CLAIMS

What is claimed is:

1. A method of processing a non-magnetic alloy workpiece, comprising:

heating the workpiece to a warm working temperature;

open die press forging the workpiece to impart a desired strain to a central region of the workpiece; and

radial forging the workpiece to impart a desired strain to a surface region of the workpiece.

2. The method of claim 1, wherein after the steps of open die press forging and radial forging, the strain imparted to the central region and the strain imparted to the surface region are each in a range of from 0.3 inch/inch to 1.0 inch/inch;

wherein a difference in strain from the central region to the surface region is not more than 0.5 inch/inch.

3. The method of claim 1, wherein after the steps of open die press forging and radial forging, the strain imparted to the central region and the strain imparted to the surface region are each in a range of from 0.3 inch/inch to 0.8 inch/inch.

4. The method of claim 1, wherein after the steps of open die press forging and radial forging, the strain imparted to the surface region is substantially equivalent to the strain imparted to the central region.

5. The method of claim 1, wherein the open die press forging step precedes the radial forging step.

6. The method of claim 1, wherein the radial forging step precedes the open die press forging step.

7. The method of claim 1, wherein the warm working temperature is in a range spanning a temperature that is one-third of an incipient melting temperature of the non-magnetic alloy up to a temperature that is two-thirds of an incipient melting temperature of the non-magnetic alloy.

8. The method of claim 1, wherein the warm working temperature comprises any temperature up to the highest temperature at which recrystallization (dynamic or static) does not occur in the non-magnetic alloy.

9. The method of claim 1, wherein the non-magnetic alloy comprises one of a non-magnetic stainless steel alloy, a nickel alloy, a cobalt alloy, and an iron alloy.

10. The method of claim 1, wherein the non-magnetic alloy comprises a non-magnetic austenitic stainless steel alloy.

11. The method of claim 10, wherein the warm working temperature is from 950°F to 1150°F.

12. The method of claim 1, further comprising, prior to heating the workpiece to the warm working temperature, annealing the workpiece.

13. The method of claim 12, wherein the workpiece comprises a non-magnetic stainless steel alloy; and annealing the workpiece comprises heating the workpiece at 1850°F to 2300°F for 1 minute to 10 hours.

14. The method of claim 12, wherein the heating the workpiece to the warm working temperature further comprises allowing the workpiece to cool from an annealing temperature to the warm working temperature.

15. The method of claim 1, wherein the workpiece comprises a circular cross-section.

16. The method of claim 15, wherein the circular cross-section of the workpiece has a diameter greater than 5.25 inches.

17. The method of claim 15, wherein the circular cross-section of the workpiece has a diameter greater than or equal to 7.25 inches.

18. The method of claim 15, wherein the circular cross-section of the workpiece has a diameter in a range of 7.25 inches to 12.0 inches.

19. A method of processing a non-magnetic austenitic stainless steel alloy workpiece, the method comprising:

heating the workpiece to a warm working temperature in the range of 950°F to 1150°F;

open die press forging the workpiece to impart a final strain of between 0.3 inch/inch to 1.0 inch/inch in a central region of the workpiece; and

radial forging the workpiece to impart a final strain of between 0.3 inch/inch to 1.0 inch/inch in a surface region of the workpiece;

wherein a difference in strain from the central region to the surface region is not more than 0.5 inch/inch.

20. The method of claim 19, wherein:

open die press forging the workpiece imparts a final strain of between 0.3 inch/inch to 0.8 inch/inch in a central region of the workpiece; and

radial forging the workpiece imparts a final strain of between 0.3 inch/inch to 0.8 inch/inch in a surface region of the workpiece.

21. The method of claim 19, wherein the open die press forging step precedes the radial forging step.

22. The method of claim 19, wherein the radial forging step precedes the open die press forging step.

23. The method of claim 19, further comprising, prior to heating the workpiece to the warm working temperature, annealing the workpiece.

24. The method of claim 23, wherein annealing the workpiece comprises heating the workpiece at 1850°F to 2300°F for 1 minute to 10 hours.

25. The method of claim 23, wherein the heating the workpiece to the warm working temperature further comprises allowing the workpiece to cool from the annealing temperature to the warm working temperature.

26. The method of claim 19, wherein the workpiece comprises a circular cross-section.

27. The method of claim 26, wherein the circular cross-section of the workpiece has a diameter of greater than 5.25 inches.

28. The method of claim 26, wherein the circular cross-section of the workpiece has a diameter of greater than or equal to 7.25 inches.

29. The method of claim 26, wherein the circular cross-section of the workpiece has a diameter in a range of 7.25 inches to 12.0 inches.

30. A non-magnetic alloy forging comprising:

a circular cross-section with a diameter greater than 5.25 inches; and

at least one mechanical property that is substantially uniform through a cross-section of the forging;

31. The non-magnetic alloy forging of claim 30, wherein the non-magnetic alloy forging comprises one of a non-magnetic stainless steel alloy, a nickel alloy, a cobalt alloy, and an iron alloy.

32. The non-magnetic alloy forging of claim 30, wherein the non-magnetic alloy forging comprises a non-magnetic austenitic stainless steel alloy.

33. The non-magnetic alloy forging of claim 30, wherein the substantially uniform mechanical property is one of ultimate tensile strength, yield strength, percent elongation, and percent reduction in area.

34. The non-magnetic alloy forging of claim 30, wherein a diameter of the circular cross-section is greater than or equal to 7.25 inches.

35. The non-magnetic alloy forging of claim 34, wherein the diameter of the circular cross-section is in a range from 7.25 inches to 12 inches.

CLAIMS

1. A method of processing a non-magnetic alloy workpiece, comprising:

heating the workpiece to a warm working temperature;

open the press forging the workpiece to impart a desired strain to a central region of the workpiece; and

radial forging the workpiece to impart a desired strain to a surface region of the workpiece;

wherein after the open die press forging and the radial forging, the strain imparted to the central region and the strain imparted to the surface region are each in a range of from 0.3 inch/inch to 1.0 inch/inch;

wherein a difference in strain from the central region to the surface region is not more than 0.5 inch/inch.

2. The method of claim 1, wherein after the open die press forging and the radial forging, the strain imparted to the central region and the strain imparted to the surface region are each in a range of from 0.3 inch/inch to 0.8 inch/inch.

3. The method of claim 1, wherein after the open the press forging and the radial forging, the strain imparted to the surface region is substantially equivalent to the strain imparted to the central region.

4. The method of claim 1, wherein the open the press forging precedes the radial forging.

5. The method of claim 1, wherein the radial forging precedes the open the press forging.

6. The method of claim 1, wherein the warm working temperature is in a range spanning a temperature that is one-third of an incipient melting temperature of the non-magnetic ahoy up to a temperature that is two-thirds of an incipient melting temperature of the non-magnetic ahoy.

7. The method of claim 1, wherein the warm working temperature comprises any temperature up to the highest temperature at which recrystallization (dynamic or static) does not occur in the non-magnetic ahoy.

8. The method of claim 1, wherein the non-magnetic ahoy comprises one of a non-magnetic stainless steel alloy, a nickel ahoy, a cobalt alloy, and an iron alloy.

9. The method of claim 1, wherein the non-magnetic alloy comprises a non-magnetic austenitic stainless steel alloy.

10. The method of claim 9, wherein the warm working temperature is from 950° F. to 1150° F.

11. The method of claim 1, further comprising, prior to heating the workpiece to the warm working temperature, annealing the workpiece.

12. The method of claim 11, wherein the workpiece comprises a non-magnetic stainless steel alloy; and annealing the workpiece comprises heating the workpiece at 1850° F. to 2300° F. for 1 minute to 10 hours.

13. The method of claim 11, wherein the heating the workpiece to the warm working temperature further comprises allowing the workpiece to cool from an annealing temperature to the warm working temperature.

14. The method of claim 1, wherein the workpiece comprises a circular cross-section.

15. The method of claim 14, wherein the circular cross-section of the workpiece has a diameter greater than 5.25 inches.

16. The method of claim 14, wherein the circular cross-section of the workpiece has a diameter greater than or equal to 7.25 inches.

17. The method of claim 14, wherein the circular cross-section of the workpiece has a diameter in a range of 7.25 inches to 12.0 inches.

18. A method of processing a non-magnetic austenitic stainless steel alloy workpiece, the method comprising:

heating the workpiece to a warm working temperature in the range of 950° F. to 1150° F.;

open die press forging the workpiece to impart a final strain of between 0.3 inch/inch to 1.0 inch/inch in a central region of the workpiece; and

radial forging the workpiece to impart a final strain of between 0.3 inch/inch to 1.0 inch/inch in a surface region of the workpiece;

wherein a difference in strain from the central region to the surface region is not more than 0.5 inch/inch.

19. The method of claim 18, wherein:

open the press forging the workpiece imparts a final strain of between 0.3 inch/inch to 0.8 inch/inch in a central region of the workpiece; and

radial forging the workpiece imparts a final strain of between 0.3 inch/inch to 0.8 inch/inch in a surface region of the workpiece.

20. The method of claim 18, wherein the open die press forging precedes the radial forging.

21. The method of claim 18, wherein the radial forging precedes the open die press forging.

22. The method of claim 18, further comprising, prior to heating the workpiece to the warm working temperature, annealing the workpiece.

23. The method of claim 22, wherein annealing the workpiece comprises heating the workpiece at 1850° F. to 2300° F. for 1 minute to 10 hours.

24. The method of claim 22, wherein the heating the workpiece to the warm working temperature further comprises allowing the workpiece to cool from the annealing temperature to the warm working temperature.

25. The method of claim 18, wherein the workpiece comprises a circular cross-section.

26. The method of claim 25, wherein the circular cross-section of the workpiece has a diameter of greater than 5.25 inches.

27. The method of claim 25, wherein the circular cross-section of the workpiece has a diameter of greater than or equal to 7.25 inches.

28. The method of claim 25, wherein the circular cross-section of the workpiece has a diameter in a range of 7.25 inches to 12.0 inches.