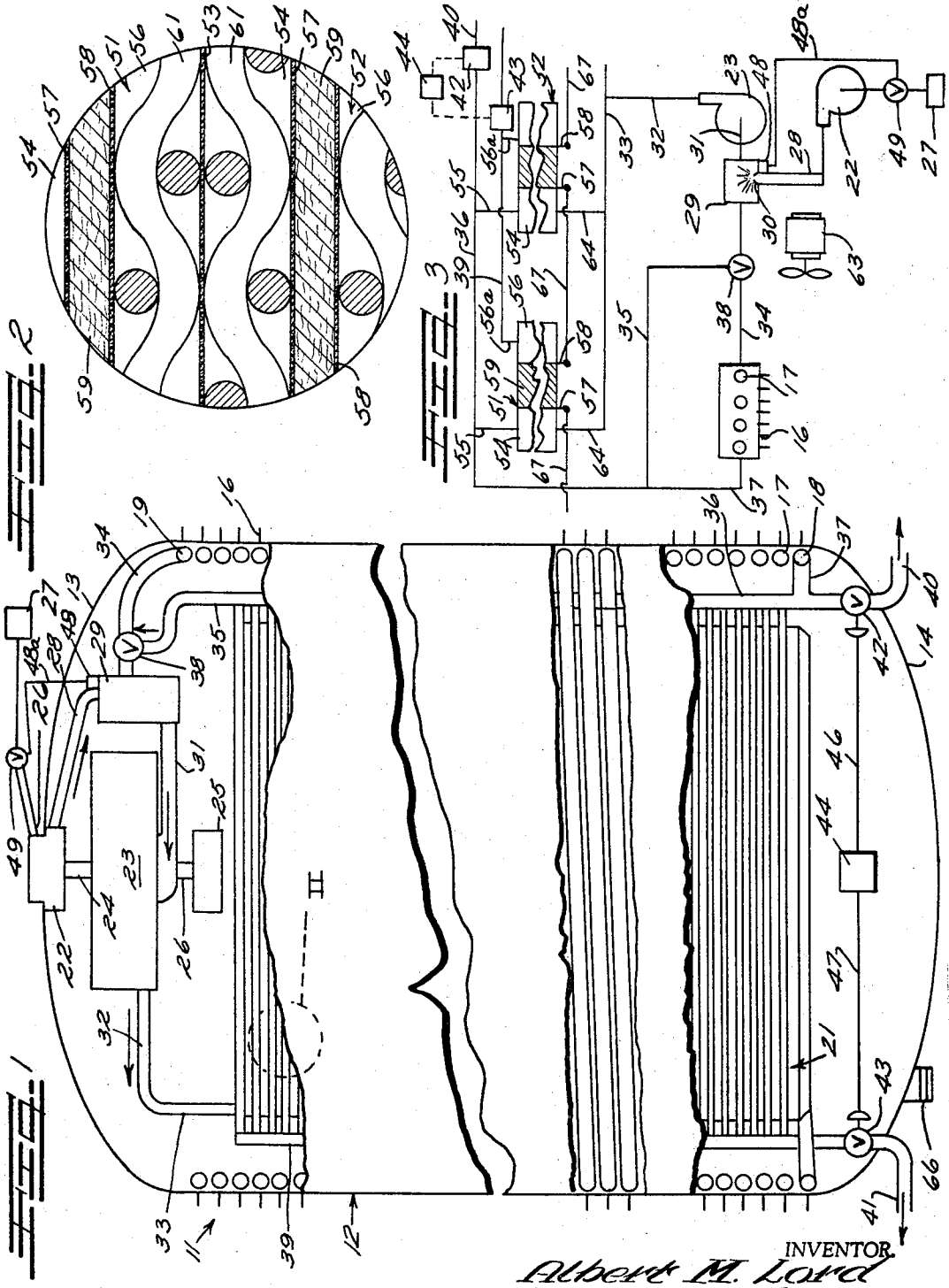
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HIGH PRESSURE ELECTROLYTIC CELL MODULE

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HIGH PRESSURE ELECTROLYTIC CELL MODULE

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ABSTRACT OF THE DISCLOSURE

This invention provides in a single housing a complete electrolytic unit provided with means whereby the emitted gas is cooled and recirculated to replenish the electrolyte.

This invention generally relates to an electrolytic cell module and more particularly relates to a compact high-pressure electrolytic cell module.

Prior known electrolytic cell modules, utilizing a plurality of electrolytic cells were unable to be effectively used in airborne vehicles because of their excessive weight and size. These modules required continuous recirculation of the electrolyte and replenish and cooled the electrolyte outside of the cell module. Further, the cell module did not contain the entire electrolytic unit in a single housing but required several various large units to provide the means for replenishing the electrolyte, and cooling the module. The present invention provides an improved high-pressure electrolytic cell module having the electrolytic cells therein connected to manifold means to recirculate a portion of the gas emitted thereby to cool and replenish the electrolyte of each electrolytic cell.

Therefore, it is an object of the present invention to provide a high-pressure water electrolytic cell module having means to feed electrolyte to each electrolytic cell by vapor diffusion.

It is another object of the present invention to provide an electrolytic cell module having means to control the electrolyte concentration and temperature by vapor diffusion.

It is still another object of the present invention to provide an electrolytic cell module having a plurality of electrolytic cells and means to control the electrolyte concentration and temperature of each electrolytic cell by vapor diffusion.

It is still another object of the present invention to provide a high-pressure water electrolytic cell module with a manifold means for receiving gas produced in each cell, means to saturate the gas with electrolyte vapors, and a manifold means for returning a portion of the saturated gas to the electrolytic cells to provide cooling thereof and vapor diffusion therein.

It is still another object of the present invention to provide a water electrolysis cell module having manifold means to receive the hydrogen gas produced by a plurality of electrolytic cells, means to humidify a portion of the hydrogen gas and return manifold means for returning the humidified hydrogen gas to each of the electrolytic cells to cool and replenish the electrolyte therein.

Other objects, features and advantages of the present invention will become apparent after considering the following description taken in conjunction with the drawings wherein like reference numerals refer to like and corresponding parts.

In the drawings:

FIGURE 1 is a partial diagrammatic view with parts in elevation illustrating an electrolytic cell module constructed in accordance with the principles of the present invention;

FIGURE 2 is a partial enlarged longitudinal cross-sectional view illustrating the electrolytic cell construction of the electrolytic cell module taken along the line II of FIGURE 1; and

FIGURE 3 is a partial schematic view illustrating the electrolysis system of the electrolytic cell module illustrated in FIGURE 1.

As shown in the drawings:

For exemplary purposes only, the electrolytic cell module of the present invention will be described for a high pressure water electrolytic cell module. It is of course understood that the electrolytic cell module may be used for the electrolysis of materials other than the water.

The electrolytic cell module of the present invention has a plurality of electrolytic cells and has its auxiliary equipment packaged in a cylindrical pressure vessel with hemispherical ends. The cells are electrically interconnected and have outlet manifold means for receiving gases evolved therefrom, with means to tap a portion of the gases from said outlet manifold means to direct said tapped gases to a cooling jacket within the module to cool said tapped gases, means to saturate said cooled gases with electrolyte, inlet manifold means connected to said electrolyte saturating means and the electrolytic cells to return the electrolyte saturated hydrogen gas to each of the electrolytic cells, and means to control the cooling and electrolyte saturation of the gas, such that the saturated gases will cool said cells and replenish the electrolyte content thereof.

Referring to FIGURE 1, there is an electrolytic cell module **11** having a cylindrical pressure vessel **12** with hemispherical ends **13** and **14**. Around the outer surface of the vessel **12** and extending substantially the length project a plurality of spaced annular fins **16** that act as radiator fins to cool the pressure vessel. Along the inner circumference of the vessel **12** and opposite the fins **16** is mounted a helical conduit **17** extending substantially the length of the pressure vessel. The conduit **17** has an inlet **18** and an outlet **19** and is utilized to conduct heat from the fluid therein to the fins **16**.

An electrolytic cell stack **21** is mounted essentially within the pressure vessel **12** and preferably has low pressure walls although the cell will operate at high-pressure. Above the electrolytic cell stack **21** and centrally to the end **13** is mounted a high-pressure water pump **22** having high-pressure construction. The water pump **22** has an inlet conduit **26** which is connected to a suitable water supply **27** and an outlet conduit **28**. The water pump **22** is connected to a circulating blower **23** having low pressure construction, by an axle **24**. The circulating blower **23** is mounted within the pressure vessel between the water pump and the electrolytic cell stack **21** and has an inlet conduit **31** and an outlet conduit **32**. A motor **25**, mounted between the stack **21** and the blower **23**, simultaneously operates the circulating blower **23** and the water pump **22** through an axle **26**. The outlet conduit **28** delivers water to a spray nozzle **30** (FIG. 3) which is located within a spray humidifier **29**. The spray humidifier **29** has a gas outlet communicating with the circulating blower conduit **31**, a liquid inlet communicating with pump conduit **28**, and a gas inlet conduit **34**, communicating the interior of the humidifier with the helical cooling coil outlet **19**. Thus, the water pump **22** delivers water to a spray nozzle **30** (FIGURE 3) mounted within the humidifier while cooled gases are delivered to the humidifier by conduit **34**. Within the humidifier, the humidity of the cooled gases is raised and preferably saturated with water vapor by the water spray from the nozzle **30**. The humidified gases are then delivered by conduit **31** to the circulating blower **23**.

A hydrogen outlet manifold **36**, an oxygen outlet manifold **39**, and a hydrogen inlet manifold **33** are mounted

within the vessel adjacent the cell stack **21**. The hydrogen outlet manifold **36** has an outlet **40** for delivering hydrogen gas to a fuel cell (not shown) or other suitable means. The cooling coil also communicates with the hydrogen manifold **36** through a hydrogen take-off conduit **37** to have a portion of the hydrogen gas delivered thereto and a heat exchanger by-pass conduit **35** communicates the manifold **36** with the conduit **34** through a normally closed three-way temperature sensitive valve means **38**. The valve means **38** opens to allow the hot hydrogen gas within the manifold **36** to mix within the conduit **34** with the cooled hydrogen gas from the cooling coil **17** when the cooling coil and associated fins **16** cool the hydrogen gas below a predetermined temperature.

The hydrogen inlet manifold is connected to the circulating blower **23** by the conduit **32** and receives cooled humidified hydrogen gas therefrom and the oxygen outlet manifold **39** has an outlet **41** for delivering oxygen gas to the fuel cell (not shown) or other suitable means.

The cell stack **21** is composed of a plurality of electrically connected electrolytic cells that decompose their aqueous electrolyte into hydrogen and oxygen gases. A plurality of hydrogen outlet conduits **55** (FIGURE 3) connect each electrolytic cell of the cell stack with the hydrogen outlet manifold **36**, a plurality of oxygen outlet conduits **56***a* (FIGURE 3) interconnect each electrolytic cell in the cell stack **21** with the oxygen outlet manifold **39**, and a plurality of hydrogen inlet conduits **64** (FIGURE 3) interconnect each electrolytic cell of the cell stack **21** with the hydrogen inlet manifold **33**. A pressure relief valve **42** is mounted on the hydrogen outlet manifold **36** between the hydrogen outlet **40** and the by-pass conduit **37** and an oxygen relief valve **43** is mounted before the oxygen outlet **41**. A valve control assembly **44** interlinks the relief valves **42** and **43** by lines **46** and **47** respectively so that the electrolytic cells do not experience a pressure difference greater than 1.0 p.s.i.a. in their respective electrode assemblies.

The rate of water spray within the spray humidifier **29** is controlled by a gas temperature depression sensor **48** mounted on the humidifier to sense the temperature therein and connected by line **48***a* to control a water supply valve **49** and thereby control the amount of water being sprayed to thus control the amount of humidification of the hydrogen gas within the humidifier.

Referring to FIGURE 2, there is illustrated a partial longitudinal cross-sectional view of two adjacent electrolytic cells **51** and **52** in the cell stack **21**. The cells are separated by a sheet metal partition **53** and each cell has a hydrogen chamber **54**, an oxygen chamber **56** and an aqueous electrolyte **59** positioned between the hydrogen and oxygen chambers. A cathode **57** is positioned between the hydrogen chamber and the electrolyte and an anode **58** is positioned between the oxygen chamber and the electrolyte. The electrolyte **59** is in a bed or mat or a matrix of asbestos fibers impregnated with an aqueous electrolyte solution of, for example, potassium hydroxide, sodium hydroxide, phosphoric acid or sulfuric acid. The thickness of the electrodes **57** and **58**, and the electrolyte matrix **59** have been exaggerated in the drawings for purposes of clarity as the thickness of the electrodes and the electrolyte are quite small i.e. the thickness of the electrolyte layer normally measures as small as 0.030 inch and the thickness of the electrodes being as small as 0.0045 inch. The electrodes **57** and **58** may be sintered nickel porous plates varying from 0.004 to 0.020 inch thick, nickel screen of 0.003 inch wire with 80 wires per inch, nickel screen with a coating of platinum black, silver and tantalum screens, or porous carbon plates.

Within the hydrogen and oxygen compartments are metal screens **61** which may be preferably nickel or copper screening utilized for making electrical contact with the electrodes **57** and **58**.

Referring to FIGURE 3 the operation of the electrolytic cell module **11** is schematically illustrated by illustrating a series of two electrolytic cells. It is of course understood that the number of electrolytic cells is many times more than two.

The electrolytic cells **51** and **52** have their electrolyte impregdated asbestos beds **59** disposed between the cathode **57** and the anode **58**. Hydrogen produced at the cathode is delivered from the hydrogen chamber **54** to the hydrogen delivery conduits **55** to the hydrogen outlet manifold **36** and the oxygen produced at the anode **58** is delivered from the oxygen chamber **56** to the oxygen outlet manifold **39** by conduits **56***a*. A portion of the hydrogen from the hydrogen manifold is delivered by conduit **37** to the annular cooling coils **17** and the hydrogen transfers its heat to the fins **16** which has ambient air blown thereover by the fan **63**. The cooled hydrogen is then delivered to conduit **34**. Conduit **34** is interconnected with the manifold by conduit **35** and at the point of juncture there is located the temperature sensitive three-way valve **38** which will allow hydrogen from the manifold **36** to by-pass the cooling coils **17** and be delivered directly to conduit **34** where it is mixed with cooled hydrogen. The function of the valve **38** is dependent upon the predetermined desired temperature of hydrogen gas to be fed to the spray humidifier **29**. The humidifier **29** has a spray nozzle **30** located therein that is fed water by the high-pressure pump **22** through the conduit **28**. The amount of water fed by the pump is determined by the temperature within the spray humidifier which is sensed by the temperature sensor **48** interconnected to valve **49** to control the water fed to the pump **22** from the water supply **27**. The cooled hydrogen is humidified in the spray chamber and then delivered to the circulating blower **23** by conduit **31**. The blower **23** delivers the humidified hydrogen to the hydrogen inlet manifold **33**. The hydrogen manifold has inlet conduits **64** communicating with the hydrogen chambers **54** opposite the hydrogen outlet conduits **55**.

The tapped hydrogen has been cooled and humidified such that the vapor pressure thereof is greater than vapor pressure of the electrolyte. Therefore, when the humidified hydrogen gas enters the hydrogen chambers **54**, a portion of its water vapor will diffuse through the cathode **57** and condense on the electrolyte to wet the electrolyte and replenish the water decomposed by the cathode and anode reaction. The production of hydrogen and oxygen gases at the cathodes and anodes of each electrolytic cell and the supply of humidified hydrogen to the hydrogen chambers **54** are such that the hydrogen and oxygen gases being delivered by the hydrogen outlet manifold **36** and the oxygen outlet manifold **39** to the fuel cell or other suitable means are being delivered at 4500 p.s.i.a., with the hydrogen and oxygen pressure relief valves **42** and **43** being interlinked by control **44** such that the hydrogen chambers **54** and the oxygen chambers **56** of each cell do not experience a pressure difference greater than 1.0 p.s.i.a.

The module hemispherical end **14** has an electrical connector **66** mounted thereon with suitable wires **67** (FIGURE 3) suitably electrically connected thereto and to the first and last electrodes of the cell stack **21** (one anode and one cathode). Lines **67** are schematically used to connect the electrolytic cells in electrical series. That is, referring to FIGURE 3, the anode **58** of the cell **51** is connected to the cathode **57** of the cell **52** by the electrical line **67** and the anode and cathode of the end cells are connected to the electrical connector **66** which may be connected to suitable electrical supply means (not shown). However, in actual practice, referring to FIGURE 2, electrical continuity across each of the cells is accomplished by the wire spacers **61** and the metal partitions **53** with only the first and last electrodes being connected to an electrical supply means. Also, the cells

may be connected in electrical parallel if desired. That is, the cathode **57** of cell **51** being interconnected to the cathode of cell **52** etc. with the cathodes of all the cells being connected by a single electrical line. Likewise, the anodes of adjacent cells are connected by another electrical line with the cathode and anode electrical lines being suitably connected to the electrical connector **66**. However, in the electrical parallel arrangement, the partition **53** may be eliminated between two adjacent electrolytic cells by rearranging the two adjacent cells to have a common gas chamber, such as an oxygen chamber **56**, with the anodes **58** facing each other instead of having the anode **58** of cell **51** facing the cathode **57** of cell **52** as is represented in FIGURE 2.

The module **11** was constructed for electrolyzing **10** pounds per hour of water to deliver hydrogen and oxygen gases at 4500 p.s.i.a. The module was 21 inches in diameter and 60 inches long and contained 100 electrolytic cells, a circulating blower, a water pump, a spray humidifier, associated cooling coils and manifolds, temperature and water controls, and had external cooling fins. The electrolytic cells operated at 300° F. with sintered nickel electrodes and 6N KOH impregnated asbestos electrolytes. The power consumption of the module was 45 kilowatts at 300 volts and water and temperature controls were set to provide saturated hydrogen gas at 277° F. to be delivered to the inlet conduits **64**. The polarization data for hydrogen and oxygen gases being delivered at 4500 p.s.i.a. was calculated as follows:

Volts:	Current density (amps./ft.²)
2.13	50
2.75	100
2.96	150

Another module **11** was constructed for electrolyzing 10 pounds per hour of water to deliver gases at 4500 p.s.i.a. This module was 21 inches in diameter and 60 inches long and contained 100 electrolytic cells operating at 300° F. with 6N KOH impregnated asbestos electrolytes and sintered nickel electrodes having a platinum catalyst thereon. The power consumption of the module was 30 kilowatts at 200 volts and the water spray and temperature controls were set to provide saturated hydrogen gas at 277° F. to be delivered to the hydrogen chambers **54**. The polarization data for hydrogen and oxygen gases being delivered at 4500 p.s.i.a. was calculated as follows:

Volts	2.0
Current density (amps./ft.²)	100

It is of course understood that although the above module was described with means to recirculate cool, and humidify a portion of the hydrogen gases, the module would operate in a similar manner if means were provided to recirculate, cool and humidify a portion of the hydrogen gas and/or the oxygen gas produced in the cells. Also a similar module may be constructed for electrolysis of materials other than water, with the gas produced by the cells being recirculated and saturated with the desired electrolyte vapor so that the gas electrolyte vapor pressure is greater than the vapor pressure of the electrolyte in the electrolytic cells. It is understood that these and other modifications and variations may be effected without departing from the true spirit and scope of the novel concepts of the present invention as defined by the following claims.

We claim as our invention:

1. An electrolytic cell module comprising:
a vessel,
an electrolytic cell mounted within said vessel,
said electrolytic cell having
a gas chamber with an electrode, an electrolyte, and
means to decompose an aqueous solution of said electrolyte to produce a gas at said electrode in said gas chamber,
a spray housing mounted within said vessel, conduit means within said vessel connected to the gas chamber and the housing to tap a portion of the gas produced in the gas chamber and deliver it to the housing,
means connected to the housing to increase the water vapor pressure of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an outlet conduit means mounted within said vessel and connected to said housing and said electrolytic cell gas chamber to deliver increased vapor pressure gas thereto,
whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its electrolyte vapor diffuse through the electrode and condense in the electrolytic cell to mix with and replace the water content of the cell electrolyte which was decomposed to produce the gas.

2. An electrolytic cell module comprising:
a vessel,
an electrolytic cell mounted within said vessel,
said electrolytic cell having
a gas chamber with an electrode, an electrolyte, and
means to decompose an aqueous solution of said electrolyte to produce a gas at said electrode in said gas chamber,
a spray housing mounted within said vessel,
first conduit means within said vessel connected to the gas chamber to tap a portion of the gas produced therein,
heat exchange means mounted within said vessel connected to said first conduit means to receive gas therefrom and remove heat from said gas by sensible cooling,
a second conduit means connecting said heat exchanger to said housing to deliver cooled gas to said housing, means connected to the housing to increase the water vapor pressure of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an inlet manifold mounted within said vessel and connected to said housing and said electrolytic cell gas chamber to deliver increased vapor pressure gas thereto whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its electrolyte vapor diffuse through the electrode and condense in the electrolytic cell to mix with and replace the water content of the cell electrolyte which was decomposed to produce the gas.

3. An electrolytic cell module comprising:
a vessel,
an electrolytic cell stack mounted within said vessel,
said electrolytic cell stack having a plurality of electrolytic cells,
each of said electrolytic cells having
a gas chamber with an electrode,
an electrolyte, and
means to decompose an aqueous solution of said electrolyte to produce a gas at said electrode in said gas chamber,
an outlet manifold mounted in said vessel adjacent said cell stack,
said outlet manifold being connected to said electrolytic cell gas chambers to receive gas therefrom,
a spray housing mounted within said vessel,
first conduit means within said vessel connected to the gas chambers to tap a portion of the gas from the gas chambers,
heat exchange means within said vessel, connected to said first conduit means to receive gas therefrom and remove heat from said gas by sensible cooling,
an outlet conduit means connecting said heat exchanger to said housing to deliver cooled gas to said housing,
a by-pass conduit means connecting said first conduit

means to said outlet conduit means to allow a portion of the tapped gas to by-pass the heat exchanger,
means normally closing said by-pass conduit means,
means to selectively open said by-pass conduit means to control the amount of sensible cooling of the tapped gas by the heat exchanger,
means connected to the housing to increase the water vapor pressure of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an inlet manifold mounted within said vessel and connected to said housing and said electrolytic cell gas chambers to deliver increased vapor pressure gas thereto

whereby the increased vapor pressure gas entering the electrolytic cell gas chambers has a portion of its electrolyte vapor diffuse through the electrodes and condense thereon to mix with and replace the water content of the cell electrolyte which was decomposed to produce the gas.

4. An electrolytic cell module comprising:
a high pressure vessel,
said vessel having a plurality of fins projecting therefrom,
an electrolytic cell stack mounted within said vessel,
said electrolytic cell stack having a plurality of electrolytic cells,
each of said electrolytic cells having
a gas chamber with an electrode,
an electrolyte, and
means to decompose said electrolyte to produce a gas at said electrode in said gas chamber,
an outlet manifold mounted in said vessel adjacent said cell stack,
said outlet manifold being connected to said electrolytic cell gas chambers to receive gas therefrom,
a spray housing mounted within said vessel,
first conduit means within said vessel connected to the gas chambers to tap a portion of the gas from the gas chambers,
a cooling coil conduit means mounted adjacent the interior wall of the vessel to conduct heat to said vessel,
said cooling coil being connected to said first conduit to receive gas therefrom,
an outlet conduit means connecting said cooling coil to said housing to deliver cooled gas to said housing,
a by-pass conduit means connecting said first conduit means to said outlet conduit means to allow a portion of the tapped gas to by-pass the cooling coil,
means normally closing said by-pass conduit means,
means to selectively open said by-pass conduit means to control the amount of sensible cooling of the tapped gas by the cooling coil,
means connected to the housing to increase the water vapor pressure of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an inlet manifold mounted within said vessel and connected to said housing and said electrolytic cell gas chamber to deliver increased vapor pressure gas thereto,

whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its electrolyte vapor diffuse through the electrode and condense in the electrolytic cell to mix with and replace the water content of the cell electrolyte which was decomposed to produce the gas.

5. An electrolytic cell module comprising:
a vessel,
said vessel having cooling fins projecting therefrom,
an electrolytic cell stack mounted within said vessel,
said electrolytic cell stack having a plurality of electrolytic cells,
each of said electrolytic cells having
a gas chamber with an electrode,
an electrolyte, and

means to decompose said electrolyte to produce a gas at said electrode in said gas chamber,
an outlet manifold mounted in said vessel adjacent said cell stack,
said outlet manifold being connected to said electrolytic cell gas chamber to receive gas therefrom,
a spray housing mounted within said vessel,
first conduit means within said vessel connected to the gas chambers to tap a portion of the gas from the gas chamber,
a cooling coil conduit means mounted adjacent the interior wall of the vessel to conduct heat to said vessel,
said cooling coil being connected to said first conduit to receive gas therefrom,
an outlet conduit means connecting said cooling coil to said housing to deliver cooled gas to said housing,
a by-pass conduit means connecting said first conduit means to said outlet conduit means to allow a portion of the tapped gas to by-pass the cooling coil,
means normally closing said by-pass conduit means,
means to selectively open said by-pass conduit means to control the amount of sensible cooling of the tapped gas by the cooling coil,
spray nozzle means connected to the interior of said housing,
pump means connected to said nozzle to deliver electrolyte thereto,
means to control the electrolyte spray in said spray chamber to provide the tapped gas with increased water vapor pressure greater than the water vapor pressure in the electrolytic cells,
an inlet manifold mounted within said vessel and connected to said electrolytic cell gas chambers to deliver increased vapor pressure gas thereto, and
pump means connected to said housing and said inlet manifold to deliver increased vapor pressure gas to the inlet manifold,

whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its electrolyte vapor diffuse through the electrode and condense thereon to mix with and replace the water content of the cell electrolyte which was decomposed to produce the gas.

6. A water electrolytic cell module comprising:
a vessel,
an electrolytic cell mounted within said vessel,
said electrolytic cell having
a gas chamber with an electrode,
an electrolyte, and
means to decompose said electrolyte to produce a gas at said electrode in said gas chamber,
an outlet manifold mounted in said vessel adjacent said cell stack,
said outlet manifold being connected to said electrolytic cell gas chamber to receive gas therefrom,
a spray housing mounted within said vessel,
first conduit means within said vessel connected to the gas chamber and the housing to tap a portion of the gas from gas chamber and deliver it to the housing,
means connected to the housing to increase the humidity of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an inlet manifold mounted within said vessel and connected to said housing and said electrolytic cell gas chamber to deliver the humidified gas thereto

whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its electrolyte vapor diffuse through the electrode and condense thereon to mix with and replace the electrolyte water which was decomposed to produce the gas.

7. An electrolytic cell module comprising:
a vessel,
an electrolytic cell mounted within said vessel,
said electrolytic cell having

a gas chamber with an electrode,
an electrolyte, and
means to decompose said electrolyte to produce a gas at said electrode in said gas chamber,
an outlet manifold mounted in said vessel adjacent said cell stack,
said outlet manifold being connected to said electrolytic cell gas chamber to receive gas therefrom,
a spray housing mounted within said vessel,
first conduit means within said vessel connected to the gas chamber to tap a portion of the gas from the gas chamber,
heat exchange means connected to said first conduit means to receive gas therefrom and remove heat from said gas by sensible cooling,
an outlet conduit means connecting said heat exchanger to said housing to deliver cooled gas to said housing,
means connected to the housing to increase the humidity of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an inlet manifold mounted within said vessel and connected to said housing and said electrolytic cell gas chamber to deliver increased vapor pressure gas thereto

whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its electrolyte vapor diffused through the electrode and condense thereon to mix with and replace the electrolyte water which was decomposed to produce the gas.

8. An electrolytic cell module comprising:
a vessel,
an electrolytic cell stack mounted within said vessel,
said electrolyte cell stack having a plurality of electrolytic cells,
each of said electrolytic cells having
a pair of gas chambers with an electrode in each chamber,
an electrolyte, and
means to decompose said electrolyte to produce hydrogen and oxygen gas in said gas chambers,
a pair of outlet manifolds mounted in said vessel adjacent said cell stack,
said outlet manifolds being connected to said electrolytic cell gas chambers to receive hydrogen and oxygen gas therefrom,
a spray housing mounted within said vessel,
first conduit means within said vessel connected to at least one gas chamber to tap a portion of the gas from the gas chamber and deliver it to the housing,
heat exchange means connected to said first conduit means to receive gas therefrom and remove heat from said gas by sensible cooling,
an outlet conduit means connecting said heat exchanger to said housing to deliver cooled gas to said spray chamber,
means connected to the housing to increase the humidity of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an inlet manifold mounted within said vessel and connected to said housing and said electrolytic cell gas chamber to deliver increased vapor pressure gas thereto

whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its electrolyte vapor diffused through the electrode and condense thereon to mix with and replace the electrolyte water which was decomposed to produce the gas.

9. An eelctrolytic cell module comprising:
a vessel,
an electrolytic cell stack mounted within said vessel,
said electrolytic cell stack having a plurality of electrolytic cells,
each of said electrolytic cells having
a hydrogen chamber with a cathode,
an aqueous electrolyte, and
means to decompose said electrolyte to produce

hydrogen gas at said cathode in said hydrogen gas chamber
an outlet manifold mounted in said vessel adjacent said cell stack,
said outlet manifold being connected to said electrolytic cell hydrogen chambers to receive gas therefrom,
a spray housing mounted within said vessel,
first conduit means within said vessel connected to the hydrogen gas chambers to tap a portion of the gas from the hydrogen gas chambers and deliver it to the housing,
heat exchange means connected to said first conduit means to receive hydrogen gas therefrom and remove heat from said hydrogen gas by sensible cooling,
an outlet conduit means connecting said heat exchanger to said housing to deliver cooled hydrogen gas to said housing,
means connected to the housing to increase the water vapor pressure of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an inlet manifold mounted within said vessel and connected to said housing and said electrolytic cell gas chamber to deliver increased vapor pressure gas thereto

whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its water vapor diffused through the cathode and condense thereon to mix with and replace the electrolytic cell water which was decomposed to produce the hydrogen gas.

10. An electrolytic cell module comprising:
a vessel,
an electrolytic cell stack mounted within said vessel,
said electrolytic cell stack having a plurality of electrolytic cells,
each of said electrolytic cells having
a hydrogen gas chamber with a cathode,
an electrolyte, and
means to decompose said electrolyte to produce hydrogen gas at said cathode in said hydrogen gas chamber
an outlet manifold mounted in said vessel adjacent said cell stack,
said outlet manifold being connected to said electrolytic cell gas chamber to receive hydrogen gas therefrom,
a humidifying spray housing mounted within said vessel, first conduit means within said vessel connected to the outlet manifold and the housing to tap a portion of the hydrogen gas from the manifold and deliver it to the housing,
cooling coil means connected to said first conduit means to receive hydrogen gas therefrom and remove heat from said hydrogen gas by sensible cooling,
an outlet conduit means connecting said cooling coil to said housing to deliver cooled hydrogen gas to said housing,
a by-pass conduit means connecting said first conduit means to said outlet conduit means to allow a portion of the tapped hydrogen gas to by-pass the cooling coil, means normally closing said by-pass conduit means,
means to selectively open said by-pass conduit means to control the amount of sensible cooling of the tapped hydrogen gas by the cooling coil,
means connected to the housing to increase the humidity of the gas within the housing above the water vapor pressure in the electrolytic cell, and
an inlet manifold mounted within said vessel and connected to said housing and said electrolytic cell hydrogen gas chamber to deliver the humidified hydrogen gas thereto

whereby the increased vapor pressure gas entering the electrolytic cell gas chamber has a portion of its water vapor diffused through the cathode and condense thereon to mix with and replace the electrolytic cell water which was decomposed to produce the gas.

11. An electrolytic cell module comprising:
a vessel having cooling fins projecting therefrom,
an electrolytic cell stack mounted within said vessel,
said electrolytic cell stack having a plurality of electrolytic cells,
each of said electrolytic cells having
a pair of gas chambers with an electrode in each,
an alkali electrolyte, and
means to decompose said electrolyte to produce hydrogen and oxygen gas at said electrodes in said gas chambers,
a pair of outlet manifolds mounted in said vessel adjacent said cell stack,
said outlet manifolds being connected to said electrolytic cell gas chambers to receive hydrogen and oxygen gas therefrom,
a spray housing mounted within said vessel, first conduit means within said vessel connected to at least one of the gas chambers to tap a portion of the gas therefrom,
cooling coil means connected to said first conduit means to receive gas therefrom and remove heat from said gas by sensible cooling,
an outlet conduit means connecting said cooling coil to said spray housing to deliver cooled gas to said spray housing,
a by-pass conduit means connecting said first conduit of the tapped gas to by-pass the cooling coil,
means to said outlet conduit means to allow a portion
means normally closing said by-pass conduit means,
means to selectively open said by-pass conduit means to control the amount of sensible cooling of the tapped gas by the cooling coil,
spray nozzle means connected to the interior of said spray housing,
pump means connected to said nozzle to deliver water thereto,
means to control the water spray in said spray housing to increase the humidity of the tapped cooled gas such that its vapor pressure is greater than the vapor pressure of the electrolyte in the electrolytic cell,
an inlet manifold means connected to the one chamber of each electrolytic cell to deliver the humidified gas thereto, and
pump means connected to said spray housing and said inlet manifold to deliver the humidified gas to the inlet manifold
whereby the increased humidified gas entering the one electrolytic cell gas chambers has a portion of its water vapor diffused through the electrode and condense thereon to mix with and replace the electrolytic cell water which was decomposed to produce the gas.

12. An electrolytic cell module comprising:
a vessel having cooling fins projecting therefrom,
an electrolytic cell stack mounted within said vessel,
said electrolytic cell stack having a plurality of electrolytic cells,
each of said electrolytic cells having

a hydrogen and oxygen gas chamber with a cathode and an anode respectively,
an alkali electrolyte positioned between the cathode and anode, and
means to decompose said electrolyte to produce hydrogen and oxygen gas at said cathode and anode in said respective hydrogen and oxygen gas chambers,
a pair of outlet manifolds mounted in said vessel adjacent said cell stack,
said outlet manifolds being connected to said electrolytic cell gas chambers to receive hydrogen and oxygen gas therefrom,
a spray housing mounted within said vessel, first conduit means within said vessel connected to the hydrogen gas chambers to tap a portion of the hydrogen gas therefrom,
cooling coil means connected to said first conduit means to receive hydrogen gas therefrom and remove heat from said hydrogen gas by sensible cooling,
an outlet conduit means connecting said cooling coil to said spray housing to deliver cooled hydrogen gas to said spray housing,
a by-pass conduit means connecting said first conduit means to said outlet conduit means to allow a portion of the tapped hydrogen gas to by-pass the cooling coil,
means normally closing said by-pass conduit means to control the amount of sensible cooling of the tapped hydrogen gas by the cooling coil,
spray nozzle means connected to the interior of said spray housing,
pump means connected to said nozzle to deliver water thereto,
means to control the water spray in said spray chamber to provide saturated hydrogen gas,
a hydrogen inlet manifold means connected to the hydrogen chamber of each electrolytic cell to deliver saturated hydrogen gas thereto, and
pump means connected to said spray chamber and said hydrogen inlet manifold to deliver saturated hydrogen gas to the hydrogen inlet manifold
whereby the saturated hydrogen gas entering the hydrogen chamber of each electrolytic cell is cooler than the electrolytic cell and cools said cell and also a portion of the water vapor in said hydrogen gas diffuses through the cathode of the electrolytic cell and condenses on said cathode to mix with electrolyte in the electrolytic cell and thereby replace the water content of said electrolyte.

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