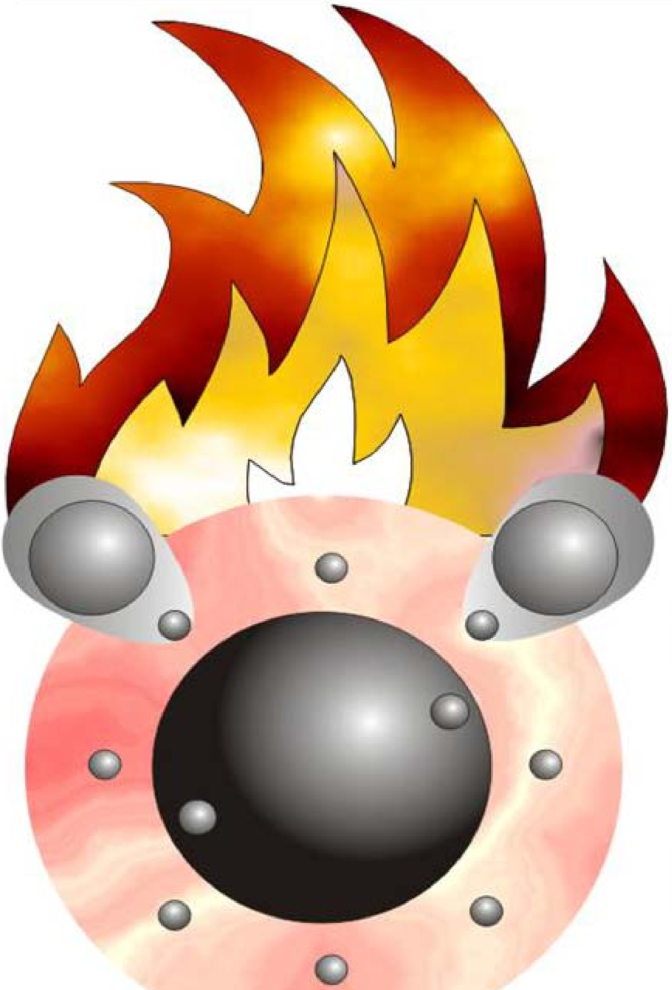
The Viability of Water as a Fuel



by
Barry Hilton

by
Barry Hilton

Releasing the Fire of Prometheus

Releasing the Fire of Prometheus
Part 1

The Viability of Water as a Fuel

Compiled and written
by Barry Hilton

Published and Distributed by

HILTON DYNAMICS
SEAFORD 3198
VICTORIA
AUSTRALIA

www.hiltondynamics.com

Releasing the Fire of Prometheus

CONTENTS PART 1

Main Bibliographical References

Agger, L.T.
Elementary Technical
Electricity (1961)

Alternator Secrets (1977)

Atkins, P.W.
The Elements of
Physical Chemistry (1992)

Barrell, F.T.
Complete Chemistry (1961)

Boles & Cengel
Thermodynamics (1994)

Carnot, Sardi
Reflections on the Motive Power
of Heat (1824)

Faraday, Michael
Chemical Manipulaton (1827)

Carnot, Sardi
Experimental Researches in
Chemistry and Physics (1859)

Fitz & Schenk
Quantitative Analytical
Chemistry (1987)

Hoffmann, Peter
Tomorrow's Energy (2002)
The Forever Fuel

Judge. Arthur
Automobile Engines (1967)

Lavoisier, Antonine Laurent
Elementary Treatise on Chemistry
(1789)

McAlister, Roy
The Solar Hydrogen
Civilizaton (2003)

Peavey, Michael A.
Fuel from Water (1980)

Resnick & Halliday
Physics (1960)

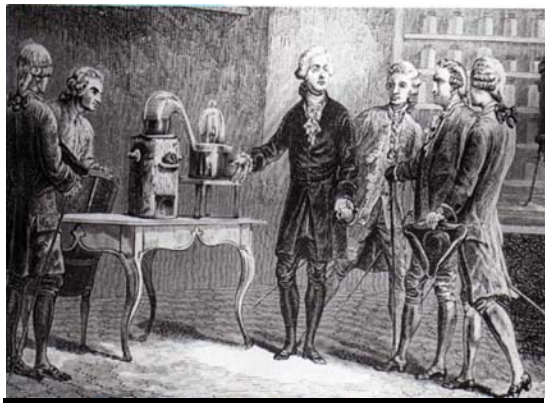
Siblerud, Robert
Our Future is Hydrogen (2001)

Wiseman, George
Hyzor Technology (2001)
Extreme Mileage (2004)

Water the Primordial Essence

To Thales of Miletos, 600 years before Christ, water was the primordial element of everything material. Theophrastus Paracelsus noted in the early 16th century when carrying out experiments with iron in sulphuric acid, "an air arises, bursting forth like the wind". Other notable researchers to have observed these mysterious gases given off by various chemical reactions were: Robert Boyle (1627-1691), - he observed the invigorating qualities of the liberated gases: In 1700, Nicolas Lemery was the first to record their explosive qualities: Herman Boerhaave wrote on the subject in 1732, "Happy he who will discover...the ingredient in air that supports breathing and combustion."; Henry Cavendish (1731-1810) called these gases, "inflammable air, that when burned, produces nothing but water".

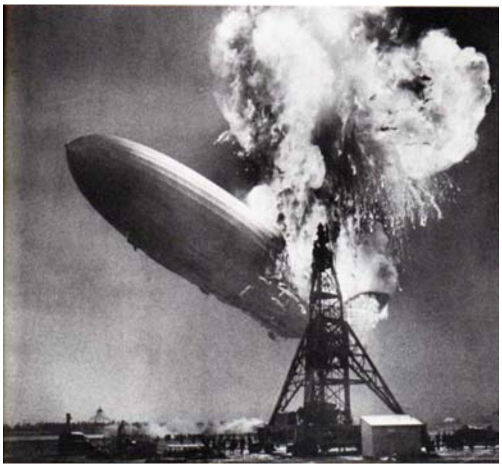
A leading physician in 1697, George Ernst Stahl published a thesis proposing that a substance called ***phlogiston*** (also called caloric), was responsible for the combustibility of matter. Stahl claimed phlogiston was released during the process of combustion and then disappeared. This theory lasted for nearly 100 years before being overturned in 1783 by Antonine Laurent Lavoisier (1743-1794), France's top scientist. Like Cavendish, Lavoisier showed that water consisted of two gases, one being oxygen, and the other he named ***hydrogen*** "water producer." Thus the process was one of union, not separation.


Lavoisier with his Hydrogen generator


Sir Humphry Davy

In 1789 Nicholson and Carlisle were the first to separate hydrogen and oxygen from water by electrolysis. Sir Humphry Davy and Michael Faraday soon followed in their footsteps. Together, these two scientists laid down the foundation and basic laws of electrolysis and separated most of the commonly known elements.

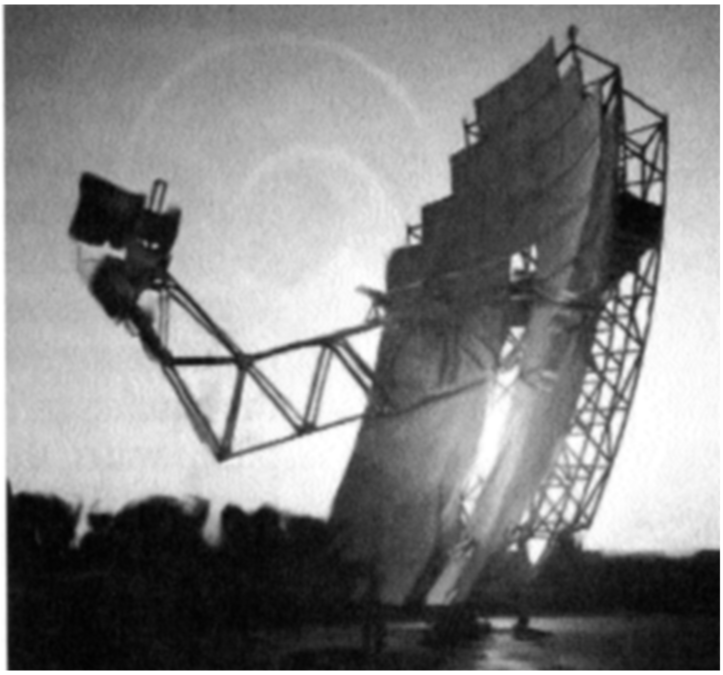
During the 19th and early 20th centuries hydrogen was used in balloons as buoyancy to facilitate air travel until public confidence was shattered with the Hindenburg disaster in 1937. It was widely believed that the hydrogen fuel was responsible for the intensity of the flames. A report by Otto Beyerdorff of Zeppelin and later a separate report by Dr. Addison Bain of NASA confirmed that the static spark, that started the fire, ignited the aluminium compound used on the outer skin of the dirigible. This same compound is used to make rocket fuel and therefore was responsible for the heat intensity— not the hydrogen.



The Rev. W. Cecil in a lecture to Cambridge Philosophical Society proposed one of the first accounts of a hydrogen engine in 1820. He wrote, ”If two and a half measures by bulk of atmospheric air be mixed with one measure of hydrogen, and a flame be applied, the mixed gas will expand into a space rather greater than three times its original bulk.”

Since the 1820’s there have been literally thousands of individuals and companies who have explored and developed hydrogen as a motive source of power. One of considerable note is Rudolf Erren who formed the Erren Motoren GmbH in Berlin in 1928 and Erren Engineering Company in London in 1930. Over the years he converted may vehicles, boats and submarines to operate either partly or completely on hydrogen and patented the process. In England alone, he had over 600 vehicles running on hydrogen. Eventually he lost everything in Germany due to World War II and the British government confiscated his assets in England .

Had it not been for the development of petrol as a fuel: Had it not been for the suppression of hydrogen by vested interests: Had it not been for the huge tax revenue gained by governments from petrol, then hydrogen power would have been the natural successor to the steam powered age. Would not the Earth have been saved from the ravages of hydrocarbon pollution Had the history of hydrogen been different?



Zero Pollution Hydrogen Generation

Carbon sequestration from biomass, coal, natural gas and oil using the Kvaerner Process at 1600^0C can strip clean hydrogen out of its hydrocarbon base, leaving pure carbon behind for use as a superior replacement for plastics, steel and timber. The process can drive itself free of emissions. A single plant can produce 50 million cubic meters of hydrogen and 20,000 metric tons of Carbon Black per year. Responsible governments like Canada have such plants already in full production.

Solar concentrators can split water directly at over 1000^0C or drive huge Sterling motors to generate electricity and supply hydrogen without pollution or fossil fuels. Just one dish can supply power for a small village.

WHY ON EARTH SHOULD WE MOVE TO NUCLEAR POWER OR CONTINUE TO WASTE COAL & OIL AS FUELS ????

THERMODYNAMICS OF AUTOMOTIVE ENGINEERING

Thermodynamics was established on the basis of three laws:

Law 1. The Law of Conservation of energy

Energy can nether be created nor destroyed but only exchanged into different manifestations of energy. The energy of an isolated system is constant. Enthalpy accounts for changes in the internal energy of a system.

Law 2. The Law of Equilibrium States

An energy process that starts in one equilibrium state and ends in another equilibrium state tends to transform its elements into an attainable system of more stable equilibrium. Heat from a hot body tends to warm a cold body towards thermal equilibrium. The level of Positive Entropy determines the degree of spontaneity.

Law 3. The Law of absolute Zero

There exists a temperature of absolute zero, below which the science of thermodynamics has no relevance and energy is at zero point. The temperature scale devised to account for this phenomenon is the Kelvin scale (after Lord Kelvin), starting from zero as absolute zero and 273.15^0 at the triple point of water.

Honour Roll of Thermodynamics

Following the experiments of Laviosier in 1783 that overturned the belief that phlogiston was a material substance, Benjamin Thompson (*Count Rumford*) proposed to the Royal Society in 1898 that caloric also was nothing more than friction of motion. Building on this revelation the principle of energy conservation was arrived at independently in different parts of the world: Julius von Mayer (1814-1878) in Germany – James Joule (1818-1889) in England – Herman von Helmholtz (1821-1894) in Germany - Colding (1815-1888) in Denmark and Sardi Carnot in France. Kinetic theory was developed by Robert Boyle (1627-1691), Daniel Bernoulli (1700-1782), James Joule, A. Kronig (1822-1879), Rudolph Clausius (1822-1888), J. Willard Gibbs (1839– 1903), Ludwig Boltzmann (1844-1906) and many others. Lord Kelvin and Max Planck gave us the third law of thermodynamics and Carnot consolidated it all.

Terminology

To describe a thermodynamic event where energy leaves the subject system, the transfer of energy is said to be **Exothermic.** On the other hand when energy enters a system from an external source it is said to be **Endothermic**.

To account for the changes of energy within a system the term used is **Enthalpy (ΔH)** from the Greek work meaning "**Heat within**". The strength of a system's tendency to move from one state of equilibrium to another is termed **Entropy (ΔS),** from the Greek word meaning "**transient**". **Gibbs Free Energy (ΔG)** defines the net energy available from a system able to do work. $\Delta G = \Delta H — T\Delta S$ where T the temperature of interest in degrees Kelvin. For further information on Thermodynamics appropriate to this subject see Appendix A.

Nicolas Leonard Sardi Carnot (French 1796 –1832, died Cholera)
“Reflections on the Motive Power of Heat” 1824 (The Carnot Cycle)

Drawing 1 shows mechanical force increasing the volume from V1 to V2. Because of the constant temperature heat sink, Temperature is constant @ T_1, and Pressure is reduced to P_2. The process is ISOTHERMAL. $Q_1 = W_1 = nRT_1 \ln V_2/V_1$

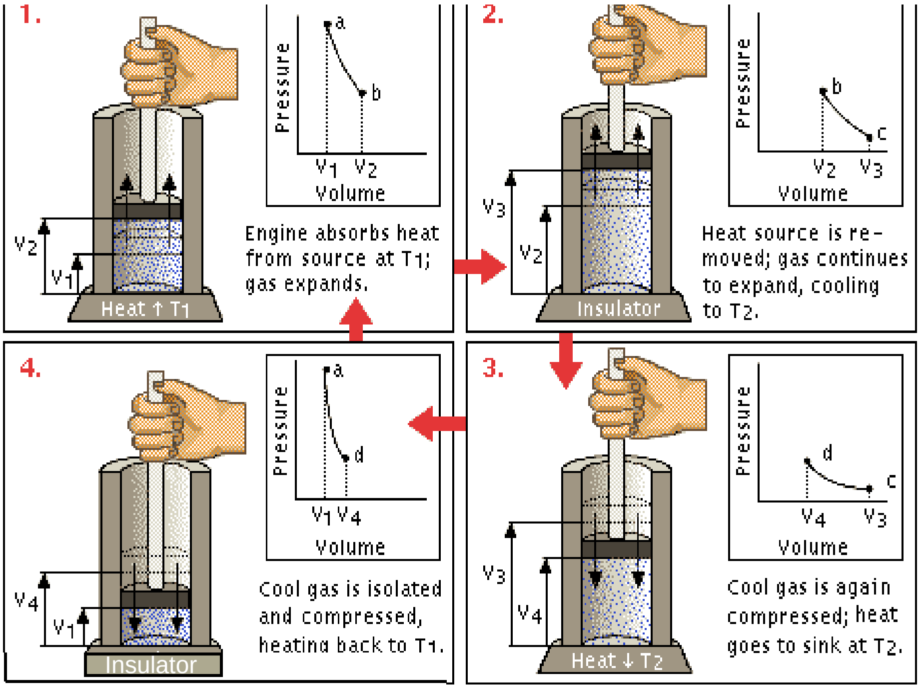
Drawing 2 shows the further mechanical force increasing the volume from V2 to V3. Because the system is now insulated from heat transfer it is called ADIABATIC. Temperature is reduced to T_2, and Pressure is further reduced to P_3. $Q_2= W_2 = (P_2P_3/2)(V_2-V_3)$

Drawing 3 shows external pressure is now applied ISOTHERMALLY @ temperature T_2. The Volume is reduced from V3 to V4, which increased the Pressure from P3 to P4. $Q_3 = W_3 = nRT_3 \ln V_3/V_4$.

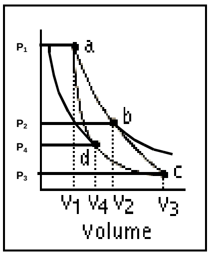
Drawing 4 shows the ADIABATIC return to the starting point @ T_1. The Volume is further compressed to V1 and the pressure returns to P1. $Q_4= W_4 = (P_1P_4/2)(V_4-V_1)$

The area scribed out by a-b-c-d represents the work energy carried out by the process and clearly demonstrates that it passes between the two temperatures T1 & T2.
An ISOBARIC process is one of constant Pressure, (as in atmospheric pressure).

“ *The efficiency of all reversible engines operating between the same two temperatures is the same, and no irreversible engine working between the same two temperatures can have a greater efficiency than this.”*
(T1 - T2) / T1 = Efficiency



Efficiency = $\frac{T_1 - T_2}{T_1}$

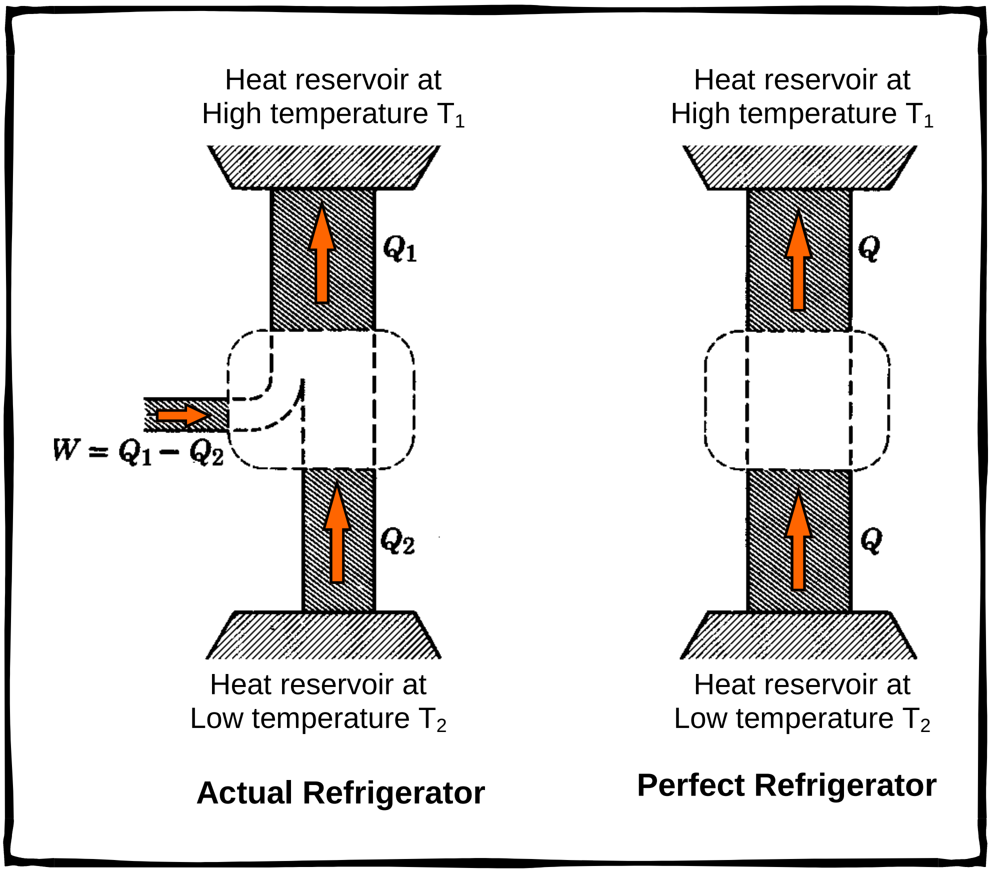


Thermal Efficiency of Real Refrigerators & Heat Engines

First Drawing Set

The drawing below on the left shows the work ethic of a refrigeration pump, pumping heat from the lower heat register Q2 to the outside high heat resister Q1 by a reverse operation of the Carnot cycle. **W = Q1 – Q2**.

Ideally, no motor would be needed and the refrigerator could dissipate its heat directly from the fridge to the outside environment as shown in the drawing on the right. Unfortunately, this would violate the second law of thermodynamics.



Second Drawing Set

The second Drawing Set on the next page shows a heat engine where part of the heat of the working gas at the higher heat register Q1 is converted to work. About 20% to 30% of the heat is converted to work and the rest goes out the exhaust as Q2. **W = Q1 – Q2.**

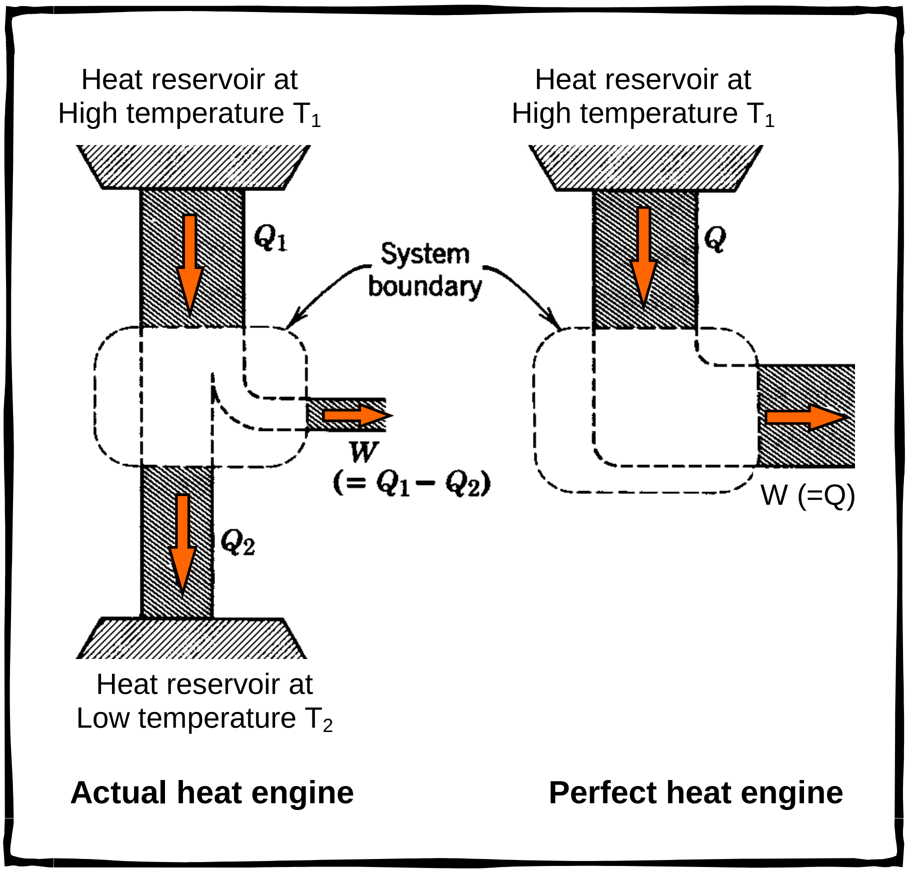
Ideally, all the heat from the higher register shown in the drawing on the right should be converted to work. Even though this does not violate either the first or second laws of thermodynamics there is always some heat that remains as waste.

Combining the Fridge system with the Heat Motor

There are people, such as Dennis Lee in the USA, who have tried to combine the two systems. By driving a heat motor, such as a Sterling motor, and using the output to drive the cooling system of a refrigerator to continually replace the heat removed from the upper register by the heat engine. It can be clearly shown mathematically that this system also cannot work as it is equivalent to trying to use heat from a single heat register and then trying to return it to the same register. Thus the system violates the second law, quite apart from efficiency losses and any loss due to external usage.

The Mother of Invention

Despite all this overwhelming evidence indicating that perpetual motion is not in natures laws, there is also overwhelming evidence to show that free energy is viable and does not violate Thermodynamic Law. Our very existence and the existence of the cosmos is evidence to that fact. If a system is free to absorb energy from it surrounds due to an **Endothermic** or **Endogonic** process of **Entropy or Electromagnetism**, then there is no law that prohibits such a process from powering a dynamic or solid state system. Indeed, it is for this very reason, that many inventors persist in trying to develop such a system.



Comparison of Fuel Requirements in an IC Engine
Hydrogen — Gasoline

Mass Air = 31grams per mol = 1.25grams per litre
Mass of Gasoline = 720grams per litre
Percentage O_2 in Air = 21% by volume and, 51.6% by mass

Air contains approximately 21% of oxygen by volume and it is this oxygen together with any other oxygen retained from the breakdown of water that is combined with the hydrocarbon or hydrogen fuel to provide the motive power to drive the engine. As a stoichiometric mix, it is easy to calculate that two moles of H_2 would have to be mixed with 4.76 moles of air (100/21 = 4.76), resulting in 29.3% of hydrogen by volume needed for complete combustion into steam {2/(4.76+2) = 29.3%}.

The ratio of the air to gasoline used to power an internal combustion engine is usually defined in automotive terms as a ratio by weight (mass) Air : Gas., of between 8:1 for a rich mixture, to 20:1 as a lean mixture – the ideal being 15:1. This means a mass of one gram of gasoline requires fifteen grams of air to produce ideal combustion of the mix in an IC engine. (*True only for Octane)*

To relate this in terms of volume: 15 grams of air = 15/1.25 = 12 litres of air.
1 gram of Gas. = 1/720 = 1.39cc of gasoline

As a ratio of air to gas by volume: 12000/1.39 = 8633:1 Air to Gasoline

Thus in a 1000cc engine: (8633/8634) x 1000 = 999.88cc would be filled with air, and 0.12cc would be gasoline. (Fully aspirated)

With hydrogen (H_2) the flammability range when combined with air by volume is from 4% to 75% with the ideal being 29.3%.

Thus in a 1000cc engine the volume of H_2 required for combustion is from 40cc to 750cc with the ideal being 290cc (the stoichiometric volume H_2O). (Fully aspirated)

290cc of H_2 would weigh $\{290/(24.8\text{x}10^3)\}$ x 2.015 = 0.0235625g
710cc of air would weigh (710/1000) x 1.25 = 0.8875g

The ratio air to hydrogen by mass: 0.8875/0.02356 = 38:1 Air to Hydrogen H_2

If a 2000cc engine were to operate at 3600 rpm then 3600 litres of mixture would be drawn into the engine every minute = 3600/60 = 60 litres per second. (Fully aspirated 4 stroke)

At ideal ratio, this would require 290cc x 60 = 17.4 litres per second.

As indicated previously, it is also possible to calculate how much hydrogen will be needed to power a vehicle based on known parameters evaluated by thermodynamic principles.

If for instance a car uses 4 litres of petrol @ 32 Megajoules /Lt over one hour, then 128 MJ is used to power the motor. If instead it is powered by hydrogen, 128MJ of H_2 would likewise be needed.

As 1 Litre of H_2 releases 10.36kJ for conversion of $H_2O(l)$ @ SATP, then the engine would need {128MJ/10.36kJ} 12355 litres of H_2 over 1 hour or 3.4 litres per second.

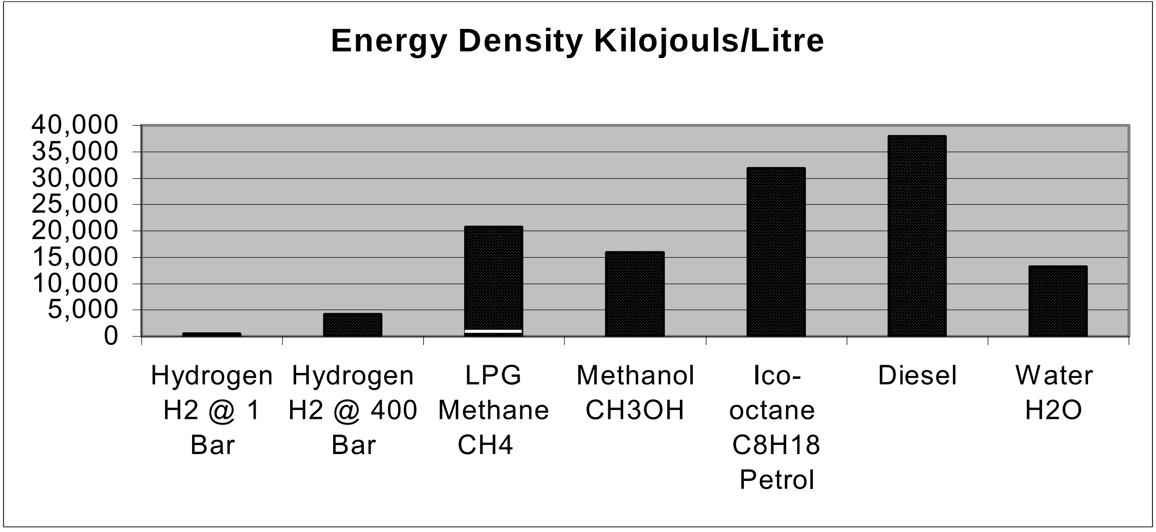
This demonstrates that at normal aspiration the average fuel consumption is (3.5/17.4) 100 = 20% of capacity. This assumes that the same vehicle is used in both calculations.

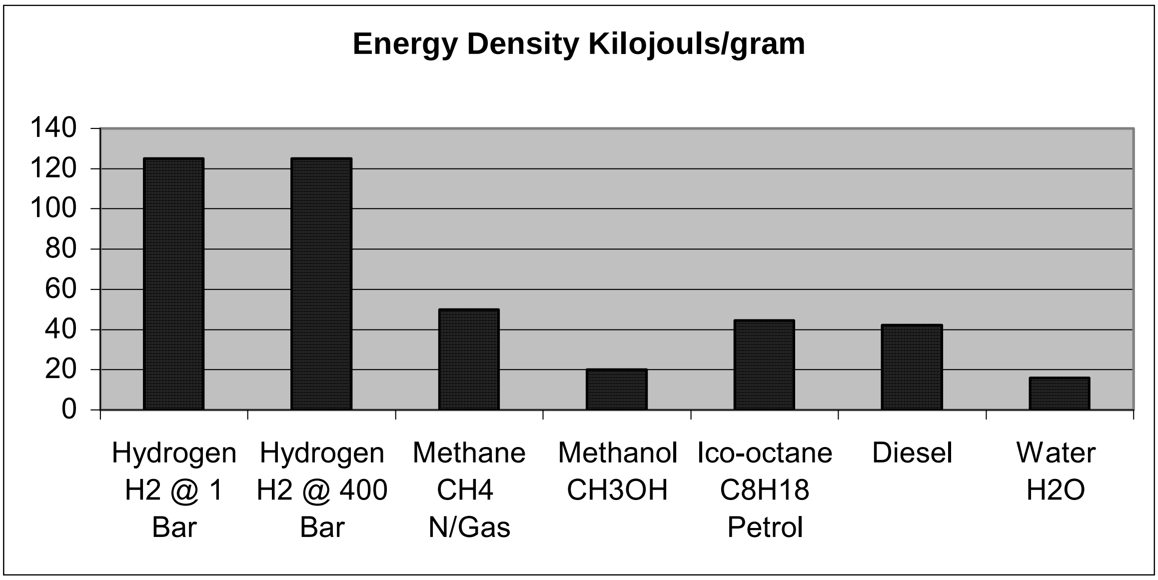
Energy Density of Fuels

A given mass of hydrogen has 2.8 times the energy of the same weight of gasoline, but on a volume basis, gasoline has 3000 times the energy of the same volume of hydrogen at normal atmospheric conditions.

When compressed to around 10,000 psi and the on-board storage volume is triple that of gasoline, then hydrogen is equivalent to the same volume of methanol or liquefied LPG @ 20,684 KJ/litre. Under these conditions, hydrogen would have over half the range of petrol - more than adequate for normal daily use.

Fuel	**BTU/LB**	**KJ/g**	**BTU/Cub.Ft**	**KJ/Lt**
Hydrogen H_2 @ 1 Bar	53,780.00	125.08	279.00	10.36
Hydrogen H_2 @ 400 Bar	53,780.00	125.08	111,600.00	4,145.70
LPG (Methane CH_4)	21,500.00	50.01	556,800.00	20,683.94
Methanol CH_3OH	8,600.00	20.00	427,400.00	15,877.01
Ico-octane C_8H_{18} Petrol	19,140.00	44.52	858,190.00	31,879.95
Diesel	18,200.00	42.33	1,019,000.00	37,853.70
Water H_2O	6,829	16	354,467	13,162
Uranium Fission	2 x 10^8	470,000	N/A	N/A
Fusion $2{}_1D^2 + 1e \rightarrow {}_2He^4$	2.6 x 10^{14}	6 x 10^{11}	N/A	N/A





Pre-Stored Hydrogen.

Hydrogen is now cheaper to make than the cost of petrol – the range and weight of the hydrogen fuel system being compatible with natural gas. Suitable high-pressure hydrolysers can be home operated.

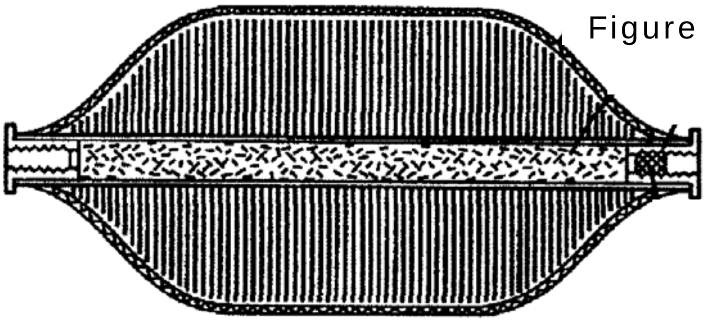


Figure 1.

There are three basic storage systems available to house hydrogen safely – Compression cylinders – Cryogenic storage and Hydride adsorption .

Modern hydrogen storage tanks are made of lightweight carbon fibre and able to withstand pressures in excess of 20,000 psi. These tanks can withstand the blast of dynamite, temperatures of 1,500^{0}C and the impact of a 0.357 magnum bullet. Carbon fibre tanks take only a few seconds to fill.

Cryogenic liquid hydrogen storage uses 1/3rd of its stored energy to liquefy the H_2 to -252.9^{0}C and requires complex systems for both liquefying and refuelling a vehicle, but will power a car for 1/3rd the range of petrol using the same storage displacement. (*Atmospheric venting is also necessary*)

Figure 1 shows a modern lightweight activated carbon hydride type storage system at atmospheric pressure that is equivalent, when fully charged, to a pressure tank of 8,000 psi and same displacement as petrol. In the experimental stage are absorption systems using carbon nano tubes and whiskers that promise to give storage capacities exceeding cryogenic densities. Refuelling takes from 15 minutes to 2 hours depending on the type of Hydride.

Figure 3 represents a spark / injector plug that can be retrofitted to the conventional spark plug inlet using the system shown in Figure 2. This conversion can be carried out in about 2 hours.

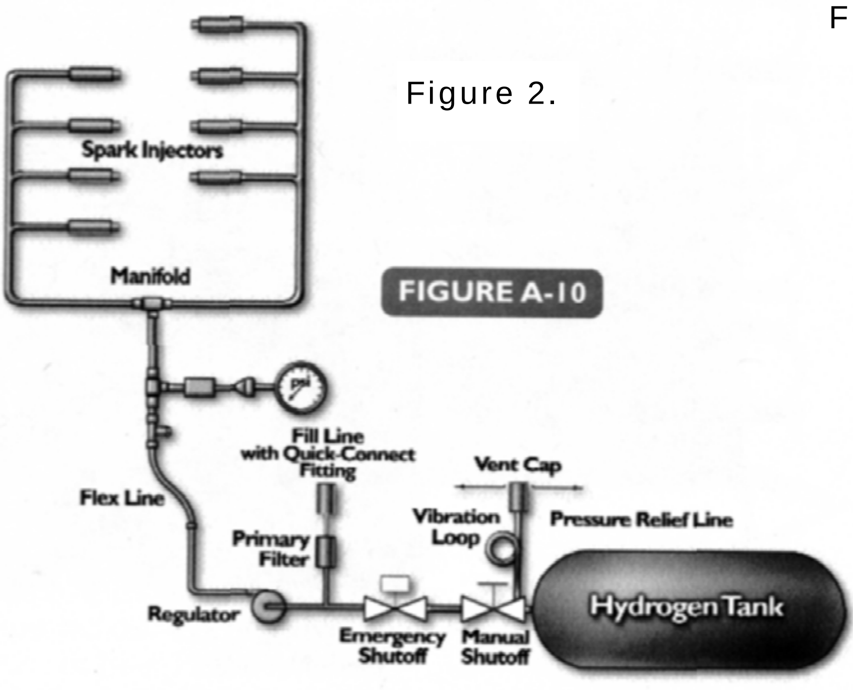


Figure 2.

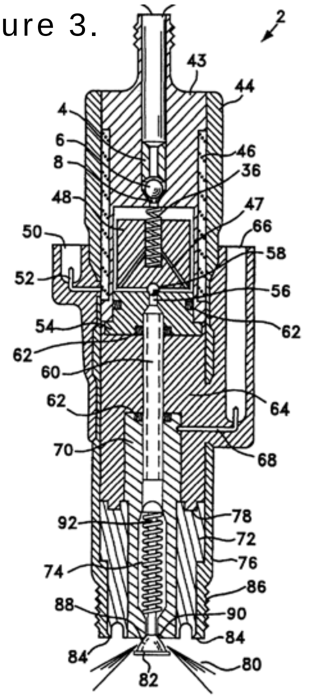


Figure 3.

The Hardware of Hydrolysis

Hydrolysis is the process of applying electrical energy to an appropriate electrolyser in order to separate the elements of hydrogen and oxygen. This is normally carried out by either supplying a direct current across two or more electrodes immerged in a liquid medium, or by pulsing the DC current at various frequencies and various mark space ratios. There are basically two different cell configurations used to achieve this purpose, but both will render the same output for the same applied wattage.

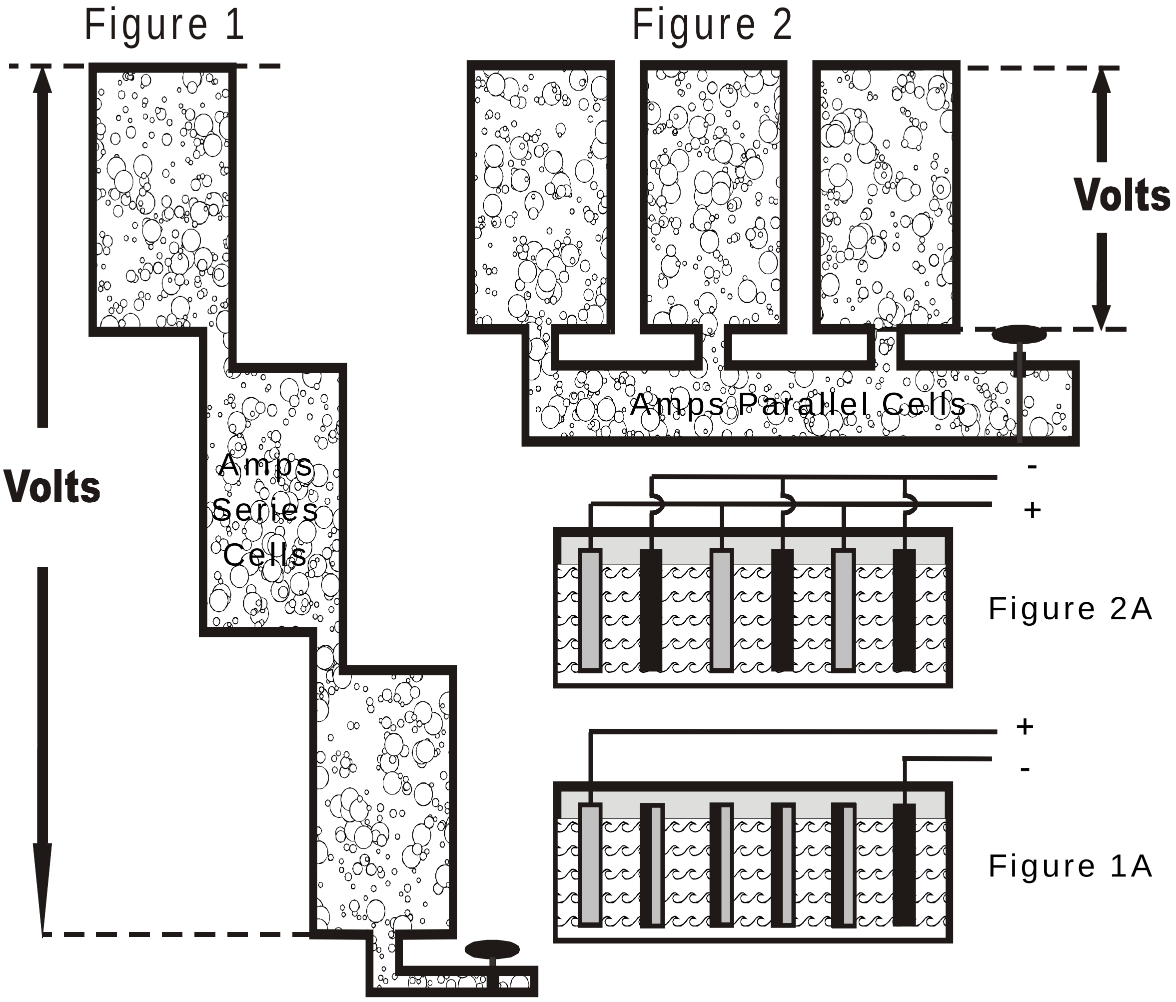


Figure 1 and 1A; depicts simulations of a series configured hydrolyser in which a chemical electrical connection is established between each adjacent electrode. The end plates of the pile are the only electrodes hard wired to the external power supply. The rest of the plates function as bipolar electrodes with one side of each plate acting as a cathode and the other as an anode. The applied voltage for the series arrangement equals the sum total of all the cells in series. If each cell for optimum efficiency requires two volts, then 6 volts will be required for a 3 cell series configuration. As can be seen from Figure 1 simulation, the same current flows through all cells. The series configuration is therefore appropriate for connection to a high voltage supply at low current drain.

Figure 2 & 2A represents a parallel-connected hydrolyser. In this arrangement, all the cathodes are hard wired to the negative terminal of the supply whilst the anodes are wired to the positive supply. The voltage for the hydrolyser is the same as for one cell, but the current demand is the total current density of all the cells. Note that the internal plates alternate in polarity with both surfaces being chemically active. The parallel electrolyser is suitable for low voltage input with a high amperage drain. If the electrolyte consumed the same wattage in both 1 & 2 with 6 volts across 1, & 2 volts across 2, then both would output the same amount of gas. *Note that 1A & 2A can be considered as 5 cells*

Powering the System

There are many different variations of hydrolysers, but all requires an electrical power supply.

If the water medium is conductive, it will require some kind of current control to prevent amperage run-a-way as the resistance of the medium changes due to heat or cell contamination. If the device is used in a non-mobile environment, such as a laboratory, the mains, batteries or other stand-a-lone electrical systems, can supply electricity. If the device is used in a mobile application, such as a vehicle, then the power supply can only come from the vehicle's stored or generated electrical system.

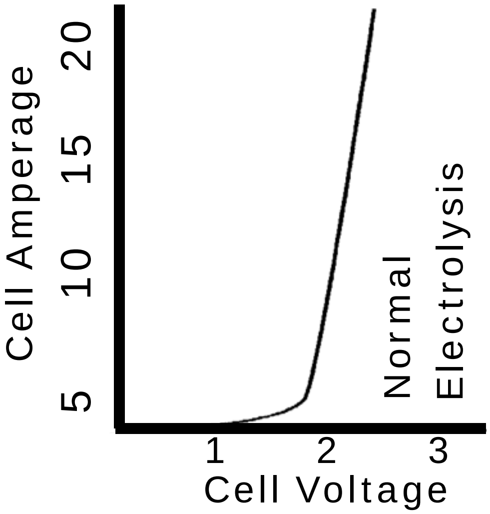
The potential required for the hydrolyser may be incompatible with the supply system. In this case, some provision must be made to increase or reduce the voltage as necessary. The power of the supply may also be inadequate to meet the demands of the hydrolyser system. In this case it may be necessary to provide a dedicated power supply. If the source is a regular car alternator supplying all electrical systems, then it may be necessary to segregate the alternator for duel output or add another alternator and/or separate battery system. (***See my Book "The Alternator & Allied Circuitry"***)

Battery Power

Although a parallel-wired cell requires a potential of only 2 volts, a 12 volts car batter is used at 12 volt potential for the parallel hydrolyser in nearly all workshop cell experimentation. The car battery is also used extensively to power various on-board hydrolysers as well.

It is a theoretical concept that defines the potential of a two plate electrolyser as 1.23 volts. This figure is established by considering ▲G = nFE (*see Thermodynamics*). In reality it is almost impossible to generate any quantity of gas with that lower potential because of associated plate gapping and electrolyte resistance to ion flow. Alternatively miss-matched voltage may be responsible for some of the energy losses due to heat of over-voltage, but it supplies a more realistic output of gas compared to the basic 1.23 volts stated is some literature.

Figure 3



On board a vehicle, the battery is an excellent source of stable DC supply and its potential is ideally suited to nearly all electronic components. In some cases the existing battery has provided all the energy needed to drive a vehicle. At lease two accounts of vehicles being fully powered by on-board water hydrolysers have been documented.

The battery also allows for the construction and use of complex circuitry. Frequency generators, pulse width modulation and electronic switching can all be used with battery operation to try and oscillate the water molecule into self-resonance and disassociation. This particular approach for electrical dissociation is the subject of the most recent patents on water separation.

If the on-board battery is inadequate to meet the demands of the electrolyser , it is a simple matter to install a dedicated battery for this function. Likewise, if the alternator is having trouble keeping up with the demand, it may be possible to fit a larger alternator.

With parallel cell systems, Hall-effect modulation is considered to be the most reliable and efficient for controlling the current. The Hall effect, *named after E.H. Hall who discovered the phenomenon in 1879*, sets up a one-way directional electromagnetic motion across a conductor that is proportional to the strength of the current. By positioning a Hall device in close proximity to a current carrying wire, it is possible to monitor the current strength and thereby trigger a suitably designed circuit to control the current flow independently of the main circuit.

Current Monitor

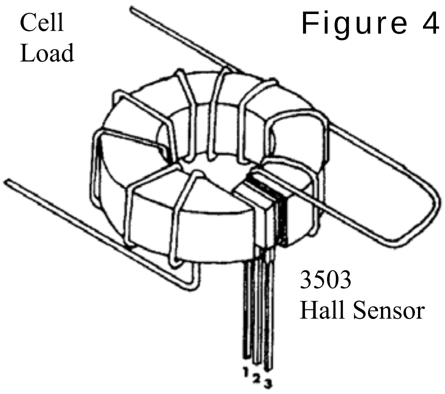


Figure 4

Mains Supply Systems

Current limiting is the first priority of any electrolysis system. With mains supply system this can be achieved by placing AC compatible capacitors in series with the neutral line of the AC outlet (Electrolytic Caps are unsuitable). Research has shown that for a current of 10 amps approximately 70µ*f is* required in the AC line. An ammeter should be placed in the hydrolyser circuit to determine the actual output so the capacitance can be adjusted accordingly.

A full bridge rectifier is then wired across the AC outlet to convert the supply to DC. The output of the bridge has the effect of doubling the frequency of the AC supply and at the same time boosting the DC voltage from 240 volts AC to approx 300 volts DC. Voltage may then be divided to match the voltage of a parallel-wired hydrolyser by use of appropriate circuitry.

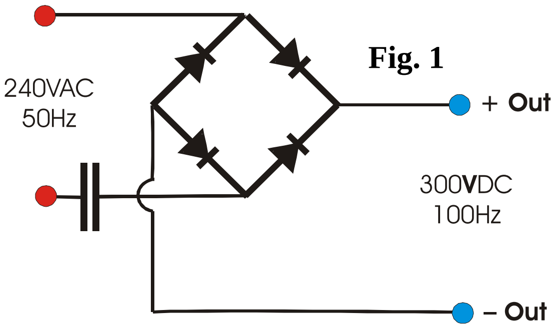


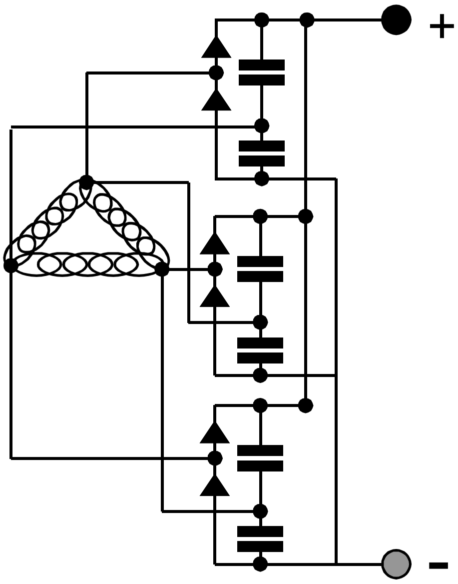
Fig. 1

Alternatively, capacitance may also be added across the output of the bridge rectifier to provide a voltage doubler of around 480 volts output. Work within the wattage of the supply.

Vehicle Alternator Modifications

For series cells that are best suited to high voltage the battery of just 12 volts DC is unsuitable. By far the most appropriate method of providing the high voltage needed is to modify the alternator. Like mains supply systems, capacitive current control may be incorporated with voltage multiplier circuits to increase the normal 12-volt AC output to hundreds of volts of rectified DC.

This technique has been comprehensively covered by George Wiseman in his book “HyZor Technology” published in 2001. The original alternator may be modified as in the drawing below without altering the normal circuitry of the alternator, but it is essential that the alternator have at least 10 amps extra capacity to supply the hydrolyser.

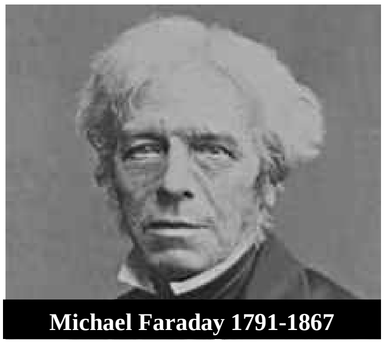


Dedicated alternators may be fitted to some vehicles. If space is limited it may be possible to fit the additional alternator where the compressor for the air conditioning is normally installed.

If still higher voltages are required the three phases may be split using the six ends of the windings to connect to the six wires shown above.

There are many alternator designs that will work. George Wiseman has a dozen alternatives listed in his above quoted book.

Understanding Electrolysis



Michael Faraday 1791-1867

Michael Faraday (1791 – 1867) was the first to provide a quantitative analysis of the process for electrolysis. In all cases, the quantity of material evolved at each electrode when current is passed through an electrolyte follows the laws he discovered:

Law 1. The quantity of material transformed at each electrode is proportional to the quantity of electricity passed through the electrolyte.

Law 2. The weight of the elements transformed is proportional to the equivalent weights of the elements, *that is, to the atomic weights of the elements divided by their valances.*

By the modern definition, to liberate one mole of ions carrying a charge of either n+ or n-, n moles of electricity in Coulombs is required. The charge carried by one mole of electricity is the Faraday constant (F) - [the product of Avogadro's constant $N_a = 6.02214 \times 10^{23}$ and the charge on the electron, $e = 1.602177 \times 10^{-19}$, both in SI units = 96,485 coulombs per mole].

Example 1. Using Faraday's method SATP:

$H_2O(l) = 2 \times 1.0079 + 1 \times 15.99 = 18.006$g atomic mass.

As the shared valance is two electrons, by Law 2,

$^1/_2$ of 18.006 = 9.003 grams of gasses are released by 1 Faraday.

The proportion of the products is the ratio of the mix ie., 1.008gms $H_{2(g)}$ + 7.995 gms $O_{2(g)}$

As 1 Coulomb sec^{-1} = 1 Amp, then 10 amps over 1 hour would produce:

$$\frac{10 \times 3600}{96,485} \times 9.003 = 3.359 \text{ gms of gasses} = 0.3732 H_2 \text{ gms} + 2.9858\ O_2 \text{gms}$$

As 24.8 litres of H_2 weighs 2.015 gms, then $\frac{0.3732}{2.015} \times 24.8 = 4.59$ litres of H_2

As 24.8 litres of O_2 weighs 31.98 gms, then $\frac{2.9858}{31.98} \times 24.8 = 2.32$ litres of O_2

Example 2. Using the modern molar calculation:

Since 2 mols of H^+ (aq) must be liberated to decompose 1 mol of H_2O
then 2 mols of electricity are required,
thus 2 x 96485 = 192,970 Coulombs liberates 2.015 gms of hydrogen.
Applying 10 amps for one hours = 10 x 60 x 60 = 36000 Coulombs.

So the mass of hydrogen released $\frac{36000}{192,970} \times 2.015 = 0.3732$ gms of H_2 approx.

For systems other than at SATP a more complex formula is used to account for pressure & temperature.

Thermodynamics of Electrolysis

The Gibbs function is defined in terms of the enthalpy H, and the entropy S of the system:

$\Delta G = \Delta H — T\Delta S$ (where T is the temperature in Kelvin)

Also, for an electrochemical cell working reversibly at constant pressure and temperature, the electrical work done by the cell is the net work of the system and given by:

$\Delta G = —w$

For a reversible process, the potential difference (emf) when a cell is balanced against an external source of electromotive force is called the zero-current cell potential and is given by:

$\Delta G = —eN_a\, nE = nFE$ (where F is in Faradays & E is the cell potential Volts)

By rearranging the formula: $\Delta G/nF = E$, so if the value of ΔG is known then E can be found:

Example: For the reaction $H_2\,(g) + {}^1/_2O_2\,(g) \rightarrow H_2O(l)$ $\Delta G_f^{\Theta} = (-237.13kJ)$

n = 2 mols and F = 96,485 coulombs per mole, then:

$$\Delta G/nF = \frac{237.13kJ}{2x96,485} = 1.23 \text{ volts (Cell potential)}$$

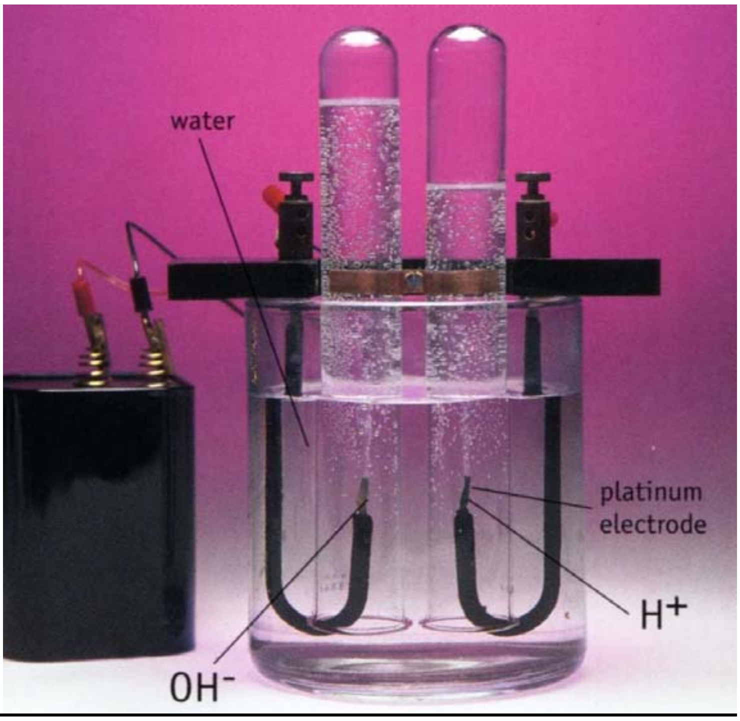
However, what is needed is ΔH_f^{Θ}as this is the energy of decomposition. ΔG_f^{Θ} represents only the spontaneous reaction of formation. The minimum emf necessary for the decomposition of water is therefore given by:

$$H_2O(l) \rightarrow H_2(g) + {}^1/_2O_2(g) \quad \Delta H_f^{\Theta} = (+285kJ)$$

Thus, $\Delta H/nF = \frac{285kJ}{2x96,485}$ =1.48 volts

(Cell minimum potential)

1.48 volts is the minimum voltage necessary to disassociate H_2O. In practice allowances have to be made for losses within the cell, resulting in a necessary potential difference of about 2 to 2.5 volts per cell. Any excess voltage applied over and above 3 voltage tends to generates heat and contributes to contamination of the cell.



Applying the theory to the Cell.

The ratio of electrolyte that is necessary for an efficient electrolytic process is determined by the design of the cell and the power system that will be used to drive the process. It is calculated by the use of Ohms law.

If a 50 watt power system is used to drive a single cell with the potential difference of 2 volts then the amperage available to drive the system is 50/2 = 25 amps.

Using ohms law: $E/I = R = \frac{2}{25} = 0.08\ \Omega$ resistance across plates

(*At 100% power output - In practice use 50%)*

If 25 amps is supplied to the cell across a resistance of 0.08 Ω for say one hour.

25 amps over 1 hour = $25 \times 60 \times 60 = 90000$ Coulombs, and

The mass of gas generated is: $\frac{90000}{96{,}485} \times 9.0 = 8.4$ grams of gas (100%). SATP

As $\Delta H = 286\ \text{kJ mol}^{-1}$ then $\frac{8.4}{18.0} \times 286 = 133.5\text{kJ}$ of energy would be consumed as internal work, SATP

As $\Delta G = 237\ \text{kJ mol}^{-1}$ then $\frac{8.4}{18.0} \times 237 = -110.6\text{kJ}$ of energy could be released as work, SATP

but this means 133.5—110.6 = 22.9kJ would have to be released as heat for the reaction to proceed and ΔS to be positive. Alternatively the full 133.5kJ may be released as heat.

If it is desired to separate the hydrogen from the oxygen, then a membrane (proton exchange membrane) or a partition of a dielectric material compatible with the electrolyte must be interposed between the anode and cathode material. With PEM's only the thickness of the membrane need separate the electrodes. With a dielectric divider, it must be extended below the bottom of the suspended electrodes so as to seal the cell into two separate compartments with only a small gap at the bottom below the divider to act as a "salt bridge".

For Hydroxy gasses no divider is required.The electrodes should be as close as possible to maximise gas production whilst reducing wattage. An accurate and uniform gap of 2mm is ideal for currents up to 40 amps. Uneven or closer gapping may result in arcing between the plates. Gapping over 6mm will result in low gas production due to the higher resistance across the electrolyte.

Series cells must be completely sealed around the edges of the electrodes below the water line to prevent electrical bypass of the intermediate electrodes. However a liquid vent hole is required through the insulator between each pair of plates at the bottom of the cell. *Some power loss will occur.*

Catalysts, Electrolytes and Cell Materials

Measurements of solution concentrations are now generally reported in terms of molar concentrations which are typically reported in moles per litre (mol L^{-1}). This is determined by measuring the actual mass of a solute (of substance in question) contained in one litre and dividing it by the atomic mass.

For example: The molar concentration of N_aCl in a liquid is given as 0.154m. As the atomic mass of N_aCl is 58.04g, then:

0.154 x 58.04 = 0.9 grams of N_aCl is contained in one litre of the mixture.

It is also acceptable practice to report the above as a percentage mass concentration. If 0.9 grams is contained in a litre of water:

then, $\frac{0.9}{1000}$ x 100 = 0.09% of N_aCl is contained in the sample of solution.

When dealing with the mixture of liquids it also common practice to report the mix in terms of the percentage volume: Thus 25% mix of a solute by volume is clearly not the same things as 25% by mass. It is therefore important to distinguish which system is being used in any literature dealing with this subject.

Both Potassium-hydroxide (KOH) and Sodium-hydroxide (N_aOH) are ideal alkalies to use as a conductive medium in a water solution as they are inert to a large range of cell materials. In most cases they will act as a perfect catalyst with stainless steel electrodes (305 or 318 grade) and most PVC materials used for containers. Bakelite or battery cases are perfect container materials but are hard to come by. Aluminium is also suitable with KOH, but will deteriorate over time and in direct proportion to the electrolyte concentration. Cast Iron will last well if it is fully submerged in the electrolyte, but will deteriorate quickly if only partly submerged.

Acids have a very limited range of materials that can be used in the hydrolyser. The electrodes are normally restricted to either lead or carbon: The casing can be a new car battery case purchased from a battery manufacturer that is specifically formulated for acid.

Contamination of the electrolyte is directly proportional to the amperage density and voltage potential above 2 volts per cell. If the (per cell) voltage is kept below the 3 volt limit, the amperage density on the electrodes kept below 0.05 amps per square centimetre, and the alkali content kept below 25% by mass, then the hydrolyser should function as intended. .

The lower the pressure and the higher the temperature the more efficiently the cell will function within limits. Care must be taken in the selection of materials to ensure they can withstand the design parameters. The pressure of Hydroxy should not exceed 100psi or it may self detonate.

Alkalies react violently with water, so wear protective clothing & face screen, and pour the alkali very slowly into the water. **Do not pour water into the alkali.** Keep vinegar handy in case of accidents. The preparation of the electrolyte is a one time effort as KOH or N_aOH are good catalysis with very low consumption rates. Be careful to contain the electrolyte in the hydrolyser as it could damage engine components. The water will be consumed at approximately twice that of petrol if high current is used. It needs to be checked regularly or an auto refill system fitted.

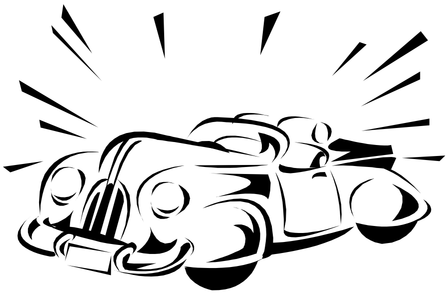
The Theoretical needs of HHO for Carbon fuel Supplementation

Modern vehicles with injector systems generally require a very high quality of fuel to function efficiently. Low grade home brewed alcohol and terpenes tend to gum up the works very quickly. Commercial methanol or ethanol may also cause similar problems.

The answer to this dilemma is to add H_2, hydroxy gas or steam to the mix in the proportions of 5% to 7% by KJ value. Such a combination will considerably improve your fuel economy, keep your engine and injectors squeaky clean and lower your undesirable emissions. With pre made H_2 this is not a problem, but with an on board hydrolysers it may be necessary to drop this percentage to around 2% to be viable. Steam may be recirculated from the exhaust and fed into the air intake through a fine screen but it may be necessary to fit stainless steel spark plugs to prevent rust.

The following demonstrates the energy requirements for a 5% supplement HHO gas at 100% efficient hydrolyser based on H_2 energy value:

Speed of Vehicle:	**60KmPH**
Time Travelled:	**1 Hour**
Fuel Economy:	**15Km per litre**
Petrol Energy	**32.MJ per Lt**
1 Kilowatt hour:	**3.6MJ**
1 Litre of H_2	**10.4kJ $H_2O(l)$**



Petrol used = 60 / 15 = 4 litres of Petrol for 1 hour
32x4 = 128 Megajoules (120MJ)

At 5% Supplementation with HHO 128MJ / 20 = 6.4MJ
6.4MJ of HHO/ 10.4kJ = 615 litres /hour = 10.3litres/minute
Converting to Kilowatt hours 6.4 / 3.6 = 1.8 Kilowatts

If the Electrical supply is a 13.8 volt battery, then Current = 1.8Kw / 13.8v = 130 amps

The Hydrolysis cells at 13.8 volts, would need 130 amps for 615 litres/hr (@ 100% efficiency)

The top efficiency of an alternator is around 70%, so input is 1.8 Kw/0.7 = 2.6 Kw

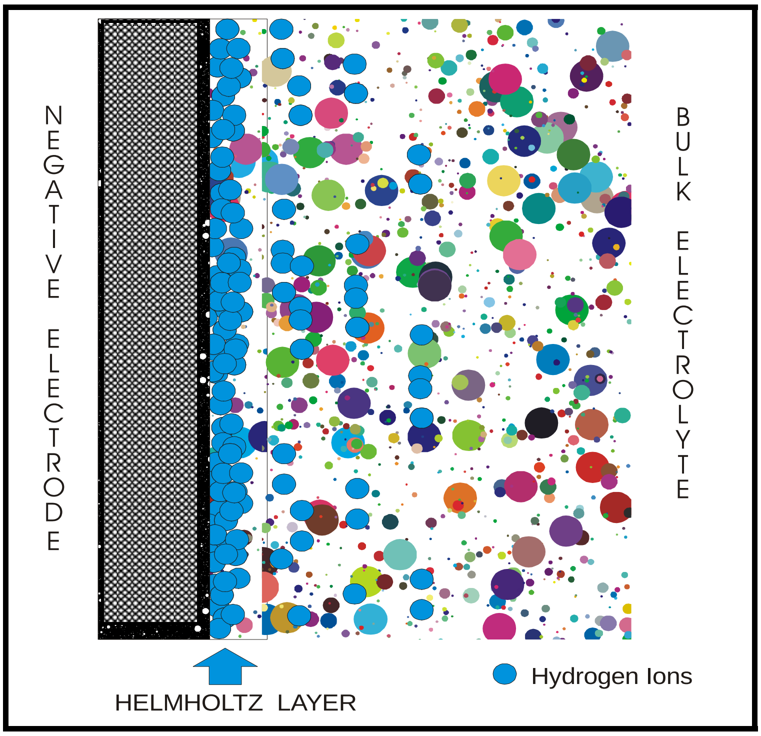
This means that the engine would have to supply 2.6kw / 746w = 3.4hp to the alternator. (*Just for the exclusive use of the hydrolyser*)

As 7 HP is the normal drag on the Alternator then 3.4 + 7 = 10.4 HP
But as the motor outputs only 34 Kilowatts = 34000/746= 46 hp

With this system 46hp – 10.4hp = 35.6hp is left to pull the car.

Clearly 5% @ 130 amps is not attainable for normal driving requirements using a conventional parallel electrolyser. However, with enhanced cell technology using series high voltage units and/or pulsed and tuned circuitry with recirculated or aerated electrolyte, the outcome is a different story that will be covered in more detail in part two of this thesis.

Could Thermodynamics have got it wrong?



The product value of 237.13 kJ per mol. of H_2O for an input of 285.83 kJ at SATP is based on Faraday's measurements of gas production in a static cell and Gibb's calculations of available energy.

In a Faraday hydrolyser the first layer of H^+ acts like an electroplating electrolyser, covering the cathode with a layer of hydrogen ions that stick to the electrode in an electrostatic bond. This layer, known as the Helmholtz layer, diminishes the rate of ion flow and therefore the rate of gas production. If air is used to remove this layer, then additional energy will not be wasted in maintaining ion flow and heating the cell.

Thus if the vacuum of the engine is used to draw air through a hydrolysis cell and power is momentarily cut in conjunction with air flow, then it may be possible to suck out sufficient HOH gas to meet the needs of an internal combustion engine provided the heat content of the reaction is sufficient to overcome piston resistance.

In the official State schools text "Complete Chemistry…" authored by F.T. Barrell and printed by Jacaranda Press in 1955 Revised (1961), Page No. 111 states inter alia: "Hydrogen is used as a flame for cutting metals, e.g., in the oxy-hydrogen (about 2400^{o}C) and atomic hydrogen (4,000^{o} – 5000^{o}) blow torches. The atomic hydrogen touch gives the hottest flame attainable with any fuel. In part of the apparatus, energy is taken in *(from the surrounds endothermically)* to separate hydrogen molecules temporarily into hydrogen atoms. As the atoms recombine to molecules, high amounts of energy are given out in the form of heat." Therefore according to academic figures, the overall energy of formation from 4H + 2O in the form $2(O—H) + 2H \rightarrow 2(H—OH) \rightarrow 2H_2O$, could be as high as:

$$2(428 + 492) = 1840 \text{ kJ mol}^{-1}, \text{ compared to just } 457 \text{ kJ mol}^{-1} \text{ for } \Delta G^{\Theta}_{f}\ 2H_2O(g).$$

If heat is drawn in from the surrounds of the combustion cylinders, then the energy released as steam may exceed the official exothermic value of 457 kj mol^{-1} for ΔG (formation) of $2H_2O$ SATP. This may explain why ice is sometimes observed on the radiator cap of Hydroxy powered vehicles.

In one of the latest books to be published on physical chemistry by P.W. Atkins (*fellow of Oxford University in Chemistry)* entitled "The Elements of Physical Chemistry", published by Oxford University Press 1998? And claimed as one of the major authoritative works, is written on Page No. 280 about reformation of water and other reactions, "A thermal explosion is due to the rapid increase of reaction rate with temperature. If the energy of an exothermic reaction cannot escape, the temperature of the reaction system rises, and the reaction goes faster. The acceleration of the rate results in a faster rise of temperature, and so the reaction goes even faster……..catastrophically fast. A chain branching explosion may occur when there are chain branching steps in a reaction, for then the number of chain carriers grows exponentially and the rate of reaction may cascade into an explosion."

"An example of both types of explosion is provided by the reaction between hydrogen and oxygen:

$$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O(g)$$ "

"Although the theoretical net reaction is very simple, the mechanism is very complicated and has not yet been fully elucidated. It is known that a chain reaction is involved, and that the chain carriers include ·H, ·O·, ·OH, and $\cdot O_2H$. Some possible steps are shown below:

Initiation: $H_2 + O_2 \rightarrow \cdot O_2H + \cdot H$

Propagation: $O_2 + \cdot H \rightarrow \cdot O\cdot + \cdot OH$ (branching reaction)

$\cdot O\cdot + H_2 \rightarrow \cdot OH + \cdot H$ (branching reaction)

$H_2 + \cdot OH \rightarrow \cdot H + H_2O$

The two branching steps can lead to chain-branching explosions." *The "·" represents unpaired electrons.*

Another possibility is that it takes less energy to produce HOH(g) than it does to produce H_2 and O_2. HOH has a much higher energy level than $H_2 + O_2$ because exothermic conversion to the diatomic state during the process of electrolysis need not occur. Likewise, in the engine the hydroxy does not need to draw in energy to disasociate $H_2 + O_2$. Therefore, all of the energy of HOH(g) may be available to recombine into superheated steam exothermically and thus overcome piston resistance.

$$2H_2O(l) \rightarrow 2\,(H^+ + OH^-) \rightarrow 2(HOH)\text{ gas} \rightarrow 2H_2O(g)$$

Hydrolyser — Engine

$\Delta H = +984kJ$ — $\Delta H = -984\ kJ$ — $\Delta H = -457kJ$

Even higher energy levels may be achieved by repeated charging of the water used in a stand alone hydrolysis cell. It may be possible to reduce protium levels and enhance deterium levels by repeated charging of the electrolyte and or the creation of large amounts of H^+ ions. Deterium has a higher energy level than protium, (*See Appendix B1 and Horvath Part 2*). Also, a large concentration of H^+ would make it easier for the freed OH^- ions to combine into HOH, thus bypassing half of Faraday's constant and developing twice the gas for half the cost. My experiments showed a Ph of less than 3, after repeated charging of spring water that started out at Ph 7. This drop from Ph7 to Ph3 actually occurred in a 15 minute period after the power had been turned off. This experiment was carried out in 1999, and the Ph3 in the retained sample has remained constant to this day.

Newton gave us $E = \frac{1}{2} mv^2$, which means the energy of combustion is proportional to the square of the velocity. The higher the velocity the exponentually greater is the energy. The flame speed of petrol is much slower than $H_2 + O$, and this is even lower than H + OH. Whether this higher level of energy can translate into higher temperature steam is yet to be determined.

From the above it is demonstrated that even the best chemistry minds in the modern world have no idea of the exact process of water formation in an engine. Again it is seen that anything is possible dispite the exactness of thermodynamics and chemical kinetics. It would appear therefore that a case has been made for possibly powering a vehicle by an insitu hydrolyser using modest input power. Over unity output could also be possible if endothermic energy is appropriated to effect combustion.

From time to time a small number of inventors, mostly from non academic backgrounds, have demonstrated this unique capability. Those that have been authenticated by patent issue and media or appear to be the most likely to be successful have been singled out and will be analysised to the extent of available information in Part II.

THERMODYNAMICS OF WATER (H_2O)

System of Main Units Used

Length = Metres (m) . Mass = Kilograms (kg) Time = Seconds (s) Energy = Joules (J)

Atmospheric pressure = 1 bar = 100 kilo Pascal (kPa) = 1 Kg m^{-1} s^{-2} Volume = Litres (L)

Temperature = Degrees Kelvin (K) : 273.15 K = 0^0 Celsius (C) : $\Delta K = \Delta C$

Mass in Moles $= n = \dfrac{\text{Mass in grams of sample}}{\text{Atomic Mass of Sample Material}}$ eg: $\dfrac{\text{Mass of water sample in grams}}{\text{18.006 grams}}$

A mole of particles = Avogadro's constant 6.02214×10^{23} particles V_m = 24.79 litres Gas

1 mole of H_2 = 24.8 litres 1 mole of O_2 = 24.8 litres 1 mole of $H_2O(l)$ = 18.006cc

Perfect Gas Equation of State

Gas Constant: $pv = nRT$. At 25^0 C & 1 bar $v = \dfrac{nRT}{p}$ = 24.79 L. $\dfrac{V_2}{V_1} = \dfrac{P_1}{P_2}$

p = Pressure in KPa **v** = Litres **R** = 8.31451 K^{-1} mol^{-1} = 8.3145 KPa L K^{-1} **T** = $Kelvin^0$

Critical Temperature

When liquid water is heated in a suitable closed container to 373^0 K, it will be completely vaporised and exert a pressure of 218 bars (3,200 PSI). H_2 has a critical temperature of -240^0C, and O_2 -118^0C.

Internal Energy of a System

Change in internal energy of a system ΔU, can be expressed succinctly as:

$\Delta U = w + q$ where **w** is the measure of work and **q** is a measure of the heat in kJouls. Work leaving the system is shown as **–w,** and work entering the system is shown as **+w**. The same is true of heat symbolised as **-q** and **+q.** Both are a measure of energy.

Maximum Work of a System

The maximum work that a system can do at constant temperature when expanding inside a closed container reversibly is given by:

work done by the system in kJ is: $w = -nRT \ln \dfrac{V_f}{V_i}$ where f = final, & i = initial volume

Heat Capacity of a System

Each different material of identical volume requires a different quantity of heat energy to raise its temperature by the same amount. This characteristic is known as the heat capacity of the material and may be calibrated for either a fixed volume C_v, or when the system is open to the air, by a fixed pressure C_p. The relationships between these two measurements and Temperature are given by the following formulae:

1. $C_p = C_v + nR$ 2. $\Delta T = q/C$

Each phase requires a different measure of Heat Capacity. For H_2O these values are:

C_p in $JK^{-1}\ mol^{-1}$ for Ice = 37. for Liquid = 75.29. for Vapour = 33.58

Example: To raise the temperature of 100g (5.55mol) of liquid water by 60 degrees Kelvin (or 60^0 C) requires the input of heat energy (q):

$$\Delta U = q = n \times C_p \times \Delta T = 5.55 \text{ mole} \times 75.29\ (C_p) \times 60K = +25.1 \text{ kJ}$$

ENTHALPY – H

Enthalpy is derived from the Greek word meaning "Heat within". A system may therefore act like a bank, in which energy can be deposited and withdrawn. The Enthalpy is the accounting system that accounts for all of these transactions. Unfortunately we do not know the total energy of the system since it was created, and therefore can only account for the changes in the system that is applicable. **ΔH** is the enthalpy change that will account for these internal changes and is given by:

$$\Delta H = C_p\, \Delta T = q \text{ per mole (at constant pressure p)}$$

1. Phase Change Enthalpy in mols
First to be considered is the enthalpy of phase change:

Fusion $H_2O(s) \rightarrow H_2O(l)$ $\Delta H = +\ 6.01$ kJ @ 273.15K (Ice to water)

Vaporisation $H_2O(l) \rightarrow H_2O(g)$ $\Delta H = +\ 43$ kJ @ 373.2K (Water to steam)

$2H_2O(l) \rightarrow 2H_2O(g)$ $\Delta H = +\ 86$ kJ @ 373.2K (Water to steam)

The last equation signifies that ΔH is proportional to the number of moles involved.

When the phase change is reversed, ΔH is negative:

Freezing $H_2O(l) \rightarrow H_2O(s)$ $\Delta H = -\ 6.01$ kJ @ 273.15K (water to ice)

Condensation $H_2O(g) \rightarrow H_2O(l)$ $\Delta H = -43$ kJ @ 373.2K (steam to water)

2. Enthalpy of Ionization in mols

The loss of an electron (e) from a gas phase atom is called Ionization and requires the input of energy to effect the change. For example:

$$\mathrm{H(g)} \rightarrow \mathrm{H^{+}(g)} + \mathrm{e^{-}(g)} \qquad \Delta H = +\,1310\ \mathrm{kJ}$$

Standard Ionization Enthalpy: $\mathrm{H^{+}(g)}$ $\Delta H = +\,1310$ kJ $\mathrm{O^{+}(g)}$ $\Delta H = +\,1310$ kJ
$\mathrm{O^{2+}(g)}$ $\Delta H = +\,3390$ kJ

The reverse of Ionization is **electron gain** (previously “affinity”)

$$\mathrm{OH(g)} + \mathrm{e^{-}(g)} \rightarrow \mathrm{OH^{-}(g)} \qquad \Delta H = -72\ \mathrm{kJ}$$

Standard Electron Gain Enthalpy: $\mathrm{H^{-}(g)}$ $\Delta H = -72$ kJ $\mathrm{O^{-}(g)}$ $\Delta H = -141$ kJ
$\mathrm{O^{2-}(g)}$ $\Delta H = +844$ kJ

3. Atomic Bond Enthalpy in mols

Bond Enthalpy determines the energy that holds atoms together. The hydrogen and oxygen bonds are as follows:

H ↔ H $\Delta H = +\,436$ kJ
O↔ O $\Delta H = +\,497$ kJ

O ↔ H $\Delta H = +\,428$ kJ
H ↔ OH $\Delta H = +\,492$ kJ
HO ↔ OH $\Delta H = +\,207$ kJ

The calculations for molecular bonding depend on the molecule in which the two atoms are linked. For example:

$$\mathrm{H_2O}(l) \rightarrow 2\mathrm{H(g)} + \mathrm{O(g)} \qquad \Delta H = +285\mathrm{kJ}$$

Note: Two OH bond enthalpy are not added into the calculation even though 2OH bonds have been dissociated. There are in fact two different dissociation steps. The first step:

$$\mathrm{H_2O}(l) \rightarrow \mathrm{OH(g)} + \mathrm{H(g)} \qquad \Delta H = +492\ \mathrm{kJ}$$

In the second step the OH bond is broken in an OH radical by combination with another OH:

$$\mathrm{OH(g)} + \mathrm{OH(g)} \rightarrow \mathrm{H_2O(g)} + \mathrm{O(g)} \qquad \Delta H = -207\ \mathrm{kJ}$$

The catalyst also enters into the reaction and ion exchange both play a big parts in the overall interaction, but as bond enthalpy is a state property, it doesn‘t matter which reactions are evaluated, the end result will have the same value of enthalpy provided all reactions are correctly evaluated.

Standard Enthalpy of Reaction ΔH^{Θ} & Formation ΔH_f^{Θ}

The standard enthalpy of reaction ΔH^{Θ}, is the enthalpy of reaction for the conversion of the reactants in their standard states into products in their standard states at one bar &.25^0 C.

$$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O(l) \qquad \Delta H^{\Theta} = —571\text{kJ}$$

Hess's Law; states that the standard enthalpy of a reaction is the sum total of all the enthalpies of the reactions into which the overall reaction may be divided. Thus a list of all substances may be compiled representing the product **enthalpy of formation ΔH_f^{Θ}** that is the sum of the contributing reactant enthalpy @ Standard ambient conditions (1 bar 25^0 C).

$$\Delta H_f^{\Theta} = \sum n\ \Delta H_f^{\Theta}\,(\text{products}) — \sum n\ \Delta H_f^{\Theta}\,(\text{reactants}) \qquad n = \text{number of mol.}$$

For $H_2O(l)$ $\quad H_2\,(g) + {}^1/_2\,O_2\,(g) \rightarrow H_2O(l) \qquad \Delta H_f^{\Theta} = —285.83\text{ kJ mol}^{-1}$
For $H_2O(g)$ $\quad H_2\,(g) + {}^1/_2\,O_2\,(g) \rightarrow H_2O(g) \qquad \Delta H_f^{\Theta} = —241.82\text{ kJ mol}^{-1}$

Enthalpy at Different Temperatures

By the use of the following formulae, enthalpy of reaction for any change in temperature by not more than 100 degrees may be calculated.

$$\Delta C_p = \sum n\ C_p\,(\text{products}) — \sum n\ C_p\,(\text{reactants})$$

n = number of mol $\qquad C_p$ = Heat capacity of element @ constant pressure

Example: $\quad H_2\,(g) + 1/2\,O_2\,(g) \rightarrow H_2O(g)$

$$\Delta C_p^{\,x} = C_p\,(H_2O\ g) — [\,C_p\,(H_2g) + 1/2\,C_p\,(O_2g)]$$

Given C_p of: $H_2O(g) = 33.58\text{J K}^{-1}\text{mol}^{-1}$. $H_2g = 28.84\text{J K}^{-1}\text{mol}^{-1}$ $\quad O_2g = 29.37\text{J K}^{-1}$.

$$\Delta C_p^{\,x} = 33.58\text{J K}^{-1} — \{28.84\text{JK}^{-1} + {}^1/_2\text{ mol x } 29.37\text{J K}^{-1}\} = —9.95\text{J K}^{-1}$$

Once the overall heat capacity has been evaluated then proceed with:

$$\Delta H^{\Theta\,1} = \Delta H^{\Theta} + C_p\,\Delta T \qquad (\text{at constant pressure } p\,)$$

Example: $\quad$ Elevating the temperature from 200K to 300K $\Delta T = 100$
$\Delta C_p^{\,x} = —9.95\text{J/K} \qquad \Delta H^{\Theta} = —241.82\text{kJ/mol}$

$$\Delta H^{\Theta\,1} = —241.82\text{kJ /mol} + \{— 9.95\text{J/K x } 100\} = —242.82\text{kJ/mol}$$

….oOo...

Entropy ΔS

Entropy may be defined as a measure of a systems chemical of mechanical expansion and therefore determines the level of a systems tendency towards spontaneity. A spontaneous change is one that is poised for change, awaiting the input of the necessary activation energy or the appropriate environmental parameters. Thermodynamics deals only with tendencies to change; it is silent on the rate at which changes occur. Its positive value indicates which of a number of possible outcomes are most likely to occur. The more positive the more likely it is to occur. An isothermal process may be defined as:

$$\Delta S = \frac{q\ \mathrm{rev}}{T} = \text{the reversible entropy heat transfer per Kelvin deg. T}$$

For an irreversible transfer of heat to a body at a temperature T:

$$\Delta S > \frac{q\ \mathrm{rev}}{T}$$

Heat transferred to a large body that is cold has a larger entropy energy level than when the same body is warm. For example, 100 kJ of heat is first transferred to the body when it is at 273K and then, when it is at 373K :

$$\Delta S = \frac{100 \times 10^3 \mathrm{J}}{273\mathrm{k}} = +366\mathrm{JK}^{-1}$$

$$\Delta S = \frac{100 \times 10^3 \mathrm{J}}{373\mathrm{k}} = +268\mathrm{JK}^{-1}$$

The change in entropy when a perfect gas expands isothermally from a volume V_i to a volume V_f is given by the expression:

$$\Delta S = nR \ln \frac{V_f}{V_i}$$

So long as there is no change in the entropy of the surrounds when the expansion takes place, the entropy increases and expands spontaneously.

Example: To calculate the change in entropy when 1 mol of hydrogen gas doubles its volume isothermally from 1 mol H^2 to 2 mol H^2 .

$$\Delta S = 1 \times 8.31451 \times \ln \frac{49.6\ \mathrm{lt}}{24.8\mathrm{lt}} = +5.8\ \mathrm{JK}^{-1}$$

So long as there is no change in the entropy of the surrounds when the expansion takes place, the entropy increases and expands spontaneously. Entropy can also increase if heat is applied from the surrounds when the system is held at a fixed volume. As the temperature increase the entropy of the system also increases:

$$\Delta S = C_v \ln \frac{T_f}{T_i}$$

C_v is the measure of the Heat Capacity of the system at constant volume

Example: The value of entropy of 1 mol H^2 (heat capacity @ constant volume of $20.44 JK^{-1}$) undergoing a temperature rise from 293K to 303K is:

$$\Delta S = 20.44 \times \ln \frac{303}{293} = +0.69 \ JK^{-1}$$

When a phase change takes place as a result of the addition or removal of heat then the entropy also changes as follows:

$$\Delta S = \frac{q \ rev}{T \ fus} = \frac{\Delta H fus}{T \ fus}$$

Example: The entropy of 1 mol of melting ice @ 273K $\Delta S = \frac{6.01kJ}{273k} = +22JK^{-1}$

Similarly the entropy change of one mol of water at boiling point may be calculated as:

$$\Delta S = \frac{\Delta H vap}{T \ boil} = \frac{40.7kJ}{373k} = +109JK^{-1}$$

Standard Entropy of Reaction ΔS^{Θ}

If the temperature is taken all the way back to 0^0 Kelvin, then its internal energy will no longer be in conflict and therefore its level of entropy will be zero. Salt (NaCl) and Dry Ice (CO_2) both measure zero entropy. ΔS^{Θ} is a measure of the standard entropy of reaction of a system taken from 0^0 K.

All phase changes must also be included in the entropy change of a system when such a change spans more than one phase. The standard molar entropy of ice is $45JK^{-1}$, water $70JK^{-1}$, and water vapour at 25^0C is $189JK^{-1}$.

The standard entropy of reaction is the difference between the standard entropies of the reactants and products.

$$\Delta S^{\Theta} = \sum n \ S^{\Theta} (\text{products}) - \sum n \ S^{\Theta} (\text{reactants}) \quad n = \text{number of mol}$$

For example, the standard entropy of reaction

$$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O(l) \qquad \Delta S^{\Theta} = —327JK^{-1}$$

$$\Delta S^{\Theta} = (2\text{ mole}) \times S^{\Theta}(H_2O,l) — \{(2\text{mol}) \times S^{\Theta}(H_2g) + (1\text{ mol})\, S^{\Theta}(O_2g)\}$$

$$= 2 \times 70JK^{-1} — \{(2 \times 131JK^{-1}) + (205JK^{-1})\} = —327JK^{-1}$$

Note the huge decrease in volume accompanying this entropy reaction:

2 mols of H_2 gas + 1 mol O_2 = 49.6 litres H_2 + 24.8 litres of O_2 = 74.4 *l* gas SAPT

Thus, 74.4 litres of gas is spontaneously compressed into just 36cc of liquid water (2067:1). However, it has been shown that spontaneity can only happen when entropy is positive. This is also true of the above reaction despite the apparent entropy paradox of —$327JK^{-1}$, because the entropy of the surroundings must also be included as the total entropy of the system, ie.:

$$\Delta S \text{ surrounds} = \frac{\Delta H^{\Theta}}{T} = \frac{572kJ}{298K} = +\,1.9\ kJK^{-1}$$

This is a massive increase in the entropy of the surroundings to swing the figure towards a positve total entropy, thus justifying a spontaneous reaction:

$$\Delta S^{\Theta}\text{ total} = \Delta S^{\Theta} + \Delta S^{\Theta}\text{surrounds} = \underset{\text{(System)}}{—327JK^{-1}} + \underset{\text{(into Surrounds)}}{1.92\ kJK^{-1}} = +1.59kJK^{-1}\,mol^{-1}$$

Gibbs Free Energy ΔG

From the above three formulae it is seen that every calculation of total entropy requires two calculations before (ΔS^{Θ} total) can be evaluated. J.W. Gibbs in the second half of 1800's formulated a way to reduce this to a single calculation as a reversible function:

$$\Delta S^{\Theta}\text{ total} = \Delta S^{\Theta} — \frac{\Delta H^{\Theta}}{T}$$

Multiply through by (—T): $—T\Delta S^{\Theta}_{tot} = +\,\Delta H^{\Theta} —T\Delta S^{\Theta} = \Delta G^{\Theta}$

ΔG is known as the Gibbs function. Whereas $\Delta S > 0$ when energy is expanding, $\Delta G < 0$. This is more in tune with natural instincts that energy drops when it is used up (transferred to another system). The Gibbs function takes place at constant pressure, whereas the (Helmholtz function=ΔA) takes place at constant volume.

What is important is that ΔG gives the maximum amount of non-expansive work that can be extracted from a system undergoing change at constant temperature and pressure.

ΔG = maximum non-expansion work @ constant pressure and temperature

In the previous example where $\Delta H = —572kJ$ for $2H_2O(l)$ and $\Delta S = —327JK^{-1}$ for $2H_2O(l)$, the Gibbs standard reaction function evaluates to:

$$\Delta G^{\Theta} = \Delta H^{\Theta} - T\Delta S^{\Theta} = (—572kJ) — \{298K \times (—327J)\} = —474kJ = —237kJ\ mol^{-1}$$

From the above it is clear that the useful driving power of a system's spontaneous chemical reaction is equal to the Gibb's function and the internal energy released is available for external work provided the external temperature T < T internal. The free energy component of 474kJ is the surplus energy of the account that is left to do work after subtracts the heat loss from the internal energy ΔH of 572kJ. In this case, 98kJ has been used up as tax on the system to allow 474kJ to escape the system to do work. If H_2 (g) + O_2 (g) is introduced into a combustion chamber as a statiometric mix then it is possible that the full 572kJ per 2 mols of $H_2O(l)$ could be released as heat energy, although it is doubtful.

Spontaneity of a reaction is dependant on ΔG^{Θ} being negative. As ΔG^{Θ} may be positive or negative depending on the reaction and temp., the switch of ΔG^{Θ} from — to + occurs at:

$$T = \frac{\Delta H^{\Theta}}{\Delta S^{\Theta}} = \frac{572^{kJ}}{327^{J}} = 1476^{0}\ C$$

Finally ΔG^{Θ} may be expressed as the **standard free energy of formation ΔG^{Θ}_f at 1 bar and 25^0 C.** Thus the Gibbs function for any chemical change can be calculated as follows:

$$\mathbf{\Delta G^{\Theta}_f} = \sum n\ \Delta G_f^{\Theta}\ (\text{products}) \ —\ \sum n\ \Delta G_f^{\Theta}\ (\text{reactants}) \qquad n = \text{number of mol}$$

Example: $H_2\ (g) + {}^1/_2O_2\ (g) \rightarrow H_2O(l)$

$$\Delta G_f^{\Theta} = (-237.13kJ)H_2O\mathit{l}\ —\ \{(0)H_2g + {}^1/_2\ (0)O_2g\} = —237.13kJ\ mol^{-1}$$

Summary

The endothermic energy required to separate $H_2O(\mathit{l}) \rightarrow H_2\ (g) + {}^1/_2O_2\ (g)$ is equal to ΔH_f^{Θ} ($+285.83kJmol^{-1}$) .

When the reverse reaction takes place by the initiation energy of a spark @ $6Jx10^{-6}$, the exothermic energy released from: $H_2\ (g) + {}^1/_2O_2\ (g) \rightarrow H_2O(l)$ is $\Delta G_f^{\Theta} =$ ($—237.13kJmol^{-1}$).

Thus the efficiency (in theory) of any electrolysis process @ SAPT can never be greater than:

$$\frac{237.13kJmol^{-1}}{285.83kJmol^{-1}} \times 100 = 83\%$$

...oOo…

APPENDIX B1

Thermodynamic Data @ 25^{0}C

Substance	Molar mass M/g mol^{-1}	Enthalpy of formation $\Delta H_f^{\ominus}$/kJ mol^{-1}	Free energy of formation $\Delta G_f^{\ominus}$/kJ mol^{-1}	Entropy $S^{\ominus}$/kJ mol^{-1}	Enthalpy of combustion $\Delta H_c^{\ominus}$/kJ mol^{-1}
Deuterium					
D_2(g)	4.03	0	0	144.96	0
D_2O(g)	20.03	-249.20	-234.54	198.34	0
D_2O(*l*)	20.03	-294.60	-243.44	75.94	0
Hydrogen					
H_2(g)	2.02	0	0	130.68	0
H(g)	1.01	217.97	203.25	114.71	0
H^+(aq)	1.01	0.00	0	0.00	0
H_2O(*l*)	18.02	-285.83	-237.13	69.91	0
H_2O(g) HOH	18.02	-241.82	-228.57	188.83	0
H_2O_2(*l*)	34.01	-187.78	-120.35	109.60	0
H_2O_2(aq)	24.01	-191.17	-134.03	143.90	0
Oxygen					
O_2(g)	32.00	0	0	205.14	0
O_3(g)	48.00	142.70	163.20	238.93	0
OH^-(aq)	17.01	-229.99	-157.24	-10.75	0
Hydrocarbons					
CH_4 Methane	16.04	-74.81	-50.72	186.26	-890.00
C_3H_8 Propane	44.01	-103.85	-23.49	270.20	-2220.00
C_5H_{12} Butane	58.12	-126.15	-17.03	310.10	-2878.00
C_8H_{18}(*l*) Octane	114.23	-249.90	6.40	358.00	-5471.00
Alcohols & Phenols					
CH_3OH(*l*) Methanol	32.04	-238.86	-166.27	126.80	-726.00
CH_3OH(g) Methanol	32.04	-200.66	-161.96	239.81	-764.00
C_2H_5OH(*l*) Ethanol	46.07	-277.69	-174.78	160.70	-1368.00
C_2H_5OH(g) Ethanol	46.07	235.10	-168.49	282.70	-1409.00

General Data and Fundamental Constants

Quantity	Symbol	Value			
Speed of light	c	2.997 924 58 x 10^8 m per sec			
Elementary charge	e	1.602 177 x 10^{-19} Coulombs			
Faraday constant	N_ae	96,485 Coulombs per mole (26.8 amp hrs)			
Avogadro's number	N_a	6.022 14 x 10^{23} X per mole			
Free fall Acceleration	g	9,906 65 m per sec^2			
Gas constant (pv = nRT)	$R = N_ak$	8.314 51 Jouls per Kelvin per mole 8.205 78 x 10^{-2} litre atm per K per mole			
1 Atmosphere	atm	101 kPa 1.01 Bar 760mm Hg 14.7 psi			
1 Joule	J	1 watt per sec 1 Coulomb x 1 V 0.23888 calories 1 amp x 1 sec x 1 V			
1 British Thermal Unit	BTU	1.055 kJ 252 Calories 2.93x10^{-4} kwH			
1 Horsepower	HP	746 watts 2,545BTU/hr 2685 kJ/hr 33k ft lbs/hr			
1 Mole Water SATP	$H_2O(l)$	18.006 grams 24.8 lts H_2 + 12.4 lts O_2			
1 Litre Water SATP	$H_2O(l)$	1000 grams 55.49 mole 0.22 gal(I)			
1 Imperial Gallon of Water	$H_2O(l)$	4.546 Kg 10 lbs 0.16 ft^3 4.546 litres			
1 Cubic foot of Water	$H_2O(l)$	28.4 Kg 62.321 lbs 28.4 litres			
Phase Changes Water	$H_2O)$	Ice/Liquid 273.15K(0C) Liquid/Steam 373.15K(100C)			
1 Mole Hydrogen (1 Bar)	H_2	22.4litre @ 20^0C 24.8litre @ 25^0C 2.016gm			
1 Litre Hydrogen Energy	H_2	$\Delta G = 9.217$ kJ $\Delta H = 9.75$ kJ $H_2O(g)$ @ SATP			
Phase Change Hydrogen	H_2	Gas/Liquid 20.25K(-252.9C) Liquid/Solid 14.05K			
Hydroxy Auto Ignition	HHO	Temp: 570C(1058F) Energy: < 0.000002 Joules			
Hydroxy Flame speeds	HHO	In Air: 2 to 9.75 m/sec Detonation 9200 m/sec			
Flame Temperatures	H_2O	Air/H_2: 2,150C H_2/O_2: 2,800C HOH: < 4000C			
Hydrogen as Fuel Gas	H_2	34,750 Wh/kg	53,780 BTU/lb	3 Wh/lt	279 BTU/ft^3
Liquid Hydrogen	H_2	34,750 Wh/kg	53,780 BTU/lb	2,430 Wh/lt	237,690 BTU/ft^3
Gasoline	C_8H_{18}	12,360 Wh/kg	19,140 BTU/lb	8,890 Wh/lt	858,190 BTU/ft^3
LPG (*l*)	CH_4	13,900 Wh/kg	21,500BTU/lb	5,770 Wh/lt	556,800 BTU/ft^3
Flammable Limits in Air	HHO	4.6% to 93.9% 1 atm 4% to 74.5% Explosive			
Hydrogen Isotopes		$^1H_2$ (Protium) $^2D_2$(Deuterium) $^3T_2$ (Tritium)			
Hydrogen forms	H	H (Monatomic) H_2 (Diatomic) HHO(Hydroxy) OH^- (Hydroxyl) H^+ (Ion+) $H_2 \rightleftarrows$(ParaH_2) $H_2 \rightrightarrows$(OrthoH_2)			
Direct Dissociation Water	H_2O	2,720^0C, but catalytic separation from 750^0C			

Releasing the Fire of Prometheus
Part 2

The Viability of Water as a Fuel

Compiled and written
by Barry Hilton M.E.

Published and Distributed
HILTON DYNAMICS

CONTENTS PART 2

CONTENTS PART 2 (CONTINUED)

...oOo...

Releasing the Fire of Prometheus

Analysis HOH as a Power Source for Automotive Applications Part 2
by Barry Hilton

Over the last 150 years or so there have been a number of vehicles with onboard water decomposition devices that defy accepted scientific principles. Just how this is possible is still open to speculation. It is my intention here to shed some light on the subject of onboard water separation as a fuel and to try to establish if such systems are commercially feasible for automotive applications.

Patents

Attached at Appendix A is a long list of patents relating to the separation of water for automotive and other commercial uses. This list is by no means comprehensive and neither does it include any of the known concepts developed independently of the patent system. The Joe Phenomenon is one such anomaly, which will be, discuss later.

Water Power the Keely Way

John Ernst Keely in the late nineteenth century demonstrated by acoustic means a method of separating water into its constituent parts with no more energy input than the pluck of a few musical wires attached to a container filled with water. Unfortunately, Keely's processes were not commercialised and many of his secrets have been lost. Keeley did reveal however, that water was easily separated by applying one or more specific harmonic cords throughout the water sample. Notably, these frequencies were 620Hz to breakdown the molecule cluster; 620 + 630Hz to separate H_2O; then 620+630+12000Hz to further reduce the gases to the etheric (By etheric, I assume Keely means subatomic).

A similar process may be applied to an electrolysis cell containing water by varying the pulses of the applied electrical energy. Henry Puharich demonstrated this principle very admirably in his US patent 4,394,230 (See Page 13). The pulses he used were alternating current, whereas Faraday used direct current exclusively. Puharich also pointed out that by changing the tetrahedral angle of water from 104 degrees to 109.28 degrees by harmonics, the water bonds could be easily broken.

By using DC pulses in an electrolytic process the gas yield can be considerably improved. The process involves pulse width modulation (PWM) of the applied energy by varying the duration of the pulses and the timing between each pulse. The ideal gas production is arrived at empirically by observing the gas output. The frequency and duration of these pulses appear to be different for each size and design of cell. It is believed the duration of the pulses is determined by the time it takes for the ions in the liquid to move from one electrode to the other. The duration between each pulse train appears to be necessary to allow the accumulated gas at the electrodes to be released. In addition, it is possible that some of the gas released by pulsing may be in a Hydrogen-Hydroxide (HOH)= (H+OH-) state, thereby conserving energy for use in its intended exothermic application. When straight DC is used, it normally requires a higher level of energy to separate the gas bubbles from the plates as the atomic hydrogen needs to gain two electrons to acquire the H_2 status.

When pure distilled or deionised water is used in the cell as the only medium, the medium has such a high dielectric constant (78 to 81 times that of air), that the processed can no longer be regarded as electrolysis. In electrolysis the process involves the transfer of ions in a conductive medium, but when the water molecule is shattered by resonance and/or a high electrical potential, then disassociation comes about by a brute force reaction – not ion transfer. (See Meyer System Page 15 - Puharich Page 13)

Magnetic & Radiation Effects

Because the water molecule reacts to a magnetic influence it may be possible to utilise either permanent magnets or electromagnets to assist in the water separation process. Although this effect is well known, its application in the separation of water has received little attention in the development of the art. Horvath centred his invention around an electromagnetic in his patent 4,107,008 and used permanent magnets in his patent 4,454,850 to direct gamma radiation across a bath of water gasses. (See Page 21 following). Meyer in his many patents and Hasebe in his patent 4,105,528, both used magnetic effects in the water separation processes, but only Hasebe was able to claim over twenty times the output of gas compared to Faraday's benchmark. These patents will be discussed later.

Conclusion – Onboard Water Separators

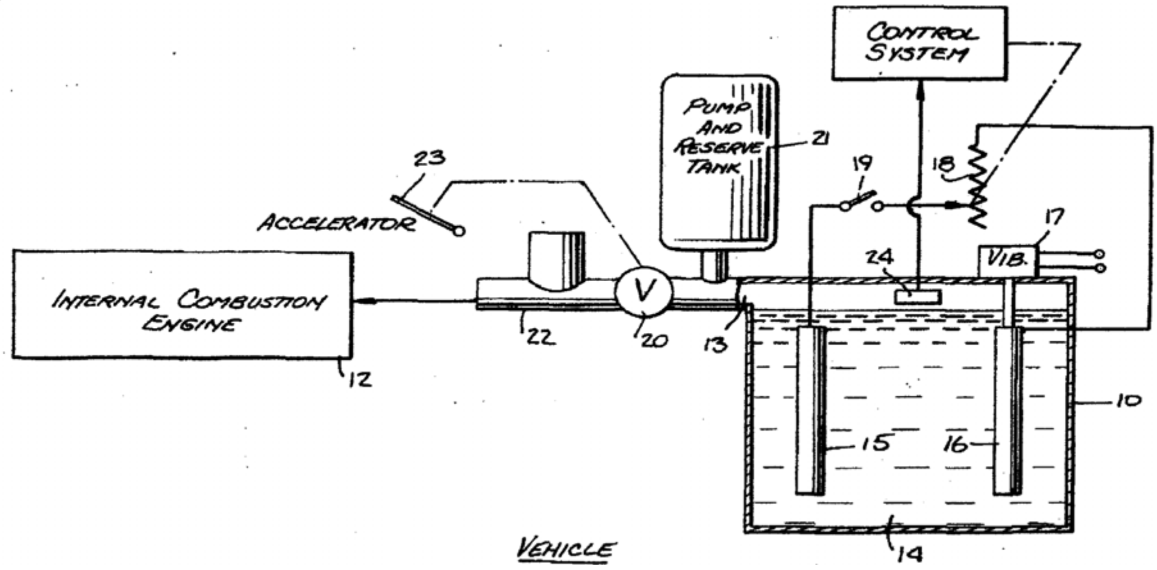
There have been many different approaches made to separate water into its constituent gasses in order to take advantage of their explosive nature when recombining. Acoustics, Optics, heat, and chemical reaction; high voltage, low voltage, direct current and alternating current; pulsed, stretched, radiated and magnetically intensified; recirculated and aerated all have been used to attack H_2O. The best of these have been singled out and an analysis of each is presented on the following pages.

...oOo...

FRANCISCO PACHECO

Patents 3,648,668 1972 – 5,089,107 1992

Pacheco developed a cell that not only generated hydrogen without the supply of energy, but it produced its own electricity as a by-product. He demonstrated the device operating an IC motor mower to Vice Present Wallace of the USA in 1943.



Assessing the potential of the Pacheco cell:

ΔG_f^{Θ} of Hydrogen $H_2O(g)$: = -228.57 kJ mol^{-1} (Amount of H_2 needed)

ΔH_c^{Θ} Combustion of Petrol : = -5471 kJ mol^{-1}

Density of Petrol: =114.23g mol^{-1}

As 1 litre of petrol weighs 720g, then there are 720/114.23 = 6.3 mols in 1 litre

6.3 x 5471 = 34.5MJ in one litre of Petrol

If a vehicle travelled for 1 hour at 100 Kmh with a fuel consumption of 10Km per litre then:

Fuel consumption is 100/10 = 10 litres consumed in 1 hour

The energy consumed is 10 x 34MJ = 345 MJ

If magnesium is now used as the source of energy for the same trip it would require an expenditure of 294,000 kJ of hydrogen at 100% efficiency from the output of the Pacheco cell:

1 mol Mg (24.31g) + 2 mols H_2O (36.012g) → $Mg(OH)_2$ (58.3g) + H_2 (2.015g)

The amount of hydrogen needed to generate 345MJ is:

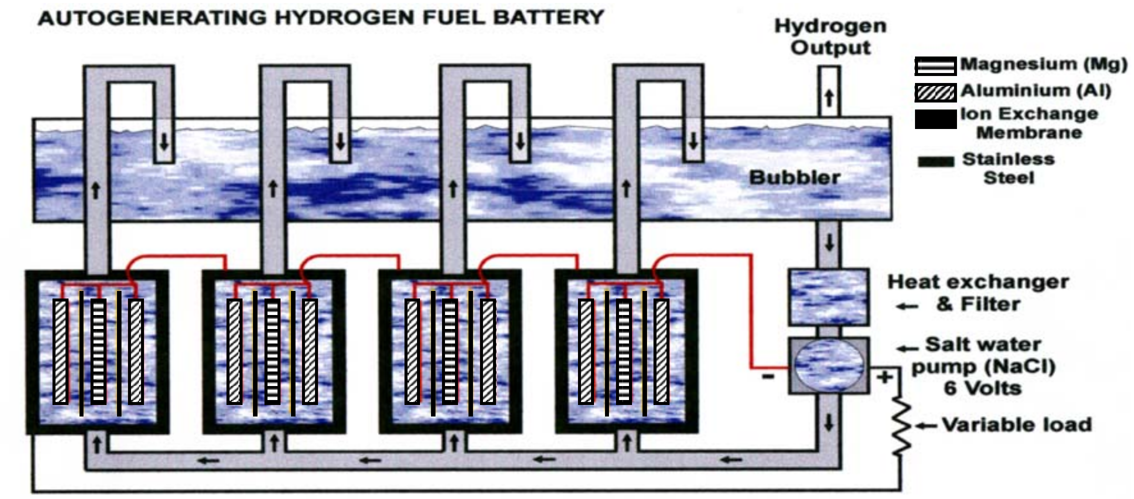
345MJ / 228.57 = 1510 mols of H_2.
At 2.015g per mol: 1510 x 2.015 = 3 Kg of H_2 is needed

For every 2.015g of H_2 , 24.31g of magnesium is used, therefore:

1510 x 24.31 = 36.7 Kg of magnesium is consumed

At $12.66 per kilogram this = 12.66 x 36.7 = $465 for a 100 Km trip by magnesium.

At $1.40 litre for petrol this is 1.4 x 10 = $14 – I don't think I will be using Mg.

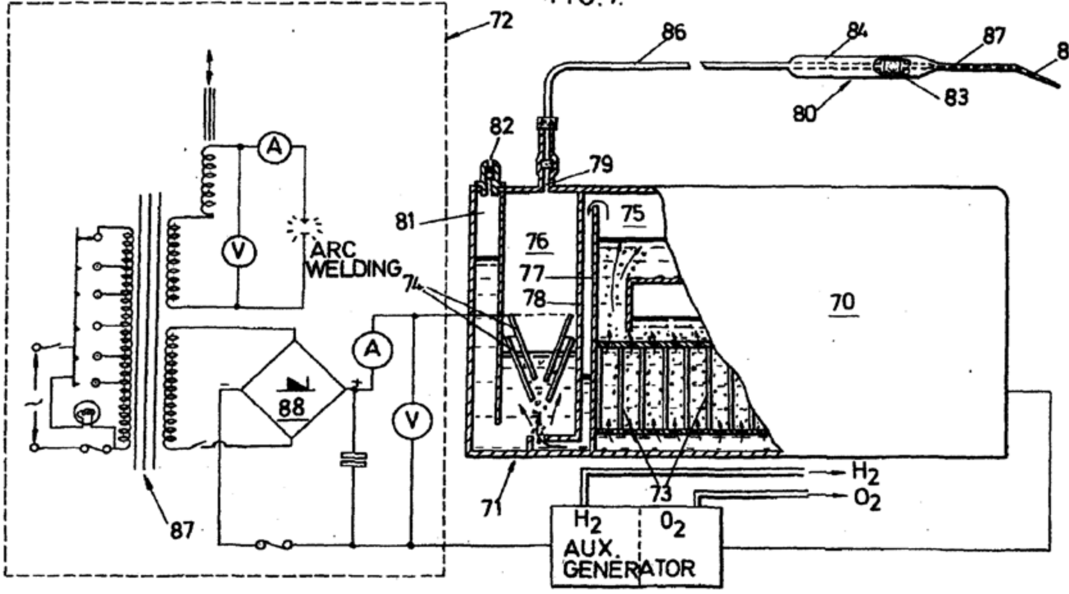


NOTE: The short between the Mg & the Al electrodes are to be externally switched and closed only during battery operation. The same applies to the external load.

YULL BROWN BIPOLAR DEVICE
US Patents 4,014,777/ 4,081,656

In 1977 Yull Brown patented a process whereby he connected a hydrolyser containing a large stack of plates in a series configuration with one terminal on each of the two end plates. By shielding the edges of the electrode plates from the electrolyte in the cell he was able to force the current to pass from one cell to the other in series without any wiring connecting the internal plates. Both sides of each plate were utilised in a bipolar arrangement - one side of each plate acting as the cathode and the opposite side acting as the anode. Allowing a potential of 2 volts for each cell, Brown included 120 cells in a single hydrolyser container. With this arrangement he was able to rectify the 240-volt house supply to feed his cell whilst passing the same current through each individual cell.

FIG. 7.



Brown’s patented device of 120 cells uses a potential of 240 volts and draws 15 amps, resulting in an output of approximately 3600 watts. By this arrangement, he demonstrated his system’s equality to a single cell of 2 volts potential requiring 1800 amps to attain the same output of 3600 watts. With a current of only 15 amps the bipolar system is commercially practical and eliminates the need for a huge transformer as well as creating a compact unit. When using the car as the power source, the system is less competitive.

Yull Brown also departed from the usual convention of separating the two gasses with a membrane or partition. In Brown’s hydrolyser he collects the two gasses as a hydroxy mixture that he normally supplies directly from the unit to the point of application as an in-situ device. He claimed that there is no danger of explosion as long as the gasses are combined in their correct ratio and not compressed beyond 100 psi. Brown’s own equipment was designed for a maximum of 30 psi.

Brown was not the first to come up with this idea, as there are a number of patents on record using a very similar configuration in their hydrolysers. Although the combined gasses will not self ignite below 570°C initiation arc, there is still considerable danger of flash back along the supply line or electrostatic arcs that could ignite the gas in any storage system that may be used. The use of a flashback prevention device is therefore essential with storage type applications.

According to published literature, Yull Brown claimed to produce 1866.6 litres of gas for each litre of water electrolysed. Based on Faraday's and Avogadro's findings it takes 18.006 grams of water to produce 24.8 litres of H_2 + 12.4 litres of O_2 = 37.2 litres of hydroxy gas at ambient temperature and pressure.

1000cc / 18.006cc = 55.5 moles of water, then: 55.5 x 37.2 litres = 2065 litres of gas for each litre of water. Yull Brown's system on this basis shows (1866.6/2065) x 100 = 90.4% volumetric efficiency.

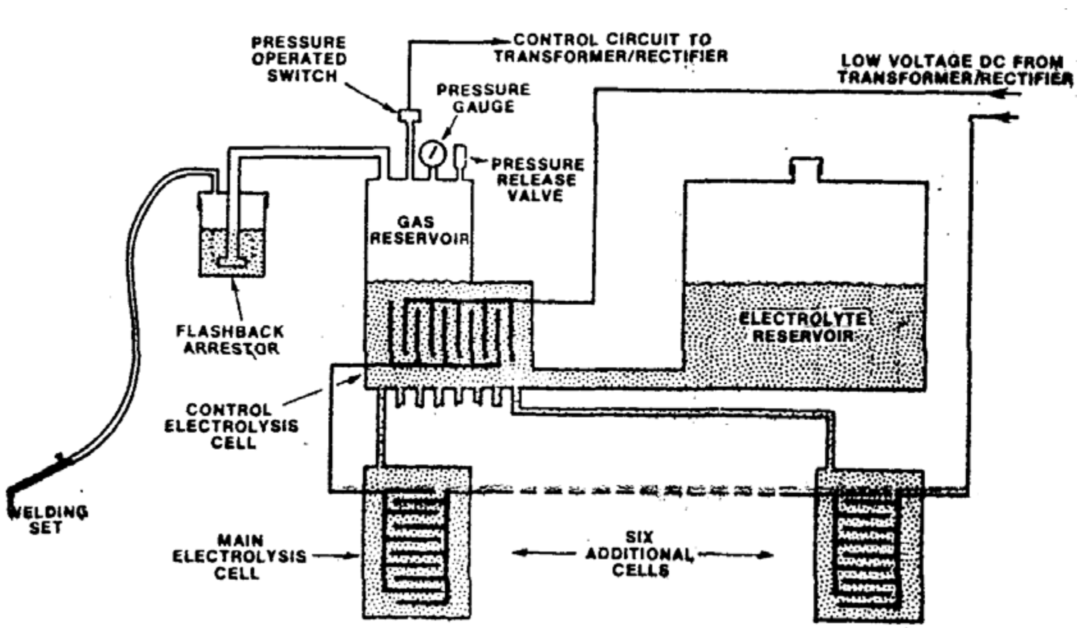
Brown also claimed that 1KwH produced 340 litres of H_2O gas:

As 1 kilowatt hour = 3600 kJ, and
- 285.83 kJ $H_2O(l)$ produces 37.2 Litres of HHO, @ 100% efficiency,

Then, 3600 kJ / 285.83 = 12.6 mols of gas, and
12.6 x 37.2 = 468.53 Total litres of gas per 1KwH @ 100% efficiency,

Therefore (340/468.53) x 100 = 72.57% Thermal efficiency

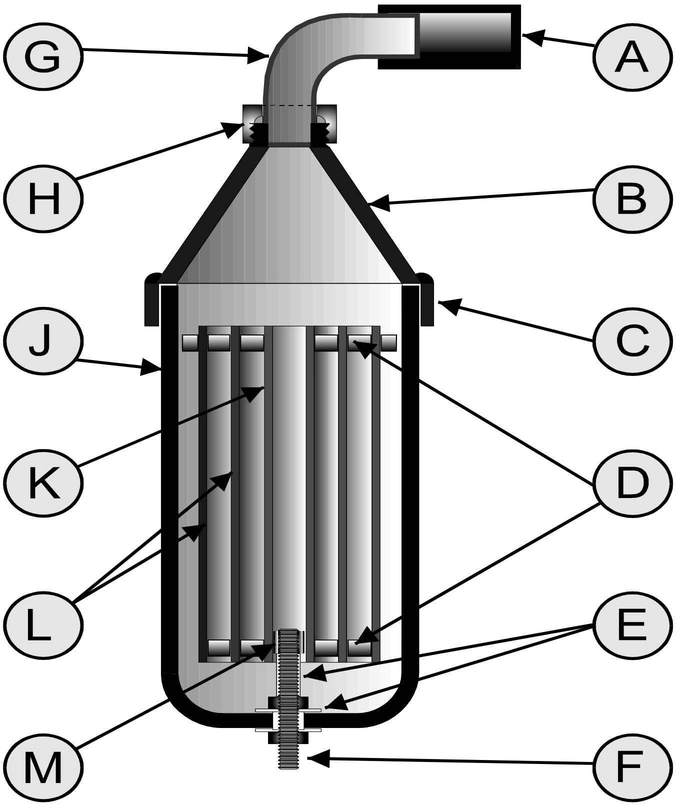
Note: There are some claims made by a close colleague of Brown's that he used a parallel connection for his welders. If this is true, then the following diagram of Brown's system may be relevant, but the current may be prohibitive for best practice using so many cells as indicated.



ELECTRONICS Australia, January, 1978

THE JOE CELL - 1990’s

From 1997 to 1999 I carried out a series of tests of the various configurations of Joe’s cell designs as revealed in my book “The Joe Phenomenon“ published by Nutech. I did not test any of these cells in a vehicle because I did not have a suitable vehicle for testing at that time. Due to other commitments, the research was abandoned following the bench tests.



8” Joe Type Car Cell

A. 1” Rubber Hose to Engine
B. 60 degree S/S Cone Lid
C. Sealed press-fit Lid flange
D. 9# Insulators (Top) & 6# (Bot) 120 deg apart
E. Nylon insulators between Cathode rod & Anode casing.
F. S/S Cathode neg. terminal
G. Aluminium 3/4”ID pipe to 1” rubber connection to engine.
H. S/S Compression fitting assembly
J. S/S Anode Casing.
K. S/S 1” dia. Cathode tube
L.. S/S 2”&3” dia. Neutral tubes
M. S/S Nut machined for press fit into Cathode & grooved for cathode venting.

Joe underwent the most vigorous scrutiny to ensure that the petrol line was disconnected from the vehicle’s carby when he demonstrated the vehicle’s drivability. Unfortunately, nobody can confirm that the cell’s output did not have direct access to the car’s manifold. It is indeed difficult to come to terms with Joe’s statement that the output “A” need only be fitted to a blank extrusion on the carby. If Joe’s claims are to be believed, then the only explanation for the phenomenon is some manifestation of an elusive and mysterious energy source such as zero point.

The only way I can justify the operation of the engine is to conclude that it must be supplied with a combustible fuel source. In my considered opinion it would be impossible to transmit sufficient energy into an IC engine through a thick solid aluminium barrier despite the minute size of hydrogen atoms (1×10^{-10}m). Hydrogen saturated aluminium could certainly release hydrogen as precipitation from one side of the lattice when additional hydrogen is injected beyond saturation from the other side of the lattice as in a billiard ball effect. However, even with the widest stretch of the imagination, insufficient hydrogen would be available to effect a combustible mixture with air. See Flick’s First Law of Permeation.

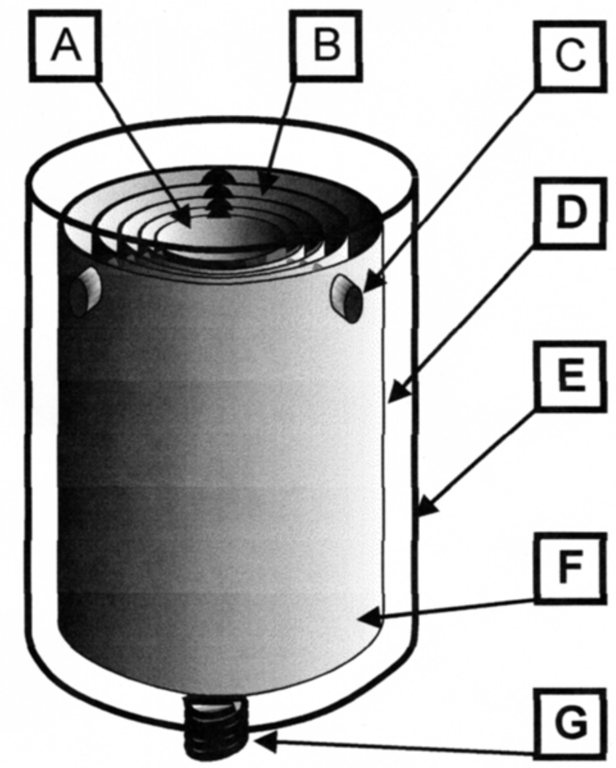
If such a device as the Joe cell was capable of providing the energy in conjunction with air to power a vehicle, then it must have direct communication with the input manifold. Only under these circumstances would there be sufficient perturbation from engine's vacuum and vehicle vibration to release reasonable quantities of gas from the normally restrictive layer adjacent to the cathodes. With a 12-volt supply, engine vacuum and transfer of heat from the surrounds to allow the action and reaction to proceed, there is at least some modicum of plausibility.

The cell tests revealed no insight into the mystery. Gas production of all the Joe cell designs followed classical scientific electrolytic outcomes. It should be pointed out that vacuum was not applied to cells in any of these experiments. Had the cell been enriched with a high level of D_2O, and engine vacuum been applied, the outcome may have yielded different results.

For my peace of mind, I prefer to consider that the Joe phenomenon fits into the same classification as the devices of Charles Garrett and Archie Blue who also demonstrated vehicles under similar circumstances.

Joe Type Glass Experimental Cell

A. S/S 1" dia. Cathode tube
B. S/S 2",3" & 4"dia. Neutral tubes
C. 15# Insulators (Top) & 12# (Bottom) 120 deg. Apart
D. 6" S/S Anode
E. Glass Container with hole in bottom for bolt
F. Insulators not required between glass to anode at base
G. S/S Nut & Bolt press fit into Cathode for electrical connection through hole in glass



ARCHIE BLUE – CHRISTCHURCH, NZ – Patent 4124463-1978

Car Cell that worked

Archie Blue converted a number of vehicles in four different countries during the 1970's using a parallel-connected electrode system, a 12-volt supply, 10 grams of Sodium Hydroxide per litre of water and a pump normally used to blow up air beds.

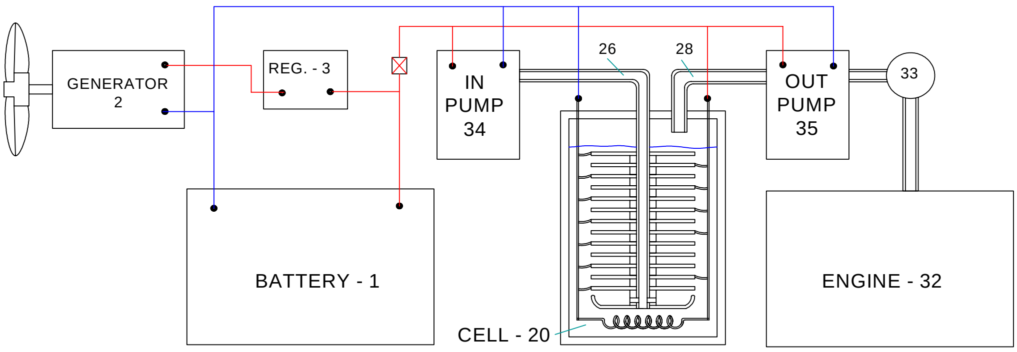
The Leyland Mini pictured above was driven around the island of Guernsey in 1978 by Michael Kemp, the motoring expert for a British newspaper. Kemp drove at an average speed of 56 Kmh and with his test being verified by the local RAC representative. The vehicle was later tested at a maximum speed of around 160 Kmh.

Archie is seen in this picture in Christchurch NZ holding the unit that is being fitted to the car in the background. The pump is on Archie's right – water filter in the middle – Glass cell on the right and modified carby in the foreground.

ARCHIE BLUE . . . and his simple device that could put "all service stations out of business."

Archie Blue's Schematic of Water Fuel System

Recreated from provisional patent No 14153/77

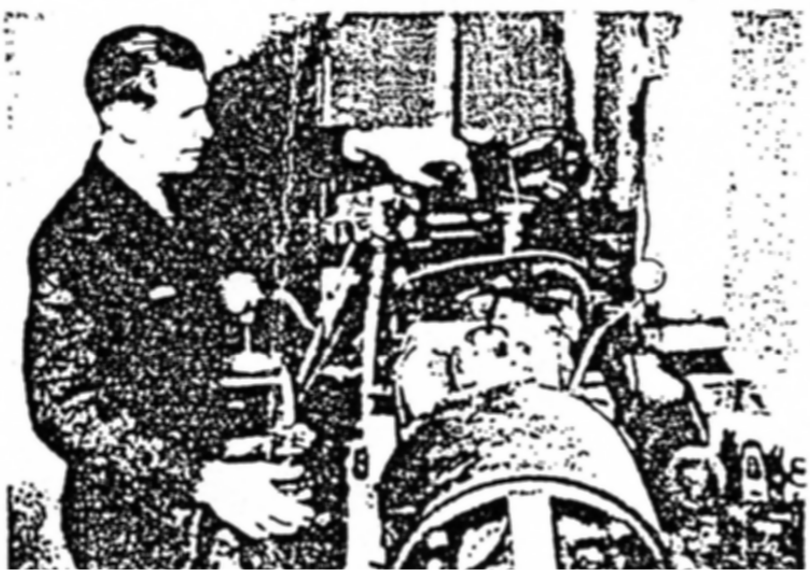


As all the air and hydroxy generated in the vehicle were passed through the cell, it is an easy matter to calculate every parameter of these tests using the information I provided in Part 1 of this book and with the data below. As different vehicles converted by Archie were driven in at least four countries it cannot be denied. What is demonstrated is that the vehicle runs on hydroxy in defiance of accepted thermodynamic law defined by Faraday.

The following parameters have been gleaned from various documents in the public domain:

Electrolyte mixture:	10g Sodium Hydroxide (N_aOH) per litre H_2O pure
Volume of cell:	1 gallon (4.55 litres)
Electrolyte Volume of cell max.:	3 litres
Electrolyte Volume of cell min:	1 litre
Height of cell:	10 inches (25.4 cm)
Diameter of cell:	6 inches (15.24 cm)
Plates stack hight in cell (1Lt):	2.5 inches (6.35 cm)
Diameter of plates:	5 inches (12.7 cm)
Number of plates in stack:	Most probably 8 discs (See Prov. Patent)
Plate gapping (2 inch stack):	0.25 inches approx (6mm) or less.
Voltage between Anode/Cathode:	12 Volts average
Current between Anode/Cathode:	1.5 to 3 amps average (See NZ interview)
Output in Watts:	3 x 12 = 36 watts maximum
Water consumption:	100 Miles (161 Kilometres) per litre approx.
Maximum speed of vehicle:	100 MPH (161 KPH)
Average speed during tests:	35 MPH (56 KPH)
Operating Pressure of cell:	Approx. 160 psi (1100kPa)
Pump flow rate:	Between 25Lt /min & 75Lt/min
Pump operating current:	Approx 23 amp x 12 volts = 276 watts
Vehicle used during tests:	Leyland-Morris Mini

CHARLES H. GARRETT – DALLAS USA – Patent: 2006676 – 1932



Charles Garrett Hydroxy Car Cell

This water powered motor is the invention of G. H. Garrett, who is shown here with his right hand upon the electrolytic carburetor which obtains explosive hydrogen from water.

This vehicle was driven in the Dallas area 1934/37. Garrett claimed to have run the motor continuously for 48 hours. He said it started instantly, ran cool, and met vehicle specifications regarding power and speed. The electrodes are lead and the electrolyte is dilute sulphuric acid.

The known specifications of the invention are as follows:

Electrolyte mixture:	Dilute Sulphuric acid (Catalyst) - H_2SO_4
Electrolyte ratio:	(Normal strength is 1 part :3 parts Acid:Water by volume)
Volume of cell:	1 Quart (1.136 Litres) + 25% clearance = 2.25 Pints (1.4 lt)
Dimensions of cell:	12cm x 12cm x 12cm (based on 1.5 *litres* volume) Cell casing made of Bakelite.
Number of plates used:	3 Positive and 3 Negative(with changing polarity over time)
Dimensions of plates:	11 cm^2 x 3 for each polarity. The two groups of plates are separated by a membrane, Plus on one side and negative on the other. The separated gasses are then recombined to form hydroxy combined with air. Plates made of lead.
Plate gapping:	5mm gap between each plate stack of 3 and 2.5cm between the two sets with a solid bakelite divider between sets. This is based on a capacity of 1.5 litres
Water consumption:	Not stated, but according to a news item, he needed to top up the cell from a nearby lake during the course of an exhibition.
Operating Pressure of cell:	Cell connected to input manifold with atmospheric valving
Vehicle used during tests:	A small four-cylinder engine vehicle of unknown make
Duration of longest test:	48 hours continuous.

The design alternated the polarity between the two sets of plates by the operation of a worm gear and breaker points. Although no frequency was given, it was regulated by the speed of the motor. As the spin relaxation frequency of water is 3 seconds, then this may be the mean frequency.

There are two basic reasons why he needed to alternate the current:

1. Garrett needed to do this to allow the airflow between the plates to clear the gas bubbles adhering to the plates.

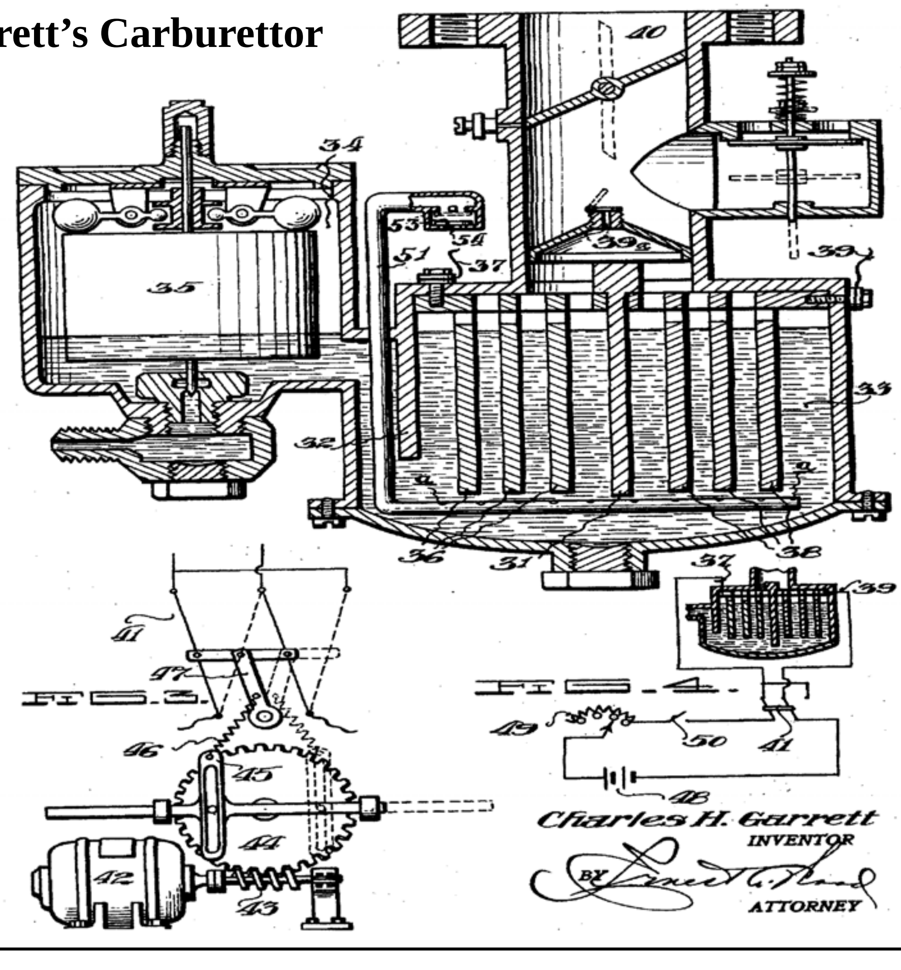
2. When power is applied, the cell acts like a lead acid battery under charge. When connected without the supply it acts like a secondary battery.

If power is continually applied in one direction across the platers, Lead peroxide forms on the anode due to oxidation of the lead, whilst the cathode remains clean. If the electrolyser is allowed to discharge, the reaction is not reversible. Instead, the Lead peroxide is converted to lead sulphate $PbSO_4$ and the cathode also reacts with the sulphuric acid becoming coated with lead sulphate. In this state the cell can no longer conduct ions. When power is reapplied, the electrode connected to the positive terminal will once again be converted to Lead peroxide whilst the lead sulphate on the negative electrode will be removed to return the electrode to its original lead.

It is believed this cell utilises the above chemical phenomenon to recoup some of the energy applied to the cell to produce an extremely high output of gas per unit of power applied to the cell.

There is no doubt that the system worked, all-be-it that a larger generator was needed for the task.

Garrett's Carburettor



PUHARICH – TESTS ON PROTOTYPE CELL - Patent 4394230/1983

Puharich’s claim to fame came from a very complex electrical circuit and small laboratory device which after 30 minutes produced 16.2cc of HHO(g). AC power was used and applied to a mild saline solution, with the only active part of the device being the surface of the electrolyte. Puharich believed that his device could reorient the water molecule from the quantum angle of 104^0 4’ to 109^0 28’ and thereby liberate the gasses from water with minuscule amounts of power. Despite these theoretical claims, the real output was not much better than a couple of wires stuck in test tubes with a standard electrolyte and the same power input.

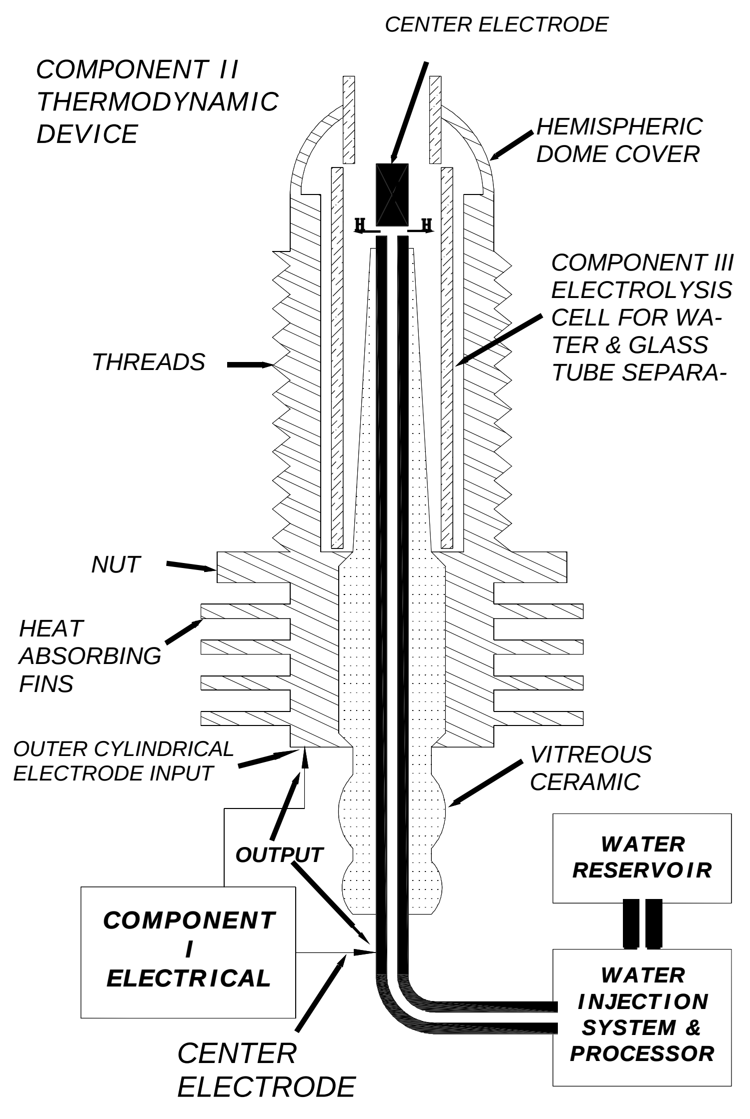
The following is Puharich’s own data from the patent:

Electrolyte:	0.09% Sodium Chloride (N_aCl) to Pure water by volume ($0.154m\ L^{-1}$)
Total duration of test	30 minutes
Voltage between Anode/Cathode:	4 Volts to 2.6 Volts AC RMS Average
Current between Anode/Cathode:	25 mA to 38 mA AC RMS Average
Power in Watts:	0.1 Watts AC RMS
Energy over 30 min.	0.1 x 60 seconds x 30 minutes = 180Jouls (1watt/sec= 1 J)
Water converted during test: Mean	16.2cc Hydroxy(g) = 0.0162Lt (10.8ccH_2(g) + 5.4ccO_2)
Mass of water converted:	(0.0162/37.2) x 18.006 = 7.841 milligrams

From here-on-in his figures became a little bit rubbery based on a quote from Penner, S and Icerman L., Energy, Vol.II, 1977.

Penner & Icerman claimed that the efficiency could be as high as $\mathbf{\Delta H^{\Theta}_{f}}$ **/** $\mathbf{\Delta G^{\Theta}_{f}}$ **,** which in energy terms is (285.83/237.13) x 100 = 121%. Unfortunately, ΔH^{Θ}_{f} is the energy required to breakdown the liquid into gas, whilst ΔG^{Θ}_{f} is the energy available to do work. If heat transfer is taken into consideration and no work is done on the external environment then ΔH^{Θ}_{f} is available as an output.

Thus at the very maximum 100% can be achieved if no work is done on the environment to push back the atmosphere. In Purharich’s case these considerations do not come into play.



PUHARICH'S AC CELL

The enthalpy required to disassociate 1 mol of water **(ΔH^{O}_{f})** = 285.83 kJ mol^{-1} @ SATP

And as 1 mole of $H_2(g)$ +1/2 $O_2(g)$ = 24.8+12.4 Lt = 37200cc, then the energy required to liberate one cubic centimetre of HHO gas is: 285830/37200 = 7.6836 Joules per cc.

The total gas produced under ideal conditions is: 180J / 7.6836 = 23.4 cc SATP

The efficiency can therefore be calculated as: 16.2cc / 23.4cc x 100 = 69% η

In Puharich's calculations he credited himself with only 91.3% efficiency, but concluded at the end of his patent quite erroneously that he had achieved 114.92% efficiency.

It had been rumoured that Puharich drove a car across America using this device, but as there is no documentary evidence of this achievement and as his efficiency is only 69% then it is questionable whether this was factual.

The Stanley Meyer Vehicle System Designed for Water Fuel

Stan Meyer had patented three varying systems for powering a vehicle, but prior to his death he had refined all these ideas into a single vehicular system with possible applications in the aviation and space industries. There is no proof that this system was capable of powering a vehicle for sustained operation. It was reported that he powered a Dune Buggy with his device but was unable to meet engine demands over long periods.

The book " Hydrogen Fracturing Process", published by Stan, attempts to describe the system in detail. Unfortunately it provides no specific information that would allow anyone to duplicate his work. In his US Patent, 4,936,961, he allowed a number of details to slip as follows:

1. Power Supply: 12Volts DC

2. This power supply drives a digital adjustable oscillator of unknown frequency and is gated by a 50% duty cycle.

3. The pulse train is then fed to a transformer. In the above patent, the transformer is wound on a Toroidal Ferrite Core 1.5 inches diameter and 0.25 inches thick and identified in Siemens Ferrites Catalogue, CG-2000-002-121 of Cleveland, Ohio as No. F626-1205 Ferramic 06# Permag powder. The primary coil is described as being 200 turns of 24 gauge copper wire and is wound on the secondary of 600 turns of 36 gauge wire. He comments that the arrangements steps up the voltage to about 5 to 1. In a later design, the copper is replaced by stainless steel resistive wire and the coil is called a "Voltage Intensifier Circuit (VIC)" but no details are given about these later windings.

4. The stepped up pulsing voltage is then fed to a 1N1198 diode which rectifies to DC pulses .

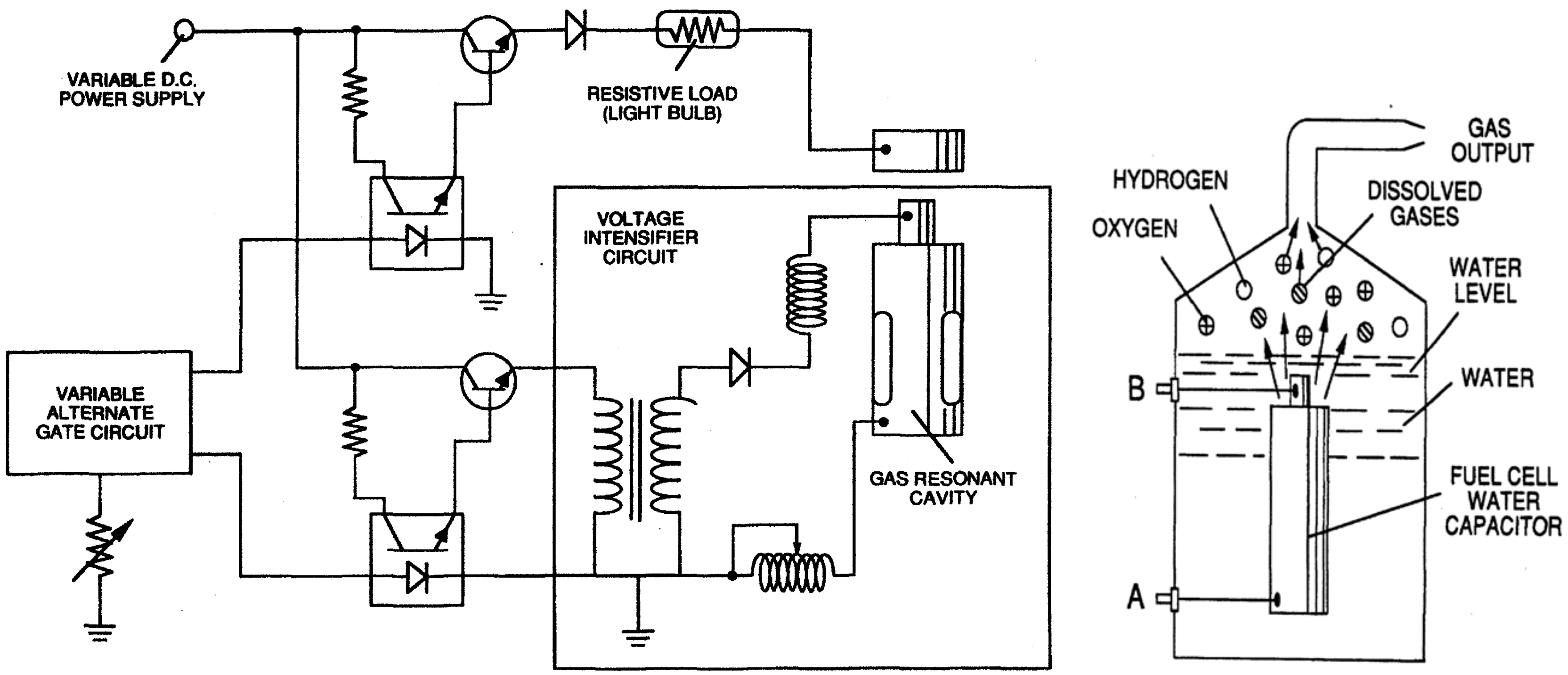
5. The pulses are then fed into a tuning coil of 100 turns of 24-gauge wire wound on an air core of 1 inch diameter. This coil is matched with an identical coil on the negative side of the secondary circuit and fitted with a tuning tap. Both windings were replaced with stainless steel resistive wire in later designs.

6. The tuning coils are then arranged in series with the electrical water cell which is connected in between these tuning coils.

7. The cell is constructed with two 4 inches long concentric tubes, also made of stainless steel (304) that is inert to magnetic influences (the drawing shows the centre tube is longer). The inner tube is 0.5 inch outside diameter and connected to the negative side of the second-ary winding. The outer tube is 0.75 inches diameter and connected to the positive side of the winding. The gapping between the two tubes is 0.0625 inches. The cell is filled with distilled water that has a dielectric constant of 78.54 at SATP.

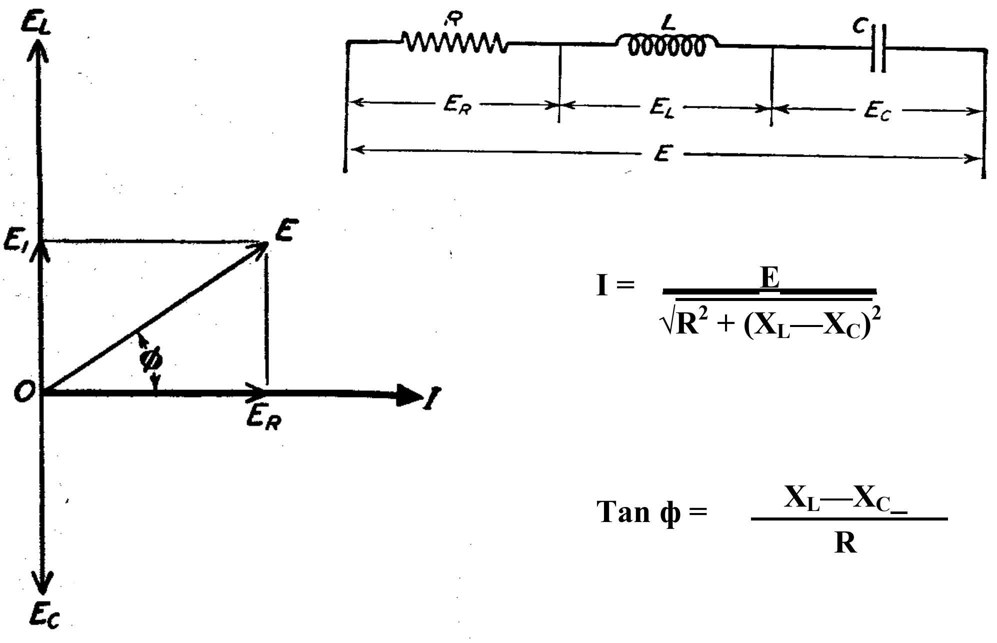
8. As the water between the tubes of the cell is highly dielectric. The cell functions as a capacitor. Therefore, the three coils and the cell, being connected in a series in an inductive/capacitive/ resistive link, may be tuned to resonance with the tuning tap on tuning coil 2. This then sets up sympathetic residence in the water , that according to Meyer is theoretically at infinite voltage. In practice he admits this is not the case, but he implies, if current is restricted so as not to lower the dielectric in the water, the pulses generated in the secondary circuit may be enough to polarise and shatter some of the bonds holding the water molecules together. The question is – is this sufficient to power a vehicle?

Stanley Meyer Patent 5,149,407 – September 92



-The Stanley Meyer Vehicle System Designed for Water Fuel (Continued)

What Stan Meyer has tried to do is use the natural frequency of the circuit to shake a stressed and polarised water molecule into its component parts. The secondary circuit may be schematically defined as follows:



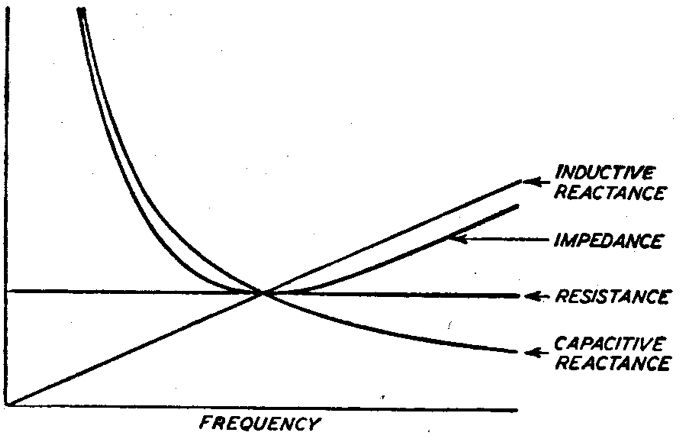
$$I = \frac{E}{\sqrt{R^2 + (X_L - X_C)^2}}$$

$$\tan \phi = \frac{X_L - X_C}{R}$$

$$X_L = 2\pi f L\text{(in Henries)},\quad X_C = 1/\{2\pi f C\text{(in Farads)}\},\quad Z = \sqrt{R^2 + (X_L - X_C)^2}$$

As can be seen from the above the Voltage across the inductor leads the current by 90^0, whilst the Voltage across the capacitor lags behind by 90^0. The vector sum can be worked out by assessing the value of ϕ and the capacitive and inductive reactances **X_C, X_L** .

The following graph represents the values of X_L, X_C, and Z for various frequencies "f".



As frequency increases, X_C decreases and X_L increases. Both approach a point at which they intersect. At this point $X_C = X_L$, and $X_L - X_C = 0$.

Ohms law E/R=I will therefore determine the amperage.

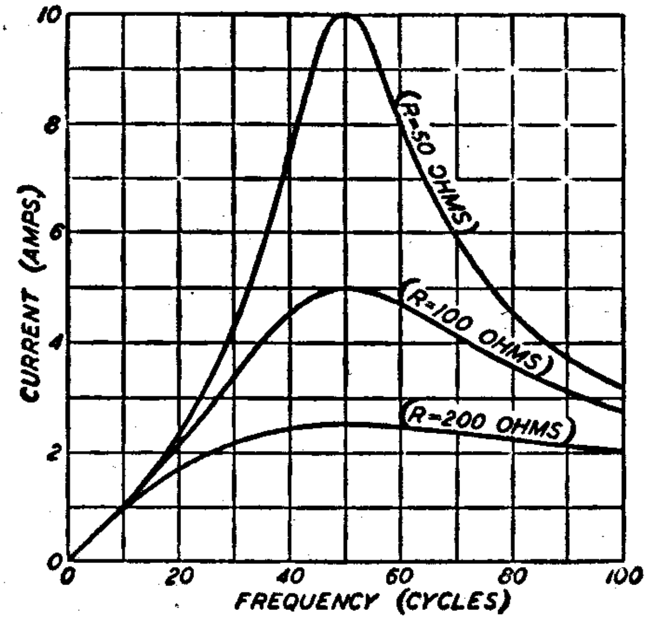
.

The natural frequency of a circuit is defined by :

$$f = 1/(2\pi \sqrt{LC}).$$

The circuit may be forced to oscillate at the frequency of the supply, but only when both this forced frequency and the natural frequency, dipicted above, are coincident will resonance be at a maximum.

In order to achieve a high output voltage across the capacitor, it is also necessary in a series LC circuit to maximise the current. This requirement is demonstrated in the following graph:



This Current/Frequency graph has an inductive and capacitive reactance each of 100 ohms. The natural resonant point is at 50 Hertz. At R=50 ohms the circuit consumes 10 amps, but at R=200 ohms it consumes only 2.5 amps, the supply being 500 Volts AC & 50 Hertz.

10 amps @ 100 ohm = 1000 Volts across either the capacitor or the coil, but

2.5 amps @ 100 ohm = only 250 Volts.

Clearly @ R=200 ohm, resonance cannot be achieved.

10 amps @ 1000 Volts = 10 Kilowatts. The circuit supply is just 5 Kilowatts

Unfortunately the Meyer system is unable to take advantage of this ideal result. If Meyer allowed 10 amps to be applied across the capacitor it would strip some of the nickel and iron from the stainless plates and contaminate the water. This would result in a breakdown of the dielectric property of the water and the cell could no longer function as a capacitor. If Meyer provides high resistance across the secondary circuit to prevent a high amperage draw, then the wattage output across the capacitor cell would be too low to be of any real value. However, if the coils and cell are designed for a very high natural frequency and it is matched by the input frequency, then it may still be possible to shatter the water molecule by the violent extent of high frequency oscillations. H_2 frequency = 1420 megahertz.

Ion action is dependent only on the electrons moving through the external circuit. The electron flow determines the amperage. As the amperage would need to be extremely low to maintain the dielectric water potential, most of the gas liberated by frequency shear would not be in a ionised state. This process would need to incorporate some method of preventing the gas atoms recombining at the end of each pulse train for the entire process to be successful. In the latter patent, Meyer has added a further stage to strip the gas of electrons to prevent this recombination.

Because of the lack of research and development documentation, there is no solid public evidence to indicate the success or failure of his research. Independent tests were carried out by a contractor appointed by the US Patent office under rule 101, but kept confidential.

Unfortunately, once ions form within the cell the dielectric breaks down and the cell is useless as a capacitor. The cell can now only be used for pulsed DC hyrolysis.

The Stephen Meyer Hydroxy Generation System

In November of 2005, the US Patent Office, published a Provisional patent 0246059 A1, on behalf of Stanley Meyer's brother, Stephen. The real brain behind the Stan Meyer patents, was actually his brother. Stephen was an electronics engineer in the military, and designed all the circuits, for the Stan Meyer devices. It is therefore interesting to note, that although, he would have proprietary rights, to Stan's patents, he has abandoned all of devices, in favour of a resonance system, where the cell is used as an antenna, rather than a capacitor, and the water used, as a resonant medium, rather than as a dielectric.

The patent is classed as a "Hydroxyl Filling Station". This may indicate, that the gas, is produced at a slower rate, than would be consumed in a vehicle, over the same production period.

In general, the new system, uses the individual, three phase AC output, of two alternators. Each pair of phases, is connected, to a DC, rectification pulsing circuit (similar to Stan's). The output, is then connected, to a pair of concentric tubes in distilled water, with a permeability, of around 78 times, that of air. In reality, there are three concentric tubes, to each phase pair. The second tube out from the centre, is permanently connect, to one phase as a common, whilst the other phase, is electronically, alternately switched, between the smallest tube in the centre, and the outside tube, to maximise the gas output.

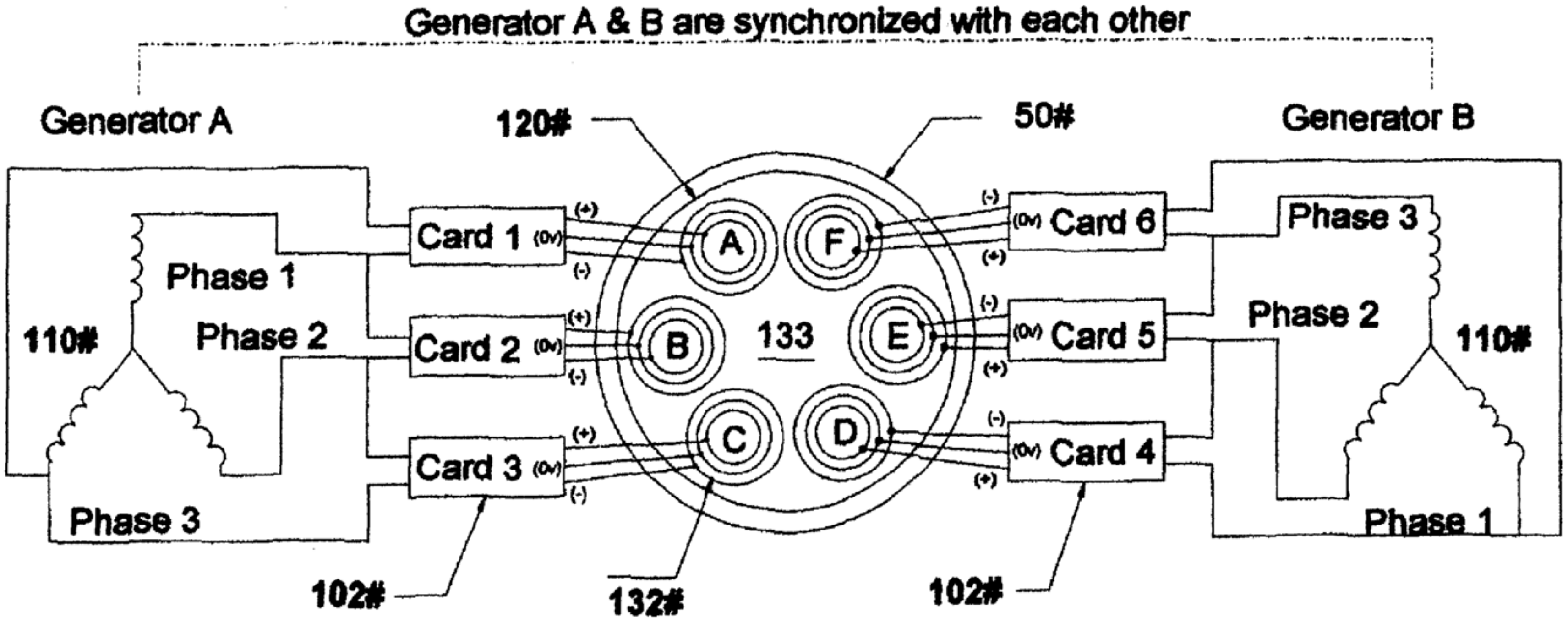
The natural resonance, of the output circuit, is matched, by controlling the speed of the alternators. When both alternators, and the output circuitry, are at a common resonant frequency, the system is designed to breakdown the water, in the antenna system. To avoid, electrically , contaminating the water medium, it is continually circulated and filtered.

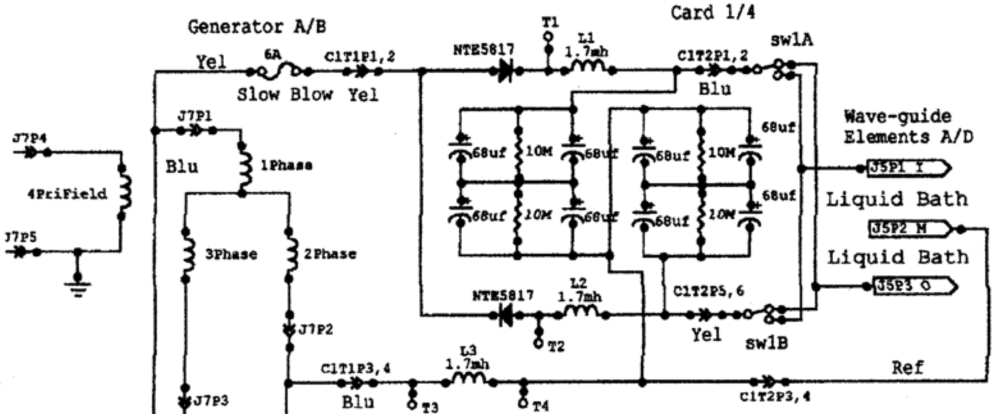
The output circuitry consists of two series NTE5817 diode rectifiers and two 1.7 mh chokes with two capacitor banks centre tapped in series with the supply and parallel with the cell. This overcomes the unresolvable problem with Stan's system and at the same time allows for voltage multiplying.

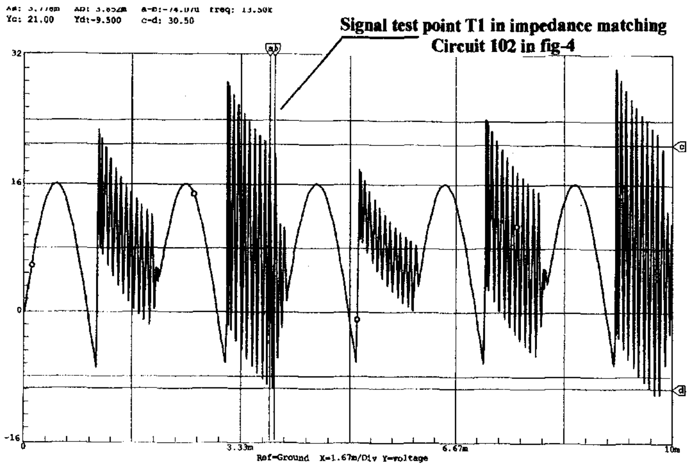
With a 12 volt RMS alternator supply to each cell, the 1.7 mh cokes provide a stable base voltage of 3.45 volts. The capacitor banks allow a peak-to-peak voltage of 12.04 volts on top of the 3.45 volts base. The frequency at which the system is at resonance is 496.9 hz.

The formula for the peak-to-peak frequency is given by **V(ripple) =I/fC**, where I = DC load current, f = frequency and C = Capacitance in farads. As V, C and f are given — I (amps) can be calculated.

No data is given for gas output. However the circuit is relatively simple with few components in each of the six duplicated circuit boards. There is enough information in the patent to allow easy duplication of the system so that proof of concept can be provided. In addition to the speed of the alternators to obtain resonance, the two mosfet-ganged switches will also need to be variably controlled to obtain the maximum gas production.


Generator A & B are synchronized with each other
Generator A
120#
50#
Generator B
Card 1 (0v)
(+)
(-)
A
F
(-)
(0v) Card 6
(+)
Phase 3
Phase 1
110#
Phase 2
Card 2 (0v)
(+)
(-)
B
133
E
(-)
(0v) Card 5
(+)
Phase 2
110#
Card 3 (0v)
(+)
(-)
C
D
(-)
(0v) Card 4
(+)
Phase 3
Phase 1
102#
132#
102#


Generator A/B
Card 1/4
Yel
6A
Slow Blow Yel
C1T1P1,2
NTE5817
T1
L1
1.7mh
C1T2P1,2
Blu
sw1A
J7P4
4PriField
J7P5
J7P1
Blu
1Phase
3Phase
2Phase
J7P2
J7P3
68uf
10M
Wave-guide
Elements A/D
J5P1 I
Liquid Bath
J5P2 M
Liquid Bath
J5P3 O
NTE5817
L2
1.7mh
T2
C1T2P5,6
Yel
sw1B
C1T1P3,4
Blu
L3
1.7mh
T3
T4
Ref
C1T2P3,4


Yc: 21.00
Ydt-9.500
c-d: 30.50
Signal test point T1 in impedance matching
Circuit 102 in fig-4
32
16
0
-16
a b
c
d
3.33m
6.67m
10m
Ref=Ground X=1.67m/Div Y=voltage

HORVATH – TESTS ON PROTOTYPE   Patent 4,107,008

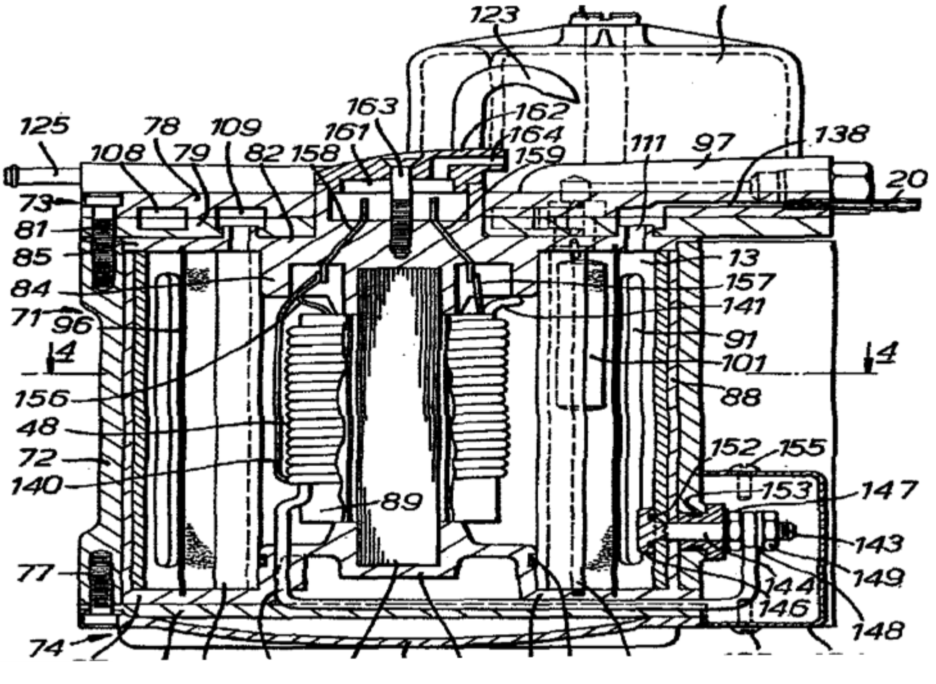
There is no proof that Horvath ever ran a car using only an on board Hydrolyser for the power source. It is clear that he was not happy with this design because he changed his concept radically in his next patent. This design incorporated electromagnetic radiation as well as high amperage across the electrodes. The patent needs to be read in its entirety for a fuller understanding.

Electrolyte:	25% of Potassium Hydroxide KOH
Electrolyte Volume at start of test:	600ml
Electrolyte Volume at end of test:	530ml
Water converted during test:	70ml
Total duration of test	60 minutes 39 seconds
Voltage to Inverter Circuit:	8.5 Volts average
Current to Inverter Circuit:	17 amps
Voltage between Anode/Cathode:	3.32 Volts average
Current between Anode/Cathode:	66 amps average
High Voltage on Radiation Tube:	39 Kilovolts
Current between Filament & Anode	4.8 milliamps average
Filament voltage:	2.66 volts average
Filament current:	1.57 amps average
Output:	1.45 Litres per minute (87 Lt/Hr)
H_2 Production per Lt Water:	60.9 Ltrs H_2 per Lt or Water
Operating Pressure:	Low
Operating Temperature:	54^0 C
Kilowatt/Hrs per Lb. H_2 :	21.6 Kwts/hrs/lb
Thermal Efficiency:	83.3%
Kwts/hrs per 1000 Standard Cubic Ft:	121 Kwts/hrs

Using the Faraday formula

100% efficiency = 80.5 Kwts/hr for 1000 ft^3

The cell design for this patent therefore operated at only 67% efficiency.



HORVATH - 1 HOUR TEST COMPARISONS PAT. 4,454,850

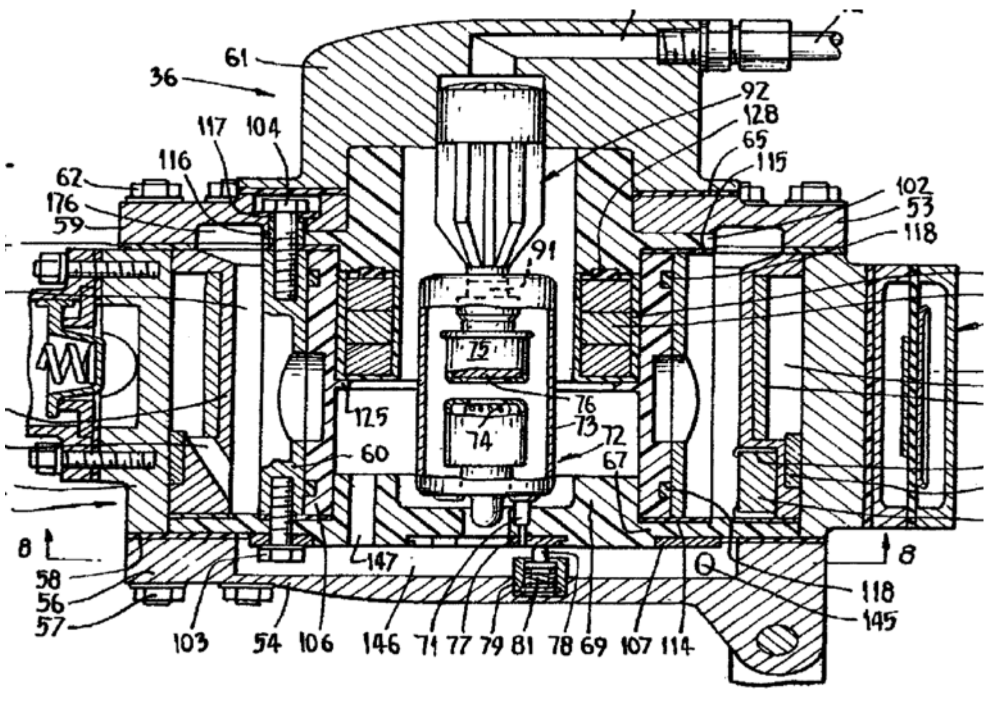
These tests were carried out by the Horvath group used bottled H_2 gas in the vehicle. It therefore cannot be classed as a true hydrolyser but demonstrates how bottled hydrogen can be energised to achieve approximately one third higher horsepower at only two thirds of the energy used by petrol.

The gas was first introduced into the device where it was then radiated with gamma radiation before being injected into the engine.

High levels of both deuterium and tritium are generated in the mix that resulted in the much higher BHP than conventional petroleum.

V8 FORD ENGINE Mod. No 24337

Petrol	
Equivalent road Speed:	40 mph
Engine speed;	1500 rpm
Petrol Consumption:	2.2 imperial gallons per hour = 328,240 BTU/Hr
	10 Ltrs per hour
Dynamometer Engine Power	23 BHP
Thermal efficiency :	17.87% Based on 2545 BTUs per BHP
Hydrogen	
Equivalent road Speed:	40 mph
Engine speed;	1500 rpm
Hydrogen Consumption:	720 cu.ft /hour = 200,880 BTU/Hr
	20,389 Ltrs per hour
Dynamometer Engine Power	30.7 BHP
Thermal efficiency :	38.89% Based on 2545 BTUs per BHP



Gamma radiation of the fuel creates highly ionized hydrogen and transmutation of the elements may be involved. The reactions that can take place during the process of combustion to account for the exhaust findings and high power level are:

$$_1D^2 + {}_1D^2 \rightarrow He^3 + {}_0n^1 + 3.27 \text{ Mev} \quad \text{(Neutron Branch)}$$

and

$$_1D^2 + {}_1D^2 \rightarrow {}_1T^3 + {}_1H^1 + 4.03 \text{ Mev} \quad \text{(Proton Branch)}$$

The tritium produced in the proton branch can react at a considerably faster rate, with deuterium nuclei in the D-T reaction:

$$_1D^2 + {}_1T^3 \rightarrow {}_2H^4 + {}_0n^1 + 17.6 \text{ Mev}$$

The He^3 formed in the first D-D reaction can also react with deuterium in the following way:

$$_1D^2 + {}_2He^3 \rightarrow {}_2He^4 + {}_1He^1 + 18.3 \text{ Mev}$$

The energy liberated by nuclear fusion is additional to that supplied by the normal combustion of hydrogen whilst the reaction proceeds to its lowest denominator without a continued chain reaction. Normal H_2 combustion would yield only 15% to 25% Thermal efficiency.

Exhaust showed 18 parts per million helium compared to 5.2 parts per million for the air intake.

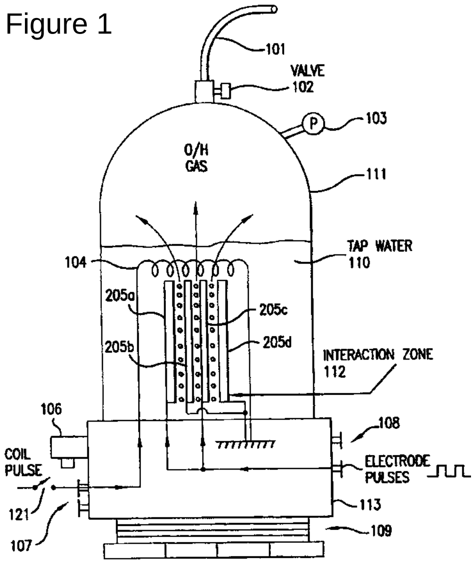
CHAMBERS ORTHO/PARA-HYDROGEN HYDROLYSER – PATENT 6,126,794

The Chambers device uses plain water from the tap and a close plate gap of 1mm to 5mm maximum. It can have as many as 40 plates in a parallel connection. The lower part of the circuit produces a 10 to 250KHz square wave frequency with a mark space ratio of 10:1. The cell draws 300 milliamps at a potential of 12 volts. The closed cell is capable of gas production with a pressure increase of 1 psi per minute (Max. pressure 75psi). He did not give any information about gas volume.

The coil above the plate electrodes is supplied from the output of the lower circuit through a divide by N chip. The frequency applied to the coil is from 17 – 22 Hz with the normal being 19 Hz. The mark-space ratio is not given, but as this is an inductor it is probably 50% duty cycle. The toroidal coil consists of 1500 turns (size not given) on a ferrite base 5x7 cm.

How it works: The claim is that only orthohydrogen is produced between the plates, whilst parahydrogen is mainly produced by the coil. It is also claimed that the orthohydrogen isomer is highly combustible whereas parahydrogen is a slower burning form of hydrogen.

Figure 1



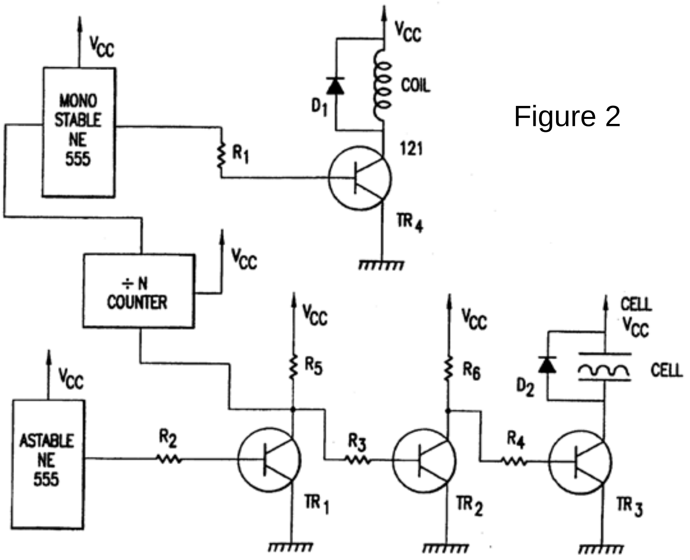


Figure 2

An Explanation of Ortho and Para-hydrogen

The ortho/para – hydrogen isomers differ in their magnetic interactions of the protons due to the spinning motion of the protons. In ortho., the spin of both protons in the diatomic dumbbell are parallel (rotate in same direction). In para., the spins are diametrical and called antiparallel. Normally both types may be regarded as completely independent. However, under temperature change at equilibrium or under stress conditions they may inter-convert.

At minus 253.1^{0}C para-hydrogen is 99.82% pure, but at 200^{0}C it is only 25% of the para/ ortho mix. Orth-hydrogen therefore cannot be isolated as its' maximum concentration is never greater than 75%. Due to their differing magnetic interactions their properties also differ slightly.

Hasebe Magnetic Vortex Hydrolyser – Patent 4,105,528

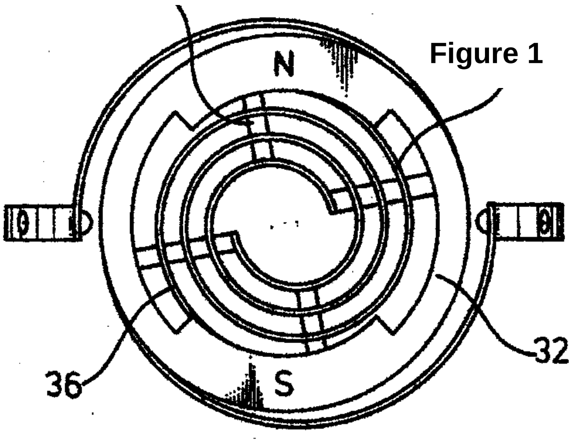


Figure 1

In this device two ring magnets with internal poles diametrically opposed horizontally are placed in the cell with one ring magnet above the electrodes and one below the electrodes.

This unique cell arrangement incorporates the plane geometry of a conventional hydrolyser coupled intrinsically with the vortical arrangement of a coil.

Hasebe claims that the permanent magnets align the water molecules in a polarised form. This then assists disassociation of the water as the oriented molecules come under the influence of the electrostatic field and spin function of the vortex designed into the electrodes.

See plan view Figure 1 and isometric projection Figure 2

In really, it makes no difference whether the theory is right or wrong, the proof of the device is in the volume of gas that is produces over time relative to the power input. This device seems to have achieved the impossible. If the gas output claimed by Hasebe can be replicated, then this cell is capable of 20 times the amount of gas predicted by thermodynamics.
See data below.

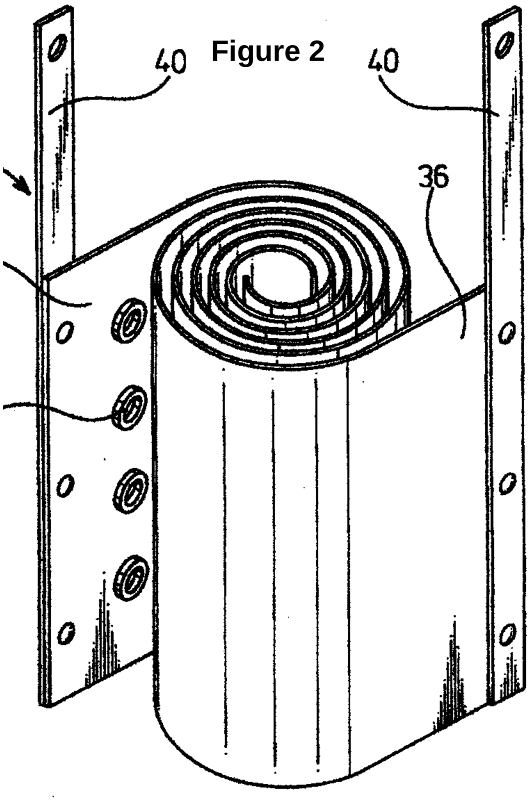


Figure 2

Experimental data

Hydroxy HHO produced	116cc/sec
Temperature of cell	25^{0}C
Applied Voltage	2.8 volts
Current	30 amps
Wattage	84 Watts
Catalyst	N_aOH

Calculated Equivalence

116cc x 60^2 seconds = 417.6 litres per hour HHO

30 amps x 60^2 seconds = 108,000 Coulombs per hr

As 96485 Coulombs (1 Faraday) produces 18.6 lts

Then, $\frac{108,000}{96485}$ x 18.6 = 20.8 litres @ 25^{0}C

(417.6 litres / 20.8 litres) x 100 = 2006 %

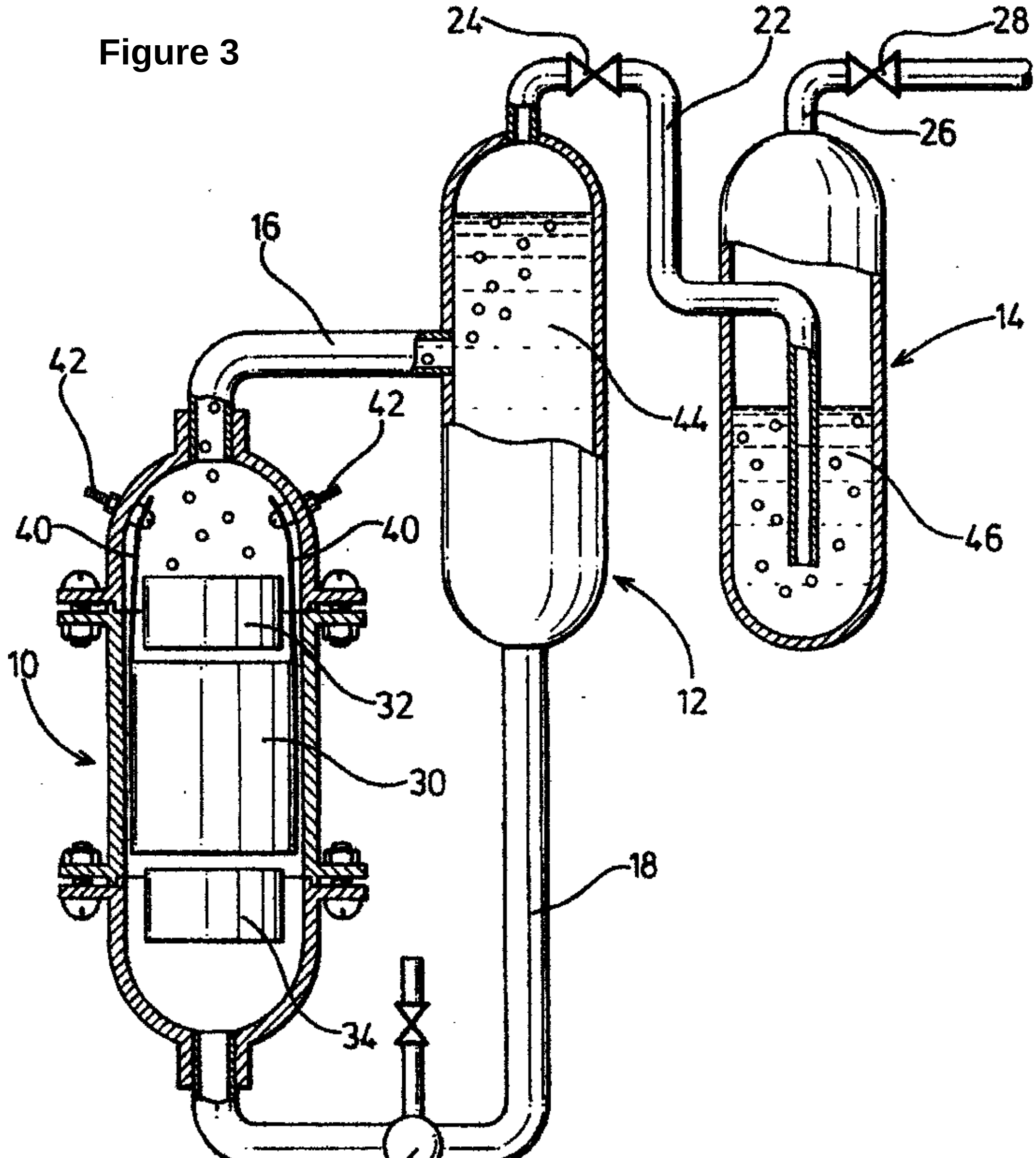
This may be enough gas to run a 45cc motor.

The Shigeta Hasebe Hydrolyser System

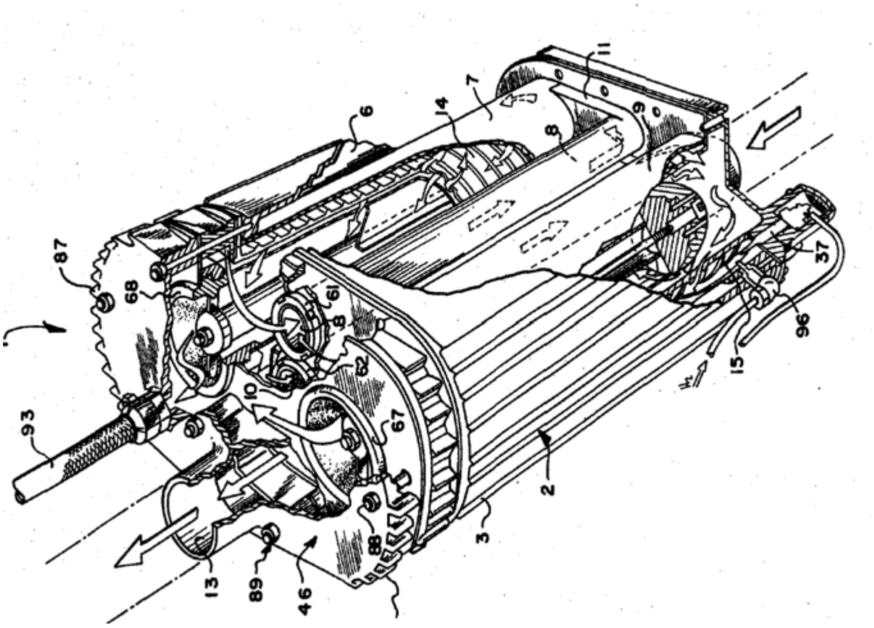
Electrolytic cell 10, a gas-liquid separation tank 12, and a gas-washing tank 14, are vertically arranged so that the cell 10 is positioned a little lower than the other two. The ferrite magnets are shown as 32 and 34. The electrodes helix is marked 30.

Electrolyte is pumped through the cell by pump 20. The collected gases are circulated into separator 12 where they migrate to the bubbler and gas washer 14. The collected gasses are then self pressurised and released through valve 28 for used as required.

Figure 3



HORVATH – CATALYTIC CONVERSION OF STEAM -Patent 4490349



No operating data was presented in this patent and the entire patent application was based on theoretical concepts of thermodynamics and chemical kinetics.

The hardware comprises a muffler shaped catalytic converter design that consists of two reactant metals, Palladium and Iron, arranged concentrically as two nested tubes. The inner tube is a Palladium alloy, with the outer tube made of pure iron. The Palladium extracts hydrogen from a flow of superheated steam and transfers it uncorrupted through the palladium barrier where it is pumped into a suitable storage tank. The iron also reacts with the steam to extract oxygen to form magnetic iron oxide.

Provided the steam is hot enough, the chemical reaction for the Iron is given by:

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2 , \qquad (1)$$

Unfortunately, the Iron would quickly become saturated with rust as Magnetite and the reaction would cease if it were not for a possible reversible reaction:

$$Fe_3O_4 + 4H_2 \rightarrow 3Fe + 4H_2O \qquad (2)$$

Obviously this is of no commercial value, as all the hydrogen separated in the first reaction would be consumed in the second reaction. However, if the $4H_2$ in (1) is taken up by the Palladium then it is possible to extract the oxygen from the iron magnetite. If the magnetite is heated beyond 750^0C (cherry red metal) and the environment is purged of free oxygen, then the ferric oxide will spontaneously disassociate, or at least disproportionate to a lower oxidation number. The reaction would then be typified by:

$$3Fe_3O_4 + 4H_2O \rightarrow 6Fe + 4H_2O + 6O_2 \text{ , or} \qquad (3)$$

$$2Fe_2O_3 + 3H_2O \rightarrow 4Fe + 3H_2O + 3O_2 \text{ etc.} \qquad (4)$$

If a small amount of hydrogen is also injected into the output side of the Magnetite tube and ignited, then the temperature of the Iron would be increased to the desired disassociation level and the hydrogen would purge the environment of free oxygen as well as combining with the oxide in the metal as in reaction (2). The product gasses of steam and free oxygen could then be exhausted.

Thermodynamically, reaction (1) together with the extraction of hydrogen by palladium will be exothermic. This release of energy will provide the necessary heat for the steam to react with both the palladium and the iron to ensure a high rate of disassociation. The thickness of the palladium alloy will also be minimised to 0.005” to ensure a rapid rate of extraction.

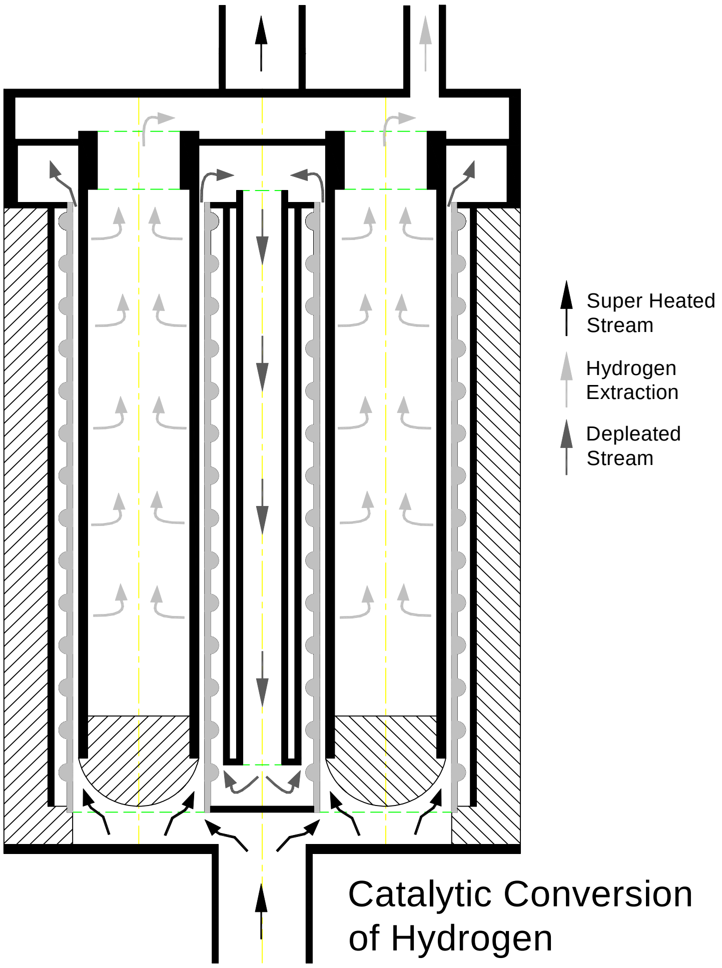
$$\Delta H_{\text{reaction}} = \Delta H_{\text{products}} - \Delta H_{\text{reactants}} = -272.3 - (-244.04) = -28.26 \text{ Kcal/mol}$$

$$\Delta S_{\text{reaction}} = \Delta S_{\text{products}} - \Delta S_{\text{reactants}} = +69.6 - (+83.8) = -14.2 \text{ cal/mol}$$

$$\Delta G_{\text{reaction}} = \Delta H - T\Delta S = -28.26 \text{ kcal/mol} - (750^{0}\text{K} \times -14.2\text{cal}) = -17.61 \text{ Kcal/mol}$$

$$4.1861 \times -17.61 \text{ Kcal/mol} = -73.72 \text{ kJ/mol (spontaneous)}$$

At 750^{0}K the palladium will take up hydrogen in excess of 3000:1 by volume on a continuous basis provided the output side is kept free of H_2 emerging from the inner tube and the iron is purged.



Catalytic Conversion of Hydrogen

APPENDIX A2

US PATENT OFFICE DOCUMENTS – FUEL FROM WATER

Patent No	Date	Name		Patent No	Date	Name
390,675	1888	Humphreys		3,207,684	Sep-65	Dotts
416,130	1889	Walters		3,218,195	Nov-65	Corren
685,274	Oct-01	Haas		3,247,024	Apr-66	Tamminen
1,032,623	7-Dec	Reed		3,256,504	Jun-66	Fidelman
1,219,333	Mar-17	Kynaston		3,262,872	Jul-66	Rhodes
1,262,034	Apr-18	Frazer		3,310,483	Mar-67	Rhodes
1,280,982	Oct-18	Ford		3,311,097	Mar-67	Mittelstaedt
1,281,962	Oct-18	Holland		3,318,293	May-67	Hickling
1,363,889	Dec-20	Linebarger		3,330,755	Jul-67	Mahany
1,376,207	Apr-21	Jacobs		3,362,883	Jan-68	Wright
1,380,183	May-21	Boisen		3,381,675	May-68	Schiavone
1,431,047	Oct-22	Ruben		3,433,729	Mar-69	Proskuryakov
1,544,052	Jun-25	Avery		3,444,098	May-69	Bottazi
1,600,478	Sep-26	Lawaczeck		3,458,412	Jul-69	Shinagawa
1,862,663	Jun-32	Curtis		3,459,953	Aug-69	Hughes
1,876,879	Sep-32	Drabold		3,518,036	Jun-70	Staats
1,905,627	Apr-33	Holland		3,616,434	Oct-71	Hausner
1,941,816	Jan-34	Stuart		3,648,668	Mar-72	Pacheco
2,000,815	May-35	Berl		3,648,668	Mar-72	Pacheco
2,016,442	Oct-35	Kilgus		3,652,431	Mar-72	Reynolds
2,073,679	Mar-37	Brown		3,705,784	Dec-72	Reichhelm
2,079,950	May-37	Negus		3,719,583	Mar-73	Ustick
2,140,254	Dec-38	Zavka		3,755,128	Aug-73	Herwig
2,295,209	Sep-42	Guiles		3,758,399	Sep-73	Pendergrass
2,295,209	Sep-42	Gulles		3,772,180	Nov-73	Prestidge
2,305,208	Dec-42	Trammell		3,839,169	Oct-74	Moyer
2,365,330	Dec-44	Carmichael		3,844,262	Oct-74	Dieges
2,373,032	Apr-45	Klein		3,868,211	Feb-75	LaHaye
2,384,463	Sep-45	Gunn		3,892,653	Jul-75	Pacheco
2,386,978	Oct-45	Ruhl		3,921,985	Nov-75	Fimml
2,496,623	Feb-50	Fragale		3,925,212	Dec-75	Tchernev
2,509,498	May-50	Heyl		3,928,550	Dec-75	Seitzer
2,565,068	Aug-51	Drabold		3,933,614	Jan-76	Bunn
2,588,450	Mar-52	Zadra		3,939,806	Feb-76	Bradley
2,687,448	Aug-54	Gulick		3,954,592	May-76	Horvath
2,687,449	Aug-54	Gulick		3,980,053	Sep-76	Horvath
2,701,608	Feb-55	Johnson		3,982,878	Sep-76	Yamane
2,742,886	Apr-56	McPherson		4,009,006	Feb-77	Hreha
2,748,570	Jun-56	Booth		4,014,777	Mar-77	Brown
2,780,602	Feb-57	Berkman		4,021,191	May-77	LaHaye
2,925,455	Feb-60	Eidensohn		4,023,545	May-77	Mosher
2,988,589	Jun-61	Osborn		4,030,890	Jun-77	Diggs
3,012,088	Dec-61	Grady		4,031,865	Jun-77	Dufour
3,045,665	Jul-62	Movat		4,045,315	Aug-77	Fletcher
3,074,390	Jan-63	O'Laughlin		4,052,139	Oct-77	Paillaud
3,110,294	Nov-63	Nyman		4,053,576	Oct-77	Fletcher
3,157,172	Nov-64	Mittelstaedt		4,053,576	Oct-77	Fletcher
3,177,633	Apr-65	McDonald		4,056,452	Oct-77	Campbell
3,192,138	Jun-65	Enk		4,059,086	Nov-77	Tsubouchi

APPENDIX A2

US PATENT OFFICE DOCUMENTS – FUEL FROM WATER
Continued

Patent No	Date	Name		Patent No	Date	Name
4,069,665	Jan-78	Bolasny		4,442,801	Apr-84	Glynn
4,105,517	Aug-78	Frosch		4,454,850	Jun-84	Horvath
4,105,528	Aug-78	Hasebe		4,457,221	Jul-84	Geren
4,107,008	Aug-78	Horvath		4,457,816	Jul-84	Galluzzo
4,107,010	Aug-78	Meyerand		4,470,894	Sep-84	Dyer
4,113,589	Sep-78	Leach		4,490,349	Dec-84	Horvath
4,124,463	Jul-78	Blue Archie		4,511,450	Apr-85	Neefe
4,152,241	May-79	Warren		4,573,435	Mar-86	Shelton
4,176,026	Nov-79	Harriman		4,575,383	Mar-86	Lowther
4,184,931	Jan-80	Inoue		4,599,158	Jul-86	Ofenloch
4,185,593	Jan-80	McClure		4,696,809	Sep-87	Vialaron
4,211,620	Jul-80	Fowler		4,696,809	Sep-87	Vialaron
4,211,621	Jul-80	Porter		4,740,283	Apr-88	Laas
4,233,127	Nov-80	Monahan		4,755,305	Jul-88	Fremont
4,233,132	Nov-80	Carr		4,773,981	Sep-88	Bidwell
4,304,627	Dec-81	Lewis		4,798,661	Jan-89	Meyer
4,310,503	Jan-82	Erickson		4,826,581	May-89	Meyer
4,312,736	Jan-82	Menth		4,936,961	Jun-90	Meyer
4,316,787	Feb-82	Themy		5,089,107	Feb-92	Pacheco
4,325,793	Apr-82	Kisch		5,149,407	Sep-22	Meyer
4,325,799	Apr-82	Gordy		5,205,994	Apr-93	Sawamoto
4,332,775	Jun-82	Genequand		5,293,857	Mar-94	Meyer
4,332,775	Jun-82	Genequand		5,304,289	Apr-94	Hayakawa
4,352,722	Oct-82	Ohkawa		5,324,398	Jun-94	Erickson
4,369,737	Jan-83	Sanders		5,376,242	Dec-94	Hayakawa
4,371,500	Feb-83	Papineau		5,399,251	Mar-95	Nakamats
4,384,943	May-83	Stoner		5,435,894	Jul-95	Hayakawa
4,389,981	Jun-83	Meyer		5,599,437	Feb-97	Taylor
4,391,793	Jul-83	Boese		5,614,078	Mar-97	Lubin
4,394,230	Jul-83	Puharich		5,632,870	May-97	Kucheroy
4,405,594	Sep-83	Pyle		5,695,650	Dec-97	Held
4,421,474	Dec-83	Meyer		5,698,107	Dec-97	Wurzburger
4,424,105	Jan-84	Hanson		6,126,794	Oct-00	Chambers
Late additions						
2,285,553	Jun-42	Arlt		3,969,214	Jul-76	Harris
3,410,783	Nov-68	Tomter		4,427,512	Jan-84	Han
3,957,596	May-76	Seto		7,041,203	May 2006	Sullivan

**This list is not comprehensive and may contain some patents not entirely appropriate to this subject.
This list is under review. A more comprehensive list with patent copies on DVD/CD will be made available when compiled.**