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(54) **APPARATUS AND SYSTEM FOR COMPOSITE FAN BLADE WITH FUSED METAL LEAD EDGE**

(71) Applicant: **General Electric Company**, Schenectady, NY (US)

(72) Inventors: **Nitesh Jain**, Bangalore (IN); **Vikulp Sharma**, Bangalore (IN); **Nicholas Joseph Kray**, Mason, OH (US)

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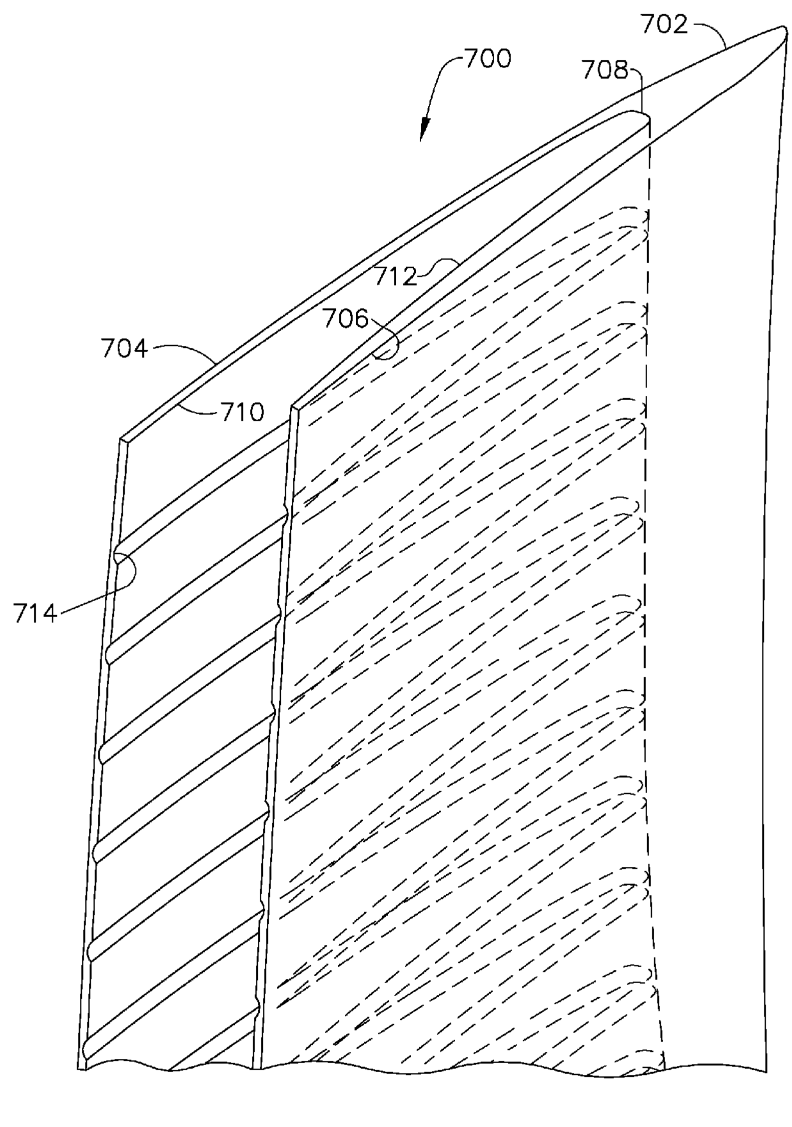
(57) **ABSTRACT**

A metal leading edge includes a nose positioned along the leading edge of a fan blade airfoil body. The metal leading edge also includes a first edge extending axially aftward from the nose along a pressure side of the fan blade airfoil body. The metal leading edge further includes a second edge extending axially aftward from the nose along a suction side of the fan blade airfoil body. The first edge and the second edge forming a notch at the conjunction of the first edge, the second edge, and the nose. The metal leading edge also includes a nose length extending from a nose tip to the notch. The nose length at a first radial location is different from the nose length at a second radial location.



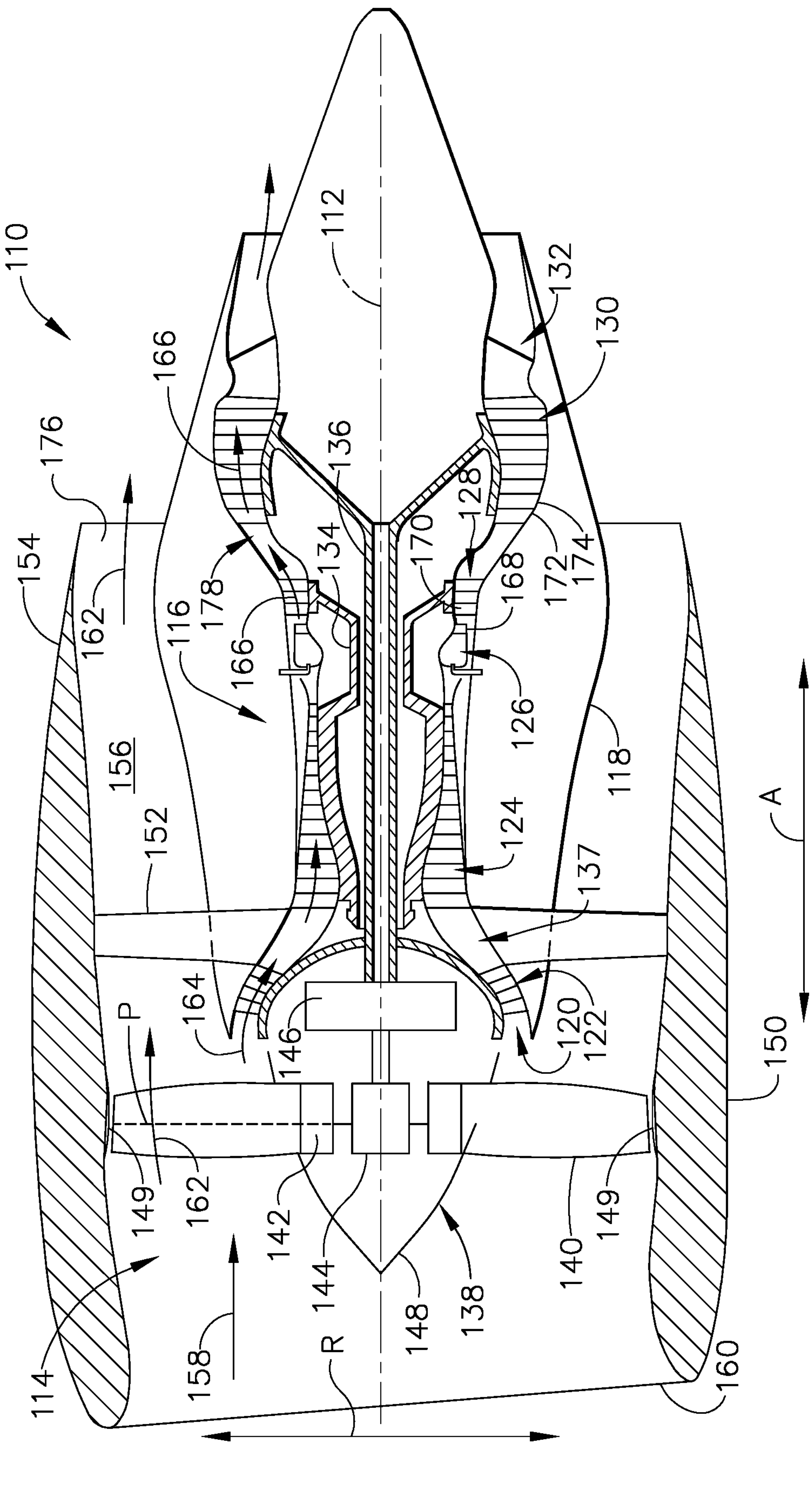

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FIG. 1

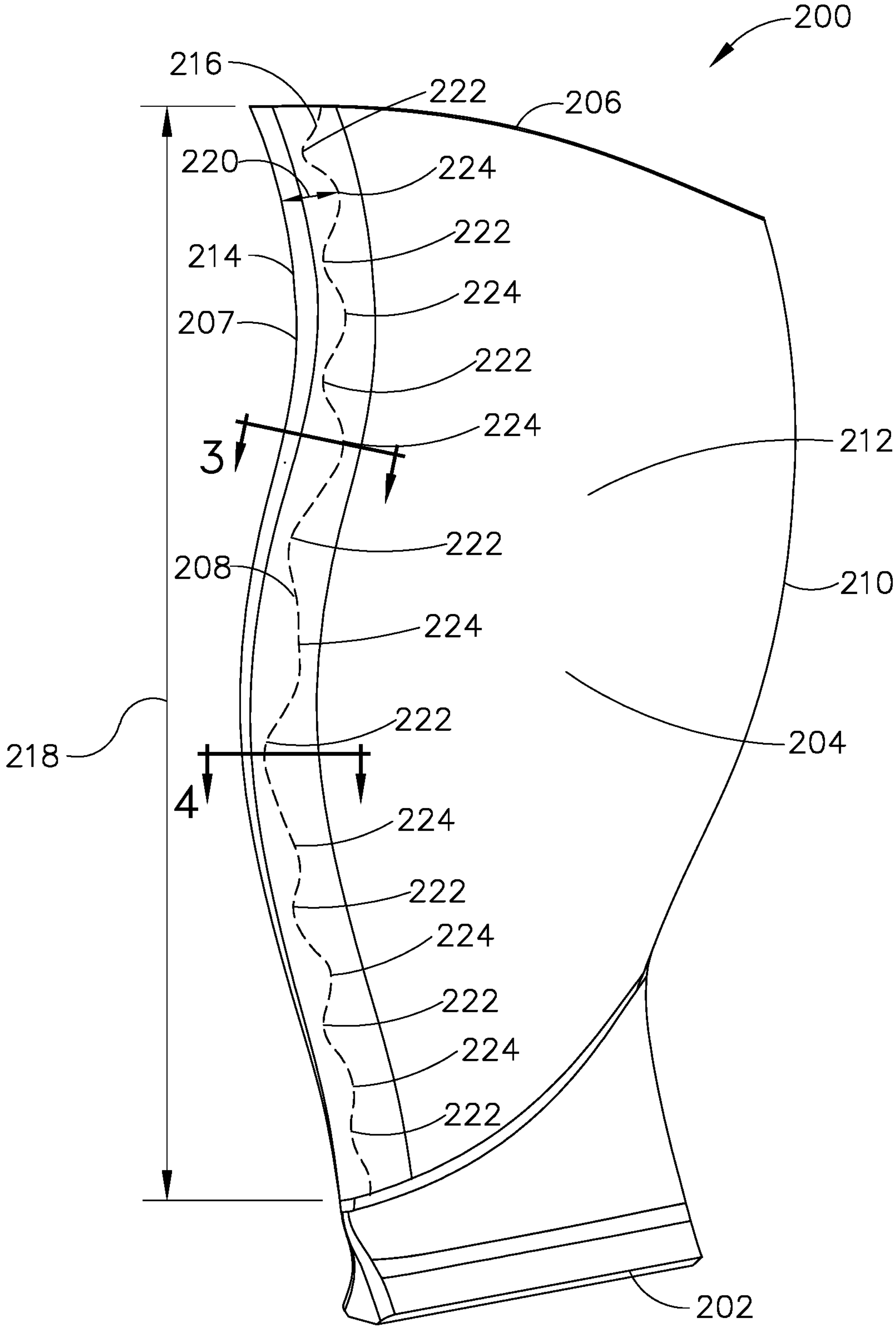
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FIG. 2

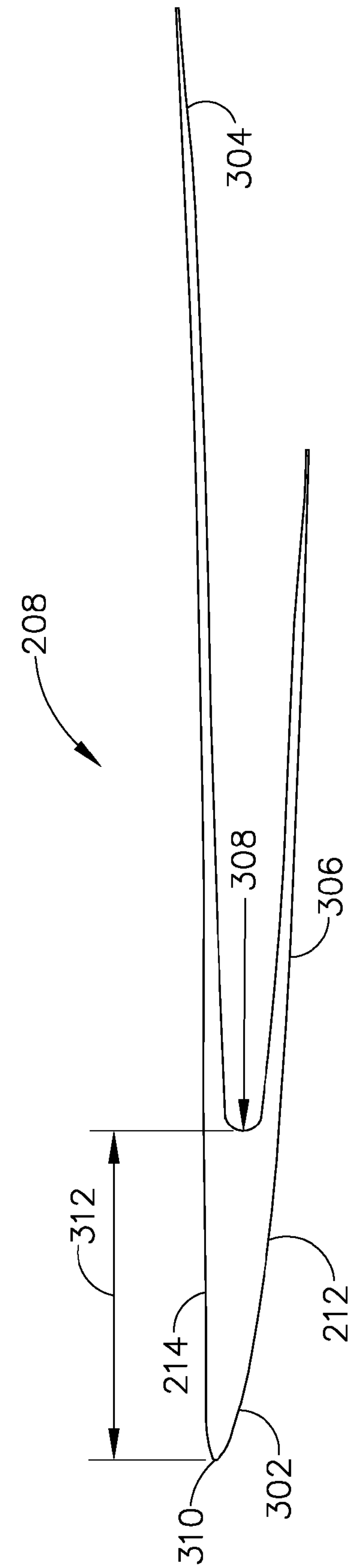
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FIG. 3

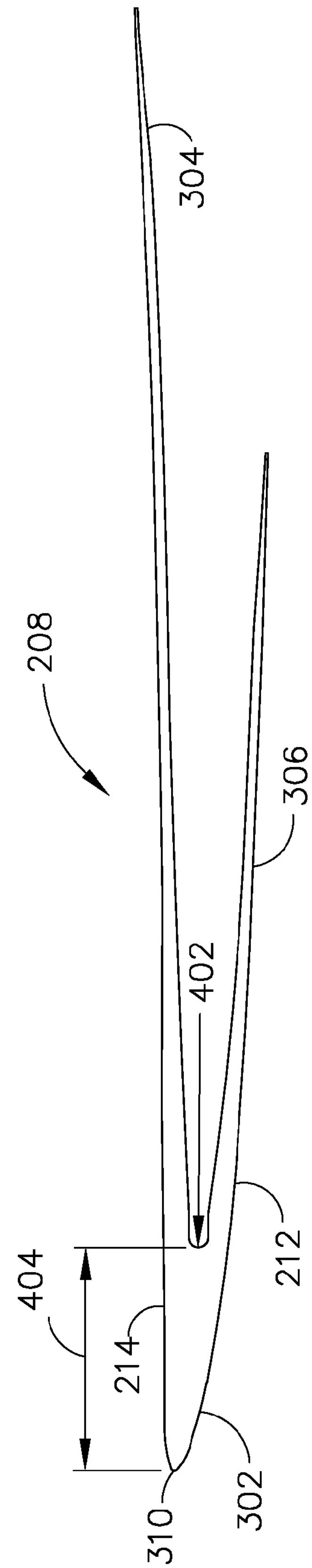
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FIG. 4

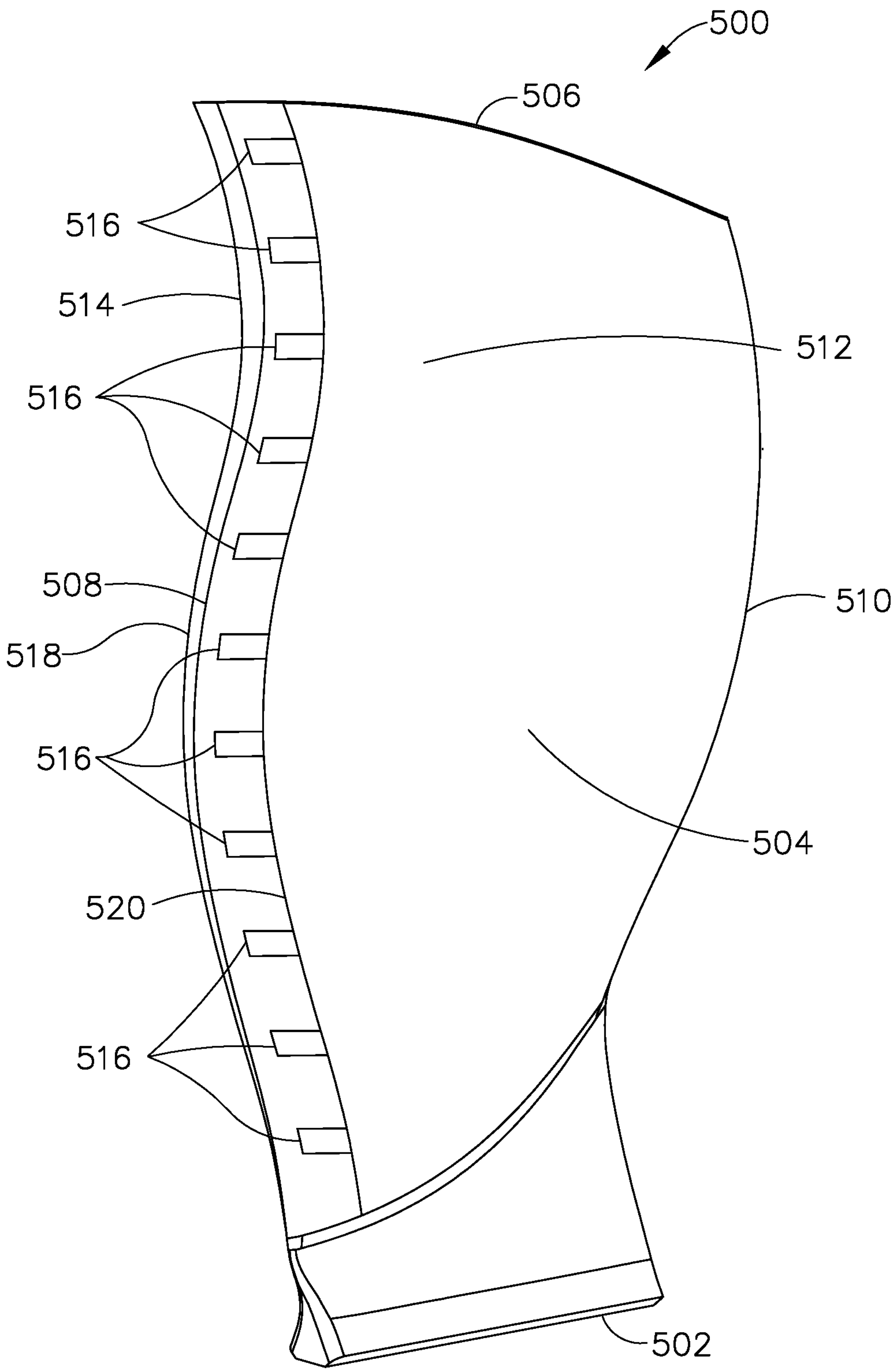

FIG. 5

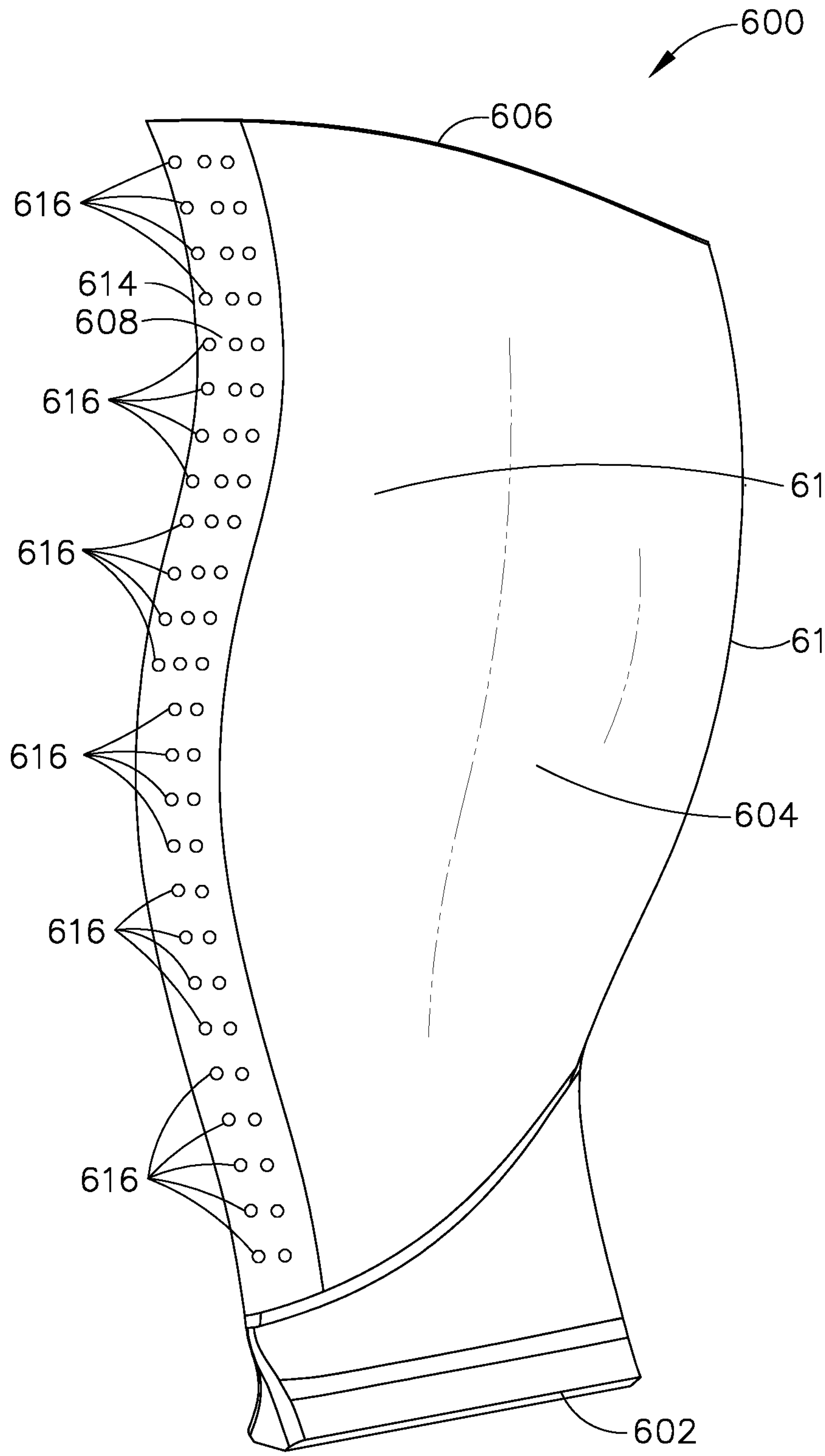

FIG.6

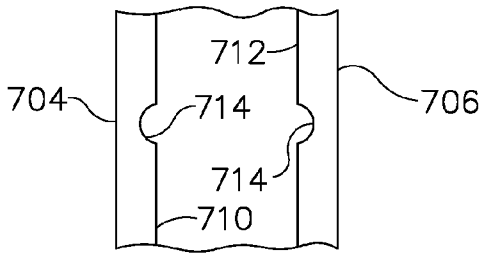

FIG. 8

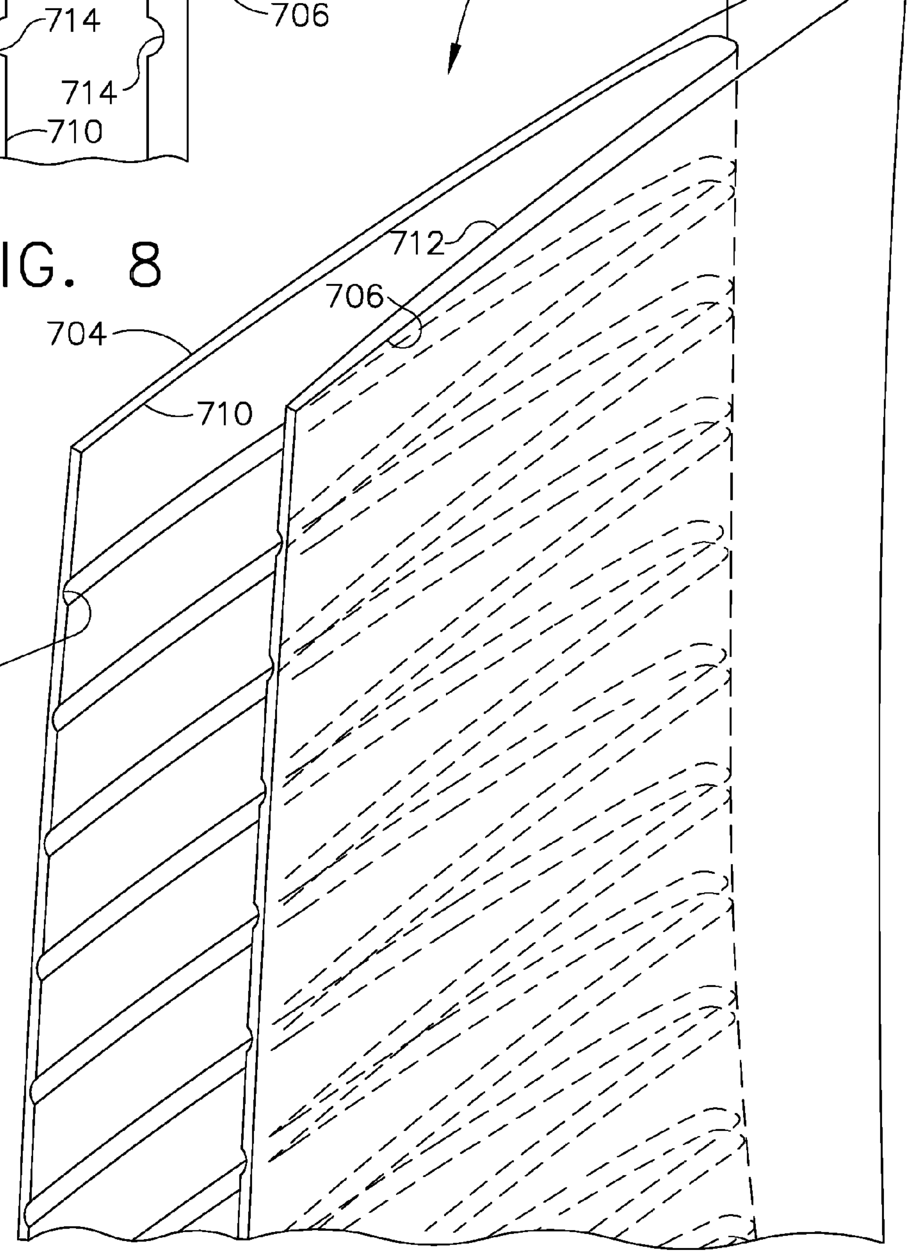

FIG. 7

APPARATUS AND SYSTEM FOR COMPOSITE FAN BLADE WITH FUSED METAL LEAD EDGE

BACKGROUND

[0001] The field of the disclosure relates generally to apparatuses and systems for fan blades in aviation engines and, more particularly, to an apparatus and system for a composite fan blade with a fused metal lead edge in aviation engines.

[0002] Aircraft engines typically include a fan assembly which directs air to a bypass duct, a low pressure compressor, and a core engine. A blade fan out event occurs when a fan blade breaks loose from the fan assembly and impacts some part of the engine. A nacelle or containment case may enclose the fan and is configured to contain the liberated fan blade during a fan blade out event. The fan assembly includes a fan hub that supports a plurality of circumferentially spaced fan blades. At least some known fan blades are fabricated from a composite material. To strengthen the composite material, to minimize danger to the fan blades during a fan blade out event, and protect the fan blades from foreign object damage, a metal leading edge may be used with the fan blade. In an event where a fan blade or a portion of a fan blade is liberated from the hub, the metal leading edge can damage the engine or containment casing. A stronger metal leading edge may necessitate a stronger containment casing, increasing the weight of the aircraft engine.

BRIEF DESCRIPTION

[0003] In one aspect, a metal leading edge is provided. A metal leading edge includes a nose positioned along the leading edge of a fan blade airfoil body. The metal leading edge also includes a first edge extending axially aftward from the nose along a pressure side of the fan blade airfoil body. The metal leading edge further includes a second edge extending axially aftward from the nose along a suction side of the fan blade airfoil body. The first edge and the second edge forming a notch at the conjunction of the first edge, the second edge, and the nose. The metal leading edge also includes a nose length extending from a nose tip to the notch. The nose length at a first radial location is different from the nose length at a second radial location.

[0004] In another aspect, a fan blade assembly is provided. A fan blade assembly includes a fan blade airfoil body. The fan blade assembly also includes a metal leading edge including a nose positioned along the leading edge of the fan blade airfoil body. The metal leading edge also includes a first edge extending axially aftward from the nose along a pressure side of the fan blade airfoil body. The metal leading edge further includes a second edge extending axially aftward from the nose along a suction side of the fan blade airfoil body. The first edge and the second edge forming a notch at the conjunction of the first edge, the second edge, and the nose. The first edge and the second edge comprise a plurality of weakening structures.

[0005] In yet another aspect, a fan blade is provided. A fan blade including a fan blade body including a fan blade root, a fan blade tip, and an airfoil body extending axially therebetween. The airfoil body includes an axially-spaced leading edge and an axially-spaced trailing edge. The fan blade also includes a metal leading edge including a nose positioned adjacent the leading edge of the fan blade. The nose includes a nose tip. The metal leading edge also includes a first edge extending axially aftward from the nose along a pressure side of the airfoil body toward the trailing edge of the fan blade. The metal leading edge further includes a second edge extending axially aftward from the nose along a suction side of the fan blade toward the trailing edge of the fan blade. The first edge and the second edge forming a notch at the conjunction of the first edge, the second edge, and the nose. The metal leading edge also includes a nose length extending from the nose tip to the notch. The nose length at a first radial location is different from the nose length at a second radial location.

DRAWINGS

[0006] These and other features, aspects, and advantages of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0007] FIGS. **1-8** show example embodiments of the method and apparatus described herein.

[0008] FIG. **1** is a schematic view of an exemplary gas turbine engine.

[0009] FIG. **2** is a perspective view of a fan blade that is used with the gas turbine engine shown in FIG. **1**.

[0010] FIG. **3** is a cutaway view of a metal leading edge at a non-fail-fused location.

[0011] FIG. **4** is a cutaway view of a metal leading edge at a fail-fused location.

[0012] FIG. **5** is a perspective view of a notched metal leading edge.

[0013] FIG. **6** is a perspective view of a metal leading edge with holes.

[0014] FIG. **7** is a perspective view of a metal leading edge with a weakened inner pressure and suction side bond edge.

[0015] FIG. **8** is a partial end view of a metal leading edge with a weakened inner pressure and suction side bond edge.

[0016] Unless otherwise indicated, the drawings provided herein are meant to illustrate features of embodiments of the disclosure. These features are believed to be applicable in a wide variety of systems comprising one or more embodiments of the disclosure. As such, the drawings are not meant to include all conventional features known by those of ordinary skill in the art to be required for the practice of the embodiments disclosed herein.

DETAILED DESCRIPTION

[0017] In the following specification and the claims, reference will be made to a number of terms, which shall be defined to have the following meanings.

[0018] The singular forms "a", "an", and "the" include plural references unless the context clearly dictates otherwise.

[0019] "Optional" or "optionally" means that the subsequently described event or circumstance may or may not occur, and that the description includes instances where the event occurs and instances where it does not.

[0020] Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as "about", "approximately", and "substantially", are not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value. Here and throughout the specification and claims, range limitations may be combined and/or interchanged, such ranges are identified and include all the sub-ranges contained therein unless context or language indicates otherwise.

[0021] Embodiments of the metal leading edge described herein allow the metal leading edge to break apart during fan blade out events. The metal leading edge includes a nose, a pressure side edge, a suction side edge, and a notch. The nose extends from the leading edge of a fan blade. The pressure side edge and the suction side edge extend from the nose along the body of the fan blade. The notch is formed from the conjunction of the nose, the pressure side edge, and the suction side edge. The notch is adhesively bonded to the fan blade. A nose length extends from the tip of the nose to the notch. Each embodiment of the metal leading edge includes a weakening structure which weakens the metal leading edge allowing it to break during extreme loading conditions, such as a fan blade out event, reducing the damage to fan case. In a first embodiment, the metal leading edge is milled to vary the nose length at different radial positions along the metal leading edge. Radial positions where the nose length is shorter weaken the nose and the metal leading edge, allowing it to break under extreme loading conditions. In a second embodiment, the pressure side edge and the suction side edge include a plurality of notches which weaken the structure of the metal leading edge, allowing it to break under extreme loading conditions. In a third embodiment, the pressure side edge and the suction side edge include a plurality of holes which weaken the structure of the metal leading edge, allowing it to break under extreme loading conditions.

[0022] The metal leading edge described herein offers advantages over known metal leading edges in aircraft engines. More specifically, the metal leading edge described herein breaks as resultant of extreme loading conditions. Aviation regulations require either the nacelle or containment case to prevent the fan blade from flying into the fuselage of the aircraft during a fan blade out event. The armoring of the nacelle or containment case must be strong enough to contain the fan blades during fan blade out events. A stronger fan blade requires stronger and heavier armoring of the nacelle or containment case which increases the weight of the aircraft engine. The metal leading edge described herein is weakened to break during a fan blade out event. A weaker metal leading edge reduces the armoring of the nacelle or containment case, reducing the weight of the engine. Additionally, a weaker metal leading edge reduces damage to trailing fans during a fan blade out event. Furthermore, metal leading edge described herein reduces fan blade out loads and unbalance.

[0023] FIG. **1** is a schematic cross-sectional view of a gas turbine engine **110** in accordance with an exemplary embodiment of the present disclosure. In the exemplary embodiment, gas turbine engine **110** is a high-bypass turbofan jet engine **110**, referred to herein as "turbofan engine **110**." As shown in FIG. **1**, turbofan engine **110** defines an axial direction A (extending parallel to a longitudinal centerline **112** provided for reference) and a radial direction R. In general, turbofan engine **110** includes a fan section **114** and a core turbine engine **116** disposed downstream from fan section **114**.

[0024] Exemplary core turbine engine **116** depicted generally includes a substantially tubular outer casing **118** that defines an annular inlet **120**. Outer casing **118** encases, in serial flow relationship, a compressor section **123** including a booster or low pressure (LP) compressor **122** and a high pressure (HP) compressor **124**; a combustion section **126**; a turbine section including a high pressure (HP) turbine **128** and a low pressure (LP) turbine **130**; and a jet exhaust nozzle section **132**. A high pressure (HP) shaft or spool **134** drivingly connects HP turbine **128** to HP compressor **124**. A low pressure (LP) shaft or spool **136** drivingly connects LP turbine **130** to LP compressor **122**. The compressor section **123**, combustion section **126**, turbine section, and nozzle section **132** together define a core air flowpath **137**.

[0025] For the embodiment depicted, fan section **114** includes a variable pitch fan **138** having a plurality of fan blades **140** coupled to a disk **142** in a spaced apart manner. As depicted, fan blades **140** extend outwardly from disk **142** generally along radial direction R. Each fan blade **140** is rotatable relative to disk **142** about a pitch axis P by virtue of fan blades **140** being operatively coupled to a suitable pitch change mechanism **144** configured to collectively vary the pitch of fan blades **140** in unison. Fan blades **140**, disk **142**, and pitch change mechanism **144** are together rotatable about longitudinal axis **112** by LP shaft **136** across a power gear box **146**. Power gear box **146** includes a plurality of gears for adjusting the rotational speed of fan **138** relative to LP shaft **136** to a more efficient rotational fan speed. In an alternative embodiment, fan blade **140** is a fixed pitch fan blade rather than a variable pitch fan blade.

[0026] Also, in the exemplary embodiment, disk **142** is covered by rotatable front hub **148** aerodynamically contoured to promote an airflow through plurality of fan blades **140**. Additionally, exemplary fan section **114** includes an annular fan casing **149** and an outer nacelle **150** that circumferentially surrounds fan **138** and/or at least a portion of core turbine engine **116**. Fan casing **149** includes an armored annular casing circumscribing fan section **114** and disposed within Nacelle **150**. Nacelle **150** is configured to be supported relative to core turbine engine **116** by a plurality of circumferentially-spaced outlet guide vanes **152**. A downstream section **154** of nacelle **150** extends over an outer portion of core turbine engine **116** so as to define a bypass airflow passage **156** therebetween.

[0027] During operation of turbofan engine **110**, a volume of air **158** enters turbofan engine **110** through an associated inlet **160** of nacelle **150** and/or fan section **114**. As volume of air **158** passes across fan blades **140**, a first portion of air **158** as indicated by arrows **162** is directed or routed into bypass airflow passage **156** and a second portion of air **158** as indicated by arrow **164** is directed or routed into core air flowpath **137**, or more specifically into LP compressor **122**. The ratio between first portion of air **162** and second portion of air **164** is commonly known as a bypass ratio. The pressure of second portion of air **164** is then increased as it is routed through HP compressor **124** and into combustion section **126**, where it is mixed with fuel and burned to provide combustion gases **166**.

[0028] Combustion gases **166** are routed through HP turbine **128** where a portion of thermal and/or kinetic energy from combustion gases **166** is extracted via sequential stages of HP turbine stator vanes **168** that are coupled to outer casing **118** and HP turbine rotor blades **170** that are coupled to HP shaft or spool **134**, thus causing HP shaft or spool **134** to rotate, thereby supporting operation of HP compressor **124**. Combustion gases **166** are then routed through LP turbine **130** where a second portion of thermal and kinetic energy is extracted from combustion gases **166** via sequential stages of LP turbine stator vanes **172** that are coupled to outer casing **118** and LP turbine rotor blades **174** that are coupled to LP shaft or spool **136**, thus causing LP shaft or spool **136** to rotate which causes power gear box **146** to rotate LP compressor **122** and/or rotation of fan **138**.

[0029] Combustion gases **166** are subsequently routed through jet exhaust nozzle section **132** of core turbine engine **116** to provide propulsive thrust. Simultaneously, the pressure of first portion of air **162** is substantially increased as first portion of air **162** is routed through bypass airflow passage **156** before it is exhausted from a fan nozzle exhaust section **176** of turbofan engine **110**, also providing propulsive thrust. HP turbine **128**, LP turbine **130**, and jet exhaust nozzle section **132** at least partially define a hot gas path **178** for routing combustion gases **166** through core turbine engine **116**.

[0030] During a fan blade out event, a fan blade of the plurality of fan blades **140** breaks loose from disk **142** and flies into nacelle **150**, fan casing **149**, other fan blades **140**, and other parts of gas turbine engine **110**. Fan casing **149** is armored to prevent a loose fan blade **140** from impacting the fuselage of the aircraft. Stronger fan blades **140** require heavier armoring for fan casing **149**. Exemplary embodiments of fan blades **140** described herein are designed to break apart during extreme loading conditions, such as a fan blade out event, reducing the damage to fan casing **149**, nacelle **150**, other fan blades **140**, and other parts of gas turbine engine **110**. Accordingly, the armoring of fan casing **149** can be reduced which reduces the weight of gas turbine engine **110**.

[0031] Exemplary turbofan engine **110** depicted in FIG. **1** is by way of example only, and that in other embodiments, turbofan engine **110** may have any other suitable configuration. It should also be appreciated, that in still other embodiments, aspects of the present disclosure may be incorporated into any other suitable gas turbine engine. For example, in other embodiments, aspects of the present disclosure may be incorporated into, e.g., a turboprop engine.

[0032] FIG. **2** is a perspective view of a fan blade **200** in accordance with an exemplary embodiment of the present disclosure. Fan blade **200** includes a fan blade root **202**, a fan blade body **204**, a fan blade tip **206**, a leading edge **207**, a metal leading edge **208**, and a trailing edge **210**. Fan blade root **202** is operatively coupled to pitch change mechanism **144** configured to vary the pitch of fan blade **200**. Fan blade body **204** extends from fan blade root **202** in radial direction R to fan blade tip **206**. Fan blade body **204** includes an airfoil shaped blade metallic or composite blade. Fan blade body **204** and metal leading edge **208** include a suction side **212** and a pressure side **214**. Trailing edge **210** extends from fan blade body **204** in the opposite direction of rotation of fan blade **200**. Leading edge **207** extends from fan blade body **204** in the direction of rotation of fan blade **200**. Metal leading edge **208** is adhesively bonded to fan blade body **204** and wraps partially around leading edge **207** forming a notch **216** (shown as a dashed line in FIG. **2**) at the intersection of the suction side **212** and pressure side **214** of fan blade body **204** and the interior portion of metal leading edge **208**. Notch **216** extends along a length **218** of metal leading edge **208** and includes a nose length **220** extending from leading edge **207** to notch **216**. Metal leading edge **208** may be composed of composite materials or metallic materials such as, but not limited to, titanium or steel.

[0033] Metal leading edge **208** includes a plurality of fail-fuse points **222** located periodically along length **218** of metal leading edge **208** and sized in a predetermined direction to break during extreme loading conditions, such as a fan blade out event, reducing the damage to fan case **149**. Metal leading edge **208** also includes a plurality of non-fail-fused points **224** located periodically along length **218** of metal leading edge **208** and sized not to break during extreme loading conditions, such as a fan blade out event. The nose lengths **220** of fail-fused points **222** are shorter than the nose lengths **220** of non-fail-fuse points **224**. The shorter nose lengths of fail-fuse points **222** weakens fail-fuse points **222** increasing the likelihood that metal leading edge **208** will break at those locations during extreme loading conditions, such as a fan blade out event. In an exemplary embodiment, nose length **220** can vary by length **218** according to a sinusoidal function, forming multiple fail-fuse points **222** along length **218**. In another embodiment, nose length **220** can vary according to radial distance from fan blade tip **202**. In another embodiment, nose length **220** can vary by step function where nose length **220** is constant at a first length for a first radial distance. Nose length **220** is then reduced to a second length for a second radial distance. Nose length **220** returns to the first length for a third radial distance. In another embodiment, nose length **220** can vary randomly along length **218**, forming multiple fail-fuse points **222** along length **218**.

[0034] As described above, during normal operations, rotation of fan blade **200** directs air into bypass airflow passage **156** and into core air flowpath **137**. During a fan blade out event, fan blade **200** breaks loose from disk **142** and flies into nacelle **150**, fan casing **149**, other fan blades **140**, and other parts of gas turbine engine **110**. Exemplary embodiments of fan blade **200** described herein are designed to break apart at fail-fuse points **222** during extreme loading conditions, such as a fan blade out event, reducing the damage to fan casing **149**, nacelle **150**, other fan blades **140**, and other parts of gas turbine engine **110**.

[0035] FIG. **3** is a cutaway view of metal leading edge **208** at a non-fail-fused point **224 3-3**. Metal leading edge **208** includes a nose **302**, a pressure side bond edge **304**, and a suction side bond edge **306**. Nose **302** extends from fan blade body **204** in the direction of rotation of fan blade **200**. Pressure side bond edge **304** and suction side bond edge **306** extend from nose **302** along fan blade body **204** in the opposite direction of rotation of fan blade **200**. A non-fail-fused notch **308** is formed from the conjunction of nose **302**, pressure side bond edge **304**, and suction side bond edge **306**. Nose **302** includes a nose tip **310** and a non-fail-fused nose length **312**. Non-fail-fused nose length **312** extends from nose tip **310** to notch **308**.

[0036] FIG. **4** is a cutaway view of metal leading edge **208** at a fail-fused point **222 4-4**. At fail-fuse point **222 4-4**, metal leading edge **208** includes a fail-fused notch **402** and a fail-fused nose length **404**. Fail-fused notch **402** is milled to extend further into nose **302** than non-fail-fused notch **308** extended into nose **302**. Accordingly, fail-fused nose length

404 is shorter than non-fail-fused nose length **312**. A shorter fail-fuse nose length **404** weakens nose **302** at fail-fuse point **222** **4-4** allowing metal leading edge **208** to break during extreme loading conditions, such as a fan blade out event, reducing the damage to fan case **149**. Metal leading edge **208** includes a plurality of fail fuse points **222** to weaken metal leading edge **208** at multiple points along length **218**.

[0037] FIG. **5** is a perspective view of a fan blade **500**. Fan blade **500** includes a fan blade root **502**, a fan blade body **504**, a fan blade tip **506**, a metal leading edge **508**, and a trailing edge **510**. Fan blade body **504** extends from fan blade root **502** in radial direction R to fan blade tip **506** and is formed of a single piece. Fan blade body **504** includes an airfoil shaped blade metallic or composite blade. Fan blade body **504** and metal leading edge **508** include a suction side **512** and a pressure side **514**. Metal leading edge **508** is adhesively bonded to fan blade body **504** and wraps partially around fan blade body **504** in the direction of rotation of fan blade **500**. Trailing edge **510** extends from fan blade body **504** in the opposite direction of rotation of fan blade **500**.

[0038] Metal leading edge **508** includes a plurality of notches **516**, a nose **518**, a suction side bond edge **520**, and a pressure side bond edge (not shown on FIG. **5**). Suction side bond edge **520** and pressure side bond edge extend from nose **518** along fan blade body **504** in the opposite direction of rotation of fan blade **500**. Each notches of the plurality of notches **516** a cut out extending from the edge of suction side bond edge **520** and pressure side bond edge toward nose **518**. Each notch of the plurality of notches **516** is sized to break during extreme loading conditions, such as a fan blade out event, reducing the damage to fan case **149**.

[0039] FIG. **6** is a perspective view of a fan blade **600** with holes. Fan blade **600** includes a fan blade root **602**, a fan blade body **604**, a fan blade tip **606**, a metal leading edge **608**, and a trailing edge **610**. Fan blade body **604** extends from fan blade root **602** in radial direction R to fan blade tip **606**. Fan blade body **604** includes an airfoil shaped blade metallic or composite blade. Fan blade body **604** and metal leading edge **608** include a suction side **612** and a pressure side **614**. Metal leading edge **608** is adhesively bonded to fan blade body **604** and wraps partially around fan blade body **604** in the direction of rotation of fan blade **600**. Trailing edge **610** extends from fan blade body **604** in the opposite direction of rotation of fan blade **600**.

[0040] Metal leading edge **608** includes a plurality of holes **616**, a nose **618**, a suction side bond edge **620**, and a pressure side bond edge (not shown on FIG. **6**). Suction side bond edge **620** and pressure side bond edge extend from nose **618** along fan blade body **604** in the opposite direction of rotation of fan blade **600**. Plurality of holes **616** are cut into suction side bond edge **620** and pressure side bond edge and weaken metal leading edge **608** such that it breaks during extreme loading conditions, such as a fan blade out event, reducing the damage to fan case **149**.

[0041] FIG. **7** is a perspective view of a metal leading edge **700** with a weakened inner pressure and suction side bond edge. FIG. **8** is a partial end view of metal leading edge **700** with a weakened inner pressure and suction side bond edge. Metal leading edge **700** includes a nose **702**, a pressure side bond edge **704**, and a suction side bond edge **706**. Nose **702** extends from fan blade body **204** (shown in FIG. **2**) in the direction of rotation of fan blade **200** (shown in FIG. **2**). Pressure side bond edge **704** and suction side bond edge **706** extend from nose **702** along fan blade body **204** in the opposite direction of rotation of fan blade **200**. A non-fail-fused notch **708** is formed from the conjunction of nose **702**, pressure side bond edge **704**, and suction side bond edge **706**. Pressure side bond edge **704** includes a pressure side bond edge inner surface **710** and suction side bond edge **706** includes a suction side bond edge inner surface **712**. Metal leading edge **700** includes a plurality of milled notches **714** cut into pressure and suction side bond edge inner surfaces **710** and **712**. Milled notches **714** are milled into suction side bond edge inner surface **712** and pressure side bond edge inner surface **710** and weaken metal leading edge **700** such that it breaks during extreme loading conditions, such as a fan blade out event, reducing the damage to fan case **149** (shown in FIG. **1**).

[0042] The metal leading edge provides an efficient method for reducing the damage caused by fan blades during fan blade out events. Specifically, the metal leading edge breaks during extreme loading conditions, such as fan blade out conditions, reducing the damage to the fan casing, nacelle, other fan blades, and other parts of gas turbine engine. Accordingly, the armoring of the fan casing can be reduced which reduces the weight of gas turbine engine. Finally, the metal leading edge described herein reduces damage to other fan blades during a fan blade out event which reduces unbalance and loading during fan blade out events.

[0043] An exemplary technical effect of the methods, systems, and apparatus described herein includes at least one of: (a) reducing damage caused by fan blades during fan blade out events; (b) reducing damage to other fan blades during a fan blade out event; (c) reducing unbalance and loading during fan blade out events; and (d) decreasing the weight of the aircraft engine.

[0044] Exemplary embodiments of the metal leading edge are described above in detail. The metal leading edge, and methods of operating such units and devices are not limited to the specific embodiments described herein, but rather, components of systems and/or steps of the methods may be utilized independently and separately from other components and/or steps described herein. For example, the methods may also be used in combination with other systems for reducing the damage caused by fan blades during fan blade out events, and are not limited to practice with only the systems and methods as described herein. Rather, the exemplary embodiment may be implemented and utilized in connection with many other machinery applications that require metal leading edges.

[0045] Although specific features of various embodiments of the disclosure may be shown in some drawings and not in others, this is for convenience only. In accordance with the principles of the disclosure, any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

[0046] This written description uses examples to describe the disclosure, including the best mode, and also to enable any person skilled in the art to practice the disclosure, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the disclosure is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A metal edge configured to engage a complementary leading edge of a composite blade member, said metal edge comprising:

an elongate nose member comprising an outside edge, an inside notch and nose body extending therebetween a variable nose length, said inside notch comprising a plurality of fail-fuse elements spaced along a length of said inside notch, said nose length being less proximate said plurality of fail-fuse elements;

a first integrally-formed edge portion extending away from said nose member along at least a portion of the length of said nose member; and

a second portion edge extending away from said nose member along the at least a portion of the length of said nose member, said first edge portion and said second edge portion forming a notch at the conjunction of said first edge portion, said second edge portion, and said nose.

2. The metal edge of claim **1**, wherein said nose length varies as a function of a radial distance along a length of said metal edge.

3. The metal edge of claim **1**, wherein said nose length comprise a first length for a first radial distance from a fan blade root and said nose length reduces to a second length for a second radial distance from said fan blade root.

4. The metal edge of claim **1**, wherein said nose length varies by a radial location according to a sinusoidal function.

5. The metal edge of claim **1**, wherein said notch is configured to adhesively bond to a composite blade member.

6. The metal edge of claim **1**, wherein said metal edge comprises titanium.

7. The metal edge of claim **1**, wherein said metal edge comprises steel.

8. A fan blade assembly comprising:

a fan blade airfoil body comprising a length and a leading edge; and

a metal edge comprising:

an elongate nose member comprising an outside edge, an inside notch and nose body extending therebetween a variable nose length, said inside notch comprising a plurality of fail-fuse elements spaced along a length of said inside notch, said nose length being less proximate said plurality of fail-fuse elements;

a first integrally-formed edge portion extending away from said nose member along at least a portion of the length of said nose member; and

a second portion edge extending away from said nose member along the at least a portion of the length of said nose member, said first edge portion and said second edge portion forming a notch at the conjunction of said first edge portion, said second edge portion, and said nose.

9. The fan blade assembly of claim **7**, wherein said plurality of fail-fuse elements comprise a plurality of slits, said slits comprise a plurality of cutaway sections of said first edge portion and said second edge portion.

10. The fan blade assembly of claim **9**, wherein said plurality of cutaway sections comprises rectangular cutaway sections.

11. The fan blade assembly of claim **7**, wherein said plurality of fail-fuse elements comprise a plurality of holes within said first edge portion and said second edge portion.

12. The fan blade assembly of claim **8**, wherein said metal leading edge comprises titanium.

13. The fan blade assembly of claim **8**, wherein said metal leading edge comprises steel.

14. A fan blade comprising:

a fan blade root, a fan blade tip, and an airfoil body extending axially therebetween, said airfoil body comprises an axially-spaced leading edge and an axially-spaced trailing edge, said airfoil body comprises a length extending between said fan blade root and said fan blade tip;

a metal edge comprising:

an elongate nose member comprising an outside edge, an inside notch and nose body extending therebetween a variable nose length, said inside notch comprising a plurality of fail-fuse elements spaced along a length of said inside notch, said nose length being less proximate said plurality of fail-fuse elements;

a first integrally-formed edge portion extending away from said nose member along at least a portion of the length of said nose member; and

a second portion edge extending away from said nose member along the at least a portion of the length of said nose member, said first edge portion and said second edge portion forming a notch at the conjunction of said first edge portion, said second edge portion, and said nose.

15. The fan blade of claim **14**, wherein said nose length varies as a function of a radial distance along said length of said airfoil body.

16. The fan blade of claim **14**, wherein said nose length comprise a first length for a first radial distance along said length of said airfoil body and said nose length reduces to a second length for a second radial distance along said length of said airfoil body.

17. The fan blade of claim **14**, wherein said nose length varies by radial location along said length of said airfoil body according to a sinusoidal function.

18. The fan blade of claim **14**, wherein said notch configured to adhesively bond to said axially-spaced leading edge of said airfoil body.

19. The fan blade of claim **14**, wherein said metal edge comprises titanium.

20. The fan blade of claim **14**, wherein said metal edge comprises steel.

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