CLAIMS:

1. A bit body, roller cone, insert roller cone, or cone, comprising:

a body material, comprising:

hard particles comprising at least one of a carbide, a nitride, a boride, a silicide, an oxide, and solid solutions thereof; and

a binder, wherein the binder comprises at least one metal selected from cobalt, nickel, iron and albys thereof.

2. The bit body, roller cone, insert roller cone, or cone of claim 1, wherein the binder further comprises at least one melting point reducing constituent selected from at least one of a transition metal carbide, boride, or silicide up to 60 weight percent, a transition metal up to 50 weight percent, boron up to 10 weight percent, silicon up to 20 weight percent, chromium up to 20 weight percent, and manganese up to 25 weight percent, wherein the weight percentages are based on the total weight of the binder.

3. The bit body, roller cone, insert roller cone, or cone of claim 2, wherein the melting point reducing constituent is at least one of tungsten carbide present from 30 to 60 weight percent, tungsten present from 30 to 55 weight percent, carbon present from 1.5 to 4 weight percent, boron present from 1 to 10 weight percent, silicon present from 2 to 20 weight percent, chromium present from 2 to 20 weight percent, and manganese present from 10 to 25 weight percent.

4. The bit body, roller cone, insert roller cone, or cone of claim 1, wherein the hard particles are at least one of individual single crystals, as polycrystalline particles, as solid solutions, as polycrystalline particles comprising two or more phases, and sintered granules comprising a binder, sintered granules without a binder.

5. The bit body, roller cone, insert roller cone, or cone of claim 1, wherein the hard particles comprise at least one transition metal carbide selected from titanium carbide, chromium carbide, vanadium carbide, zirconium carbide, hafnium carbide, tantalum carbide, molybdenum carbide, niobium carbide, and tungsten carbide.

6. The bit body, roller cone, insert roller cone, or cone of claim 2, wherein the melting point reducing constituent is at least one of tungsten carbide, boride, and silicide in the range of 30 to 60 weight percent based on the total weight of the binder.

7. The bit body, roller cone, insert roller cone, or cone of claim 2, wherein the binder comprises 40 to 50 weight percent of tungsten carbide and 40 to 60 weight

percent of at least one or iron, cobalt, and nickel, all based on the total weight of the binder.

8. The bit body, roller cone, insert roller cone, or cone of claim 7, wherein the binder comprises 40 to 50 weight percent of tungsten carbide and 40 to 60 weight percent of cobalt, all based on the total weight of the binder.

9. The bit body, roller cone, insert roller cone, or cone of claim 8, wherein the binder further comprises up to 10 weight percent of at least one of boron and silicon based on the total weight of the binder.

10. The bit body, roller cone, insert roller cone, or cone of claim 2, wherein the melting point reducing constituent is silicon in the range of 2 to 20 weight percent based on the total weight of the binder.

11. The bit body, roller cone, insert roller cone, or cone of claim 7, wherein the binder comprises 40 to 50 weight percent of tungsten carbide and 40 to 60 weight percent of nickel, all based on the total weight of the binder.

12. The bit body, roller cone, insert roller cone, or cone of claim 11, wherein the binder further comprises up to 10 weight percent of boron based on the total weight of the binder.

13. The bit body, roller cone, insert roller cone, or cone of claim 2, wherein the binder comprises at least 80 weight percent of at least of one of nickel, iron, and cobalt based on the total weight of the binder.

14. The bit body, roller cone, insert roller cone, or cone of claim 13, wherein the binder further comprises up to 20 weight percent of silicon based on the total weight of the binder.

15. The bit body, roller cone, insert roller cone, or cone of claim 13, wherein the binder further comprises up to 10 weight percent of boron based on the total weight of the binder.

16. The bit body, roller cone, insert roller cone, or cone of claim 2, wherein the binder comprises from 90 to 99 weight percent of nickel and 1 to 10 weight percent of boron, all based on the total weight of the binder.

17. The bit body, roller cone, insert roller cone, or cone of claim 2, wherein the binder comprises from 90 to 99 weight percent of cobalt and 1 to 10 weight percent of boron, all based on the total weight of the binder.

18. The bit body, roller cone, insert roller cone, or cone of claim 2, wherein the binder comprises up to 60 weight percent of the melting point reducing constituent based on the total weight of the binder.

19. The bit body, roller cone, insert roller cone, or cone of claim 18, wherein the melting point reducing constituent is at least one of a tungsten carbide, chromium, boron, carbon, and silicon.

20. The bit body, roller cone, insert roller cone, or cone of claim 18, wherein the melting point reducing constituent is one of tungsten carbide, boron, and silicon.

21. A bit body, roller cone, insert roller cone, or cone for an earth-boring bit, comprising:

hard particles comprising at least one of a carbide, a nitride, a boride, a silicide; an oxide, and solid solutions thereof; and

a binder, wherein the binder has a melting point in the range of 1050°C to 1350°C.

22. The bit body, roller cone, insert roller cone, or cone of claim 21, wherein the hard particles are present as individual single crystals, as polycrystalline particles, as solid solutions, as polycrystalline particles comprising two or more phases, or sintered granules (with or without the aid of a binding agent.

23. The bit body, roller cone, insert roller cone, or cone of claim 21, wherein the carbide is at least one transition metal carbide selected from titanium carbide, chromium carbide, vanadium carbide, zirconium carbide, hafnium carbide, tantalum carbide, molybdenum carbide, niobium carbide, and tungsten carbide.

24. The bit body, roller cone, insert roller cone, or cone of claim 23, wherein the transition metal carbide of the hard particles is tungsten carbide.

25. The bit body, roller cone, insert roller cone, or cone of claim 21, wherein the binder is an alloy comprising at least one of iron, cobalt and nickel.

26. The bit body, roller cone, insert roller cone, or cone of claim 24, wherein the binder further comprises at least one transition metal carbide selected from titanium carbide, tantalum carbide, niobium carbide, chromium carbide, molybdenum carbide, boron carbide, carbon carbide, silicon carbide, and ruthenium carbide.

27. The bit body, roller cone, insert roller cone, or cone of claim 21, wherein the binder comprises at least one of silicon, a transition metal carbide, and boron.

28. The bit body, roller cone, insert roller cone, or cone of claim 21, wherein the concentration of transition metal carbide in the composition is in the range of 30% to 99% by volume.

29. The bit body, roller cone, insert roller cone, or cone of claim 21, wherein the concentration of transition metal carbide in the composition is in the range of 45% to 85% by volume.

30. The bit body, roller cone, insert roller cone, or cone of claim 20, further comprising:

at least one cemented carbide insert.

31. The bit body, roller cone, insert roller cone, or cone of claim 30, wherein the cemented carbide insert includes at least one cutter pocket.

32. The bit body, roller cone, insert roller cone, or cone of claim 21, wherein the hard particles comprise at least one of macrocrystalline tungsten carbide, eutectic tungsten carbide, sintered transition metal carbide, crushed sintered metal carbide.

33. The bit body, roller cone, insert roller cone, or cone of claim 32, wherein the hard particles are one or more of irregularly shaped, prolate, oblate, and spherical.

34. A bit body, roller cone, insert roller cone, or cone, comprising:

hard particles of a transition metal carbide; and

a binder comprising at least one of nickel, iron, and cobalt and having a melting point less than 1350°C.

35. The bit body, roller cone, insert roller cone, or cone of claim 34, wherein the transition metal carbide is at least one transition metal selected from titanium carbide, chromium carbide, vanadium carbide, zirconium carbide, hafnium carbide, tantalum carbide, molybdenum carbide, niobium carbide, and tungsten carbide.

36. The bit body, roller cone, insert roller cone, or cone of claim 35, wherein the transition metal carbide is tungsten carbide.

37. The bit body, roller cone, insert roller cone, or cone of claim 34, wherein the binder is an alloy comprising at least one of iron, cobalt, and nickel.

38. The bit body, roller cone, insert roller cone, or cone of claim 37, wherein the binder further comprises at least one of a transition metal carbide, tungsten, carbon, boron, silicon, chromium, manganese, silver, aluminum, copper, tin, and zinc in a concentration that reduces the melting point of the at least one of nickel, iron, and cobalt.

39. The bit body, roller cone, insert roller cone, or cone of claim 38, wherein the binder comprises at least one of tungsten carbide, boron, silicon, chromium, and manganese.

40. The bit body, roller cone, insert roller cone, or cone of claim 1, wherein the binder comprises greater than 20 volume percent of the composition.

41. The bit body, roller cone, insert roller cone or cone, of claim 40, wherein the binder comprises between 20 volume percent and 60 volume percent of the composition.

42. The bit body, roller cone, insert roller cone, or cone of claim 40, wherein the binder comprises between 20 volume percent and 50 volume percent of the composition.

43. The bit body, roller cone, insert roller cone, or cone of claim 40, wherein the binder comprises between 25 volume percent and 40 volume percent of the composition.

44. The bit body, roller cone, insert roller cone, or cone of claim 1, wherein the binder comprises at least one of a transition metal carbide, a transition element, carbon, boron, silicon, chromium, manganese, silver, aluminum, copper, tin, rhenium, ruthenium, and zinc.

45. The bit body, roller cone, insert roller cone, or cone of claim 1, wherein the binder comprises at least one of cobalt and nickel.

46. The bit body, roller cone, insert roller cone of claim 1, wherein the hard particles comprise crystals comprising tungsten carbides and the binder comprises cobalt.

47. A bit body comprising

a body material, comprising hard particles, wherein the hard particles comprise at least one of a carbide, a nitride, a boride, a silicide, an oxide, and solid solutions thereof.

a binder, wherein the binder comprises at least one of cobalt, nickel, iron, and alloys thereof; and

an alloy steel shank.

48. A bit body, roller cone, insert roller cone, or cone, comprising:

a body material having transverse rupture strength greater than 300 ksi.

49. The bit body, roller cone, insert roller cone, or cone of claim 48, comprising:
hard particles comprising at least one of a carbide, a nitride, a boride, a silicide, an oxide, and solid solutions thereof; and

a binder, wherein the binder comprises at least one metal selected from cobalt, nickel, iron and alloys thereof.

50. A bit body, roller cone, insert roller cone, or cone, comprising:
a body material having a transverse rupture strength greater than 280 ksi and a Young's modulus greater than 55 $(10)^6$ psi.

51. The bit body, roller cone, insert roller cone, or cone of claim 50, comprising:

hard particles comprising at least one of a carbide, a nitride, a boride, a silicide, an oxide, and solid solutions thereof; and

a binder, wherein the binder comprises at least one metal selected from cobalt, nickel, iron and alloys thereof

52. The bit body, roller cone, insert roller cone, or cone of claim 51, comprising:

a body material having a Young's Modulus greater than 60 $x10^6$ psi.

53. The bit body, roller cone, insert roller cone, or cone of claim 52, comprising:

hard particles comprising at least one of a carbide, a nitride, a boride, a silicide, an oxide, and solid solutions thereof; and

a binder, wherein the binder comprises at least one metal selected from cobalt, nickel, iron and alloys thereof

54. A bit body, roller cone, insert roller cone, or cone, comprising:

a body material having a fatigue resistance greater than 85 ksi @ 10 x 10^6 cycles.

55. The bit body, roller cone, insert roller cone, or cone of claim 54, comprising:

hard particles comprising at least one of a carbide, a nitride, a boride, a silicide, an oxide, and solid solutions thereof; and

a binder, wherein the binder comprises at least one metal selected from cobalt, nickel, iron and alloys thereof

56. A bit body, roller cone, insert roller cone, or cone comprising:

a body material having a fatigue resistance greater than 50 ksi and a Modulus greater than 55 $(10)^6$ psi.

57. The bit body, roller cone, insert roller cone, or cone of claim 56, comprising:

hard particles comprising at least one of a carbide, a nitride, a boride, a silicide, an oxide, and solid solutions thereof; and

a binder, wherein the binder comprises at least one metal selected from cobalt, nickel, iron and alloys thereof

58. The bit body, roller cone, insert roller cone or cone of claim 1, comprising at least two regions with different compositions.

59. The bit body, roller cone, insert roller cone or cone of claim 58, wherein one region has higher toughness than at least one other region.

60. The bit body, roller cone, insert roller cone or cone of claim 59, wherein the region having increased toughness is at least one of internal region of a blade, an internal region of a roller cone, a portion of the shank, and a region surrounding a shank.

61. The bit body, roller cone, insert roller cone or cone of claim 58, wherein one region has a higher wear resistance than at least one other region.

62. The bit body, roller cone, insert roller cone or cone of claim 1, wherein the hard particles comprise greater than 50 volume % of the bit body, roller cone, insert roller cone, or cone.

63. The bit body, roller cone, insert roller cone or cone of claim 62, wherein the hard particle comprise between 60 and 80 volume % of the bit body, roller cone, insert roller cone, or cone.

64. The bit body, roller cone, insert roller cone or cone of claim 1, wherein the binder comprises between 20 and 35 volume % of the bit body, roller cone, insert roller cone, or cone.

Claims:

1. A method of forming an article, comprising:
melting a binder to form a molten liquid binder; and
introducing the molten liquid binder into a mass of hard particles from outside the mass of hard particles and infiltrating the mass of hard particles with the molten liquid binder, wherein the mass of hard particles comprises at least one transition metal carbide, and further wherein the molten liquid binder comprises at least one melting point reducing constituent dissolved therein to reduce the melting point of the molten liquid binder, the at least one melting point reducing constituent selected from at least one of a transition metal carbide up to 60 weight percent, a transition metal boride up to 60 weight percent, and a transition metal silicide up to 60 weight percent, wherein the weight percentages are based on the total weight of the binder.

2. The method of claim 1, wherein the binder comprises a melting point from 1050° C. to 1350° C.

3. The method of claim 1, wherein the binder comprises at least one of iron, nickel, and cobalt from at least 10 weight percent based on the total weight of the binder.

4. The method of claim 3, wherein the binder comprises at least one of iron, nickel, and cobalt from 40 to 99 weight percent based on the total weight of the binder.

5. The method of claim 1, wherein the binder further comprises at least one of tungsten, carbon, boron, silicon, chromium, manganese, silver, aluminum, copper, tin, and zinc.

6. The method of claim 1, wherein the binder comprises at least one of tungsten carbide, boron, silicon, chromium, and manganese.

7. The method of claim 1, wherein the transition metal carbide of the hard particles comprises at least one carbide selected from titanium carbide, chromium carbide, vanadium carbide, zirconium carbide, hafnium carbide, tantalum carbide, molybdenum carbide, niobium carbide, and tungsten carbide.

8. The method of claim 1, wherein the binder comprises a near-eutectic composition.

9. The method of claim 8, wherein the binder comprises a concentration of at least one of iron, nickel, and cobalt within 10 weight percent of the eutectic concentration.

10. The method of claim 1, wherein the article is selected from the group consisting of a bit body, a roller cone, and a conical holder.

11. A method of producing a body of an earth-boring tool, comprising:

heating elemental constituents and forming a molten mixture from the heated elemental constituents having a chemical composition comprising a near-eutectic composition of a transition metal carbide and at least one of nickel, iron, and cobalt; and

casting the body of the earth-boring tool from the molten mixture, casting the body of the earth-boring tool comprising precipitation of a phase comprising the transition metal carbide from the molten mixture.

12. The method of claim 11, wherein a total concentration of each of the transition metal, carbon, and the at least one of nickel, iron, and cobalt are respectively within ten atomic percent of a eutectic composition of the transition metal carbide and at least one of nickel, iron, and cobalt.

13. The method of claim 11, wherein the transition metal of the transition metal carbide comprises at least one of tungsten, chromium, titanium, vanadium, zirconium, hafnium, tantalum, molybdenum, and niobium.

14. The method of claim 13, wherein the mixture further comprises at least one of boron, silicon, and manganese.

15. The method of claim 11, wherein heating the elemental constituents further comprises heating the elemental constituents to a temperature of about 1350° C. or less to form the molten composition.

16. The method of claim 15, wherein a total concentration of each of the transition metal, carbon, and the at least one of nickel, iron, and cobalt are respectively within ten atomic percent of a eutectic composition of the transition metal carbide and at least one of nickel, iron, and cobalt.

17. The method of claim 11, wherein casting the body of the earth-boring tool from the molten mixture comprises casting a bit body of a fixed-cutter earth-boring rotary drill bit.