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(54) **BICAST TURBINE ENGINE COMPONENTS**

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(57) **ABSTRACT**

A turbine blade assembly includes a turbine blade having a pressure sidewall and an opposed suction sidewall and a first snubber assembly associated with one of the pressure sidewall and the suction sidewall. The first snubber assembly includes a first base portion extending outwardly from the one of the pressure sidewall and the suction sidewall, and a first snubber portion. The first base portion is integrally cast with the turbine blade and includes first connection structure. The first snubber portion is bicast onto the first base portion and includes second connection structure that interacts with the first connection structure to substantially prevent separational movement between the first base portion and the first snubber portion.

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(63) Continuation-in-part of application No. 12/752,460, filed on Apr. 1, 2010.

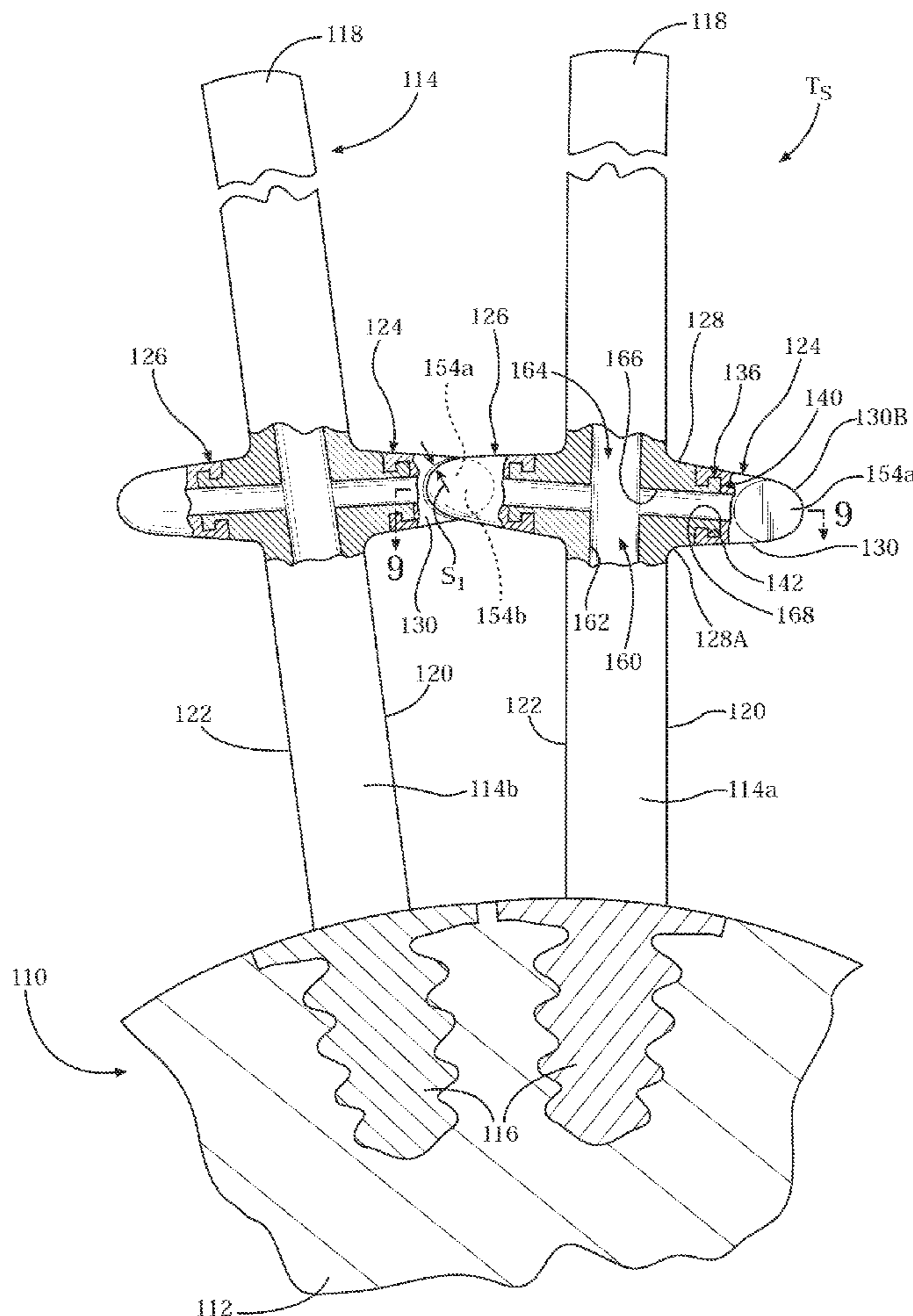
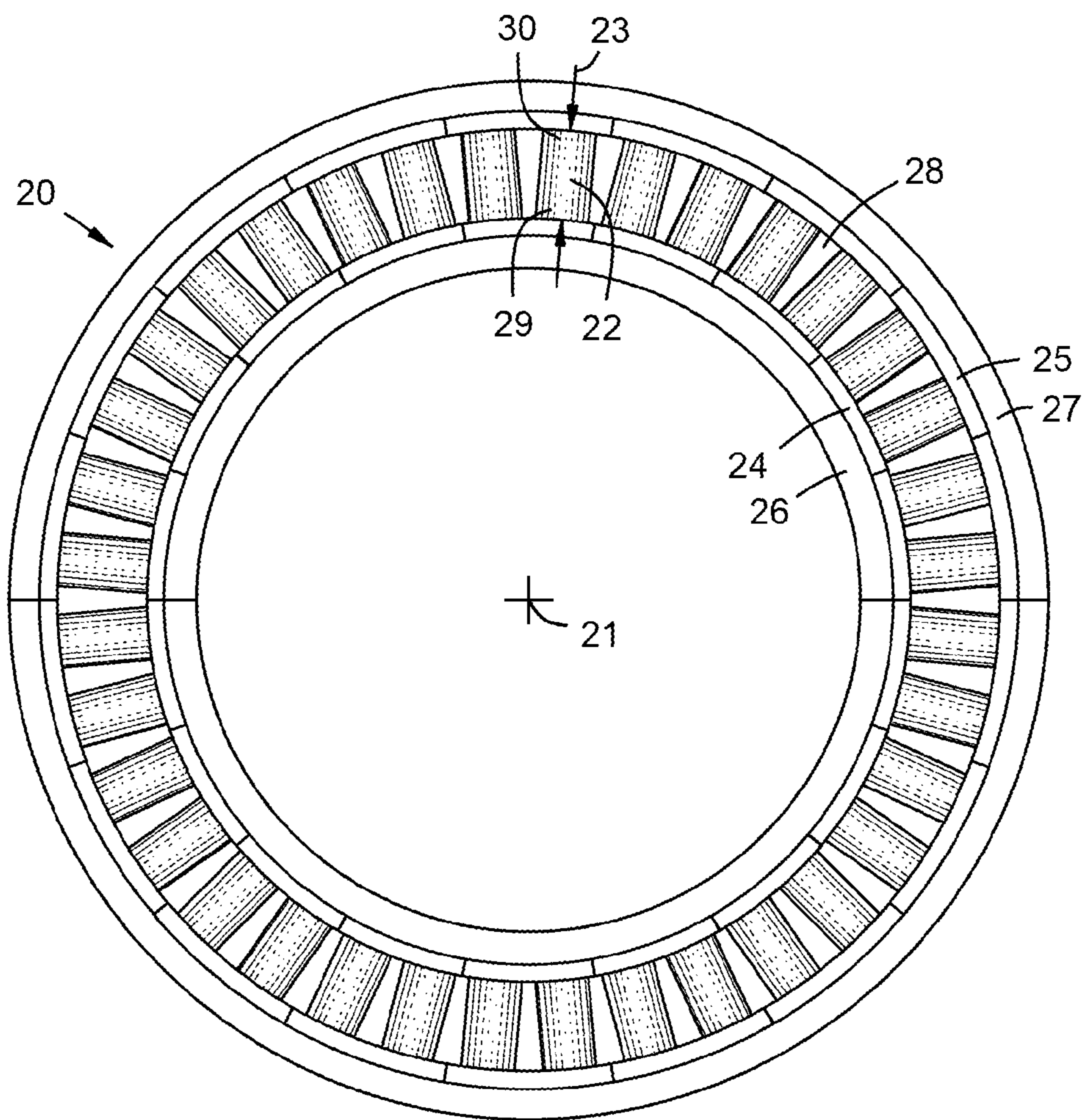
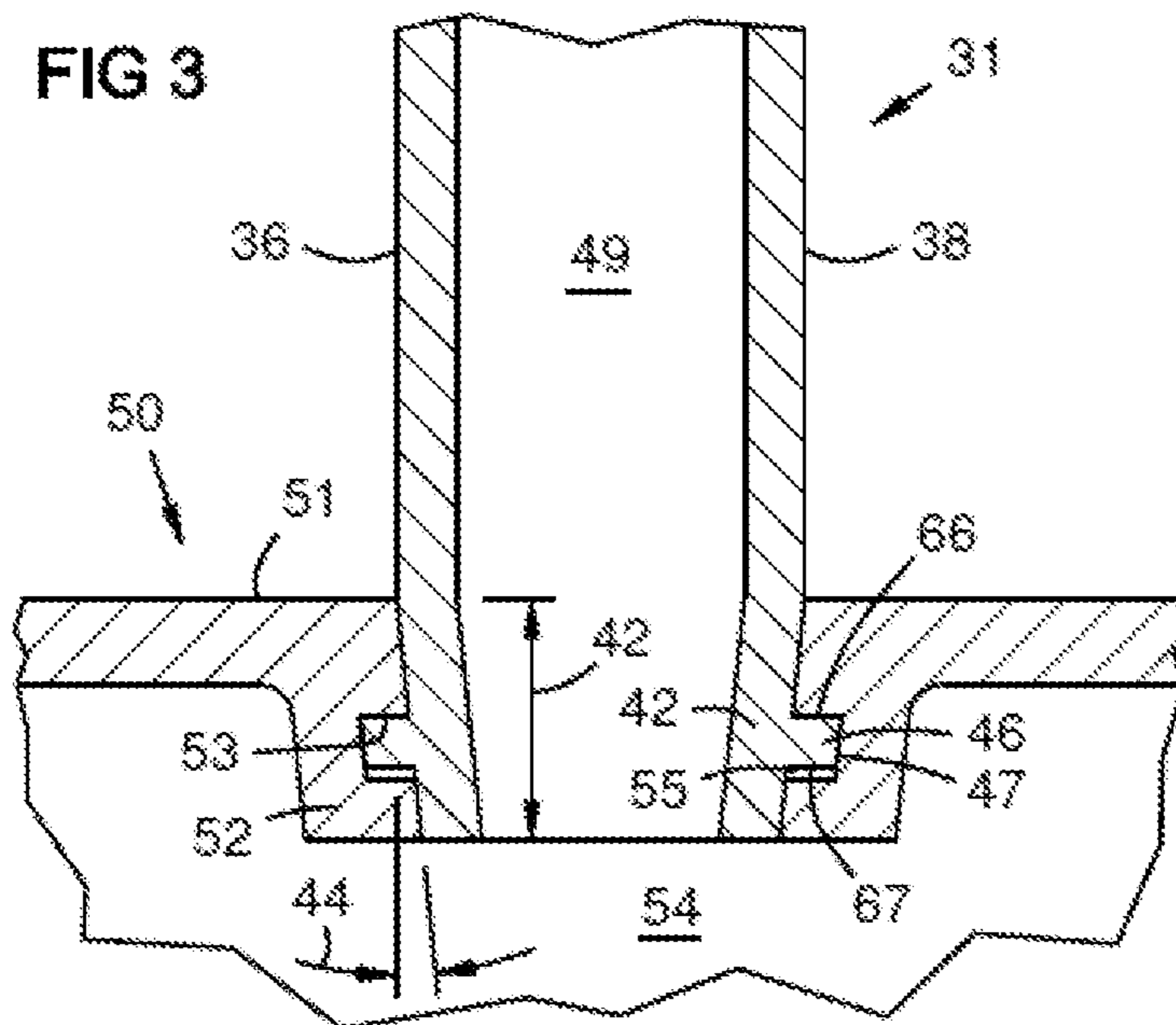
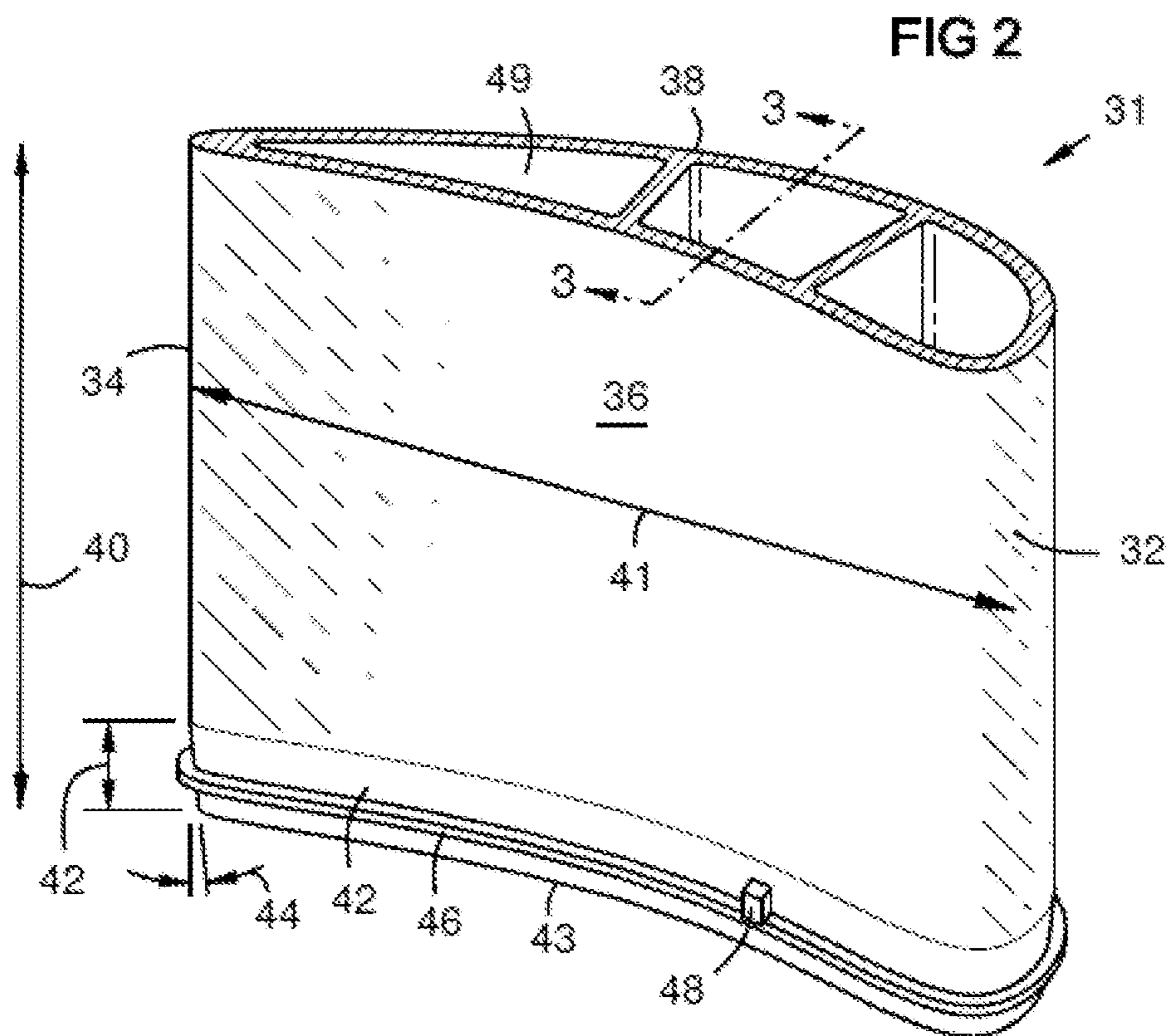


FIG 1





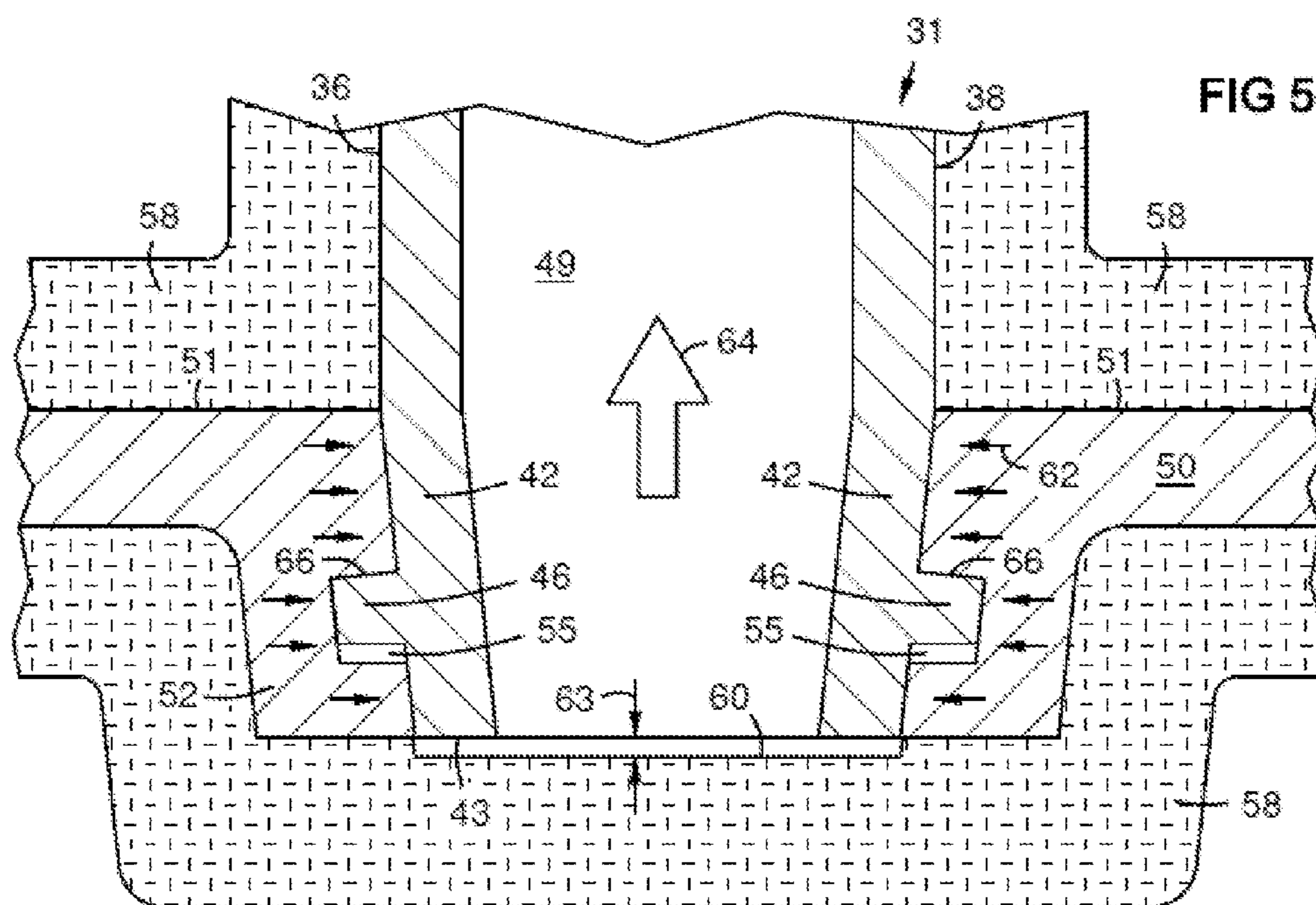
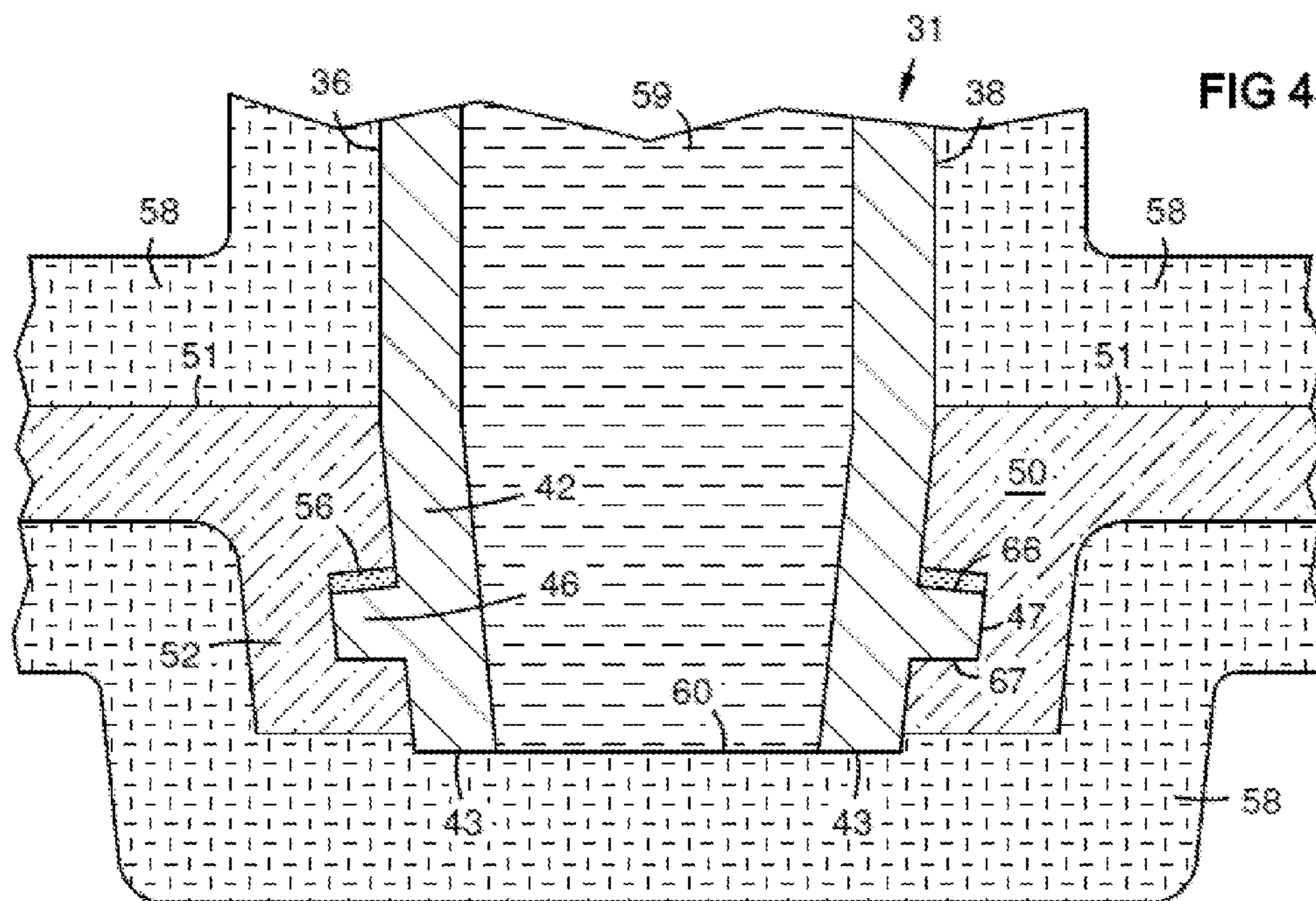


FIG 6

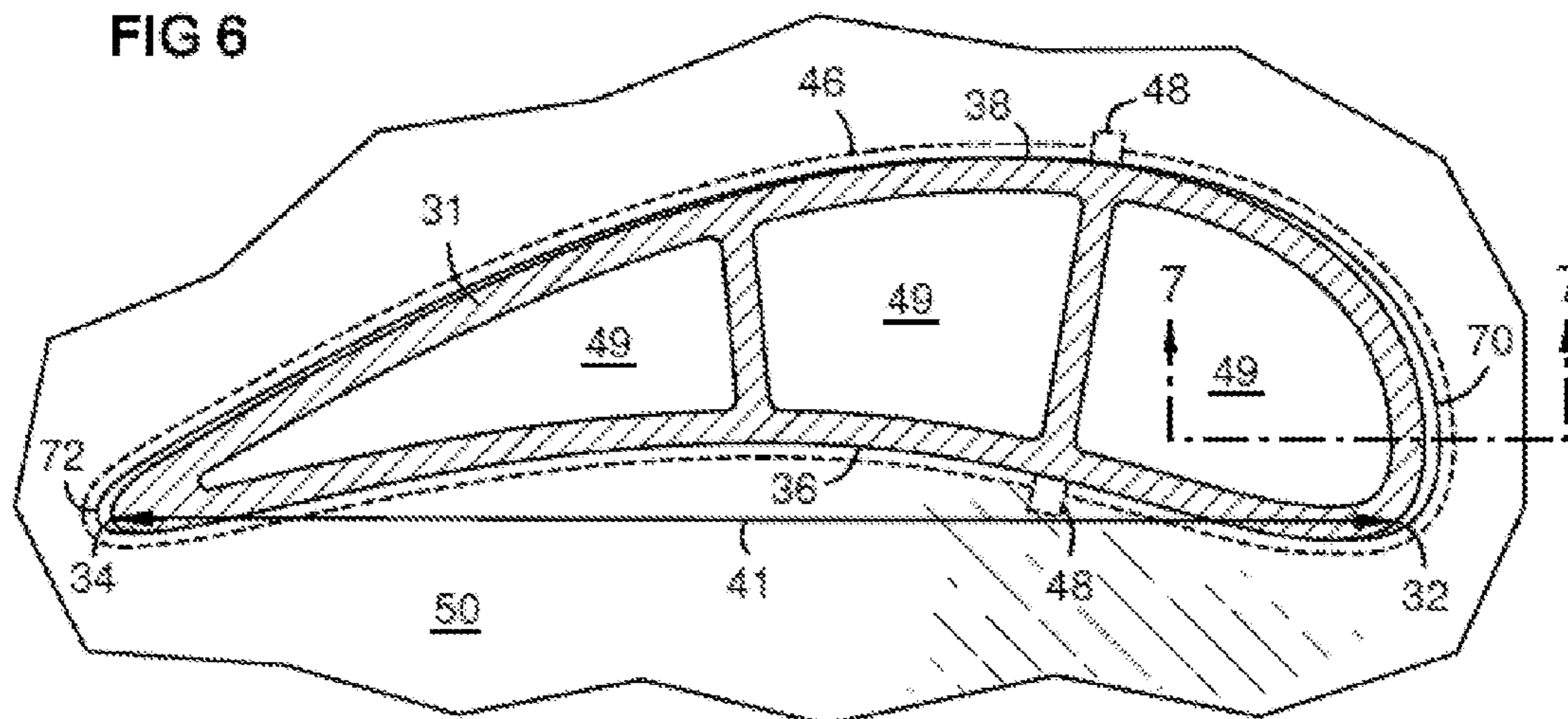
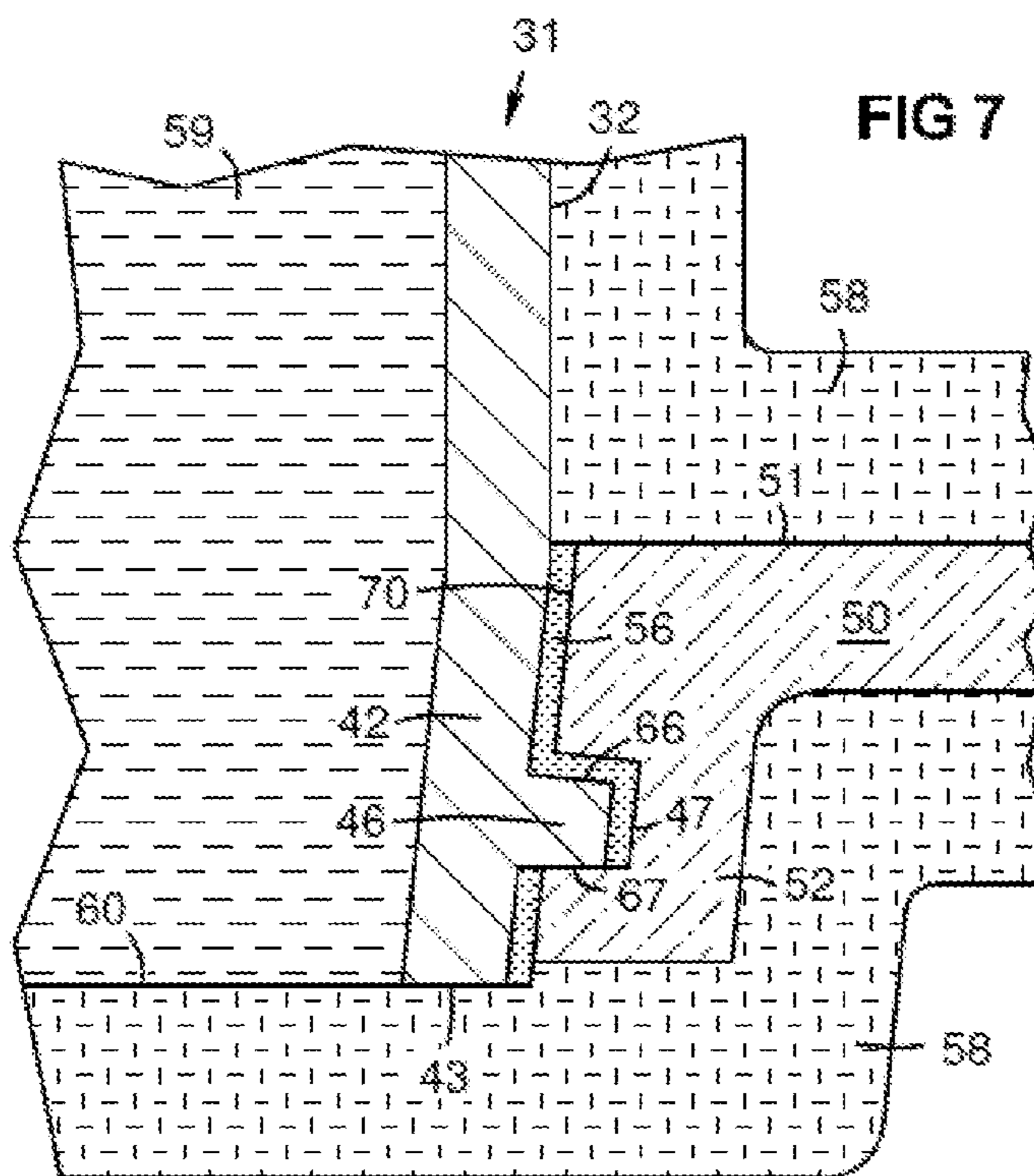
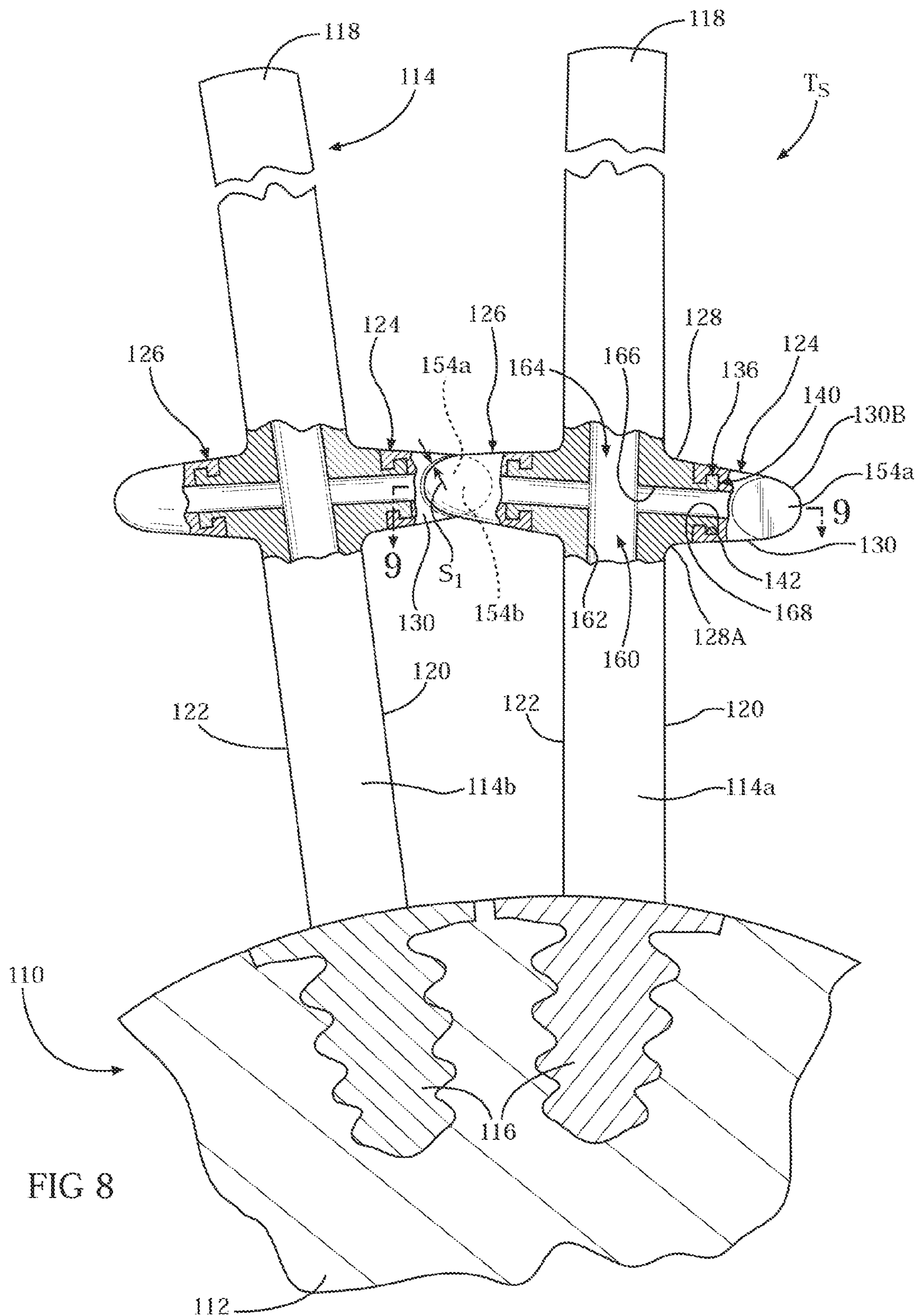


FIG 7





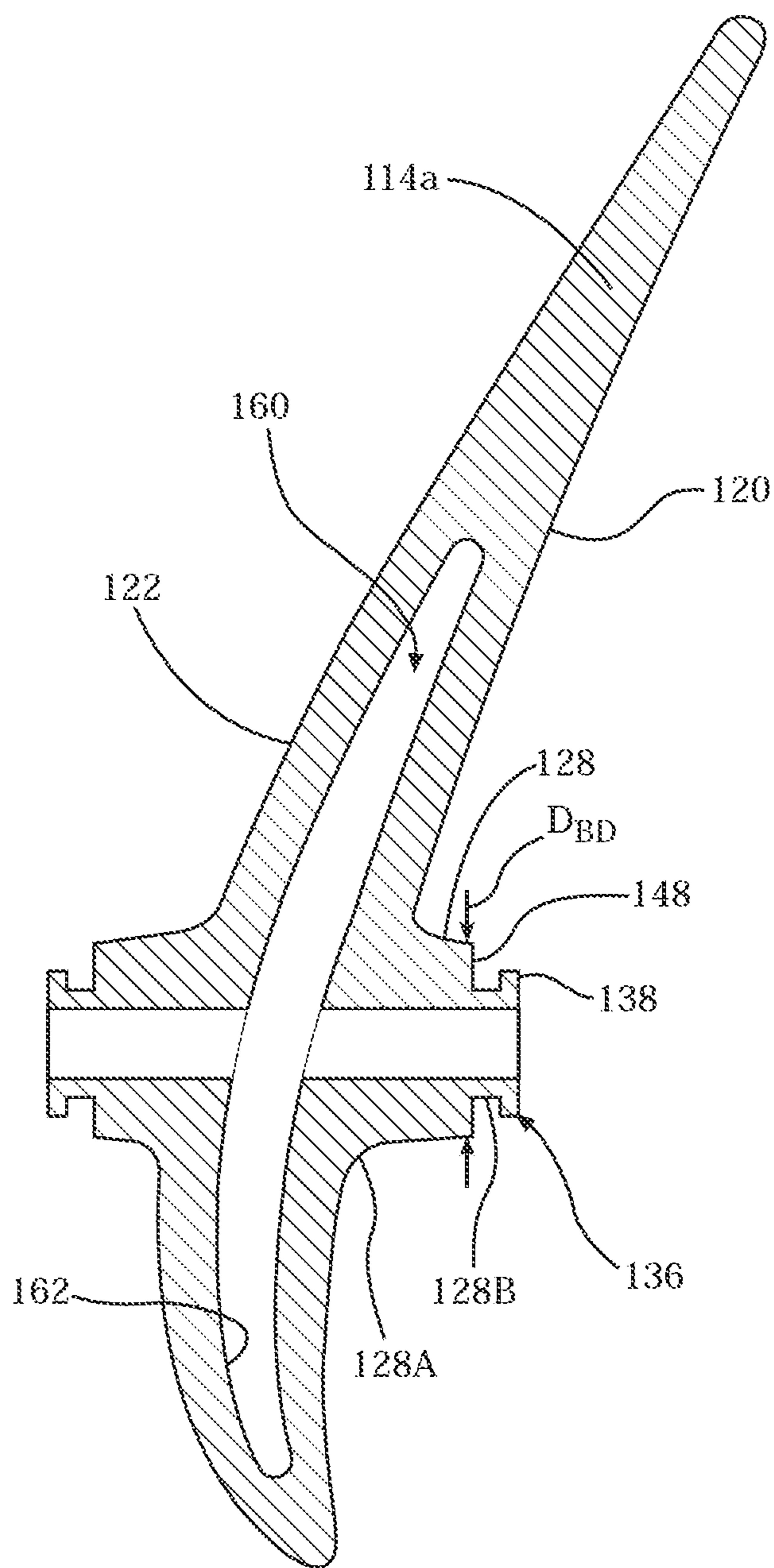


FIG 10

BICAST TURBINE ENGINE COMPONENTS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation-In-Part of U.S. patent application Ser. No. 12/752,460, filed Apr. 1, 2010 and entitled "TURBINE AIRFOIL TO SHROUD ATTACHMENT" by Christian X. Campbell et al., the entire disclosure of which is incorporated by reference herein.

[0002] This invention was made with U.S. Government support under Contract Number DE-FC26-05NT42644 awarded by the U.S. Department of Energy. The U.S. Government has certain rights to this invention.

FIELD OF THE INVENTION

[0003] The present invention relates generally to couplings between components in a turbine engine, and, more particularly, to bicast couplings between turbine engine components, such as turbine blades and snubber assemblies.

BACKGROUND OF THE INVENTION

[0004] A turbomachine, such as a steam or gas turbine is driven by a hot working gas flowing between rotor blades arranged along the circumference of a rotor so as to form an annular blade arrangement, and energy is transmitted from the hot working gas to a rotor shaft through the rotor blades. As the capacity of electric power plants increases, the volume of flow through industrial turbine engines has increased more and more and the operating conditions (e.g., operating temperature and pressure) have become increasingly severe. Further, the rotor blades have increased in size to harness more of the energy in the working gas to improve efficiency. A result of all the above is an increased level of stresses (such as thermal, vibratory, bending, centrifugal, contact and torsional) to which the rotor blades are subjected.

[0005] In order to limit vibrational stresses in the blades, various structures may be provided to the blades to form a cooperating structure between blades that serves to dampen the vibrations generated during rotation of the rotor. For example, mid-span snubber structures, such as cylindrical standoffs, may be provided extending from mid-span locations on the blades for engagement with each other. Two mid-span snubber structures are typically located at the same height on either side of a blade with their respective contact surfaces pointing in opposite directions. The snubber contact surfaces on adjacent blades are separated by a small space when the blades are stationary. However, when the blades rotate at full load and untwist under the effect of the centrifugal forces, snubber surfaces on adjacent blades come in contact with each other to dampen vibrations by friction at the contacting snubber surfaces.

SUMMARY OF THE INVENTION

[0006] In accordance with one aspect of the invention, a turbine blade assembly is provided in a turbine engine. The turbine blade assembly comprises a turbine blade having a pressure sidewall and an opposed suction sidewall and a first snubber assembly associated with one of the pressure sidewall and the suction sidewall. The first snubber assembly comprises a first base portion extending outwardly from the one of the pressure sidewall and the suction sidewall, and a first snubber portion. The first base portion is integrally cast with the turbine blade and includes first connection structure.

The first snubber portion is bicast onto the first base portion and includes second connection structure that interacts with the first connection structure to substantially prevent separational movement between the first base portion and the first snubber portion.

[0007] In accordance with a second aspect of the invention, a coupling is provided between two components in a turbine engine. The coupling comprises a first component formed by a first casting procedure and including first connection structure comprising one of a continuous annular ridge and a continuous annular groove, and a second component bicast onto the first component during a second casting procedure and having second connection structure comprising the other of a continuous annular ridge and a continuous annular groove. The second connection structure interacts with the first connection structure to substantially prevent separational movement between the first component and the second component.

[0008] In accordance a third aspect of the invention, a method is provided for forming a turbine blade assembly. A first casting procedure is performed to form: a turbine blade having a pressure sidewall and an opposed suction sidewall; and a base portion of a snubber assembly, the base portion extending from one of the pressure sidewall and the suction sidewall. A second casting procedure is performed by casting a snubber portion onto the base portion such that first connection structure of the base portion interacts with second connection structure of the snubber portion to substantially prevent separational movement between the base portion and the snubber portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] While the specification concludes with claims particularly pointing out and distinctly claiming the present invention, it is believed that the present invention will be better understood from the following description in conjunction with the accompanying Drawing Figures, in which like reference numerals identify like elements, and wherein:

[0010] FIG. 1 schematically illustrates a prior art ring of vanes centered on an axis;

[0011] FIG. 2 is a partial perspective view of a vane airfoil according to aspects of the present invention;

[0012] FIG. 3 is a sectional view taken along line 3-3 of FIG. 2 including a partial shroud platform;

[0013] FIG. 4 is a sectional view of a stage of bi-casting of a platform on an end portion of a vane in which the platform is molten;

[0014] FIG. 5 is a sectional view of a stage of bi-casting in which the platform has solidified and contracted and fugitive materials have been removed;

[0015] FIG. 6 shows a partial plan view of a platform with a vane in section

[0016] FIG. 7 shows a sectional view taken along line 7-7 of FIG. 6;

[0017] FIG. 8 is a partial end view of a rotor partially in section, as viewed in an axial flow direction, taken in a plane perpendicular to an axis of rotation and showing another embodiment of the present invention;

[0018] FIG. 9 is a cross sectional view of only a first turbine blade taken on the plane indicated by the line 9-9 in FIG. 8; and

[0019] FIG. 10 is a view similar to that of FIG. 9 after a first casting procedure has been performed but before a second casting procedure, also referred to as a bicasting procedure or

a bicast, has been performed in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020] In the following detailed description of the preferred embodiment, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration, and not by way of limitation, a specific preferred embodiment in which the invention may be practiced. It is to be understood that other embodiments may be utilized and that changes may be made without departing from the spirit and scope of the present invention.

[0021] FIG. 1 illustrates a prior art ring 20 of stationary vanes 22 centered on an axis 21 in a turbine. Each vane 22 is an airfoil with first and second ends 29, 30. The vane spans radially 23 between inner and outer shroud segments or platforms 24, 25. Herein “radially” means perpendicular to the axis 21 and “axially” means generally parallel to the axis 21, although it is noted that the terms “inner”, “outer”, “radial”, “axial”, “circumferential”, and the like, as used herein, are not intended to be limiting with regard to orientation of the elements recited for the present invention. The platforms 24, 25 may be attached to respective inner and outer ring structures 26, 27, which may be support rings and/or cooling air plenum structures. Between each pair of vanes 22 is a working gas flow passage 28. In a gas turbine, the vanes 22 direct a combustion gas flow against an adjacent downstream ring of rotating blades not shown. Individual vane segments are traditionally cast with one or more airfoils per pair of inner/outer platforms 24, 25 to form what is sometimes called a nozzle. For large industrial gas turbine vanes, easily cast alloys (e.g. the cobalt based alloy ECY-768) may be cast with two or three airfoils per vane segment, while alloys that are more difficult to cast (e.g. nickel based superalloys such as IN939 and CM247LC) are limited to single airfoil vane segments.

[0022] FIGS. 2 and 3 show a portion of a turbine airfoil 31, also referred to herein as a first component, according to an embodiment of the invention. It has leading and trailing edges 32, 34, pressure and suction sides 36, 38, an end 43, and an end portion 42 with a taper 44 and a ridge 46, also referred to herein as first connection structure, with proximal and distal sides 66, 67. The ridge 46 may surround the airfoil continuously or discontinuously along the pressure side, leading edge, suction side, and trailing edge. A radial spanwise dimension 40 is defined along a length of the airfoil. A chordwise dimension 41 is defined between the leading and trailing edges 32, 34, and may be considered as being parallel to a working gas containment surface 51 at the connection under consideration.

[0023] A tab 48 may extend from the pressure and/or suction sides of the end portion 42 to function in cooperation with an associated vane platform to define an origin for differential expansion and contraction of the platform in the chordwise dimension. Tab 48 may be located for example at a mid-chord position or at a maximum airfoil thickness position as shown in FIG. 6. The opposite end of the airfoil 31 (not shown) may use the same connection type as the shown end portion 42 or it may use a different connection type. Cooling chambers 49 may be provided in the airfoil.

[0024] FIG. 3 is a sectional view taken along line 3-3 of FIG. 2. A bi-cast platform 50, also referred to herein as a second component, has a working gas containment surface 51 and a collar portion 52 that holds the end portion 42 of the airfoil 31. It may have a cooling air plenum 54. The ridge 46

has a proximal side 66 that contacts a proximal side 53 of a bi-cast groove, also referred to herein as second connection structure, surrounding the ridge 46 in the collar 52 to create a coupling between the airfoil 31 and the platform 50, which coupling substantially prevents separational movement between the airfoil 31 and the platform 50, although in the illustrated embodiment clearance 55 is provided in the groove below the ridge 46 for spanwise differential expansion of the airfoil 31. The ridge 46 may have a top surface 47 aligned with the adjacent taper angle 44.

[0025] The taper angle 44 may vary around the airfoil to accommodate varying amounts of differential contraction of the platform 50 and collar 52 at different points around the curvature of the airfoil. The taper angle on the pressure side 36 may be less than on the suction side in order to equalize pressure on the various contact surfaces. In an exemplary engineering model, a taper angle of 3-5 degrees on the pressure side and 50% greater than the pressure side taper angle on the suction side was found to be advantageous—for example, 4 degrees on the pressure side and 6 degrees on the suction side. The optimum angles depend on the airfoil shape.

[0026] FIG. 4 illustrates a stage of bi-casting, also referred to herein as a second casting procedure, in a mold 58 in which the platform 50 material is molten. The mold material may encapsulate the airfoil. The airfoil 31 may be filled with a fugitive ceramic core 59 to block the molten alloy from entering the cooling chambers. The tapered end 42 of the airfoil is placed in the mold 58. The mold may have a positioning depression 60 that fits the end 43 of the airfoil to a given depth 63 best seen in FIG. 5. For example, this depth may be equal to the clearance 55. Prior to placing the airfoil in the mold, a layer of fugitive material 56 may be applied to the proximal side 66 of the ridges 46 as shown.

[0027] FIG. 5 illustrates a stage of bi-casting after the platform 50 has solidified and further cooled. The platform 50 shrinks 62 as it cools. The airfoil 31 shrinks less than the platform due to a temperature differential during bi-casting. Molten metal is poured or injected into the mold 58. The airfoil stays cooler than the platform during bi-casting. As an example, the temperature of the airfoil end portion 42 may reach about 900.degree. C. when the platform solidifies at about 1300.degree. C. Cooling from this point causes differential shrinkage that compresses 62 the collar 52 onto the tapered end portion 42 of the airfoil. This pushes 64 the airfoil upward in the drawing, or proximally with respect to the airfoil, due to the reverse wedging effect of the taper 44. The taper angle should be high enough to overcome the high contact friction between the contacting surfaces to allow sliding.

[0028] FIG. 6 shows a partial plan view of a platform 50 with a vane 31 in section. Stress relief slots 70, 72 may be provided at the leading edge 32 and/or trailing edge 34 to accommodate platform contraction during casting, and airfoil expansion during operation. These slots 70, 72 may be formed with a fugitive material such as alumina and/or silica coating deposited by slurry or a spray process that is chemically leached away after casting. This may be a continuation of the fugitive material 56 on the ridge 46. The leaching chemical may reach the fugitive material on the ridge 46 via the stress relief slots 70, 72. The slots 70, 72 may extend across the tapered end portion as seen in FIG. 7. They may extend in respective leading and trailing chordwise directions 41.

[0029] FIG. 7 shows a sectional view taken along line 7-7 of FIG. 6, illustrating a stage of bi-casting with fugitive material 56 on the leading edge of the tapered end portion 42 to form a leading edge stress relief slot 70.

[0030] The combination of stress relief slots 70, 72, span-wise clearance gap 55, and varying taper angles 44 provides substantially uniformly distributed contact pressures in the connection over a range of operating temperatures and differential thermal expansion conditions. The connection allows a limited range of relative movement, maintains a gas seal along the contact surfaces, minimizes vibration, minimizes stress concentrations, and provides sufficient contact area and pressure for rigidity and stability of the vane ring assembly.

[0031] The use of bi-casting enables less costly repair should the platform become damaged in service. The platform can be cut off, saving the high-value airfoil, and then a new replacement platform can be bi-cast onto the airfoil.

[0032] Referring now to FIG. 8, a portion of a turbine section T_s in a gas or steam turbine engine is illustrated. A rotor 110 illustrated in FIG. 8 comprises a rotor disc 112 and a plurality of blades 114, illustrated herein as an exemplary first blade 114a and an adjacent exemplary second blade 114b. The blades 114a, 114b comprise radially elongated structures extending from a blade root 116 engaged with the rotor disc 112 to a blade tip 118. Each of the blades 114a, 114b includes a pressure sidewall 120 and a suction sidewall 122 opposed from the pressure sidewall 120. It is noted that the blades 114a, 114b and rotor disc 112 illustrated in FIG. 8 and the blade 114a illustrated in FIG. 9 are schematically shown and may have other configurations than as shown without departing from the scope and spirit of the invention.

[0033] Each of the blades 114a, 114b further includes first and second snubber assemblies 124, 126 located generally mid-span between the blade root 116 and the blade tip 118 of each of the blades 114a, 114b.

[0034] The first snubber assembly 124 associated with the first blade 114a will now be described, it being understood that the first snubber assemblies 124 of the other blades 114 are substantially identical to the first snubber assembly 124 described herein. As shown in FIGS. 8 and 9, the first snubber assembly 124 comprises a first base portion 128 extending from the pressure sidewall 120 of the first blade 114a at a first end 128A of the first base portion 128, and a first snubber portion 130 affixed to the first base portion 128. As shown in FIGS. 8 and 9, the first snubber assembly 124 is a tapered member having an outer diameter D_1 (see FIG. 9) that decreases as the first snubber assembly 124 extends away from the pressure sidewall 120 of the first blade 114a, although it is understood that the first snubber assembly 124 could have a generally constant outer diameter D_1 and/or could have other shapes or configurations as desired, such as, for example, elliptical, airfoil-shaped, etc.

[0035] As will be described herein, the first base portion 128 is cast integrally with the first blade 114a during a first casting procedure. The first base portion 128 and the first blade 114a may be formed, for example, from an equiaxed material or a directionally solidified material. More specifically, the base portion 128 and the first blade 114a may be formed, for example from a nickel based superalloy, such as CM247CC or CM247DS.

[0036] The first snubber portion 130 is cast onto the first base portion 128 of the first snubber assembly 124 during a second casting procedure, also referred to herein as a bicasting procedure or a bicast. The first snubber portion 130 is

formed from a material that preferably has good oxidation, corrosion, and/or creep resistance characteristics. It is noted that the first snubber portion 130 may preferably be formed from the same/similar material as the first base portion 128 and the first blade 114a such that each of these components has the same or similar coefficient of thermal expansion, although the first snubber portion 130 may be formed from a different material than the first base portion 128 and the first blade 114a.

[0037] As shown in FIGS. 8 and 9, the first base portion 128 includes first connection structure 136 comprising an annular ridge 138 (see FIGS. 9 and 10) or flange that extends radially outwardly from a second end portion 128B of the first base portion 128 distal from the first blade 114a, wherein the second end portion 128B has a reduced diameter than a remainder of the first base portion 128. The first connection structure 136 may be formed in the first base portion 128 during the first casting procedure, or may be formed in the first base portion 128 during a material removal procedure, e.g., a grinding, electro-discharge machining, or waterjet machining procedure, subsequent to the first casting procedure. The first snubber portion 130 includes second connection structure 140 comprising an annular groove 142 or recess that extends radially outwardly from an inner wall 144 of the first snubber portion 130 near a first end portion 130A of the first snubber portion 130, see FIG. 9. The second connection structure 140, which is formed in the first snubber portion 130 during the bicasting procedure, receives the first connection structure 140 to create a coupling between the snubber portion 130 to the first base portion 128, i.e., to secure the first snubber portion 130 to the first base portion 128. That is, the second connection structure 140 interacts with the first connection structure 136 to substantially prevent separational movement between the first base portion 128 and the first snubber portion 130 during operation of the engine, which separational movement between the first base portion 128 and the first snubber portion 130 is substantially prevented by the first and second connection structures 136, 140 without a bonding material.

[0038] As shown most clearly in FIG. 9, the first base portion 128 and the first snubber portion 130 have substantially equivalent outer diameters D_{BP} , D_{SP} at a junction 148 therebetween such that there is substantially no discontinuity of the first snubber assembly 124 at the junction 148. Hence, the first snubber assembly 124 being formed from two pieces, i.e., the first base portion 128 and the first snubber portion 130, is not believed to adversely affect flow characteristics through the turbine section T_s of the engine when compared to prior art one-piece snubber assemblies.

[0039] A second end portion 130B of the first snubber portion 130 in the embodiment shown defines a first angled surface 154a. The first angled surface 154a is spaced from a corresponding angled surface 154b of a snubber portion 130 of a snubber assembly 124 of the adjacent second blade 114b, such that a first space S_1 or gap is formed therebetween, see FIG. 8.

[0040] Referring now to FIG. 9, the first blade 114a includes a cooling circuit 160 comprising at least one cooling passage 162 in a hollow interior portion 164 of the first blade 114a. It is noted that while a single cooling passage 162 is schematically shown in the hollow interior portion 164 of the first blade 114a in FIG. 9, one skilled in the art will recognize that there are many types of configurations for cooling passages within turbine blades, such that the present invention is

not intended to be limited to any specific type of internal blade cooling configuration. The cooling passage 162 receives cooling fluid, such as compressor discharge air, for cooling the first blade 114a during operation of the engine.

[0041] In accordance with an aspect of the present invention, the first base portion 128 of the first snubber assembly 124 includes an opening 166 formed therein, which opening 166 is in communication with the cooling passage 162 within the first blade 114a. The opening 166 may comprise a central bore formed in the first base portion 128, which may be formed during the first casting procedure or subsequent to the first casting procedure during a machining operation. The opening 166 receives cooling fluid from the cooling passage 162 for cooling the first snubber assembly 124.

[0042] The first snubber portion 130 in turn includes a cooling passageway 168 defined by the inner wall 144, which cooling passageway 168 is in communication with the opening 166 in the first base portion 128, see FIG. 9. The cooling passageway 168 may comprise a central bore formed in the first snubber portion 130, which may be formed during the bicasting procedure or subsequent to the bicasting procedure during a machining operation. The cooling passageway 168 receives cooling fluid from the opening 166 for cooling the first snubber portion 130.

[0043] The first snubber portion 130 also includes at least one cooling fluid outlet 170 that discharges cooling fluid in the cooling passageway 168 from the first snubber assembly 124, see FIG. 9. While the illustrated first snubber assembly 124 includes only a single cooling fluid outlet 170 located near the second end portion 130B of the first snubber portion 130, the first snubber assembly 124 may include one or more additional cooling fluid outlets, which may be positioned in any suitable location.

[0044] The second snubber assembly 126 associated with the first blade 114a extends from the suction sidewall 124 of the first blade 114a but is otherwise generally a mirror image of the first snubber assembly 124 associated with the first blade 114a. The second snubber assembly 126 (and the second snubber assemblies 126 associated with the remaining blades 114) will thus not be described in detail herein.

[0045] It is noted that while the illustrated first blade 114a includes the cooling circuit 160, the present invention is not intended to be limited to blades including cooling circuits. For example, the snubber assemblies 124, 126 described herein, which are formed by first and second casting procedures, could also be used with blades that are not cooled by internal cooling circuits. In such a case, the snubber assemblies 124, 126 would not need to include the openings 166 or cooling passageways 168.

[0046] During operation of the engine, centrifugal forces are exerted on the blades 114 and first and second snubber structures 124, 126 as a result of the rotation of the blades 114 with the rotor 110. These centrifugal forces cause the blades 114 to “untwist”, which causes the first and second angled surfaces 154a, 154b of the respective snubber structures 124, 126 to move toward each other to engage each other with a damping force. It should be noted that it is desirable to configure the snubber structures 124, 126 to produce a damping force that is sufficient to produce damping at the interface between the snubber structures 124, 126 to control blade vibration.

[0047] Referring to FIGS. 8-10, a method will now be described for forming a turbine blade assembly including a

blade, e.g., the first blade 114a, and first and second snubber assemblies, e.g., the first and second snubber assemblies 124, 126.

[0048] The first blade 114a and the base portions 128 of the first and second snubber assemblies 124, 126 are formed during a first casting procedure. The resulting structure is illustrated in FIG. 10, although, as noted above, the first connection structures 136 can be formed in the second end portions 128B of the base portions 128 of the first and second snubber assemblies 124, 126 during the first casting procedure or during a subsequent material removal operation. The openings 166 in the base portions 128 of the first and second snubber assemblies 124, 126 can also be formed during the first casting procedure or during a subsequent material removal operation.

[0049] Thereafter, the snubber portions 130 of the first and second snubber assemblies 124, 126 are formed during a second casting procedure, wherein the second connection structures 140 of the snubber portions 130 of the first and second snubber assemblies 124, 126 interact with the first connection structures 136 of the base portions 128 of the first and second snubber assemblies 124, 126 to substantially prevent separational movement between the snubber portions 130 and the base portions 128 of the first and second snubber assemblies 124, 126.

[0050] By forming the snubber assemblies 124, 126 via first and second casting procedures, difficulties associated with the formation of prior art snubber assemblies are avoided. For example, prior art attempts to cast the entire snubber assembly with the blade during a single casting procedure have resulted in snubber assemblies having significant defects or deformities, which must be repaired to be suitable for use. In addition prior art attempts at casting a base portion of a snubber assembly with the blade during a first casting procedure and then affixing a snubber portion to the base portion by welding, brazing, or other technique using a bonding material are expensive and often result in damage to the blade, base portion, and/or snubber portion. These difficulties of the prior art are avoided by the formation of snubber assemblies using two casting procedures as disclosed herein.

[0051] While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed is:

1. A turbine blade assembly in a turbine engine comprising:
 - a turbine blade having a pressure sidewall and an opposed suction sidewall; and
 - a first snubber assembly associated with one of the pressure sidewall and the suction sidewall and comprising:
 - a first base portion extending outwardly from the one of the pressure sidewall and the suction sidewall, the first base portion being integrally cast with the turbine blade and including first connection structure; and
 - a first snubber portion bicast onto the first base portion and having second connection structure that interacts with the first connection structure to substantially prevent separational movement between the first base portion and the first snubber portion.
2. The turbine blade assembly of claim 1, wherein the first connection structure comprises one of an annular ridge and an

annular groove and the second connection structure comprises the other of an annular ridge and an annular groove.

3. The turbine blade assembly of claim **1**, wherein the first base portion and the first snubber portion have substantially equivalent outer diameters at a junction therebetween such that there is substantially no discontinuity of the first snubber assembly at the junction.

4. The turbine blade assembly of claim **1**, wherein the outer diameter of the first snubber portion decreases as the first snubber portion extends away from the turbine blade.

5. The turbine blade assembly of claim **1**, wherein separational movement between the first base portion and the first snubber portion is substantially prevented by the first and second connection structures without a bonding material.

6. The turbine blade assembly of claim **1**, wherein the first base portion includes an opening formed therein in communication with a cooling passage within the turbine blade, the opening receiving cooling fluid from the cooling passage.

7. The turbine blade assembly of claim **6**, wherein the first snubber portion includes a cooling passageway in communication with the opening in the first base portion, the cooling passageway receiving cooling fluid from the opening.

8. The turbine blade assembly of claim **7**, wherein the first snubber portion includes at least one cooling fluid outlet that discharges cooling fluid in the cooling passageway from the first snubber assembly.

9. The turbine blade assembly of claim **1**, further comprising:

a second snubber assembly associated with the other of the pressure sidewall and the suction sidewall and comprising:

a second base portion extending outwardly from the other of the pressure sidewall and the suction sidewall, the second base portion being integrally cast with the turbine blade and including third connection structure; and

a second snubber portion bicast onto the second base portion and having fourth connection structure that interacts with the third connection structure to substantially prevent separational movement between the second base portion and the second snubber portion.

10. A coupling between two components in a turbine engine comprising:

a first component formed by a first casting procedure and including first connection structure comprising one of a continuous annular ridge and a continuous annular groove; and

a second component bicast onto the first component during a second casting procedure and having second connection structure comprising the other of a continuous annular ridge and a continuous annular groove, the second connection structure interacting with the first connection structure to substantially prevent separational movement between the first component and the second component.

11. The coupling of claim **10**, wherein the first component and the second component have substantially equivalent

outer diameters at a junction therebetween such that there is substantially no discontinuity between the first and second components at the junction.

12. The coupling of claim **10**, wherein separational movement between the first component and the second component is substantially prevented by the first and second connection structures without a bonding material.

13. A method for forming a turbine blade assembly comprising:

performing a first casting procedure to form:

a turbine blade having a pressure sidewall and an opposed suction sidewall; and

a base portion of a snubber assembly, the base portion extending from one of the pressure sidewall and the suction sidewall;

performing a second casting procedure comprising:

casting a snubber portion onto the base portion such that first connection structure of the base portion interacts with second connection structure of the snubber portion to substantially prevent separational movement between the base portion and the snubber portion.

14. The method of claim **13**, wherein:

the first connection structure is machined into the base portion after the first casting procedure and comprises one of an annular ridge and an annular groove; and

the second connection structure comprises the other of an annular ridge and an annular groove.

15. The method of claim **13**, wherein the base portion and the snubber portion are cast to have substantially equivalent outer diameters at a junction therebetween such that there is substantially no discontinuity of the snubber assembly at the junction.

16. The method of claim **13**, wherein separational movement between the base portion and the snubber portion is substantially prevented by the first and second connection structures without a bonding material.

17. The method of claim **13**, wherein the base portion is cast to include an opening in communication with a cooling passage cast within the turbine blade, the opening for receiving cooling fluid from the cooling passage during operation of an engine including the turbine blade assembly.

18. The method of claim **17**, wherein the snubber portion is cast to include a cooling passageway in communication with the opening in the base portion, the cooling passageway for receiving cooling fluid from the opening during operation of the engine.

19. The method of claim **18**, further comprising forming at least one cooling fluid outlet in the snubber portion, the at least one cooling fluid outlet for discharging cooling fluid in the cooling passageway from the snubber assembly during operation of the engine.

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