attach the spacer to the outer peripheral surface of the liner, wherein the first weld joint is formed such that the spacer and the liner do not melt.

17. The method of claim 16 wherein the spacer forming step and the spring clip forming step are performed together such that the spacer and the spring clip seal are unitary.

18. The method of claim 16 wherein the first weld joint forming step is performed by fillet welding.

19. The method of claim 16 wherein the spacer is an insert formed separately from the spring clip seal, and further including the step of forming a second weld joint to attach the spacer to the outer peripheral surface of the liner, wherein the second weld joint forming step is performed such that the spacer and the liner do not melt.

20. The method of claim 19 wherein the second weld joint forming step is performed by fillet welding.

* * * * *