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(54) Title: HIGH PERFORMANCE OUTBOARD SECTION FOR ROTOR BLADES

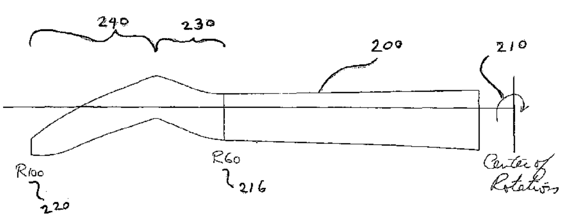

FIG 2

(57) Abstract: Blades for rotorcraft are designed and/or implemented with rotor blades having a swept portion that occupies at least 20-40% of a length of the blade. Forward and aft sweeps are contemplated, with up to 20° or more of sweep. The swept portion preferably has a thickness ration of at least 10-20% at R80, and can have a tapered planform with a relatively outboard section having a smaller chord than a relatively inboard section. Contemplated design methods include optimizing or otherwise designing the rotor blade planform and lift distribution along the blade for efficiency in various flight conditions without taking into account the detrimental effects of high Mach numbers, and then using sweep angle, airfoil thickness and transonic airfoil shaping to maintain the lift distribution, low drag and low noise level at real Mach numbers at the various blade stations at the various flight conditions.

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AMENDED CLAIMS

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1. A rotorcraft, comprising:
   a composite rotor blade having a swept portion that occupies at least 20% of a length of the blade.

2 The rotorcraft of claim 1, wherein the blade uses at least one of a high- and medium-modulus carbon-epoxy composite.

3. The rotorcraft of claim 1, wherein the swept portion that occupies at least 30% of a length of the blade.

4. The rotorcraft of claim 1, wherein the swept portion that occupies at least 40% of a length of the blade.

5. The rotorcraft of claim 1, wherein the swept portion has a leading edge sweep angle of at least 20°.

6. The rotorcraft of claim 1, wherein the swept portion has a plurality of leading edge sweep angles that vary along the swept portion.

7. The rotorcraft of claim 1, wherein the swept portion that includes a forward sweep.

8. The rotorcraft of claim 1, wherein the swept portion has a thickness ratio of at least 10% at R80.

9. The rotorcraft of claim 1, wherein the swept portion has a thickness ratio of at least 15% at R80.

10. The rotorcraft of claim 1, wherein the blade has a tapered planform with a relatively outboard section having a smaller chord than a relatively inboard section.

11. A rotorcraft having a composite rotor blade with a swept portion that: (a) occupies at least 20% of a length of the blade; (b) has a leading edge sweep angle of at least 20°; and (c) includes a single forward sweep.

12. The rotorcraft of claim 11, wherein the swept portion that includes at least 30% of a length of the blade.

13. The rotorcraft of claim 11, wherein the swept portion that includes at least 40% of a length of the blade.

14. The rotorcraft of claim 11, wherein the swept portion has a thickness ratio of at least 10% at R80.

15. The rotorcraft of claim 11, wherein the swept portion has a thickness ratio of at least 15% at R80.

16. The rotorcraft of claim 11, wherein the blade has a tapered planform with a relatively outboard section having a smaller chord than a relatively inboard section.

17. A method of designing a blade for a rotorcraft, comprising:

designing a rotor blade planform and lift distribution for high efficiency in various flight conditions, without taking into account detrimental effects of high Mach numbers of an outer section of the blade; and

using a combination of sweep angle, airfoil thickness and transonic airfoil shaping to maintain the lift distribution, low drag and low noise level at realistic Mach numbers at various blade stations.

18. The method of claim 17, modeling with a goal of providing substantially equal margins from transonic limits of lift, shock waves, and vibrations.

19. The method of claim 17, modeling the blade using both forward sweep and aft sweep.

20. The method of claim 17, modeling the blade using sweep from at least R70 to R100.