CLAIMS

What is claimed is:

1. A fan blade comprising:

a root including a front surface, a rear surface, a first side surface connected to the front surface and the rear surface, and a second side surface connected to the front surface and the rear surface, wherein the front surface engages the first side surface and the second side surface by one or more blunted surfaces, and the rear surface engages the first side surface and the second side surface by one or more blunted surfaces; and

a blade extending from the root.

2. The fan blade as recited in claim 1 wherein the front surface and the rear surface are substantially flat.

3. The fan blade as recited in claim 1 wherein a cross-section of the root taken substantially parallel to a bottom surface of the root includes no angles.

4. The fan blade as recited in claim 1 wherein each of the blunted surfaces has a radius.

5. The fan blade as recited in claim 4 wherein the radius is between about 0.1 inch to about 0.6 inch.

6. The fan blade as recited in claim 1 wherein each of the blunted surfaces is an ellipse.

7. The fan blade as recited in claim 1 wherein each of the blunted surfaces is a chamfer.

8. The fan blade as recited in claim 1 wherein the front surface and the rear surface are curved.

9. The fan blade as recited in claim 1 wherein the first side surface and the second side surface are substantially straight.

10. The fan blade as recited in claim 1 wherein the first side surface and the second side surface are substantially curved.

11. The fan blade as recited in claim 1 wherein the fan blade is made of at least one of aluminum and titanium.

12. The fan blade as recited in claim 1 wherein the root includes a portion having substantially parallel walls defining a width therebetween, wherein a distance is defined between an outer edge of the portion of the root and a line that extends substantially parallel to the outer edge, wherein the line passes through a point where the front surface and a first blunted surface meet and a point where the rear surface and a second blunted surface meet, and wherein a ratio of the distance to the width is between about 0.15 to about 0.50.

13. A turbine engine comprising:

a compressor section;

a combustor in fluid communication with the compressor section;

a turbine section in fluid communication with the combustor; and

a fan including a fan rotor and a plurality of fan blades, wherein the fan rotor includes a plurality of slots, each of the plurality of fan blades includes a root and a blade, and the root of each of the plurality of fan blades is received in one of the plurality of slots of the fan rotor,

wherein each root includes a front surface, a rear surface, a first side surface connected to the front surface and the rear surface, and a second side surface connected to the front surface and the rear surface, wherein the front surface engages the first side surface and the second side surface by one or more blunted surfaces, and the rear surface engages the first side surface and the second side surface by one or more blunted surfaces.

14. The turbine engine as recited in claim 13 wherein the front surface and the rear surface are substantially flat.

15. The turbine engine as recited in claim 13 wherein a cross-section of the root taken substantially parallel to a bottom surface of the root includes no angles.

16. The turbine engine as recited in claim 13 wherein each of the blunted surfaces has a radius.

17. The turbine engine as recited in claim 16 wherein the radius is between about 0.1 inch to about 0.6 inch.

18. The turbine engine as recited in claim 13 wherein each of the blunted surfaces is an ellipse.

19. The fan blade as recited in claim 13 wherein each of the blunted surfaces is a chamfer.

20. The turbine engine as recited in claim 13 wherein the front surface and the rear surface are curved.

21. The turbine engine as recited in claim 13 wherein at least one of the fan blades is made of at least one of aluminum and titanium.

22. The turbine engine recited in claim 13 wherein the root includes a portion having substantially parallel walls defining a width therebetween, wherein a distance is defined between an outer edge of the portion of the root and a line that extends substantially parallel to the outer edge, wherein the line passes through a point where the front surface and a first blunted surface meet and a point where the rear surface and a second blunted surface meet, and wherein a ratio of the distance to the width is between about 0.15 to about 0.50.

CLAIMS

1. A method of designing a turbine blade, the method comprising the steps of:

forming at least two notches on a tip of a turbine blade having a pressure side and a suction side, wherein each of the at least two notches have a known radius, at least one of the at least two notches is located on one of the pressure side and the suction side, and each of the at least two notches have a different radii;

operating a gas turbine engine including the turbine blade to expand a radial length of the turbine blade such that the tip of the turbine blade engages a casing;

rubbing the tip of the turbine blade against the casing to wear away a portion of the tip and at least a portion of at least one of the two notches;

viewing the tip of the turbine blade after the step of operating of the gas turbine engine;

determining an appearance of the at least two notches and the tip; and

determining a manufacturing length of the turbine blade based on the step of determining the appearance the at least two notches.

2. The method as recited in claim 1 wherein the at least two notches have a semi-circular shape.

3. The method as recited in claim 1 wherein the step of forming the at least two notches includes forming one of the at least two notches on the pressure side of the turbine blade and forming another of the at least two notches on the suction side of the turbine blade to determine creep.

4. The method as recited in claim 1 wherein the step of forming the at least two notches includes forming both of the at least two notches on at least one of the pressure side of the turbine blade and the suction side of the turbine blade to determine tilt.

5. The method as recited in claim 1 wherein the step of forming the at least two notches includes machining the at least two notches.

6. A turbine blade comprising:

a tip; and

at least two notches formed on the tip, wherein each of the at least two notches has a known radius, and the turbine blade has a pressure side and a suction side, each of the at least two notches have a different radius, one of the at least two notches is located on the pressure side of the turbine blade, and another of the at least two notches is located on the suction side of the turbine blade.

7. The turbine blade as recited in claim 6 wherein the at least two notches have a semi-circular shape.

8. The turbine blade as recited in claim 6 wherein both of the at least two notches are formed on at least one of the pressure side of the turbine blade and the suction side of the turbine blade.

9. A turbine blade comprising:

a tip; and

at least two notches formed on the tip, wherein each of the at least two notches has a known dimension, and the turbine blade has a pressure side and a suction side, the at least two notches comprise a first set of three notches located on the pressure side of the turbine blade and a second set of three notches located on the suction side of the turbine blade, and each of the first set of three notches on the pressure side have a different radius and each of the second set of three notches on the suction side have a different radius, wherein the tip and the at least two notches have an initial appearance before testing the turbine blade and an appearance after testing the turbine blade that is different from the initial appearance caused by removal of at least a portion of the tip and the at least two notches during testing.

10. The turbine blade as recited in claim 9 wherein the first set of three notches and the second set of three notches each comprise a first notch having a radius of 0.005 mils, a second notch having a radius of 0.010 mils, and a third notch having a radius of 0.015 mils, wherein the first notch is located closest to a leading edge of the turbine blade, the second notch is located between

the first notch and the third notch, and the third notch is located closest to a trailing edge of the turbine blade.

11. A turbine blade comprising:

a tip; and

at least two notches formed on the tip, wherein each of the at least two notches has a known dimension, and the turbine blade has a pressure side and a suction side, the at least two notches comprise a first set of four notches located on the pressure side of the turbine blade and a second set of four notches located on the suction side of the turbine blade.

12. The turbine blade as recited in claim 11 wherein the first set of four notches and the second set of four notches each comprise a first notch having a radius of 0.005 mils, a second notch having a radius of 0.015 mils, a third notch having a radius of 0.010 mils, and a fourth notch having a radius of 0.005 mils, wherein the first notch is located closest to a leading edge of the turbine blade, the second notch is located between the first notch and the third notch, the third notch is located between the second notch and the fourth notch, and the fourth notch is located closest to a trailing edge of the turbine blade.

13. A gas turbine engine comprising:

a turbine blade including a tip and at least two notches formed on the tip, wherein each of the at least two notches has a known radius, the turbine blade having a pressure side and a suction side, at least one of the at least two notches is located on one of the pressure side and the suction side, and each of the at least two notches have a different radius, wherein the tip and the at least two notches have an initial appearance before testing the turbine blade and an appearance after testing the turbine blade that is different from the initial appearance caused by removal of at least a portion of the tip and the at least two notches during testing; and

a casing including a hole adapted to receive a borescope to view the tip of the turbine blade.

14. A gas turbine engine as recited in claim 13 wherein the at least two notches have a semi-circular shape.

15. The gas turbine engine as recited in claim 13 wherein one of the at least two notches is located on the pressure side of the turbine blade, and another of the at least two notches is located on the suction side of the turbine blade.

16. The gas turbine engine as recited in claim 13 wherein both of the at least two notches are formed on at least one of the pressure side of the turbine blade and the suction side of the turbine blade.

17. The method as recited in claim 1 wherein one of the at least two notches is located on the pressure side and the other of the at least two notches is located on the suction side.

18. The gas turbine engine as recited in claim 13 wherein one of the at least two notches is located on the pressure side and the other of the at least two notches is located on the suction side.

19. The method as recited in claim 1 wherein the at least two notches and tip have an initial appearance before the step of rubbing the tip of the turbine blade against the casing, and a

difference between the initial appearance and the appearance is used to determine the manufacturing length of the turbine blade.

20. The turbine blade as recited in claim 6 wherein the tip engages a casing during testing.

21. The gas turbine engine as recited in claim 13 wherein the tip engages the casing during testing.