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Inventors	William R. Good,

	Jonathan Phillips, Arthur I. Popov
Applicant	Black Light Power, Inc., William R. Good, Hydrocatalysis Power Corporation, Randell L. Mills, Jonathan Phillips, Arthur I. Popov, Less «5 More »
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Lower-energy hydrogen methods and structures

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ABSTRACT

Methods and apparatus for releasing energy from hydrogen atoms (molecules) by stimulating their electrons to relax to quantized lower energy levels and smaller radii (smaller semimajor and semiminor axes) than the "ground state"
by providing energy sinks or means to remove energy resonant with the hydrogen energy released to stimulate these transitions. An energy sink, energy hole, can be provided by the transfer of at least one electron between participating species including atoms, ions, molecules, and ionic and molecular compounds.
In one embodiment, the energy hole comprises the transfer of t electrons from one or more donating species to one or more accepting species whereby the sum of the ionization energies and/or electron affinities of the electron donating species minus the sum of the ionization energies and/or electron affinities of the electron accepting species equals approximately mX27.21 eV (mX48.6 eV) for atomic (molecular) hydrogen below "ground state" transitions where m and t are integers. The present invention further comprises a hydrogen spillover catalyst, a multifunctionality material having a functionality which dissociates molecular hydrogen to provide free hydrogen atoms which spill over to a functionality which supports mobile free hydrogen atoms and a functionality which can be a source of the energy holes. The energy reactor includes one of an electrolytic cell, a pressurized hydrogen gas cell, and a hydrogen gas discharge cell. A preferred pressurized hydrogen gas energy reactor comprises a vessel; a source of hydrogen; a means to control the pressure and flow of hydrogen into the vessel; a material to dissociate the molecular hydrogen into atomic hydrogen, and a material

which can be a source of energy holes in the gas phase. The gaseous source of energy holes includes those that sublime, boil, and/or are volatile at the elevated operating temperature of the gas energy reactor wherein the exothermic reaction of electronic transitions of hydrogen to lower energy states occurs in the gas phase.

CLAIMS

Claims 1. A cell for extracting energy from hydrogen atoms comprising:
a reaction vessel containing gaseous hydrogen atoms and a gaseous catalyst having a net enthalpy of reaction of about 27 * (p/2) eV, where p is an integer greater than 1.
2. A cell according to claim 1, wherein said gaseous catalyst comprises hydrogen atoms having a binding energy of about E b=13.6/n2eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.
3. A cell according to claim 1, Wherein said cell is constructed and arranged to be capable of maintaining the reaction, Image not available. View PDF where m and p are positive non-zero integers, m' is an integer greater than 1 and a H the radius of the hydrogen atom (n=1).
4. A cell according to claim 1, further comprising a source of hydrogen atoms including molecules containing hydrogen atoms, and a second catalyst for disassociating said molecules to produce hydrogen atoms.
5. A cell according to claim 4, wherein said second catalyst comprises at least one element selected from the group consisting of transition elements, inner transition elements, precious metals, refractory metals, lanthanides, actinides, and activated charcoal.
6. A cell according to claim 4, wherein said second catalyst is at least one element selected from the group consisting of the refractory metals, activated charcoal, platinum, palladium, gold, rhenium and iridium.
7. A cell according to claim 4, further comprising a valve for controlling the flow of said molecules over said second catalyst.
8. A cell according to claim 1, wherein said gaseous catalyst is formed from a source of gaseous catalyst which is adapted to sublime, boil, or volatize when heated.
9. A cell according to claim 1, wherein said gaseous catalyst is formed from a salt.
10. A cell according to claim 9, wherein said salt is selected from the group consisting of halides, sulfates, phosphates, carbonates hydroxides and sulfides.
11. A cell according to claim 9, wherein said gaseous catalyst is formed from a salt of rubidium or potassium.
12. A cell according to claim 11, wherein said salt of potassium is selected from the group consisting of KF, KCl, KBr, Kl, K2S2, KOH, K2CO3, K2PO4, and K2GeF4.
13. A cell according to claim 11, wherein said salt of rubidium is selected from the group consisting of RbF, RbCl, RbBr, Rbl, Rb2S2, RbOH, Rb2SO4, Rb2CO3, and Rb3PO4.
14. A cell according to claim 1, wherein said gaseous catalyst comprises a cation having a vapor pressure greater than zero when said gaseous catalyst is heated, said cation being selected from the group consisting of (K+), (Rb+), (Mo2+), and (Tiz+).
15. A cell according to claim 1, Wherein said gaseous catalyst comprises a pair of cations having a

vapor pressure greater than zero when said gaseous catalyst is heated, said pair cations being selected from the group consisting of: (Sn4+, Si4+), (Pr3+, Ca2+), (Sr2+, Cr2+), (Cr3+, Tb3+), (Sb3+, Co2+), (Bi3+, Ni2+), (Pd2+, In+), (La3+, Dy3+), (La3+, Ho3+), (K+, K+), (V3+, Pd2+), (Lu3+, Zn2+), (As3+, Ho3+), (Mo5+, Sn4+), (Sb3+, Cd2+), (Ag2+, Ag+), (La3+, Er3+), (V4+, B3+), (Fe3+, Ti3+), (Co2+, Ti+), (Bi3+, Zn2+), (As3+, Cy3+), (Ho3+, Mg2+), (K+, Rb+), (Cr3+, Pr3+), (Sr2+, Fe2+), (Ni2+, Cu+), (Sr2+, Mo2+), (Y3+, Zr4+), Cd2+, Ba2+), (Ho3+, Pb2+), (Pd2+, Li+), (Eu3+, Mg2+), (Er3+, Mg2+), (Bi4+, Al3+), (Ca2+, Sm3+), (V3+, La3+), (Gd3+, Cr2+) (Mn2+, Tl+), (Yb3+, Fe2+), (Ni2+, Ag+), (Zn2+, Yb2), (Se4+, Sn4+), (Sb3+, Bi2+), and (Eu3+, Pb2+).

16. A cell according to claim 1, wherein said gaseous catalyst comprises an ionic compound resistant to reduction by hydrogen atoms.

17. A cell according to claim 1, wherein said gaseous catalyst is adapted to provide ions.

18. A cell according to claim 1, wherein said vessel includes temperature controlling structure capable of maintaining an atomic hydrogen partial pressure of less than about 1 torr.

19. A cell according to claim 1, wherein said vessel includes temperature controlling structure capable of maintaining said catalyst in molten form.

20. A cell according to claim 1, wherein said vessel includes temperature controlling structure capable of maintaining the temperature of said vessel at about 50?C above the melting point of said gaseous catalyst.

21. A cell according to claim 1, wherein said vessel is constructed and arranged to be capable of maintaining the hydrogen partial pressure in said vessel at about 200 millitorr.

22. A cell according to claim 15, wherein said vessel includes temperature controlling structure capable of maintaining the temperature of said vessel at about 500?C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise a source of said gaseous catalyst.

23. A cell according to claim 1, further comprising a valve for releasing said catalyst from said vessel.

24. A cell according to claim 1, further comprising a valve for releasing said hydrogen atoms having a binding energy of about E b=13.6/n2eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

25. A cell according to claim 1, wherein said vessel includes temperature controlling structure to control a temperature of said vessel.

26. A cell according to claim 1, further comprising a heater for heating said vessel.

27. A cell according to claim 1, further comprising a catalyst reservoir communicating with said reaction vessel, said catalyst reservoir containing said gaseous catalyst or a source of gaseous catalyst.

28. A cell according to claim 27, further comprising a heater for heating said catalyst.

29. A cell according to claim 27, wherein said catalyst reservoir is external to said reaction vessel.

30. A cell according to claim 29, further comprising a flow control valve for controlling the flow of said catalyst from said catalyst reservoir into said vessel.

31. A cell according to claim 1, further comprising a chamber for containing hydrogen atoms or a source of hydrogen atoms communicating with said reaction vessel.

32. A cell according to claim 31, further comprising a flow control valve for controlling the flow of hydrogen atoms from said chamber into said vessel.
33. A cell according to claim 31, wherein said source of hydrogen atoms comprises an internal combustion engine.
34. A cell according to claim 31, wherein said source of hydrogen atoms comprises a tungsten capillary constructed and arranged to be heated for dissociating molecules containing hydrogen atoms to produce said gaseous hydrogen atoms.
35. A cell according to claim 34, further comprising a valve for controlling the flow of said molecules over said tungsten capillary.
36. A cell according to claim 31, wherein said source of hydrogen atoms comprises an inductively coupled plasma flow tube for dissociating molecules contaning hydrogen atoms to produce hydrogen atoms.
37. A cell according to claim 36, further comprising a valve for controlling the flow of said molecules into said inductively coupled plasma flow tube.
38. A cell according to claim 36, further comprising a power controller for contrlling the power dissipated in said inductively coupled plasma flow tube.
39. A cell according to claim 1, further comprising a heat exchanger for removing said extracted power from said cell.
40. A cell according to claim 1, further comprising a power gauge for measuring the amount of extracted power in said cell.

41. A cell according to claim 1, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction and which is adapted to sublime, boil or become volatile when heated.
42. A cell according to claim 1, wherein said source of gaseous catalyst comprises an ionic compound which is adapted to sublime, boil or become volatile when heated.
43. A cell according to claim 1, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to thermal degradation.
44. A cell according to claim 1, wherein said gaseous catalyst is formed from at least one metal selected from the group consisting of Mo, Ti, and Rb.
45. A cell according to claim 1, wherein said gaseous catalyst is formed from at least one salt selected from the group consisting of Mol2, TiCl2, TiCl4, SnCl4, SiCl4, PrBr3, CaBr2, SrCl2, Crl2, Tbl3, SbCl3, CrF3, CoCl2, BiCl3, NiCl2, PdF2, InCl, LaCl3, DyCl3, Lal3, Hol3, KNO3, VF3, PbF2, VOCl, Pbl2, LuCl3, PbCl2, Asl3, Hol3, MoCl5, SnCl4, Sbl3, Cdl2, AgF2, AgF, Lal3, Erl3, VCl4, BC13, FeCl3, TiCl3, Col2, CoF2, TII, TIF, BiBr3, ZnBr2, Asl3, Dyl3, HoCl3, MgCl2, CrCl3, PrCl3, SrCl2, FeCl2, NiCl2, CuCl, SrCl2, MoCl2, YCl3, ZrCl4, Cdl2, Bal2, Hol3, Pbl2, PdF2, LiF, EuCl3, MgCl2, ErCl3, MgCl2, ErCl3, MgCl2, BiCl4, AICl3, CaBr2, SmBr3, VaF3, LaCl3, Gdl3, Crl2, Mnl2, YbBr3, FeBr2, NiCl2, AgCl, ZnCl2, YbCl2, SeF4, SnCl4, SnF4, Sbl3, Bil2, EuF3, and PbCl2.
46. A cell according to claim 1, wherein said catalyst comprises potassium and has a net enthalpy of reaction of 27.28 eV.
47. A cell according to claim 1, wherein said catalyst has a net enthalpy of reaction of about 27.2 eV.
48. A cell according to claim 1, wherein said cell comprises a source of said gaseous catalyst

combined with at least one of a hydrocarbon or water disposed such that said gaseous catalyst and said gaseous hydrogen atoms are capable being formed during combustion.
49. A cell according to claim 1, further comprising a means for converting a source of catalyst to said gaseous catalyst.

50. A cell according to claim 49, wherein said means for converting said source of catalyst to said gaseous catalyst comprises at least one of heat, electron-beam energy, photon energy, acoustic energy, electric field, or magnetic field.

51. A cell according to claim 1, further comprising a filament coated with a source of gaseous catalyst.

52. A cell according to claim 1, further comprising a source of gaseous hydrogen atoms is selected from the group consisting of hydrogen gas, water, hydrides, metal-hydrogen solutions, and hydrocarbons.

53. A cell according to claim 52, further comprising means to disassociate water to form gaseous hydrogen atoms.

54. A cell according to claim 1, further comprising a hot filament and a hydrogen containing gas stream.

55. A cell according to claim 1, further comprising a hot grid and a hydrogen containing gas stream.

56. A cell according to claim 1, further comprising a heated tungsten capillary and a hydrogen containing gas stream.

57. A cell according to claim 1, further comprising a hydride maintained under nonequilibrium conditions.

58. A cell according to claim 1, further comprising an inductively coupled plasma flow tube and a hydrogen gas containing stream.

59. A cell according to claim 1, further comprising means to reform hydrocarbons to at least one of gaseous molecular and gaseous atomic hydrogen.

60. A cell according to claim 4, wherein said second catalyst is treated with an aqueous solution of K_2CO_3 and H_2O_2.

61. A cell according to claim 4, further comprising a temperature controlling structure capable of maintaining a selected atomic hydrogen partial pressure by controlling the temperature of said second catalyst.

62. A cell according to claim 61, wherein said temperature controlling structure is at least one selected from the group consisting of an internal heater, an external heater, the catalysis of hydrogen, and a heat exchanger which removes energy from the cell.

63. A cell according to claim 1, further comprising a source of UV light for disassociating hydrogen-containing molecules to form said gaseous hydrogen atoms.

64. A cell according to claim 1, further comprising a means for pyrolysis of hydrocarbons or water to form said gaseous hydrogen atoms.

65. A cell according to claim 4, wherein said second catalyst comprises at least one selected from the group consisting of an element, compound, alloy or mixture of transition elements, inner transition elements, iron, platinum, palladium, zirconium, vanadium, nickel, titanium, Sc, Cr, Mn, Co, Cu, Zn, Y, Nb, Mo, Tc, Ru, Rh, Ag, Cd, La, Hf, Ta, W, Re, Os, Ir, Au, Hg, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Vb, Lu, Th, Pa, U, activated charcoal, and intercalated Cs carbon.

66. A cell according to claim 4, further comprising a heater to heat said second catalyst.

67. A cell according to claim 4, further comprising a filament or grid constructed and arranged to dissociate hydrogen and to heat said second catalyst.

68. A cell according to claim 4, further comprising means for controlling the power output of said cell.

69. A cell according to claim 68, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said second catalyst.

70. A cell according to claim 69, wherein said means for controlling the temperature of said second catalyst comprises a filament or grid.

71. A cell according to claim 31, further comprising a flow control means for controlling the flow of a source of gaseous hydrogen atoms or said gaseous hydrogen atoms from said chamber to said reaction vessel.

72. A cell according to claim 1, further comprising a flow control means for controlling the flow of hydrogen from said reaction vessel.

73. A cell according to claim 71, wherein said flow control means comprises a valve.

74. A cell according to claim 1, further comprising a vacuum pump constructed and arranged for controlling the flow of hydrogen from said reaction vessel.

75. A cell according to claim 27, further comprising a flow control means for controlling the flow of

catalyst from said catalyst reservoir to said reaction vessel.

76. A cell according claim 1, further comprising means for controlling the flow of said gaseous catalyst from said reaction vessel.

77. A cell according to claim 76, wherein said means for controlling the flow of said gaseous catalyst from said reaction vessel comprises a valve.

78. A cell according to claim 1, further comprising a vacuum pump constructed and arranged for controlling the flow of said gaseous catalyst from said reaction vessel.

79. A cell according to claim 1, further comprising a nonreactive gas.

80. A cell according to claim 1, further comprising a means for controlling the amount of a nonreactive gas in said reaction vessel.

81. A cell according to claim 1, further comprising flow control means for controlling the flow of a nonreactive gas into said reaction vessel.

82. A cell according to claim 81, wherein said means for controlling the amount of nonreactive gas in said vessel comprises a valve constructed and arranged to regulate the flow of said nonreactive gas into said reaction vessel.

83. A cell according to claim 1, further comprising at least one of a valve or pump constructed and arranged for controlling the flow of a nonreactive gas from said reaction vessel.

84. A cell according to claim 1, further comprising a pump in communication with said reaction vessel.

85. A cell according to claim 1, further comprising structure for controlling the vapor pressure of said catalyst.

86. A cell according to claim 85, wherein said structure for controlling the vapor pressure of said catalyst comprises a heater constructed and arranged to control the temperature of said reaction vessel.

87. A cell according to claim 1, further comprising structure for maintaining a selected vapor pressure of said gaseous catalyst or source of said gaseous catalyst.

88. A cell according to claim 1, further comprising structure for maintaining a selected vapor pressure of said gaseous catalyst or source of gaseous catalyst.

89. A cell according to claim 88, wherein said structure for maintaining a selected vapor pressure of

said gaseous catalyst or source of gaseous catalyst comprises a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir and a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

90. A cell according to claim 88, wherein said structure for maintaining a selected vapor pressure of said source of gaseous catalyst or said gaseous catalyst comprises a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

91. A cell according to claim 1, further comprising a valve for releasing hydrogen atoms having a binding energy of about E b = 13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1 or a compound containing said hydrogen atoms from said reaction vessel.

92. A cell according to claim 1, further comprising means for adsorbing energy released from said hydrogen atom.

93. A cell according to claim 1, wherein said vessel comprises an internal combustion chamber.

94. A cell according to claim 93, wherein said internal combustion chamber is an engine cylinder.

95. A cell according to claim 1, further comprising means for controlling the power output of said cell.

96. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the amount of said gaseous catalyst.

97. A cell according to claim 96, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the temperature of said vessel and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said reaction vessel.

98. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the flow of a source of gaseous catalyst or gaseous catalyst from said reaction vessel.

99. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a source of catalyst.

100. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the amount of said gaseous hydrogen atoms or a source of gaseous hydrogen atoms in said vessel.

101. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the flow of gaseous hydrogen atoms or source of said hydrogen atoms into said reaction vessel.

102. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the flow of gaseous hydrogen atoms or source of said hydrogen atoms from said reaction vessel.

103. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises controlling the amount of said nonreactive gas present in said reaction vessel.

104. A cell according to claim 103, wherein said means for controlling the amount of nonreactive gas comprises means for controlling the flow of said nonreactive gas into said reaction vessel.

105. A cell according to claim 103, wherein said means for controlling the amount of nonreactive gas comprises means for controlling the flow of said nonreactive gas from said reaction vessel.

106. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the flow of a hydrogen containing gas over at least one of a hot filament, a tungsten capillary heated by electron bombardment, or an inductively coupled plasma flow.

107. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the power dissipated in an inductively coupled plasma flow tube.

108. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the power dissipated in a hot filament, grid, or tungsten capillary heated by electron bombardment.

109. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a hot filament, grid or tungsten capillary heated by electron bombardment over which a hydrogen containing gas flows.

110. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a hydride maintained under nonequilibrium conditions.

111. A cell according to claim 27, further comprising means for controlling the power output of said cell.

112. A cell according to claim 111, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said catalyst reservoir and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said catalyst reservoir.

113. A cell according to claim 111, wherein said means for controlling the power output of said cell comprises means for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir into said reaction vessel.

114. A cell according to claim 1, further comprising a boat contained within said reaction chamber, said boat containing a source of gaseous catalyst or said gaseous catalyst.

115. A cell according to claim 114, further comprising a means for controlling the power of said cell.

116. A cell according to claim 114, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said boat and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said boat.

117. A cell according to claim 27, further comprising means for measuring the temperature of said catalyst reservoir.

118. A cell according to claim 114, further comprising means for measuring the temperature of said boat.

119. A cell according to claim 27, further comprising a means for measuring the temperature of said source of said gaseous catalyst contained in said catalyst reservoir.

120. A cell according to claim 114, further comprising a means for measuring the temperature of said source of said gaseous catalyst contained in said boat.

121. A cell according to claim 1, further comprising means for measuring the temperature of said reaction vessel.

122. A cell according to claim 1, further comprising means for measuring the temperature of a source of said gaseous hydrogen atoms.

123. A cell according to claim 4, further comprising means for measuring the temperature said second catalyst.

124. A cell according to claim 1, further comprising means to measure the cell temperature.

125. A cell according to claim 124, further comprising temperature controlling structure constructed and arranged to maintain a temperature in said reaction vessel greater than a temperature in said catalyst reservoir.

126. A cell according to claim 114, further comprising temperature controlling structure constructed

and arranged to maintain a temperature in said reaction vessel greater than a temperature in said boat.

127. A cell according to claim 1, further comprising temperature controlling structure for maintaining a selected temperature of said reaction vessel.

128. A cell according to claim 1, further comprising a nebulizer or atomizer.

129. A cell according to claim 1, further comprising means to measure the pressure in said reaction vessel.

130. A cell according to claim 1, further comprising means to measure the hydrogen pressure in said reaction vessel.

131. A cell according to claim 1, further comprising means to measure the gaseous catalyst pressure in said reaction vessel.

132. A cell according to claim 1, wherein said vessel is capable of containing a pressure within the range of 10 -3 atmospheres to 100 atmospheres.

133. A cell according to claim 1, further comprising a vacuum pump in communication with said vessel and said vessel being constructed and arranged to contain pressures less than atmospheric.

134. A cell according to claim 27, further comprising a temperature controlling structure capable of maintaining a temperature in the said reaction vessel that is greater than a temperature of said catalyst reservoir.

135. A cell according to claim 27, further comprising temperature controlling structure capable of maintaining said source of gaseous catalyst in a molten form.

136. A cell according to claim 114, further comprising temperature controlling structure capable of maintaining said source of gaseous catalyst in a molten form.

137. A cell according to claim 27, further comprising temperature controlling structure capable of maintaining the temperature of said catalyst reservoir at about 50?C above the melting point of said gaseous catalyst.

138. A cell according to claim 1, further comprising temperature controlling structure capable of maintaining the temperature of said reaction vessel at about 50?C above the melting point of a source of gaseous catalyst.

139. A cell according to claim 114, further comprising temperature controlling structure capable of

maintaining the temperature of said boat at about 50?C above the melting point of said gaseous catalyst.

140. A cell according to claim 15, further comprising a catalyst reservoir in communication with said reaction vessel and temperature controlling structure capable of maintaining the temperature of said catalyst reservoir at about 50?C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise said source of gaseous catalyst.

141. A cell according to claim 15, further comprising a boat contained in said reaction vessel and temperature controlling structure capable of maintaining the temperature of said boat at about 50?C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise said source of gaseous catalyst.

142. A cell according to claim 27, further comprising temperature controlling structure capable of maintaining the temperature of said reaction vessel at about 50?C above the melting point of said gaseous catalyst.

143. A cell according to claim 15, further comprising a catalyst reservoir containing said source of gaseous catalyst and being in communication with said reaction vessel, and temperature controlling structure capable of maintaining the temperature of said reaction vessel at about 50?C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise said source of gaseous catalyst.

144. A cell according to claim 15, further comprising a boat containing said source of gaseous catalyst and being disposed in said reaction vessel, and temperature controlling structure capable of maintaining the temperature of said reaction vessel at about 50?C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise said source of gaseous catalyst.

145. A method for extracting energy from hydrogen atoms comprising the steps of:
providing a gaseous catalyst having a net enthalpy of reaction of about 27*(p/2)eV, where p is an integer greater than 1;
providing gaseous hydrogen atoms.

146. A method according to claim 145, wherein said gaseous hydrogen atoms are provided by disassociating molecules containing hydrogen atoms.

147. A method according to claim 145, wherein gaseous hydrogen atoms are provided by contacting molecules containing hydrogen atoms with a second catalyst for disassociating said molecules to produce hydrogen atoms in the gas phase.

148. A method according to claim 145, wherein said gaseous catalyst comprises gaseous hydrogen

atoms having a binding energy of about E b=13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

149. A method according to claim 145, wherein said gaseous catalyst is provided according to the reaction, Image not available. View PDF Image not available. View PDF where m and p are positive non-zero integers, m is an integer greater than 1, and a H is the radius of the hydrogen atom (n=1).

150. A method according to claim 145, wherein said gaseous catalyst is provided by volatizing a material to a gaseous state and ionizing said gaseous material.

151. A method according to claim 145, wherein said hydrogen atoms are provided by flowing gaseous molecules containing hydrogen atoms over a hot refractory metal, transition metal, platinum, palladium, gold, rhenium, or iridium.

152. A method according to claim 145, wherein said hydrogen atoms are provided by flowing gaseous molecules containing hydrogen atoms over a tungsten capillary heated by electron bombardment to between 1800 and 2000K.

153. A method according to claim 145, wherein said hydrogen atoms are provided by flowing gaseous molecules containing hydrogen atoms in an inductively coupled plasma flow tube.

154. A method according to claim 145, wherein said reaction occurs at a pressure less than about one torr.

155. A method according to claim 145, wherein the partial pressure of hydrogen atoms in the reaction is less than about one torr.

156. A method according to claim 145, wherein the partial pressure of hydrogen atoms in the reaction is about 200 millitorr.

157. A method according to claim 145, wherein said reaction occurs at a temperature of about 50?C, above the melting point of said gaseous catalyst.

158. A method according to claim 145, wherein the vapor partial pressure of said gaseous catalyst is controlled by varying the temperature of said gaseous catalyst.

159. A method according to claim 145, further comprising a step of isolating produced hydrogen atoms having a binding energy of about Eb=13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

160. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising an ionic compound which is resistant to

hydrogen reduction.

161. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising an ionic compound which is resistant to hydrogen reduction and which is adapted to sublime, boil or become volatile when heated.

162. A method according to claim 145, further comprising the step of forming said gaseous compound from a source of gaseous catalyst comprising an ionic compound which is adapted to sublime, boil or become volatile when heated.

163. A method according to claim 145, further comprising the step of forming said gaseous compound from a source of gaseous catalyst comprising an ionic compound which is resistant to thermal degradation.

164. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising a salt of rubidium or potassium.

165. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising a salt that can form a vapor comprising ions when heated.

166. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising a salt of rubidium selected from the group consisting of RbF, RbCl, RbBr, Rbl, Rb2S2, RbOH, Rb2SO4, Rb2CO3, and Rb3POa4.

167. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising a salt of potassium selected from the group consisting of KF, KCI, KBr, Kl, K2S2, KOH, K2SO4, K2CO3, K3PO4, and K2GeF4.

168. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising at least one metal selected from the group consisting of Mo, Ti, and Rb.

169. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising at least one salt selected from the group consisting of Mol2, TiCl2, TiCl4, SnCl4, SiCl4, PrBr3, CaBr2, SrCl2, Crl2, Tbl3, SbCl3, CrF3, CoCl2, BiCl3, NiCl2, PdF2, InCl, LaCl3, DyCl3, Lal3, Hol3, KNO3, VF3, PbF2, VOCl, Pbl2, LuCl3, PbCl2, Asl3, Hol3, MoCl5, SnCI4, Sbl3, Cdl2, AgF2, AgF, Lal3, Erl3, VCl4, BCl3, FeCl3, TiCl3, Col2, CoF2, Tll, TIF, BiBr3, ZnBr2, Asl3, Dyl3, HoCl3, MgCl2, CrCl3, PrCl3, SrCl2, FeCl2, NiCl2, CuCl, SrCl2, MoCl2, YCl3, ZrCl4, Cdl2, Bal2, Hol3, Pbl2, PdF2, LiF, EuCl3, MgCl2, ErCl3, MgCl2, ErCl3, MgCl2, BiCl4, AlCl3, CaBr2, SmBr3, VaF3, LaCl3, Gdl3, Crl2, Mnl2, YbBr3, FeBr2, NiCl2, AgCl, ZnCl2, YbCl2, SeF4, SnCl4, SnF4, Sbl3, Bil2, EuF3, and PbCl2.

170. A method according to claim 145, wherein said gaseous catalyst comprises at least one ion selected from the group consisting of Mo2+, Ti2+, and Rb+.

171. A method according to claim 145, wherein said gaseous catalyst comprises at least one pair of ions selected from the group consisting of:
(Sn4+, Si4+), (Pr3+, Ca2+), (Sr2+, Cr2+), (Cr3+, Tb3+), (Sb3+,CO2+), (Bi3+, Ni2+), (Pd2+, In+), (La3+, Dy3+), (La3+. Ho3+), (K+, K+), (V3+, Pd2+), (Lu3+, Zn2+), (As3+, Ho3+), (Mo5+. Sn4+), (Sb3+, Cd2+). (Ag2+, Ag+), (La3+, Er3+), (V4+, B3+), (Fe3+, Ti3+), (Co2+, Ti+), (Bi3+, Zn2+), (As3+, Dy3+). (Ho3+, Mg2+), (K+, Rb+), (Cr3+, Pr3+). (Sr2+. Fe2+), (Ni2+, Cu+). (Sr+, Mo2+), (Y3+, Zr4+), (Cd2+, Ba2+), (Ho3+, Pb2+), (Pb2+, Li+), (Eu3+, Mg2+), (Er3+, Mg2+), (Bi4+, A13+). (Ca2+, Sm3+), (V3+, La3+), (Gd3+. Cr2+), (Mnz+, Ti+). (Yb3+, Fez+), (Ni2+ , Ag+), (Zn2+, Yb2+), (Se4+, Sn4+), (Sb3+, Bi2+), and (Eu3+, Pb2+).

172. A method according to claim 145, further comprising the step of forming said gaseous catalyst from a source of gaseous catalyst comprising a salt of one or more cations and at least one anion selected from the group consisting of halides, sulfates, phosphates, carbonates, hydroxide and sulfides.

173. A method according to claim 145, wherein said gaseous catalyst is selected to have a resonant adsorption with the energy released from said gaseous hydrogen atoms undergoing a transition to a lower energy state.

174. A method according to claim 145, wherein said gaseous catalyst comprises potassium and has a net enthalpy of reaction of 27.28 eV.

175. A method according to claim 145, wherein said gaseous catalyst has a net enthalpy of reaction of about 27.2 eV.

176. A method according to claim 145, further comprising the step of combining a source of gaseous catalyst with a source of gaseous hydrogen atoms comprising at least one of a hydrocarbon or water, and providing combustion which volatizes said source of gaseous catalyst to form said gaseous catalyst and provide said gaseous hydrogen atoms.

177. A method according to claim 145, further comprising the step of forming a source of gaseous catalyst or said gaseous catalyst in situ.

178. A method according to claim 177, wherein said step of forming said source of gaseous catalyst or said gaseous catalyst in situ comprises the ionization of a reactant.

179. A method according to claim 178, wherein said step of ionization comprises thermal ionization of said reactant.

180. A method according to claim 178, wherein said step of ionization comprises chemical ionization of said reactant.

181. A method according to claim 180, wherein said step of chemical ionization comprises oxidation or reduction of said reactant.

182. A method according to claim 145, further comprising the step of volatizing a source of catalyst to form said gaseous catalyst utilizing energy from at least one of heat, electron-beam energy, photon energy, acoustic energy, electric field, or magnetic field.

183. A method according to claim 145, wherein said the step of volatizing a source of catalyst comprises the step of heating a filament coated with said source of gaseous catalyst.

184. A method according to claim 145, further comprising adding a source of catalyst to said reaction vessel and heating said source of catalyst to form said gaseous catalyst.

185. A method according to claim 145, further comprising the step of providing a source of catalyst in a catalyst reservoir comprising a container separate from said vessel and said container communicates with said reaction vessel.

186. A method according to claim 145, further comprising the step of providing a source of catalyst in a boat contained within said reaction vessel.

187. A method according to claim 145, wherein said step of providing hydrogen atoms comprises the steps of disassociating a hydrogen containing compound into hydrogen atoms.

188. A method according to claim 145, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas over a hot filament.

189. A method according to claim 145, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas over a hot grid.

190. A method according to claim 145, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas through a tungsten capillary heated by electron bombardment.

191. A method according to claim 145, wherein said step of providing hydrogen atoms comprises the steps of maintaining a hydride under nonequilibrium conditions.

192. A method according to claim 147, wherein said second catalyst comprises at least one element selected from the group consisting of transition elements, inner transition elements, precious metals,

refractory metals, lanthanides, actinides and activated charcoal.

193. A method according to claim 147, wherein said second catalyst is selected from the group consisting of an element, compound, alloy or mixture of transition elements, inner transition elements, iron, platinum, palladium, zirconium, vanadium, nickel, titanium, Sc, Cr, Mn, Co, Cu, Zn, Y, Nb, Mo, Tc, Ru, Rh, Ag, Cd, La, Hf, Ta, W, Re, Os, Ir, Au, Hg, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Vb, Lu, Th, Pa, U, activated charcoal, and intercalated Cs carbon.

194. A method according to claim 147, further comprising the step of utilizing a hot filament or hot grid to disassociate a hydrogen containing gas into gaseous hydrogen atoms and to heat said second catalyst.

195. A method according to claim 147, further comprising the step of controlling the power output of said cell.

196. A method according to claim 147, wherein said step of controlling the power output of said cell comprises controlling the temperature of said second catalyst.

197. A method according to claim 196, wherein said step of controlling the temperature of said second catalyst comprises utilizing a heated filament or grid.

198. A method according to claim 145, further comprising the step of forming said gaseous hydrogen atoms from at least one source of gaseous hydrogen atoms selected from the group consisting of hydrogen gas, water, hydrides, metal-hydrogen solutions, and hydrocarbons.

199. A method according to claim 145, wherein said step of providing gaseous hydrogen atoms comprises pyrolyzing hydrocarbons or water.

200. A method according to claim 145, further comprising the step of reforming hydrocarbons to at least one of gaseous molecular and gaseous atomic hydrogen.

201. A method according to claim 145, further comprising the step of disassociating hydrogen containing molecules using UV light to form said gaseous hydrogen atoms.

202. A method according to claim 145, further comprising the step of controlling the amount of gaseous hydrogen provided in said reaction vessel.

203. A method according to claim 145, further comprising the step of controlling the flow of a source of gaseous hydrogen atoms or said gaseous hydrogen atoms from a chamber to said reaction vessel.

204. A method according to claim 145, further comprising the step of utilizing a valve for controlling the flow of gaseous hydrogen or source of gaseous hydrogen from said reaction vessel.

205. A method according to claim 145, further comprising the step of controlling the flow of gaseous hydrogen from said reaction vessel.

206. A method according to claim 145, further comprising the step of utilizing a vacuum pump for controlling the flow of gaseous hydrogen from said reaction vessel.

207. A method according to claim 145, further comprising the step of utilizing a valve for controlling the flow of gaseous hydrogen from a chamber into said reaction vessel.

208. A method according to claim 145, further comprising controlling the partial pressure of said gaseous hydrogen atoms.

209. A method according to claim 145, wherein a partial pressure of said gaseous hydrogen atoms or source of gaseous hydrogen atoms in said reaction vessel is maintained within the range of 10-3 atmospheres to 100 atmospheres.

210. A method according to claim 145, further comprising controlling the amount of gaseous catalyst or a source of gaseous catalyst introduced into said reaction vessel.

211. A method according to claim 145, further comprising controlling the flow of gaseous catalyst or a source of gaseous catalyst from a catalyst reservoir containing gaseous catalyst or a source of gaseous catalyst to said reaction vessel.

212. A method according to claim 145, further comprising controlling the flow of gaseous catalyst or a source of gaseous catalyst from a boat containing gaseous catalyst or a source of gaseous catalyst.

213. A method according to claim 145, further comprising the step of controlling the flow of said gaseous catalyst or a source of gaseous catalyst from said reaction vessel.

214. A method according to claim 145, further comprising the step of controlling the vapor pressure of said gaseous catalyst or a source of gaseous catalyst in said reaction vessel.

215. A method according to claim 145, wherein a vapor pressure of said gaseous catalyst or a source of gaseous catalyst is maintained at about 50 to 210 millitorr.

216. A method according to claim 145, further comprising using a vacuum pump to control the flow of said gaseous catalyst or a source of gaseous catalyst from said reaction vessel.

217. A method according to claim 145, further comprising using a valve to control the flow of a source of gaseous catalyst or a source of gaseous catalyst from a catalyst reservoir into said reaction vessel.

218. A method according to claim 145, further comprising using a valve to control the flow of a source of gaseous catalyst or said catalyst from said reaction vessel.

219. A method according to claim 145, further comprising the step of supplying a nonreactive gas to said reaction vessel.

220. A method according to claim 219, further comprising the step of controlling the vapor pressure of said nonreactive gas in said reaction vessel.

221. A method according to claim 219, further comprising the step of controlling the flow of said nonreactive gas supplied to said reaction vessel.

222. A method according to claim 219, further comprising the step of controlling the amount of said nonreactive gas released from said reaction vessel.

223. A method according to claim 219, further comprising utilizing a vacuum pump for controlling the flow of said nonreactive gas from said reaction vessel.

224. A method according to claim 219, further comprising the step of utilizing a valve for controlling the flow of said nonreactive gas from said reaction vessel.

225. A method according to claim 219, further comprising the step of utilizing a valve for controlling the flow of said nonreactive gas into said reaction vessel.

226. A method according to claim 145, further comprising the step of controlling the vapor pressure of said gaseous catalyst in said reaction vessel.

227. A method according to claim 226, wherein said step of controlling the vapor pressure of said gaseous catalyst comprises controlling the temperature in a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel, and controlling the flow of gaseous catalyst from said catalyst reservoir.

228. A method according to claim 226, wherein said step of controlling the vapor pressure of said gaseous catalyst comprises controlling the temperature in a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel, and controlling the flow of gaseous catalyst from said boat.

229. A method according to claim 145, further comprising the step of controlling the temperature in a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel.

230. A method according to claim 145, further comprising the step of controlling the temperature in a

boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel.

231. A method according to claim 145, wherein the reaction to provide a net enthalpy of about 27 (p/2) eV, where p is a positive integer greater than 1, comprises an electrochemical, chemical, photochemical, thermal, free radical, sonic, nuclear, inelastic photon, or particle scattering reaction, or mixtures thereof.

232. A method according to claim 145, wherein a pressure in said reaction vessel is maintained within the range of 10-3 atmospheres to 100 atmospheres.

233. A method according to claim 145, wherein said reaction occurring at a pressure less than atmospheric pressure.

234. A method according to claim 145, further comprising the step of releasing hydrogen atoms from said reaction vessel having a binding energy of about E b = 13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1 or a compound containing said hydrogen atoms.

235. A method according to claim 145, further comprising the step of adsorbing said released energy.

236. A method according to claim 145, further comprising the step of converting energy released from said hydrogen atom into electrical energy.

237. A method according to claim 145, wherein said reaction step is conducted in an internal combustion chamber.

238. A method according to claim 145, wherein said internal combustion chamber is an engine cylinder.

239. A method according to claim 145, further comprising the step of controlling the power output of said cell.

240. A method according to claim 239, wherein said step of controlling the power output of said cell comprises controlling the amount of said gaseous catalyst present in said reaction vessel.

241. A method according to claim 240, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of said reaction vessel and selecting said gaseous catalyst or source of gaseous catalyst to have a vapor pressure dependent upon the temperature of said reaction vessel.

242. A method according to claim 240, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel, and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said catalyst reservoir.

243. A method according to claim 240, wherein said step of controlling the amount of gaseous catalyst comprises controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir into said reaction vessel.

244. A method according to claim 240, wherein said step of controlling the amount of gaseous

catalyst comprises controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

245. A method according to claim 240, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel, and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said boat.

246. A method according to claim 239, wherein said step of controlling the power output of said cell comprises controlling the amount of said gaseous hydrogen atoms present in said reaction vessel.

247. A method according to claim 246, wherein said step of controlling the amount of said gaseous hydrogen atoms comprises controlling the flow of gaseous hydrogen atoms or source of gaseous hydrogen atoms into said reaction vessel.

248. A method according to claim 246, wherein said step of controlling the amount of said source of gaseous hydrogen atoms or gaseous hydrogen atoms comprises controlling the flow of said source of gaseous hydrogen atoms or gaseous hydrogen atoms from said reaction vessel.

249. A method according to claim 246, wherein said step of controlling the amount of said source of gaseous hydrogen atoms or gaseous hydrogen atoms comprises controlling the temperature of a second catalyst for dissociating a hydrogen containing compound into gaseous hydrogen atoms.

250. A method according to claim 249, wherein said step of controlling the temperature of a second catalyst for dissociating a hydrogen containing compound into gaseous hydrogen atoms comprises controlling the power dissipated in a second catalyst heater.

251. A method according to claim 239, wherein said step of controlling the power output of said cell comprises controlling the amount of nonreactive gas in said reaction vessel.

252. A method according to claim 251, wherein said step of controlling the amount of nonreactive gas in said reaction vessel comprises controlling the flow of nonreactive gas into said reaction vessel.

253. A method according to claim 252, wherein said step of controlling the amount of nonreactive gas in said reaction vessel comprises controlling the flow of nonreactive gas from said reaction vessel.

254. A method according to claim 239, wherein said step of controlling the power output of said cell comprises controlling the temperature of a source of gaseous catalyst.

255. A method according to claim 239, wherein said step of controlling the power output of said cell comprises controlling the flow of a hydrogen containing gas over at least one of a hot filament, a tungsten capillary heated by electron bombardment, or an inductively coupled plasma flow.

256. A method according to claim 239, wherein said step of controlling the power output of said cell comprises controlling the power dissipated in an inductively coupled plasma flow tube, hot filament or grid, or tungsten capillary heated by electron bombardment.

257. A method according to claim 239, wherein said step of controlling the power output of said cell comprises controlling the temperature of a hot filament or tungsten capillary heated by electron bombardment over which a hydrogen containing gas flows.

258. A method according to claim 239, wherein said step of controlling the power output of said cell comprises controlling the temperature of a hydride maintained under nonequilibrium conditions.

259. A method according to claim 145, wherein a temperature in said reaction vessel is maintained at a higher temperature than in a catalyst reservoir in communication with said reaction vessel or a boat contained within said reaction vessel.

260. A method according to claim 145, further comprising the step of measuring the temperature of a catalyst reservoir in communication with said reaction vessel or a boat contained in said reaction vessel.
261. A method according to claim 145, further comprising the step of measuring the temperature of a source of said gaseous catalyst contained in a catalyst reservoir in communication with said reaction vessel or a boat contained within said reaction vessel.
262. A method according to claim 145, further comprising the step of measuring the temperature of a chamber containing a source of said hydrogen atoms in communication with said reaction vessel.
263. A method according to claim 145, further comprising the step of measuring the temperature of a source of said gaseous hydrogen atoms.
264. A method according to claim 147, further comprising the step of measuring the temperature of said second catalyst.
265. A method according to claim 145, further comprising the step of controlling the temperature of said reaction vessel.
266. A method according to claim 145, further comprising utilizing a nebulizer or atomizer to form said gaseous catalyst.
267. A method according to claim 145, further comprising the step of measuring the pressure in said reaction vessel.
268. A method according to claim 145, further comprising the step of controlling the pressure in said reaction vessel.
269. A method according to claim 145, further comprising the step of measuring the hydrogen pressure in said reaction vessel.
270. A method according to claim 145, further comprising the step of measuring the gaseous catalyst pressure in said reaction vessel.
271. A method according to claim 145, further comprising the step of converting energy released from said gaseous hydrogen atoms into electrical energy.

272. A method according to claim 145, further comprising controlling the pressure of said gaseous catalyst by controlling the amount of said source of catalyst being added to said reaction vessel.
273. A cell for extracting energy from hydrogen atoms comprising:
a reaction vessel;
a source of gaseous hydrogen atoms; and a source of a gaseous catalyst having a net enthalpy of reaction of about 27(p/2) eV, where p is an integer greater than 1.
274. A cell for extracting energy from hydrogen atoms comprising:
a reaction vessel;
a chamber communicating with said vessel, said chamber containing gaseous hydrogen atoms or a source of said hydrogen atoms; and a catalyst reservoir communicating with said reaction vessel or a boat contained in said reaction vessel, said catalyst reservoir or boat containing a gaseous catalyst having a net enthalpy of reaction of about 27* (p/2) eV, where p is an integer greater than 1, or a source of said gaseous catalyst.
275. A cell according to claim 274, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction.

276. A cell according to claim 274, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction and which is adapted to sublime, boil or become volatile when heated.
277. A cell according to claim 274, wherein said source of gaseous catalyst comprises an ionic compound which is adapted to sublime, boil or become volatile when heated.
278. A cell according to claim 274, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to thermal degradation.
279. A cell according to claim 274, wherein said source of gaseous catalyst comprises a salt of rubidium or potassium.
280. A cell according to claim 274, wherein said source of gaseous catalyst comprises a salt that can form a vapor comprising ions when heated.

281. A cell according to claim 274, wherein said source of gaseous catalyst comprises a salt of rubidium selected from the group consisting of RbF, RbCI, RbBr, RbI, Rb2S2, RbOH, Rb2SO4, Rb2CO3, and Rb3PO4.
282. A cell according to claim 274, wherein said source of gaseous catalyst comprises a salt of potassium selected from the group consisting of KF, KCl, KBr, KI, K2S2, KOH, K2SO4, K2CO3, K3PO4, and K2GeF4.
283. A cell according to claim 274, wherein said source of gaseous catalyst comprises at least one metal selected from the group consisting of Mo, Ti, and Rb.
284. A cell according to claim 274, wherein said source of gaseous catalyst comprises at least one salt selected from the group consisting of MoI2, TiCl2, TiCl4, SnCl4, SiCl4, PrBr3, CaBr2, SrCl2, CrI2, TbI3, SbCl3, CrF3, CoCl2, BiCl3, NiCl2, PdF2, InCI, LaCl3, DyCl3, LaI3, HoI3, KNO3, VF3, PbF2, VOCI, PbI2, LuCl3, PbCl2, AsI3, HoI3, MoCl5, SnCl4, SbI3, CdI2, AgF2, AgF, LaI3, ErI3, VCl4, BCI3, FeCl3, TiCl3, CoI2, CoF2, TII, TIF, BiBr3, ZnBr2, AsI3, DyI3, HoCl3, MgCl2, CrCl3, PrCl3, SrCl2, FeCl2, NiCl2, CuCl, SrCl2, MoCl2, YC13, ZrCl4, CdI2, BaI2, HoI3, PbI2, PdF2, LiF, EuCl3, MgCl2, ErCl3, MgCl2, ErCl3, MgCl2, BiCl4, AIC13, CaBr2, SmBr3, VaF3, LaCl3, GdI3, CrI2, MnI2, YbBr3, FeBr2, NiCl2, AgCl, ZnCl2, YbCl2, SeF4, SnCl4, SnF4, SbI3, BiI2, EuF3, and PbCl2.
285. A cell according to claim 274, wherein said gaseous catalyst comprises at least one ion selected from the group consisting of Mo2+, Ti2+, and Rb+.
286. A cell according to claim 274, wherein said gaseous catalyst comprises at least one pair of ions selected from the group consisting of: (Sn4+, Si4+), (Pr3+, Ca2+), (Sr2+, Cr2+), (Cr3+, Tb3+), (Sb3+,Co2+), (Bi3+, Ni2+), (Pd2+, In+), (La3+, Dy3+), (La3+, Ho3+), (K+, K+) , (V3+, Pd2+), (Lu3+, Zn2+), (As3+, Ho3+), (Mo5+, Sn4+), (Sb3+, Cd2+), (Ag2+,Ag+), (La3+, Er3+), (V4+, B3+), (Fe3+, Ti3+), (Co2+, Ti+), (Bi3+, Zn2+), (As3+, Dy3+), (Ho3+, Mg2+), (K+, Rb+),(Cr3+, Pr3+), (Sr2+, Fe2+), (Ni2+, Cu+), (Sr2+, Mo2+), (Y3+, Zr4+), (Cd2+, Ba2+), (Ho3+, Pb2+), (Pb2+, Li+), (Eu3+, Mg2+), (Er3+, Mg2+), (Bi4+, Al3+), (Ca2+, Sm3+), (V3+, La3+), (Gd3+, Cr2+), (Mn2+, Ti+), (Yb3+, Fe2+), (Ni2+, Ag+), (Zn2+, Yb2+), (Se4+, Sn4+), (Sb3+, Bi2+), and (Eu3+, Pb2+).
287. A cell according to claim 274, wherein said source of gaseous catalyst comprises a salt of one or more cations and at least one anion selected from the group consisting of halides, sulfates, phosphates, carbonates, hydroxide and sulfides.
288. A cell according to claim 274, wherein said gaseous catalyst comprises hydrogen atoms having

a binding energy of about E b = 13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.
289. A cell according to claim 274, wherein said gaseous catalyst comprises potassium and has a net enthalpy of reaction of 27.28 eV.
290. A cell according to claim 274, wherein said gaseous catalyst has a net enthalpy of reaction of about 27.2 eV.
291. A cell according to claim 274, wherein said cell comprises said source of said gaseous catalyst combined with at least one of a hydrocarbon or water disposed such that said gaseous catalyst and said gaseous hydrogen atoms are capable being formed during combustion.
292. A cell according to claim 274, further comprising a means for converting said source of catalyst to said gaseous catalyst.
293. A cell according to claim 292, wherein said means for converting said source of catalyst to said gaseous catalyst comprises at least one of heat, electron-beam energy, photon energy, acoustic energy, electric field, or magnetic field.
294. A cell according to claim 274, further comprising a filament coated with said source of gaseous catalyst.
295. A cell according to claim 274, wherein said source of gaseous hydrogen atoms is selected from the group consisting of hydrogen gas, water, hydrides, metal-hydrogen solutions, and hydrocarbons.
296. A cell according to claim 274, wherein said source of hydrogen atoms comprises a hot filament and a hydrogen containing gas stream.

297. A cell according to claim 274, wherein said source of hydrogen atoms comprises a hot grid and a hydrogen containing gas stream.
298. A cell according to claim 274, wherein said source of hydrogen atoms comprises a heated tungsten capillary and a hydrogen containing gas stream.
299. A cell according to claim 274, wherein said source of hydrogen atoms comprises a hydride maintained under nonequilibrium conditions.
300. A cell according to claim 274, wherein said source of hydrogen atoms comprises an inductively coupled plasma flow tube and a hydrogen gas containing stream.
301. A cell according to claim 274, wherein said source of hydrogen atoms comprises a hydrogen containing gas stream and a second catalyst for disassociating said hydrogen containing gas stream into free hydrogen atoms.
302. A cell according to claim 274, wherein said source of hydrogen atoms comprises an internal combustion engine.
303. A cell according to claim 301, wherein said second catalyst comprises at least one element selected from the group consisting of transition elements, inner transition elements, precious metals, refractory metals, lanthanides, actinides, and activated charcoal.
304. A cell according to claim 301, wherein said second catalyst comprises at least one selected from the group consisting of an element, compound, alloy or mixture of transition elements, inner transition elements, iron, platinum, palladium, zirconium, vanadium, nickel, titanium, Sc, Cr, Mn, Co, Cu, Zn, Y, Nb, Mo, Tc, Ru, Rh, Ag, Cd, La, Hf, Ta, W, Re, Os, Ir, Au, Hg, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Vb, Lu, Th, Pa, U, activated charcoal, and intercalated Cs carbon.

305. A cell according to claim 301, wherein said second catalyst is treated with an aqueous solution of K_2CO_3 and H_2O_2.
306. A cell according to claim 301, further comprising a heater to heat said second catalyst.

307. A cell according to claim 301, further comprising a filament or grid constructed and arranged to dissociate hydrogen and to heat said second catalyst.
308. A cell according to claim 301, further comprising means for controlling the power output of said cell.
309. A cell according to claim 308, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said second catalyst.
310. A cell according to claim 309, wherein said means for controlling the temperature of said second catalyst comprises a filament or grid.
311. A cell according to claim 301, further comprising a temperature controlling structure capable of maintaining a selected atomic hydrogen partial pressure by controlling the temperature of said second catalyst.
312. A cell according to claim 311, wherein said temperature controlling structure is at least one selected from the group consisting of an internal heater, an external heater, the catalysis of hydrogen, and a heat exchanger which removes energy from the cell.
313. A cell according to claim 274, wherein said source of hydrogen atoms comprises a means for pyrolysis of hydrocarbons or water.
314. A cell according to claim 274, further comprising means to reform hydrocarbons to at least one of gaseous molecular and gaseous atomic hydrogen.
315. A cell according to claim 274, further comprising a source of UV light for disassociating hydrogen containing molecules to form said gaseous hydrogen atoms.
316. A cell according to claim 274, further comprising a flow control means for controlling the flow of said source of gaseous hydrogen atoms or said gaseous hydrogen atoms from said chamber to said reaction vessel.
317. A cell according to claim 316, wherein said flow control means comprises a valve.
318. A cell according to claim 274, further comprising a flow control means for controlling the flow of hydrogen from said reaction vessel.
319. A cell according to claim 318, wherein said flow control means comprises a valve.
320. A cell according to claim 274, further comprising a vacuum pump constructed and arranged for controlling the flow of hydrogen from said reaction vessel.
321. A cell according to claim 274, further comprising a flow control means for controlling the flow of said gaseous catalyst or a source of gaseous catalyst from said catalyst reservoir to said reaction vessel.
322. A cell according to claim 321, wherein said flow control means comprises a valve.
323. A cell according claim 274, further comprising means for controlling the flow of catalyst from said reaction vessel.
324. A cell according to claim 274, further comprising a valve constructed and arranged for controlling the flow of said catalyst from said reaction vessel.
325. A cell according to claim 274, further comprising a vacuum pump constructed and arranged for

controlling the flow of said gaseous catalyst or source of gaseous catalyst from said reaction vessel.
326. A cell according to claim 274, further comprising a nonreactive gas.
327. A cell according to claim 274, further comprising a means for controlling the amount of a nonreactive gas in said vessel.
328. A cell according to claim 274, further comprising flow control means for controlling the flow of a nonreactive gas into said reaction vessel.
329. A cell according to claim 328, wherein said means for controlling the amount of nonreactive gas in said vessel comprises a valve constructed and arranged to regulate the release of said nonreactive gas from said reaction vessel.
330. A cell according to claim 274, further comprising a valve constructed and arranged for controlling the flow of a nonreactive gas from said reaction vessel.

331. A cell according to claim 274, further comprising a vacuum pump constructed and arranged for controlling the flow of a nonreactive gas from said reaction vessel.
332. A cell according to claim 274, further comprising a pump in communication with said reaction vessel.
333. A cell according to claim 274, further comprising structure for controlling the vapor pressure of said catalyst.
334. A cell according to claim 333, wherein said structure for controlling the vapor pressure of said catalyst comprises a heater constructed and arranged to control the temperature of said catalyst reservoir or said boat.
335. A cell according to claim 333, wherein said structure for controlling the vapor pressure of said catalyst comprises a heater constructed and arranged to control the temperature of said reaction chamber.
336. A cell according to claim 274, further comprising structure for maintaining a selected vapor pressure of said gaseous catalyst.
337. A cell according to claim 336, wherein said structure for maintaining a selected vapor pressure of said gaseous catalyst comprises a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir and a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.
338. A cell according to claim 336, wherein said structure for maintaining a selected vapor pressure of said source of gaseous catalyst or said gaseous catalyst comprises a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.
339. A cell according to claim 274, further comprising a valve for releasing hydrogen atoms having a binding energy of about E b = 13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1 or a compound containing said hydrogen atoms.

340. A cell according to claim 274, further comprising means for adsorbing energy released from said hydrogen atom.
341. A cell according to claim 274, wherein said vessel comprises an internal combustion chamber.

342. A cell according to claim 341, wherein said internal combustion chamber is an engine cylinder.
343. A cell according to claim 274, further comprising means for controlling the power output of said cell.
344. A cell according to claim 343, wherein said means for controlling the power output of said cell comprises means for controlling the amount of said gaseous catalyst.
345. A cell according to claim 344, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the temperature of said vessel and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said reaction vessel.
346. A cell according to claim 344, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the temperature of said catalyst reservoir and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said catalyst reservoir.
347. A cell according to claim 344, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the temperature of said boat and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said boat.
348. A cell according to claim 344, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir into said reaction vessel.
349. A cell according to claim 344, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir from said reaction vessel.
350. A cell according to claim 343, wherein said means for controlling the power output of said cell comprises means for controlling the amount of said gaseous hydrogen atoms or said source of gaseous hydrogen atoms in said vessel.
351. A cell according to claim 350, wherein said means for controlling the amount of said gaseous hydrogen atoms or said source of gaseous hydrogen atoms comprises means for controlling the flow of gaseous hydrogen atoms or source of said hydrogen atoms into said vessel.
352. A cell according to claim 350, wherein said means for controlling the amount of said gaseous hydrogen atoms or said source of gaseous hydrogen atoms comprises means for controlling the flow of gaseous hydrogen atoms or source of said hydrogen atoms from said vessel.
353. A cell according to claim 343, wherein said means for controlling the power output of said cell comprises controlling the amount of said nonreactive gas present in said reaction vessel.
354. A cell according to claim 353, wherein said means for controlling the amount of nonreactive gas comprises means for controlling the flow of said nonreactive gas into said reaction vessel.
355. A cell according to claim 354, wherein said means for controlling the amount of nonreactive gas comprises means for controlling the flow of said nonreactive gas from said reaction vessel.
356. A cell according to claim 343, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said source of catalyst.
357. A cell according to claim 343, wherein said means for controlling the power output of said cell comprises means for controlling the flow of a hydrogen containing gas over at least one of a hot filament, a tungsten capillary heated by electron bombardment, or an inductively coupled plasma flow.

358. A cell according to claim 343, wherein said means for controlling the power output of said cell

comprises means for controlling the power dissipated in an inductively coupled plasma flow tube.

359. A cell according to claim 343, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a hot filament or tungsten capillary heated by electron bombardment over which a hydrogen containing gas flows.

360. A cell according to claim 343, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a hydride maintained under nonequilibrium conditions.

361. A cell according to claim 274, further comprising means for measuring the temperature of said catalyst reservoir or said boat.

362. A cell according to claim 274, further comprising a means for measuring the temperature of said source of said gaseous catalyst contained in said catalyst reservoir or said boat.

363. A cell according to claim 274, further comprising means for measuring the temperature of said reaction vessel.

364. A cell according to claim 274, further comprising means for measuring the temperature of said source of said gaseous hydrogen atoms.

365. A cell according to claim 301, further comprising means for measuring the temperature said second catalyst.

366. A cell according to claim 274, further comprising means to measure the cell temperature.

367. A cell according to claim 274, further comprising temperature controlling structure constructed and arranged to maintain a temperature in said reaction vessel greater than a temperature in said catalyst reservoir.

368. A cell according to claim 274, further comprising temperature controlling structure constructed and arranged to maintain a temperature in said reaction vessel greater than a temperature in said boat.

369. A cell according to claim 274, further comprising temperature controlling structure for maintaining a selected temperature of said reaction vessel.

370. A cell according to claim 274, further comprising a nebulizer or atomizer.

371. A cell according to claim 274, further comprising means to measure the pressure in said reaction vessel.

372. A cell according to claim 274, further comprising means to measure the hydrogen pressure in said reaction vessel.

373. A cell according to claim 274, further comprising means to measure the gaseous catalyst pressure in said reaction vessel.

374. A cell according to claim 274, wherein said vessel is capable of containing a pressure within the range of 10 -3 atmospheres to 100 atmospheres.

375. A method for extracting energy from hydrogen atoms comprising the steps of:
volatizing a source of gaseous catalyst to form a gaseous catalyst having a net enthalpy of reaction of about 27 * (p/2) eV, where p is an integer greater than 1;
providing gaseous hydrogen atoms; and reacting said gaseous catalyst with said gaseous hydrogen atoms, thereby releasing energy from said gaseous hydrogen atoms and producing hydrogen atoms having a binding energy of about E b = 13.6/n2 eV, where n is a fraction whose numerator is 1 and a denominator is an integer greater than 1.

376. A method according to claim 375, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction.

377. A method according to claim 375, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction and which is adapted to sublime, boil or become volatile when heated.

378. A method according to claim 375, wherein said source of gaseous catalyst comprises an ionic compound which is adapted to sublime, boil or become volatile when heated.

379. A method according to claim 375, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to thermal degradation.

380. A method according to claim 375, wherein said source of gaseous catalyst comprises a salt of rubidium or potassium.

381. A method according to claim 375, wherein said source of gaseous catalyst comprises a salt that can form a vapor comprising ions when heated.

382. A method according to claim 375, wherein said source of gaseous catalyst comprises a salt of rubidium selected from the group consisting of RbF, RbCI, RbBr, Rbl, Rb2S2, RbOH, Rb2SO4, Rb2CO3, and Rb3PO4.

383. A method according to claim 375, wherein said source of gaseous catalyst comprises a salt of

potassium selected from the group consisting of KF, KCI, KBr, KI, K2S2, KOH, K2SO4, K2CO3, K3PO4, and KZGeF4.

384. A method according to claim 375, wherein said source of gaseous catalyst comprises at least one metal selected from the group consisting of Mo, Ti, and Rb.

385. A method according to claim 375, wherein said source of gaseous catalyst comprises at least one salt selected from the group consisting of Mol2, TiCl2, TiCl4, SnCl4, SiCl4, PrBr3, CaBr2, SrCl2, Crl2, Tbl3, SbCl3, CrF3, CoCl2, BiCl3, NiCl2, PdF2, InCl, LaCl3, DyCl3, Lal3, Hol3, KNO3, VF3, PbF2, VOCl, Pbl2, LuCl3, PbCl2, Asl3, Hol3, MoCl5, SnCl4, Sbl3, Cdl2, AgF2, AgF, Lal3, Erl3, VCl4, BCl3, FeCl3, TiCl3, Col2, CoF2, TII, TIF, BiBr3, ZnBr2, Asl5, Dyl3, HoCl3, MgCl2, CrCl5, PrCl3, SrCl2, FeCl2, NiCl2, CuCl, SrCl2, MoCl2, YC13, ZrCl4, Cdl2, Bal2, Hol3, Pbl2, PdF2, LiF, EuCl3, MgCl2, ErCl3, MgCl2, ErCl3, MgCl2, BiCl4, AIC13, CaBr2, SmBr3, VaF3, LaCl3, Gdl3, Crl2, Mnl2, YbBr3, FeBr2, NiCl2, AgCI, ZnCl2, YbCl2, SeF4, SnCl4, SnF4, Sbl3, Bil2, EuF3, and PbCl2.

386. A method according to claim 375, wherein said gaseous catalyst comprises at least one ion selected from the group consisting of Mo2+, Ti2+, and Rb+.

387. A method according to claim 375, wherein said gaseous catalyst comprises at least one pair of ions selected from the group consisting of:

(Sn4+, Si4+), (Pr3+, Ca2+), (Sr2+, Cr2+), (Cr3+, Tb3+), (Sb3+,Co2+), (Bi3+, Ni2+), (Pd2+, In+), (La3+, Dy3+), (La3+, Ho3+), (K+, K+) , (V3+, Pd2+), (Lu3+, Zn2+), (As3+, Ho3+), (Mo5+, Sn4+), (Sb3+, Cd2+), (Ag2+,Ag+), (La3+, Er3+), (V4+, B3+), (Fe3+, Ti3+), (Co2+, Ti+), (Bi3+, Zn2+), (As3+, Dy3+), (Ho3+, Mg2+), (K+, Rb+), (Cr3+, Pr3+), (Sr2+, Fe2+), (Ni2+, Cu+), (Sr2+, Mo2+), (Y3+, Zr4+), (Cd2+, Ba2+), (Ho3+, Pb2+), (Pb2+, Li+), (Eu3+, Mg2+), (Er3+, Mg2+), (Bi4+, Al3+), (Ca2+, Sm3+), (V3+, La3+), (Gd3+, Cr2+), (Mn2+, Ti+), (Yb3+, Fe2+), (Ni2+, Ag+), (Zn2+, Yb2+), (Se4+, Sn4+), (Sb3+, Bi2+), and (Eu3+, Pb2+).

388. A method according to claim 375, wherein said source of gaseous catalyst comprises a salt of one or more cations and at least one anion selected from the group consisting of halides, sulfates, phosphates, carbonates, hydroxide and sulfides.

389. A method according to claim 375, wherein said gaseous catalyst comprises hydrogen atoms having a binding energy of about Eb =
13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

390. A method according to claim 375, wherein said catalyst is selected to have a resonant adsorption with the energy released from said gaseous hydrogen atoms undergoing a transition to a lower energy state.

391. A method according to claim 375, wherein said gaseous catalyst comprises potassium and has a

net enthalpy of reaction of 27.28 eV.

392. A method according to claim 375, wherein said gaseous catalyst has a net enthalpy of reaction of about 27.2 eV.

393. A method according to claim 375, further comprising the step of combining a source of gaseous catalyst with a source of gaseous hydrogen atoms comprising at least one of a hydrocarbon or water, and providing combustion which volatizes said source of gaseous catalyst to form said gaseous catalyst and provide said gaseous hydrogen atoms.

394. A method according to claim 375, further comprising the step of forming said source of gaseous catalyst or said gaseous catalyst in situ.

395. A method according to claim 344, wherein said step of forming said source of gaseous catalyst or said gaseous catalyst in situ comprises the ionization of a reactant.

396. A method according to claim 345, wherein said step of ionization comprises thermal ionization of said reactant.

397. A method according to claim 395, wherein said step of ionization comprises chemical ionization of said reactant.

398. A method according to claim 397, wherein said step of chemical ionization comprises oxidation or reduction of said reactant.

399. A method according to claim 375, wherein said step of volatizing said source of catalyst to form said gaseous catalyst utilizes energy from at least one of heat, electron-beam energy, photon energy, acoustic energy, electric field, or magnetic field.

400. A method according to claim 375, wherein said step of volatizing said source of catalyst comprises the step of heating a filament coated with said source of said gaseous catalyst.

401. A method according to claim 375, wherein said step of volatizing said source of gaseous catalyst to form said gaseous catalyst comprises the steps of volatizing said material to form gaseous atoms and ionizing said gaseous atoms to form ions.

402. A method according to claim 375, further comprising adding a source of catalyst to said reaction vessel and heating said source of catalyst to form said gaseous catalyst.

403. A method according to claim 375, wherein said source of catalyst is provided in a catalyst reservoir comprising a container separate from said reaction vessel and said container communicates with said reaction vessel.

404. A method according to claim 375, wherein said source of catalyst is provided in a boat contained within said reaction vessel.

405. A method according to claim 375, wherein said step of providing hydrogen atoms comprises the steps of disassociating a hydrogen containing compound into hydrogen atoms.

406. A method according to claim 375, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas over a hot filament.

407. A method according to claim 375, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas over a hot grid.

408. A method according to claim 375, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas through a tungsten capillary heated by electron bombardment.

409. A method according to claim 375, wherein said step of providing hydrogen atoms comprises the steps of maintaining a hydride under nonequilibrium conditions.

410. A method according to claim 375, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas through an inductively coupled plasma flow tube.

411. A method according to claim 375, wherein said step of providing hydrogen atoms comprises the steps of contacting a hydrogen containing gas with a second catalyst for disassociating said hydrogen containing gas into free hydrogen atoms.

412. A method according to claim 411, wherein said second catalyst comprises at least one element selected from the group consisting of transition elements, inner transition elements, precious metals, refractory metals, lanthanides, actinides and activated charcoal.

413. A method according to claim 411, wherein said second catalyst is selected from the group consisting of an element, compound, alloy or mixture of transition elements, inner transition elements, iron, platinum, palladium, zirconium, vanadium, nickel, titanium, Sc, Cr, Mn, Co, Cu, Zn, Y, Nb, Mo, Tc, Ru, Rh, Ag, Cd, La, Hf, Ta, W, Re, Os, Ir, Au, Hg, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Vb, Lu, Th, Pa, U, activated charcoal, and intercalated Cs carbon.

414. A method according to claim 411, further comprising the step of utilizing a hot filament or hot grid to disassociate a hydrogen containing gas into gaseous hydrogen atoms and to heat said second catalyst.

415. A method according to claim 411, further comprising the step of controlling the power output of

said cell.

416. A method according to claim 415, wherein said step of controlling the power output of said cell comprises controlling the temperature of said second catalyst.

417. A method according to claim 416, wherein said step of controlling the temperature of said second catalyst comprises utilizing a heated filament or grid.

418. A method according to claim 375, wherein said source of gaseous hydrogen atoms is selected from the group consisting of hydrogen gas, water, hydrides, metal-hydrogen solutions, and hydrocarbons.

419. A method according to claim 375, wherein said step of providing gaseous hydrogen atoms comprises pyrolyzing hydrocarbons or water.

420. A method according to claim 375, further comprising the step of reforming hydrocarbons to at least one of gaseous molecular and gaseous atomic hydrogen.

421. A method according to claim 375, further comprising the step of disassociating hydrogen containing molecules using UV light to form said gaseous hydrogen atoms.

422. A method according to claim 375, further comprising the step of controlling the amount of gaseous hydrogen provided in said reaction vessel.

423. A method according to claim 375, further comprising the step of controlling the flow of a source of gaseous hydrogen atoms or said gaseous hydrogen atoms from a chamber to said reaction vessel.

424. A method according to claim 375, further comprising the step of utilizing a valve for controlling the flow of gaseous hydrogen or source of gaseous hydrogen from said reaction vessel.

425. A method according to claim 375, further comprising the step of controlling the flow of gaseous hydrogen or source of gaseous hydrogen from said reaction vessel.

426. A method according to claim 375, further comprising the step of utilizing a vacuum pump for controlling the flow of gaseous hydrogen or source of gaseous hydrogen from said reaction vessel.

427. A method according to claim 375, further comprising the step of utilizing a valve for controlling the flow of gaseous hydrogen or source of gaseous hydrogen from a chamber into said reaction vessel.

428. A method according to claim 375, further comprising controlling the partial pressure of said gaseous hydrogen atoms.

429. A method according to claim 375, wherein a partial pressure of said gaseous hydrogen atoms or source of gaseous hydrogen atoms in said reaction vessel is maintained within the range of 10-3 atmospheres to 100 atmospheres.

430. A method according to claim 375, further comprising controlling the amount of gaseous catalyst or source of gaseous catalyst introduced into said reaction vessel.

431. A method according to claim 375, further comprising controlling the flow of gaseous catalyst or source of gaseous catalyst from a catalyst reservoir containing gaseous catalyst or a source of gaseous catalyst to said reaction vessel.

432. A method according to claim 375, further comprising controlling the flow of gaseous catalyst or source of gaseous catalyst from a boat containing gaseous catalyst or a source of gaseous catalyst.

433. A method according to claim 375, further comprising the step of controlling the flow of said gaseous catalyst or said source of gaseous catalyst from said reaction vessel.

434. A method according to claim 375, further comprising the step of controlling the vapor pressure of said gaseous catalyst or source of gaseous catalyst in said reaction vessel.

435. A method according to claim 375, wherein a vapor pressure of said gaseous catalyst or said source of gaseous catalyst is maintained at about 50 to 210 millitorr.

436. A method according to claim 375, further comprising using a vacuum pump to control the flow of said catalyst or said source of gaseous catalyst from said reaction vessel.

437. A method according to claim 375, further comprising using a valve to control the flow of said source of gaseous catalyst or said catalyst from a catalyst reservoir into said reaction vessel.

438. A method according to claim 375, further comprising using a valve to control the flow of said source of gaseous catalyst or said catalyst from said reaction vessel.

439. A method according to claim 375, further comprising the step of supplying a nonreactive gas to said reaction vessel.

440. A method according to claim 375, further comprising the step of controlling the vapor pressure of said nonreactive gas in said reaction vessel.

441. A method according to claim 440, further comprising the step of controlling the flow of said nonreactive gas supplied to said reaction vessel.

442. A method according to claim 440, further comprising the step of controlling the amount of said nonreactive gas released from said reaction vessel.

443. A method according to claim 440, further comprising utilizing a vacuum pump for controlling the flow of said nonreactive gas from said reaction vessel.

444. A method according to claim 440, further comprising the step of utilizing a valve for controlling the flow of said nonreactive gas from said reaction vessel.

445. A method according to claim 440, further comprising the step of utilizing a valve for controlling the flow of said nonreactive gas into said reaction vessel.

446. A method according to claim 375, further comprising the step of controlling the vapor pressure of said gaseous catalyst in said reaction vessel.

447. A method according to claim 446, wherein said step of controlling the vapor pressure of said gaseous catalyst comprises controlling the temperature in a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel, and controlling the flow of gaseous catalyst from said catalyst reservoir.

448. A method according to claim 446, wherein said step of controlling the vapor pressure of said gaseous catalyst comprises controlling the temperature in a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel, and controlling the flow of gaseous catalyst from said boat.

449. A method according to claim 375, further comprising the step of controlling the temperature in a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel.

450. A method according to claim 375, further comprising the step of controlling the temperature in a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel.

451. A method according to claim 375, wherein the reaction to provide a net enthalpy of about 27 (p/2) eV, where p is a positive integer greater than 1, comprises an electrochemical, chemical, photochemical, thermal, free radical, sonic, nuclear, inelastic photon, or particle scattering reaction, or mixtures thereof.

452. A method according to claim 375, wherein a pressure in said reaction vessel is maintained within the range of 10 -3 atmospheres to 100 atmospheres.

453. A method according to claim 375, wherein said reaction occurring at a pressure less than

atmospheric pressure.

454. A method according to claim 375, further comprising the step of releasing hydrogen atoms from said reaction vessel having a binding energy of about Eb = 13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1 or a compound containing said hydrogen atoms.
455. A method according to claim 375, further comprising the step of adsorbing said released energy.
456. A method according to claim 375, further comprising the step of converting energy released from said hydrogen atom into electrical energy.
457. A method according to claim 375, wherein said reaction step is conducted in an internal combustion chamber.
458. A method according to claim 457, wherein said internal combustion chamber is an engine cylinder.
459. A method according to claim 375, further comprising the step of controlling the power output of said cell.
460. A method according to claim 459, wherein said step of controlling the power output of said cell comprises controlling the amount of said gaseous catalyst present in said reaction vessel.
461. A method according to claim 460, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of said reaction vessel and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said reaction vessel.
462. A method according to claim 460, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of a catalyst reservoir containing a source of gaseous catalyst or said gaseous and being in communication with said reaction vessel, and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said catalyst reservoir.

463. A method according to claim 460, wherein said step of controlling the amount of gaseous catalyst comprises controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir into said reaction vessel.

464. A method according to claim 460, wherein said step of controlling the amount of gaseous catalyst comprises controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

465. A method according to claim 460, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of a boat containing a source of gaseous catalyst or said gaseous and being contained in said reaction vessel, and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said boat.

466. A method according to claim 459, wherein said step of controlling the power output of said cell comprises controlling the amount of said gaseous hydrogen atoms or source of gaseous hydrogen atoms present in said reaction vessel.

467. A method according to claim 466, wherein said step of controlling the amount of said gaseous hydrogen atoms or source of gaseous hydrogen atoms comprises controlling the flow of gaseous hydrogen atoms or source of gaseous hydrogen atoms into said reaction vessel.

468. A method according to claim 466, wherein said step of controlling the amount of said source of gaseous hydrogen atoms or gaseous hydrogen atoms comprises controlling the flow of said source of gaseous hydrogen atoms or gaseous hydrogen atoms from said reaction vessel.

469. A method according to claim 466, wherein said step of controlling the amount of said source of gaseous hydrogen atoms or gaseous hydrogen atoms comprises controlling the temperature of a second catalyst for dissociating a hydrogen containing compound into gaseous hydrogen atoms.

470. A method according to claim 469, wherein said step of controlling the temperature of a second catalyst for dissociating a hydrogen containing compound into gaseous hydrogen atoms comprises controlling the power dissipated in a second catalyst heater.

471. A method according to claim 459, wherein said step of controlling the power output of said cell comprises controlling the amount of nonreactive gas in said reaction vessel.

472. A method according to claim 471, wherein said step of controlling the amount of nonreactive gas in said reaction vessel comprises controlling the flow of nonreactive gas into said reaction vessel.

473. A method according to claim 472, wherein said step of controlling the amount of nonreactive gas in said reaction vessel comprises controlling the flow of nonreactive gas from said reaction vessel.

474. A method according to claim 459, wherein said step of controlling the power output of said cell comprises controlling the temperature of a source of gaseous catalyst.

475. A method according to claim 459, wherein said step of controlling the power output of said cell comprises controlling the flow of a hydrogen containing gas over at least one of a hot filament, a tungsten capillary heated by electron bombardment, or an inductively coupled plasma flow.

476. A method according to claim 459, wherein said step of controlling the power output of said cell comprises controlling the power dissipated in an inductively coupled plasma flow tube, hot filament or grid, or tungsten capillary heated by electron bombardment.

477. A method according to claim 459, wherein said step of controlling the power output of said cell comprises controlling the temperature of a hot filament or tungsten capillary heated by electron bombardment over which a hydrogen containing gas flows.

478. A method according to claim 459, wherein said step of controlling the power output of said cell comprises controlling the temperature of a hydride maintained under nonequilibrium conditions.

479. A method according to claim 375, wherein a temperature in said reaction vessel is maintained at a higher temperature than in a catalyst reservoir in communication with said reaction vessel or a boat contained within said reaction vessel.

480.A method according to claim 375, further comprising the step of of measuring the temperature of a catalyst reservoir in communication with said reaction vessel or a boat contained in said reaction vessel.

481.A method according to claim 375, further comprising the step of measuring the temperature of a source of said gaseous catalyst contained in a catalyst reservoir in communication with said reaction vessel or a boat contained within said reservoir.

482.A method according to claim 375, further comprising the step of measuring the temperature of a chamber containing a source of said hydrogen atoms in communication with said reaction vessel.

483.A method according to claim 375, further comprising the step of measuring the temperature of a source of said gaseous hydrogen atoms.

484.A method according to claim 411, further comprising the step of measuring the temperature of said second catalyst.

485.A method according to claim 375, further comprising the step of controlling the temperature of said reaction vessel.

486.A method according to claim 375, further comprising utilizing a nebulizer or atomizer to form said gaseous catalyst.

487.A method according to claim 375, further comprising the step of measuring the pressure in said reaction vessel.

488.A method according to claim 375, further comprising the step of controlling the pressure in said reaction vessel.

489.A method according to claim 375, further comprising the step of measuring the hydrogen pressure in said reaction vessel.

490.A method according to claim 375, further comprising the step of measuring the gaseous catalyst pressure in said reaction vessel.

491.A method according to claim 375, further comprising the step of converting energy released from said gaseous hydrogen atoms into electrical energy.

492. A method according to claim 375, further comprising controlling the pressure of said gaseous catalyst by controlling the amount of said source of catalyst being added to said reaction vessel.

493. A cell comprising:

a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;
a source of hydrogen atoms; and a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen.

494. A cell comprising:
a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;
a source of hydrogen atoms; and a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said gaseous catalyst comprises hydrogen atoms having a binding energy of about Eb = 13.6/n2 eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

495. A cell comprising:
a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;
a source of hydrogen atoms; and a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said source of gaseous catalyst comprises at least one salt selected from the group consisting of RbF, RbCl, RbBr, Rbl, Rb2S2, RbOH, Rb2SO4, Rb2CO3, Rb3PO4, KF, KCl, KBr, Kl, K2S2, KOH, K2SO4, K2CO3, K3PO4, and K2GeF4.

496. A cell comprising:
a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;
a source of hydrogen atoms; and a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said gaseous catalyst comprises at least one ion selected from the group consisting of Mo2+, Ti2+, and Rb+.

497. A cell comprising:
a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;
a source of hydrogen atoms; and a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen

atom, wherein said source of gaseous catalyst comprises at least one metal selected from the group consisting of Mo, Ti, and Rb.

498. A cell comprising:
a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;
a source of hydrogen atoms; and a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said source of gaseous catalyst comprises at least one salt selected from the group consisting of MoI2, TiCl2, TiCl4, SnCl4, SiCl4, PrBr3, CaBr2, SrCl2, CrI2, TbI3, SbCl3, CrF3, CoCl2, BiCl3, NiCl2, PdF2, InCl, LaCl3, DyCl3, LaI3, HoI3, KNO3, VF3, PbF2, VOCl, PbI2, LuCl3, PbCl2, AsI3, HoI3, MoCl3, SnCl4, SbI3, CdI2, AgF2, AgF, LaI3, ErI3, VCl4, BCl3, FeCl3, TiCl3, CoI3, CoF2, TlI, TlF, BiBr3, ZnBr2, AsI3, DyI3, HoCl3, MgCl2, CrCl3, PrCl3, SrCl2, FeCl2, NiCl2, CuCl, SrCl2, MoCl2, YCl3, ZrCl4, CdI2, BaI2, HoI3, PbI2, PdF2, LiF, EuCl3, MgCl2, ErCl3, MgCl2, ErCl3, MgCl2, BiCl4, AlCl3, CaBr2, SmBr3, VaF3, LaCl3, GdI3, CrI2, MnI2, YbBr3, FeBr2, NiCl2, AgCl, ZnCl2, YbCl2, SeF4, SnCl4, SnF4, SbI3, BiI2, EuF3, and PbCl2.

499. A cell comprising:
a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;
a source of hydrogen atoms; and a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said gaseous catalyst comprises at least one pair of ions selected from the group consisting of: (Sn4+, Si4+), (Pr3+, Ca2+), (Sr2+, Cr2+), (Cr3+, Tb3+), (Sb3+,Co2+),(Bi3+, Ni2+), (Pd2+, In+), (La3+, Dy3+), (La3+, Ho3+), (K+, K+) , (V3+, Pd2+), (Lu3+, Zn2+), (As3+, Ho3+), (Mo5+, Sn4+), (Sb3+, Cd2+), (Ag2+,Ag+), (La3+, Er3+), (V4+, B3+), (Fe3+, Ti3+), (Co2+, Ti+), (Bi3+, Zn2+), (As3+, Dy3+), (Ho3+, Mg2+), (K+, Rb+), (Cr3+, Pr3+), (Sr2+, Fe2+), (Ni2+, Cu+), (Sr2+, Mo2+), (Y3+, Zr4+), (Cd2+, Ba2+), (Ho3+, Pb2+), (Pb2+, Li+), (Eu3+, Mg2+), (Er3+, Mg2+), (Bi4+, Al3+), (Ca2+, Sm3+), (V3+, La3+), (Gd3+, Cr2+), (Mn2+, Ti+), (Yb3+, Fe2+), (Ni2+, Ag+), (Zn2+, Yb2+), (Se4+, Sn4+), (Sb3+, Bi2+), and (Eu3+, Pb2+).

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LEGAL EVENTS

Date	Code	Event	Description
Nov 12, 1997	AFNE	National phase entry	
Nov 12, 1997	EEER	Examination request	