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FABRICATION OF WATER FUEL ENGINE

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ABSTRACT

A Water fuel engine (hydrogen vehicle is an alternative fuel vehicle that uses hydrogen as its onboard fuel for motive power. Combustion of hydrogen with air is receiving increasing attention in the future energy scenario. The term may refer to a personal transportation vehicle, such as an automobile, or any other vehicle that uses hydrogen in a similar fashion, such as an aircraft. The power plants of such vehicles convert the chemical energy of hydrogen to mechanical energy either by burning hydrogen in an internal combustion engine (spark ignition engine), Widespread use of hydrogen for fueling transportation is a key element of a proposed hydrogen economy. Hydrogen fuel does not occur naturally on Earth and thus is not an energy source, but is an energy carrier. Currently it is most frequently made from methane or other fossil fuels. However, it can be produced from a wide range of sources (such as wind, solar, or nuclear) that are intermittent, too diffuse or too awkward to directly propel vehicles. Integrated wind-to-hydrogen plants, using electrolysis of water, are exploring technologies to deliver costs low enough, and quantities great enough, to compete with traditional energy sources. In the late 1990s Canada developed a world leading position in fuel cell and hydrogen technologies based in large part by advances in Proton Exchange Membrane fuel cell technology by Ballard Power Systems and several smaller highly innovative firms. Global trend is to move from fossil fuels to carbon free fuels, including renewable. Decarbonization driven by protection of environment. For India and other oil importing developing countries, energy security is the main driver for decarbonization this paper will provide an overview of the current state of the hydrogen in the spark ignition engine.

Keywords: WATER AS FUEL, SPARK PLUG ENGINE, ELECTROLYSIS

1.1 Introduction

CHAPTER-1

The fuel cell is in the transformation from chemical energy to electricity a very promising primary energy converter for automotive propulsion due to their high efficiency and ultra-low emissions. The polymer- electrolyte-membrane fuel cell (PEFC) - among the different types of fuel cells - is almost exclusively discussed for applications in traction because of their rugged design and suitability for dynamic operation. Therefore, this paper deals exclusively with PEFC technology. In comparative views with other vehicle power trains "tank to wheel" lowest CO2-emissions for vehicles with fuel cell power trains were obtained with the PEFC-fuel cell technology. However, extending the view to "well-to-wheel" it becomes apparent that the advantage is getting smaller or - for unfavorable fuel supply chains - CO -emissions could be also higher. The PEFC's preferable fuel for is hydrogen. As fuel up-to-date almost exclusively hydrogen is used, because it has been found that the realization of gas generation systems, which convert hydrocarbons to a hydrogen rich gas on-board, is very complex. Consequently, the above cited potential can only be assessed, if satisfying answers to the questions of hydrogen production, infrastructure and storage are found regarding economics. Furthermore, technical progress is needed in fuel cell propulsion technology. Main issues are: cost of the power train; lifetime of the core components, namely the fuel cell stack; cold start ability; performance under freezing conditions; and operating range of the vehicles. Improved materials are needed to meeting the envisaged targets. This paper gives some examples for challenges in material science developing advanced PEFC-stacks and advanced hydrogen storages.

Many companies are working to develop technologies that might efficiently exploit the potential of hydrogen energy for mobile users. The attraction of using hydrogen as an energy currency is that, if hydrogen is prepared without using fossil fuel inputs, vehicle propulsion would not contribute to carbon dioxide emissions. The drawbacks of hydrogen use are low energy content per unit volume, high tank age weights, the storage, transportation and filling of gaseous or liquid hydrogen in vehicles, the large investment in infrastructure that would be required to fuel vehicles and the inefficiency of production processes. Buses, trains, PHB bicycles, canal boats, cargo bikes, golf carts, motorcycles, wheelchairs, ships, airplanes, submarines, and rockets can already run on hydrogen, in various forms. NASA uses hydrogen to launch Space Shuttles into space. There is even a working toy model car that runs on solar power, using a regenerative fuel cell to store energy in the form of hydrogen and oxygen gas. It can then convert the fuel back into water to release the solar energy. The current land speed record for a hydrogen-powered vehicle is 286.476 mph (461.038 km/h) set by Ohio State University's Buckeye Bullet 2, which achieved a “flying-mile” speed of 280.007 mph (450.628 km/h) at the Bonneville Salt Flats in August 2008. For production-style vehicles, the current record for a hydrogen-powered vehicle is 333.38 km/h (207.2 mph) set by a prototype Ford Fusion Hydrogen 999 Fuel Cell Race Car at Bonneville Salt Flats in Wend over, Utah in August 2007. It was accompanied by a large compressed oxygen tank to increase power. Honda has also created a concept called the FC Sport, which may be able to beat that record if put into production.

CHAPTER-2

2.1 LITERATURE REVIEW

[1]. Edwards, et. al. explained that the car was wonderful unlikely, dram while it lasted offering a pollution free feature powered by a limitless source of energy.

[2] State of New Jersey Department of law releases at the way back machine.

[3] Charles H. Garrett allegedly demonstrated a water-fueled car "for several minutes", which was reported on September 8, 1935, in The Dallas Morning News. The car generated hydrogen by electrolysis as can be seen by examining Garrett's patent, issued that same year.

[4] Stanley Meyer, who claimed to run a car on water in 1984, car running with the help of water

[5] Charles Frazer, an inventor from Ohio who, in 1918 patented a hydrogen booster which claimed to use electrolysis to increase vehicle power and fuel efficiency while greatly reducing exhaust emissions.

[6] Daniel Dingel said he began working on his hydrogen reactor in 1969, and claimed to have used the device to power his 1996 Toyota Corolla. Dingel explained that his invention splits from water in an onboard water tank, producing hydrogen and does not produce any carbon emissions.

[7] Dennis Klein has claimed that the firm Hydrogen Technology Applications patented an electrolysis design and trademarked the term "Aquygen" to refer to the hydrogen oxygen gas mixture produced by the device.

[8] Japanese company Genepax unveiled a car it claimed ran on only water and air, and many news outlets dubbed the vehicle a "water-fuel car". The company said it "cannot [reveal] the core part of this invention" yet, but it disclosed that the system used an onboard energy generator, which it called a "membrane electrode assembly", to extract the hydrogen using a "mechanism which is similar to the method in which hydrogen is produced by a reaction of metal hydride and water.

CHAPTER-3

3.1 HYDROGEN FUEL

Hydrogen fuel in a flame of pure hydrogen gas, burning in air, the hydrogen (H_2) reacts with oxygen (O_2) to form water (H_2O) and heat. It does not produce other chemical by-products, except for a small amountof nitrogen oxides. Hence a key feature of hydrogen

Fig.3.1: Hydrogen fuel

as a fuel is that it is relatively non-polluting (since water is not a pollutant). Pure hydrogen does not occur naturally; it takes energy to manufacture it. Once manufactured it is an energy carrier (i.e. a store for energy first generated by other means). The energy is eventually delivered as heat when the hydrogen is burned. The heat in a hydrogen flame is a radiant emission from the newly formed water molecules. The water molecules are in an excited state of initial formation and then transition to a ground state, the transition unleashing thermal radiation. When burning in air, the temperature is roughly 2000°C. Hydrogen fuel can provide motive power for cars, boats and aeroplanes, portable fuel cell applications or stationary fuel cell applications, which can power an electric motor. The current leading technology for producing hydrogen in large quantities is steam reforming of methane gas (CH_4). Other methods are discussed in the Hydrogen Production article. Primarily because hydrogen fuel can be environmentally friendly, there are advocates for its more widespread use. At present, however, there is not a sufficient technical and economic infrastructure to support widespread use. The proposed creation of such an infrastructure is referred to as the hydrogeneconomy.

Hydrogen can also serve as fuel for internal combustion engines. However, unlike FCEVs, these produce tailpipe emissions and are less efficient. Learn more about fuel cells.

The energy in 2.2 pounds (1 kilogram) of hydrogen gas is about the same as the energy in 1 gallon (6.2 pounds, 2.8 kilograms) of gasoline. Because hydrogen has a low volumetric energy density, it is stored onboard a vehicle as a compressed gas to achieve the driving range of conventional vehicles. Most current applications use high-pressure tanks capable of storing hydrogen at either 5,000 or 10,000 pounds per square inch (psi). For example, the FCEVs in production by automotive manufacturers and available at dealerships have 10,000 psi tanks. Retail dispensers, which are mostly co-located at gasoline stations, can fill these tanks in about 5 minutes. Fuel cell electric buses currently use 5,000 psi tanks that take 10–15 minutes to fill. Other ways of storing hydrogen are under development, including bonding hydrogen chemically with a material such as metal hydride or low-temperature sorbent materials.

3.2 HYDROGEN VEHICLE

Hydrogen vehicle is an alternative fuel vehicle that uses hydrogen as its on-board fuel for motive power. such as an automobile, or any other vehicle that uses hydrogen in a similar fashion, such as an aircraft. The power plants of such vehicles convert the chemical energy of hydrogen to mechanical energy either by burning hydrogen in an internal combustion engine, or by reacting hydrogen with oxygen in a fuel cell to run electric motors. The widespread use of hydrogen for fueling transportation is a key element of a proposed hydrogen economy. Hydrogen fuel does not occur naturally on Earth, and thus is not an energy source, but is an energy carrier. Currently it is most frequently made from methane or other fossil fuels. However, it can be produced from a wide range of sources (such as wind, solar, or nuclear) that are intermittent, too diffuse too cumbersome to directly propel vehicles. Integrated wind-to- hydrogen plants, using electrolysis of water, are exploring technologies to deliver cost low enough, and quantities great enough, to compete with traditional energy sources. Many companies are working to develop technologies that might eminently exploit the potential of hydrogenenergy for mobile users.

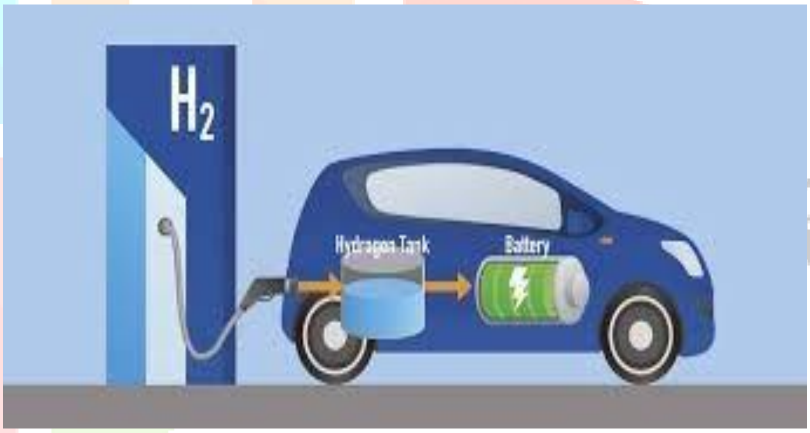

Fig.3.2: Hydrogen charging

CHAPTER:4

4.1 ENGINE THEORY AND CHARACTERISTICS

After becoming familiar with the physical characteristics of hydrogen, the engine criteria can be focused on. The initial goal was to design and develop a working hydrogen fueled internal combustion engine without extraordinary modifications. This chapter will discuss basic engine theory with a description and specifications of the engine used in this research. Before an engine is selected, designed, and built some engine theory is important to know. Most engines used in automobiles are known as four stroke engines. The four-stroke cycle means that each cylinder requires four strokes

4.2 PROCEDURE AND PHENOMENON INVOLVED

PHENOMENON INVOLVED:

- The phenomenon involved in the separation of hydrogen and oxygen in water is"ELECTROLYSIS OF WATER"
- In electrolysis the anode is connected to the positive terminal of the battery andthe cathode is connected to the negative terminal in water.
- When the current is passed the oxygen reacts with anode and the hydrogen reactswith cathode with the help of polymer electrolyte membrane.
- Thus, the hydrogen and oxygen liberate from the water.
- The liberated hydrogen is used for combustion in the engine.

PROCEDURE:

Splitting of Water:

- At first fuel tank is placed at the top of the engine with anode and cathode connectionsof the battery into the tank.
- When the battery circuit is closed, the electricity passes into the water, thereby the splitting of oxygen and hydrogen takes place and the hydrogen liberates from the water and the oxygen is let out.
- The liberated hydrogen is collected separately by a tube from the fuel tank. (To check whether it is hydrogen or not, introduce the tube which carries the hydrogen gas into a container with soap water. In the soap water, there is formation of bubbles. Keep a flame near a bubble, the fire starts to sparkle due to the hydrogen) PATH WAY OF THE FUEL

CARBURETTOR:

- The tube which carries the hydrogen is inserted into Carburettor. The carburettor mixes hydrogen with the air. Engine, generally a four-stroke engine is an internal combustion engine that utilizes four different engine strokes,

Fig.4.1: Carburettor

(1) Intake/Suction

(2) Compression

(3) Power

(4) Exhaust

- Intake: In "intake" when the spark plug ignites, combustion takes place and thereby the piston starts to work and it pumps the air and the fuel mixture (the engine starts).

- Compression: In 'compression' the air and fuel mixture is kept at more pressure to produce more power.
- Power: In 'power the rotational force of the engine is transmitted to the wheel. Thus, the vehicle starts to move. This is how the engine starts to work with water as a fuel.
- Exhaust: During the exhaust stroke, the turning crankshaft forces the piston back up the cylinder, the exhaust valve (or valves) opens, and the piston pushes out the burnt air/fuel mixture past the exhaust valve.

4.2 EXPERIMENTAL SETUP

Electrolysis tank: This tank has two components in it which will helps inbreaking the H2ointo hydrogen and oxygen

Engine: Engine is the main component of a vehicle which will helps incombustion ofhydrogen into the energy

Battery: This battery is considered as the power house of the vehiclewhich will helps inelectrolysis process

Hydrogen storage tank: This tank helps in storage of hydrogen which wasproduced duringthe electrolysis process

Chassis: Chassis is considered as the skeleton system of a vehicle

<u>Main Components:</u>

1. Engine
2. Carbourator
3. Container
4. Tubes
5. Copper And Aluminium Strips
6. Batteries

4.3.1 ENGINE:

Any device which can convert heat energy of fuel into mechanical energy is known as engineor heat engine may be classified into two types

1.External Combustion (E.C) engine2.Internal Combustion (I.C) engine

This engine is the vehicles main source of power. The engine uses fuel and burns it to produce mechanical power. the heat produced by the combustion is used to create pressure which is then used to drive a mechanical device.

An internal combustion engine (I.C) is a heat engine in which the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an internal part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high temperature and high-temperature and high-pressure gasses produced by combustion applies direct force to some component of the engine This engine helps in the combustion of hydrogen which was passed through the carburettor.

Internal combustion engines are those heat engines that burn their fuel inside the engine cylinder. In internal combustion engine the chemical energy stored in their operation. The heat energy is converted in to mechanical energy by the expansion of gases against the piston attached to the crankshaft that can rotate. The engine which gives power to propel the automobile vehicle is a petrol burning internal combustion engine. Petrol is a liquid fuel and is called by the name gasoline in America. The ability of petrol to furnish power rests on the two basic principles; Burning or combustions always accomplished by the production of heat. When a gas is heated, it expands. If the volume remains constant, the pressure rises according to Charles's law.

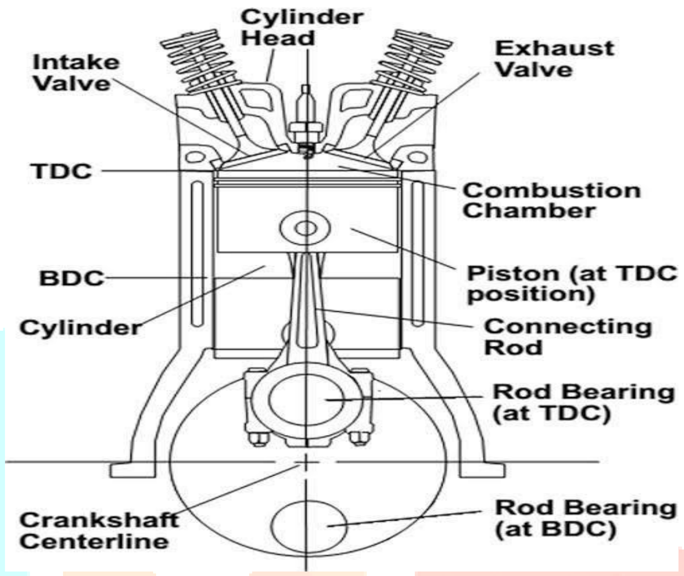

Fig.4.2: I.C Engine

(1) Suction stroke: The 4-stroke engine takes its name from the fact that it takes four strokes of the piston to complete one cycle. On the suction stroke the intake valve (or valves) opens, and as the piston goes down in the cylinder, the air/fuel mixture is drawn into the cylinder. During this stroke the airflow meter in the fuel injection system sends a signal to indicate how much air is coming in. Then a computer-controlled fuel injector sprays a precise amount of fuel into the cylinder at just the right moment.

(2) Compression stroke: The intake valves close as the piston travels up the cylinder, and the piston compresses the air/fuel mixture. The higher the compression, the more power is generated in the next stroke.

(3) Power stroke: As the piston approaches the top of the compression stroke, the spark plugs fires, igniting the compressed air/fuel mixture. The rapidly expanding gases push the piston back down the cylinder. This is the stroke that generates the engine's power. The strokes in each cylinder are timed so they occur at intervals that create a smooth-running engine and quiet performance.

(4) Exhaust stroke: During the exhaust stroke, the turning crankshaft forces the piston back up the cylinder, the exhaust valve (or valves) opens, and the pistonpushes out the burnt air/fuel mixture past the exhaust valve.

4.3.2 CONTAINER:

Container is the major component which will helps in storage of thewater(H2o).

In the container both the copper and aluminum strips are inserted which are attached with bolts and nuts horizontally one another. This relate to the cooper wires and then connected with the battery for furtherprocess called electrolysis this electrolysis process was done within the container only.

Fig.4.3: Electrolysis Container

This container helps in producing the hydrogen gas by the electrolysis process so that it can be useful the internal combustion in engine.

In this picture there are two containers where one is contained of copper and aluminum plates are attached with the batterie so that the electricity is passed for the further process.

1st container produceses combination of both the hydrogen and oxygen where another container is contains of water which is used for oxidization of produced gas in this container it will help by dissolving oxygen in water and leaving hydrogen as it is lighter in weight floated. Floated hydrogen then sent to combustion chamber through the carburetor

4.3.3 TUBES:

These tubes are used as the carries of gases from one container to another. This tube helps to carries breakdown gases hydrogen(H) and oxygen (O2)

Fig. 4.4: Tubes

This tubes are widely used all main work is depended on the tubes this tubes are connected in between both the 1st and 2nd tubes

4.3.4 COPPER AND ALUMINUM STRIPS:

This aluminum and copper strips are the major components of electrolysis process Aluminum and copper act as positive electrode(anode) and negative electrode (cathode) with the help of this water(H2o) will be breakdown into Hydrogen(H) and oxygen(o2)

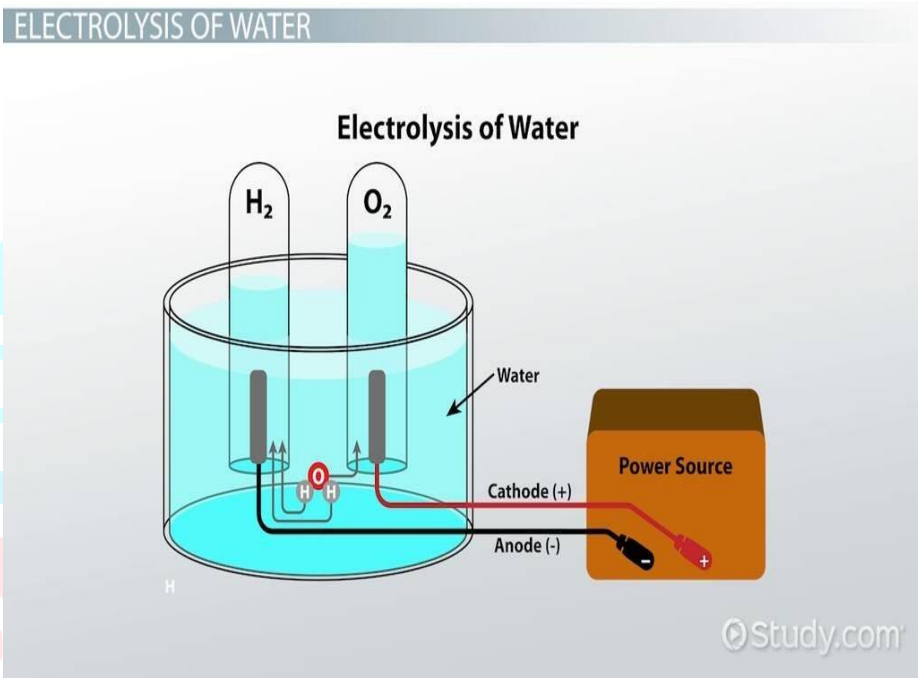

Fig. 4.5: Copper and Aluminium strips arrangement

After that breakdown gases will send to another container which is fill with water so oxygen is dissolved in water and the hydrogen sent to engine for later combustion

4.3.5 BATTERIES

Batteries and similar devices accept, store, and release electricity on demand. Batteries use chemistry, in the form of chemical potential, to store energy, just like many other everyday energy sources.

Fig. 4.6: Battery

By this positive terminal is connected to the copper and negative terminal isconnected to the aluminum so that the electrolysis process is done

4.2.1 ADVANTAGES AND LIMITATIONS OF HYDROGEN ASA VEHICLE FUEL

The most compelling incentive for use ofhydrogen as a vehicle fuel is the
low pollution nature of its combustion. For fuel-air mixtures leaner than 0.65 of the stoichiometric (chemically correct) fuel-air ratio, the combustion of hydrogen in air results in essentially no harmful emissions.

The primary exhaust product is water. For mixtures between 0.65 and 0.95 of stoichiometric, certain levels of NOx (oxides of nitrogen) are produced as a result of the combination of nitrogen and oxygen from air at the high combustion temperatures. Lower NOx levels are encountered with precisely stoichiometric fuel-air mixture, although difficulties in achieving a perfectly homogeneous stoichiometric fuel-air charge prevent the use of such mixtures without deterioration of efficiency. The unique zero-pollution nature of lean-burn hydrogen engine operation makes hydrogen particularly attractive in vehicle applications which require the performance of an internal combustion engine, but the zero-pollution features previously only achievable with electric vehicles. In addition, engines operated on hydrogen are noted for their high thermal efficiency. A hydrogen fueled vehicle can be expected to achieve higher miles per BTU ratings than equivalent vehicles operated on gasoline or diesel fuel. Several disadvantages of hydrogen must be pointed out. Hydrogen possesses substantially different combustion properties than most common fuels. These are summarizedin Table 1.

A hydrogen-air mixture can be ignited much more 3easily than mixtures of other common fuels with air. This is fundamentally due to the very wide flammability limits, and the very low minimum ignition energy of hydrogen in air. One important ramification of these properties is that special fuel handling procedures must be observed to assure safe refueling and operation of a hydrogen vehicle. An additional ramification of hydrogen's ignitability is the tendency of hydrogen engines to backfire in the intake manifold when conventional gaseous fuel carburetion equipment is used for the conversion of the engine. One of the key technical tasks of this project was elimination of this backfire problem.

These are summarized in Table 2. It was originally proposed that a metal hydride fuel storage system be used for fuel storage on the bus. Due to budgetary limitations, this phase of the project was not funded. Therefore, the least expensive means for on-board hydrogen storage was selected. This was compressed storage in high pressure cylinders. This method suffers from a poor hydrogen density per system weight and per system volume. For the bus, nine pressure cylinders are used to provide approximately one hour of operation in typical service. Details of this system are provided later in this report

4.2.2 Fuel Injection Development

The development of a means for elimination of backfiring in hydrogen engines was a problem that required a solution in order to achieve acceptable operational characteristics for the bus. Considerable effort was made to better understand the reasons behind backfiring and then to implement a means for preventing backfiring and achieving adequate engine power output levels. Although the problem of induction ignition is not unique to hydrogen, it is certainly more pronounced with hydrogen than with other gaseous or liquid fuels. This is fundamentally due to the exceptionally low minimum ignition energy (0.02mJ at

~=1) and the wide flammability limits (0.21 < ~ < 7.34) of a hydrogen air mixture. The equiva1ence ratio ~ is defined as the actua1 fuel-air molar ratio divided by the stoichiometric or chemically correct ratio. Several mechanisms by which a backfire may be initiated have been identified or suggested. The surfaces of the exhaust valve, piston or spark plug can ignite 6a fuel-air charge if their temperatures are sufficiently high. Combustion chamber hot spots can also be conducive to backfiring, due to their high local temperatures. This situation may be accentuated by the very small (0.6 mm for 0=1) surface quenching distance of the hydrogen-air mixture. The catalytic effects of some materials contacted by the fuel-air charge in the combustion chamber have also been identified as mechanisms by which ignition can occur at decreased temperatures. The presence of deposits caused by the pyrolysis of lubricating oil have been shown to cause ignition, even while average surface temperatures are acceptably low. The temperatures of small particles attached to combustion chamber surfaces or suspended in residual exhaust gas at the end of the exhaust stroke can be significantly higher than the average surface temperatures, due to the small thermal mass and poor heat transfer of these particles. At the beginning of the intake stroke, these particles may be of sufficient temperature to serve as ignition sites for the incoming fuel-air charge.

They suggest that as the incoming hydrogen-air mixture is combined with unavenged residua 1 exhaust gases, its temperature increases and its composition is diluted; but the temperature of the first introduced hydrogen-air mixture increases more rapidly than the mixing process can dilute the composition below its flammability point. As a result, ignition of the intake charge may occur. Thishypothesis might be extended to account for the situation in which valve overlap allows the backflow of exhaust products into the intake manifold, which occurs especially under high load, low RPM conditions. Ignition of the intake fuel-air charge has also been attributed to undesired firing of the spark plug due to electromagnetic cross-induction between spark plug leads, or individual ignition coils if used.

In the previous work of this investigator and others at UCLA, several geometries of electronically controlled hydrogen fuel injection were evaluated as possible means for avoiding the backfire problem.

The essential features of both direct and port injection systems are that:

1) no combustible fuel-air charge is present in the intake manifold, and

2) fuel delivery may be delayed somewhat after the intake of air has begun. The delayed fuel delivery feature allows for quench cooling of residual exhaust gases and potential ignition sites having low thermal masses. These include deposits and suspended particles from oil pyrolysis, and sufficiently small combustion chamber hot spots. The absence of fuel in the intake manifold ensures that should induction ignition occur; it will only involve the charge of a single cylinder rather than the entire contents of the intake manifold. The resulting backfire is better

described in the same context as ignition 11 miss, 11 much 1ess consequential than the backfire of a carbureted hydrogen engine. For the bus application, a port injection approach was selected. Th is is especially true as equivalence ratios approaching stoichiometric are used, since complete combustion of a stoichiometric mixture required perfectly homogeneous mixing of the fuel and air. This is extremely difficult to accomplish entirely during the compression stroke since turbulent mixing effects from the intake stroke are largely diminished.

Other 8 limitations of direct injection are the requirement for a hydrogen supply pressure higher than might normally be available from a metal hydride or liquid hydrogen vehicular storage system, and the need for a high flow injection valve capable of withstanding combustion chamber temperatures and pressures. Several design approaches to realizing timed port injection on a multi-cylinder engine were investigated. The test engine selected for system development was a 2.6-liter, 4 cylinder, 4-cycle, Mitsubishi engine normally used in several Chrysler automobiles and light trucks. A feature of this engine is the 11 MCA-Jet11 third valve which is normally used to improve the combustion efficiency of a lean fuel- air mixture with substantial EGR. The cylinder head is aluminum alloy and the engine block is cast iron. No special provisions were made to reduce lube oil entry into the combustion chamber. In fact, the rapid accumulation of greasy carbon deposits on the spark plugs indicated that significant oil was entering the upper cylinder, either past the piston rings or through the valve guides. Surface gap spark plugs and a capacitive discharge ignition system were used for all tests.

The ambient air pressure during all tests was approximately 82 kPa (620 mmHg) because of Denver's 1610 m (5300 ft) altitude. Fuel-air equivalence ratio datawere determined by analysis of exhaust oxygen content. The initial injectionconfiguration tested involved the timed injection of fuel through the third valvesunder electronic control. A single electronic fuel injector of the type previouslydescribed was used to supply all four cylinders by manifolding of all third valveinlets to the common fuel injector. In this manner, the third valves acted as selector valves since only one of these valves is open at any time. A fuel metering device as described in Figure 1 was constructed as a means of mechanically metering hydrogen mass flow to be proportion a 1 to intake air mass flow. This metering unit incorporates the throttle body and vacuum controlled slide of a standard SU carburetor. The position of the slide follows air mass flowrate in a non-linear, but one-to one relationship.

A tapered pin coupled to the slide is used to meter hydrogen flow in the lower hydrogen metering valve assembly. A differential pressure across the metering valve orifice of 221 kPa (32 psi) or greater is maintained in order to ensure sonic flow conditions in the orifice, which makes FL orate in the va1ve independent of the downstream intake manifold pressure.

By selectively cutting an appropriate (experimentally determined) taper on the metering pin, a relationship between hydrogen and air flow rate is established which can be either held constant, or varied with air flow. In our engine tests using this metering unit, a constant fuel-air ratio was maintained over the entire range, except at low flowrates and idle condition where a leaner fuel-air ratio was used. This metering unit was emp 1oyed to supply hydrogen to the third va 1ve manifold. This configuration allows the separate delivery of fuel, but since the third valve opens simultaneously with the main intake valve, independent timing of fuel delivery was not possible. Tests of the engine using this setup provided similar results to those obtained for electronic injection timing at TDC. Backfiring occurred for engine loads greater than 345 kPa (50 psi) BMEP (Brake Mean Effective Pressure) at engine speeds above 2500 RPM. A means by which hydrogen flow from the fuel metering unit may be timed was devised using a rotary valve as depicted in Figure 2. Hydrogen enters the 10rotary valve through the central inlet port, and is distributed to the appropriate cylinder by the rotation of the valve shaft, which is driven through a 2 to 1 reduction timing belt drive from the crankshaft. The total duration that each of the out1ets is open is 163 degrees of crankshaft rotation, although the majority of flow occurs within the central 81° of this period

Timing of fuel delivery is adjusted by rotation of the valve assembly in its mounting bracket. Hydrogen flows from each of the out1et ports to nozzles located just upstream of each intake valve in the intake ports. Tests were conducted using the metering unit - rotary valve combination. With the injection period located between 15°ATDC and 178°ATDC, backfiring was not observed atany speed or load setting.

It was observed that with cool ant temperatures higher than 71 °C (160°F), specifically 82°C (180°F), backfiring would occur after approximately 30 seconds of continuous operation at the maximum power condition. Conversely, even with coolant temperatures as low as 54°C (130°F), backfiring would occur immediately during full throttle runs if the injection initiation position was advanced to prior to TDC or retarded to later than 60°ATDC. For injection timing later than approximately 60°ATDC, injection flow continues after the point of closure of the intake valve leaving some hydrogen entrained just upstream of the intake valve, which 11is inducted at the beginning of the next intake stroke. Only with decreased coolant temperatures and injection initiation between 10° and 20°ATDC was backfiring eliminated under all conditions. The results of full-throttle variable RPM tests of this configuration are shown in the lower data of Figure 4. For these runs, a fixed ignition timing position of 19°BTDC was used. No backfiring was observed during these tests. To investigate improved power output of the engine, a turbocharger and charge air cooler were fitted. The turbocharger was an IHI RHOS unit with internal adjustable wastegate. This would normally be considered too small a turbocharger for this engine displacement if the engine were operated on gasoline, but was selected because the lower exhaust heat content of a 1ean operated hydrogen engine dictates the use of a sma11er turbine in the turbocharger. Engine tests showed that positive boost pressure was available at 2000 RPM with full 10 psi boost available at 2500 RPM (limit set by the wastegate). However, the compressor efficiency drops off rapidly for engine speeds greater than 3500 RPM such that only 4 psi boost is available at 4000 RPM. A somewhat larger turbocharger would be optimum for this engine. A different metering pin was used in the fuel metering unit, and the hydrogen supply pressure was increased to 414 kPa (60 psi) to provide a richer fuel-air ratio of 0 = 0.7±.05. The liquid-to-air charge air cooler maintained the intake air temperature between 60 and 80°C (140 and 176°F) during these runs.

The resulting timing curve was timing at TDC for 1500 RPM and less, linearly increasing to 12°BTDC at 3000 RPM, and constant at 12° above 3000 RPM. 12Full-throttle, variable RPM test results of the turbocharged, injected engine are shown in the upper data of Figure 4. The roll-off in power above 3500 RPM shown in Figure 4 was due to the decrease in turbocharge boost above this speed. As before, the engine coolant temperature was limited to 71°C (160°F).

Each data point represents a 120 second continuous run at full throttle. No backfiring was observed during these tests. It was observed that if the ignition timing was abnormally advanced to the point of audible knock, backfiring would result within approximately 15 seconds of operation at the 3500 RPM maximum power point. This is presumed to be due to excessive average temperatures of combustion chamber surfaces induced by the knock condition. From the data and observations of these tests, certain conclusions were drawn. Induction ignition can be caused by excessive temperatures of large thermal mass combustion chamber surfaces such as the cylinder walls, valves, piston or spark plug, or by low thermal mass sites with cyclically varying temperatures such as surface deposits, suspended pyrolysis products or hot residua 1 exhaust gases. Avoidance of induction ignition required both the maintenance of acceptably low average temperatures of the large thermal mass surfaces, and the provision for convective cooling of the small thermal mass sites prior to the delivery of fuel to the cylinder.

Improved cooling of the cylinder head, piston and valves, and the use of very cold spark plugs is indicated to achieve the 1ower average temperatures. Timed fue1 injection provides a means of de 1ayed fue1 de 1i very in order to pre-coo1 the small thermal mass sites and residual exhaust gases.

The fuel injection system developed for the 2.6L. Chrysler-Mitsubishi engine was up-scaled for use on the eight-cylinder engine of the bus. The engine supplied in the FMC bus was a Chrysler 440 in. 3 displacement V-8 industrial engine. The condition of the engine as delivered from the RTD was extremely poor, so that a complete rebuild was required. Preliminary design effort had been directed toward the use of a Ford 351 in. 3 V-8 industrial engine which would have replaced the diesel engine in the originally proposed Vetter's mall transit bus. This design work was modified to accommodate the larger Chrysler engine.

The Chrysler engine was a poor candidate for hydrogen conversion. Its wedge configuration combustion chamber generates low turbulence, so that poor combustion efficiency and excessively high engine operation temperatures are problems.

CHAPTER-5

5.1 METHODOLOGY

HHO gas was generated by electrolysis process and the generator integrated to the petrol engine. The experiment was done on single cylinder 180cc SI engine at a constant speed. load was varied along with HHO gas. HHO gas was varied by varying the current supplied to the generator.

Amperes Used were 1, 2 and 3 amperes with DC supply of 12 volts. HHO gas was supplied along with air through intake manifold. From the results it was observed that, at full load and at 3 ampere current total reduction in fuel consumption was about 18.87% compared with

normal petrol engine. This was due to better combustion. After hydrogen enrichment at full load and at 3 ampere, brake thermal/eminency was increased by 3.72%. Also, HC was

decrease by 28.33% at full load CO was reduced to 1.42% from 1.7% by volume at 3 amperes current supply.

The main reason was presence of oxygen which came along with hydrogen fuel enhances complete combustion. Oxy- Hydrogen gas is produced in common ducted electrolyze & then sent to the intake manifold to introduce into combustion chamber of the engine. Oxy- Hydrogen gases will combust in the combustion chamber when brought to its auto-ignition or self-ignition temperature. The minimum energy required to ignite such a mixture with a spark is about 20 micro joules. At normal temperature and pressure-Hydrogen gas can burn when it is between about 4% and 94% hydrogen by volume. When ignited, the gas mixture converts to water vapor and releases energy.

The amount of heat released in independent of the mode of combustion, but the temperature of the flame varies.

The maximum temperature of about 2800oC is achieved with a pure stoichiometric mixture, about 700oC hotter than hydrogen flame in air. Oxy-hydrogen gas has very diffusivity. This ability to disperse in air is considerably greater than gasoline and it is advantageous in mainly two reasons. Firstly, it facilitates the formation of homogeneous air fuel mixture and secondly if any leak occurs it can disperse at rapid rate. Oxyhydrogen gas is very low in density.

The engine selected for the experiment was duel twin spark plug, c80cc with specifications of carburetor type Pulsar 1 bore and stroke as63.5x56.4 having Amax. power of 17.02HP @ 8500 rpm and max. torqueof 14.22 Nm @ 6500 rpm.HHO

Generator: - Component requirements for the Generator are Hydrogen cell, connection pipes, Cold rated spark plug, Bubbler, Water tank, KOH, Battery (12 V, 32 A). A typical dry cell generator is shown. As shown each plate in the generator comes with a gasket to prevent leakage of water. Hear, electrolyte was stored in a tank connected to the generator. The HHO gas generated here is served back into the same tank. In this process the electrolyte circulates through thesystem due to its gravity.

5.2 EXTRACT ENERGY FROM WATER:

Energy was extracted with the help of electrolysis process which was in existence. A DC electrical power source is connected to two electrodes, or two plates (typically made from an inert metal such as platinum or iridium) that are placed in the water. Hydrogen appears at the cathode (where electrons enter the water), and oxygen at the anode. Assuming ideal faradaic efficiency, the amount of hydrogen generated is twice the amount of oxygen, and both are proportional to the total electrical charge conducted by the solution. However, in many cells competing side reactions occur, resulting in additional products and less than ideal faradaic efficiency.

Electrolysis of pure water requires excess energy in the form of overpotential to overcome various activation barriers. Without the excess energy, electrolysis occurs slowly or not at all. This is in part due to the limited self-ionization of water. Pure water has an electrical conductivity about one-millionth that of seawater. Many electrolytic cells lack requisite electrocatalysts. Efficiency is increased through the addition of an electrolyte (such as a salt, an acid or a base) and electrocatalysts.

Required equations

Cathode(reduction): $2\ H_2O(l) + 2e^- \rightarrow H_2(g) + 2\ OH^-(aq)$

Anode (oxidation): $2\ OH^-(aq) \rightarrow 1/2\ O_2(g) + H_2O(l) + 2\ e^-$

This electrolysis process is done with the help of two types of water they are:

Pure water

Electrolyte-free pure water electrolysis has been achieved via deep-sub- Debye-length nanogap electrochemical cells. When the gap between cathode and anode are smaller than Debye-length (1 micron in pure water, around 220 nm in distilled water), the double layer regions from two electrodes can overlap, leading to a uniformly high electric field distributed across the entire gap. Such a high electric field can significantly enhance ion transport (mainly

due to migration), further enhancing self-ionization, continuing the reaction
and showing little resistance between the two electrodes. In this case, the two half-reactions are coupled and limited by electron-transfer steps (the electrolysis current is saturated at shorter electrode distances).

Sea water

Ambient seawater presents challenges because of the presence of salt and other impurities. Approaches may or may not involve desalination before electrolysis. Traditional electrolysis produces toxic and corrosive chlorine ions and ClO^-

Multiple methods have been advanced for electrolyzing unprocessed seawater. Typical proton exchange membrane (PEM) electrolysis requiredesalination.

Fig.5.2: Test to know the presence of hydrogen

5.3 CLAIMS ON WATER FUEL ENGINE:

5.3.1 Garret electrolyte process

Charles H. Garrett allegedly demonstrated a water-fueled car "for several minutes", which was reported on September 8, 1935, in The News. The car generated hydrogen by electrolysis as can be seen by examining Garrett's patent, issued that same year.[This patent includes drawings which show carburetor similar to an ordinary float-type carburetor but with electrolysis plates in the lower portion, and where the float is used to maintain the level of the water. Garrett's patent fails to identify a new source

Water Succeeds Gasoline As New Invention Is Perfected

WATER powered automobiles are predicted for the not too distant future as the result of an invention of G. H. Garrett of Dallas, Texas, which substitutes water for gasoline.

Garrett uses an electrolytic carburetor which breaks up water by electrolysis into its component gases, hydrogen and oxygen, and then forces the explosive hydrogen into the combustion chambers for fuel.

For operating the automobile motor on which the tests have been conducted, Garrett has added an over-size generator to supply the extra electricity needed by the carburetor. Beyond that, the motor has needed no changes, though it has been in operation continuously for several days.

Garrett has protected his device with patents.

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.

Fig. 5.1: Garret water powered prototype

5.3.2 Stanley Meyer's water fuel cell:-

Stanley Meyer's water fuel cell At least as far back as 1980, Stanley Meyer claimed that he had built a dune buggy that ran on water, although he gave inconsistent explanations as to its mode of operation.

In some cases, he claimed that he had replaced the spark plugs with a "water splitter", while in other cases it was claimed to rely on a "fuel cell" that split the water resonance, would split the water mist into hydrogen and oxygen gas, which would then be combusted back into water vapor in a conventional internal combustion engine to produce net energy. Meyer's claims were never independently verified, and in an Ohio court in 1996 he was found guilty of "gross and egregious fraud". He died of ananeurysm in 1998, although conspiracy theories claim that hewas poisoned

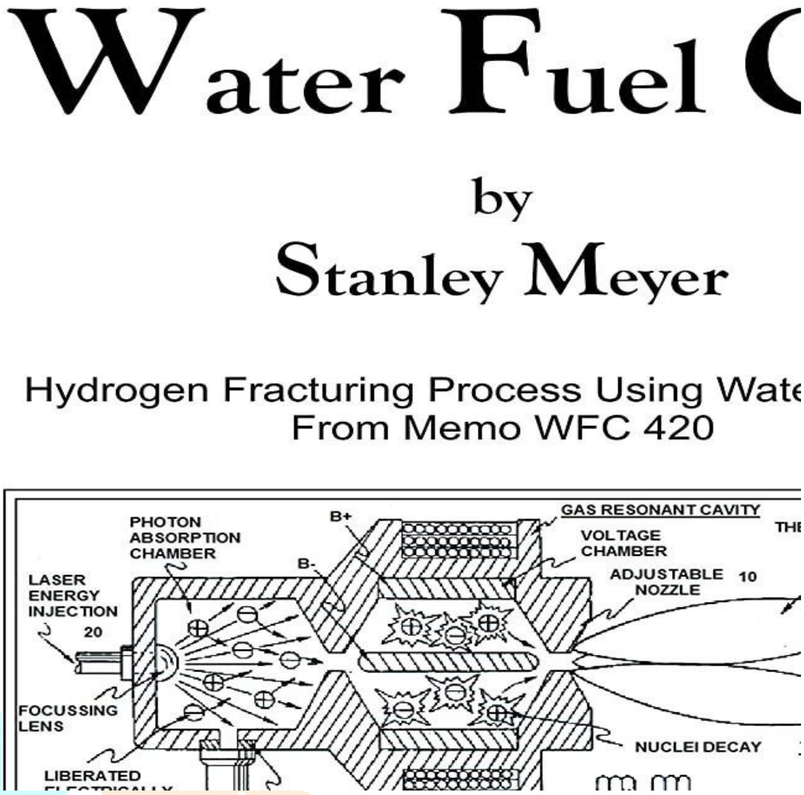

Fig. 5.2: Stanley Meyer's water fuel cell

5.3.3 Dennis Klein: -

In 2002, the firm Hydrogen Technology Applications patented aselectrolyze design and trademarked the term "Aquagenic" to refer to thehydrogen oxygen gas mixture produced by the device. Originallydeveloped as an alternative to oxyacetylene welding, the company claimed to be able to run a vehicle exclusively on water, via theproduction of "Aquagenic", and invoked an unproven state of matter called "magnegas" and a discredited theory about magnecules to explaintheir results. Company founder Dennis Klein claimed to be innegotiations with a major

US auto manufacturer and that the US government wanted to produce Hummers that used his technology. At present, the company no longer claims it can run a car exclusively on water, and is instead marketing "Aquagenic" production as a technique to increase fuel eminency, thus making it Hydrogen fuel enhancement rather than a water fuel car.

Fig. 5.3: Dennis Klein prototype

5.3.4 Genesis World Energy (GWE): -

Also in 2002, Genesis World Energy announced a market ready device which would extract energy from water by separating the hydrogen and oxygen and then recombining them. In 2003, the company announced that this technologyhad been adapted to power automobiles.

The company collected over $2.5 million from investors, but none of their devices were ever brought to market. In 2006, Patrick Kelly, the owner of Genesis World Energy was sentenced in New Jersey to five yearsin prison for theft and ordered to pay $400,000

Fig. 5.4: Genesis World Energy

5.3.5 Genepax Water Energy System: -

In June 2008, Japanese company Genepax unveiled a car it claimedran on only water and air, and many news outlets dubbed the vehicle a"water-fuel car". The company said it "cannot [reveal] the core part ofthis invention" yet, but it disclosed that the system used an onboardenergy generator, which it called a "membrane electrode assembly", toextract the hydrogen using a "mechanism which is similar to the method inwhich hydrogen is produced by a reaction of metal hydride and water". The hydrogen was then used to generate energy to run the car. This led to speculation that the metal hydride is consumed in the process and is the ultimate source of the car's energy, making it a hydride-fueled "hydrogen on demand" vehicle rather than water-fueled as claimed. On the company's website the energy source is explained only with the words "Chemical reaction". The science and technology magazine Popular Mechanics described Genepax'sclaims as "rubbish".

The vehicle Genepax demonstrated to the press in 2008 was a REVAi electric car, which was manufactured in India and sold in the UK as the G- Wiz. [*citation needed*] In early 2009, Genepax announced they were closing their website, citing large development cost

Fig. 5.5: Genepax Water Energy System

5.3.6 Thushara Priyamal Edirisinghe: -

Also in 2008, Sri Lankan news sources reported that Thushara Priyamal Edirisinghe claimed to drive a water-fueled car about 300 km (190 miles). On 3 liters (5.3 imperial pints) of water. Like other alleged water-fueled cars described above, energy for the car was supposedly produced by splitting water into hydrogen and oxygen using electrolysis, and then burning the gases in the engine.

Thushara showed the technology to Prime Minister Ratnasiri Wickramanayake, who "extended the Government's full support to his efforts to introduce the water-powered car to the Sri Lankan market". Thushara was arrested a few months later on suspicion of investment fraud

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Fig. 5.6: Thushara Priyamal Edirisinghe

5.3.7 DANIEL DINGLE WATER FUEL: -

Daniel Dingle, A Filipino inventor, has been claiming since 1969 to have developed technology allowing water to be used as fuel. In 2000, Dingle entered into a business partnership with Formosa Plastics Group to further develop the technology. In 2008, Formosa Plastics successfully sued Dingle for fraud and Dingle, who was 82, was sentenced to 20 years' imprisonment.

Fig. 5.7: Daniel Dingle water fuel

5.3.8 Ghulam Sarwar: -

In December 2011, Ghulam Sarwar claimed he had invented a car that ran only on water. At the time the invented car was claimed to use 60% water and 40% Diesel or fuel, but that the inventor was working to make it run on only water, probably by end of June 2012. It was further claimed the car "emits only oxygen rather than the usual carbon".

Fig. 5.8: Ghulam Sarwar water fuel car

5.3.9 Agha Waqar Ahmad: -

Pakistani man Agha Waqar Ahmad claimed in July 2012 to have invented a water-fueled car by installing a "water kit" for all kind of automobiles, which consists of a cylindrical jar that holds the water, a bubbler, and a pipe leading to the engine. He claimed the kit used electrolysis to convert water into "HHO", which is then used as fuel. The kit required use of distilled water to work.

Ahmed claimed he has been able to generate more oxyhydrogen than any other inventor because of "undisclosed calculations". He applied for a patent in Paki. Some stan.[Pakistani scientists said Agha's invention wasa fraud that violates the laws ofthermodynamics.

Fig. 5.9: Agha Waqar's water-fueled car

CHAPTER - 6

6.1 RESULT: -

- Hydrogen is produced and used in the fuel combustion.
- Produced hydrogen is passed through carburetor and then suppliedto the engine so that the combustion has been done.
- Hydrogen production in electrolysis tank is taking more time.

- Effect of production rate of hydrogen gas with variation of appliedvoltage in 0.1 mole electrolyte concentration of solution (at ambient temperature and pressure).
- Hydrogen Powered through 4-Stroke S.I. Engine (HHO Engine)

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[2] State of New Jersey Department of Law and Public Safety press release Archived June 22, 2008, at the Wayback Machine, November 9, 2006.

[3] C. H. GARRETT 6 ELECTROLYTIC CARBURETOR Original Filed July 1, 1952 2 Sheets-Sheet l LEI-55-1.}- (W/65d Garrett uvvzm' R A TTORNE Y July 2, 1935. c. H. GARRETT 2,006,676 ' ELECTROLYTIC CABBURETQR Original Filed July 1, 1952 2 Sheets-Sheet 2 CW/esli- Garrett m v z m ATTORNEY Patented July 2, 1935 Application July 1, 1932, Serial No..620,364 I Renewed November 30, 1934 Claims.

[4] Stanley Mayer (August 24, 1940 – March 20, 1998). Water fuel cell is a technical design of a "perpetual motion machine" .Meyer claimed that a car retrofitted with the device could use water as fuel instead of gasoline. Meyer's claims about his "Water Fuel Cell" and the car that it powered were found to befraudulent by an Ohio court in 1996.

[5] Charles Frazer, an inventor from Ohio who, in 1918 patented a hydrogen booster which claimed to use electrolysis to increase vehicle power and fuel efficiency while greatly reducing exhaust emissions. US4414071A *1980-04- 221983-11-08Johnson, Matthey & Co., Limited Electrode.

[6] Daniel Dingel said he began working on his hydrogen reactor in 1969, and claimed to have used the device to power his 1996 Toyota Corolla. Dingel explained that his invention splits from water in an onboard water tank, producing hydrogen and does not produce any carbon emissions.

[7] Dennis J. "Denny" KLEIN Obituary KLEIN, Dennis J. "Denny" 73, passed away suddenly on Aug. 29, 2013. He was an entrepreneur his whole life with a passion for life and world energy. He was determined to make this world a cleaner, betterplace.

http://www.legacy.com/obituaries/tampabaytimes/obituary.aspx?pid=166922928

[8] Professor doubts water car claims – A leading alternative fuels expert throws water on Japanese company claims that it is developed the world's first car powered by just water. Archived June 10, 2010, at the Wayback Machine Ball, Philip (September 14, 2007). "Burning water and other myths". Nature News:10.1038/news070910-13. S2CID 129704116. Archived from the original on April 17, 2020. Retrieved September 14, 2007.