



US 20040118978A1

(19) **United States**

(12) **Patent Application Publication**
Anning

(10) **Pub. No.: US 2004/0118978 A1**

(43) **Pub. Date: Jun. 24, 2004**

(54) **HELICOPTER ROTOR AND METHOD OF
REPAIRING SAME**

Publication Classification

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(51) **Int. Cl.⁷ B64C 1/00; B64C 3/00; B64C 5/00**

(52) **U.S. Cl. 244/123**

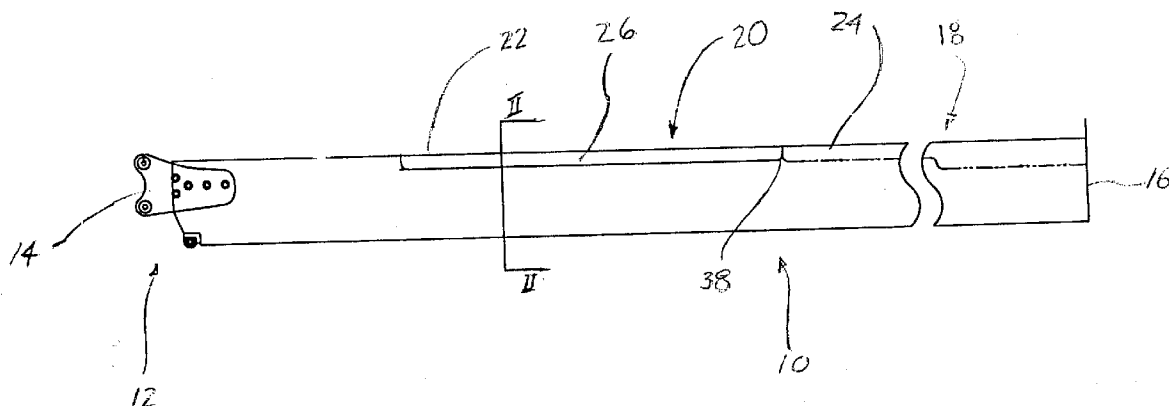
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(57) **ABSTRACT**

An aerofoil, particularly a helicopter main rotor blade has a leading edge protector comprising a strip of resilient polymer, preferably polyurethane, adhered to the leading edge of the blade.

(21) **Appl. No.: 10/326,995**

(22) **Filed: Dec. 24, 2002**



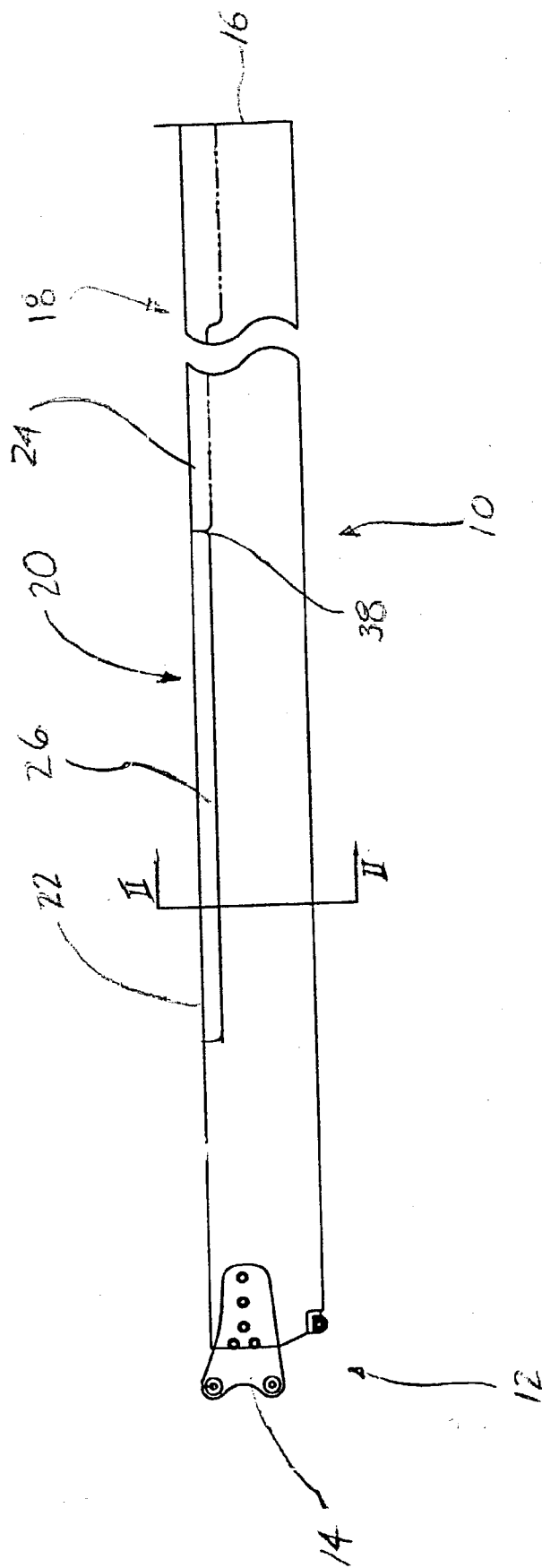


FIG. 1

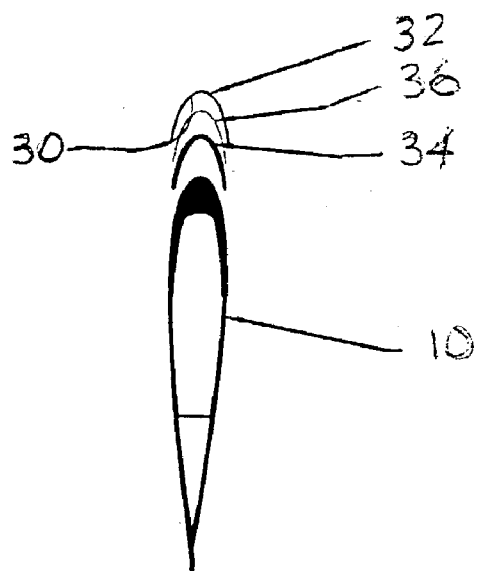


FIG. 2

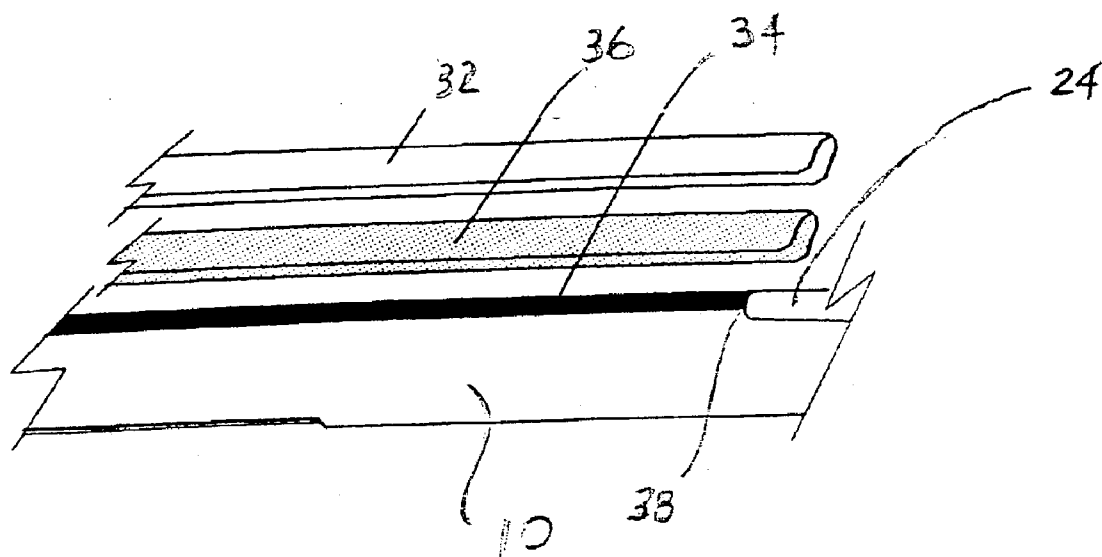


FIG. 3

HELICOPTER ROTOR AND METHOD OF REPAIRING SAME

FIELD OF THE INVENTION

[0001] The present invention relates to aerofoils, and more particularly to the protection of aerofoil leading edges from erosion damage. The invention has particular application to rotary wings, for example helicopter rotor blades.

BACKGROUND

[0002] The invention was developed in the environment of helicopter rotor blade repair, and will be described primarily in connection with that application. It will be understood by those knowledgeable in the art that the invention may have wider application to aerofoils for other purposes.

[0003] The leading edges of helicopter rotor blades are subject to environmental wear, particularly when the helicopter is operated in harsh conditions, for example with significant quantities of ambient sand or salt. It has been found in particular that there is a recurring problem of skin erosion located inboard of the metal leading edge abrasion strips in main rotor blades. Current practice is to remove the blades from the helicopter and send them for repair. In some cases, the damage cannot be repaired. The damage requires skin repairs to the leading edge with reinforcement doublers applied. It has been found that a metal skin repair in the flex section of the blade is prone to delamination.

[0004] Impact damage is another significant concern with rotor blades since impact damage to the blade also requires removal of the blade and shipping to specialized shop capable of performing the repairs.

[0005] Either repair, of erosion or impact damage can mean several weeks downtime for the aircraft while the blade is dismounted, packed and shipped, repaired and returned.

[0006] The present invention is concerned with an alternative arrangement that ameliorates many of the problems with current repair techniques for aerofoil leading edges.

SUMMARY

[0007] According to one aspect of the present invention there is provided an aerofoil for use in an aircraft, the aerofoil having a leading edge and a wear resistant, resilient polymeric material extending along at least a portion of the leading edge.

[0008] The polymeric leading edge has been found to provide good resistance to erosion. It has been found to be particularly effective in the flex section of helicopter main rotor blades as the flexibility of the material limits any tendency to delaminate as occurs with rigid metal leading edge repairs in this section of the blade. On the other hand, it is to be noted that when used in the outboard flight section of a helicopter rotor, the high centrifugal forces on the polymer may cause creep of the material, leading to the polymer disengaging off the end of the blade. In consequence, the polymer leading edge is, in this environment, preferably limited to the flex section of the blade, with the flight section being equipped with a conventional metal leading edge.

[0009] Minor impact damage to a polymeric leading edge can readily be repaired in the field rather than dismounting the blade and shipping it away for repair, as would be the case with damage to a conventional leading edge.

[0010] According to another aspect of the present invention there is provided a method of protecting the leading edge of an aerofoil from erosion, comprising securing to the leading edge a layer of resilient polymeric material.

[0011] The installation of the polymeric leading edge is much more easily performed than the installation of a metal leading edge. It conforms more closely to the blade configuration since the metal edge is conventionally shaped using a brake, forming a sequence of substantially flat segments only approximating the smooth, uniform curvature of the original blade.

[0012] Where the aerofoil is a rotor blade for a rotary wing aircraft with a mounting end for attachment to a rotor drive, a flight section adjacent a blade tip, opposite the mounting end and a flex section between the flight section and the mounting end, the method preferably comprises securing the resilient polymer to the leading edge of the flex section.

[0013] The resilient polymer is preferably an elastomeric material, for example polyurethane. The currently preferred material is ether urethane 85 Shore A polyurethane, desirably black in colour with a matte finish and UV stabilized. It is preferably bonded to the leading edge skin using an adhesive and with a bond line thickness control medium. This may be a scrim cloth.

[0014] The currently preferred adhesive is an epoxy adhesive, Hysol EA 9309.3NA containing 5-mil glass beads for bond line thickness control. It is preferably cured at an elevated temperature, with a uniform pressure applied over the polyurethane.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In the accompanying drawings, which illustrate an exemplary embodiment of the present invention:

[0016] **FIG. 1** is a plan view of a helicopter rotor blade;

[0017] **FIG. 2** is an exploded section along line II-II of **FIG. 1**; and

[0018] **FIG. 3** is an exploded isometric of a leading edge repair.

DETAILED DESCRIPTION

[0019] Referring to the accompanying drawings, there is illustrated a blade **10** for use in a helicopter main rotor. The blade has a mounting end **12** carrying a mounting fitting **14** which is used to mount the blade on the rotor hub of the aircraft. The opposite end of the blade is the blade tip **16**. That section of the blade adjacent the tip is the flight section **18** which, because it is furthest from the axis of rotation, travels at the greatest speed and provides the majority of lift. Inboard of the flight section, **18** is the flex section **20** which, in use, undergoes bending deflection under the lift forces exerted on the blade.

[0020] The entire blade has an aerofoil shape as shown most particularly in FIG. 2.

[0021] The leading edge 22 of the blade is subject to erosion during use. The erosion is most pronounced in the flight section where the speed of the blade is highest. To limit erosion in the flight section, the rotor is equipped with an erosion strip 24. When wear of the erosion strip reaches an unacceptable level, it is removed and replaced. With the present invention, For leading edge wear inboard of the erosion strip, the worn skin of the rotor is abraded and cleaned and equipped with a polyurethane leading edge strip 26 as edge protection.

EXAMPLE

[0022] With the illustrated blade 10, the repair area of the blade is marked off. It is then abraded and cleaned with an appropriate solvent.

[0023] The bonding surface 30 of a polyurethane strip 32 is also abraded and cleaned with a solvent.

[0024] Adhesive 34 is applied to the abraded bonding surfaces of the blade and the polyurethane strip.

[0025] A scrim cloth 36, in this case 0.008 inch (0.2 mm.) nylon is positioned smoothly over the repair area, leaving no wrinkles or creases.

[0026] The polyurethane strip 32 is then positioned on the repair area over the scrim cloth and subjected to a uniform pressure of 15 psi (10^5 N/m²) and an elevated temperature (e.g. 180° F. (82° C.) for a duration sufficient to cure the adhesive. It has been found that good conformity to the original shape of the blade and uniform adhesion are achieved through the use of a pressurized bladder acting on the outer surface of the polymeric sheet during curing of the adhesive.

[0027] This produces the polyurethane leading edge protector 26 in the flex section, abutting the metal edge protection used in the flight section at a junction 38 where the edge of the metal sheet of the flight section edge protection 24 provides a surface against which the outboard edge of the polyurethane sheet 32 engages, to support the polyurethane sheet against creep owing to the centrifugal force that is generated during operation of the blade.

[0028] While one particular embodiment of the present invention has been described in the foregoing, it is to be understood that other embodiments are possible within the

scope of the appended claims. Thus, while the present invention has been described in connection with its application to helicopter main rotor blades, it is to be understood that the invention has application to other aerofoils that require edge protection. Examples may include the wings of fixed wing aircraft and the leading edges of aircraft propellers. The invention is therefore to be considered limited solely to the scope of the appended claims.

Embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An aerofoil for use in an aircraft, the aerofoil having a leading edge and a wear resistant polymeric material extending along at least a portion of the leading edge.

2. An aerofoil according to claim 1 wherein the polymeric material is an elastomer.

3. An aerofoil according to claim 1 wherein the polymeric material is polyurethane.

4. An aerofoil according to claim 1, wherein the aerofoil is a rotor blade for a rotating wing aircraft.

5. An aerofoil according to claim 4 wherein the rotor blade has an inboard end section for attachment to a rotor drive, an outboard flight section adjacent an outboard tip end of the blade and a flexible blade section between the inboard and outboard sections of the blade, the polymeric material being applied to the leading edge of the flexible blade section.

6. A method of protecting the leading edge of an aerofoil from erosion, comprising securing to the leading edge a layer of resilient polymer material.

7. A method according to claim 6 wherein the aerofoil is a rotor blade for a rotary wing aircraft with an inboard mounting end for attachment to a rotor drive, a flight section adjacent an outboard blade tip opposite the mounting end and a flex section between the flight section and the mounting end, the method comprising securing the resilient polymer to the leading edge of the flex section.

8. A method according to claim 6 wherein the resilient polymer is an elastomeric material.

9. A method according to claim 6, wherein the resilient polymer is polyurethane.

10. A method according to claim 6 comprising applying a bond line thickness control medium to the leading edge and applying the resilient polymer to the thickness control medium.

11. A method according to claim 10 wherein the bond line thickness control medium is a scrim cloth.

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