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(54) **Structural composite fan exit guide vane for a turbomachine**

Strukturverbundfanleitschaufel für eine Turbomaschine

Aube directrice de sortie de fan composite structurelle pour turbomachine

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Description

BACKGROUND

[0001] The present disclosure is directed toward turbomachine assemblies and more particularly, toward a structural fan exit guide vane for use in a gas turbine engine.

[0002] Turbomachines, such as gas turbine engines, draw air or other gases into the machine using a fan component. The rotation of the fan blades drawing the air in causes the incoming air to swirl in the direction of the fan's rotation. In order to operate the turbomachine properly, however, the air must pass axially through the turbomachine. To rectify the radial swirling of the air, turbomachines include fan exit guide vanes that straighten the air flow behind the fan blades.

[0003] Fan exit guide vanes assemblies include multiple vanes, each of which has an airfoil shaped profile that is aerodynamically designed to force the airflow passing through the fan exit guide vane into an axial flow path. Also included within turbomachine assemblies is a separate fan frame that supports the engine core, the fan, and the fan case. The fan frame also maintains the concentricness of the fan case, and the fan blades, and the engine core, thus providing for proper fan tip clearance between the engine shroud and the fan blades. EP 0513958 A2 describes a composite fan stator assembly for a gas turbine engine having at least two fan rotor stages. EP 0654586 A1 describes a stator vane assembly comprising a row of spaced stator vanes for passing engine fluid working medium in a gas turbine engine. WO 91/15357 A1 describes a fabric preform for reinforcing a composite structure gas turbine engine blade. US 2006/113706 A1 describes a method of producing parts made of a high temperature-resistant composite, such as the vanes of an inlet guide vane assembly. US 2009/0317246 A discloses a guide vane segment for a by-pass flow channel of an engine. The guide vane segment comprises an outer ring and inner ring with guide vanes arranged therebetween. The segments are formed of fiber-reinforced plastic composite material.

SUMMARY

[0004] There is provided a gas turbine engine according to claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

Figure 1A illustrates a partial side view of an air intake for the gas turbine engine of Figure 1A.

Figure 1B illustrates a front view of the air intake for a gas turbine engine.

Figure 2 is a contextual drawing of a structural fan exit guide vane assembly.

Figure 3A illustrates a first isometric view of a structural fan exit guide vane segment.

Figure 3B illustrates a second isometric view of the structural fan exit guide vane segment of Figure 3A.

Figure 4 illustrates a partial isometric view of a fan exit guide vane assembly outer diameter shroud.

DETAILED DESCRIPTION OF THE INVENTION

[0006] Figure 1A illustrates a partial side view of an air intake for a gas turbine engine 10. Figure 1B illustrates a front view of the gas turbine engine 10 with a cutout view 60 illustrating the fan exit guide vanes 50 behind the fan blades 30.

[0007] Referring to Figure 1A, the gas turbine engine 10 has an air intake fan 40 that rotates fan blades 30 radially about an axis A. The rotation of the fan blades 30 draws air into the gas turbine engine 10 along a flow path 32. The fan 40 is encased in a fan case 20, such as a turbine engine shroud. As the air passes through the fan blades 30, the air begins swirling radially relative to axis A due to the rotation of the fan blades 30.

[0008] In order to straighten the flow path 32, and allow the air to flow axially through the gas turbine engine 10, the air is passed through a multiple of structural fan exit guide vane segments 50. Each of the structural fan exit guide vane segments 50 includes multiple foil shaped guide vanes 52. Each guide vane 52 is connected to an inner diameter shroud 58 and an outer diameter shroud 56. Each of the outer diameter shrouds 56 are connected to the fan case 20. Each of the inner diameter shrouds 58 are connected to an engine core 42.

[0009] In addition to straightening the flow path 32 through the gas turbine engine 10, the structural fan exit guide vanes 50 provide structural support to the engine core 42 and the fan case 20, thereby ensuring that proper clearance is maintained between the tips of the fan blades 30 and the fan case 20. Additionally, the structural support of the structural fan exit guide vane segments 50 maintains the concentricness of the engine core 42, the fan blades 30, and the fan case 20.

[0010] Figure 1B illustrates a front view of the gas turbine engine 10, with a cutout segment 60 illustrating the structural fan exit guide vane segments 50 positioned axially behind the fan blades 30. Each of the structural fan exit guide vanes segments 50 includes a first exit guide vane 52 and a second exit guide vane 54. The outer diameter shroud 56 of each structural fan exit guide vane segment 50 abuts the outer diameter shrouds of each adjacent structural fan exit guide vane segment 50 resulting in a circular structural fan exit guide vane segment assembly behind the fan blades 30. The structural fan exit guide vane assembly structurally supports the engine core 42, the fan blades 30, and the fan case 20 and axially straightens the flow path 32. As with the outer diameter shrouds 56, each of the inner diameter shrouds 58 abuts the inner diameter shrouds 58 of each adjacent structural fan exit guide vane segment 50.

[0011] The above described configuration with each structural fan exit guide vane segment 50 abutting two adjacent fan exit guide vane segments 50 creates a circular structural fan exit guide vane assembly that provides the structural support described above, and the airflow straightening described above, while at the same time not requiring a separate structural frame assembly to support the fan 40, the fan case 20, and the engine core 42.

[0012] Figure 2 illustrates a more detailed contextual side drawing of a single structural fan exit guide vane 100. The outer diameter shroud 156 and the inner diameter shroud 158 of the structural fan exit guide vane 100 are connected by guide vanes 152, 154. Each of the shrouds 156, 158 is fastened to the fan case 20 and the engine case 42 via a plurality of fasteners 170, such as bolts. The fasteners 170 protrude through the shrouds 156, 158 and into the fan case 20 and the engine core 42. Each of the inner diameter shroud 158 and the outer diameter shroud 156 also includes a fiber bulge 160, resulting from the molding process, that physically contacts the fan case 20 (in the case of the outer diameter shroud 156) and the engine core 42 (in the case of the inner diameter shroud 158).

[0013] Figure 3A illustrates an isometric view of a structural fan exit guide vane segment 200 that can be used as the structural fan exit guide vane segment 50 of Figures 1A and 1B. The structural fan exit guide vane segment 200 includes an arced outer diameter shroud 256 and an arced inner diameter shroud 258 with each of the arcs being coaxial. The shrouds 256, 258 are connected via two fan exit guide vanes 252, 254. Each of the shrouds 256, 258 also includes multiple counter sunk holes 272 for fastening the shrouds 256, 258 to the fan case 20 and the engine core 42. The arcing of the shrouds is concentric. The countersinking of the fastener bolts allows the fastener heads to be flush with the exposed surface of the shrouds 256, 258, thereby minimizing the effect of the fasteners on the airflow along the flow path 32 through the gas turbine engine 10.

[0014] Also attached to both the inner and the outer diameter shrouds 256, 258 is an integral flow path spacer 280. The integral flow path spacer 280 on the outer diameter shroud 256 is visible in Figure 3A, while the integral flow path spacer 280 on the inner diameter shroud 258 is hidden due to the view angle. The integral flow path spacer 280 provides an airflow seal between each structural guide vane 200 and the adjacent structural guide vanes 200.

[0015] Due to the circular nature of the structural guide vane assembly, the integral flow path spacer 280 is only placed on a single shroud edge of each of the inner and outer diameter shrouds 256, 258. When assembled, each shroud edge with a spacer abuts an edge of an adjacent shroud 256, 258 without a spacer resulting in each abutment being sealed by a single integral flow path spacer 280.

[0016] Each of the guide vanes 252, 254 has an airfoil shaped profile that allows the vanes 252, 254 to force air passing through the structural fan exit guide vane assembly into an axial flow path. The particular foil profile of the vanes 252, 254 can be designed according to known techniques to fit the requirements of a particular gas turbine engine implementation.

[0017] Figure 3B illustrates an alternate viewpoint of the structural guide vane assembly of Figure 3A, with like numerals indicating like elements. The view shown in Figure 3B shows the integral flow path spacer 280 on each of the inner and outer diameter shrouds 256, 258. Also illustrated is the fiber bulge 260 on the inner diameter shroud 256. The isometric view of Figure 3B further illustrates the foil profile of the guide vanes 252, 254.

[0018] Figure 4 provides a zoomed isometric view of the outer diameter shroud 256 and the integral flow path spacer 280 of Figures 3A and 3B. The integral flow path spacer 280 is a solid piece of flexible material, such as rubber, and includes a seal portion 282 and a connection portion 284. The seal portion 282 overhangs the edge of the outer diameter shroud 258. When the structural guide vane segment 200 abuts an adjacent guide vane segment, the seal portion 282 deforms to provide an airtight seal between the two outer diameter shrouds 256. The seal portion 282 also provides vibrational damping between the structural guide vane segments 200. The connection portion 284 of the integral flow path spacer 280 is affixed to the shroud segment, attaching the integral flow path spacer 282 to the shroud. A similar integral flow path spacer 282 design is used with the inner diameter shroud 258.

[0019] The structural fan exit guide vane segments described above and illustrated in the figures, use a single monolithic carbon/epoxy structure to construct the guide vane segment as a single piece. In order to create the single monolithic guide vane segment, the two vanes are shaped into a preform having the desired airfoil profile using a continuous or semi-continuous fiber. The fiber preform is then infused with a carbon/epoxy resin during a molding process. This type of resin molding generates an end component that is a single piece and is constructed of a fiber reinforced polymer matrix composite. The molding process also creates the inner and outer diameter shrouds using standard carbon/epoxy laminate molding processes. The counter sunk holes can either be created as part of the molding process or drilled after the molding process is finished. In an alternative example, three or more guide vanes can be constructed in the same manner, and could be used in each monolithic vane segment and still fall within the above disclosure.

Claims

1. A gas turbine engine comprising;
a fan (40); and
a fan frame supporting said fan (40); said fan frame comprising a plurality of fan exit guide vane seg-

ments (200), wherein each of said structural composite fan exit guide vane segments (200) comprises:

a monolithic component having an inner diameter shroud (258);
an outer diameter shroud (256);
a plurality of fan exit guide vanes (252,254) connecting said inner diameter shroud (258) and said outer diameter shroud (256);
wherein said inner diameter shroud (258) comprises at least one counter sunk hole (272) operable to connect said inner diameter shroud (258) to an engine frame (42); and
wherein said outer diameter shroud (256) comprises at least one counter sunk hole (272) operable to connect said outer diameter shroud (256) to an engine casing (20);
wherein said inner diameter shroud (258) is an arc segment having a first radius, said outer diameter shroud (256) is an arc segment having a second radius, and said second radius is larger than said first radius; and
wherein said inner diameter shroud (258) comprises a plurality of counter sunk holes (272), a fastener protruding through each of said plurality of counter sunk holes (272) thereby fastening said fan exit guide vane segment (200) to said frame; and wherein said outer diameter shroud (256) comprises a plurality of counter sunk holes (272), a fastener protruding through each of said plurality of counter sunk holes (272) thereby fastening said fan exit guide vane segment (200) to an engine casing, and wherein a head of each said fastener is flush with such counter sunk holes (272), such that the fastener heads are flush with the exposed surface of the shrouds (256, 258) thereby minimizing the effect of the fasteners on the airflow along the flow path of the gas turbine engine.

2. The gas turbine engine of claim 1, wherein said monolithic component (200) is constructed of a composite material, said composite material comprising, for example, a carbon/epoxy laminate molding.

3. The gas turbine engine of any preceding claim, further comprising an integral flow path spacer (280) affixed to a single side of said outer diameter shroud (256) and/or of said inner diameter shroud (258).

4. The gas turbine engine of any preceding claim, wherein each of said fan exit guide vanes (252;254) has an airfoil shaped profile.

5. The gas turbine engine of any preceding claim, wherein said plurality of fan exit guide vanes (252;254) comprises exactly two fan exit guide vanes (252;254).

6. The gas turbine engine of any preceding claim, wherein said plurality of fan exit guide vanes (252;254) comprise a fiber reinforced polymer matrix composite.

7. The gas turbine engine of any preceding claim, wherein each of said plurality of fan exit guide segments (200) abuts at least two adjacent fan exit guide vane segments (200).

8. The gas turbine engine of claim 7, further comprising an integral flow path spacer (280) operable to create a seal between each abutting outer diameter shroud (256) and/or further comprising an integral flow path spacer (280) operable to create a seal between each abutting inner diameter shroud (258).

9. The gas turbine engine of any of claims 1 to 8, wherein each of said plurality of fan exit guide vanes segments (200) structurally supports said gas turbine engine, for example wherein said gas turbine engine is structurally supported at a gas exit via only said fan exit guide vane segments (200).

Patentansprüche

1. Gasturbinentriebwerk, das Folgendes umfasst;
einen Fan (40); und
einen Fanrahmen, der den Fan (40) stützt; wobei der Fanrahmen eine Vielzahl von Fanausgangsleitschaufelsegmenten (200) umfasst, wobei jedes der Strukturverbundfanausgangsleitschaufelsegmente (200) Folgendes umfasst:

eine monolithische Komponente, die eine Innendurchmesserverkleidung (258) aufweist;
eine Außendurchmesserverkleidung (256);
eine Vielzahl von Fanausgangsleitschaufeln (252, 254), welche die Innendurchmesserverkleidung (258) und die Außendurchmesserverkleidung (256) verbinden;
wobei die Innendurchmesserverkleidung (258) mindestens ein angesenktes Loch (272) umfasst, das dazu betriebsfähig ist, die Innendurchmesserverkleidung (258) mit einem Triebwerksrahmen (42) zu verbinden; und
wobei die Außendurchmesserverkleidung (256) mindestens ein angesenktes Loch (272) umfasst, das dazu betriebsfähig ist, die Außendurchmesserverkleidung (256) mit einem Triebwerksgehäuse (20) zu verbinden;
wobei die Innendurchmesserverkleidung (258) ein Bogensegment ist, das einen ersten Radius aufweist, wobei die Außendurchmesserverkleidung (256) ein Bogensegment ist, das einen

zweiten Radius aufweist und der zweite Radius größer ist als der erste Radius; und
wobei die Innendurchmesserverkleidung (258) eine Vielzahl von angesenkten Löchern (272) und ein Befestigungselement umfasst, das durch jedes der Vielzahl von angesenkten Löchern (272) hervorsteht, wodurch das Fanausgangssegment (200) an dem Rahmen befestigt wird; und wobei die Außendurchmesserverkleidung (256) eine Vielzahl von angesenkten Löchern (272) und ein Befestigungselement umfasst, das durch jedes der angesenkten Löcher (272) hervorsteht, wodurch das Fanausgangsleitschaufelsegment (200) an einem Triebwerkgehäuse befestigt wird, und wobei ein Kopf von jedem Befestigungselement bündig mit derartigen angesenkten Löchern (272) ist, sodass die Befestigungselementköpfe bündig mit der freigelegten Fläche der Verkleidungen (256, 258) sind, wodurch die Wirkung der Befestigungselemente auf den Luftstrom entlang des Strömungspfads des Gasturbinentriebwerks verringert wird.

2. Gasturbinentriebwerk nach Anspruch 1, wobei die monolithische Komponente (200) aus einem Verbundmaterial hergestellt ist, wobei das Verbundmaterial zum Beispiel ein Kohlenstoff-/Epoxy-Laminatformteil umfasst.

3. Gasturbinentriebwerk nach einem der vorhergehenden Ansprüche, das ferner einen integrierten Strömungspfadabstandhalter (280) umfasst, der an einer einzigen Seite der Außendurchmesserverkleidung (256) und/oder der Innendurchmesserverkleidung (258) angebracht ist.

4. Gasturbinentriebwerk nach einem der vorhergehenden Ansprüche, wobei jede der Fanausgangsleitschaufeln (252; 254) ein luftschaufelförmiges Profil aufweist.

5. Gasturbinentriebwerk nach einem der vorhergehenden Ansprüche, wobei die Vielzahl von Fanausgangsleitschaufeln (252; 254) genau zwei Fanausgangsleitschaufeln (252, 254) umfasst.

6. Gasturbinentriebwerk nach einem der vorhergehenden Ansprüche, wobei die Vielzahl von Fanausgangsleitschaufeln (252; 254) einen faserverstärkten Polymermatrixverbundstoff umfasst.

7. Gasturbinentriebwerk nach einem der vorhergehenden Ansprüche, wobei die Vielzahl von Fanausgangsleitsegmenten (200) an mindestens zwei benachbarte Fanausgangsleitschaufelsegmente (200) angrenzt.

8. Gasturbinentriebwerk nach Anspruch 7, das ferner einen integrierten Strömungspfadabstandhalter (280) umfasst, der dazu betriebswirksam ist, eine Dichtung zwischen jeder angrenzenden Außendurchmesserverkleidung (256) zu erzeugen, und/oder das ferner einen integrierten Strömungspfadabstandhalter (280) umfasst, der dazu betriebswirksam ist, eine Dichtung zwischen jeder angrenzenden Innendurchmesserverkleidung (258) zu erzeugen.

9. Gasturbinentriebwerk nach einem der Ansprüche 1 bis 8, wobei jedes der Vielzahl von Fanausgangsleitschaufelsegmenten (200) strukturell das Gasturbinentriebwerk stützt, zum Beispiel, wobei das Gasturbinentriebwerk strukturell an einem Gasausgang über nur die Fanausgangsleitschaufelsegmente (200) gestützt ist.

Revendications

1. Moteur à turbine à gaz comprenant :

un ventilateur (40) ; et
un cadre de ventilateur supportant ledit ventilateur (40) ;
ledit cadre de ventilateur comprenant une pluralité de segments d'aube de guidage de sortie de ventilateur (200), dans lequel chacun desdits segments d'aube de guidage de sortie de ventilateur composites structurels (200) comprend :

un composant monolithique présentant un bandage de diamètre intérieur (258) ;
un bandage de diamètre extérieur (256) ;
une pluralité d'aubes de guidage de sortie de ventilateur (252, 254) raccordant ledit bandage de diamètre intérieur (258) et ledit bandage de diamètre extérieur (256) ;
dans lequel ledit bandage de diamètre intérieur (258) comprend au moins un trou fraisé (272) utilisable pour raccorder ledit bandage de diamètre intérieur (258) à un cadre de moteur (42) ; et
dans lequel ledit bandage de diamètre extérieur (256) comprend au moins un trou fraisé (272) utilisable pour raccorder ledit bandage de diamètre extérieur (256) à un carter de moteur (20) ;
dans lequel ledit bandage de diamètre intérieur (258) est un segment d'arc présentant un premier rayon, ledit bandage de diamètre extérieur (256) est un segment d'arc présentant un second rayon, et ledit second rayon est plus grand que ledit premier rayon ; et
dans lequel ledit bandage de diamètre inté-

rieur (258) comprend une pluralité de trous fraisés (272), un élément de fixation faisant saillie au travers de chacun de ladite pluralité de trous fraisés (272) fixant ainsi ledit segment d'aube de guidage de sortie de ventilateur (200) audit cadre ; et dans lequel ledit bandage de diamètre extérieur (256) comprend une pluralité de trous fraisés (272), un élément de fixation faisant saillie au travers de chacun de ladite pluralité de trous fraisés (272) fixant ainsi ledit segment d'aube de guidage de sortie de ventilateur (200) à un carter de moteur, et dans lequel une tête de chaque dit élément de fixation est alignée sur de tels trous fraisés (272) de sorte que les têtes d'élément de fixation soient alignées sur la surface exposée des bandages (256, 258) minimisant ainsi l'effet des éléments de fixation sur le flux d'air le long de la voie de flux du moteur à turbine à gaz.

2. Moteur à turbine à gaz selon la revendication 1, dans lequel ledit composant monolithique (200) est construit en un matériau composite, ledit matériau composite comprenant par exemple un moulage de laminé carbone/époxy.

3. Moteur à turbine à gaz selon une quelconque revendication précédente, comprenant en outre un écarteur de voie de flux intégral (280) fixé à un seul côté dudit bandage de diamètre extérieur (256) et/ou dudit bandage de diamètre intérieur (258).

4. Moteur à turbine à gaz selon une quelconque revendication précédente, dans lequel chacune desdites aubes de guidage de sortie de ventilateur (252 ; 254) présente un profil en forme de profil aérodynamique.

5. Moteur à turbine à gaz selon une quelconque revendication précédente, dans lequel ladite pluralité d'aubes de guidage de sortie de ventilateur (252 ; 254) comprend exactement deux aubes de guidage de sortie de ventilateur (252 ; 254).

6. Moteur à turbine à gaz selon une quelconque revendication précédente, dans lequel ladite pluralité d'aubes de guidage de sortie de ventilateur (252 ; 254) comprend un composite de matrice de polymère renforcé par des fibres.

7. Moteur à turbine à gaz selon une quelconque revendication précédente, dans lequel chacun de ladite pluralité de segments de guidage de sortie de ventilateur (200) bute contre au moins deux segments d'aube de guidage de sortie de ventilateur adjacents (200).

8. Moteur à turbine à gaz selon la revendication 7, comprenant en outre un écarteur de voie de flux intégral (280) utilisable pour créer un joint entre chaque bandage de diamètre extérieur en butée (256) et/ou comprenant en outre un écarteur de voie de flux intégral (280) utilisable pour créer un joint entre chaque bandage de diamètre intérieur en butée (258).

9. Moteur à turbine à gaz selon l'une quelconque des revendications 1 à 8, dans lequel chacun de ladite pluralité de segments d'aubes de guidage de sortie de ventilateur (200) supporte structurellement ledit moteur à turbine à gaz, par exemple dans lequel ledit moteur à turbine à gaz est supporté structurellement sur une sortie de gaz via seulement lesdits segments d'aube de guidage de sortie de ventilateur (200).

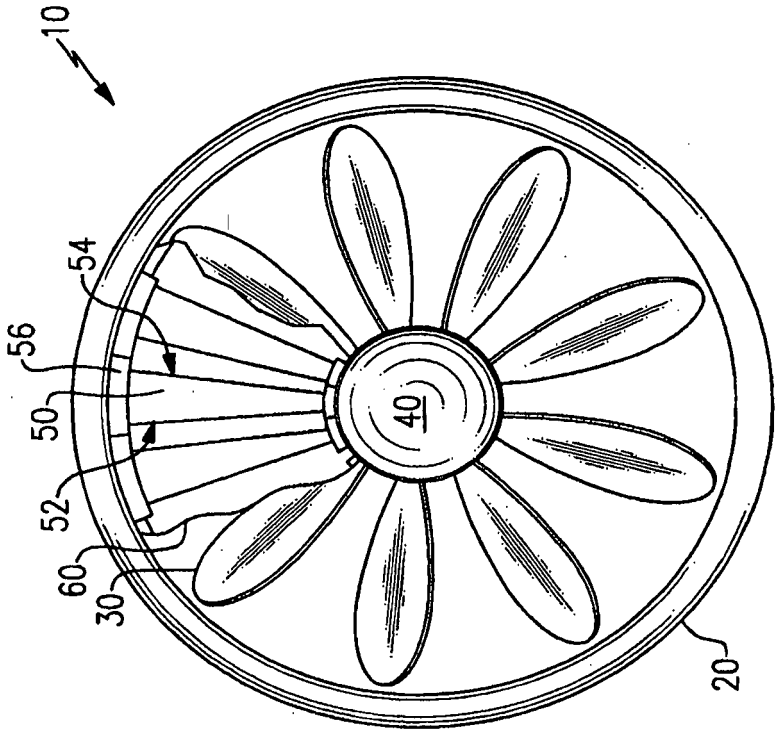

FIG.1B

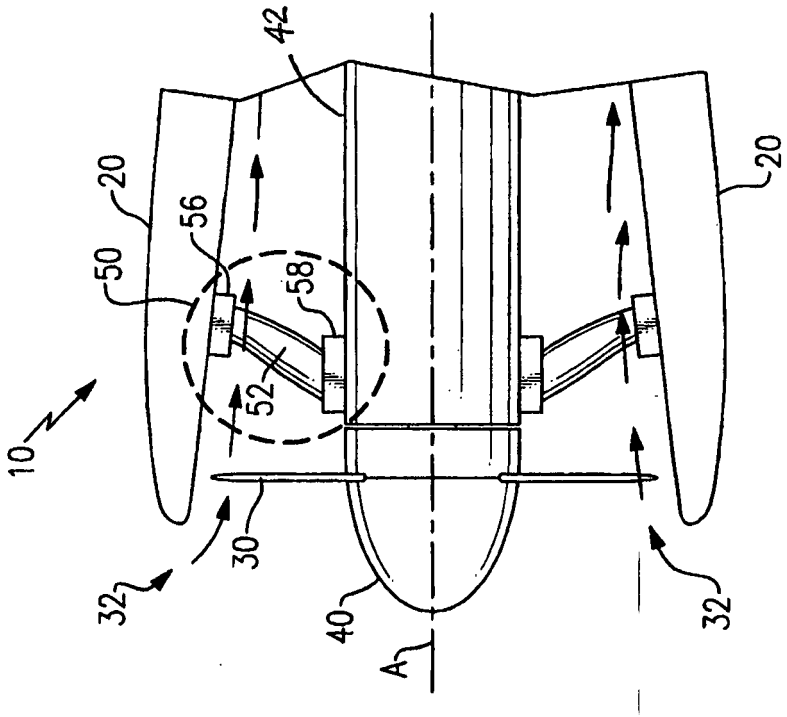

FIG.1A

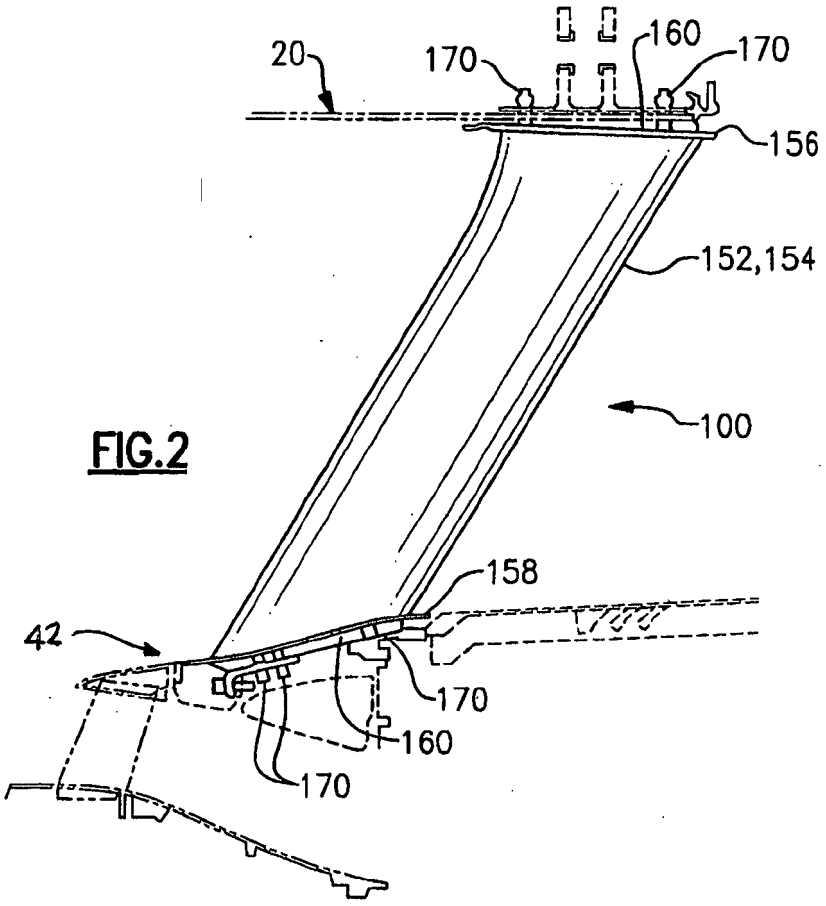

FIG.2

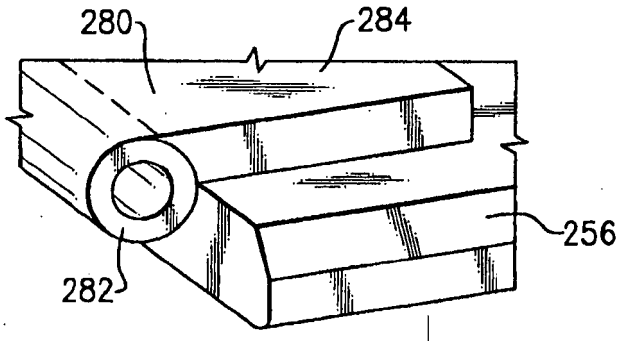

FIG.4

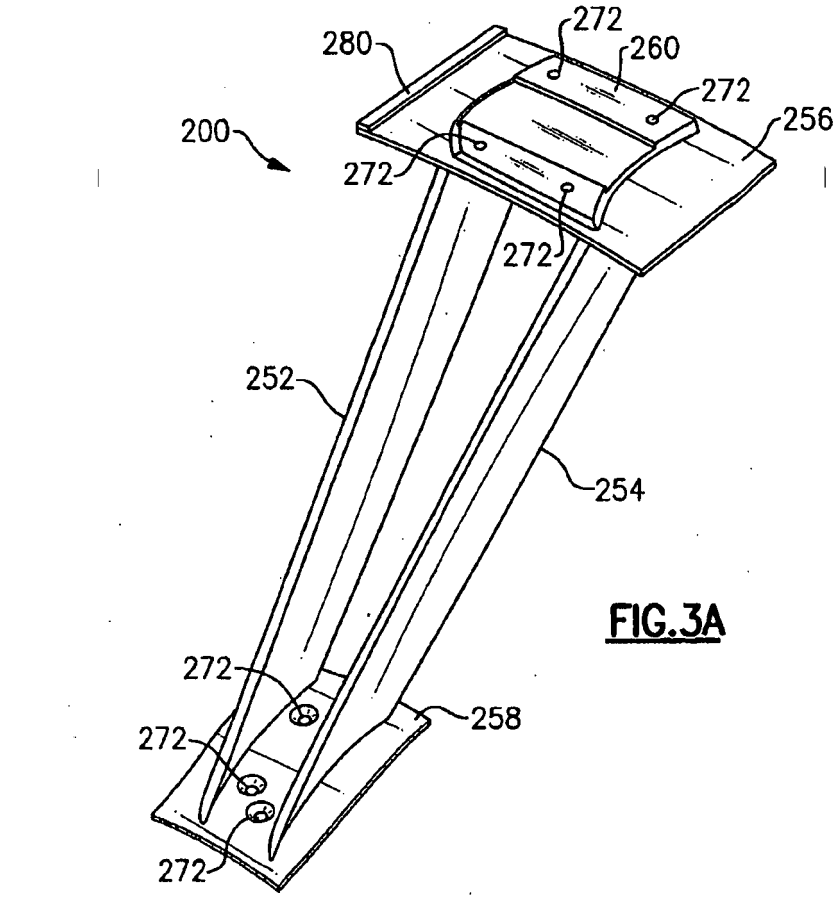
280
272
260
272
256
200
272
272
252
254
272
272
272
258

FIG.3A

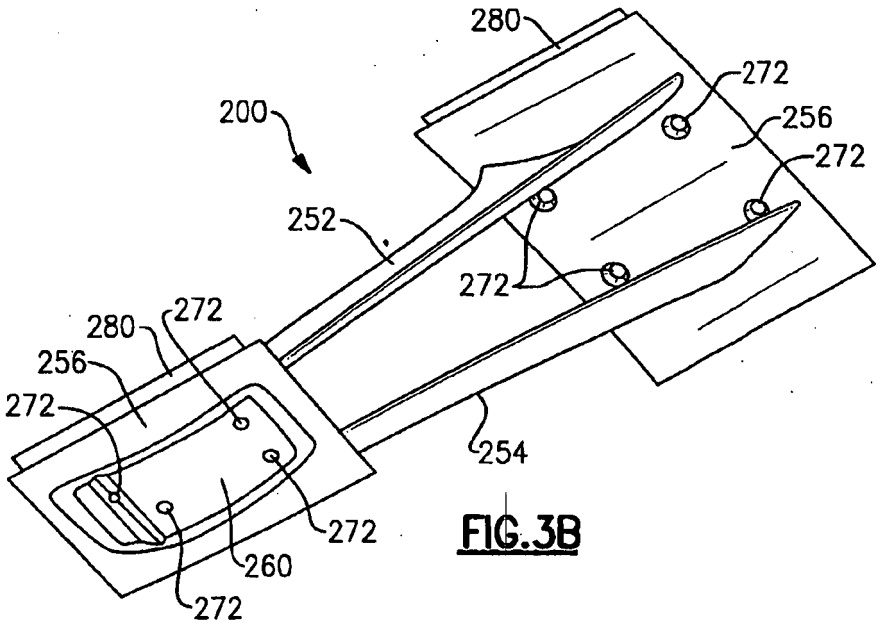
280
272
200
256
272
252
272
280
272
256
272
254
272
260
272

FIG.3B

REFERENCES CITED IN THE DESCRIPTION

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