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(19) **United States**(12) **Patent Application Publication****Haywood**(10) **Pub. No.: US 2011/0005939 A1**(43) **Pub. Date: Jan. 13, 2011**(54) **GENERATION OF HIGH OCTANE
HYDROGEN GAS FROM ACETIC ACID****Publication Classification**(51) **Int. Cl.**
C25B 1/02 (2006.01)(52) **U.S. Cl.** **205/630; 204/278**(57) **ABSTRACT**

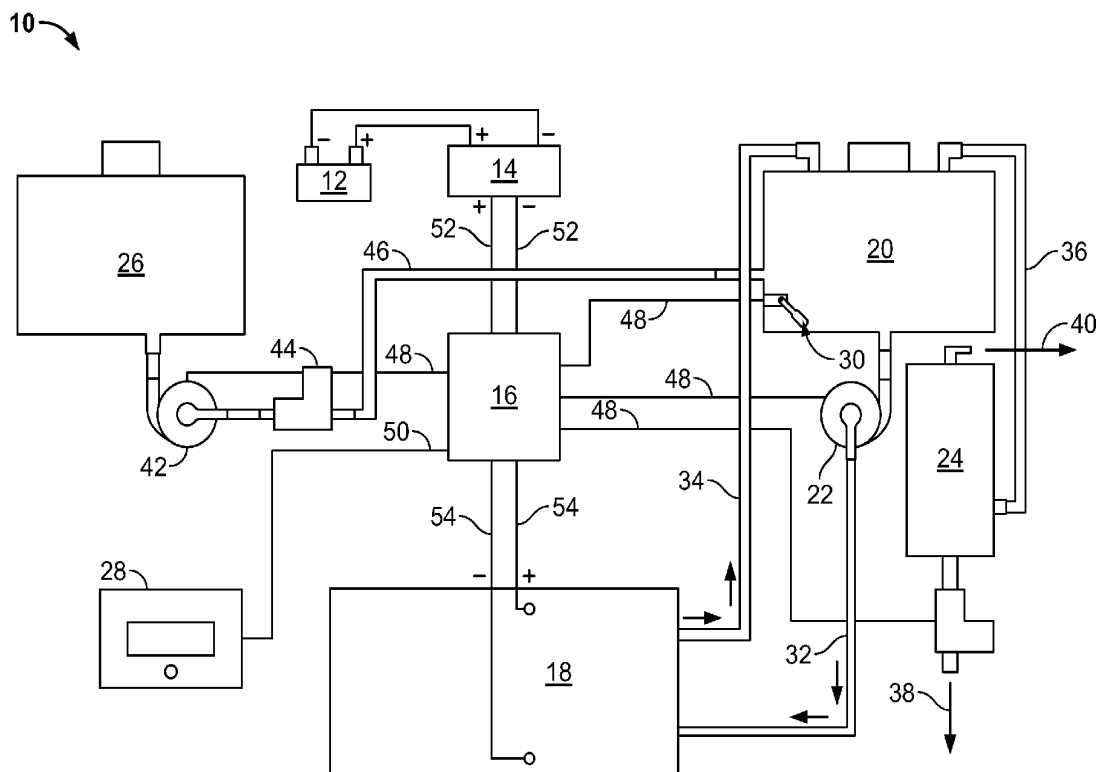
A device and method for generation of high octane hydrogen gas from acetic acid includes providing an electrolysis unit having a cathode, an anode, neutral elements, gaskets, and an electrolyte including acetic acid; applying pulse-width-modulated power to the cathode and anode to produce hydrogen and oxygen gas from the electrolyte; transporting the gas and some of the electrolyte from the electrolysis unit to a reservoir; transporting the electrolyte in the reservoir back to the electrolysis unit, thereby reusing the electrolyte; refilling the reservoir with distilled water when the level of electrolyte in the reservoir is low; utilizing a condensate trap to dump water that condenses out of the gas in the reservoir; and transporting the gas in the condensate trap for use. The hydrogen and oxygen gas may be provided to the air intake of an engine.

(75) **Inventor:** **Jim Haywood, Alma, AR (US)**

Correspondence Address:
Larry E Severin, Esq
3581 Teaberry Circle
Seal Beach, CA 90740 (US)

(73) **Assignee:** **HAYLIN HYDROGEN
SYSTEMS, LLC, Alma, AR (US)**(21) **Appl. No.:** **12/833,360**(22) **Filed:** **Jul. 9, 2010****Related U.S. Application Data**

(60) Provisional application No. 61/224,194, filed on Jul. 9, 2009.



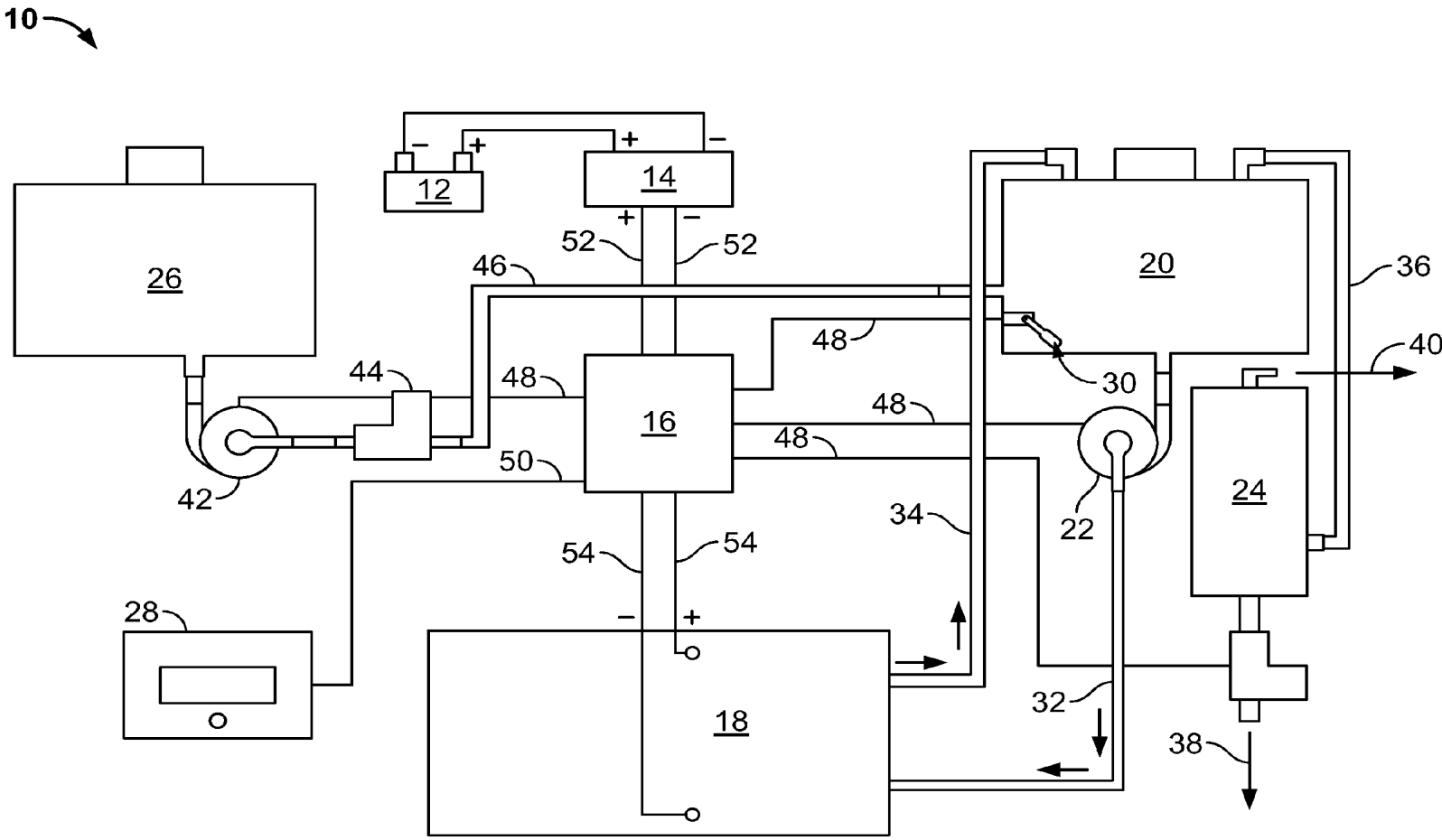


FIG. 1

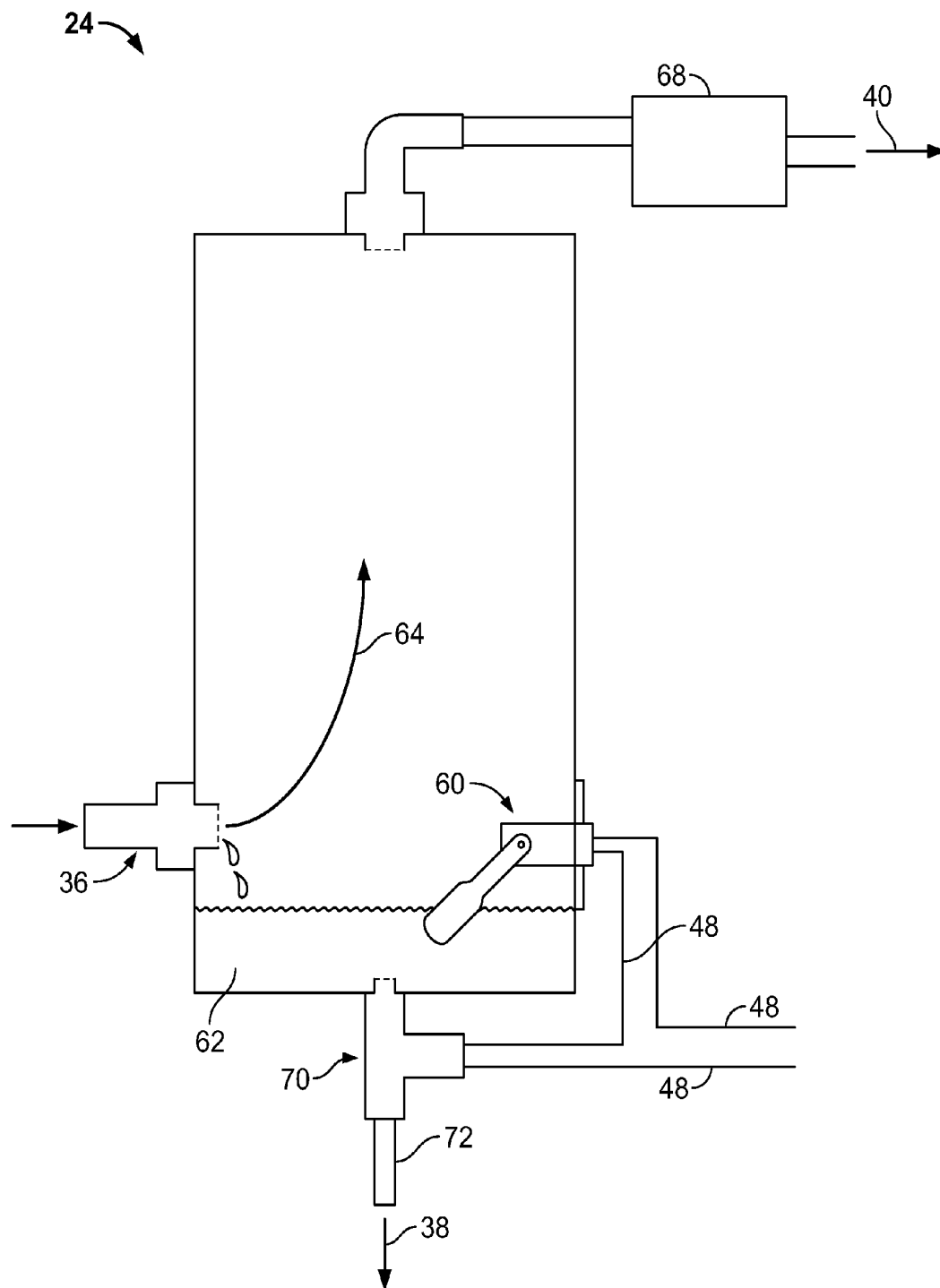


FIG. 2

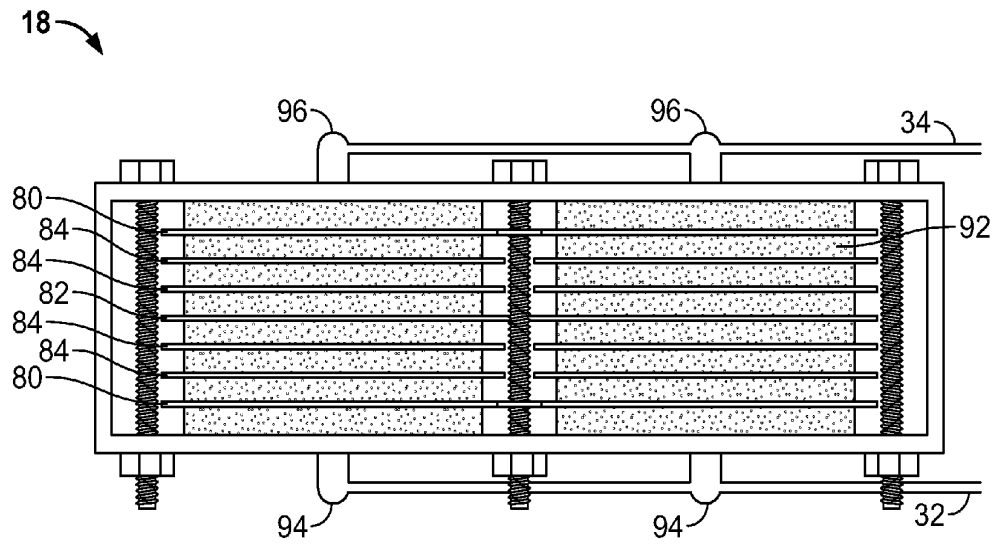


FIG. 3A

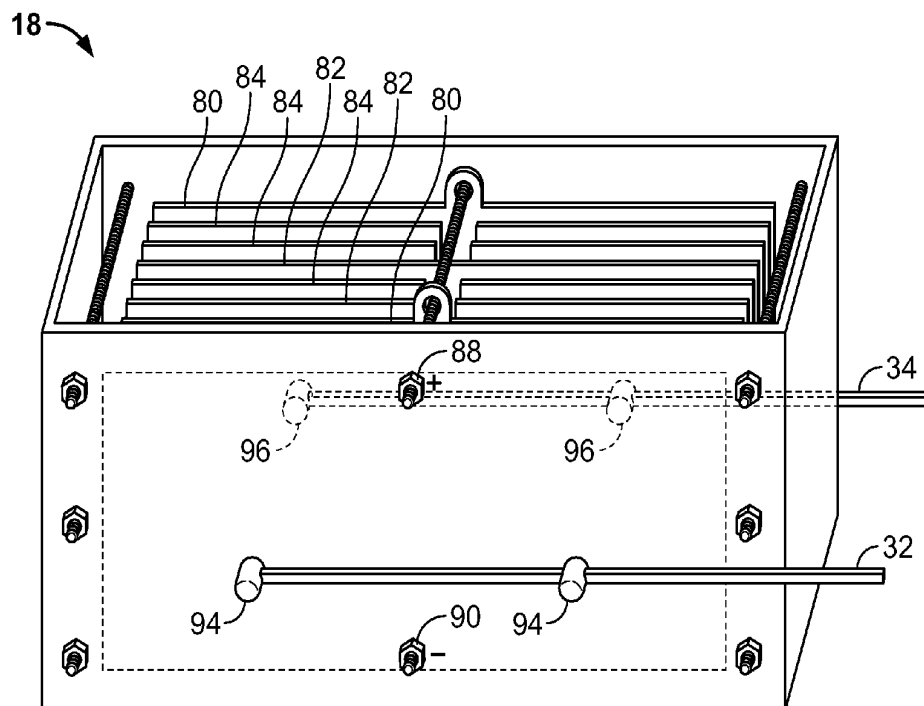


FIG. 3B

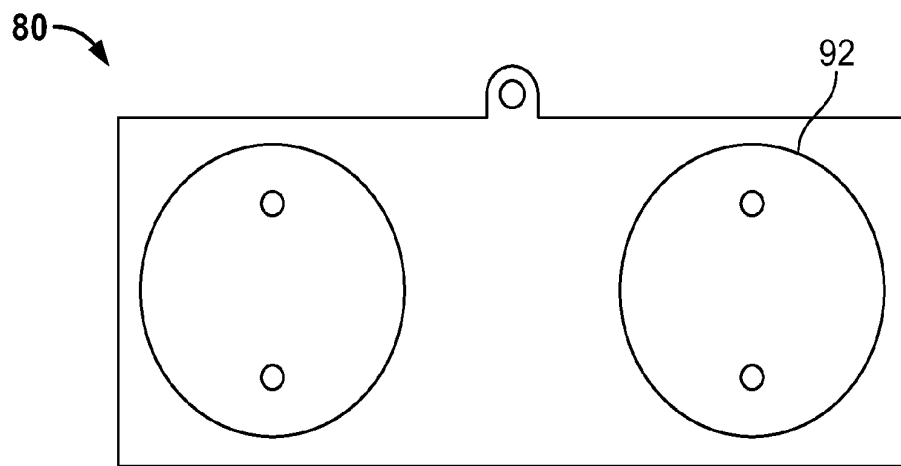


FIG. 4A

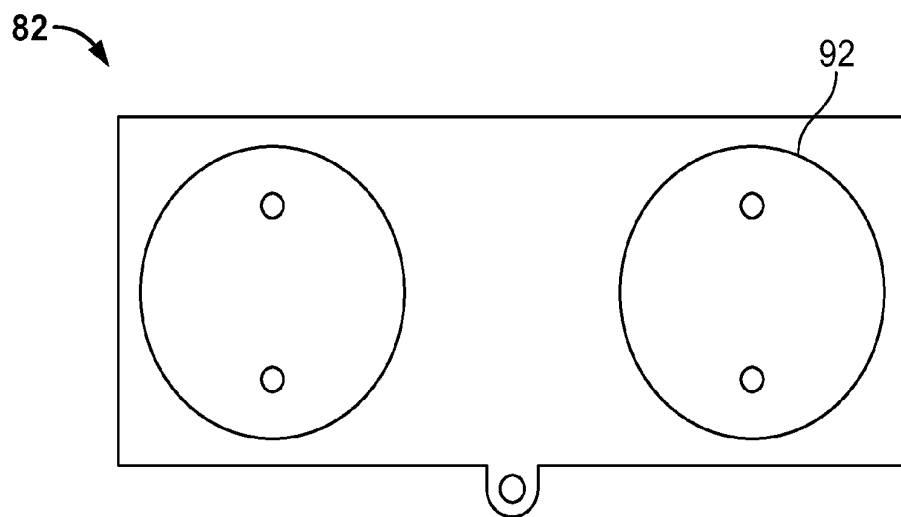


FIG. 4B

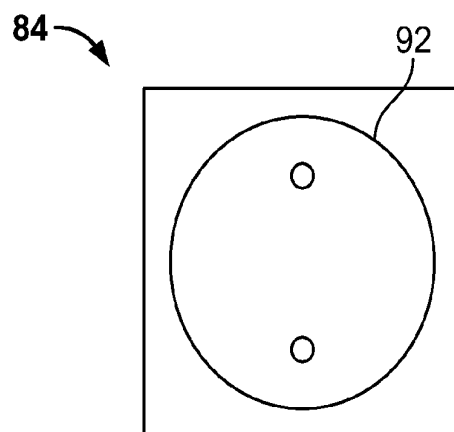


FIG. 4C

GENERATION OF HIGH OCTANE HYDROGEN GAS FROM ACETIC ACID

RELATED APPLICATIONS

[0001] This application claims the benefit of the filing date of U.S. Patent Application No. 61/224,194, filed Jul. 9, 2009, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] The present invention generally relates to generation of hydrogen gas and more specifically to generation of high octane hydrogen gas from acetic acid.

[0003] Existing internal combustion engines for automobiles may burn only 20% of the carbon in the gasoline or diesel fuel. Carbon is sent to a catalytic converter, which is wasteful, and produces emissions that include noxious gasses and green house gasses, such as carbon monoxide (CO), carbon dioxide (CO₂), and nitrous oxide (NO).

[0004] The use of on-board electrolysis in producing small amounts of hydrogen and oxygen gasses into the air intake of an internal combustion engine may increase mileage and reduce emissions from the automobile.

[0005] It would be therefore be desirable to have a device that may be useful to an individual, business or corporation who desires or needs a reduction in fuel consumption and has a desire to reduce emissions, such as, for example trucking companies, police departments, school systems, individuals who commute to and from work, and others who wish to reduce emissions.

SUMMARY OF THE INVENTION

[0006] In one aspect of the present invention, a device for producing a gas includes an electrolyte; an electrolysis unit that retains the electrolyte; a cathode inside the electrolysis unit; a positive lead electrically connected to the cathode; an anode inside the electrolysis unit; a negative lead electrically connected to the anode; a neutral element inside the electrolysis unit, between the cathode and anode; a pulse width modulator that provides pulse-width-modulated power to the leads so that the cathode and anode react with the electrolyte to produce a gas; a first conduit that transports gas and electrolyte in the electrolysis unit to a reservoir; a second conduit that transports the electrolyte in the reservoir to the electrolysis unit; and a third conduit that transports the gas in the reservoir out of the device, thereby producing the gas.

[0007] In another aspect of the present invention, a device for producing a gas includes an electrolysis unit that retains an electrolyte, the electrolyte including acetic acid; a cathode inside the electrolysis unit, having a metal plate and a cathode tab electrically connected to a positive lead; an anode inside the electrolysis unit, having a metal plate and an anode tab electrically connected to a negative lead; a neutral plate between the cathode and anode, the anode, cathode, and neutral plate oriented generally parallel to each other inside the electrolysis unit; a plurality of gaskets between the plates; a pulse width modulator that provides pulse-width-modulated power to the leads so that the cathode and anode react with the electrolyte to produce a gas that includes hydrogen and oxygen; a first conduit that transports gas and electrolyte in the electrolysis unit to a reservoir; a second conduit that transports the electrolyte in the reservoir to the electrolysis unit; and a third conduit that transports the gas in the reservoir out of the device, thereby producing the gas.

[0008] In yet another aspect of the present invention, a method of producing a gas includes providing an electrolysis unit having a cathode, an anode, a neutral element between the cathode and anode, gaskets therebetween, and an electrolyte including acetic acid; applying pulse-width-modulated power to the cathode and anode to produce gas from the electrolyte, the gas substantially containing hydrogen and oxygen; transporting the gas and some of the electrolyte from the electrolysis unit to a reservoir; transporting the electrolyte in the reservoir back to the electrolysis unit, thereby reusing the electrolyte; refilling the reservoir with distilled water when the level of electrolyte in the reservoir is low; utilizing a condensate trap to dump water that condenses out of the gas in the reservoir; and transporting the gas in the condensate trap for use, thereby producing the gas.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 depicts a schematic depiction of an embodiment of the present invention;

[0010] FIG. 2 depicts a condensate trap according to the embodiment of FIG. 1;

[0011] FIG. 3A depicts a top view of an electrolysis unit according to the embodiment of FIG. 1;

[0012] FIG. 3B depicts a side view of the electrolysis unit of FIG. 3A;

[0013] FIG. 4A depicts a positive plate according to the embodiment of FIG. 1;

[0014] FIG. 4B depicts a negative plate according to the embodiment of FIG. 4A; and

[0015] FIG. 4C depicts a neutral plate according to the embodiment of FIG. 4A.

DETAILED DESCRIPTION

[0016] The preferred embodiment and other embodiments, which can be used in industry and include the best mode now known of carrying out the invention, are hereby described in detail with reference to the drawings. Further embodiments, features and advantages will become apparent from the ensuing description, or may be learned without undue experimentation. The figures are not necessarily drawn to scale, except where otherwise indicated. The following description of embodiments, even if phrased in terms of "the invention" or what the embodiment "is," is not to be taken in a limiting sense, but describes the manner and process of making and using the invention. The coverage of this patent will be described in the claims. The order in which steps are listed in the claims does not necessarily indicate that the steps must be performed in that order.

[0017] An embodiment of the present invention generally generates high-octane hydrogen gas from acetic acid. Embodiments may provide, for example, 115 octane hydrogen gas. Embodiments may be self-contained units that, when connected to an automobile or other vehicle's battery and engine air intake, provide hydrogen gas to improve mileage and reduce emissions.

[0018] An embodiment of a device may burn fuel that is otherwise normally exhausted. The device may generate high-octane hydrogen gas that is used by the motor. An embodiment may use electrolysis of acetic acid and other chemicals to generate, for example, 115 octane hydrogen gas at 5 pounds per square inch. Elements of an embodiment of the device may include a polycarbonate resin thermoplastic, such as, for example, Lexan®, which houses stainless steel

plates and silicone gaskets. Steel bolts may be used for assembly. Electrical terminals may be made of brass. Tubing for acetic acid circulation may include polyurethane, such as, for example, Superthane®. A reservoir may contain acetic acid used for the electrolysis. A circulation pump for the acid may be 12 volt, and may be driven by the automobile battery. Hydrogen gas or vapor may be generated by electrolysis. Gaskets may provide insulation. The acetic acid may be circulated and reused. Embodiments may produce hydrogen gas, which is collected and output.

[0019] Embodiments may introduce hydrogen gas into the air intake of an internal combustion engine, such as an engine for an automobile that uses gasoline, diesel fuel, natural gas, or propane. The hydrogen may help provide a complete and rapid burn of all carbon in the fuel for the engine, which may improve mileage and reduce emissions of emitting noxious gasses and green house gasses including carbon monoxide, carbon dioxide, and nitrous oxide. The hydrogen may be produced through electrolysis or hydrolysis, by a system operated from the automobile battery. The hydrogen may be produced on demand, only when the automobile is on, and thereby avoid the need for a dedicated gas holding tank.

[0020] As depicted in FIG. 1, an embodiment of a system 10 may utilize a battery 12, such as a 12-volt automobile battery or a dry cell, electrically connected to a relay 14. Battery 12 also provides power to a system controller/pulse width modulator (PWM) 16. Embodiments of PWM 16 may incorporate other functions of the system, such as relay 14. PWM 16 may be a pre programmed microcontroller or other computer, and may provide pulse-width modulated power to an electrolysis unit 18, which is a fuel cell or hydrogen-cell that utilizes an electrolyte such as acetic acid for hydrolysis. Gaseous hydrogen, oxygen, and aerosol electrolyte from the electrolysis unit 18 may be delivered to a reservoir 20, which is a tank for electrolyte to be re-used, and gasses to be externally output. Condensed liquid electrolyte in the reservoir 20 may be returned to the electrolysis unit 18 as needed using a circulation pump 22 that runs continuously. The hydrogen and oxygen gasses in reservoir 20 may be provided to a water condensate trap 24 which may be delivered as an external fuel output 40 to the air intake of an internal combustion engine. Excess water 38 formed by condensed hydrogen and oxygen in the water condensate trap 24 may be dumped as needed. To replace this dumped excess water 38, distilled water may be provided to the reservoir 20 from a reserve water tank 26 as needed. A dashboard unit 28 may display system status from PWM 16 and receive control inputs from a user. Pump 22 may continuously pump electrolyte from the reserve 20 to the electrolysis unit 18 through an electrolysis recharge line 32. This may help blow the bubbles of hydrogen and oxygen off of the plates in the electrolysis unit 18, as well as help provide pressure to urge the mixture of hydrogen, oxygen, and electrolyte to pass through the electrolysis recharge line 32.

[0021] The level of acetic acid or other electrolyte in the reserve 20 may be detected by an electrolyte float switch 30, and if the level is low, a reserve water tank 26 located adjacent or near the reservoir 20 may pump distilled water with a water pump 42 through a water valve 44 into a water pipe 46 and into the reservoir 20. The addition of distilled water from water valve 44 may be controlled by PWM 16 based upon signals received from electrolyte float switch 30. The gasses produced by the electrolysis unit may be collected and provided to the reservoir 20 through an electrolysis gas line 34. Hydrogen and oxygen in the reservoir 20 may be provided to

the water condensate trap 24 through a hydrogen and oxygen fuel line 36. Power and control lines 48 may provide status information to the controller/pulse width modulator (PWM) 16 from components of the system, which may include the reserve water tank's water pump 42 and water valve 44, the reservoir 20, the circulation pump 22, and the water condensate trap 24. This status information may be interchanged using a data line 50 with a dashboard unit 28, so that a user may provide control inputs to adjust the proportions and balances of the system. An embodiment of a PWM 16 may receive direct current (DC) power 52 such as 12-volt DC power from an automobile battery 14, and provide pulse-width modulated power 54 to the electrolysis unit 18. Embodiments of electrolysis unit 18 may be determined by the size of the internal combustion engine, which may be, for example, 4-cylinder, 6-cylinder, 8-cylinder, or diesel.

[0022] An embodiment of a pulse width modulator 16 may be used to control the amperage and voltage sent to the electrolysis unit 18. In some embodiments, the PWM 16 rate may range from 300 to 3,000 pulses per second. The amperage may control both the supply of hydrogen gas produced and the amount of heat built up in the unit. An embodiment of a PWM 16 may function to help retard heat. The greater the amperage, the more hydrogen gas will be produced.

[0023] An embodiment of a dashboard unit 28 may be a free-standing element that has a computer or other control mechanism which sets the desired amperage of the PWM 16. Users may use the dashboard unit 28 to make changes. Dashboard unit 28 may include a display screen, such as a liquid crystal display (LCD), that tells the user if there is a failure at any point in the system, such as, for example, a low electrolyte level in the reservoir 20. The dashboard unit 28 may also indicate the electrolyte temperature, and might shut the system down for a period of time or decrease the amperage.

[0024] Embodiments may provide automatic refill, in that an extra reserve water tank 26 distilled water may be kept adjacent to reservoir 20. When the level of acetic acid becomes low in reservoir 20, electrolyte float switch 30 in the reservoir 20 tank electrically trips, which triggers water pump 42 and water valve 44 to transfer fresh distilled water from reserve water tank 26 to reservoir 20. When replenished, water pump 42 shuts off and water valve 44 closes.

[0025] In an embodiment, acetic acid at 5% strength by volume may be stored in the electrolysis unit and may be used as an electrolyte because it is chemically stable, safe for humans, safe for the environment, and safe for internal combustion engines. The resulting hydrolysis product may help burn carbon build up which may have accumulated over years and may improve engine performance. Metal plates may be used to accomplish hydrolysis, and may be titanium coated with iridium tin, or ceramic covered stainless steel plates, or possibly plain stainless steel plates. However, the latter choice may produce hexavalent chromium which may be considered toxic in some areas, such as California. To perform hydrolysis, the electrolyte, such as 5% acetic acid with distilled water, may enter an embodiment of a dry electrolysis unit and may be introduced to the plates. Some plates may have leads that are attached to the automobile's positive terminal, which may act as cathodes, and other plates may have leads that are attached to the automobile's negative terminal, which may act as anodes, and yet other plates may be neutral. Hydrogen atoms, having negative electrons, will arise at the cathodes, and oxygen atoms, having positive protons, will arise at the anodes.

[0026] As depicted in the embodiment of FIG. 2, a water condensate trap 24 may receive hydrogen and oxygen gas from a fuel line 36, dump excess water 38, and deliver an external fuel output 40 to an outside entity such as the air intake of an engine. Power and control lines 48 may power and control a condenser float switch 60 that measures the level of condensed gas 62. An embodiment of condensate trap 24 may include a closed container that accepts the gaseous products of electrolysis produced in electrolysis unit 18. This gaseous product may be a type of aerosol, and when it arrives in the container via hydrogen and oxygen fuel line 36, the outside temperature and the heat of the gas produces water condensate 62 consisting substantially of water, in addition to fuel gas 64. The pressure of the fuel gas 64, which consists substantially of hydrogen and oxygen, may force moisture to separate and drop to the bottom of water condensate trap 24 as a condensate which in turn forms into a liquid water condensate 62. As this liquid rises, at a certain level it trips a condenser float switch 60 or electronic valve in the floor, and the condensate liquid 62 exits through a water dump tube 66 in the floor of the trap 24. In the meantime, the hydrogen and oxygen gasses rise and move through external fuel output 40 into the air intake of the internal combustion engine. An electronic condenser valve 70, in response to a signal from condenser float switch 60, may open to dump the water condensate 62 out of the system through a condenser output tube 72.

[0027] Embodiments may include an oxygen sensor 68 in line with the external fuel output 40, as may be mandated by the Environmental Protection Agency. Embodiments of the system may include a special chip or other sensor component to assist in oxygen detection. When high oxygen levels are detected, a control system may regulate the production of oxygen.

[0028] As depicted in the embodiment of FIGS. 3A and 3B, an electrolysis unit 18 may include a number of plates including positive plates 80, negative plates 82, and neutral plates 84. As depicted in FIG. 3A, the plates may be organized as +NN-NN+, with positive plates 80 electrically connected to the positive lead 88 and negative plates 82 electrically connected to the negative lead 90, and with two neutral plates between each positive and negative plate. Other embodiments may include, for example, -NN+NN-NN+NN-, -NNN+NNN-NNN+NN-, or -NN+NN-. Additional configurations may be made. A positive lead 88 may electrically connect the positive plates 80, which have a tab in a first orientation such as tab up, and a negative lead 90 may electrically connect the negative plates 82, which may be similar to the positive plates except that they are in a second orientation such as tab down. One or more electrolysis input sockets 94 in the front of the electrolysis unit 18 may connect to the electrolysis recharge line 32 near the bottom of the electrolysis unit 18 to receive electrolyte from the reservoir. The acetic acid may be forced into the electrolysis unit 18 under pressure by the circulation pump, which will help blow the bubbles of hydrogen and oxygen gas off of the plates, helping enhance hydrolysis. One or more gas output sockets 96 in the back of the electrolysis unit may connect to the electrolysis gas line 34 to send the products of hydrolysis to the reservoir. The output sockets 96 may be located approximately 1.5 inches from the top of the electrolysis unit, so as to extract the gasses produced by hydrolysis, and also to uptake the electrolyte when the unit is full of electrolyte (thereby helping make room for gasses in the electrolysis unit as gasses are produced).

[0029] As depicted in FIGS. 4A, 4B, and 4C, plates 80, 82, and 84 have gaskets 92 for insulation between the plates.

Positive plates 80 have a tab in a first orientation such as tab up, and negative plates 82 may be similar to the positive plates except that they are in a second orientation such as tab down. Neutral plates 84 may help provide space between alternating positive and negative plates in the electrolysis unit.

[0030] Embodiments of the present invention may be packaged in a single housing, and all elements kept within, except wires and tubes and the dashboard unit. The package may be steel for automobiles or plastic for trucks. In automobiles, the package may be located in the trunk. In trucks, or diesels, the package may be bolted to the frame.

I claim:

1. A device for producing a gas, comprising:
 - an electrolyte;
 - an electrolysis unit that retains the electrolyte;
 - a cathode inside the electrolysis unit;
 - a positive lead electrically connected to the cathode;
 - an anode inside the electrolysis unit;
 - a negative lead electrically connected to the anode;
 - a neutral element inside the electrolysis unit, between the cathode and anode;
 - a pulse width modulator that provides pulse-width-modulated power to the leads so that the cathode and anode react with the electrolyte to produce a gas;
 - a first conduit that transports gas and electrolyte in the electrolysis unit to a reservoir;
 - a second conduit that transports the electrolyte in the reservoir to the electrolysis unit; and
 - a third conduit that transports the gas in the reservoir out of the device, thereby producing the gas.
2. The device of claim 1, wherein the electrolyte is acetic acid, the cathode produces hydrogen, the anode produces oxygen, and the gas includes the hydrogen and the oxygen.
3. The device of claim 1, wherein the anode is a metal plate, the cathode is a metal plate, the neutral element is a plate, and the anode, cathode, and neutral element are oriented generally parallel to each other inside the electrolysis unit.
4. The device of claim 3, further comprising:
 - gaskets between the plates.
5. The device of claim 1, wherein the anode includes iridium tin and the cathode includes iridium tin.
6. The device of claim 1, wherein the cathode has a cathode tab, the cathode lead is connected to the cathode tab, the anode has an anode tab, and the negative lead is connected to the anode tab.
7. The device of claim 1, further comprising:
 - a pump to urge the electrolyte in the reservoir through the second conduit to the electrolysis unit so that the electrolyte helps blow bubbles of gas produced by the anode and the cathode off of the anode and the cathode.
8. The device of claim 1, further comprising:
 - a condensate trap that receives gas from the reservoir, dumps condensate that condenses from the gas out of the trap, and provides the gas to the third conduit to be transported out of the device.
9. The device of claim 1, further comprising:
 - a water reserve that contains water; and
 - a sensor that determines the level of electrolyte in the reservoir;
 wherein, when the sensor determines that the level of electrolyte in the reservoir is low, water in the reserve is provided to the reservoir so as to raise the level of electrolyte.

10. The device of claim **1**, wherein the third conduit is adapted to produce the gas to the air intake of an engine, and the pulse width modulator is adapted to obtain direct current power from a battery.

11. The device of claim **1**, further comprising:

a display screen that provides device status to a user; and
a control input that provides an input from the user to the pulse width modulator.

12. A device for producing a gas, comprising:

an electrolysis unit that retains an electrolyte, the electrolyte including acetic acid;

a cathode inside the electrolysis unit, having a metal plate and a cathode tab electrically connected to a positive lead;

an anode inside the electrolysis unit, having a metal plate and an anode tab electrically connected to a negative lead;

a neutral plate between the cathode and anode, the anode, cathode, and neutral plate oriented generally parallel to each other inside the electrolysis unit;

a plurality of gaskets between the plates;

a pulse width modulator that provides pulse-width-modulated power to the leads so that the cathode and anode react with the electrolyte to produce a gas that includes hydrogen and oxygen;

a first conduit that transports gas and electrolyte in the electrolysis unit to a reservoir;

a second conduit that transports the electrolyte in the reservoir to the electrolysis unit; and

a third conduit that transports the gas in the reservoir out of the device, thereby producing the gas.

13. The device of claim **12**, further comprising:

a pump to urge the electrolyte in the reservoir through the second conduit to the electrolysis unit so that the electrolyte helps blow hydrogen bubbles off of the cathode plate and oxygen bubbles off of the anode plate.

14. The device of claim **12**, further comprising:

a condensate trap that receives hydrogen gas and oxygen gas from the reservoir, dumps water that condenses from

the gasses out of the trap, and provides the gasses to the third conduit to be transported out of the device.

15. The device of claim **12**, further comprising:

a water reserve that provides distilled water to the reservoir when electrolyte in the reservoir is low.

16. The device of claim **12**, further comprising:

a dashboard unit, electrically connected to the pulse width modulator, having a status display screen and a control input.

17. The device of claim **12**, further comprising:

a dashboard unit, electrically connected to the pulse width modulator, having a status display screen and a control input.

18. A method of producing a gas, comprising:

providing an electrolysis unit having a cathode, an anode, a neutral element between the cathode and anode, gaskets therebetween, and an electrolyte including acetic acid;

applying pulse-width-modulated power to the cathode and anode to produce gas from the electrolyte, the gas substantially containing hydrogen and oxygen;

transporting the gas and some of the electrolyte from the electrolysis unit to a reservoir;

transporting the electrolyte in the reservoir back to the electrolysis unit, thereby reusing the electrolyte;

refilling the reservoir with distilled water when the level of electrolyte in the reservoir is low;

utilizing a condensate trap to dump water that condenses out of the gas in the reservoir; and

transporting the gas in the condensate trap for use, thereby producing the gas.

19. The method of claim **18**, further comprising:

pumping the electrolyte in the reservoir into the electrolysis unit to help enhance hydrolysis.

20. The method of claim **18**, further comprising:

transporting the gas that is produced to an air intake of an engine for a vehicle having a battery; and

powering the electrolysis unit utilizing power from the battery so that the gas is produced when the vehicle is on.

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