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(54) **WEAR RESISTANT GAS TURBINE ENGINE AIRSEAL ASSEMBLY**

ABRIEBFESTE LAGERUNG EINES DICHTRINGES IN EINER GASTURBINE

ENSEMBLE DE JOINT D'ETANCHEITE A L'AIR RESISTANT A L'USURE POUR TURBINE A GAZ

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Description

[0001] The present invention relates to gas turbine engines and, more particularly, to airseal assemblies therefor.

[0002] Conventional gas turbine engines include a compressor, a combustor, and a turbine. The sections of the gas turbine engine are sequentially situated about a longitudinal axis and enclosed in an engine case. Air flows axially through the engine. As is well known in the art, air compressed in the compressor is mixed with fuel, ignited and burned in the combustor. The hot products of combustion emerging from the combustor are expanded in the turbine, thereby rotating the turbine and driving the compressor.

[0003] Both the compressor and the turbine include alternating rows of rotating airfoils and stationary airfoils, also commonly referred to as blades and vanes, respectively. Each airfoil includes an airfoil portion flanged by an outer diameter portion and an inner diameter portion. The blades are secured within a rotating disk. The vanes are typically cantilevered from the engine case. The outer diameter portion of each vane is mounted on the engine case at a forward attachment point and a rear attachment point. The inner diameter portion of each vane loosely fits into an airseal.

[0004] The airseal prevents higher pressure air from leaking to a lower pressure area. The airseals currently used in gas turbine engines are a one piece design, fabricated from a metal alloy. The existing airseal includes an annular airseal body with an integrally machined forward and rear rails spaced apart from each other and extending radially outward from the airseal body. A flange disposed on the inner diameter portion of the vane fits into the space between the forward and the rear rails. For assembly purposes, the rear rail is shorter than the forward rail.

[0005] Although the current airseal is simple and relatively inexpensive, the airseal wears out relatively quickly. One contributor to extensive wear of the airseal are general engine vibrations to which the gas turbine is subjected. The engine vibrations result in relative motion between the loose fitting flange of the inner diameter portion of the vane and the contact surfaces of the forward and the rear rails of the airseal. As the flange of the vane rubs against the contact surfaces of the forward and rear rails, the contact surfaces of the rails wear down. As a result of van loading within the gas turbine engine, the rear rail is especially susceptible to wear.

[0006] One method for reducing the wear of the metal parts is to apply a layer of wear resistant coating on the contact surfaces. The coating is a high durability, high temperature, wear resistant metal that must be sprayed onto the surface in a flame spray or plasma spray operation. For the coating to be sprayed onto the surface, there must be access to the surface, also referred to as a "line of sight". The contact surface of the forward rail of the existing airseal is accessible for the application of

the coating, because the rear rail is shorter than the forward rail. However, the rear rail is not accessible for spraying with a layer of wear resistant coating because the longer forward rail blocks the line of sight thereto. Therefore, the rear rail of the present design remains unprotected.

[0007] Furthermore, the rate of wear is greater on the rear rail than on the forward rail because the rear rail is shorter than the forward rail. It is well known in the art that the rate of wear is a function of the contact area. The rear rail, having a smaller area of contact with the vane flange, wears faster than the forward rail. Extensive wear of the rear rail results in leaning of the vane toward the row of the rotating blades. If the rear rail is completely worn through, the vane will clash with the row of turbine blades adjacent to the row of vanes. Such contact between the vane and the rotating blades is detrimental to engine performance and potentially may result in engine failure.

[0008] Another approach for reducing wear of the rear rail is to increase the area of contact between the vane and the rear rail. However, a longer rear rail would make current assembly procedure impossible and would also block the line of sight for spraying the forward rail with wear resistant coating, thereby preventing coating of the forward rail.

[0009] Another option for reducing rear rail wear is to fabricate the entire airseal from a more wear resistant metal. One such metal could be cobalt. However, manufacturing the entire airseal from cobalt or a similar wear resistant metal would be extremely expensive and, therefore cost prohibitive.

[0010] The current practice in the industry during overhaul and repair of the gas turbine engines is to replace the entire airseal. This practice is very costly. Thus, there is a need in the industry for a more wear resistant airseal and it is an object of the present invention to reduce wear in gas turbine engine airseal assemblies.

[0011] FR-A-2086275 discloses an airseal assembly for a gas turbine engine having alternating rows of rotor blades and stationary vanes, said blades being secured in a rotor disk, said stationary vanes having an inner diameter portion and an outer diameter portion, said outer diameter portion of said vanes being cantilevered from an engine case, said inner diameter portion of said vane being fitted into said airseal assembly, said airseal assembly having;

an airseal having an annular body and an annular forward rail extending radially outward from said body, said forward rail having a plurality of forward rail openings;

a ring rail being spaced apart from said forward rail to define a space there between, said ring rail having a plurality of ring rail openings therein and a ring rail contact surface facing said forward rail and extending radially outward from a radially inward end

of said ring rail;

a plurality of spacers spacing apart and fitting between said forward rail and said ring rail, each said spacer having a spacer opening therein; and

a plurality of fasteners each passing through said ring rail opening, said spacer opening and said forward rail opening to fasten said ring rail onto said airseal with said plurality of spacers there between to accommodate said inner diameter portion of said vane between said forward rail and said ring rail.

[0012] The present invention is characterised over FR-A-2086275 by said ring rail having a tapered surface intersecting said ring rail contact surface and disposed radially outward from said ring rail contact surface.

[0013] Thus, in accordance with the present invention, the contact surface of the ring rail that comes in contact with the vane flange is partially tapered toward the radially outer end of the ring rail. It is well known in the art that the increased area of contact between the metal parts reduces the rate of wear thereof. The tapered surface increases the area of contact between the vane flange and the ring rail as the initial contact surface of the ring rail begins to wear. Thus, the tapered surface of the present invention slows the rate of wear as the wear progresses.

[0014] The present invention also allows the forward rail and the ring rail to be sprayed with wear resistant coating individually prior to assembly. The wear resistant coating protects the forward rail and the ring rail from wear induced by the relative motion between the rails and the vane flange, and thus prolongs the service life thereof.

[0015] One primary advantage of the present invention is that the ring rail can be fabricated such that it is radially longer. The extra length of the ring rail will increase the contact area between the ring rail and the vane flange when inevitable wear will occur, thereby, reducing the rate of wear of the ring rail. The extended length of the ring rail will not prevent spraying of the forward rail with the wear resistant coating, because the forward rail can be sprayed with the wear resistant coating prior to assembly. Furthermore, the assembly process will not be hindered by the extended length of the ring rail because the tapered surface provides sufficient clearance for the vanes to be fitted between the forward and rear rails.

[0016] Another major advantage of the present invention is that the ring rail can be fabricated from cobalt or from other similar wear resistant materials. The relatively small size of the ring rail makes it economically feasible to manufacture the ring rail from much more expensive metals than the conventional materials that are used to fabricate airseals.

[0017] Another advantage of the present invention is that once the ring rail eventually becomes worn, only the ring rail has to be replaced, rather than the entire airseal. This advantage represents significant cost savings dur-

ing operational life of the airseal because the loading on the ring rail is greater than on the forward rail, thereby requiring more frequent repair or replacement of the ring rail than of the forward rail.

[0018] A preferred embodiment of the invention will now be described by way of example only, and with reference to the accompanying drawings in which:

FIG. 1 is a simplified, partially broken away representation of a gas turbine engine;

FIG. 2 is an enlarged, simplified, fragmentary representation of a vane mounted onto a gas turbine engine case and having an airseal assembly fitted thereon, according to the present invention;

FIG. 3 is a cross-sectional elevation of the airseal assembly of FIG. 2;

FIG. 4 is an exploded, perspective elevation of the airseal assembly of FIG. 3 with vane clusters fitting therein;

FIG. 5 is a partially broken away, side elevation of the airseal assembly of FIG. 4 with vane clusters fitted therein;

FIG. 6 is an enlarged, partially broken away elevation of the airseal assembly of FIG. 5 with a ring rail having a tapered surface, according to the present invention;

FIG. 7 is a partially broken away elevation of the airseal assembly of FIG. 6 that has been worn; and
FIG. 8 is a cross-sectional elevation of an alternate embodiment of the airseal assembly.

[0019] Referring to FIG. 1, a gas turbine engine 10 includes a compressor 12, a combustor 14, and a turbine 16. Sections 12, 14, 16 of the gas turbine engine 10 are sequentially situated about a longitudinal axis 18 and are enclosed in an engine case 20. Air 22 flows axially through the sections 12, 14, 16 of the engine 10. The compressor 12 and the turbine 16 include alternating rows of rotating blades 24 and stationary vanes 26. The rotating blades 24 are secured onto a rotating disk 28. The stationary vanes 26 are cantilevered from the engine case 20.

[0020] Referring to FIG. 2, the vane 26 comprises an airfoil portion 30 flanged by an outer diameter buttress 32 and an inner diameter buttress 34. The outer diameter buttress 32 includes a forward hook 36 and a rear hook 38. The forward hook 36 and the rear hook 38 are secured within the engine case 20 at a forward attachment point 40 and a rear attachment point 42, respectively. The inner diameter buttress 34 has a vane flange 46 protruding therefrom. As best seen in FIGs. 4 and 5, the flange 46 includes a slot 48. FIGs. 4 and 5 depict vanes 26 arranged in vane clusters 50 of three vanes 26 per each cluster 50. Each vane cluster 50 shares one inner diameter buttress 34 and one outer diameter buttress 32. The vane flange 46 of the inner diameter buttress 34 fits into an airseal assembly 54.

[0021] Referring to FIGs. 2-4, the airseal assembly 54

includes a first annular airseal 56, a ring rail 58, and a plurality of spacers 60. The first airseal 56 has an airseal body 62 with an upstream end 64 and a downstream end 66 and a forward rail 68 extending radially outward from the upstream end 64 of the airseal body 62. The forward rail 68 includes a forward rail contact surface 70 that comes into contact with the vane flange 46. The forward rail 68 has a plurality of forward rail openings 72 formed therein.

[0022] The ring rail 58 has an inner diameter end 74, an outer diameter end 76, and a ring rail contact surface 80 therebetween. The ring rail contact surface 80 comes into contact with the vane flange 46 and faces the forward rail contact surface 70. The ring rail 58 includes a plurality of ring rail openings 82 spaced to be in register with the forward rail openings 72.

[0023] Each spacer 60 is sized to fit into the slot 48 of the vane cluster 50. Each spacer 60 has a spacer opening 84 formed therein.

[0024] Prior to assembly of the airseal assembly 54, the forward rail contact surface 70 and the ring rail contact surface 80 are sprayed with wear resistant coating. To assemble the airseal assembly 54, the ring rail openings 82 are lined up to be in register with the forward rail openings 72 so that the ring rail 58 is spaced apart from the forward rail 68 by the plurality of spacers 60. The assembly is then fastened together by means of either a bolt 86, or a pin or some other fastening device with the fastening device 86 passing through the ring rail opening 82, the spacer opening 84, and the forward rail opening 72. Once the airseal assembly 54 is completed, the vane flanges 46 of the vane clusters 50 are fitted into the airseal assembly 54 with the spacers 60 fitting into the slots 48, as best shown in FIG. 5. The spacers 60 function as anti-rotational devices that prevent the airseal assembly 54 from rotating. The airseal and the vane subassembly is then placed into the engine case 20 with the forward hook 36 and the rear hook 38 of each vane 26 fitting into the engine case 20 at the forward attachment point 40 and the rear attachment point 42, as shown in FIG. 2.

[0025] The wear resistant coating applied on the ring rail contact surface 80 retards the wear of the ring rail 58, thereby prolonging the service life of the airseal assembly 54 substantially.

[0026] FIG. 6 illustrates another feature of the present invention. The ring rail 58 includes a tapered surface 88 that intersects with the ring rail contact surface 80 and extends tapering off toward the outer diameter end 76 of the ring rail 58.

[0027] The tapered surface 88 slows down the rate of the wear of the ring rail 58. The initial ring rail contact surface 80 has a predetermined radial length 90, as shown in FIG. 6. Although the wear resistant coating significantly reduces the rate of wear, the initial ring rail contact surface 80 will inevitably wear. As the initial ring rail contact surface 80 wears, the radial length 190 of the subsequent contact surface 180 of the ring rail increases

as a result of the tapered surface 88, as shown in FIG. 7. The increase in the subsequent contact surface 180, reduces the rate of wear of the ring rail 58. Thus, the airseal assembly 54 of the present invention is more wear resistant because the ring rail contact surface 80 is accessible for spraying with coating and because the tapered surface 88 increases the subsequent contact area between the vane flange 46 and the ring rail 58.

[0028] Furthermore, the present invention permits an even greater area of contact between the vane flange 46 and the ring rail contact surface 80 by increasing the radial length of the ring rail 58 without adverse consequences. The tapered surface 88 provides sufficient clearance for the vane flange 46 to be fitted between the forward rail 68 and the ring rail 58 so that the assembly process remains unaffected.

[0029] Furthermore, the additional length of the ring rail 58 does not effect the accessibility of the forward rail 68 for wear resistant coating spray because the forward rail 68 is sprayed prior to assembly.

[0030] Although any metal alloy is suitable for fabrication of the airseal assembly, the present invention makes it economically feasible to fabricate the ring rail 58 from a more expensive and more wear resistant material such as cobalt. Since the ring rail 58 is relatively small compared to the entire airseal assembly 54, it is not financially prohibitive to manufacture only a small part of the airseal assembly from cobalt or similar material having wear resistant properties.

[0031] Another advantage of the present invention is that once the ring rail 58 eventually wears, only the ring rail 58 has to be replaced, rather than the entire airseal 54. This advantage represents a significant cost savings during the useful life of the gas turbine engine 10 because the ring rail 58 is subjected to greater loading than the forward rail and consequently wears faster, thereby requiring more frequent repairs and replacements than the forward rail.

[0032] Referring to FIG. 8, an alternate embodiment of an airseal assembly 254 includes a first airseal 256 having an airseal body 262 with a forward rail 268 extending radially outward therefrom and an L-shaped ring rail 258 attaching onto the airseal body 262. The ring rail 258 is attached to the airseal body 262 by means of either rivets 286, as shown in FIG. 8, or can be welded onto the airseal body 262. The plurality of spacers 260 are shown to be integral with the forward rail 268 of the first airseal 256. However, the spacers 260 can be also integral with the ring rail 258.

[0033] Although the spacers 60 are depicted having square shape, spacers having any shape will fall within the scope of the present invention as long as the forward rail 68 and the ring rail 58 are spaced apart and the airseal assembly 54 is prevented from rotation.

[0034] Furthermore, in the present invention the airseal is segmented in at least two portions such that contact surfaces 70,80 of each rail 68, 58 can be sprayed with wear resistant coating prior to assembly. Therefore,

to practice the present invention, the airseal assembly can be segmented at any point as long as the forward and ring rails are disposed on separate segments so that the contact surfaces of each rail can be sprayed with wear resistant coating prior to assembly of the airseal. Additionally, although the airseal assembly depicted is for the second stage turbine vane, the invention is applicable for any stage of either compressor or turbine vane.

Claims

1. An airseal assembly (54) for a gas turbine engine (10) having alternating rows of rotor blades (24) and stationary vanes (26), said blades being secured in a rotor disk (28), said stationary vanes having an inner diameter portion (34) and an outer diameter portion (32), said outer diameter portion of said vanes being cantilevered from an engine case, said inner diameter portion (34) of said vane being fitted into said airseal assembly (54), said airseal assembly having;

an airseal (56) having an annular body and an annular forward rail (68) extending radially outward from said body, said forward rail having a plurality of forward rail openings (72);

a ring rail (58) being spaced apart from said forward rail to define a space there between, said ring rail having a plurality of ring rail openings (82) therein and a ring rail contact surface (80) facing said forward rail and extending radially outward from a radially inward end of said ring rail;

a plurality of spacers (60) spacing apart and fitting between said forward rail and said ring rail, each said spacer having a spacer opening (84) therein; and

a plurality of fasteners (86) each passing through said ring rail opening, said spacer opening and said forward rail opening to fasten said ring rail onto said airseal with said plurality of spacers there between to accommodate said inner diameter portion of said vane between said forward rail and said ring rail; characterised by

said ring rail (58) having a tapered surface (88) intersecting said ring rail contact surface and being disposed radially outward from said ring rail contact surface.

2. The airseal assembly as claimed in claim 1;

said forward rail contact surface (70) being coated with a wear resistant coating.

3. The airseal assembly as claimed in claim 1 or 2;

said ring rail contact surface (80) being coated with a wear resistant coating.

4. The airseal assembly as claimed in claim 1, 2 or 3 wherein said fastener (86) is a bolt.

5. The airseal assembly for a gas turbine engine as claimed in any of claims 1 to 4 wherein said plurality of spacers (60) are integrally attached to said forward rail (68).

Patentansprüche

1. Luftdichtungsanordnung (54) für eine Gasturbinenmaschine (10) mit alternierenden Reihen von Rotorlaufschaufeln (24) und stationären Leitschaufeln (26), wobei die Laufschaufeln in eine Rotorscheibe (28) befestigt sind, wobei die Leitschaufeln einen Innendurchmesser-Bereich (34) und einen Außendurchmesser-Bereich (32) haben, wobei der Außendurchmesser-Bereich der Leitschaufeln von einem Maschinengehäuse wegkragt, wobei der Innendurchmesser-Bereich (34) der Leitschaufel in die Luftdichtungsanordnung (54) gepaßt ist, wobei die Luftdichtungsanordnung aufweist:

eine Luftdichtung (56) mit einem ringförmigen Körper und einer ringförmigen Vorderschiene (68), die sich von dem Körper radial nach außen erstreckt, wobei die vordere Schiene eine Mehrzahl von Vorderschienenöffnungen (72) aufweist;

eine Ringschiene (58), die von der Vorderschiene beabstandet ist, um einen Raum dazwischen zu definieren, wobei die Ringschiene eine Mehrzahl von Ringschienenöffnungen (82) darin und eine Ringschienenkontaktfläche (80) hat, die zu der Vorderschiene gerichtet ist und sich von einem radial inneren Ende der Ringschiene radial nach außen erstreckt;

eine Mehrzahl von Abstandselementen (60), welche die Vorderschiene und die Ringschiene voneinander beabstanden und dazwischenpassen, wobei jedes Abstandselement eine Abstandselementöffnung (84) darin hat; und eine Mehrzahl von Befestigungselementen (86), von denen jedes durch eine Ringschienenöffnung, eine Abstandselementöffnung und eine vordere Schienenöffnung hindurchgeht, um die Ringschiene an der Luftdichtung mit der Mehrzahl von Abstandselementen dazwischen zu befestigen, um den Innendurchmesser-Bereich der Leitschaufel zwischen der Vorderschiene und der Ringschiene aufzunehmen;

dadurch gekennzeichnet,

daß die Ringschiene (58) eine abgeschrägte Oberfläche (88) hat, die an die Ringschienenkontaktfläche anschließt und radial außerhalb von der Ringschienenkontaktfläche angeordnet ist.

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2. Luftdichtungsanordnung nach Anspruch 1, wobei die Vorderschienenkontaktfläche (70) mit einer verschleißbeständigen Beschichtung beschichtet ist.

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3. Luftdichtungsanordnung nach Anspruch 1 oder 2, wobei die Ringschienenkontaktfläche (80) mit einer verschleißbeständigen Beschichtung beschichtet ist.

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4. Luftdichtungsanordnung nach Anspruch 1, 2 oder 3, wobei das Befestigungselement (86) eine Schraube ist.

5. Luftdichtungsanordnung für eine Gasturbinenmaschine nach einem der Ansprüche 1 bis 4, wobei die Mehrzahl von Abstandselementen (60) integral an der Vorderschiene (68) angebracht ist.

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Revendications

1. Ensemble de joint d'air (54) pour un moteur à turbine à gaz (10) possédant des rangées alternées d'ailettes de rotor (24) et d'aubes fixes (26), lesdites ailettes étant fixées dans un disque de rotor (28), lesdites aubes fixes ayant une partie de diamètre intérieur (34) et une partie de diamètre extérieur (32), ladite partie de diamètre extérieur desdites aubes étant en porte-à-faux par rapport à une carcasse de moteur, ladite partie de diamètre intérieur (34) de ladite aube étant montée dans ledit ensemble de joint d'air (54), ledit ensemble de joint d'air possédant ;

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un joint d'air (56) qui possède un corps annulaire et un rail avant annulaire (68) qui s'étend radialement vers l'extérieur à partir dudit corps, ledit rail avant présentant une pluralité d'ouvertures (72) de rail avant ;

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un rail annulaire (58) étant espacé dudit rail avant pour définir un espace entre eux, ledit rail annulaire présentant une pluralité d'ouvertures (82) de rail annulaire et une surface de contact (80) de rail annulaire tournée vers ledit rail avant et s'étendant radialement vers l'extérieur à partir d'une extrémité radialement intérieure dudit rail annulaire ;

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une pluralité d'entretoises (60) qui maintiennent ledit rail avant et ledit rail annulaire espacés l'un de l'autre et qui sont montées entre ces rails, chacune desdites entretoises présentant intérieurement une ouverture d'entretoise

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(84) ; et

une pluralité d'organes de fixation (86) dont chacun traverse ladite ouverture du rail annulaire, ladite ouverture de l'entretoise et ladite ouverture du rail avant pour fixer ledit rail annulaire sur ledit joint d'air, ladite pluralité d'entretoises étant interposées entre eux pour s'adapter à ladite partie de diamètre intérieur de ladite aube entre ledit rail avant et ledit rail annulaire ; caractérisé en ce que ledit rail annulaire (58) présente une surface effilée (88) qui coupe ladite surface de contact du rail annulaire et qui est disposée radialement à l'extérieur de ladite surface de contact du rail annulaire.

2. Ensemble de joint d'air selon la revendication 1, dans lequel ladite surface de contact (70) du rail avant est revêtue d'un revêtement résistant à l'usure.

3. Ensemble de joint d'air selon la revendication 1 ou 2, dans lequel ladite surface de contact (80) du rail annulaire est revêtue d'un revêtement résistant à l'usure.

4. Ensemble de joint d'air selon la revendication 1, 2 ou 3, dans lequel ledit organe de fixation (86) est un boulon.

5. Ensemble de joint d'air pour un moteur à turbine à gaz selon l'une quelconque des revendications 1 à 4, dans lequel ladite pluralité d'entretoises (60) sont fixées audit rail avant (68) en formant une seule pièce avec ce dernier.

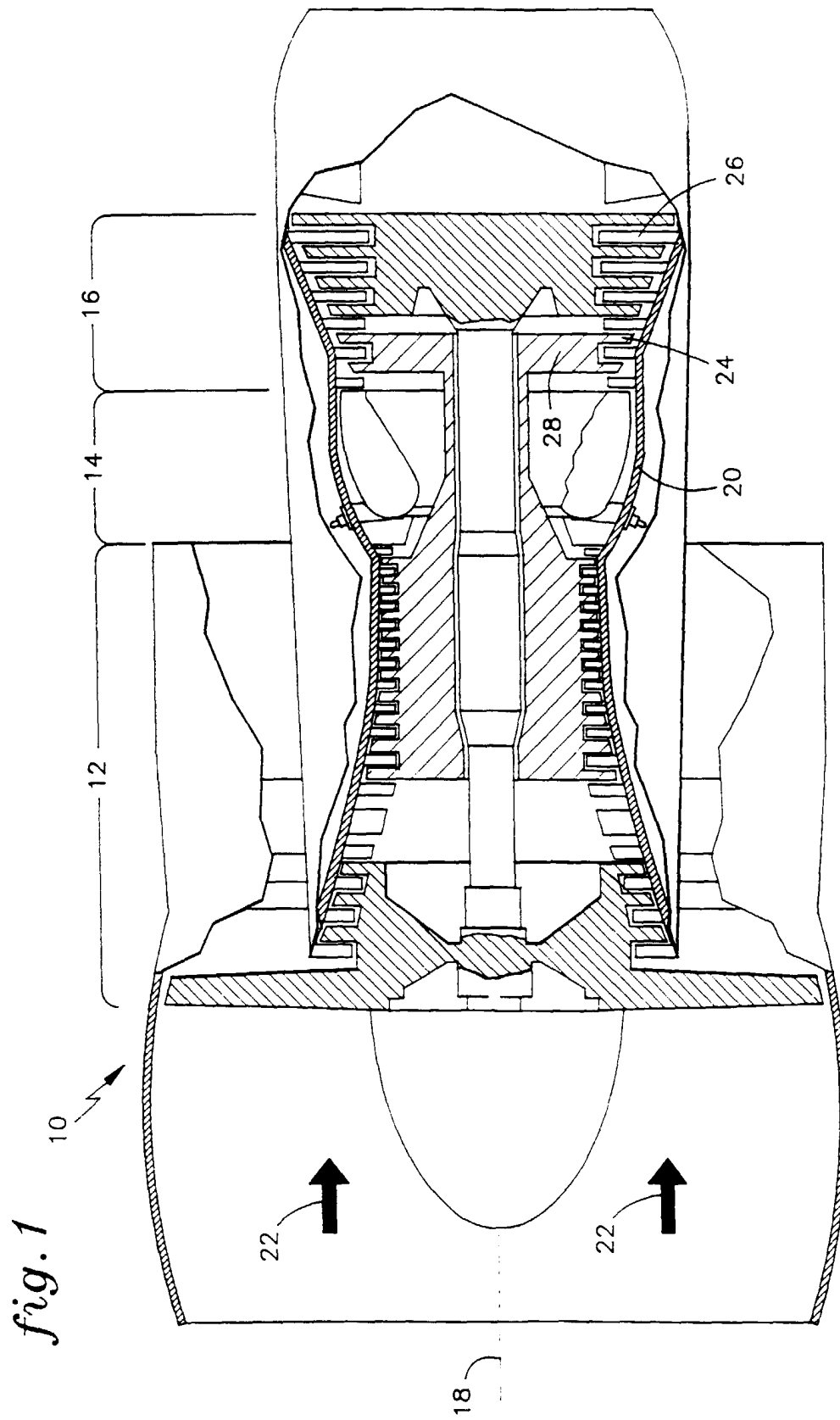


FIG. 2

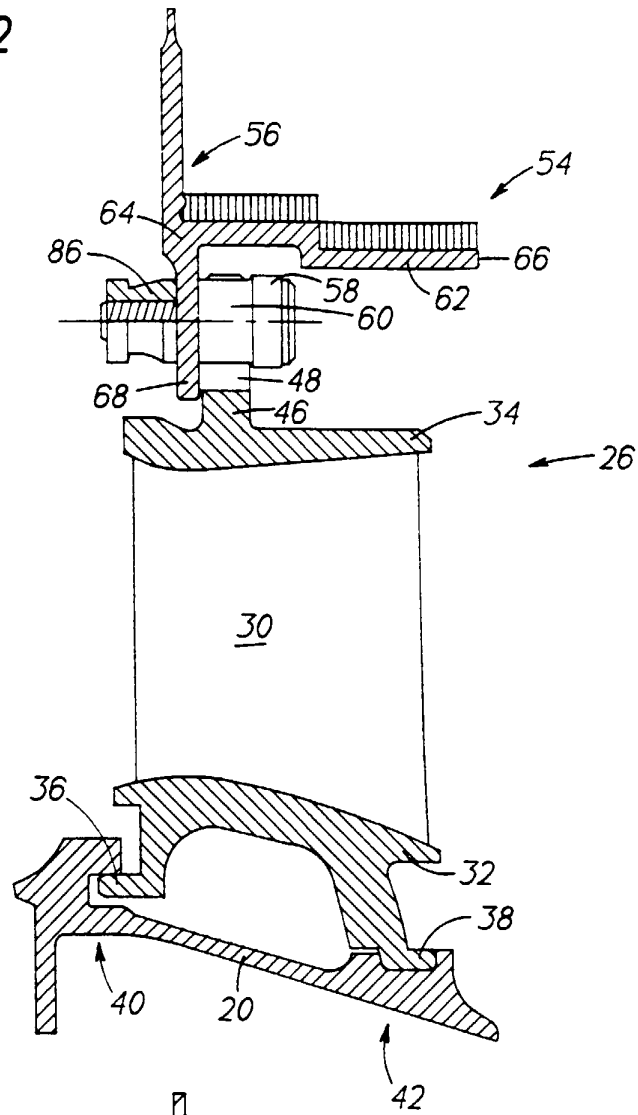


FIG. 3

