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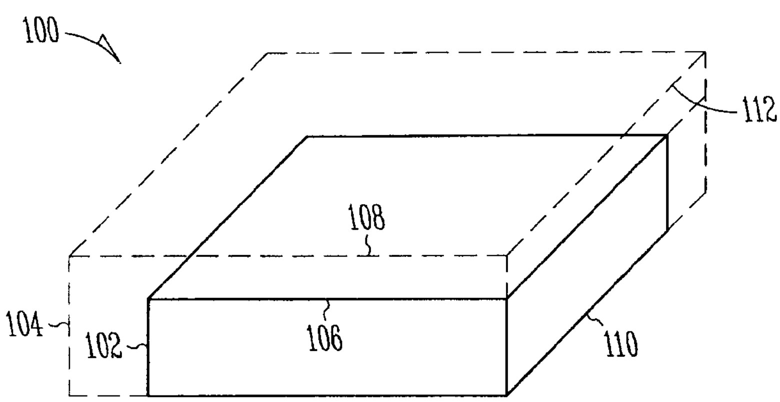

(57) Abstract: Embodiments of the invention relate to a charge indicator for determining the mass of a fluid contained within a fluid enclosure, including a charge indicator that responds to a deformation of a solid component in contact with a fluid contained within a fluid enclosure and wherein the deformation is a function of the mass of fluid contained within the fluid enclosure.

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STATE OF CHARGE INDICATOR AND METHODS RELATED THERETO

TECHNICAL FIELD

Embodiments of the present invention relate to a state of charge indicator. More specifically, embodiments of the invention relate to a state of charge indicator for a fluid enclosure, such as with a fuel cell system.

BACKGROUND

When using any consumable power source, a determination of the amount of operating time left before refueling is a consistent problem. For metal hydride fuel storage systems, this problem becomes especially difficult. Metal hydrides are often used to store fuels, such as hydrogen, in conjunction with fuel cells for electrochemical generation of power. Hydrogen is absorbed into a metal alloy, creating a hydride of the alloy.

Measuring the weight of the fluid stored within metal hydrides is error prone as the fluid weight is low compared to the overall weight of the system. The error in weight-based fuel gauging increases dramatically as the amount of fuel in a system lowers, leading to great uncertainty in a weight-based assessment.

In powder-based hydride systems, some try to correlate internal pressure to a state of charge. This method does not work well as hydrides are designed to operate at a constant pressure until they are nearly fully discharged. Also, this constant pressure of operation is highly correlated with environmental temperature. Therefore, any pressure-based measurement of a hydride system is a better indicator of the system temperature than it is of the system state of charge. In addition, conventional hydride systems based on powders can pack and therefore induce large strains on an enclosure, confounding the determination as to whether any hydrogen remains in the enclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are not necessarily drawn to scale, like numerals describe substantially similar components throughout the several views. Like numerals having different letter suffixes represent different instances of substantially similar components. The drawings illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present document.

FIG. **1** illustrates a perspective view of a component and its dimensions associated with a deformation, according to some embodiments.

FIG. **2** illustrates a schematic view of a fluid enclosure containing a fluid storage material, according to some embodiments.

FIG. **3** illustrates a schematic view of a fluid enclosure including a mechanical transducer, according to some embodiments.

FIG. **4** illustrates a perspective view of a portion of an electronic device and a fluid enclosure, according to some embodiments.

FIG. **5** illustrates a schematic view of a fluid enclosure in an empty state of charge, according to some embodiments.

FIG. **6** illustrates a schematic view of a fluid enclosure in a full state of charge, according to some embodiments.

FIG. **7** illustrates a perspective view of a portion of an electronic device and a fluid enclosure including an observation window, according to some embodiments.

FIG. **8** illustrates a schematic view of a fluid enclosure including an observation window, according to some embodiments.

FIG. **9** illustrates a schematic view of a fluid enclosure including an observation window at an angle less than perpendicular, according to some embodiments.

FIG. **10** illustrates a schematic view of a state of charge indicator system utilizing more than one fluid enclosure, according to some embodiments.

FIG. **11** illustrates a block flow diagram of a method of using a state of charge indicator, according to some embodiments.

SUMMARY

Embodiments of the invention relate to a charge indicator for determining the mass of a fluid contained within a fluid enclosure, including a charge indicator that responds to a deformation of a solid component in contact with a fluid contained within a fluid enclosure and wherein the deformation is a function of the mass of fluid contained within the fluid enclosure.

Embodiments also relate to a fuel cell system. The fuel cell system comprises a fluid enclosure, one or more solid components in contact with the fluid enclosure, and a charge indicator in contact with at least one of the one or more solid components and fluid enclosure. Further, the fuel cell system comprises one or more fuel cells in contact with at least one of the one or more the solid components, charge indicator and fluid enclosure. The charge indicator responds to a deformation of one or more of the solid components or fluid enclosure and the deformation is a function of the mass of a fluid contained within the fluid enclosure.

DETAILED DESCRIPTION

The following detailed description includes references to the accompanying drawings, which form a part of the detailed description. The drawings show, by way of illustration, specific embodiments in which the invention may be practiced. These embodiments, which are also referred to herein as "examples," are described in enough detail to enable those skilled in the art to practice the invention. The embodiments may be combined, other embodiments may be utilized, or structural, and logical changes may be made without departing from the scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims and their equivalents.

In this document, the terms "a" or "an" are used to include one or more than one and the term "or" is used to refer to a nonexclusive "or" unless otherwise indicated. In addition, it is to be understood that the phraseology or terminology employed herein, and not otherwise defined, is for the purpose of description only and not of limitation. Furthermore, all publications, patents, and patent documents referred to in this document are incorporated by reference herein in their entirety, as though individually incorporated by reference. In the event of inconsistent usages between this document and those documents so incorporated by reference, the usage in the incorporated reference should be considered supplementary to that of this document; for irreconcilable inconsistencies, the usage in this document controls.

Embodiments of the invention relate to a state of charge indicator in contact with a fluid enclosure. The state of charge indicator may respond to a deformation of a component, such as a fluid enclosure or fluid storage material. The deformation may be a function of the state of charge of the fluid enclosure. The deformation may be a direct result of the mass of fluid contained within the fluid enclosure and not simply a measure or result of a pressure change, similar to conventional measurements. Unlike strain measurements on traditional rigid enclosures, embodiments of the invention relate to deformations greater than about 1%, greater than about 3% or between about 3% and about 10%, for example. By responding to a deformation, the state of charge indicator relies on an effect directly related to the state of charge of the fluid enclosure and not on any secondary effects. The response to a deformation may be substantially independent of secondary effects, such as environmental temperature, fluid storage material settling, environmental barometric pressure, environmental humidity, aging of fluid storage material or combinations thereof. Substantially independent may indicate an error in determination of the state of charge of less than about 1%, for example.

Definitions

As used herein, “charge indicator” or “state of charge indicator” refers to a device or instrument that senses or converts a signal relating to the charge of a fluid in a fluid enclosure. Transducers are an example of a charge indicator.

As used herein, “transducer” refers to a device that senses or converts one form of a signal to another. A mechanical linkage is an example of a transducer.

As used herein, “indicating” or “indicate” refers to signifying or displaying. A charge indicator may indicate or signify the state of charge of a fluid enclosure.

As used herein, "state of charge" refers to a mass of fluid contained within a fluid enclosure. State of charge may refer to an absolute mass of fluid, or to a mass of fluid relative to a mass of fluid contained within a fluid enclosure when said enclosure is "full" or substantially full, for example.

As used herein, "responding" or "responds" refers to acting in reply to a stimulus. Responding may include physical, chemical or electrical reply to a stimulus, such as a deformation.

As used herein, "determine" or "determining" refers to ascertaining, such as by measuring for example. Determining may include indicating or an indication may be subsequent to a determination, for example.

As used herein, "deformation" refers to an alteration of shape. The deformation may be in any dimension, for example. A solid component, such as a fluid enclosure, may deform when in contact with a fluid, for example. A deformation of a solid component may be greater than about 1%, between about 1% and about 3% or between about 3% and about 10%, for example. The deformation of a solid component may be in response to a change in strain state of a solid component, for example.

As used herein, "change" or "changing" refers to becoming different or undergoing alteration or transformation.

As used herein, "change in strain state" refers to an altered state caused by an external force. For example, an altered state may include physical deformation or changes in electrical resistance. An external force may be physical, chemical or an electrical force, for example. A physical force may be a deformation caused by an increased or decreased mass of fluid in a flexible fluid enclosure, for example.

As used herein, "strain state" refers to a state of a material dependent on any strain exposed to the material.

As used herein, "function" refers to a variable so related to another that for each value assumed by one there is a value determined for the other. For example, deformation may be a function of the state of charge of a fluid enclosure such that as fluid mass within the enclosure varies, the deformation varies in a determinable way.

As used herein, "observable property" refers to a property of a material that can be measured or visually monitored. A material that changes color upon displacement is an example of an observable property.

As used herein, "secondary effects" refers to external forces that may affect a response to the state of charge of a fluid in contact with a fluid enclosure. For example, secondary effects may include environmental temperature, barometric pressure, humidity, fluid storage material settling, fluid storage material aging or combinations thereof.

As used herein, "displaying" refers to a visual representation of information. For example, displaying may refer to the creation or use of visible words, indicating lines, patterns, digital numbers, etc. in response to a state of charge of a fluid enclosure. Displaying may also refer to the illustration of words, symbols, or numbers on an electronic screen, such as an LCD screen, for example.

As used herein, "composite hydrogen storage material" refers to active material particles mixed with a binder, wherein the binder immobilizes the active material particles sufficient to maintain relative spatial relationships between the active material particles. Examples of composite hydrogen storage materials are found in commonly-owned U.S. Patent Application Serial No.11/379,970, filed April 24, 2006, whose disclosure is incorporated by reference herein in its entirety.

As used herein, "metal hydride particles" or "metal hydrides" refer to metal or metal alloy particles that are capable of forming metal hydrides when contacted with hydrogen. Examples of such metal or metal alloys are FeTi, ZrV_2, $LaNi_5$, Mg_2Ni and V. Such compounds are representative examples of the more general description of metal hydride compounds: AB, AB_2, A_2B, AB_5 and BCC, respectively. When bound with hydrogen, these compounds form metal hydride complexes, such as MgH_2, Mg_2NiH_4, $FeTiH_2$ and $LaNi_5H_6$, for example. Examples of metals used to form metal hydrides include vanadium, magnesium, lithium, aluminum, calcium, transition metals, lanthanides, and intermetallic compounds and solid solutions thereof.

As used herein, "fluid" refers to a gas, liquefied gas, liquid, liquid under pressure or any one of the above in physical or chemical contact with a fluid storage material. Examples of fluids include hydrogen, methanol, ethanol, formic acid, butane, borohydride compounds, etc. Fluid may be amorphous and free-flowing or in physical or chemical contact with a fluid storage material. A fluid may be bound to absorbing materials, for example.

As used herein, "occluding/desorbing material" refers to a material capable of absorbing, adsorbing or retaining a substance and further capable of allowing the substance to be removed. The occluding/desorbing material may retain the substance chemically or physically, such as by chemisorption or physisorption, for example. Examples of such a material include metal hydrides, composite hydrogen storage materials, clathrates, etc.

As used herein, "occlude" or "occluding" or "occlusion" refers to absorbing or adsorbing and retaining a substance. Hydrogen may be the substance occluded, for example. A substance may be occluded chemically or physically, such as by chemisorption or physisorption, for example.

As used herein, "desorb" or "desorbing" or "desorption" refers to the removal of an absorbed or adsorbed substance. Hydrogen may be removed from active material particles, for example. The hydrogen may be bound physically or chemically, for example.

As used herein, "contacting" refers to physically, chemically or electrically touching or functionally integrating. A fluid may contact an enclosure, in which the fluid is physically forced inside the enclosure, for example. Contacting may include fluidic communication in which two or more components are in such position as to pass a fluid in one or more directions between them, for example. One or more fuel cells may contact a fluid enclosure, such as by fluidic communication. A fluid storage material may be functionally integrated within a fluid enclosure, such as being contained within (and yet, not be physically touching, for example).

As used herein, "releasing" refers to freeing from something that binds, fastens or holds back, either physically or chemically. A fluid may be physically released from an enclosure, for example. A fluid may be chemically or physically released from a fluid storage material, for example.

As used herein, "flexible fluid enclosure" or "flexible portion of a fluid enclosure" may refer to a fluid enclosure including a structural filler and an outer enclosure wall, conformably coupled to the structural filler. Examples of such a fluid enclosure are found in commonly-owned U.S. Patent Application Serial No. 11/473,591, filed June 23, 2006, whose disclosure is incorporated by reference herein in its entirety.

As used herein, "conformably coupled" refers to forming a bond that is substantially uniform between two components and are attached in such as way as to chemically or physically bind in a corresponding shape or form. A structural filler may be conformably coupled to an outer enclosure wall, for example, in which the outer enclosure wall chemically or physically binds to the structural filler and takes its shape.

As used herein, "outer enclosure wall" refers to the outermost layer within a fluid enclosure that serves to at least partially slow the diffusion of a fluid from the fluid enclosure. The outer enclosure wall may include multiple layers of the same or differing materials. The outer enclosure wall may include a polymer or a metal, for example.

As used herein, "structural filler" refers to a material with a sufficient tensile strength to withstand the internal pressure of a fluid enclosure, when pressurized with a fluid. Structural fillers may be solid. Structural fillers may include metallic or plastic lattices, composite hydrogen storage materials, clathrates, nano-structured carbon foams, aerogels, zeolites, silicas, aluminas, graphite, activated carbons, micro-ceramics, nano-ceramics, boron nitride nanotubes, borohydride powder, palladium-containing materials or combinations thereof, for example.

As used herein, "fluid storage material" refers to a material that may be in physical or chemical contact with a fluid, usually for the purpose of assisting the storage of the fluid. Hydrogen may be chemically bound with a metal alloy to provide a metal hydride, an example of a fluid storage material.

Referring to FIG. **1**, a perspective view of a component 100 and its dimensions associated with a deformation is shown, according to some embodiments. A component 100 may alter its dimensions based on a deformation. In FIG. **1**, for example, a component 100 may change dimensions 102, 106 and 110 to the larger dimensions of 104, 108 and 112 respectively, when charged with a fluid, such as hydrogen. Charging a component 100 may include filling, contacting, occluding, absorbing, adsorbing, etc. with a fluid, such as hydrogen. The component 100 may comprise a fluid storage material or a fluid enclosure, for example. The dimensions 104, 108 and 112 may be up to about 10% greater than dimensions 102, 106 and 110, for example. The change in dimensions may be reversible as the fluid mass decreases within the component 100. The shape of the component may be arbitrary or prismatic and any of its dimensions may be altered with a deformation, for example.

Many types of charge indicators may be utilized to respond to a deformation of component 100. A charge indicator may comprise a liquid or solid that may displace with a deformation. A charge indicator may include a solid that changes an observable property as it is displaced. An observable property may be color, for example. A charge indicator may be a mechanical indicator in contact with the component 100, for example. The charge indicator may respond directly to the deformation, such as with a mechanical linkage, or indirectly by responding to an electronic signal or change in electrical properties of the component 100 based on the deformation, for example. A charge indicator may include an optical interference pattern, such that a visual pattern may be created or altered based on the deformation. Examples of optical interference patterns may include faceted patterns, grids, pixels, one or more visible words, or combinations thereof. The charge indicator may include an array of conductors on the surface of the component and in contact with one or more fixed brushes, for example. As a deformation alters the dimensions of a component, the conductors may respond to the number of brushes currently in contact, for example.

In some embodiments, the component 100 may not be visible to a user. The charge indicator would then communicate information about the state of charge associated with a fluid enclosure from within a system, such as a fuel cell system, to some exterior location where the information may be communicated to a user or to a monitoring system, for example. A transducer, such as an electronic transducer, may be in contact with the component 100 and indicate the state of charge of the fluid enclosure as a function of the deformation of the component 100, for example. An extensometer or strain gauge may be an example of an electronic transducer. The deformation may also be monitored indirectly by responding to the electrical resistance of the component 100, such as with a charge-variable resistor, for example.

The component 100 may include a metal hydride, a composite hydrogen storage material or a mixture thereof. The component 100 may include a structural filler, such as metallic or plastic lattices, composite hydrogen storage materials, clathrates, nano-structured carbon foams, aerogels, zeolites, silicas, aluminas, graphite, activated carbons, micro-ceramics, nano-ceramics, boron nitride nanotubes, borohydride powder, palladium-containing materials or combinations thereof, for example. The component 100 may include a flexible fluid enclosure or a flexible portion of a fluid enclosure, for example.

Referring to FIG. **2**, a schematic view of a fluid enclosure containing a fluid storage material 200 is shown, according to some embodiments. A fluid enclosure 202 may enclose fluid storage material. The fluid storage material may comprise a composite hydrogen storage material 212, metal hydride powder 210 and a composite hydrogen storage material 206 in contact with a state of charge indicator 208. The state of charge indicator 208 may be a transducer and be in contact with transducer connector leads 216, for example. The leads 216 may be in contact with the fluid enclosure 202 through a sealed aperture 214, for example. A fluid inlet/outlet port 204 may also be positioned in contact with the fluid enclosure 202. As the strain state changes within the composite hydrogen storage material 212 and metal hydride powder 210, the state of charge of the fluid enclosure 202 may be monitored as the one or more composite hydrogen storage materials 206 in contact with a state of charge indicator 208 deforms, correlating to the state of charge of all fluid storage material within the fluid enclosure 202. The state of charge indicator 208 may be transducer, such as an extensometer, a resistance or fiber strain gauge, for example.

The fluid storage material may be capable of occluding/desorbing a fluid, for example. The composite hydrogen storage material 212 and 206 may be capable of occluding and desorbing hydrogen, for example. The fluid may be a gas, a liquefied gas, a liquid or a combination thereof. The fluid may be hydrogen, for example.

Referring to FIG. **3**, a schematic view of a fluid enclosure including a mechanical transducer 300 is shown, according to some embodiments. A fluid enclosure 202 may enclose a fluid storage material 302. A mechanical transducer 306, such as a mechanical linkage, may be in contact with the fluid storage material 302. The mechanical transducer 306 may be in contact with the fluid enclosure 202 through a sealed aperture 214, for example. A fluid inlet/outlet port 204 may also be positioned in contact with the fluid enclosure 202. As the fluid storage material 302 deforms, it may change its dimensions 304. The mechanical transducer 306 would then change position 308 as a function of the deformation of the fluid storage material 302. The position change 308 may then be an indication of the state of charge or be used to communicate that information to a monitoring system, for example.

Referring to FIG. **4**, a perspective view of a portion of an electronic device and a fluid enclosure 400 is shown, according to some embodiments. A portion of an electronic device 402 may surround a fluid enclosure 404 and a cavity 406 enclosing the fluid enclosure 404. A charge indicator 408 may be in contact with the fluid enclosure 404 and also in contact with the portion of an electronic device 402. As the fluid enclosure 404 deforms, the charge indicator 408 may respond to the deformation, such as by responding to the change in distance 410 between the fluid enclosure 404 and the cavity 406, for example. The charge indicator 408 may indicate an empty state of charge 502 of the fluid enclosure 404 (as shown in FIG. **5**). As the fluid enclosure 404 changes dimensions in response to a deformation, the distance 410 between the fluid enclosure 404 and cavity 406 may change. The charge indicator 408 may then indicate a full state of charge 602 (as shown in FIG. **6**).

The fluid enclosure 404 may be flexible or a portion of the fluid enclosure may be flexible, such that the deformation due to fluid mass within the fluid enclosure causes dimension changes or changes in electrical properties of the fluid enclosure, for example.

The charge indicator 408 may be a mechanical displacement device, for example. Further examples of charge indicators 408 may be open cell foam, closed cell foam, a spongy material or an elastomer that expands on discharge of a fluid, a fluid drawn into an increasing volume or a lever based indicator. The fluid enclosure 404 or a portion of the enclosure may change color due to the deformation, for example.

The portion of electronic device 402 may be part of a fluid enclosure system, such as fuel cell system, for example. The fluid enclosure system may include a volume less than about 1000 cubic centimeters, for example. Examples of electronic devices include a cellular phone, satellite phone, PDA, laptop computer, computer accessory, ultra mobile computer, display, personal audio or video player, medical device, television, transmitter, receiver, lighting device, flashlight or electronic toy. A fuel cell system may include at least one or more components, a charge indicator in contact with the one or more components, and one or more fuel cells in contact with one or more of the components and charge indicator, for example.

Referring to FIG. **7**, a perspective view of a portion of an electronic device and a fluid enclosure including an observation window 700 is shown, according to some embodiments. A portion of an electronic device 402 may surround a fluid enclosure 404 and a cavity 406 enclosing the fluid enclosure 404. A cover 702 may contact the cavity 406 and the fluid enclosure 404. The cover 702 may have an observation window 704 disposed within in order to visually observe changes in the dimensions of the fluid enclosure 404, such as by observing the changing distance 410 between the cavity 406 and fluid enclosure 404, for example. The observation window 704 may be an observation window 804 at an angle about 90 degrees or an observation window 902 at an angle less than about 90 degrees, for example (FIGS. **8** and **9**, respectively). If the observation window 902 is at an angle less than about 90 degrees (about 50 degrees would be an example), then the dimension change of the fluid enclosure 404 may be more observable or amplified. The dimension change of the fluid enclosure 404 may be visually noted using color stripes, hash marks or grids, for example.

Referring to FIG. **10**, a schematic view of a state of charge indicator system utilizing more than one fluid enclosure 1000 is shown, according to some embodiments. The state of charge of a larger fluid enclosure 1004 may be indicated by the correlated state of charge of a smaller fluid enclosure 1002 associated with a charge indicator, for example. Fluid may pass through a connection 1006 before or after contacting the fluid inlet/outlet 1008. If substantially the same fluid or fluid storage material is utilized in each enclosure, the state of charge of the smaller fluid enclosure 1002 may be utilized as an indication of the state of charge of the larger fluid enclosure 1004, without it being separately monitored.

Referring to FIG. **11**, a block flow diagram of a method of using a state of charge indicator 1100 is shown, according to some embodiments. A charge indicator may respond 1102 to a deformation of a component. A state of charge or a mass of fluid may then be displayed 1104. Displaying may include converting the response to a digital display, such as on an LCD screen, for example. Responding 1102 may include displacing a solid, displacing a liquid or resisting an electrical signal, for example.

The Abstract is provided to comply with 37 C.F.R. §1.72(b) to allow the reader to quickly ascertain the nature and gist of the technical disclosure. The Abstract is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

CLAIMS

What is claimed is:

1. A charge indicator for determining the mass of a fluid contained within a fluid enclosure, comprising:

a charge indicator that responds to a deformation of a solid component in contact with a fluid contained with a fluid enclosure;

wherein the deformation is a function of the mass of fluid contained within the fluid enclosure.

2. The charge indicator of claim 1, wherein environmental temperature changes introduce less than about a 1% error in determining the mass of fluid contained within the fluid enclosure.

3. The charge indicator of claim 1, wherein environmental humidity changes introduce less than about a 1% error in determining the mass of fluid contained within the fluid enclosure.

4. The charge indicator of claim 1, wherein environmental barometric pressure changes introduce less than about a 1% error in determining the mass of fluid contained within the fluid enclosure.

5. The charge indicator of claim 1, wherein the deformation comprises a change in physical dimensions of the solid component.

6. The charge indicator of claim 1, wherein the deformation comprises about a 1% deformation.

7. The charge indicator of claim 1, wherein the deformation comprises about a 1% to about a 3% deformation.

8. The charge indicator of claim 1, wherein the deformation comprises about a 3% to about a 10% deformation.

9. The charge indicator of claim 1, wherein the fluid comprises a gas, a liquefied gas, a liquid or a combination thereof.

10. The charge indicator of claim 1, wherein the fluid comprises a gas.

11. The charge indicator of claim 1, wherein the fluid comprises hydrogen.

12. The charge indicator of claim 1, wherein the solid component comprises a fluid storage material in contact with the fluid enclosure.

13. The charge indicator of claim 12, wherein settling in the fluid storage material introduces less than about a 1% error in determining the mass of fluid contained within the fluid enclosure.

14. The charge indicator of claim 12, wherein aging of the fluid storage material introduces less than about a 1% error in determining the mass of fluid contained within the fluid enclosure.

15. The charge indicator of claim 12, wherein the fluid storage material is capable of occluding and desorbing hydrogen.

16. The charge indicator of claim 1, wherein the solid component comprises a composite hydrogen storage material.

17. The charge indicator of claim 1, wherein the solid component comprises a metal hydride.

18. The charge indicator of claim 1, wherein the solid component comprises a mixture of metal hydride powder and a composite hydrogen storage material.

19. The charge indicator of claim 1, wherein the solid component comprises type AB, AB_2, A_2B, AB_5, BCC metal hydrides or combinations thereof.

20. The charge indicator of claim 1, wherein the solid component comprises $LaNi_5$, FeTi, or $MmNi_5$, wherein Mm refers to a mixture of lanthanides.

21. The charge indicator of claim 1, wherein the solid component comprises clathrates, silicas, aluminas, zeolites, graphite, activated carbons, nano-structured carbons, micro-ceramics, nano-ceramics, boron nitride nanotubes, palladium-containing materials or combinations thereof.

22. The charge indicator of claim 1, wherein the solid component comprises a fluid enclosure.

23. The charge indicator of claim 1, wherein the solid component comprises a flexible fluid enclosure.

24. The charge indicator of claim 23, wherein the charge indicator comprises a color change in the flexible fluid enclosure.

25. The charge indicator of claim 1, wherein the solid component comprises a portion of a flexible fluid enclosure.

26. The charge indicator of claim 1, wherein the charge indicator comprises a mechanical transducer.

27. The charge indicator of claim 1, wherein the charge indicator comprises open cell foam.

28. The charge indicator of claim 1, wherein the charge indicator comprises a fluid.

29. The charge indicator of claim 1, wherein the charge indicator comprises a lever indicator.

30. The charge indicator of claim 1, wherein the charge indicator comprises a visible window to view the deformation of a component.

31. The charge indicator of claim 30, wherein the window is at about a 90 degree angle to the component.

32. The charge indicator of claim 30, wherein the window is at an angle less than about a 90 degree angle to the component.

33. The charge indicator of claim 30, wherein the window is at about a 90 degree angle to the flexible fluid enclosure.

34. The charge indicator of claim 30, wherein the window is at an angle of about 50 degrees to about 90 degrees to the component.

35. The charge indicator of claim 22, further comprising a second fluid enclosure.

36. The charge indicator of claim 35, wherein the second fluid enclosure contacts a fluid and wherein the fluid comprises substantially the same fluid as in contact with the first fluid enclosure.

37. The charge indicator of claim 36, wherein the charge indicator associated with the first fluid enclosure maintains a charge balance with the second fluid

enclosure, such that the charge correlates and the second fluid enclosure is not monitored.

38. The charge indicator of claim 1, wherein the charge indicator comprises a mechanical indicator.

39. The charge indicator of claim 38, wherein the mechanical indicator comprises a mechanical linkage.

40. The charge indicator of claim 1, wherein the charge indicator comprises a solid that changes an observable property when displaced.

41. The charge indicator of claim 1, wherein the charge indicator comprises a liquid.

42. The charge indicator of claim 1, wherein the charge indicator comprises an optical interference pattern.

43. The charge indicator of claim 42, wherein the optical interference pattern comprises a grid.

44. The charge indicator of claim 42, wherein the optical interference pattern comprises a faceted pattern.

45. The charge indicator of claim 42, wherein the optical interference pattern comprises pixels.

46. The charge indicator of claim 42, wherein the optical interference pattern provides one or more visible words upon straining of the component.

47. The charge indicator of claim 1, wherein the charge indicator comprises a transducer.

48. The charge indicator of claim 1, wherein the charge indicator comprises a charge-variable resistor.

49. The charge indicator of claim 1, wherein the charge indicator comprises a strain gauge.

50. The charge indicator of claim 1, wherein the charge indicator comprises an extensometer.

51. The charge indicator of claim 1, wherein the charge indicator comprises a fiber optic strain gauge.

52. The charge indicator of claim 1, wherein the charge indicator comprises a resistance strain gauge.

53. The charge indicator of claim 1, wherein the charge indicator comprises an array of conductors on the surface of the component and in contact with one or more fixed brushes.

54. A fuel cell system comprising:

a fluid enclosure;

one or more solid components, in contact with the fluid enclosure;

a charge indicator, in contact with at least one of the one or more solid components and fluid enclosure; and

one or more fuel cells, in contact with at least one of the one or more the solid components, charge indicator and fluid enclosure;

wherein the charge indicator responds to a deformation of one or more of the solid components or fluid enclosure and wherein the deformation is a function of the mass of a fluid contained within the fluid enclosure.

55. The fuel cell system of claim 54, wherein the one or more solid components are contained within the fluid enclosure.

56. The fuel cell system of claim 54, wherein the one or more fuel cells are in fluidic communication with at least one of the one or more solid components, charge indicator and fluid enclosure.

57. The fuel cell system of claim 54, wherein the one or more solid components comprise a composite hydrogen storage material.

58. The fuel cell system of claim 54, wherein the one or more solid components comprise a metal hydride.

59. The fuel cell system of claim 54, wherein the one or more solid components comprise a mixture of metal hydride powder and a composite hydrogen storage material.

60. The fuel cell system of claim 54, wherein the one or more solid components comprise type AB, AB_2, A_2B, AB_5, BCC metal hydrides or combinations thereof.

61. The fuel cell system of claim 54, wherein the one or more solid components comprise $LaNi_5$, FeTi, or $MmNi_5$, wherein Mm refers to a mixture of lanthanides.

62. The fuel cell system of claim 54, wherein the one or more solid components comprise clathrates, silicas, aluminas, zeolites, graphite, activated carbons, nano-structured carbons, micro-ceramics, nano-ceramics, boron nitride nanotubes, palladium-containing materials or combinations thereof.

63. The fuel cell system of claim 54, wherein the fluid enclosure comprises a flexible fluid enclosure.

64. The fuel cell system of claim 54, wherein the fluid enclosure comprises a fluid enclosure with a flexible portion.

65. The fuel cell system of claim 54, wherein one or more of the charge indicator and fuel cells are further coupled to an electronic device.

66. The fuel cell system of claim 54, wherein the electronic device comprises a cellular phone, satellite phone, PDA, laptop computer, computer accessory, ultra mobile computer, display, personal audio or video player, medical device, television, transmitter, receiver, lighting device, flashlight or electronic toy.

67. The fuel cell system of claim 54, wherein the fluid enclosure system comprises a volume of less than about 1000 cubic centimeters.

68. A method for determining the mass of fluid contained within a fluid enclosure, the method comprising:

responding to a deformation of a solid component;

wherein the deformation is a function of the mass of a fluid contained within the fluid enclosure.

69. The method of claim 68, further comprising after responding, displaying a mass of fluid in contact with a fluid enclosure.

70. The method of claim 68, wherein responding comprises displacing a solid.

71. The method of claim 68, wherein responding comprises displacing a liquid.

72. The method of claim 68, wherein responding comprises resisting an electrical signal.

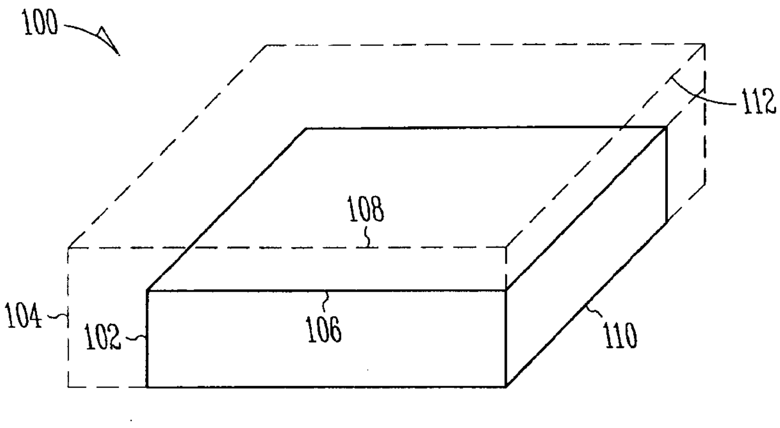

Fig.1

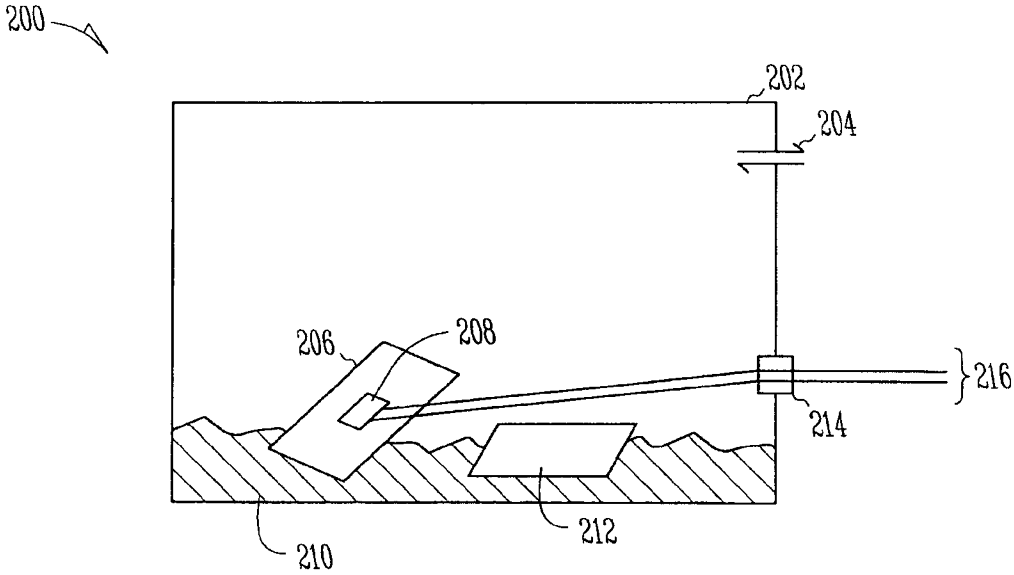

Fig.2

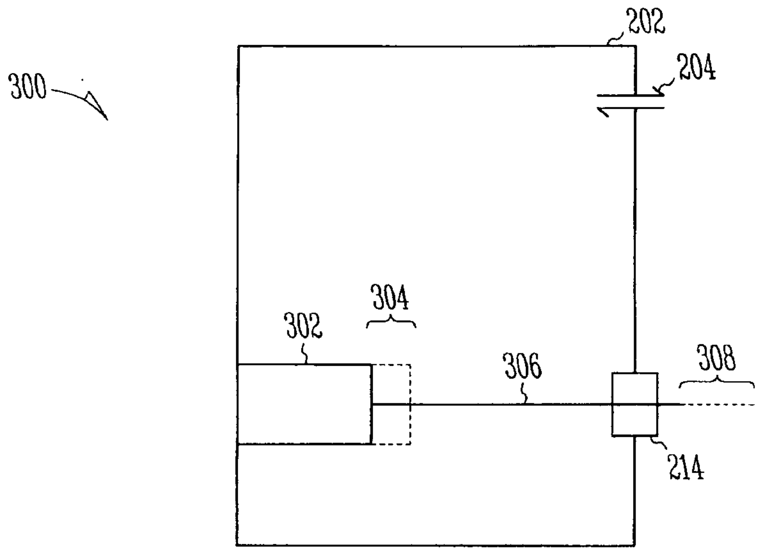

Fig.3

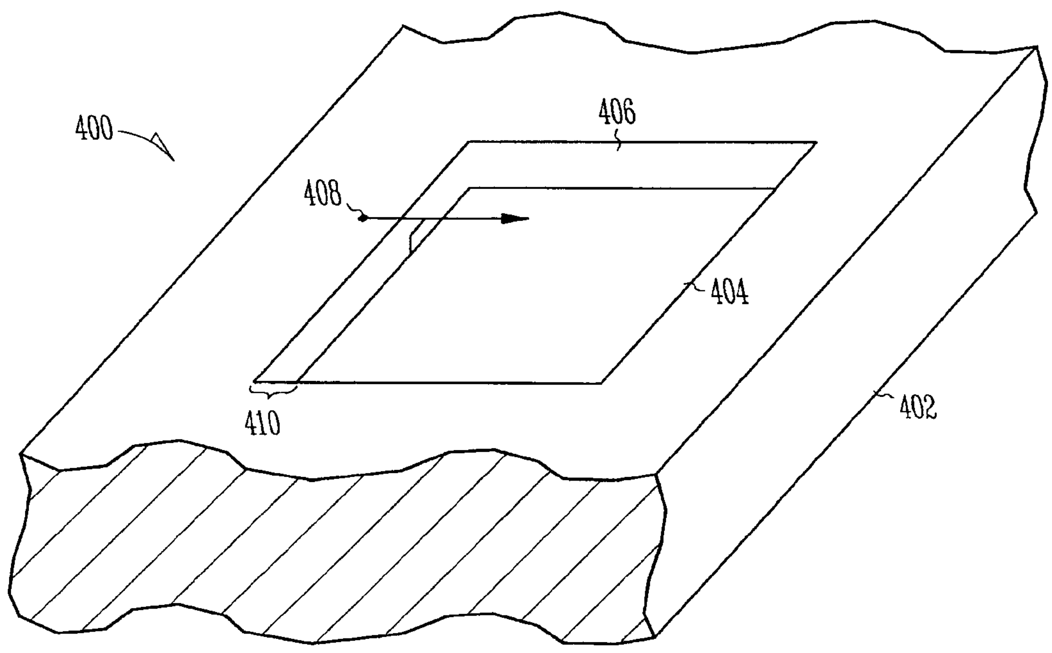

Fig.4

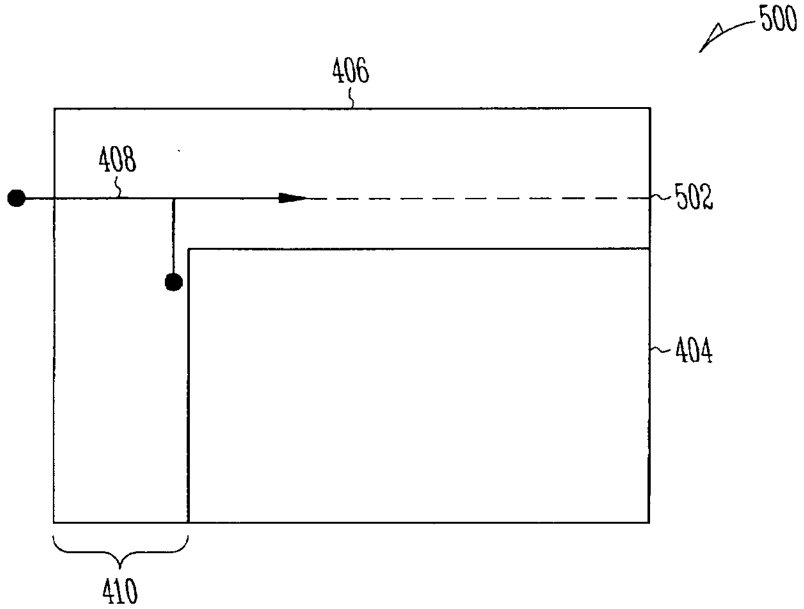

Fig.5

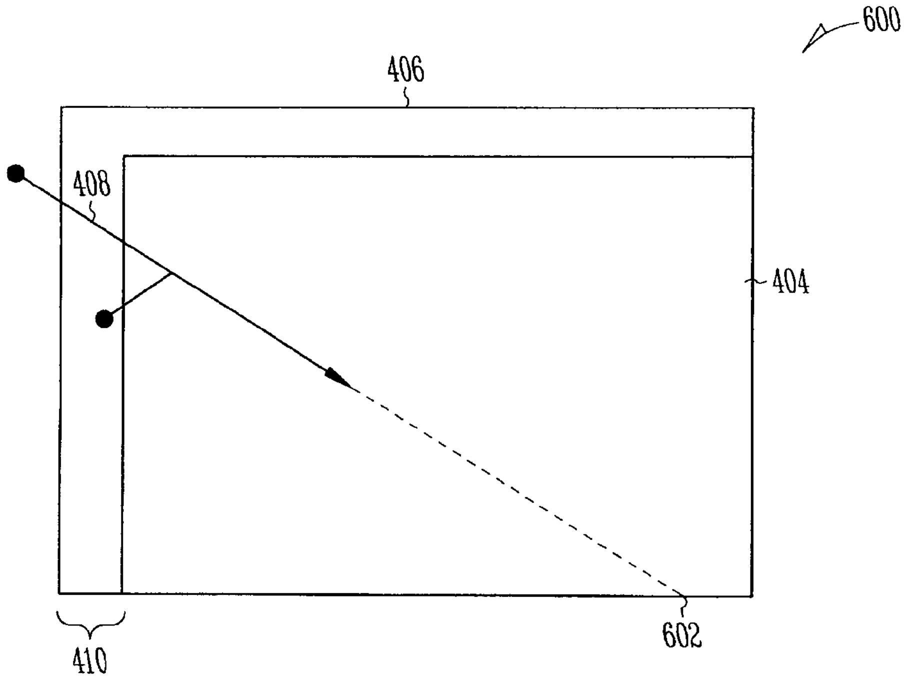

Fig.6

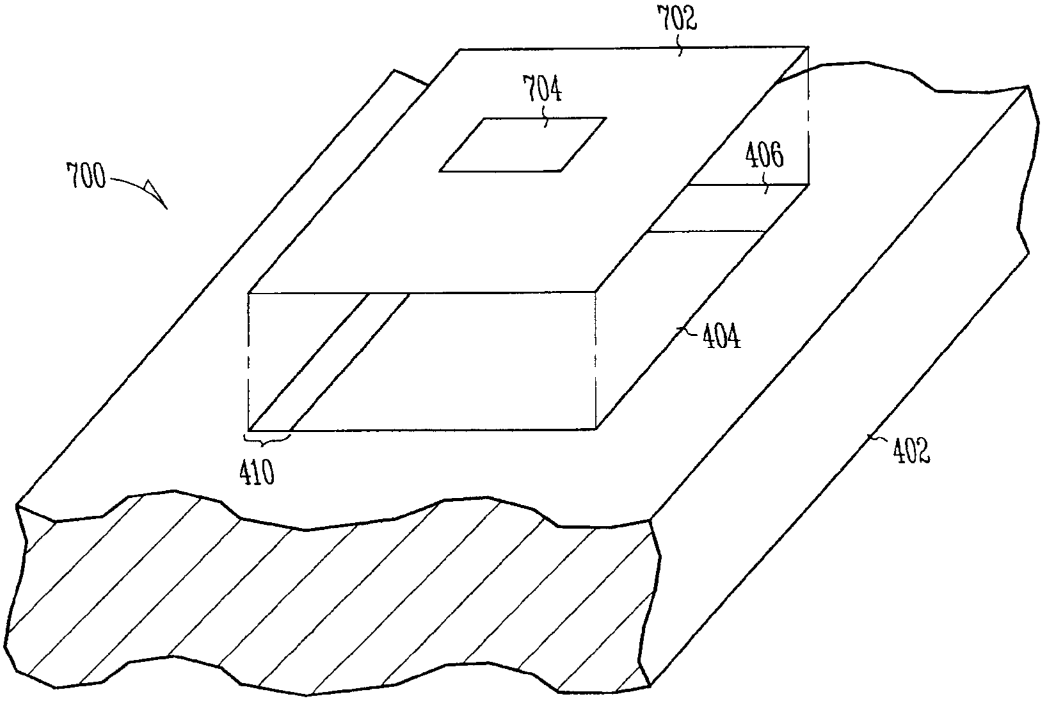

Fig.7

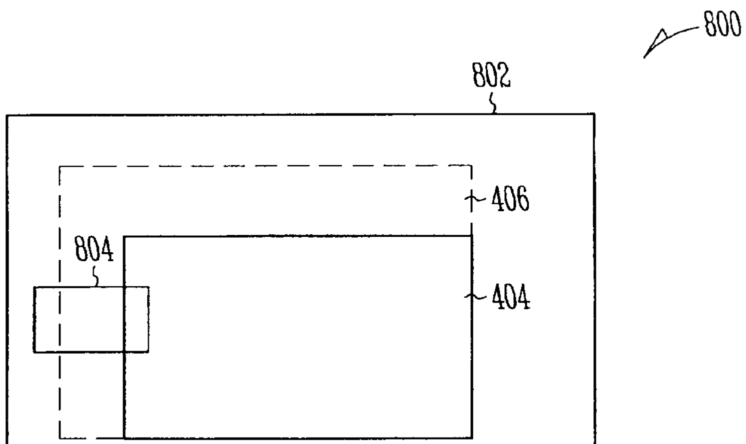

Fig.8

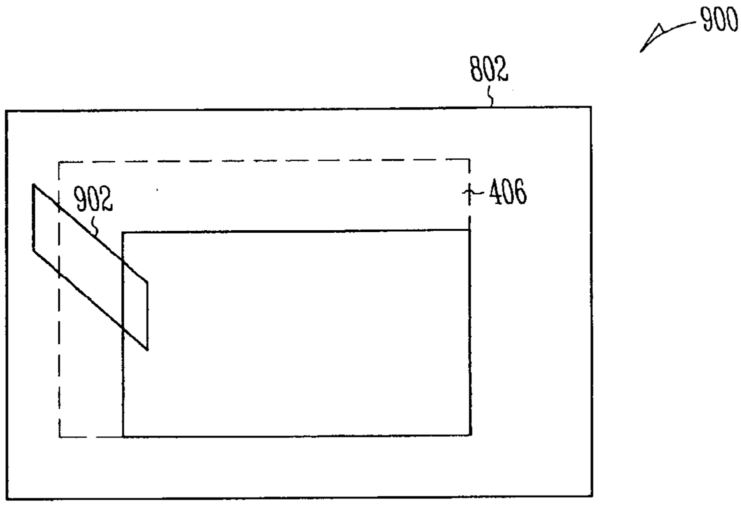

Fig.9

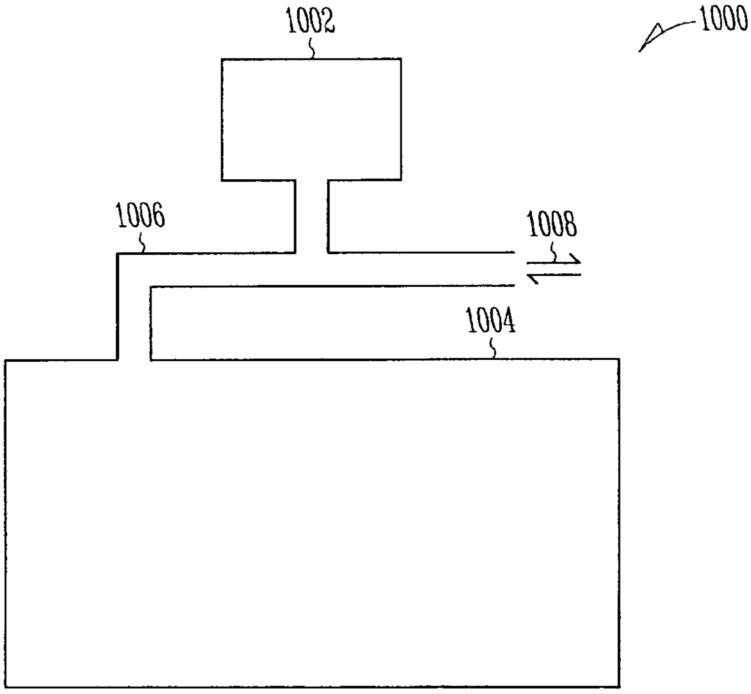

Fig.10

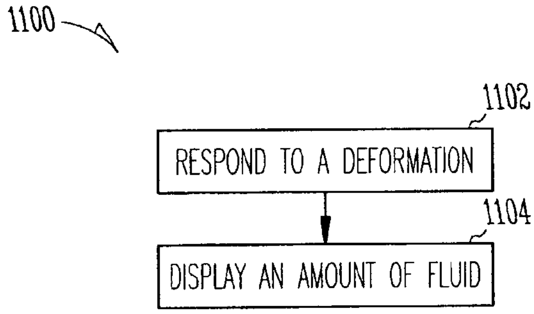
1100
1102
RESPOND TO A DEFORMATION
1104
DISPLAY AN AMOUNT OF FLUID

Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2007/002350

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***G01G 17/04*** (2006.01) , ***G01G 3/12*** (2006.01) , ***G01G 3/14*** (2006.01) , ***H01M 8/04*** (2006.01) , ***H01M 8/24*** (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01G 17/04 (2006.01) , ***G01G 3/12*** (2006.01) , ***G01G 3/14*** (2006.01) , ***H01M 8/04*** (2006.01) , ***H01M 8/24*** (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Techsource (fluid, mass, weight, expansion, detector, thermal), Google and Fampat (weigh, fluid, dial, mass, fluid. expansion, hydrogen, storage, material, sensor, detector, composite, hydrogen, storage, material) IEEEXplore (pressure, storage, tank, mass, strain gauge)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10046102 A1 Heinz-Ronald 28 March 2002 (28-03-2002) *Abstract, Fig1*	1-29 and 35-72
A,P	US 2007/0186662 A1 Linglin et al. 16 Aug. 2007 (16-08-2007)	1-72

[ ] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
0 3 April 2008 (03-04-2008)	25 April 2008 (25-04-2008)

Name and mailing address of the ISA/CA	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Jean Fortin 819- 997-7985

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2007/002350

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
DE10046102	28-03-2002	NONE	
US2007186662	16-08-2007	CN1926410 A	07-03-2007
		EP1721134 A1	15-11-2006
		FR2867275 A1	09-09-2005
		WO2005095903 A1	13-10-2005