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(54) Title: NICKEL ALLOYS FOR HYDROGEN STORAGE AND THE GENERATION OF ENERGY THEREFROM

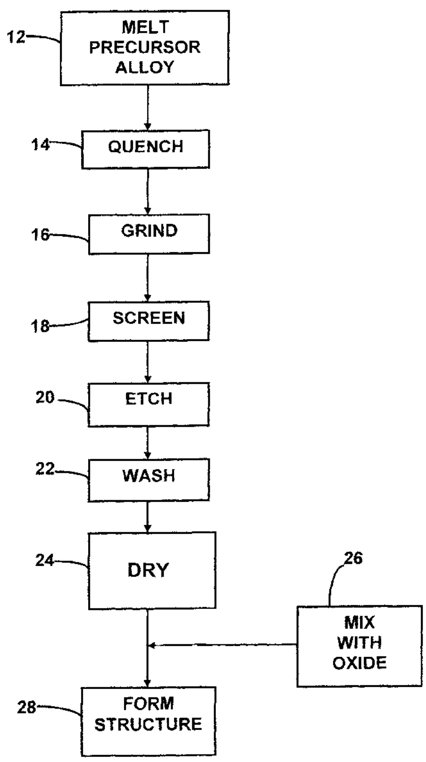

FIG.1

(57) Abstract: An apparatus for the generation of thermal energy comprises a reactor vessel containing a volume of pressurized hydrogen; a hydrogen-storing nickel alloy structure in the reactor vessel and configured to have an electric potential applied across it and to be heated to at least about 100 C; and a heat exchange conduit configured to carry a heat exchange medium past the nickel alloy structure so as to allow thermal energy generated in the nickel alloy structure to be transferred to the heat exchange medium. The hydrogen-storing nickel alloy structure comprises a nickel alloy skeletal catalyst mixed with an oxide. The applied electric potential, and the increase in the gas pressure and temperature of the hydrogen from the applied heat, create a reaction between hydrogen nuclei and nickel nuclei in the nickel alloy structure whereby thermal energy is generated by the emission of phonons from the nickel alloy structure.

WO 2012/166808 A4

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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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AMENDED CLAIMS
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1. (Original) A method of making a hydrogen-storing nickel alloy structure, the method comprising:

(a) providing a nickel alloy skeletal catalyst powder;

(b) mixing the nickel alloy skeletal catalyst powder with a powdered oxide to form a nickel alloy/oxide powder; and

(c) forming the nickel alloy/oxide powder into a hydrogen storing nickel alloy structure.

2. (Original) The method of claim 1, wherein the nickel alloy skeletal catalyst powder is formed from a precursor alloy that comprises approximately 35%-50% by weight nickel, the remainder being one or more metals selected from the group consisting of aluminum, lithium, zinc, molybdenum, manganese, titanium, iron, chromium, and cobalt, and one or more materials selected from the group consisting of boron, carbon and silicon.

3. (Original) The method of claim 1, wherein the powdered oxide comprises magnetite.

4. (Original) The method of claim 1, wherein the nickel alloy skeletal catalyst powder comprises at least about 80% by weight nickel.

5. (Original) The method of claim 4, wherein the nickel alloy skeletal catalyst powder further comprises not more than about 15% by weight of one or more metals selected from the group consisting of aluminum, lithium, zinc, molybdenum, manganese, titanium, iron, chromium, and cobalt, and not more than about 10% by weight of one or more materials selected from the group consisting of boron, carbon and silicon.

6. (Original) The method of claim 2, wherein the precursor alloy comprises, by weight, approximately 40% aluminum, 10% silicon, 3%-4% molybdenum, and the balance nickel.

7. (Original) The method of claim 6, wherein the precursor alloy further includes, by weight, a maximum of 0.03% carbon.

8. (Original) The method of claim 6, wherein the nickel alloy skeletal catalyst powder includes particles comprising about 5%-15% elemental aluminum by weight, with aluminum oxide on the surface of the particles.

9. (Original) The method of claim 2, wherein the precursor alloy comprises, by weight, approximately 40% aluminum, 10% silicon, 10% cobalt, 3%-4% molybdenum, and the balance nickel.

10. (Original) The method of claim 9, wherein the nickel alloy skeletal catalyst powder includes particles comprising about 5%-15% elemental aluminum by weight, with aluminum oxide on the surface of the particles.

11. (Currently Amended) Apparatus for the generation of thermal energy, comprising:

a gas-tight reactor vessel having a gas inlet configured to receive pressurized hydrogen gas from a pressurized hydrogen gas source;

a hydrogen-storing nickel alloy structure contained within the reactor vessel, wherein the hydrogen-storing nickel alloy structure comprises a mixture of a nickel alloy skeletal catalyst powder and a powdered oxide;

a voltage source electrically connected to the hydrogen-storing nickel alloy structure so as to apply a voltage across it; and

a heating device operatively associated with the reactor vessel so as to apply heat to the vessel.

12. (Canceled)

13. (Currently Amended) The apparatus of claim [[12]] 11, wherein the nickel alloy skeletal catalyst powder is formed from a precursor alloy that comprises approximately 35%-50% by weight nickel, the remainder being one or more metals selected from the group consisting of aluminum, lithium, zinc, molybdenum, manganese, titanium, iron, chromium, and cobalt, and one or more materials selected from the group consisting of boron, carbon and silicon.

14. (Currently Amended) The apparatus of claim [[12]] 11, wherein the powdered oxide comprises magnetite.

15. (Currently Amended) The apparatus of claim [[12]] 11, wherein the nickel alloy skeletal catalyst powder comprises at least about 80% by weight nickel.

AMENDED SHEET (ARTICLE 19)

16. (Original) The apparatus of claim 15, wherein the nickel alloy skeletal catalyst powder further comprises not more than about 15% by weight of one or more metals selected from the group consisting of aluminum, lithium, zinc, molybdenum, manganese, titanium, iron, chromium, and cobalt, and not more than about 10% by weight of one or more materials selected from the group consisting of boron, carbon and silicon.

17. (Original) The apparatus of claim 16, wherein the nickel alloy skeletal catalyst powder includes particles comprising about 5%-15% elemental aluminum by weight, with aluminum oxide on the surface of the particles.

18. (Canceled)

19. (Currently Amended) A method of generating thermal energy, comprising:

(a) providing a reactor vessel containing a hydrogen-storing nickel alloy structure comprising a mixture of a nickel alloy skeletal catalyst powder and a powdered oxide;

(b) filling the reactor vessel with hydrogen; [[and]]

(c) increasing the pressure of the hydrogen in the reactor vessel by heating the reactor vessel to a temperature of at least 100° C; and

[[(c)]] (d) while heating the reactor vessel, applying an electric potential across the hydrogen-storing nickel alloy structure ~~while heating the reactor vessel to a temperature of at least 100° C~~ that is sufficient, at the increased pressure of the hydrogen in the reactor vessel, to result in the absorption of hydrogen by the hydrogen-storing nickel alloy structure in a manner that creates a nuclear reaction between hydrogen nuclei and nickel nuclei in the hydrogen-storing nickel alloy structure, wherein the thermal energy is generated by the nuclear reaction in the form of phonons emitted from the hydrogen-storing nickel alloy structure.

20. (Canceled)

21. (Canceled)

22. (Currently Amended) The method of claim [[21]] 19, wherein the nickel alloy skeletal catalyst powder is formed from a precursor alloy that comprises approximately 35%-50% by

weight nickel, the remainder being one or more metals selected from the group consisting of aluminum, lithium, zinc, molybdenum, manganese, titanium, iron, chromium, and cobalt, and one or more materials selected from the group consisting of boron, carbon and silicon.

23. (Currently Amended) The method of claim [[21]] 19, wherein the powdered oxide comprises magnetite.

24. (Currently Amended) The method of claim [[21]] 19, wherein the nickel alloy skeletal catalyst powder comprises at least about 80% by weight nickel.

25. (Original) The method of claim 24, wherein the nickel alloy skeletal catalyst powder further comprises not more than about 15% by weight of one or more metals selected from the group consisting of aluminum, lithium, zinc, molybdenum, manganese, titanium, iron, chromium, and cobalt, and not more than about 10% by weight of one or more materials selected from the group consisting of boron, carbon and silicon.

26. (Original) The method of claim 25, wherein the nickel alloy skeletal catalyst powder includes particles comprising about 5%-15% elemental aluminum by weight, with aluminum oxide on the surface of the particles.

27. (Original) The method of claim 19, wherein the temperature is approximately 400° C.

28. (Original) The method of claim 19, wherein the electric potential is applied by a DC voltage source.

29. (Original) The method of claim 28, wherein the electric potential is approximately 1V.

30. (Original) The method of claim 19, wherein the pressure of the hydrogen in the reactor vessel is increased to about 100 bar in response to the application of heat.

31. (Original) The method of claim 30, wherein the temperature is approximately 400° C, and wherein the applied electric potential is approximately 1V DC.

32. (Original) A hydrogen-storing nickel alloy structure, comprising:

a nickel alloy skeletal catalyst; and

an oxide.

33. (Original) The hydrogen-storing nickel alloy structure of claim 32, wherein the nickel alloy skeletal catalyst is formed from a precursor alloy that comprises approximately 35%-50% by weight nickel, the remainder being one or more metals selected from the group consisting of aluminum, lithium, zinc, molybdenum, manganese, titanium, iron, chromium, and cobalt, and one or more materials selected from the group consisting of boron, carbon and silicon.

34. (Original) The hydrogen-storing nickel alloy structure of claim 32, wherein the nickel alloy skeletal catalyst comprises at least about 80% nickel by weight.

35. (Original) The hydrogen-storing nickel alloy structure of claim 34, wherein nickel alloy skeletal catalyst further comprises not more than about 15% by weight of one or metals selected from the group consisting of aluminum, lithium, zinc, molybdenum, manganese, titanium, iron, chromium, and cobalt, and not more than about 10% by weight of one or more materials selected from the group consisting of boron, carbon and silicon.

36. (Original) The hydrogen-storing nickel alloy structure of claim 33, wherein the precursor alloy comprises, by weight, approximately 40% aluminum, 10% silicon, 3%-4% molybdenum, and the balance nickel.

37. (Original) The hydrogen-storing nickel alloy structure of claim 36, wherein the precursor alloy further includes, by weight, a maximum of 0.03% carbon.

38. (Original) The hydrogen-storing nickel alloy structure of claim 36, wherein the nickel alloy skeletal catalyst includes about 5%-15% elemental aluminum by weight, with aluminum oxide on the surface of the particles.

39. (Original) The hydrogen-storing nickel alloy structure of claim 33, wherein the precursor alloy comprises, by weight, approximately 40% aluminum, 10% silicon, 10% cobalt, 3%-4% molybdenum, and the balance nickel.

40. (Original) The hydrogen-storing nickel alloy structure of claim 39, wherein the nickel alloy skeletal catalyst is a powder including particles comprising about 5%-15% elemental aluminum by weight, with aluminum oxide on the surface of the particles.

41. (Original) The hydrogen-storing nickel alloy structure of claim 32, wherein the oxide is an oxide of an element selected from a group consisting of one or more of strontium, barium, and calcium.

42. (Original) The hydrogen-storing nickel alloy structure of claim 32, wherein the oxide is an oxide of an element selected from a group consisting one or more of indium, silicon, and aluminum.

43. (Original) The hydrogen-storing nickel alloy structure of claim 32, wherein the oxide is an oxide of an element selected from a group consisting of one or more of sodium, potassium, rubidium, cesium, and beryllium.

44. (Original) The hydrogen-storing nickel alloy structure of claim 32, wherein the oxide is an oxide of an element selected from a group consisting of one or more of the elements with atomic numbers 21-30, 39-48, and 57-80, and elements in Groups III-A, IV-A, V-A, and VI-A of the Periodic Table.

45. (Original) The hydrogen-storing nickel alloy structure of claim 32, wherein the oxide is selected from a group consisting of one or more of $CaCrO_3$, $BaTiO_3$, $SrVO_3$, and ZrO_2 mixed with up to 10% Y_2O_3 by weight.

46. (Original) The hydrogen storing nickel alloy structure of claim 32, wherein the oxide is selected from a group consisting of one or more of an oxide of zinc, an oxide of tin, an oxide of titanium, an oxide of copper, an oxide of chromium, and Fe_3O_4.