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(54) Title: HYDROGEN CELL

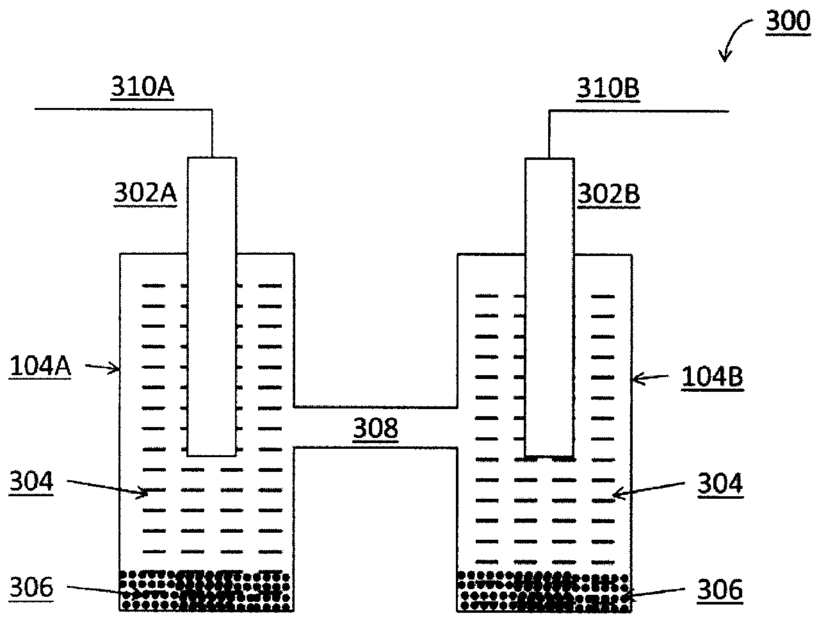

Fig. 3

(57) Abstract: A Hydrogen generator cell (104), comprising at least one electrolysis cell (104A, 104B) having liquid water (304) as aqueous solution base, reusable Sodium amalgam (306) disposed in the liquid water (304) of the electrolysis cell (104A, 104B) for use as a catalytic converter, an electrical potential applied across a pair of electrodes (302A, 302B)

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immersed in the liquid water (304) of the electrolysis cell (104A, 104B) and at least one of the pair of electrodes (302A, 302B) electrolyzes the liquid water (304) for generating Hydrogen gas using the catalytic converter.

TITLE OF INVENTION : HYDROGEN CELL

TECHNICAL FIELD OF THE INVENTION

The invention relates to a method for the electrolysis of an aqueous solution having a Sodium salt for producing high concentration of Hydrogen.

BACKGROUND OF THE INVENTION

With a considerable surge in demand for clean fuels, mainly due to reducing non-renewable resources and increase in environmental concerns, search for fast, efficient, effective, clean, qualitative, easily transportable or locally producible fuels has been a major focus area for global corporations. Among such fuels Hydrogen gas is a widely accepted, efficient and clean fuel to produce electricity or power in different applications. Hydrogen gas is found in abundance in our environment, but its conversion or usage as a fuel has been a challenge. This clean fuel effectively counters the effects of harmful emissions, reduces energy wastage in importing or transporting of fuels. Hydrogen is a resource which can be produced or generated using domestically available renewable resources, such as wind, solar, water, chemicals and biomass.

A Hydrogen based fuel cell system has features, such as high efficiency and energy conservation, reliability and stability, strong environmental adaptability, and being green and environment-friendly, and can be widely applied to fields such as automobile, power source systems, etc. Hydrogen based cells can use Hydrogen as a direct fuel to be used in powering of an engine or it can use chemical reaction processes to further produce electricity. In such different scenarios electrolysis of water has long been used to split Hydrogen from water, multiple technologies used for electrolysis included chemical based reactions and electricity based electrolysing of water. One of the most sought after method includes using a Magnesium sulphate salt as an electrolyte with the aqueous solution of water. The reaction in this process is stable but produces low quantities of Hydrogen. Further, the assembly used requires completely manual operation, which becomes cumbersome and in situations impractical for small vehicles, such as motorbike's or small and medium sized cars in order to use it effectively.

Furthermore, for example, 'The sodium amalgam-oxygen continuous feed cell' authored by Ernest Yeager and published by 'Ft. Belvoir Defense Technical Information Centre' in December 1960, describes an anode of a sodium amalgam-oxygen continuous feed cell consisting of a vertical steel electrode with liquid amalgam flowing continuously down its surface. Porous carbon electrodes of semi-lyophobic type have been used as a cathode. An amalgam is produced (over) external to the cell by introducing sodium directly into mercury. The overall cell reaction is 4 Na + O2 + 2 H2O to 4 NaOH. Performance characteristics are reported for a small single cell laboratory unit as well as a five-cell unit of several hundred watts capacity.

'Electricity – A Powerful Agent' published by 'Undersea Warfare' as published in 2004, describes that when mixed with mercury, sodium forms an amalgam that takes the place of zinc in Bunsen batteries. The mercury is never consumed, only the sodium is used up, and the sea resupplies with that. Moreover, sodium batteries are powerful. Their electric motive force is twice that of zinc batteries.

US3427199 titled 'Method for starting operation of a sodium amalgam-oxidant fuel cell', invented by 'Erwin A. Schumacher et al.' as published on 11 February, 1969, describes a method for starting operation of a sodium amalgam-oxidant fuel cell at room temperatures, and particularly refers to a method which substantially eliminates the need for an auxiliary supply of heat and electrical energy during starting period. The construction of a sodium amalgam-oxidant fuel cell is similar to the construction of a Hydrogen-oxygen cell. Both comprise an anode, a cathode, and an electrolyte between the two, and the cathode in both is usually a porous conductive body repellent to electrolyte but permeable to a gaseous oxidant. In a sodium amalgam oxidant fuel cell, however, the anode is usually at vertical, conductive plate instead of the ordinary porous conductive body used in conjunction with anodic Hydrogen gas. This change in construction is necessary because the sodium amalgam, which contains sodium as the anodic material, is a liquid rather than a gas. During cell operation, the sodium amalgam is usually introduced at the top of the anode plate, permitted to flow down the face of the plate to present the dissolved sodium as a usable surface, and then removed as depleted amalgam from the bottom of the cell.

The depleted amalgam is then enriched with solid or liquid sodium in suitable regenerators and re-circulated through the cell.

The 'FY01 Annual Report' titled 'Joint Coordinating Committee for Environmental Systems' authored by 'Institute for Ecology of Industrial Areas' as published in 2001, describes that metallic mercury has been used for chlorine and sodium hydroxide production by electrolysis of sodium chloride solutions. During the electrolysis process, gaseous chlorine is generated at the anode and mercury amalgamate is generated at the Hg cathode. Titanium and fixed parameter anodes are used in the paper. Further, gaseous chlorine is generated in the electrolysis tank and, after drying, is supplied to other production processes. Sodium amalgamate is transferred from the electrolysis tank to the decomposer where it decomposes into soda lye, Hydrogen and mercury in the presence of water. The generated Hydrogen is utilized as fuel in a local power and heating plant. From the decomposer, mercury is pumped to the electrolysis tank.

US3881955 titled 'Wall-sealed battery casing and sealed primary sodium-halogen battery' invented by Robert R. Dubin et al.' as published on May 6, 1975, describes a wall-sealed battery casing and a sealed primary sodium-halogen battery are disclosed wherein the casing includes an open ended inner vessel of a solid crystalline ion-conductive material, an electronic conductor within the interior of the inner vessel, two outer opposed open ended metallic portions each with an additional opening surrounding the inner vessel, the two opposed vessel portions sealed together and to the outer wall of the inner vessel, and a fill tube associated with the respective additional opening in each outer vessel portion. A sealed primary sodium halogen battery has the above type of wall-sealed casing with solid sodium containing ion-conductive inner vessel. The anode and cathode are positioned, respectively, in either the inner vessel or between the inner vessel and the outer vessel portion adjacent the closed end of the inner vessel.

US3181848 titled 'Amalgam regenerator for primary battery system' and invented by 'Kenneth D. Miller et al.' as published on May 4, 1965, describes certain alkali metals, such as sodium, will form an explosive mixture with the sea water electrolyte, the system contemplates admitting the selected metal in the state or form of an amalgam to the cells. The problem of obtaining a sodium amalgam for use in the present battery system is more complex than simply adding sodium to mercury since the sodium concentration must be of a precise value and, additionally, the amalgam must be very pure and free of the formation of oxides. Another object is to provide for the intimate mixing of controlled amounts of sodium with sodium amalgam which is re-circulated in a primary battery system in order to regenerate the amalgam to a desired sodium concentration.

Further, an internal combustible engine working on Hydrogen gas fuel uses a Hydrogen container or reservoir for storing Hydrogen gas. The Hydrogen gas could be produced at a factory and supplied in cylinders/ containers to be used while engine is running. A better application will be local production of Hydrogen and usage while the automobile is in operation. Hydrogen gas as a gaseous fuel exhibits poor installation or storage efficiency when installed on the vehicle, as compared with a liquid hydrocarbon fuel, such as petrol. Hence, the requirement of a small, compact and efficient Hydrogen producing fuel cell has been felt for long.

While it is desirable to generate Hydrogen in fast, effective, balanced manner, it is equally desirable to produce more amount of Hydrogen in less time with a shorter and transportable equipment for powering of smaller automotive vehicles. However, during the implementation of the present disclosure, the inventor finds that, when the Hydrogen gas needs to be supplemented, a shortage is felt with respect to the current methods and therefore an inconvenience is felt by the users of the fuel.

SUMMARY OF THE INVENTION

In one embodiment, the present invention relates to a Hydrogen generator cell having at least one electrolysis cell containing liquid water. Further, reusable Sodium amalgam is disposed in the liquid water of the electrolysis cell for use as a catalytic converter. An electrical potential is applied across a pair of electrodes immersed in the liquid water of the electrolyte chambers and at least one of the pair of electrodes electrolyzes the liquid water for generating Hydrogen gas using the catalytic converter.

Further, the present invention relates to an applied electric potential as supplied by a battery, the battery is chargeable by power produced from Hydrogen generated by a cell. The Hydrogen generator cell also has a rheostat and a corresponding switch to supply a required switching power to the electrodes through conductor wires.

The present invention also relates to a Hydrogen generator cell having an outlet, for supplying Hydrogen to an engine. The outlet is above level of the liquid water of the electrolysis cells of the Hydrogen generator cell. The Hydrogen generator cell supplies the Hydrogen to a Hydrogen container which further supplies it to the engine.

Further, the present invention relates to a signalling system for recording a status of water level in the Hydrogen generator cell and generated Hydrogen pressure in an outlet of the Hydrogen generator cell. A liquid water supply system for circulating water to at least one of the electrolyte chambers and a controller for controlling the liquid water supply system in response to a signal received from the signalling system.

The present invention also relates to a Hydrogen generator cell wherein pluralities of such Hydrogen generator cells are connected in series, for use in an automobile.

In another embodiment, the present invention relates to a method of generating Hydrogen from a cell, by using Sodium amalgam disposed in liquid water of at least one electrolyte chambers, preferably two, as a catalytic converter and applying an electric potential across a pair of electrodes immersed in the liquid water of the electrolyte chambers for electrolysing the liquid water for generating Hydrogen by electrolysing the liquid water using the catalytic converter.

In yet another embodiment, the present invention relates to a method of controlling generation of Hydrogen from a cell, while receiving a status of water level in the cell and receiving a status of generated Hydrogen pressure in an outlet of the cell and controlling circulation of water in the cell and electric potential applied on electrodes of the cell, using a liquid water supply system in response to the received status of the water level and the Hydrogen pressure.

In yet another embodiment, the present invention relates to a controller for a Hydrogen generating cell, having a first recorder for receiving a status of water level in the cell and having a second recorder for receiving a status of generated Hydrogen pressure in an outlet of the cell. Further the controller controls circulation of water in the cell and electric potential applied on electrodes of the cell, using a liquid water supply system in response to the received status of the water level and the Hydrogen pressure from the first recorder and the second recorder.

These and other aspects, processes and features of the invention will become more fully apparent when the following detailed description is read with the accompanying figures and examples. However, both the foregoing summary of the invention and the following detailed description of it represent one potential embodiment, and are not restrictive of the invention or other alternate embodiments of the invention.

BRIEF DESCRIPTION OF DRAWINGS

To illustrate the solutions according to the embodiments of the present disclosure more clearly, the accompanying drawings needed for describing the embodiments are introduced below briefly. Apparently, the accompanying drawings in the following descriptions merely show some of the embodiments of the present disclosure, and persons skilled in the art may obtain other drawings according to the accompanying drawings without creative efforts.

FIG. 1 is a schematic diagram of a Hydrogen fuel cell in an automobile system, according to various embodiments of the invention;

FIG. 2 is a schematic diagram of a Hydrogen fuel cell system, according to various embodiments of the invention;

FIG. 3 is a schematic structural diagram of components of a Hydrogen fuel cell of the Hydrogen fuel cell system, according to various embodiments of the invention;

FIG. 4 is a schematic structural diagram of top view of a Hydrogen fuel cell of the Hydrogen fuel cell system, according to various embodiments of the invention;

FIG. 5 is a schematic structural diagram of a Hydrogen supply system in a Hydrogen fuel cell of the Hydrogen fuel cell system, according to various embodiments of the invention;

FIG. 6 is a schematic structural diagram of a Hydrogen fuel cell of the Hydrogen fuel cell system using various input resources, according to various embodiments of the invention;

FIG. 7 is a schematic structural diagram of a controller for controlling various supply systems to a Hydrogen fuel cell of the Hydrogen fuel cell system using various input resources, according to various embodiments of the invention;

While the invention is amenable to various modifications and alternative forms, some embodiments have been illustrated by way of example in the drawings and are described in detail below. The intention, however, is not to limit the invention by those examples and the invention is intended to cover all modifications, equivalents, and alternatives to the embodiments described in this specification.

DETAILED DESCRIPTION OF DRAWINGS

The solutions of the present disclosure are to be clearly described in the following with reference to the accompanying drawings. It is obvious that the embodiments to be described are only a part rather than all of the embodiments of the present disclosure. All other embodiments obtained by persons skilled in the art based on the embodiments of the present disclosure without creative efforts shall fall within the protection scope of the present disclosure.

A Hydrogen supply system in a Hydrogen fuel cell system is the backbone of system. The Hydrogen supply system is beneficial if the quantity and quality of Hydrogen fuel produced vis-a-vis the input (including water, electrolyte salt, electricity to electrolyse) is high. The Hydrogen fuel cell generally includes a Hydrogen generating unit, a Hydrogen containing unit and a Hydrogen supplying unit. However, during the implementation of the present disclosure, the inventors find that, when the Hydrogen gas needs to be produced a large system is required to be carried by a vehicle as smaller systems do not produce enough fuel to be feasibly used in an automobile operation. Conventional method based smaller systems do not produce enough

Hydrogen fuel for small vehicle applications, such as motor bikes or hatchback cars to practically carry and use the Hydrogen fuel cells while operation.

In order to solve the above problem, an embodiment of the present disclosure provides a Hydrogen generator cell. **FIG. 1** shows a structure of the Hydrogen fuel cell system **100**, including a Hydrogen generator cell **104**, and an engine **102** connected to the Hydrogen generator cell **104**. A detailed structure of the Hydrogen generator cell **104** is described in detail in the subsequent embodiment of the present disclosure.

The engine **102** includes an internal combustion engine (Hydrogen-using internal combustion engines) which uses Hydrogen gas as a direct fuel, along with a hydrocarbon fuel, such as petrol or diesel. In general Hydrogen gas has higher combustibility than hydrocarbon fuel. The mixture of Hydrogen gas with a hydrocarbon fuel allows the engine **102** to work with better, improved fuel economy, and also offer reduction in the amount of harmful gas emissions, such as reduction in NOx emission to environment. The mixture in certain designs increases the power output and in turn increases value of the Hydrogen clean fuel.

The engine **102** uses a significant amount of electric energy and chemical salts along with aqueous solution while electrolysis for producing Hydrogen gas. The power or electrical energy required for producing Hydrogen gas is supplied from an on-board or vehicle-mounted battery. Therefore, it is necessary for the engine **102** to control and supply the required energy to the battery for use in Hydrogen gas production. For clean fuel based energy balance, it is important to record the yield of the Hydrogen gas to the amount of energy supplied and other inputs such as water, salts, electrodes, these points will help the industry to ascertain the cost, value proposition, environmental benefits and also to secure the carbon points under Kyoto protocol.

For achieving the high yield of the Hydrogen gas the invention uses Sodium amalgam as a catalytic converter which is reusable, thus, producing high Hydrogen concentration with the same electric energy in place of Magnesium sulphate, which has long been used for similar reaction.

In various embodiments, Sodium amalgam used is mercury salt, such as Na5Hg8 or Na3HG8.

FIG. 2 shows a structure of the Hydrogen fuel cell system **200**, including the Hydrogen generator cell **104**, a battery **202** connected to electrodes of the Hydrogen generator cell **104**. The battery **202** passes required current or applies an electric potential to electrodes of the Hydrogen generator cell **104**. A detailed structure of the Hydrogen generator cell **104** is described in detail in the subsequent embodiment of the present disclosure.

The battery **202**, using an electronics circuit, passes current to the Hydrogen generator cell **104** required for its operation of generating Hydrogen gas. A control apparatus (not shown) is used for measuring and regulating the current passing through electrodes of the Hydrogen generator cell **104** with which it is associated.

In an embodiment, a battery **202** includes a casing configured to at least partially receive a battery pack therein. The battery pack can be a single battery or a plurality of batteries. The casing of the battery forms part of structure of a vehicle body, which will further include mechanically adjustable mechanisms for receiving and removing the battery form the casing. A battery **202** has a limited charge level resulting in too limited maximal distance the vehicle can drive with such battery. In various embodiments, a battery **202** can be charged from an engine **102** or can be replaced by a road side service station,

The electronics circuit used for supplying electrical energy/ current to the Hydrogen generator cell **104** includes a switch **206** and a rheostat **204**. The rheostat **204** controls the electricity flowing from the battery **202** into the electrodes of the Hydrogen generator cell **104**. This could be controlled by the switch **206** in an automobile application, for example.

FIG. 3 shows a detailed structure of the Hydrogen fuel cell system **300**, including the Hydrogen generator cell **104**. The interior of the Hydrogen generator cell **104** is described here.

The Hydrogen generator cell **104** includes at least one and preferably two electrolysis cells **104A, 104B**. The electrolysis cells **104A, 104B** are generally known in the art and can be used from any standard offering with features as detailed below. According to various embodiments, an electrolysis cell **104A, 104B** includes a cathode **302A** located within a cathode region electrolysis cell **104A**, an anode **302B** located within anode region electrolysis cell **104B**, and an aqueous electrolyte solution, using water **304** as aqueous filled in the electrolysis cells **104A, 104B**. The cathode **302A** receives current from the battery **202** by a conductor wire **310A**; similarly anode **302B** receives current from the battery **202** by a conductor wire **310B**. The liquid water **304** is reduced at the cathode region **104A** and oxidized at the anode region **104B**. The electrolyte **306** is responsible for charge transfer and the movement of ions within the Hydrogen generator cell **104**.

According to various embodiments of the present invention, the water electrolysis includes a separate cathode region and a separate anode region within one electrolysis cell.

There is an electrolyte solution, preferably using liquid water **304** that fills the interior up to a particular level of the Hydrogen generator cell **104**. The electrolyte solution is composed of an electrolyte **306** in solution with liquid water **304**. Although many different electrolytes may be used, the embodiment of current invention uses distilled liquid water **304** as base and Sodium amalgam salt **306** as the electrolyte. The Sodium amalgam salt **306** works as an electrolyte to lower resistance of the liquid water **304**. This improves the performance of the Hydrogen generator cell **104**. An operating range of Sodium amalgam **306** to water **304** is about 0.5%-15% by weight, with a preferred range being 2% to 5%, and 3% being the most preferred ratio.

According to one exemplary embodiment of the present invention, the aqueous electrolyte solution of liquid water **304** and Sodium amalgam **306** is a saturated solution prepared by adding a total 30gm of Sodium amalgam to about 1000 ml of clean distilled water dividedly placed in two electrolysis cells **104A, 104B**. The electrodes **302A, 302B** of the Hydrogen generator cell 104 are connected to a 9V battery through conductor wires **310A, 310B**. The solution is maintained at about 30 degrees Celsius (°C.) while being mechanically mixed. The electrolysis process produces Hydrogen gas as per following chemical reaction. The electrolysis reaction within the water electrolysis unit of the present invention produces about 100 parts per million (ppm) of Hydrogen.

$$Na5Hg8 + 2H2O \rightarrow 2NaOH + H2 + Na3Hg8$$

The production of Hydrogen is very effective and sufficient for the combustion and power required for a motorbike engine to work smoothly for more than 20 Km on city roads. In addition, the concentration of Sodium amalgam **306** will prevent the solution from freezing up to a temperature of about minus -10 degrees C.

In one embodiment, a water level indicator is placed in the electrolyte cell. The electrolyte cathode and anode rods **302A**, **302B** are made from copper and descend vertically into the liquid water solution **304**.

The cathode rod **302A** connects to the outer electrode conductor wire **310A** which is connected to a battery terminal for receiving current for electrolysing the electrolyte solution. Similarly the anode rod **302B** connects to the outer electrode conductor wire **310B** which is connected to another battery terminal for receiving current for electrolysing the electrolyte solution. The conductor wires are made most preferably from Copper, which has found to yield suitable results, but other conductor material may also be suitable. Not shown on the drawing is that both conductor wires are surrounded end to end by insulation, so there is no short circuiting or electrical or electrolysis interaction between the rods and the surrounding solution.

The cathode region **302A** and the anode region **302B** are electrically connected by an aqueous electrolyte solution **304** through a funnel **308**, supplied from an aqueous electrolyte solution. The aqueous electrolyte solution includes electrolyte salt, such as Sodium amalgam. According to various embodiments, the aqueous electrolyte includes an alkali salt. The alkali salt is substantially free of chloride and is a salt of the groups 1(IA) or 2(IIA) of the periodic table. Exemplary electrolytes suitable for use with the present invention include, but are not limited to, the following: sodium amalgam, sodium sulphate, potassium sulphate, calcium sulphate, magnesium sulphate, sodium nitrate, potassium nitrate, sodium bicarbonate, sodium carbonate, potassium bicarbonate, potassium carbonate, calcium carbonate, and magnesium carbonate. According to other embodiments, the aqueous electrolyte solution can include sea water and/or sea salt.

The concentration of the aqueous electrolyte solution can vary depending on the demands of the electrolysis cell and the Hydrogen generator cell **104**. The electrolyte concentration may vary with changes in the temperature, pH, and/or the selected electrolyte salt.

In all embodiments of the present invention, during electrolysis Sodium amalgam **306** reacts with water as shown above and forms Sodium amalgamate during the electrolysis process. A high quantity of Hydrogen gas is produced which is routed to the engine **102** through Hydrogen outlet channel **502A**, **502B**.

Water is reduced using a metal that is in a highly active state. For example, copper or a copper alloy is subjected to rubbing in pure water so as to accelerate corrosive reactions between water and the metal and decompose water molecules, in catalytic presence of Sodium amalgam thereby to produce high quantity of pure Hydrogen gas. Furthermore, Sodium amalgamate will be reversed to Sodium amalgam releasing more Hydrogen and oxygen and reused in next electrolysis cycle.

As the electrolysis proceeds the fluid level will decline as water is decomposed. The Sodium amalgam **306** electrolyte does not get, effectively, used up in the reaction, and therefore does not need to be added in the usual case. However, the result is that as the water **304** decomposes and is lost from the electrolysis cell **104A**, **104B**, concentration of the Sodium amalgamate will increase. With increasing concentration, efficiency of electrolysis will be reduced and with more exposure of cathode **302A** and anode **302B** rods a risk of a spark which, in the environment containing combustible gas, could cause an explosion will increase. Hence, the water **304** solution needs to be refilled on periodical basis.

FIG. 4 presents top view of an embodiment of the Hydrogen generator cell **104**. The conductor wires **310A**, **310B** are connected to the battery **202** terminals.

According to one embodiment, the predetermined voltage supplied to the electrolysis cell is at least 1.2 volts. According to other embodiments, the predetermined voltage supplied to the cell ranges from about 1.2 volts to about 16.0 volts. The result of the electrolysis reaction within the Hydrogen generator cell **104** is formation of Hydrogen gas, along with catalytic salt conversion to Sodium amalgamate.

FIG. 5 describes a Hydrogen generator cell **104**, after water **304** in the aqueous electrolyte solution and Sodium amalgam **306** is electrolyzed to produce Hydrogen gas, the gas is produced and routed to the engine **102** using metal pipes **502A**, **502B**. The Hydrogen gas is routed from the cathode region **302A** or anode region **302B** to storage or flow systems designed to collect gas. The low density of the Hydrogen gas relative to the aqueous electrolyte solution causes the Hydrogen gas to rise.

In one embodiment, produced Hydrogen gas is collected in a Hydrogen container (not shown) and further passed to an engine **102** as a product of electrolysis which is used directly as a fuel for the automobile engine.

According to one embodiment of the present invention, there is provided a system for retrofitting an internal combustion engine to use a proportion of Hydrogen gas and existing hydrocarbon liquid fuel. The system includes providing one source of Hydrogen gas to combustion chamber of the engine and another source for delivering hydrocarbon liquid fuels via separate fuel injectors. The system further includes adjusting the engine operating parameters and controlling the delivery of selective fuel in engine's operating cycle.

The high amount of Hydrogen gas for hydrocarbon fuel engine provides a fast combustion cycle, resulting in better fuel efficiency.

FIG. 6 shows the Hydrogen generator cell **104** having two electrolysis cells **104A**, **104B**. In certain embodiments the Hydrogen gas pressure may increase abruptly or due to misappropriation of the required electrolyte solution ingredients, while the electrolytic cell is in operation, which may result in breaking or explosion of the electrolytic cells. Therefore, a modified overflow safety valve **608A**, **608B**, in both electrolysis cells **104A**, **104B** respectively, is used for maintaining the Hydrogen pressures in a given ratio as a safety device.

The overflow safety valve **608A**, **608B** is used as a safety device which is set with a requisite pressure to release Hydrogen gas out from the electrolysis cells **104A**, **104B** so that unnecessary leakage will not occur.

Further, a liquid water supply system **602** includes a water inlet reservoir and is connected to electrolysis cells **104A**, **104B** through water pipes **604A, and 604B**. During electrolysis reaction water **304** gets used up, as explained, and the level of water in electrolysis cells **104A**, **104B** goes down. This creates a requirement of water **304** in the electrolysis cell **104A**, **104B** and thus is supplied by a water inlet reservoir of the liquid water supply system **602**.

In another embodiment, a Sodium amalgam reservoir **606** is connected to electrolysis cells **104A**, **104B** through SA pipes **608A, and 608B**. During electrolysis reaction water **304** gets used up and the level of water in the electrolysis cells **104A**, **104B** goes down. The Sodium amalgam salt **306** is used to form Sodium amalgamate but is reversed into Sodium amalgam **306**. Effectively the salt works as a catalytic converter and is not depleted instantly. However, a small storage of Sodium amalgam **306** is preferred in the Hydrogen generator cell **104** arrangement, for use in the long run.

The cathode **302A** receives current from the battery **202** by the conductor wire **310A**; similarly anode **302B** is connected to another battery terminal using the conductor wire **310B**.

FIG. 7 shows a signalling system **702A**, **702B** disposed outside the electrolysis cells **104A**, **and 104B**. The signalling system **702A**, **702B** receives inputs from the electrolysis cells **104A**, **104B** in form of aqueous solution level i.e. level of water through channels **706A**, **706B** from the electrolysis cells **104A**, **104B**.

Further, the signalling system **702A, 702B** receives signal inputs about the pressure of Hydrogen produced in outlet pipe **502A**, **502B** of the electrolysis cells **104A**, **104B** through channels **704A**, **704B**.

A controller **708** receives the readings of the signalling system **702A**, **702B** through channel **710A**, **710B** and thereafter regulates the liquid water supply system **602** with water inlet reservoir to pass off required water to the electrolysis cells **104A**, **104B**.

As shown, electrolysis process works in presence of electrolytic solution as water **304** inside the electrolysis cells **104A**, **104B**. The electrolytic solution has a substantial water component which is used up by the electrolytic process. As the water is used up, the liquid level of solution declines and needs to be replenished. Generally, a rider or driver of the vehicle would need to refill the cells with Water by stopping the vehicle and spending time. The driver may not be technically equipped to do the process skilfully. The present invention avoids these problems by including a refill process that operates automatically and in the background. It is therefore an advantage of the present invention that it extends the length of time during which the electrolysis cells can operate without service by the operator.

As described above, when the level of liquid water **304** reaches a pre-determined low level, a signal is sent from the electrolysis cell **104A**, **104B** by the transmission channels **706A**, **706B** connected to sensors (not shown) inside the electrolysis cells **104A**, **104B** on one side and to the signalling system **702A**, **702B** on the other side. The Controller **708** receives the signals from the signalling system **702A**, **702B** and computes through a first recorder to generate a signal that activates the liquid water supply system **602** through transmission channel **712**. Thus, the water reservoir of the liquid water supply system **602** begins pumping water to the electrolysis cells **104A**, **104B**.

The refilling continues until the level of water **304** in the electrolyte cells **104A**, **104B** reaches a predetermined high level, at which point another signal is sent using inputs from the signalling system **702A**, **702B** to stop the refill process by the controller **708** to the liquid water supply system **602**.

In another embodiment, a method of controlling generation of Hydrogen from a cell **104**, comprising receiving a status of water level of at least one electrolysis cell **104A**, **104B**, receiving a status of generated Hydrogen pressure in an outlet **502A**, **502B** of at least one electrolysis cell **104A**, **104B**, controlling circulation of water in the electrolysis cell **104A**, **104B** and electric potential applied on electrodes **310A**, **310B** of the electrolysis cell **104A**, **104B**, using a liquid water supply system **602** in response to the received status of the water level and the Hydrogen pressure.

In yet another embodiment a controller **708** for a Hydrogen generating cell **104**, comprising a first recorder for receiving a status of water level in at least one electrolysis cell **104A**, **104B**, a second recorder for receiving a status of generated Hydrogen pressure in an outlet **502A**, **502B** of the electrolysis cell **104A**, **104B**, wherein the controller controls circulation of water in the electrolysis cell **104A**, **104B** and electric potential applied on electrodes **310A, 310B** of the cell **104**, using a liquid water supply system **602** in response to the received status of the water level and the Hydrogen pressure from the first recorder and the second recorder.

In yet another embodiment, several Hydrogen generator cells **104** are typically combined in a fuel cell stack to generate the desired power. For example, a typical fuel cell stack for a vehicle may have ten or more stacked fuel cells.

The Hydrogen generator cell system according to any one of the above embodiments, and the system for producing and supplying Hydrogen gas mainly formed by the Hydrogen generator cell disclosed by any one of the above embodiments all fall within the protection scope of the present disclosure. Apart from being applied to the communication base station, each of the above systems may also be applied to fields such as automobile driving and portable power source system.

In addition, in aspects of leak prevention and leak processing, when the above systems are applied to the automobile driving, insulation of the Hydrogen generator cell from a passenger compartment and fast dilution after leak is fully considered. Meanwhile, in narrow space in an automobile, shake-proof property and anti-static property of the Hydrogen supply pipelines and components, distances and insulation of the pipelines from mechanical parts and electronic components in the automobile are also considered.

The embodiments in the specification are described in a progressive manner, and focus of description in each embodiment is the difference from other embodiments. For same or similar parts of each embodiment, reference may be made to each other. Because the method disclosed in the embodiment is corresponding to the apparatus disclosed in the embodiment, the description of the method is simple. For related parts, reference may be made to the description of the apparatus.

It will be appreciated by those skilled in the art that the foregoing description was in respect of preferred embodiments and that various alterations and modifications are possible within the broad scope of the appended claims without departing from the spirit of the invention with the necessary modifications.

Persons skilled in the art should understand that all or a part of the processes of the method according to the embodiments of the present disclosure may be implemented by a program instructing relevant hardware. The program may be stored in a computer readable storage medium. When the program is run, the processes of the method according to the embodiments of the present disclosure are performed. The storage medium may be a magnetic disk, an optical disk, a read-only memory (Read-Only Memory, ROM) or a random access memory (Random Access Memory, RAM).

Based on the description of disclosed embodiments, persons skilled in the art can implement or apply the present disclosure. Various modifications of the embodiments are apparent to persons skilled in the art, and general principles defined in the specification can be implemented in other embodiments without departing from the spirit or scope of the present disclosure. Therefore, the present disclosure is not limited to the embodiments in the specification, but intends to cover the most extensive scope consistent with the principle and the novel features disclosed in the specification.

CLAIMS

1. A Hydrogen generator cell (104), comprising:

   at least one electrolysis cell (104A, 104B) having liquid water (304) as aqueous solution base;

   reusable Sodium amalgam (306) disposed in the liquid water (304) of the electrolysis cell (104A, 104B) for use as a catalytic converter;

   an electrical potential applied across a pair of electrodes (302A, 302B) immersed in the liquid water (304) of the electrolysis cell (104A, 104B);

   at least one of the pair of electrodes (302A, 302B) electrolyzes the liquid water (304) for generating Hydrogen gas using the catalytic converter.

2. The Hydrogen generator cell (104) as claimed in claim 1, wherein the applied electric potential is supplied by a battery (202), wherein the battery (202) is chargeable by the power produced from the Hydrogen generated by the cell (104).
3. The Hydrogen generator cell (104) as claimed in claim 1, further comprising a rheostat (204) and a switch (206) to supply a required switching power to the electrodes (302A, 302B) through conductor wires (310A, 310B).
4. The Hydrogen generator cell (104) as claimed in claim 1, further comprising an outlet (502A, 502B), for supplying Hydrogen to an engine (102), above level of the liquid water (304) of the electrolysis cell (104A, 104B).
5. The Hydrogen generator cell (104) as claimed in claim 4, wherein the Hydrogen is supplied to the engine (102) through a Hydrogen container.

6. The Hydrogen generator cell (104) as claimed in claim 1, further comprising a signalling system (702A, 702B) for recording a status of water level in the electrolysis cell (104A, 104B) and generated Hydrogen pressure in an outlet (502A, 502B) of the electrolysis cell (104A, 104B).
7. The Hydrogen generator cell (104) as claimed in claim 6, further comprising a liquid water supply system (602) for circulating water to at least one of the electrolysis cells (104A, 104B).
8. The Hydrogen generator cell (104) as claimed in claim 7, further comprising a controller (708) for controlling the liquid water supply system (602) in response to a signal received from the signalling system (702A, 702B).
9. The Hydrogen generator cell (104) as claimed in claim 1, wherein the Hydrogen generator cell (104) is connectable to a series of such cells for use in an automobile.
10. A method of generating Hydrogen from a cell, comprising:

    using Sodium amalgam (306) disposed in liquid water (304) of at least one electrolysis cells (104A, 104B) as a catalytic converter;

    applying an electric potential across a pair of electrodes (302A, 302B) immersed in the liquid water (304) of the electrolysis cell (104A, 104B) for electrolysing the liquid water (304);

    generating Hydrogen by electrolysing the liquid water (304) using the catalytic converter.

11. The method of generating Hydrogen from a cell as claimed in claim 10, wherein the applied electric potential is supplied by a battery (202), wherein

the battery (202) is chargeable by the power produced from the Hydrogen generated by the cell (104).

12. The method of generating Hydrogen from a cell as claimed in claim 10, further comprising supplying a required switching power to the electrodes (302A, 302B) through conductor wires (310A, 310B) using a rheostat (204) and a switch (206).

13. The method of generating Hydrogen from a cell as claimed in claim 10, further comprising supplying Hydrogen to an engine (102), above level of the liquid water (304) of the electrolysis cell (104A, 104B) through an outlet (502A, 502B).

14. The method of generating Hydrogen from a cell as claimed in claim 13, wherein the Hydrogen is supplied to the engine (102) through a Hydrogen container.

15. The method of generating Hydrogen from a cell as claimed in claim 10, further comprising recording a status of water level in the electrolysis cell (104A, 104B) and generated Hydrogen pressure in an outlet (502A, 502B) of the electrolysis cell (104A, 104B) using a signalling system (702).

16. The method of generating Hydrogen from a cell as claimed in claim 15, further comprising circulating water to at least one of the electrolysis cell (104A, 104B) by a liquid water supply system (602).

17. The method of generating Hydrogen from a cell as claimed in claim 16, further comprising controlling the liquid water supply system (602) in response to a signal received from the signalling system (702) by a controller (708).

18. The method of generating Hydrogen from a cell as claimed in claim 10, further comprising connecting a series of the Hydrogen generator cells (104) for use in an automobile.

19. A method of controlling generation of Hydrogen from a cell (104), comprising:

receiving a status of water level of at least one electrolysis cell (104A, 104B);

receiving a status of generated Hydrogen pressure in an outlet (502A, 502B) of at least one electrolysis cell (104A, 104B);

controlling circulation of water in the electrolysis cell (104A, 104B) and electric potential applied on electrodes (310A, 310B) of the electrolysis cell (104A, 104B), using a liquid water supply system (602) in response to the received status of the water level and theHydrogen pressure.

20. A controller (708) for a Hydrogen generating cell (104), comprising:

a first recorder for receiving a status of water level in at least one electrolysis cell (104A, 104B);

a second recorder for receiving a status of generated Hydrogen pressure in an outlet (502A, 502B) of the electrolysis cell (104A, 104B);

wherein the controller controls circulation of water in the electrolysis cell (104A, 104B) and electric potential applied on electrodes (310A, 310B) of the cell (104), using a liquid water supply system (602) in response to the received status of the water level and the Hydrogen pressure from the first recorder and the second recorder.

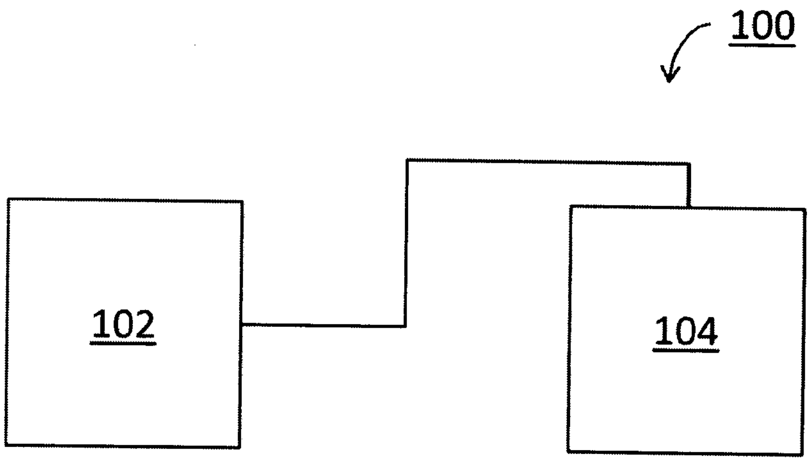


Fig. 1

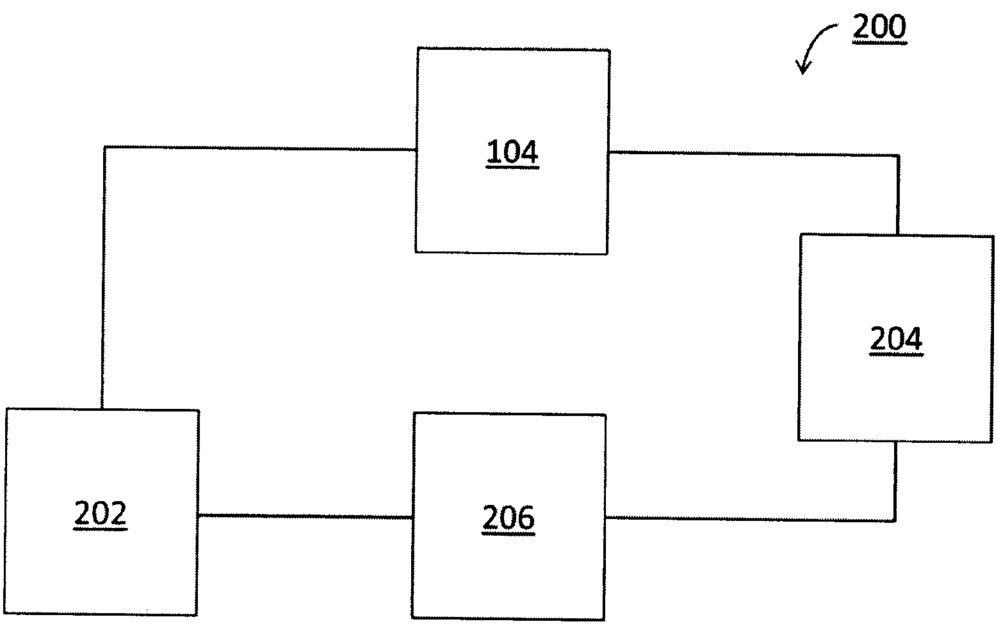


Fig. 2

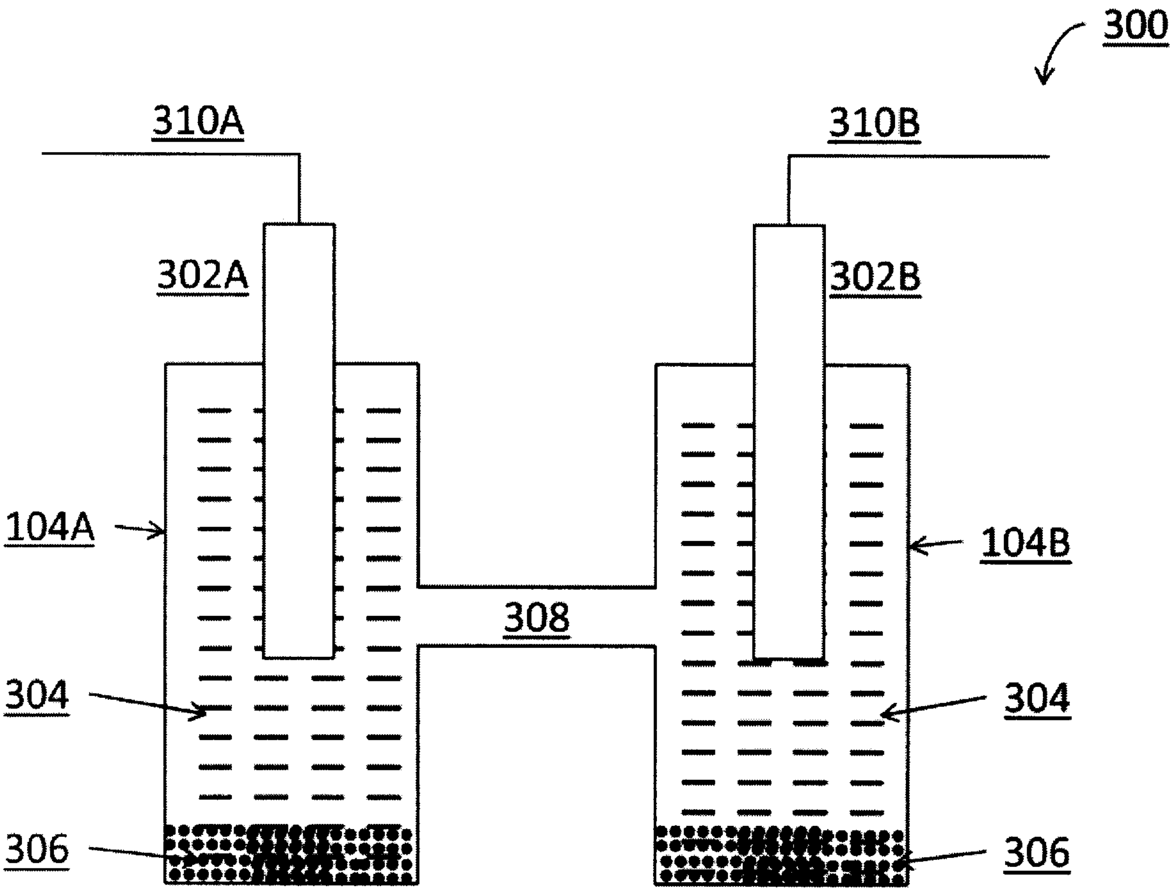
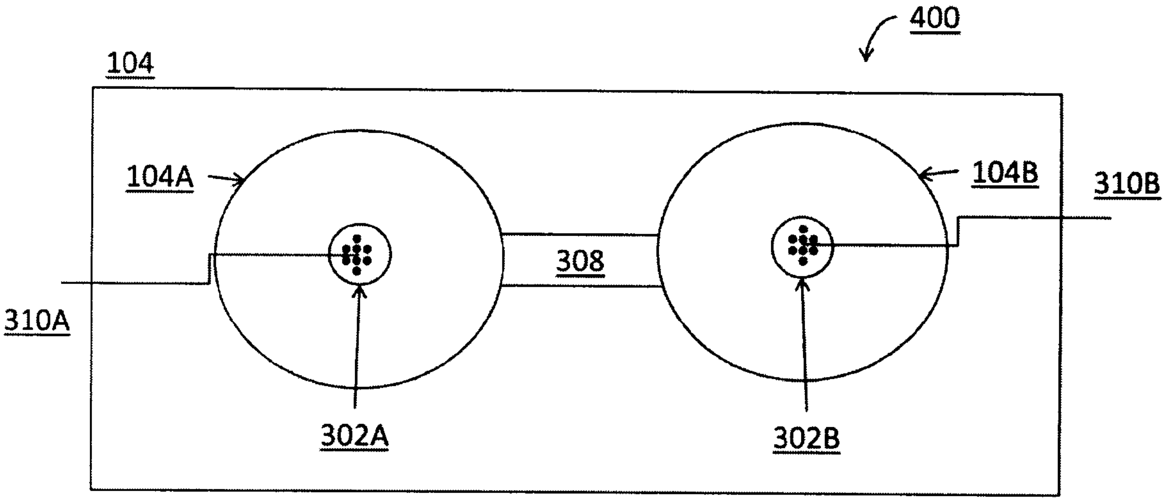


Fig. 3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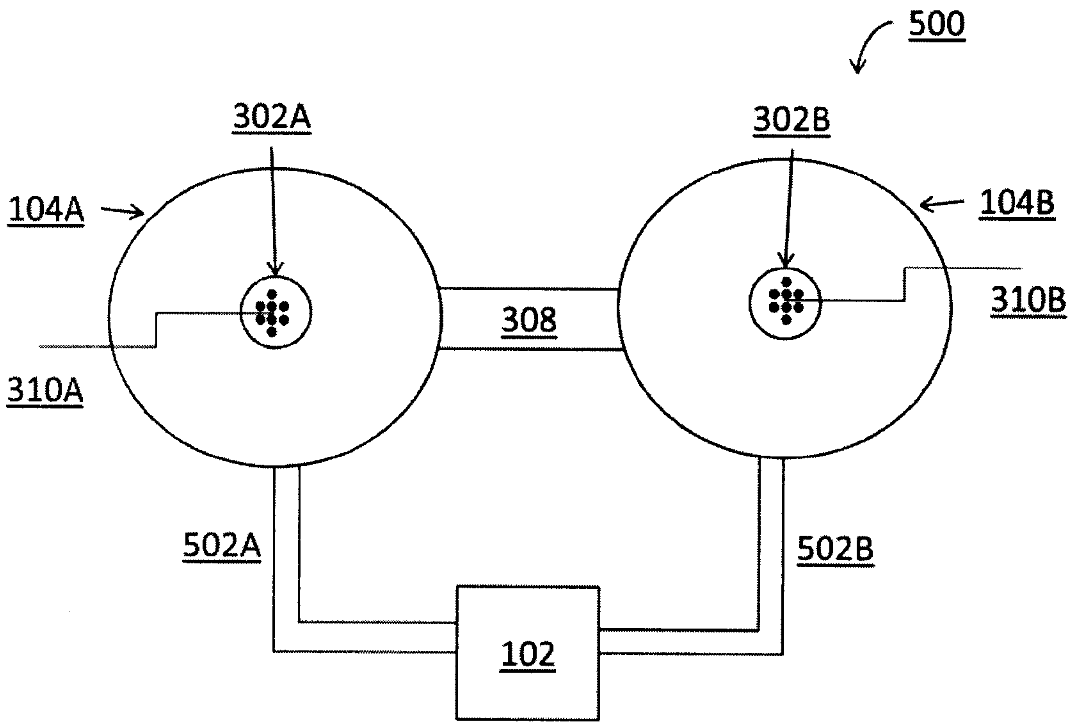
104B
310B
308
310A
302A
302B

Fig. 4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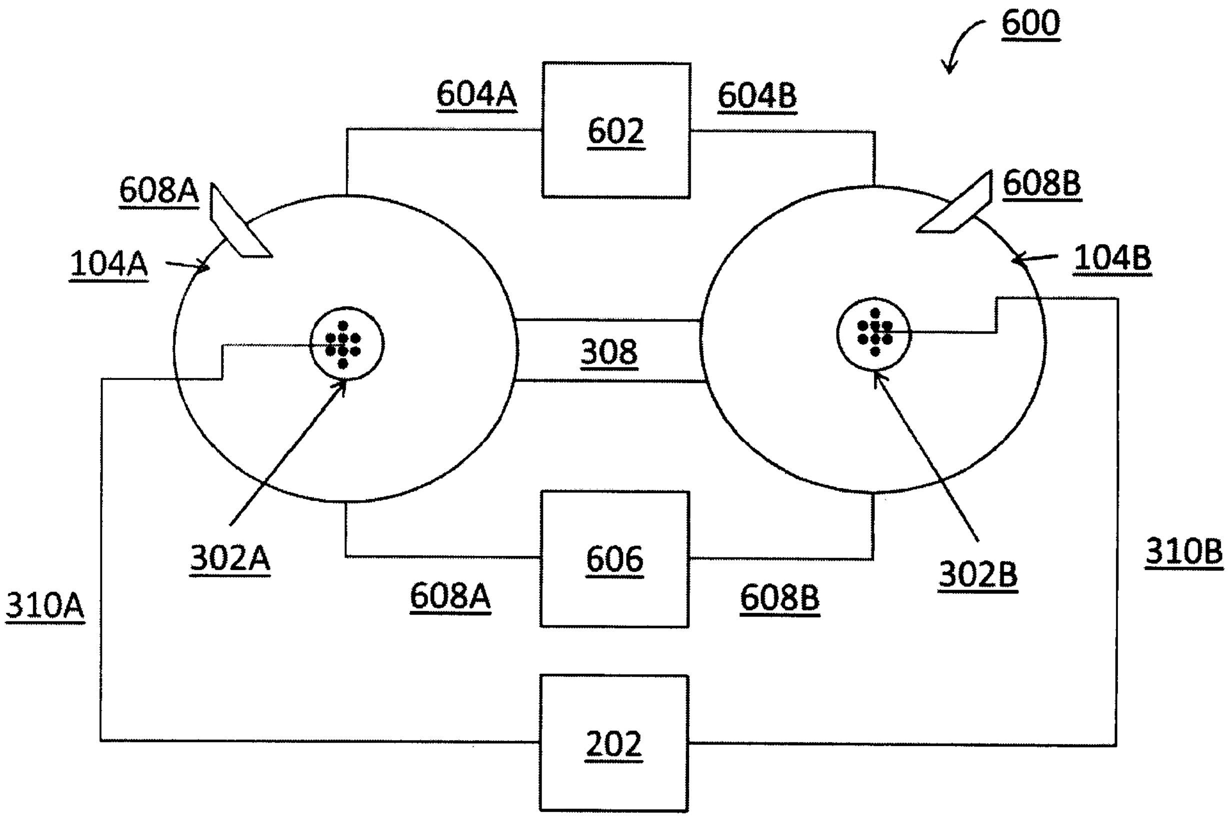
302B
104A
104B
308
310B
310A
502A
502B
102

Fig. 5


600
604A
602
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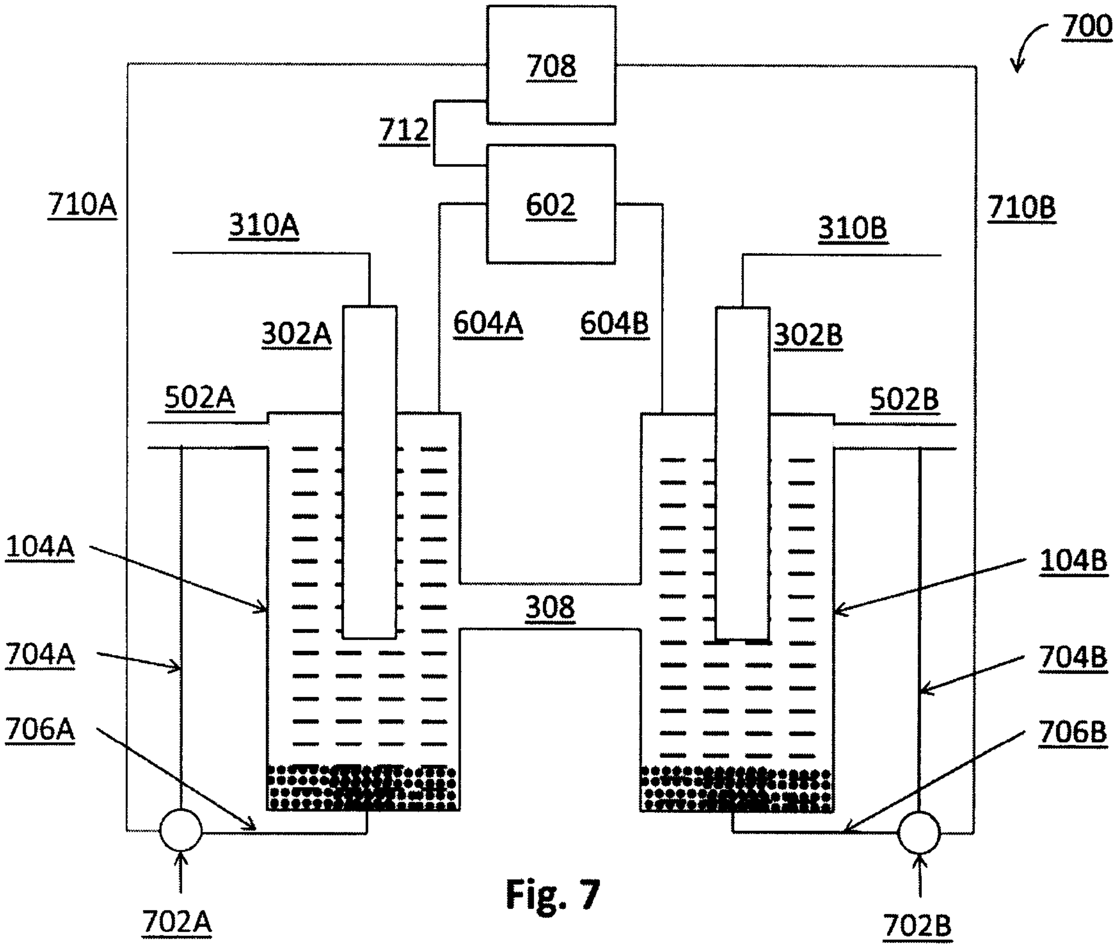
608B
104A
104B
308
302A
302B
606
608A
608B
310A
310B
202

Fig. 6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712
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310B
710B
302A
604A
604B
302B
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308
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704A
704B
706A
706B
702A
702B

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IN2014/000803

A. CLASSIFICATION OF SUBJECT MATTER
INV. C25B15/02 C25B15/08 C25B1/04
ADD.

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)
C25B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

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X Y	CA 2 209 237 A1 (BALAN GABI [CA]; SOUZA MARIO DE [CA]) 27 December 1998 (1998-12-27) claims 1-4,6-10 page 12, line 11 - page 13, line 39 page 15, lines 4-39 page 16, lines 21-37	19,20 1-18
Y	US 2004/025807 A1 (JHETHAM SHABIER [ZA]) 12 February 2004 (2004-02-12) claims 1,3-6,8,10,12,14-19,22,30	1-20

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"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
6 May 2015	15/05/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Perednis, Dainius

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IN2014/000803

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)

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Information on patent family members

International application No
PCT/IN2014/000803

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