



Thank you for deciding to install the cargoh2o water conversion kit. Please take the time to view your bonus products from the member's only area. This will help you understand the water conversion process and will give you more options when installing the device.

Introduction

It is recommended that you trial this system initially on a second car, one that doesn't have to be used daily, until you are confident with the technology.

The plans that make this system DIY (do it yourself) allow all of us to make a difference. This system is the simplest and most cost-effective way to convert your vehicle to run on (almost) free energy.

With technology that is already available, we can all make a difference to the environment by making a reduction in pollution from vehicles and to our pockets by getting rid of petrol expenses. We can assist in the repairing of our atmosphere and provide ourselves and others with better quality air to breathe.

Using this plan allows you to use all of your existing engine components with the exception of the fuel tank and the catalytic converter.



Now let's get started!

The Plan

You can build and install a cheaper alternative system to run the internal combustion engine in your vehicle on plain tap water, using components that are readily available. This system is just an efficient conversion of tap water (H₂O) into gaseous hydrogen and oxygen. These gases are then burnt in your engine instead of gasoline.

This system will run from the battery and electrical system already in your vehicle and can be attached to your carburetor using fittings readily available.

You will need to install the following items:

A plastic water tank

A control circuit

A reaction chamber

A high pressure fitting for your carburetor or fuel injector

Three gauges

This system is very simple as it is “on demand” and therefore doesn't need complicated storage or plumbing. As you use the throttle you are creating more vapor that will be immediately used when it is needed, with variable flow from low idle to maximum revs.

The only difference is that the fuel you are using is tap water rather than the old fashioned petroleum based fuel (gasoline). If you had the choice, which fuel would you use?

Frequently Asked Questions

Q: Does this actually work?

A: Yes. This technology dates back to the creation of stainless steel. However, you must follow all instructions regarding the proper mechanical and **electrical** assembly of the components as it combines the best ideas of a number of techniques.

Q: How can you say that this is “free energy”?



A: If you pay for your water, then it isn't actually "free", but in comparison to the rising costs of gasoline it is much much less expensive and the hydrocarbon pollution that gasoline causes won't occur with this alternative fuel.

Q: Is this a safe fuel?

A: It is a safer alternative to fossil fuel because it doesn't result in toxic emissions. It is as safe to use as gasoline as you will be including some safety devices in your installation, using the standards of motor vehicle manufacturers.

Q: Does this affect the performance of my vehicle?

A: Providing you adjust the system appropriately, the vapor-only system will run cooler, resulting in a small increase in power. The fuel economy expectations with this design range from 50 – 300 mpg (using water), according to your adjustments.

Q: Could I do the modifications on my own, without a professional?

A: It is possible. Even if you are a novice with anything mechanical, you can ask someone with basic mechanical or electrical skills to do some of the work for you. If your vehicle has a fuel-injection system, you may need to seek a mechanic's advice. (An adapter is required for a fuel injection system just as if you were converting your vehicle to run on propane, hydrogen or natural gas.)

Q: What kind of impact on the environment will my vehicle have?

A: Your vehicle will produce water vapor and unburnt oxygen. As a result, it has the ability to clean the environment rather than pollute it with nasty toxins. Any unused vapor converts to steam or oxygen. Other people will notice!

Q: So, is this just another type of steam engine?

A: No, it isn't, because it does not rely on very high temperatures and pressure as do steam engines. Your vehicle still has an internal combustion engine which burns orthohydrogen. The steam in the exhaust is a mere by-product.

Read This!

Here are some things you should know about our conventional fuel.

Petroleum as a fuel is optional – it is not the only choice.

Petroleum versus Water

Petroleum possesses a high degree of thermo-chemical energy, but water has much more. The DOE (Department of Energy) says that it is about 40%, so it is most likely more.

Most people don't understand that "internal combustion" is also referred to as "a thermo-vapor process" – this means that there is no actual liquid involved in the reaction. A large



amount of the petrol in a normal engine is consumed in the catalytic converter after it has been inefficiently used in the engine. Unfortunately, the result is that most of the fuel, rather than being burnt, is used to merely cool down the combustion and this is remarkably inefficient.

How It Works

It is really easy. The water needed to maintain the level in the chamber is pumped when it is needed. The electrodes are vibrated with an impulse of 0.5-5A which breaks $2(\text{H}_2\text{O}) \Rightarrow 2\text{H}_2 + \text{O}_2$. When the pressure reaches the level required, the engine is started and off you go. If you press the gas pedal down, this sends more energy to the electrodes and results in more vapor sent to the cylinders as fuel vapor on demand. To get the most efficient max-flow rate and best use of power, you set the idle and away you go.

Looking at the “bigger picture” your “free”/ very cheap energy results from tap water. The latent energy in the water is sufficient to make the engine work and drive the alternator and other belt-driven accessories. In turn the alternator is able to efficiently run other electrical systems. No extra batteries are needed!

STEP BY STEP CONSTRUCTION (please refer to diagrams)

Overview and sequence of steps:

1. Install the CHT gauge and record the current operating temperature range (gasoline) as a comparison.
2. Construct and check the controller to ensure that the pulse output is correct.
3. Construct the reaction chamber and check the pressure out.
4. Install the water tank, controller, chamber and pressure fittings.
5. Test run the engine and adjust the control circuit to gain optimum performance.
6. Have the pistons coated with ceramic and install stainless steel valves.
7. Coat the exhaust system with ceramic with the exception of the catalytic converter.

YOU WILL NEED

- plastic water tank with pump and level sensor
- control circuit, wiring, connectors and epoxy resin
- reaction chamber with electrodes and fittings
- 3/8” stainless steel flex-tubing, fittings and clamps
- carburetor/fuel injection vapor pressure fitting kit and level gauges
- stainless steel valves
- copper mesh junction
- ceramic coating for cylinders and pistons



- ceramic or stainless steel treated exhaust system

BASIC TOOLS

- drill, screwdriver and pliers
- hole cutter
- wire-wrap, soldering iron and clippers
- DVM and oscilloscope

REACTION CHAMBER

Build as indicated in the diagrams, using a piece of 4" PVC waste pipe that has a threaded screw cap fitting on one end and a standard end-cap on the other. Set the water level to ensure that the pipe electrodes are submersed yet there is enough headroom so that the hydrogen/oxygen vapor pressure is able to build up. Make sure that you use either stainless steel wires or apply a protective coating on them for inside the chamber and use insulated wires outside the chamber. Make sure that you have a perfect seal using either epoxy or waterproof silicone that can maintain pressure.

You may need to use a gasket or silicone to seal the screw fitting. The purpose of the screw fitting is to maintain pressure and to enable you to perform a periodic inspection of the electrodes. If it doesn't leak, you won't have any problems. You should ensure a symmetric gap of between 1-5mm between the two stainless steel pipes. It is best to have it as close to 1mm as possible. It is advisable to have the chamber level sensor checked before you glue the cap on.

The solder connections between wire and electrodes should be neat, strong and smooth and when this is so you should apply a coating which is water proof such as the epoxy resin you previously used. Make sure that the sealant you use is completely waterproof and able to withstand pressure whilst holding metal to plastic.

CONTROL CIRCUIT

A simple circuit used to operate this mini system is shown in the diagram. Your job is to create a "square-pulse" signal that can be seen on the oscilloscope – you are "playing" the electrodes as though they are a tuning fork. The concept that experts suggest is that the faster you wish your vehicle to travel, then the bigger you make the pulses entering the reaction chamber.

There is no mystery concerning the generation of a pulse waveform. The diagrams show a few of the many ways this can be done. One diagram illustrates the NE555-circuit approach from the referenced patent. You must ensure that the output switching transistor is rated for 1-5 amps @ 12VDC (in saturation).



Work out a plan that suits you, or your friendly neighborhood mechanic. Then purchase all the pieces required for the circuit from an electronics supplier. These parts should include the circuit board, IC sockets and an enclosure or box.

Make certain that the circuit board you choose has a built in ground plane and that it has room to mount 2 or 3 of the gauges. You will need to run a stub to a pressure gauge when you mount the reaction chamber in the engine bay so you can keep an eye on it.

It is simple to make 30-gauge wire wrap connections between socket pins and components that have wire leads. You should also ensure that you have the requisite spec sheets for any IC you are using.

THROTTLE CONTROL

If your vehicle is fitted with a throttle position sensor it should be possible to access its signal from either the sensor itself or the computer connector. The signal should read as primary control (ie throttle level = pulse width = vapor rate).

If your vehicle isn't fitted with a sensor, you will have to make up a variable resistor (POT) to the fuel linkage ie the throttle cable that runs to the carb or fuel injector. Use a POT that can withstand the engine temperature variables; one that is rated for long life and mechanical wear. Make sure that when you mount it in the engine compartment, it is to something that won't fall off when you push the pedal down.

Control Range. The entire throttle range from idle to maximum revs has to control the vapor rate and therefore the pulse width (duty). The resistor values must allow the voltage to drive the rate of vapor, through, for example, a 1-4 Volt swing. This voltage swing is used to generate a square pulse of 10% ON.

The circuit enables you to tune to the most efficient frequency for vapor conversion. Ensure that you have the correct specs for each IC you are using so that the pins and wires are connected properly. Use spares to try out component values before you construct the real thing.

Increase the throttle signal, putting "fatter" pulses into the electrodes. Check that you are able to obtain 10% duty on the scope. The averaging DVM will show the 90% - 10% DC voltage across the output transistor. Next, connect the DVM into the supply current and measure .5-5 amps, taking care not to blow the DVM fuse.

You can now check your wiring using the DVM to make sure that everything is flowing as it should. It is best to check each wire individually and record your findings as you go. For anything that you want to be "automatic", you can use board mounted POTs. LEDs can allow you to perform a quick visual check of the system.



CARBURETOR/FUEL INJECTION CONNECTION

Fittings are also required to the carburetor or fuel injector. You can obtain ready made kits for pressure fittings for either system. You will have to seal the built in vents to create a one way air intake.

Use copper mesh as backfire protection for the reaction chamber. All vapor and duct joins should be completely air tight and able to withstand full pressure without leaking. The system is successful if you are able to obtain full power range at lower temperatures and the minimum vapor flow without causing the pressure safety valve to blow.

CHT (or EGT)

The engine temperature should be monitored with the CHT (cylinder head temperature) or EGT (exhaust gas temperature) rather than using the existing engine temperature gauge. This gauge is not appropriate for the new system as it doesn't warn you of any overheating in time, resulting in damage of some kind. **You must ensure that the engine runs within the same temperature range as the original configuration.** You can purchase a CHT gauge with a platinum sensor – this is fitted under the spark plug against the cylinder head. It has to be really clean as it is also an electrical ground.

ENGINE/EXHAUST TREATMENT

When you have had a successful trial run of the new system, arrange for the valves to be replaced with stainless steel valves and the pistons/cylinders coated with ceramic. This should be done ASAP, otherwise these components will rust, even if you don't use the vehicle. Eventually, you will also have to have the same treatment done to your exhaust system. You won't need a catalytic converter.

GENERAL

1. Don't throw out any of the original engine components unless necessary. It is best to have a "back up". Some people run a tandem system so they can switch between systems at will.
2. Set up the circuit for the throttle to enable minimum vapor flow at **idle** and maximum flow at **full power** without causing the pressure relief valve to blow. This way you can control the mixture by the strength of the pulse.
3. If you aren't achieving enough power at any setting you will need to do one of the following: (i) change the frequency of the pulse; (ii) adjust the gap between the electrodes; (iii) increase the size of the electrodes or (iv) as a last resort create a higher output pulse voltage. Always ensure that the output transistor is rated for the current required to work efficiently. You may have to make a few adjustments – isn't that the fun part of the job?

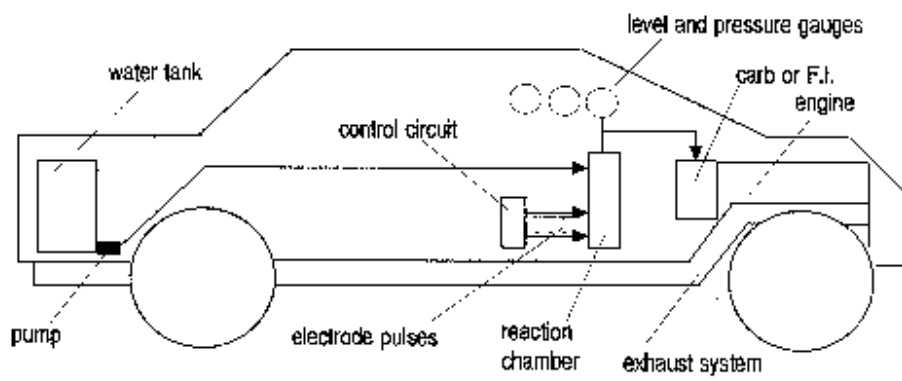


4. If you hear any engine “knock” or loud combustions that cannot be removed through timing adjustments, you will need to install another coil in the chamber and operate this coil with another pulse signal (approximately 19Hz on the .1 sec time base). This will ensure that the burn rate is reduced enough to allow the vapors to burn throughout the piston power stroke. You should also include a board mount POT to set the strength of this second pulse signal into the coil. The coil has thin wire turned approximately 1500 times that you can place around the centre pipe and directly over the 1-5mm gap in a donut shape. Make sure it doesn’t touch either electrode. You should aim for no knocking whatsoever; only smooth acceleration.
5. Be sure to build the canister as tall as possible but not so tall that they cannot be mounted near the dash panel or in the engine compartment. This will then give you the ability to increase the size of the electrodes. Everything that you mount in the engine compartment must be able to withstand all the vibrations and temperature variables that other components have to endure.
6. If there is a need for drilling through metal to allow access for wiring or plumbing, use a grommet to prevent any wiring or pipes from being cut. Ensure that the chamber pressure range is from 15-25 psi at IDLE to 30-60 psi at MAXIMUM REVS. Set the valve relief to 75 psi but ensure that it is rated to go much higher.
7. **Pull over and stop the engine any time that there is a malfunction of the system.** Your engine will last its longest when it still develops optimum power at the lowest temperature. You may have to consider using a water vapor cooling technique. Record your fuel efficiency to ensure that there is no increase in fuel use and be sure to inspect and maintain the system regularly. Keep your engine clean. Save money. Clean the air and help the planet. Have fun driving. Tell a friend about your system. Enjoy the fact that you have done this!
8. There is a lack of documented information when converting to this system via a fuel injector. You may have to find out things on your own through creating prototypes. You may have to consider injecting the hydrogen/oxygen vapor without any water vapor to prevent rusting of the injectors. If there is a concern with engine temperature and/or CHT, then perhaps you will have to consider coating the injectors with ceramic or replacing the fuel injectors with a carburetor.
9. If you have installed the water vapor cooling system you will need to make the mixture “lean” to obtain any throttle rate at the minimum vapor flow rate. Ensure that your flow does the job without killing the combustion.
10. If stainless steel pipe combinations that allow a 1-5mm gap are not available, you can use alternating plates of +/- electrodes.
11. If there is a possibility of water freezing in the system you can either (a) put 98% isopropyl alcohol into the system and adjust the pulse frequency or (b) install electric heating coils.
12. **Don’t allow ANYBODY to distract you from your dream, to take away your freedom, independence or truth.**



**CONVERT YOUR ENGINE TO BURN HYDROGEN AND OXYGEN
VAPOR FROM WATER..... ON DEMAND + POLLUTION-FREE**

FIGURE 1



**BUILD YOUR OWN WATER VAPOR SYSTEM
CONTROLLER FROM THE-SHELF MATERIALS**

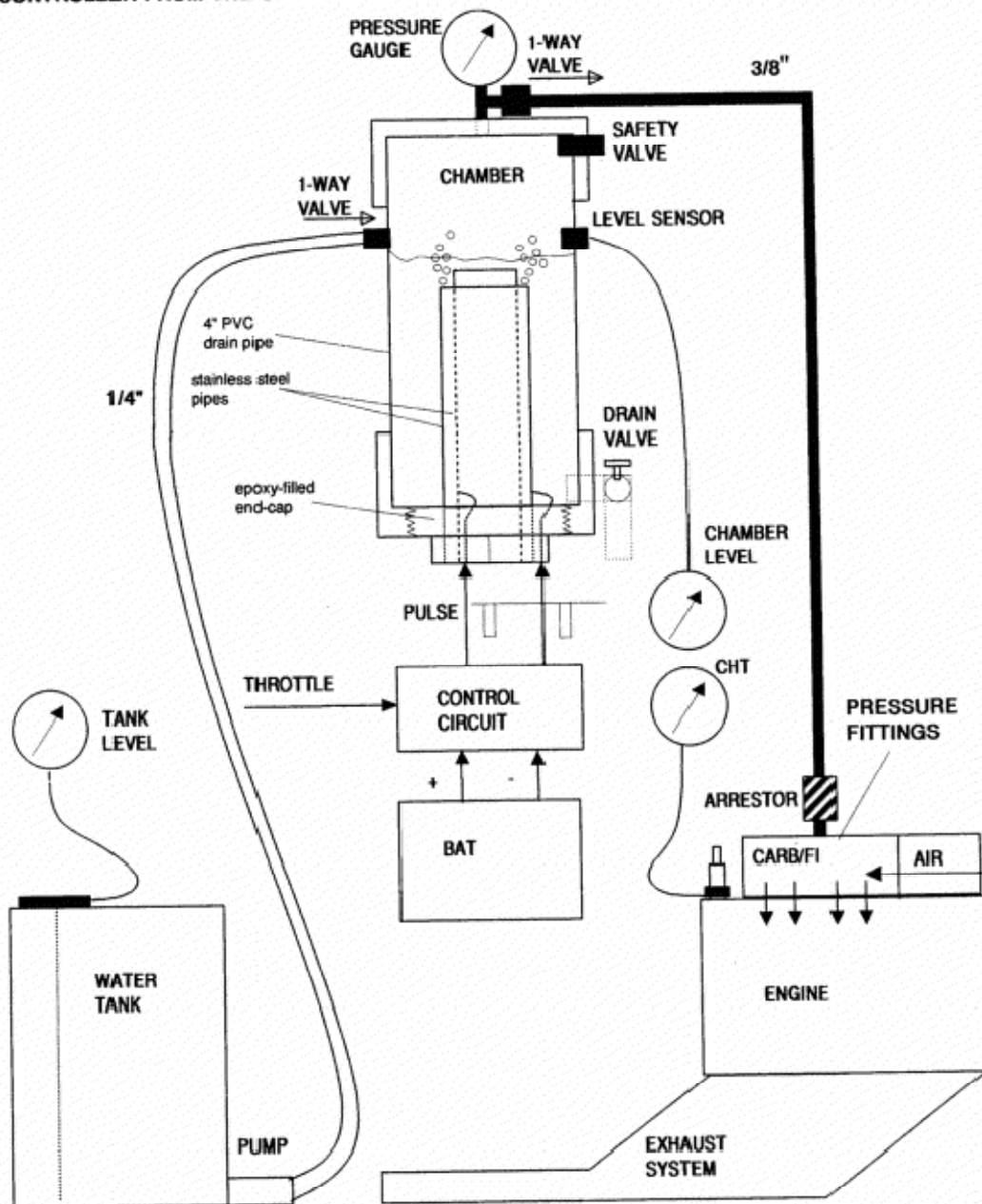


FIGURE 2 BLOC DIAGRAM



**BUILD YOUR OWN WATER VAPOR SYSTEM
CONTROLLER FROM THE-SHELF MATERIALS**

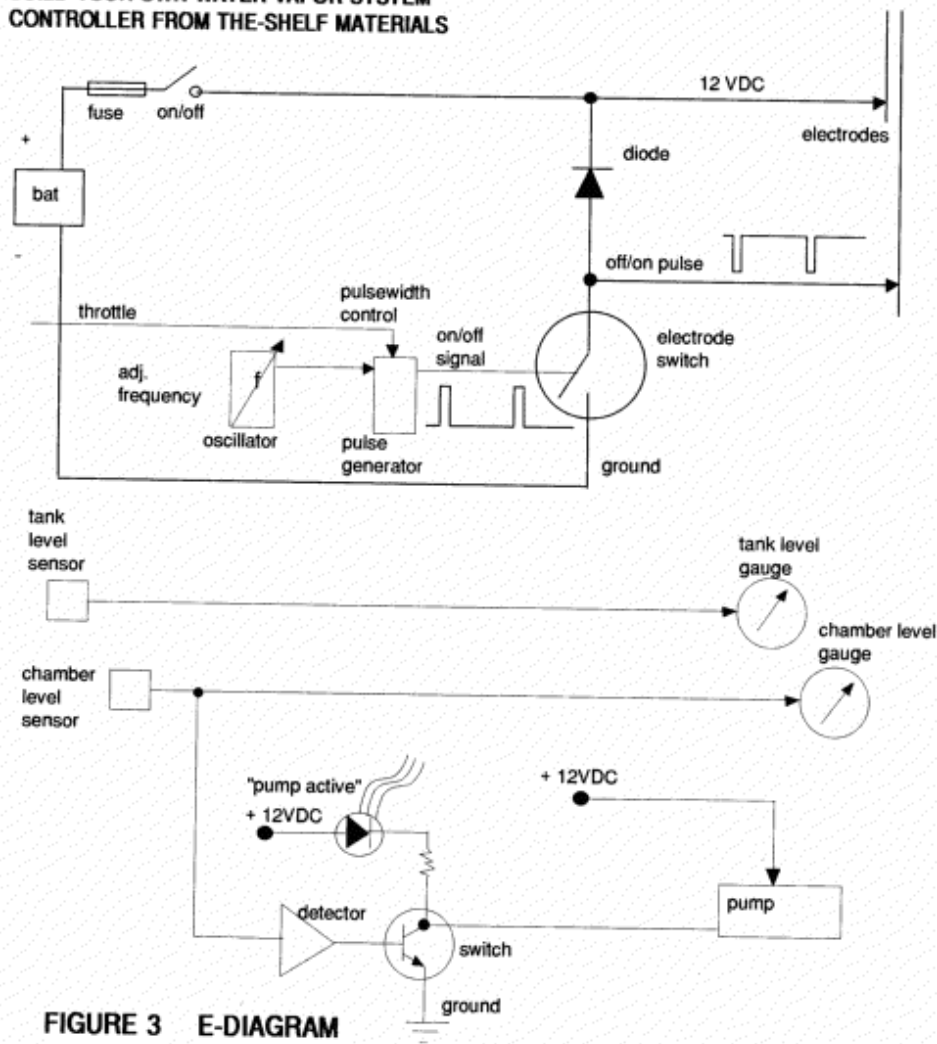


FIGURE 3 E-DIAGRAM





**BUILD YOUR OWN WATER VAPOR SYSTEM
CONTROLLER FROM THE-SHELF MATERIALS**

REV. A

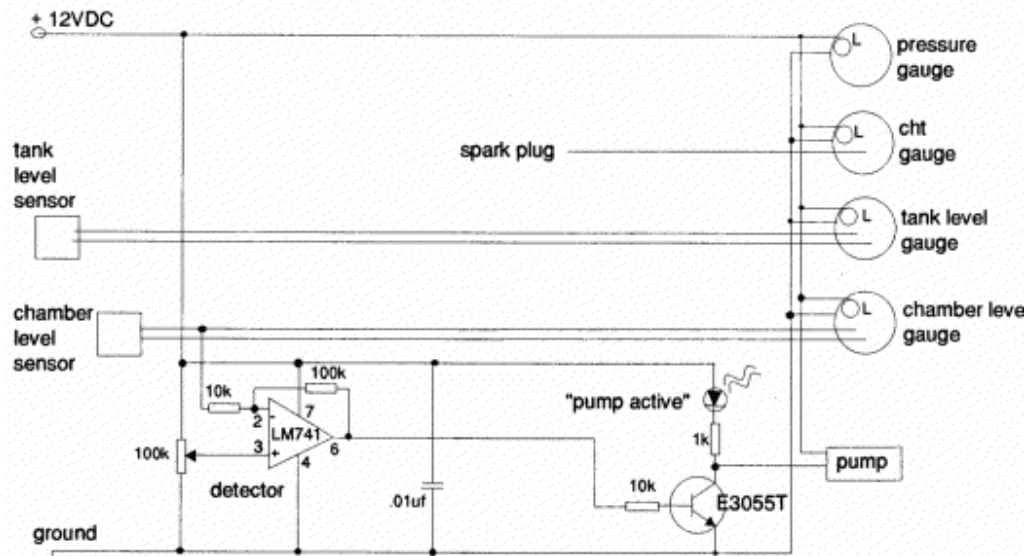
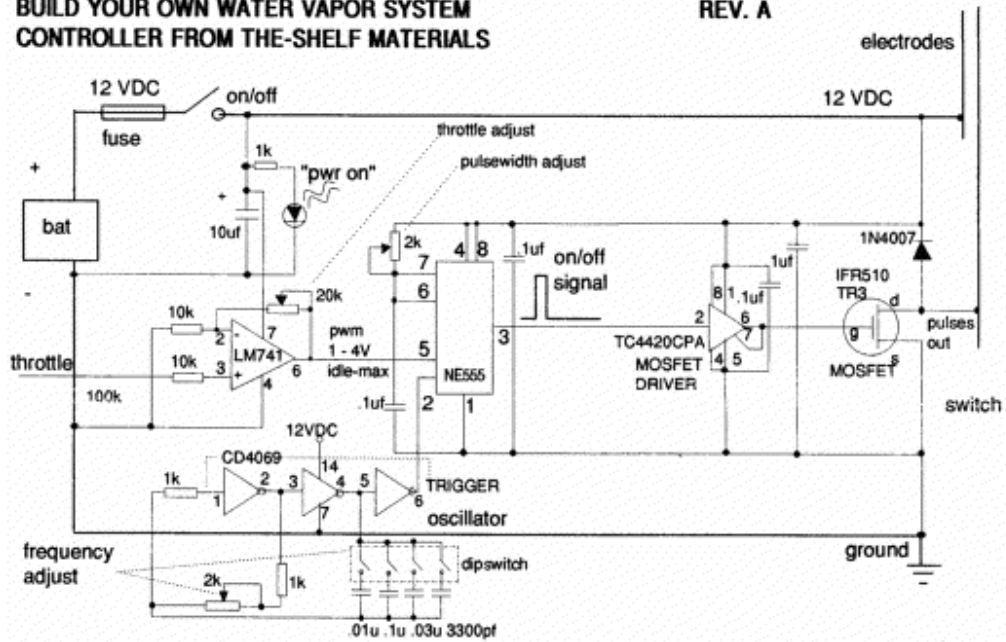


FIGURE 4 E-SCHEMATIC



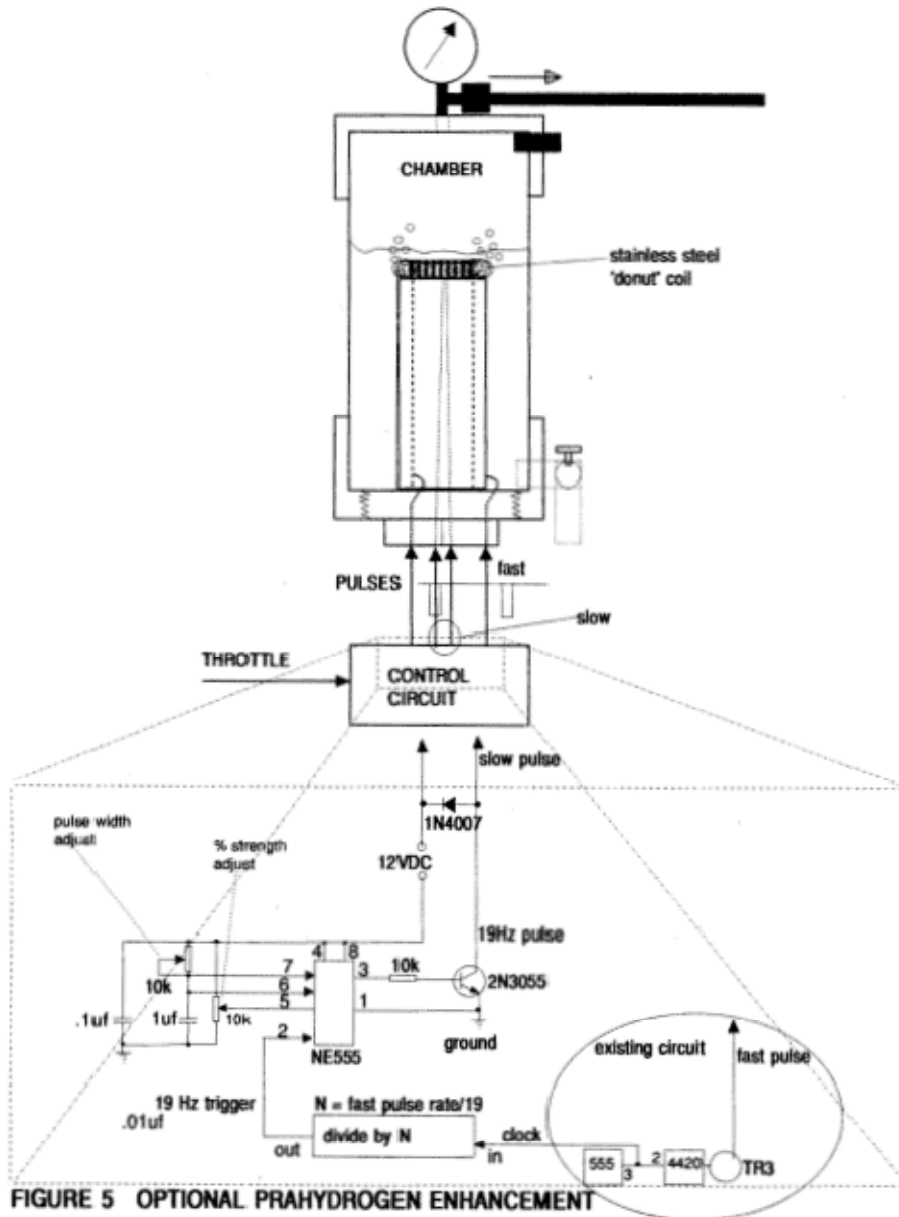


FIGURE 5 OPTIONAL PRAHYDROGEN ENHANCEMENT

**BUILD YOUR OWN WATER VAPOR SYSTEM
CONTROLLER FROM THE-SHELF MATERIALS**

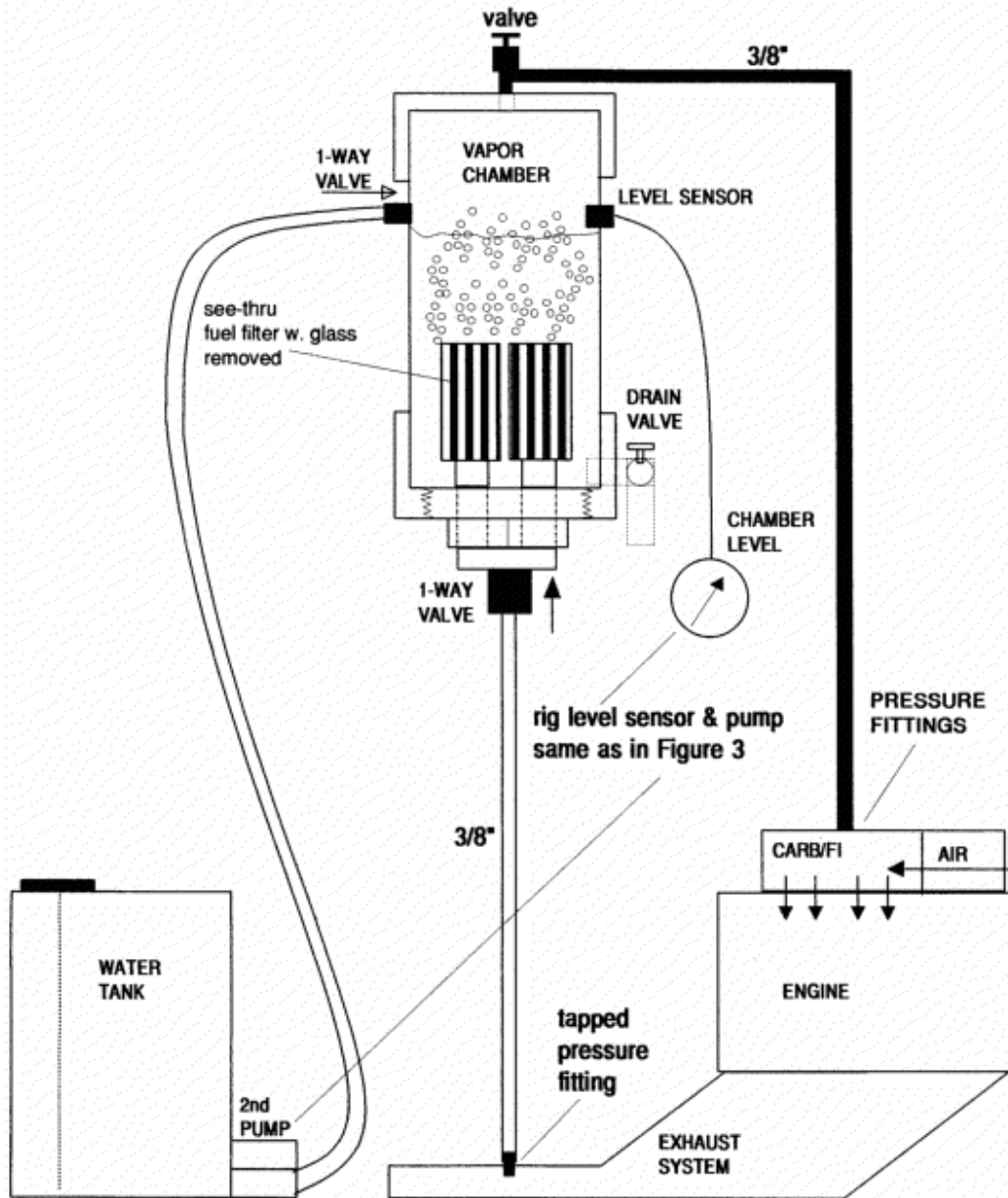


FIGURE 6 OPTIONAL WATER COOLING

REFERENCES

- Stephen Chambers 'Apparatus for Producing Orthohydrogen and/or Parahydrogen' US Patent 6126794, uspto.gov
- Stanley Meyer 'Method for the Production of a Fuel Gas' US Patent 4936961, uspto.gov
- Creative Science & Research, 'Fuel From Water', fuelless.com
- Carl Cella "A Water-Fuelled Car" *Nexus Magazine* Oct-Nov 1996



Peter Lindemann “Where in the World is All the Free Energy”, free-energy.cc
George Wiseman “The Gas-Saver and HyCO Series”, eagle-research.com
C.Michael Holler “The Dromedary Newsletter” and “SuperCarb Techniques”
Stephen Chambers “Prototype Vapor Fuel System”, xogen.com

So what exactly is a Water-Powered Engine? Is it actually possible to run your vehicle on water?

Yes! A water-fueled engine is simple. It operates on hydrogen and oxygen, which are generated by the process of electrolysis of water. When hydrogen and oxygen combust in the engine, the only by-product is water and this is expelled through the exhaust. You will be able to assist the environment due to the cleaner properties of this emission. When compared to the traditional system, it is very “environmentally friendly”! It is powered by a resource that is virtually free and renewable. It does not result in pollution.

This is a real alternative. There have been many years of research and testing put into this system. It revolves around water electrolysis.

Simply put, water electrolysis is the breaking down of water into the atoms that make it – hydrogen and oxygen. This is done by passing an electric current through it.

There is nothing mysterious about this process. You don’t have to add anything to plain old tap water to make it work.

The process of electrolysis is much like that used in your car’s battery. It is not new – it has been around for over a century! Unlike before when it wasn’t much use, the process had been improved to make your vehicle run on water.

This system produces low voltage electronic pulses that are shaped like no other. The system has low power consumption so it can be powered easily by the generator or alternator in your car and will have enough in reserve to run all the other devices and gadgets that we need today.

So, is running your car on water actually safe?

In reality, it is actually safer than running your car on its existing fuel system. Consider the capacity of your fuel tank and the potential combustibility of that fuel. In a car accident it can be very dangerous.



When you run your car on water, hydrogen is only stored in small amounts within the hydrogen generator, so it is much safer than a conventional vehicle. The main fuel stored in this system is water, which is not combustible.

So why is this a conversion system?

This is known as a conversion because you don't have to take anything out of your engine or disable anything. You are able to run your vehicle on the existing system as well as the water-fueled system – you can switch between systems when you wish or if there are any problems with either system. You should be aware though that this is a system that you will be very happy with and you probably won't want to switch back to the old system once everything is set up properly.

How far can you travel once this system is fitted? How well does it perform?

Depending on how you drive and the weight of the vehicle, you should be able to travel between 50 to 300 miles per gallon of water. Rest assured though that you will be saving a great deal of money by not having to pay for gasoline, as well as making a difference to the environment! If we all had this system in our vehicles, think about how much we could help the environment and reduce pollution. This system has to be considered for the future – some experts estimate that it will be standard technology in new vehicles within five years.

How hard is this system to build?

The system is not that hard to build and it is reasonably inexpensive. You won't need specialized tools either. You will only need ordinary tools found in the garden shed or workshop.

Assembly of the HyTronics module can be difficult and needs special attention, but with concentration it can be done.

You may need to purchase an oscilloscope if you don't already have one. These can be bought at any electronics store. It's not absolutely necessary, but it will make installation easier.

Is there no way to buy this system and get someone to fit it?

The water-fueled system is not available to buy as a kit at this time, but within a decade it surely will be.

The Water-Fueled System

The Hydrogen/Oxygen generator is the major component of this system. (Refer to the diagram). This generator converts water into the gases used to power the vehicle,



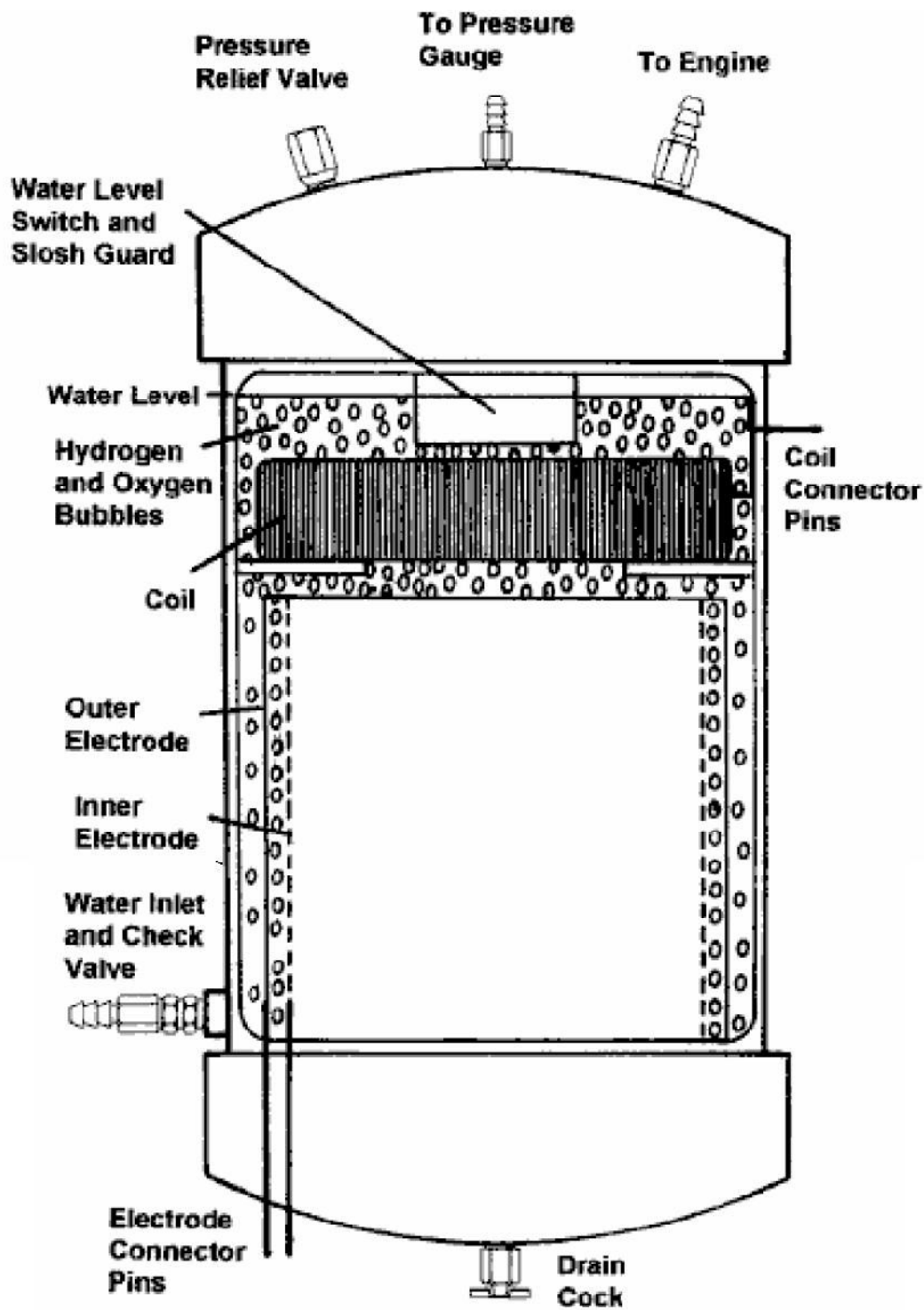
therefore allowing you to use water as a fuel. The HyTronics module sends precise electronic signals to begin and continue the creation of hydrogen and oxygen within the generator. You can accurately monitor everything with this system through the use of an in-dash gauge and indicator assembly.

(Don't be afraid to re-read anything in this section if you feel confused!)

The Hydrogen/Oxygen Generator

This is the heart of the system. It is a cylinder made from high temperature CPVC pipe, which is a practically indestructible material used in building construction and by plumbers. It is very user-friendly.





Hydrogen/Oxygen Generator



Figure 1

The generator is composed of a coil and two cylindrical electrodes housed within the CPVC pipe. These are used to generate oxygen and hydrogen. Both coil and electrodes are made from very durable materials - stainless steel and ceramic.

Within the generator, two atomically different forms of hydrogen are made. Most is orthohydrogen, which is a powerful, fast burning gas created by the two electrodes. The electrodes are activated and controlled by a high frequency signal from the HyTronics module.

The second form of hydrogen is called parahydrogen and is created by the coil. There is much less of this form of hydrogen. It is activated and controlled by a low-frequency signal from a separate circuit. Parahydrogen does not have the same power as orthohydrogen but is necessary as it stops “precombustion” from occurring within your engine. Its task is to slow the burning rate of the hydrogen mix and therefore boost its octane level. You can then adjust it to suit your engine’s octane needs. If you want to raise octane levels in gasoline, you have to use special additives.

The Hydrogen/Oxygen generator is basically an electronic circuit. The two electrodes create a very large capacitor and water acts as the dielectric. The inner electrode is negatively charged and the outer electrode is positively charged using the HyTronics signal. Within each water molecule there are two positively charged atoms of hydrogen and one negatively charged atom of oxygen. Because opposite charges attract, the positively charged hydrogen atoms are attracted to the inner electrode and the negatively charged oxygen atom is attracted to the outer electrode. All the water molecules are then aligned between the electrodes, with the ends of each being pulled in opposite directions.

This alignment occurs only for a short time. The HyTronics signal pulses continue to charge the water capacitor at higher and higher voltage levels. The electrical force becomes big enough to burst apart the water molecules into their gaseous forms of hydrogen and oxygen and forms millions of bubbles of hydrogen and oxygen gas. This continues as long as the HyTronics signal is applied and the water capacitor remains fully charged and creates a supply of orthohydrogen and oxygen.

An inductive circuit is also formed by the generator coil. This creates a magnetic field as opposed to the charged field created by the water capacitor. The magnetic field of the coil is activated by the very low frequency HyTronics signal. The magnetic field collapses when the pulse stops. This creates a very strong magnetic field of opposite polarity. This is how the inductive circuit works – each pulse is timed to coincide with the reversal of the magnetic field. The magnetic field grows in strength with the energy of each new pulse. Eventually the coil reaches saturation point, which is very high.



Magnetic fields affect most molecules. The water molecules are vibrated so violently by the coils reversing magnetic fields to cause them to disassociate into their gaseous forms of parahydrogen and oxygen. We can witness this disassociation through the creation of millions of tiny hydrogen and oxygen bubbles around the coil. How this occurs remains a mystery, even to scientists.

The generator is the heart of the system. Other components are used to control the generator's actions. Varying the strength and frequency of HyTronic signals varies the production rates of hydrogen and oxygen to match engine requirements. The tank and pump are used to supply water and a sensor is used to control the water level within the generator. A relief valve is employed for safety purposes to protect against excess pressure build up within the generator. Hoses used to direct gas to the engine and attached to a gauge to monitor gas pressure within the generator are attached to separate ports. To enable periodic flushing of accumulated contaminants and minerals, a drain valve is installed. So that the generator can be opened for inspection or repair work, the bottom end cap is threaded. The ends of two pairs of stainless steel rods protrude from the generator body to allow the electrodes and coil to be connected to the HyTronics module.

A flame arrestor is attached to the generator gas output hose and this also connects to the pressure fittings attached to the engine. This gives protection against combustion flashback into the generator if the engine backfires. The arrestor body is made from small diameter CPVC pipe with hose fittings and containing stainless steel wool stuffed into its cavity. Pressure fitting kits, such as those used to convert engines to run on propane, are available at shops specializing in high-performance.

The generator should be ideally installed in the engine bay, for ease of wiring and attaching to gauges and hoses.

Water Tank and Pump

This is the easiest part by far! Any large container can be used to store water. Although the whole system is relatively inexpensive to build, it is wise not to take short cuts to save a little bit as it may mean the difference between the system working efficiently and failing. It is highly advisable to install a water level sensor into your tank so you can monitor the water quantity. Considering that they are reasonable in price, it is much easier than having to keep track of how far you have traveled and when you last filled up, or having to check the water level regularly.

You should opt to use a tank of at least 5 – 10 gallons capacity. To prevent spillage from sloshing water, it is a good idea to install a 6 inch vent tube into the tank cap. The only practical place for the tank is in the trunk. The position of the pump also has to be considered. If it is self priming, it can be placed in the engine compartment, otherwise it will have to be mounted directly on to the tank or very close. With a non self-priming



pump, the choice of hose will have to be one that can take at least 66 psi water pressure as 66 is the minimum recommended pump pressure capacity required. You will also need to run an extra power cable to the trunk if you use a non self-priming pump, so it is easier in the long run to use a self-priming!

In-Dash Indicators

To allow you to easily monitor the system, it is recommended that you use two gauges. One should be for generator pressure and the other for cylinder head temperature. You should also have four indicator lights: generator water low, tank water low, pump on and power on. These gauges should be installed either on the dash or in a nearby console. Refer to Figure 2 below as an example.

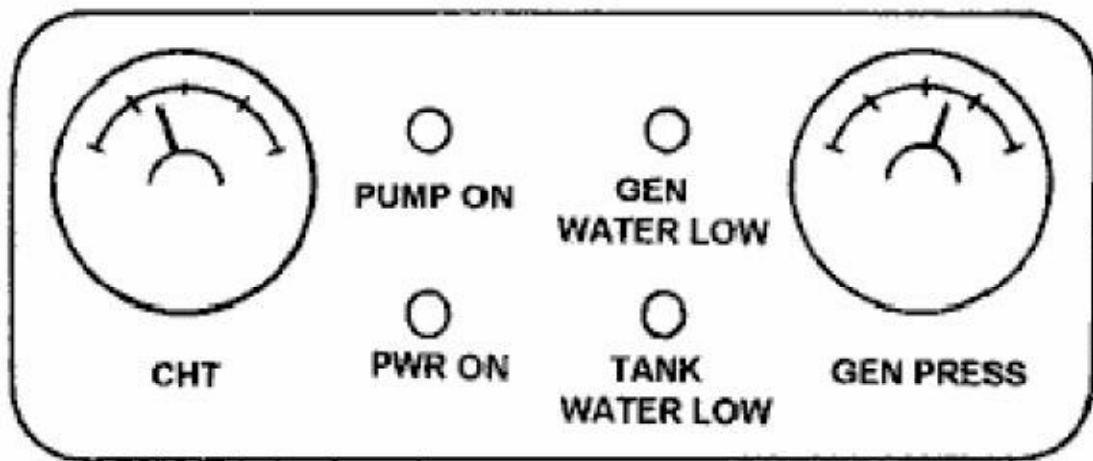


Figure 2

Monitoring the generator pressure and CHT gauges helps you to develop a feel for how the system responds to changing driving conditions. It can also assist you when you are tweaking the system for maximum performance and economy.

With this unit, the generator water low light would remain unlit until there is a need for the pump to switch on and replenish the fuel supply. If the pump is on, the pump on light should also illuminate. When there is enough water in the generator, the generator water low light should go out and the pump should stop and its light should also go out. As such, if everything is working as it should, both lights should appear at the same time. If one or the other is not on, there is a malfunction.

When the tank water level drops to $\frac{1}{3}$ full, the tank water low light should illuminate, telling you that it is advisable to replenish the water. The power on light should be on for as long as the system is in normal operation mode. The HyTronics module sends this



signal, so if this light ever goes out whilst the engine is going or it is flashing, this means that there is a malfunction with the HyTronics module.

The HyTronics Module

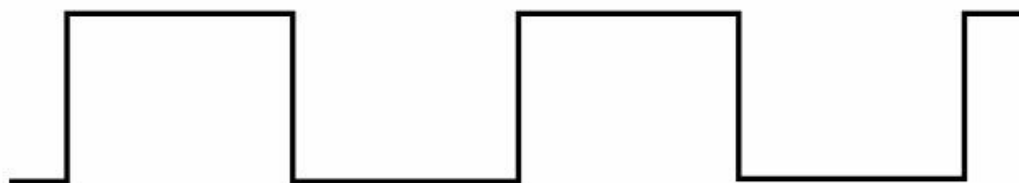
The HyTronics module services all of the electrically operated devices and contains electronic circuits to perform this duty. There are separate circuits for:

- High frequency power signal to the electrodes in the generator to create orthohydrogen and oxygen.
- Low frequency power signal to the generator coil to create parahydrogen and oxygen.
- Through signals received from the generator water level sensor, control the power to the water tank.
- Distributing power to system gauges, indicators and sensors through busing and terminal points.

Generator Electrode Circuit Schematic

Figure 5 shows the schematic diagram for the generator electrode circuit. It has a square wave pulse output and this is sent to the cylindrical electrodes of the Hydrogen/Oxygen Generator. (See figure 18)

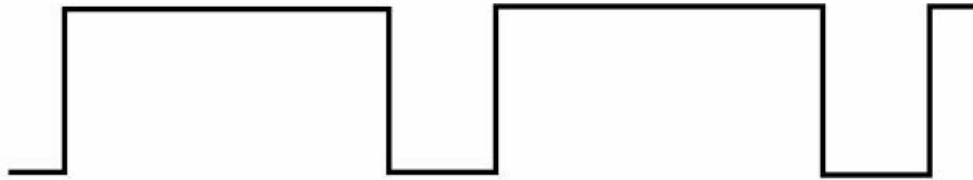
In figure 3 below we can see that the square wave pulse has an ON:OFF ratio of 1:1 ie it is on as much as it is off. In figure 4, the square wave pulse has a ratio of 3:1 ie it is ON for three times as long as it is OFF.



Square Wave - ON:OFF Ratio 1:1

Figure 3





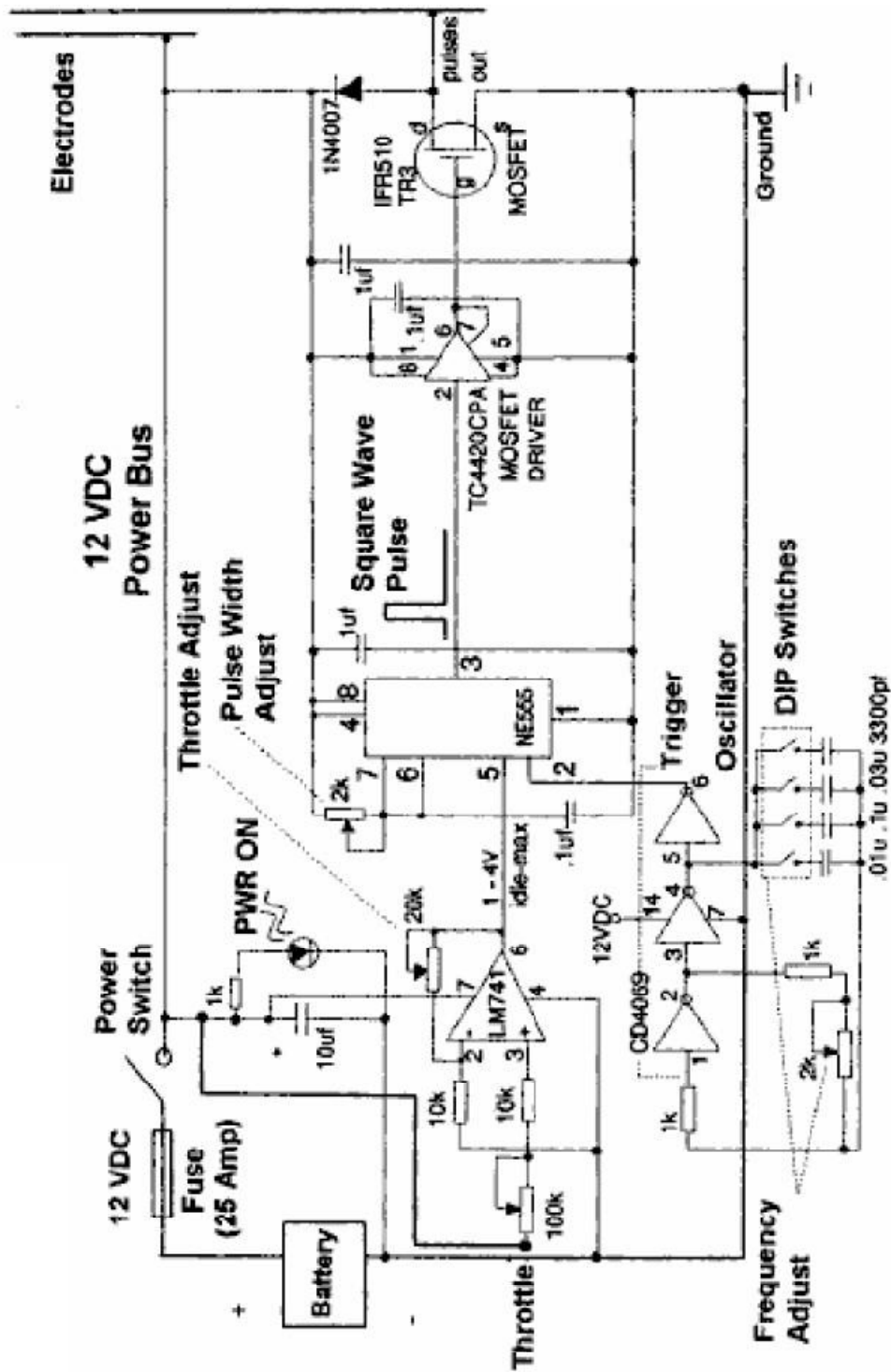
Square Wave - ON:OFF Ratio 3:1

Figure 4

Each of these ON:OFF pulse sequences are referred to as a “cycle” as they continue cycling identically.

If these cycles were to happen within one second they would be said to have a frequency of 3 cycles per second or 3cps. Although this was the manner in which this occurrence was described, it has since been changed to 3Hz, in honor of Mr Hertz. He was a scientist who helped pioneer the theories and practical uses of electronic signals. If there are 1,000 Hz, it would be shortened to 1KHz, “K” being used to represent 1,000.





Generator Electrode Circuit Schematic



Figure 5

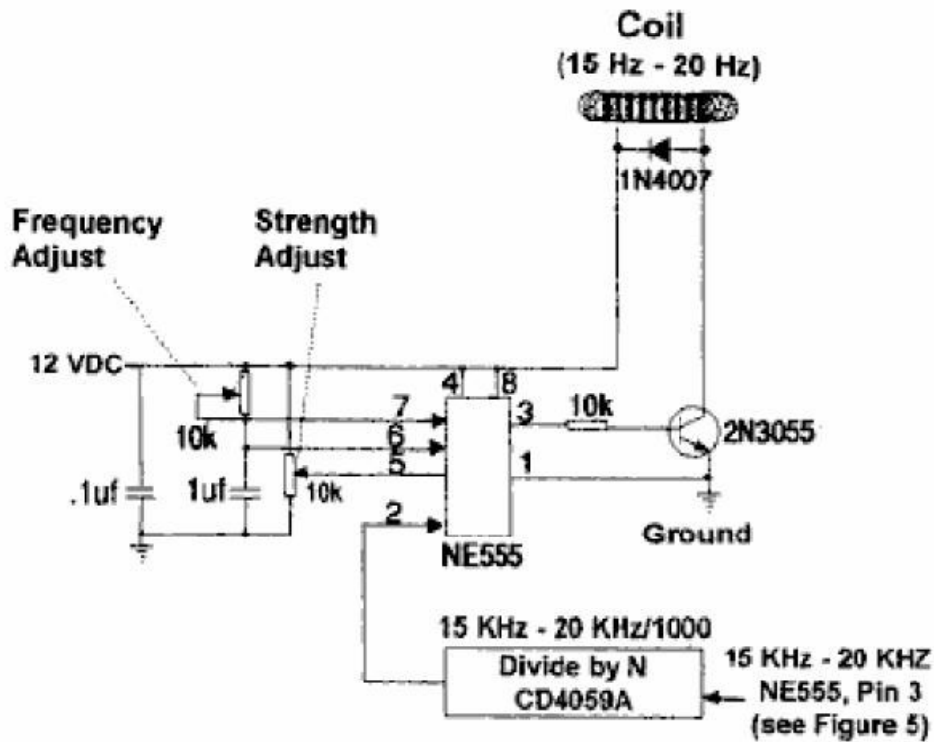
Referring to figure 5, we can see that the amount of current sent to the generator electrodes is determined by the ratio of the square wave pulse. Very little current arrives if the ratio is low, eg 1:1 so the generator is able to produce the maximum gas volume. Using a potentiometer connected to pin 3 of component LM741 via a 10K resistor to vary voltage input causes the circuit to change the pulse ratio and controls the gas production. Control of gas volume occurs in direct response to voltage variance when the potentiometer is connected to the vehicle throttle linkage and this variance corresponds to the rotation of the potentiometer shaft in relation to throttle positioning. A trimming potentiometer connects pins 2 and 6 of component LM741, enabling precise adjustments of the throttle input signal. A second trimming potentiometer connects pins 4 and 7 of component NE555, enabling precise pulse width adjustment.

Optimum gas volume is created because of the unique frequency of electrical resonance shown by the electrode pairs of each generator. Different generators can have varying frequencies, determined by such factors as the size and shape of electrodes, the size and shape of the generator chamber, electrode spacing coil parameters and relative positioning and pulse amplitude (voltage level). A trimming potentiometer connected between pins 1 and 2 of component CD4069 allows for the precise frequency to be obtained. Pulse frequency can be varied between approximately 8 KHz and 260 KHz using various combinations of dipswitch connections to a bank of four capacitors.

Generator Coil Circuit Schematic

Figure 6 shows the schematic diagram for the generator coil circuit. It has as its output a square wave pulse and this is applied to the Hydrogen/Oxygen generator.





Generator Coil Circuit Schematic

Figure 6

Although the pulsed signal of the generator coil circuit is similar to that of the electrode circuit, parahydrogen and oxygen production by the coil involves totally different operating parameters to those in orthohydrogen and oxygen production by the electrodes. The coil has a lower optimum operating frequency, between 16 Hz and 25 Hz. There is a direct correlation between the coil's frequency and that of the electrode because its input signal is received directly from pin 3 of the electrode circuit NE555. The "Divide by N" logic circuit sends the signal to the electrode circuit. This logic circuit produces one output signal in response to a specific number of input signals.

Parahydrogen and oxygen production can be precisely regulated by making adjustments to the pulse width and amplitude trimmer potentiometers of its associated circuit.

Parahydrogen is an octane booster, so the amount needed depends upon the operating demands of your engine. If there is too much parahydrogen, it tends to reduce engine efficiency because of its ability to cool combustion. As a result, limiting parahydrogen production through adjustments to the coil circuit so ensure that there is only enough to prevent engine precombustion is advisable. Conversely, if the CHT gauge suggests that



the engine operating temperature is a little too high, an increase of parahydrogen can be used as an effective way to reduce the temperature.

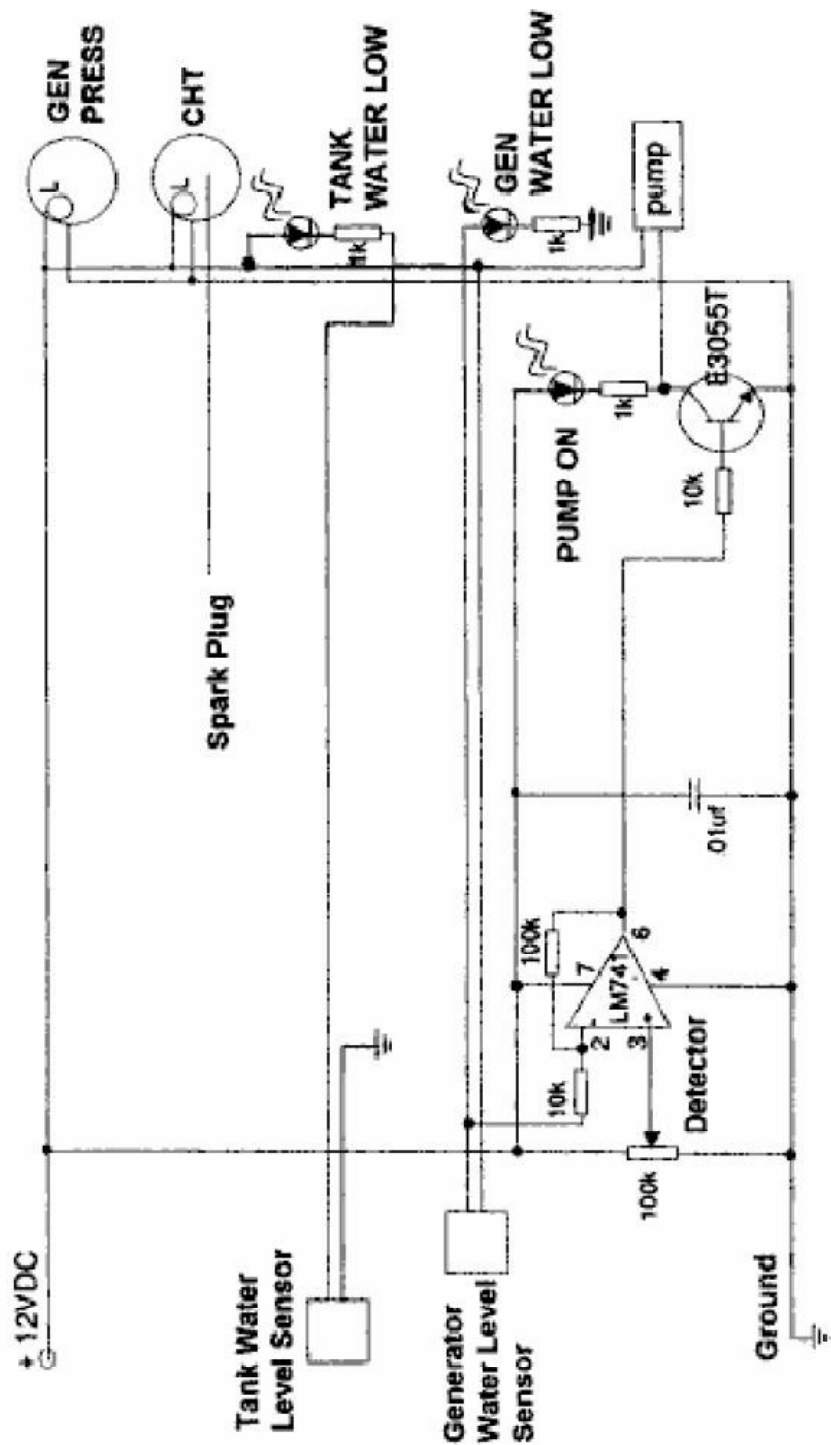
In-Dash Indicators Circuit Schematic

Figure 7 shows the in-dash indicators circuit schematic. The assembly is comprised of two gauges and four light emitting diodes (LEDs). The generator pressure gauge is connected to its fitting on the generator itself via a hose. (See Figure 13) There is an electrical connection between the cylinder head temperature gauge and a sensor placed beneath an engine spark plug.

When low water level in the generator is sensed, the sensor's 12 VDC signal is relayed to pin 2 of detector LM741 via a 10K resistor. The output from the detector at pin 6 triggers the base of power transistor E3055T and this completes the circuit to activate the water pump and illuminate the "pump on" LED. The 12 VDC sensor signal also illuminates the "Generator Water Low" LED. When the water in the generator has again reached its normal level, the level sensor opens and this shuts off the pump and both LEDs.

When low water level in the tank is sensed, the water level sensor is activated and this illuminates the "Water Low" LED. After the water is replenished, the level sensor opens, turning off the LED.





In-Dash Indicators Circuit Schematic

Figure 7



The “PWR” LED illuminates when the system is switched on. You will be aware of a problem if the LED fails to illuminate as the electrode circuit activates the LED. This will indicate an electrode circuit malfunction.

So Let’s Build the System!

It is advisable, to accommodate the different requirements of engines and because gas volume is variable, to make the generator as large as is practicable to allow a reserve capacity. The maximum outside diameter of 4.5 inches is already decided because of the CPVC piping being used for the generator housing. A minimum height of 10 inches is recommended and maximum height depends upon how much space you have in the engine compartment. Carefully check here to ensure you have the necessary space. However, so that it is structurally sound, don’t build it any bigger than 18 inches. If you don’t have enough space in the engine compartment, you may have to locate it in the trunk or as far forward as possible underneath the dashboard.

CAUTION:

Do not use cheap tubing. You may be able to purchase 3½ inch outside diameter stainless steel tubing with a wall thickness of .040 inch to .063 inch and T304 alloy at an exhaust or muffler systems manufacturer. Make sure that all tube dimensions including the roundness remain within .005 inch throughout its entire length. If you use cheap tubing you will severely degrade the efficiency of the system.

If you don’t have a local supplier, this one is recommended:

**Eagle Stainless
Tube and fabricating INC
10 Discovery Way
Franklin, MA 02038**

**Phone: 1-800-528-8650
Local Phone: 508-528-8650**

1. Once you have decided upon the generator height, purchase or otherwise obtain a 3½ inch outside diameter stainless steel tube with wall thickness of .040 inch to .063 inch and a length that is 5 inches shorter than the generator’s height. The use of standard alloy T-304 stainless steel is recommended for the electrodes. This tube will be the outer electrode.

Note:

Steps 2 – 4 will determine the outside diameter for the inner electrode. This procedure will allow for a .045 inch gap between the inside wall of the outer electrode and the outside wall of the inner electrode, which is an ideal gap for the most efficient production of hydrogen and oxygen gases with the system.



2. Double the wall thickness of the outer electrode and record this amount as dimension A. eg if the wall thickness is .050 inch, dimension A should be .100 inch.
3. Add .090 inch to the value of dimension A and record this as dimension B. eg if dimension A is .00 inch, dimension B should be .190 inch.
4. Subtract dimension B from 3.50 inch and record this as dimension C. eg if dimension B was .190 inch, dimension C should be 3.31 inch.
5. To make your inner electrode, purchase stainless steel tubing with the outside dimensions equal to dimension C, with wall thicknesses of .040 inch to .063 inch, of T-304 alloy and an equivalent length to the outer electrode.
6. Using the diagram in Figure 8 as a reference point, drill eight 1/4 inch holes, spaced at 45 degree intervals around the diameter of one end of the outer electrode tube. Ensure that the hole centers are 11/32 inch from the edge of the tube and to back up the electrode whilst drilling, clamp a large diameter wooden dowel or rod to it. Get rid of any sharp edges after drilling.

Note:

To make sure that you get the best results, use a carbide-tipped drill bit and light lubricating oil when drilling stainless steel. Don't rush the drilling – you don't want to overheat the electrode.

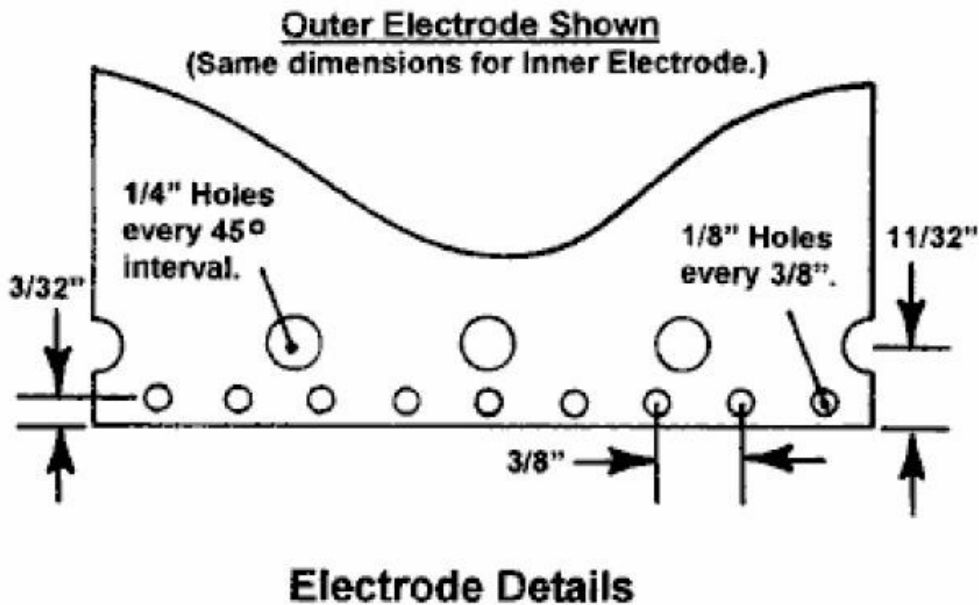


Figure 8



7. Repeat step 6 to drill eight $\frac{1}{4}$ inch holes the same distance from the end of the inner electrode tube.
8. In reference to Figure 8 again, drill $\frac{1}{8}$ inch holes around the end of the outer electrode closest to the $\frac{1}{4}$ inch holes. Ensure that the hole centers are $\frac{3}{32}$ inch from the tube edge, with hole centers spaced at $\frac{3}{8}$ intervals around the entire diameter. Get rid of any sharp edges after drilling.
9. Repeat this procedure to drill $\frac{1}{8}$ inch holes around the diameter of the end of the inner tube. Clean up the sharp edges. Make sure that all oil residue is removed from both electrodes – the use of a soft cleaning cloth and MEK or acetone is a good solvent.

Note: You can get bare stainless steel welding rod (T-304 alloy) from any welding supply store. Similarly, silver-bearing solder and flux can be purchased at any large hardware or electrical supply store.

10. In reference once more to Figure 8, cut two 3 inch rod lengths from $\frac{3}{32}$ inch diameter bare stainless steel welding rod, alloy T-304. Square off and deburr the rod ends using a file.
11. Again looking at Figure 8, solder one of the rods to the outside surface of the outer electrode. The rod should be parallel to the length of the electrode and have 2 inches protruding beyond the tube end. Use silver bearing solder and flux that is appropriate for this task.
12. Repeat step 11's procedure to solder the remaining rod to the inside surface of the inner electrode.
13. Once the electrodes are cool to touch, scrub the solder joints thoroughly with warm soapy water and using a stiff-bristle brush. Rinse them with warm water and dry with a soft clean cloth.

Housing.

Caution:

Take careful note of the following:

- Use CPVC pipe (schedule 80) to build your generator housing. DO NOT use PVC or CPVC schedule 40 pipe because it is unable to withstand high temperature or pressure as well as CPVC schedule 80.
- DO NOT use CPVC pipe that is greater than 4 inch diameter because it does not provide an adequate safety margin against rupture when high temperature and pressure is applied.
- Taking great care with your craftsmanship and detail whilst you are building your generator with ensure safe and reliable operation.



Note: Larger plumbing supply stores or plastics suppliers should be able to sell you CPVC schedule 80 pipe and the fittings and accessories needed to complete the generator housing. One recommended supplier is United States Plastic Corporation. They provide friendly and dependable service and stock everything you will ever require. They can be contacted on **1-800-537-9724**.

List of Materials:

One CPVC 4 inch threaded pipe nipple, length 12 inches, schedule 80

One CPVC 4 inch pipe, length 12 inches, schedule 80 (if housing height exceeds 10 inches)

One CPVC 1½ inch pipe, length 12 inches, schedule 80

Two CPVC 4 inch straight couplings, schedule 80 (if housing height equals 10 inches)

One CPVC 4 inch cap, schedule 80

One CPVC threaded cap, schedule 80

One ¼ inch thick 24 inches x 48 inches, CPVC sheet

One 1 inch diameter, 6 inch length, CPVC rod

One pint can of CPVC cement

One pint can of primer

Once 8 ounce can of pipe join compound

Note:

- CPVC 4 inch schedule 80 pipe has an outside diameter of 4.5 inches.
 - If you are building your generator to a height of 10 inches as determined by the procedure at the beginning of “Electrodes”, follow the directions of step 2 then go to step 8. If its height is greater than 10 inches, go to step three.
1. Building the generator housing uses CPVC 4 inch schedule 80 pipe. Because one end of the pipe needs threading, it is recommended that you purchase a 12 inch threaded pipe nipple to make it easier. Refer to the Generator details view – figure 10.
 2. Cut off one of the 12 inch pipe nipple threaded ends 2¾ inches from the end, using a miter box or table saw to ensure it is square. Dress the cut edges using sandpaper or a fine tooth file. Proceed to step 8.



3. Cut the threaded pipe nipple $5\frac{1}{2}$ inches from one of its threaded ends, using a miter box or table saw to ensure it is square. Dress the cut edges using sandpaper or a fine tooth file.

Caution:

Be sure to carefully read all directions on the primer and cement can labels so that you understand the correct use of the products. After you have primed a surface, apply the cement as soon as possible to obtain safe and reliable bonding. Don't allow the primer to dry out.

4. Apply primer to both the outside mating surface of the cut end of the $5\frac{1}{2}$ inch pipe nipple and one of the inside mating surfaces of the coupling. Be careful to apply an even layer of cement to the primed surfaces and assemble the parts. Before continuing to step 5, allow the parts to air dry for at least 10 minutes.
5. Apply primer to the outside mating surface of the 12 inch pipe and the inside mating surface of the coupling that has been attached to the pipe nipple. Once again, carefully apply an even layer of cement to these primed surfaces and assemble the parts. Before continuing to step 6, allow the parts to air dry, this time for at least 30 minutes.
6. For housing height of 18 inches, go to step 8. If the height is less than 18 inches, continue to step 7.
7. Cut the pipe assembly near the unthreaded end to a length that is the housing height minus $\frac{1}{2}$ inch, using a miter box or table saw to ensure that it is square. Dress the cut edges with sandpaper or a fine-tooth file.
8. Carefully measure the inside diameter of the threaded end cap. Clamp the $\frac{1}{8}$ inch thick CPVC sheet securely to the bed of a drill press. Drill a $\frac{1}{2}$ inch diameter hole through the sheet. Cut a disk with the measured diameter as shown in Figure 9, using a fly cutter. Check that this disk fits securely into the end cap. If it is loose, cut a slightly larger disk and use this one to replace the loose one. If it is too tight, cut a slightly smaller one and use this to replace the tight one. Don't forget to cut the $\frac{1}{2}$ inch hole first if you have to cut a new disk. Cut a replica disk with the $\frac{1}{2}$ inch center hole.
9. Apply the primer as before and join the disks together. Make sure that the edges match up and wipe off any excess cement. Before proceeding to step 10, allow the disks to air dry for an hour.
10. (Refer to Figure 9) Bevel the disk edges to fit the curved contour of the end cap bottom. Check that the outer edge of the disk measures between $\frac{1}{32}$ inch and $\frac{1}{16}$ inch after the beveling.

Caution:

Take careful note of the following:

- The electrodes will be secured to the contoured disk, so the contour has to be accurate to ensure structural integrity.



- Be careful that you do not use excessive cement when you are installing the disk as this may result in the end cap being bonded to the housing (it is only to be temporarily threaded to make sure that the disk is correctly aligned).
- When using petroleum jelly, ensure that it is only coating the end cap threads.

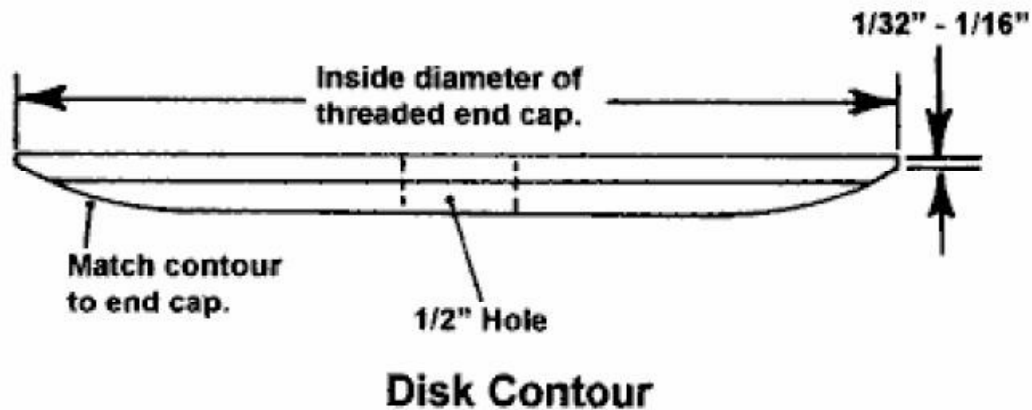


Figure 9

11. Put a light coat of petroleum jelly on to the threads of the housing and end cap as well as the bottom edge of the housing. Prime the mating surfaces of the disk and end cap. Carefully apply cement only to the primed area of the end cap and put the disk on, ensuring that it is seated firmly and evenly. Remove any excess cement with cotton swabs.
12. As a temporary measure only, thread the end cap onto the housing, being sure to seat it slowly but firmly. Remove the end cap carefully after waiting for about 15 minutes for the cement to partially dry.

Caution: Make sure that you carefully measure the inside diameter of the unthreaded end cap before you cut the disks.

13. Repeat steps 8 -10 for the unthreaded end cap. You don't need to use petroleum jelly on any areas of the unthreaded end cap. Prime the mating surfaces of the disk and end cap, then apply cement only to the primed area of the end cap and install the disk, making sure that it is even and firmly seated. Remove any excess cement with cotton swabs.
14. Using electrical tap, seal the ½ inch hole in the threaded end cap disk with electrical tape, then thoroughly clean all of the housing using warm soapy water and a stiff bristle brush, making sure that all petroleum jelly is removed. Rinse all parts with warm water.
15. Repeat step 14, then wipe all parts dry with a soft clean cloth.
16. Carefully remove the electrical tap from the threaded end cap. The end caps then need to dry for at least 8 hours before proceeding to step 17.



17. Using electrical tape, completely cover the inside surfaces of both end caps and then cut the tape to open up the ½ inch hole in both disks.

Note: Each end cap cavity is to be filled with epoxy cement. Whilst the epoxy cures, the caps have to stay level to avoid trapping air bubbles. Placing the end caps on the inner cores of large rolls of tape often works well, provided they are centered.

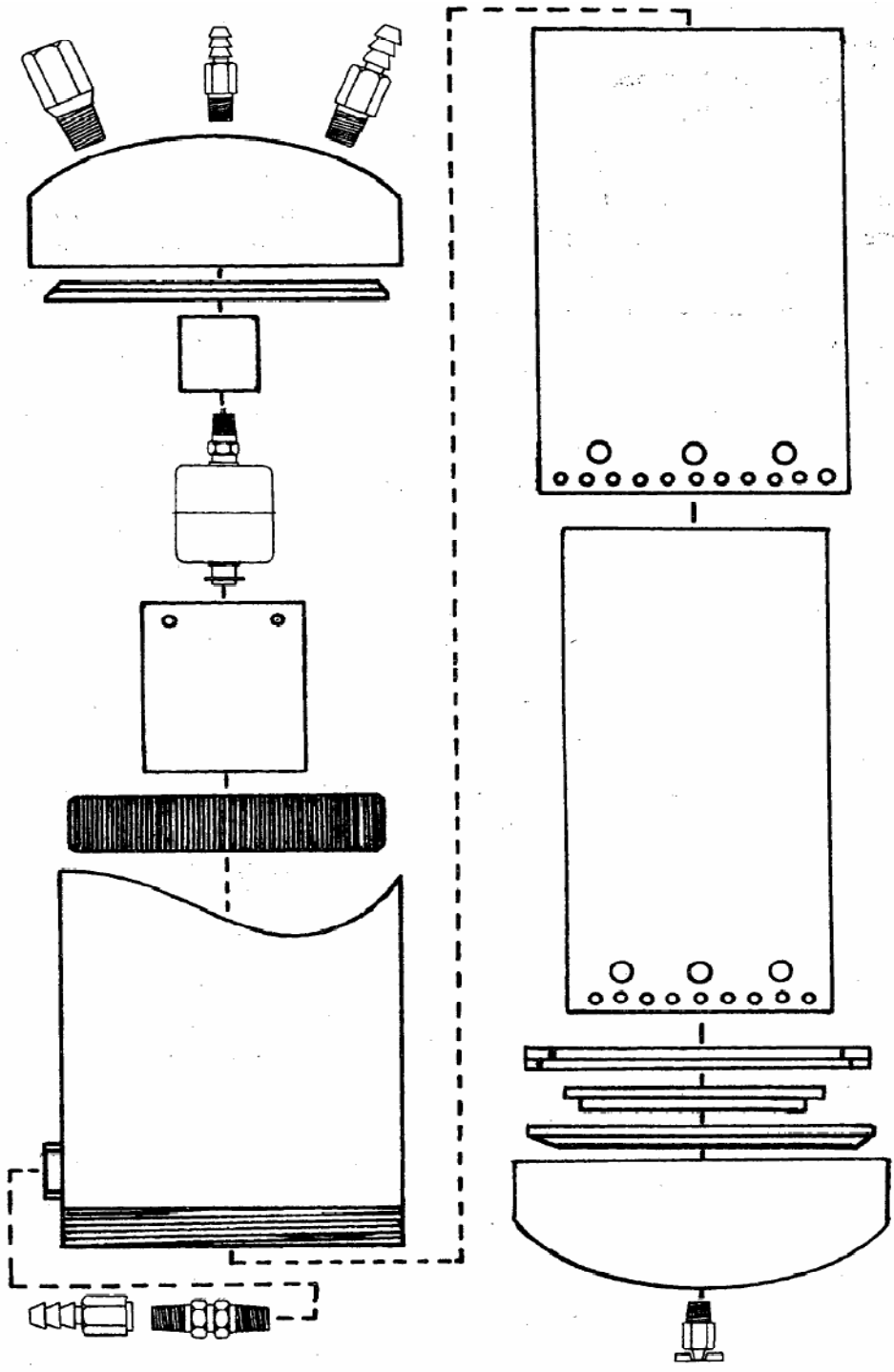
Caution: Ensure that the epoxy resin you use is high quality, high temperature and waterproof. If you choose inferior cement it may lead to the eventual failure of the system.

18. To fill the end cap cavities, obtain a high quality, high temperature and waterproof epoxy cement. J-B WELD is highly recommended and it can be purchased at any large hardware or automotive store. It comes in two 2-ounce tubes (1 tube resin, 1 tube hardener) and you will probably need to purchase at least one pair for each end cap. Should you have any questions about J-B WELD, they can be contacted on:

J-B WELD
PO BOX 483
Sulphur Springs TX 75483
Phone 1-903-885-7696







Generator Details

Figure 10



Note: Epoxy resins cured through a chemical reaction, when the hardener is mixed in. There is no urgency when filling the end cavities with J-B WELD because it stays pliable for around 30 minutes. Just keep in mind that once the hardener has been added, you cannot prevent the resin from curing.

Note: Make sure that you mix equal amounts of resin and hardener. J-B WELD have color-coded each (one black, one white) to avoid confusion. If you mix hardener with hardener or resin with resin, nothing will happen except you will have created a big mess.

19. Mix a batch of epoxy in a disposable container (eg a paper cup). To prevent air bubbles occurring, fill the cavity slowly to the top of the $\frac{1}{2}$ inch hole in one of the end caps. If you need to, mix more epoxy.

Note: Make sure that you have enough epoxy on hand to fill the second cavity and if necessary, buy some more before you start to fill the second cap. Newly mixed epoxy has poor adhesion to cured epoxy.

20. Repeat step 19 for the second end cap.
21. The epoxy should be allowed to cure for at least 24 hours. You should then remove the electrical tape and any epoxy that is above the top of the $\frac{1}{2}$ inch hole until it is flush with the disk surface. You may have to sand or even grind it off.
22. Carefully measure the inside diameter of the inner electrode and record this measurement as dimension D.
23. Clamp the $\frac{1}{8}$ inch thick CPVC sheet securely to a drill press bed and cut a disk with a diameter equal to dimension D from the sheet using a fly cutter. Ensure that this disk is able to slide easily (not too loose or too tight) into the end of the inner electrode opposite the soldered rod. If it is too tight, cut a new disk slightly smaller and if it is too loose, cut a slightly larger disk.
24. Subtract .250 inch from dimension D and record this new measurement as dimension E. An example of this is if dimension D is 3.21 inch, dimension E would be 2.96 inch.
25. With the $\frac{1}{8}$ inch CPVC sheet still secured to the drill press bed, cut another disk with a diameter equal to dimension E with a fly cutter.
26. Apply primer followed by cement to one of the flat surfaces of each disk and then join the disks, taking care to center the smaller disk on the larger disk.
27. With the $\frac{1}{8}$ inch CPVC sheet still secured to the drill press bed, ensure that the cutter is centered at least 3 inches from any edge. Cut a $3\frac{1}{2}$ inch hole in the sheet.
28. Adjust the cutter to enable it to cut a ring with an outside diameter of $3\frac{15}{16}$ inches.
29. Ensure that the ring is neither too loose nor too tight to slide onto the end of the outer electrode opposite the soldered rod. If it is too loose, cut another with a slightly smaller inside diameter. If it is too tight, cut another with a slightly larger inside diameter.
30. Repeat step 27 to cut a $3\frac{5}{8}$ inch hole into $\frac{1}{8}$ inch CPVC sheet.



31. Repeat step 28 EXACTLY.
32. Apply primer followed by cement to one of the flat surfaces of each ring and join the rings ensuring that the outer edges are aligned. Wipe excess cement from the edges and allow them to air dry for at least 30 minutes before proceeding.
33. Cut or grind a small notch into the inner edge of the rings that will enable the rings to clear the soldered rod.

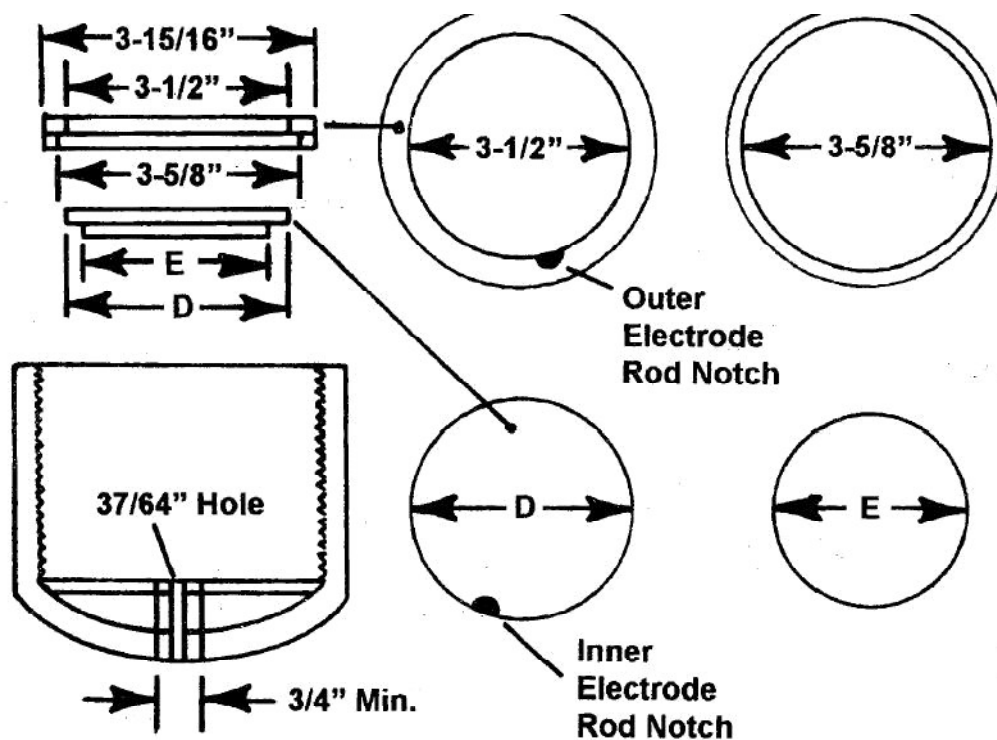
Note: In step 34, make sure that the wrapping tape does not protrude below the edge of the smaller ring at any time. Don't overlap the ends of the tape – just butt the tape ends before continuing to wrap.

34. Wrap the outer edges of the rings with electrical tape until they slide easily into the threaded end cap.

Note: Refer to Figure 11 regarding the installation of the rings into the threaded end cap. Apply primer only to the flat surface if the threaded end cap in contact with the smaller ring and do not remove the tape until instructed.

35. Apply primer to the flat surface of the smaller ring and with a cotton swab apply primer also to the flat surface of the threaded end cap in contact with the smaller ring. Apply a thin even layer of cement to these primed surfaces and install the ring assembly into the end cap. Allow these parts to dry before proceeding.





Threaded end cap details - figure 11

Note: In step 36, make sure that the wrapping tape does not protrude below the edge of the smaller ring at any time. Don't overlap the ends of the tape – just butt the tape ends before continuing to wrap.

36. Use electrical tape to wrap the edge of the large disk until it is a snug fit with the inside edge of the ring assembly.

Note: Make sure that the disks are aligned with their notch offset at least $\frac{3}{4}$ inch from the ring notch as shown in Figure 11.

37. Apply primer followed by cement to both the flat surface of the small disk and the flat inside surface of the threaded end cap. Install the disk assembly into the end cap. Make sure that the disks are aligned with their notch offset at least $\frac{3}{4}$ inch from the ring notch as shown in Figure 11. Lightly clamp the disks and end cap



- with a large C-clamp and allow the parts to dry for at least 8 hours before proceeding.
38. Now remove all electrical tape from the threaded end cap assembly and ensure that all excess cement that may have escaped onto the flat inside surface of the end cap is cleaned off. Take particular care in scraping off any cement in the areas that will contact the bottom edges of the electrodes and threaded end of the housing.
 39. Drill a $37/64$ inch hole through the center of the threaded end cap.

Note: To attach the drain cock, threads will be tapped into the hole drilled through the center of the end cap.

40. Two holes are to be drilled, using a #41 drill bit, through the bottom of the threaded end cap at the locations shown in Figure 11. Make a temporary alignment of each electrode and rod with its respective hole (drilled in step 39). Ensure that each electrode is able to be installed into the threaded end cap and seated firmly on the cap surface, making any necessary adjustments. Mark a short reference line with a marking pen near the top inside of the inner electrode and another near the top inside of the outer electrode, ensuring that these are aligned, then remove the electrodes from the end cap.
41. Wrap the top end of the inner electrode with electrical tape until it is a snug fit in the outer electrode. To make it easier to remove the tape later, leave about $1/4$ inch above the edge of the electrode. Do not remove the tape as yet!
42. Create a solid support for the threaded end cap whilst installing the electrodes and waiting for the epoxy to cure (about 8 hours). Placing the curved cap on the inner core of a large roll of tape is a good support provided the cap is centered and level.
43. Make sure that the bottom ends of the electrodes are clean – use MEK or acetone and a soft clean cloth.
44. To prevent the epoxy from dripping out, seal the bottoms of the two holes in the end cap with short strips of electrical tape. This tape will be pushed aside when the electrode rods poke through and then the tape can be removed.
45. In a disposable container eg a paper cup, mix a 2-ounce batch of epoxy and then fill the slot in the end cap where the electrodes will be installed all around to approximately half full. **Be sure to install the outer electrode first.**
46. Apply a very thin but unbroken band of epoxy, with your finger, completely around the bottom edge (rod end) of the outer electrode. This band should be about $1/4$ inch from the bottom edge and coat both the inside and outside surfaces of the electrode.

Caution: When you are installing the electrodes into the end cap, do so slowly to avoid trapping air bubbles within the holes around the bottom edges of the electrodes. These holes help in securing the electrodes to the end cap because the epoxy fills the holes.



47. Taking note of the above caution, install the outer electrode into the end cap. When the electrode is firmly seated onto the end cap surface, remove the tape from the bottom of the end cap.
48. Apply a small amount of petroleum jelly to the surface of the tape wrapped around the top of the inner electrode.
49. To install the inner electrode into the end cap, repeat steps 46 to 48. Use the alignment marks in the tops of the electrodes as a guide to the location of the rod hole in the end cap.
50. Weight the electrodes down with about five pounds to keep them firmly seated against the end cap. A stack of hardcover books on a folded towel is enough for this purpose as it distributes the weight evenly.
51. Remove any excess epoxy oozing from the eight $\frac{1}{4}$ inch holes around the bottoms of the electrodes. You may have to repeat this until the epoxy begins to thicken (around 30-45 minutes). Clean the epoxy from the rod ends protruding through the end cap and from the surrounding surface of the end cap, using either household tissues or disposable rags.

Caution: The epoxy should be allowed to cure for at least 24 hours at temperatures of 70 degrees + before the weights on the electrodes are removed. Allow more time in cooler temperatures.

52. When it is ready, remove the weights from the electrode assembly and remove the tape from the inner electrode. Using #400 grit (or finer) sandpaper, clean off any residue from the epoxy from around and on the rod ends protruding through the bottom of the threaded end cap.

Housing Attachments:

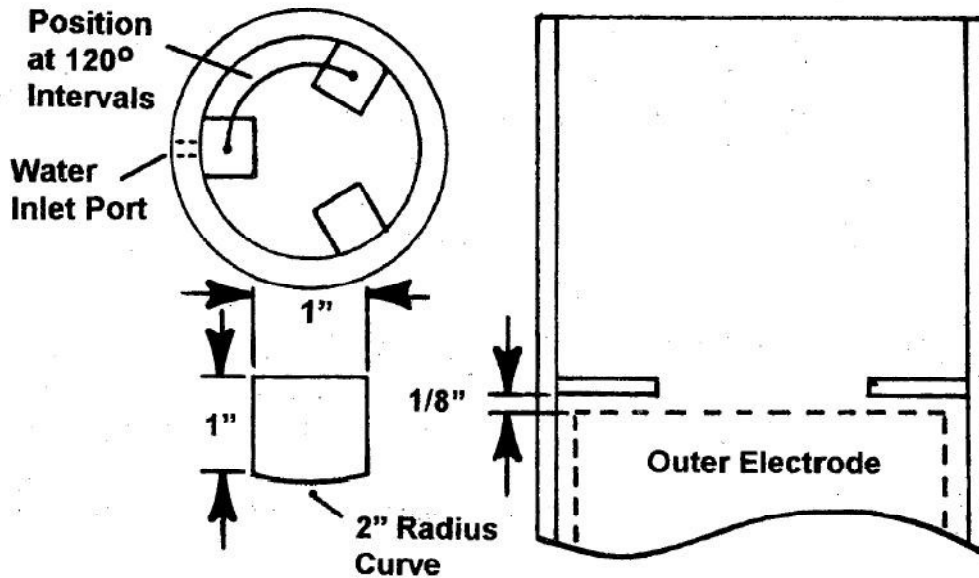
1. Thread the electrode assembly temporarily onto the generator housing and tighten it firmly. Support the entire assembly as per step 42.
2. Make 3 coil support brackets (refer to figure 12 for the dimensions) from $\frac{1}{8}$ inch thick CPVC sheet.

Note: For operational efficiency, locate the coil approximately $\frac{1}{4}$ inch above the tops of the electrodes. To achieve the correct clearance a shim is placed between the brackets and electrodes – be careful that you don't cement the shims to the brackets.

3. Scrap pieces of $\frac{1}{8}$ inch CPVC sheet can be employed as shims between the electrodes and the brackets. Apply primer followed by cement to both the brackets and the inside wall of the housing at 120 degree intervals (see figure 12). Attach the brackets and wait at least 30 minutes for the cement to air dry before proceeding to step 4.



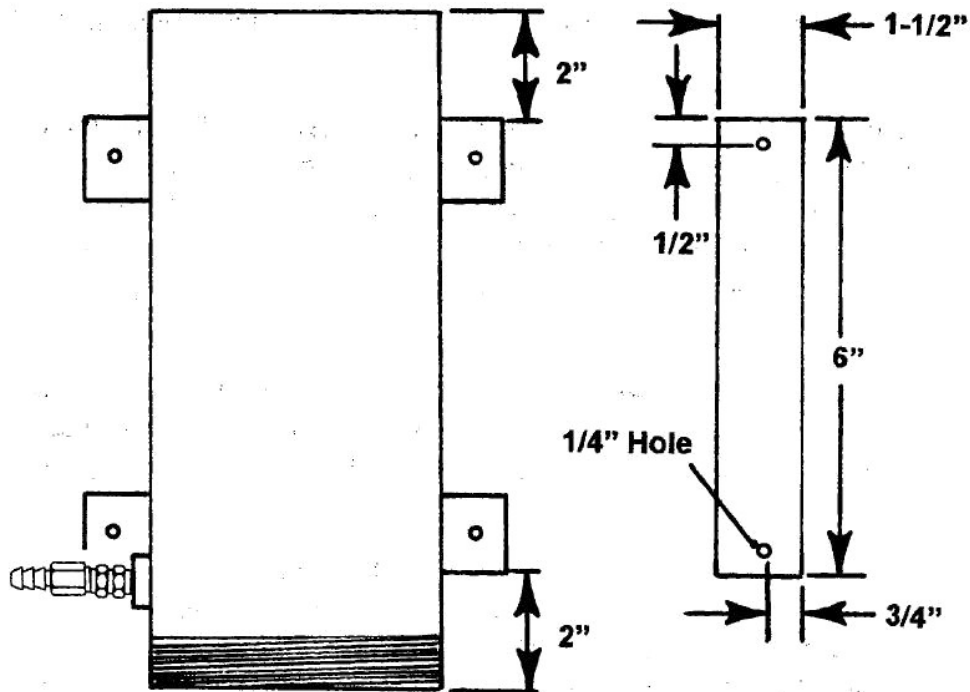
4. Remove the electrode assembly from the housing.



**Coil Mounting Brackets
Figure 12**

Note: When mounting the generator, the way the brackets are arranged depends upon the individual requirements of each system. Figure 13 shows a simple and common arrangement. Others can be easily made from $\frac{1}{8}$ inch CPVC sheet. You can make $\frac{1}{4}$ inch thick brackets using two layers of $\frac{1}{8}$ inch thick CPVC sheet.





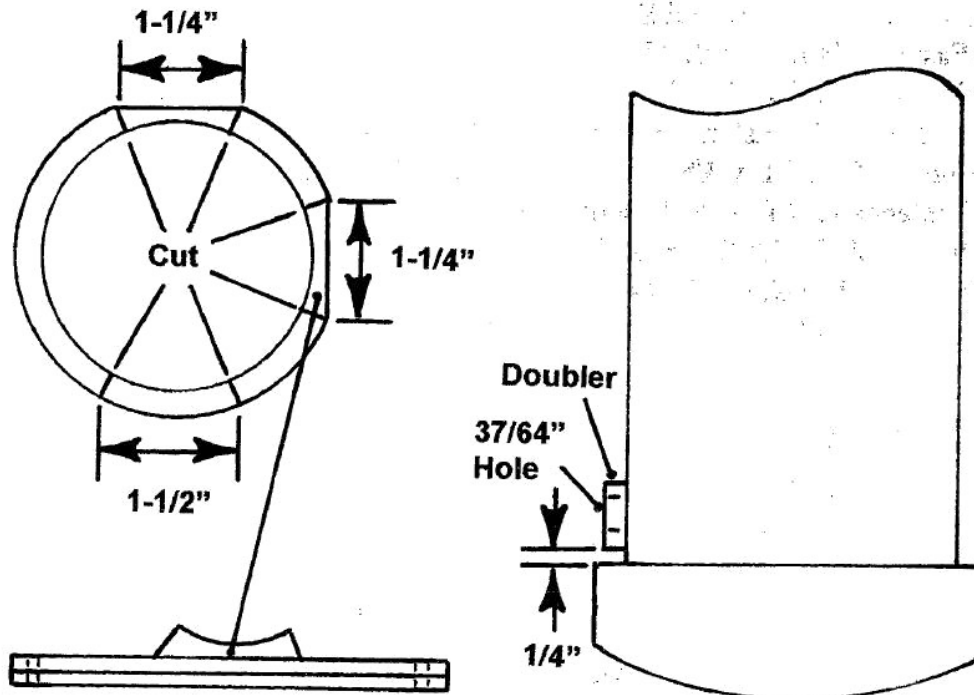
Housing Attachment Details
Figure 13

5. Using Figure 13 as a reference, cut four 1½ inch x 6 inch mounting bracket strips from ⅛ inch thick CPVC sheet. Use sandpaper or a fine-tooth file to dress all the edges of each strip. Apply primer followed by cement to the mating surfaces of each of two strips and join them together. Make sure that the edges are aligned and wipe any excess cement from the edges.
6. From the end of the coupling, cut a 1½ inch wide ring and, referring to Figure 14, using a band saw sand the side of the ring in order to create a flat surface approximately 1¼ inches wide. To form a similar surface, sand the side of the ring at a second point. Cut at both ends of each flat surface to create the two flat surface sections. As can be seen in Figure 14 this creates two sections from the ring that have flat outside surfaces 1½ inches by approximately 1¼ inches. Round the corners slightly with sandpaper or a fine-tooth file.
7. A pipe section then needs to be attached to each of the two brackets at their midpoints by applying primer and cement to the flat surface of each section and the corresponding mating surface on the bracket. The curved surface of each section must be squared with the length of the bracket.
8. Create a doubler by cutting a section 1½ inches wide from the ring (see Figure 14). Again, dress the edges and round the corners slightly using sandpaper or a fine-tooth file. The end cap should now be temporarily yet firmly threaded onto the housing and a spot marked ¼ inch up from the edge of the end cap anywhere



- around the housing. The end cap is then removed and the doubler is attached to the housing at the marked spot by applying primer followed by cement to the mating surfaces of the doubler and housing. Make sure that the edge is aligned parallel to the housing bottom edge. Before proceeding, allow the cement to air dry for at least 8 hours.
9. As shown in Figure 14, drill a $\frac{3}{8}$ inch hole through the center of the $1\frac{1}{2}$ inch x $1\frac{1}{2}$ inch doubler and housing wall, ensuring that the hole is square with the housing wall. To install a barbed hose fitting to connect the check valve, at a later stage threads will need to be tapped. It is a good idea to decide now the direction you prefer the fitting point to be – either directly left or right.
 10. Near the end of each bracket drill a $\frac{1}{4}$ inch fastener hole at the locations shown in Figure 13. Round the corners slightly as before.
 11. As shown in Figure 13, place the brackets and clamp them to a flat surface. Make sure that the housing seats evenly into the curved section of each of the brackets and that there are no gaps between the housing and the curved section. Loosen the clamps to move the brackets if necessary. Apply primer followed by cement to the mating surfaces of the brackets and housing and attach the housing to the brackets. Support the housing to prevent it from rotating or moving whilst it is being assembled and wait at least 8 hours before removing the clamps and moving the assembly.





More housing attachment details - figure 14

Unthreaded end cap:

List of materials:

- Thread taps, 1/8" NPTF and 3/8" NPTF (cutting tool supply: specify Greenfield taps from CPVC pipe, or obtain locally)
- Two 1/8" NPT x 1/8" barbed hose fittings (SMC part #: 253490)
- Two 3/8" NPT stainless steel inline check valves (Generant part #: ICVMM-375-SS-1)
- One 3/8" NPT pressure relief valve (stra-val part #: RVA-05, 3/8" NPT, specify pressure setting of 85 psi)
- One 3/8" NPT internal seat drain cock (fastener hut part #: 230a)
- Five 3/8" PTF 3/8" brass barb hose fittings, male pipe rigid (PTF short) (fastener hut part#: 10506b-106a)
- Four 3/8" NPTF x 3/8" brass barb hose fittings, female pipe rigid (fastener hut part #:10506b-206a)
- One 35 ss series stainless steel top mount level switch, 1/8" NPT (norgren part #: 0107-024)
- One LS 11 plastic side mount level switch, PBT, 5/8" – 11 UNC (norgren part #: 1873-024)



Material source:

Cutting Tool Supply (CTS)

340 W Gerri Ln

Addison Il 60101

Phone: 1-630-543-7171 fax: 1-630-543-6906

The Specialty Mfg Co (SMC)

5858 Centerville Rd

St Paul, MN 55127

Phone: 1-651-653-0599 Fax: 1-652-653-0989

Generant

1865 Route 23 S, PO Box 768

Butler, NJ 07405

Phone: 1-973-838-6500 Fax: 1-973-838-4888

Stra- Val

21 Columbus Ave

Garfield, NJ 07026

Phone: 1-973-340-9258

Toll-Free: 1-888-380-966 Fax: 1-973-340-9933

Fastener Hut Inc

3781 Glengarry Way NE

Roswell, GA 30075-2615

Phone:1-770-480-4617 Fax: 1-770-998-2721

Norgren, C/o Kip Fluid Controls INC

72 Spring Ln

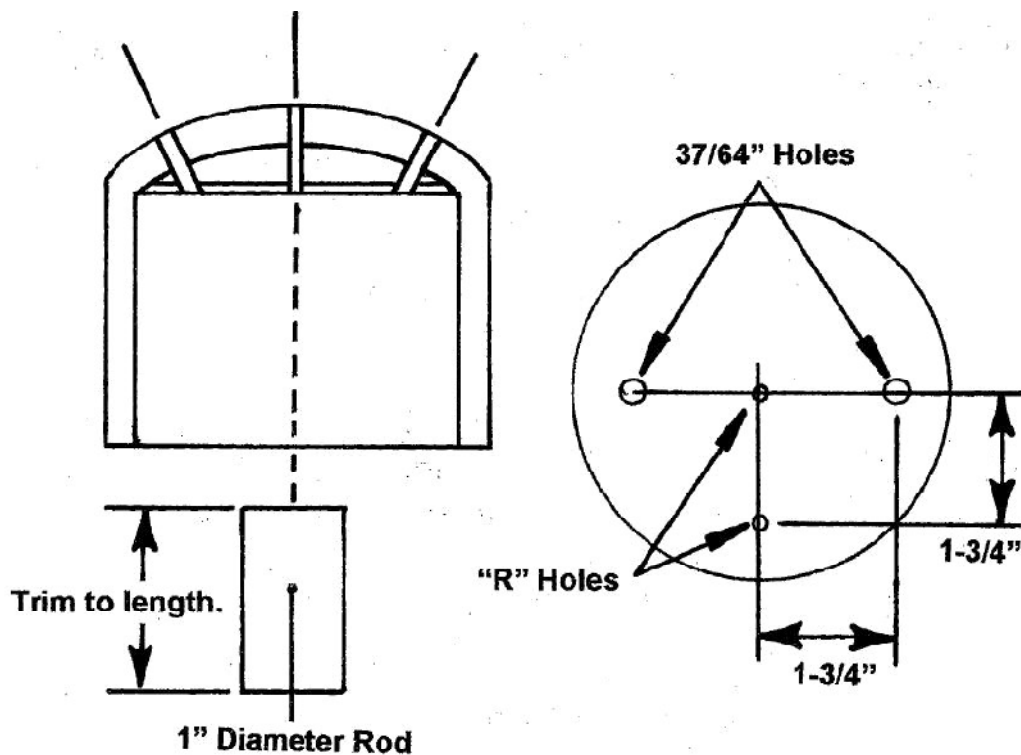
Farmington, CT 06032

Phone – Toll-Free: 1-800-722-5547 Fax: 1-860-677-4999

Note: A spacer for the water level switch will be made from a short length of CPVC rod inside the end cap.

1. Cut a spacer approximately 2 inches long from 1 inch diameter CPVC rod, using a miter box or table saw to make sure it is square. Drill a hole, using an “R” size drill bit, through the entire length of the rod at its center and parallel to its length. As well, again with the “R” drill bit, drill a hole through the center of the end cap as shown in Figure 15.





Unthreaded end cap details - figure 15

Caution: Only use NPTF taps, not NPT taps, to prevent the possibility of water and gas leakage. Check that you are using NPTF taps as both NPT and NPTF tap threads will seal properly in NPTF tapped holes.

Also ensure that you have tapped to the correct depth by continuing to turn the tap until the 12th thread from the front of the tap is fully within the hole.

Always ensure that the tap is aligned parallel to the sides of the spacer.

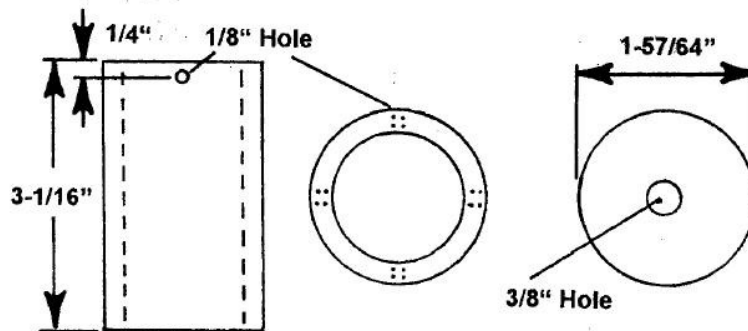
2. Tap threads into an end of the hole drilled in the spacer, using a $\frac{1}{8}$ - 27 tap. Make sure that the tap is aligned parallel to the sides of the spacer and that it is tapped to the correct depth of 12 threads from the end of the tap.
3. Thread the 35 ss water level switch temporarily into the tapped hole and seat it firmly. Insert the power leads of the switch from inside the end cap through the hole that has been drilled. Take measurements of a record the distance between the inside surface of the end cap and the end of the switch center tube. Take the switch from the rod and then make a square cut, shortening the rod so that the ends of the switch center tube is positioned 3 inches from the surface of the end cap (see Figure 15).
4. Apply primer followed by cement as before to the untapped end of the spacer and the mating surface inside the end cap and install the spacer, making sure that the



holes in the spacer and end cap are aligned. Remove any excess cement that may have oozed into the hole with a cotton swab.

Slosh Shield

1. Cut a $3 \frac{1}{16}$ inch long section from $1 \frac{1}{2}$ inch CPVC pipe, using a miter box or table saw to ensure that it is square. Drill four $\frac{1}{8}$ inch holes into the sides of the pipe at 90 degree intervals and $\frac{1}{4}$ inch from the edge (see Figure 16).
2. Cut seven $1 \frac{57}{64}$ inch disks from $\frac{1}{8}$ inch thick CPVC sheet, using a fly cutter. Six of these will be used for the flame arrestor. Drill a $\frac{3}{8}$ inch diameter hole through the centre of the seventh disk.
3. Apply primer followed by cement as before to each of the mating surfaces of the drilled disk and the end of the pipe opposite the four holes. Attach the disk to the pipe, making sure that the disk is centered on the pipe.



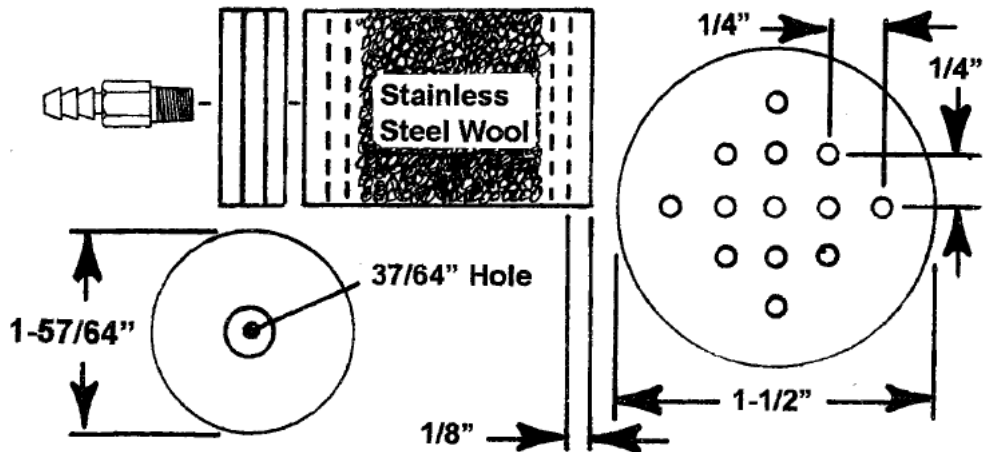
**Slosh Shield Details
Figure 16**

Flame Arrestor

1. Cut a 3 inch long section from $1 \frac{1}{2}$ inch CPVC pipe, using a miter box or table saw to ensure that it is square.
2. Cut a $1 \frac{1}{2}$ inch disk from $\frac{1}{8}$ inch thick CPVC sheet using a fly cutter. Make sure that the disk fits snugly inside the pipe. If it doesn't, make adjustments to the cutter and cut three more (a total of 4 identical disks).
3. Apply primer followed by cement as before to the surface of each of two disks and join them. Repeat this for the remaining disks.
4. As in step 3, create 2 stacks of 3 disks each from the 6 that were cut in step 2 of the slosh shield procedure. Allow these cemented disks to air dry for at least an hour and then drill a $\frac{3}{7}$ inch hole through the center of each of the two stacked disks.



- (See Figure 17) Drill 13 $\frac{1}{8}$ inch holes through each of the two $1\frac{1}{2}$ inch disks at the locations shown.



**Flame Arrestor Details
Figure 17**

- Apply primer followed by cement as before to the edge of one of the $1\frac{1}{2}$ inch disks and about $\frac{3}{8}$ inch into each end of the 3 inch pipe bore and slide the disk $\frac{1}{4}$ inch into the bore. This creates a $\frac{1}{8}$ inch gap between the disk and the pipe end (see Figure 17). Create a small “fillet” of cement around the outer join of the disk and pipe bore, stand it on end until the cement won’t run. This prevents plugging the holes with cement. If any holes do become plugged, open them back up. Allow the cement to air dry for around one hour before proceeding.
- Pack stainless steel inside the flame arrestor and then repeat step 6’s procedure to install the remaining $1\frac{1}{2}$ inch disk.

Note: Stainless steel wool is available at some large supermarkets or you can obtain it from the following source:

IWP
2575 Lemoyne
Melrose Park IL 60160
Toll Free: 1-800-732-9336
Fax: 1-708-345-0810

Note: Ensure that you have allowed the two stacks of three disks that were joined in step 4 to air dry for at least 24 hours.



8. (See Figure 15) Drill two $37/64$ inch holes through the top of the unthreaded end cap. Each hole should be $1\frac{3}{4}$ inches from the center hole in the cap. Ensure that the drill bit is square with the curved outer surface of the unthreaded end cap. Drill a hole through the top end cap $1\frac{3}{4}$ inches from the centre hole in the cap, using an “R” sized drill bit.
9. Tap $\frac{3}{8}$ -18 threads into the $37/64$ inch holes at:
 - two holes on the top of the unthreaded end cap
 - one hole on the bottom of the threaded end cap
 - one hole in the doubler on the housing wall
 - one hole in each of the two flame arrestor end caps.Be sure that the taps remain square with the surface around the holes and that it is tapped to the correct depth of 12 threads from the end of each tap. Into an “R” size hole closest to the edge on top of the unthreaded end cap, tap $\frac{1}{8}$ -27 threads.
10. Tap threads into the $37/64$ inch hole in each of the two stacks of three disks that were joined in step 4, using a $\frac{3}{8}$ -18 tap. Apply primer followed by cement as before to the mating surfaces of one of the stacks of disks and the 3 inch flame arrestor pipe and attach them. Repeat this procedure for the other stack of disks.

Water Level Switch Test

Caution: Under no circumstances should you attempt to control power to any electrical device directly through the water level switch as it will either damage or indeed destroy the switch.

Note: You should confirm that the water level switch is working properly before the slosh shield is installed.

The water level switch has reed contacts that are of very high quality and as such will be reliable through millions of cycles if it is connected to a properly designed electronic circuit.

The water level switch is usually configured with NC (normally closed) contact. This is confirmed in step 1.

1. Ohmmeter leads are connected to the switch power leads and then the switch is suspended from the power leads to allow confirmation that the switch contacts are closed. If the contacts are not closed, go to step 3.
2. The switch float is slowly slid upwards. Confirm that the contacts open at around the midpoint of float travel. If this is so, go to step 4. If the contacts do not open properly, this indicates a defective switch that needs to be replaced.
3. Mark a small dot on the top of the switch float with a marker pen, then carefully remove the float retaining clip which is at the bottom of the center tube. Take the



float out, invert it and then place it back in. This will change it to the required NC configuration. Put the retaining clip back on and confirm that the dot on the float is now at the bottom. You may now repeat steps 1 and 2.

4. Form a small bevel in the outer end of the center hole in the unthreaded end cap using a countersink tool or large drill bit. This will allow for the switch leads to pass through.

Note: To provide added protection against possible water and/or gas leakage, it is highly recommended that pipe joint compound is applied to all threaded generator housing components.

Caution: Avoid using excessive torque on the water level switch threads when the switch is installed into its mounting spacer. This can cause damage to the spacer threads and will result in water/gas leakage and possible system failure.

5. Taking note of the directions on the product label, apply a light coating of pipe joint compound to the threads of the switch and mounting spacer. Push the switch power leads through the spacer hole and then thread the switch into place, ensuring that it has a firm seat.

Note: The following steps confirm that the switch operates correctly in response to changes in water levels.

6. Locate a large glass jar or similar transparent container. This container should have an outside diameter of approximately 2½ inches to 3¾ inches and an inside depth of at least 3½ inches. Put the unthreaded end cap on the top of the container, making sure that the switch is inside the container and that the bottom surface of the end cap is evenly seated on the container. Place the end cap to allow at least one of the large tapped holes projects inside the container and that the switch float is at least ¼ inch from the wall of the container.

Note: Make sure that the water level is measured with the switch float in water.

7. The ohmmeter leads should be connected to the switch leads. Ensure that the switch contacts are closed and then very slowly pour water through the large tapped hole until the switch contacts are just open and remain so. If they close again add a small amount of water until they open and wait for a short while before you recheck. Repeat this process until the switch stays open and check that the water level is at least 2 inches below the top edge of the jar. If this is not so, then the switch is defective and will need replacing.
8. Once you have removed the end cap assembly from the jar, dry it with a soft clean cloth.
9. Apply primer followed by cement as before to the mating surfaces of the sloss shield and the end cap and attach the sloss shield ensuring that it is centered around the switch float.



Toroid Coil

List of materials:

- One Ferrite Toroid Coil Core, 3.50 OD x 2.00 ID x .500 Thick (National Magnetics Part #: 995)
- Copper Magnet Wire, Teflon coated, Heavy Build, 23 AWG, 550 Ft (MWS Wire Industries, must be custom ordered)
- Teflon Etching Solution (“FluoroEtch”) (Acton Technologies)
- One Package Heat Shrink Tubing, Assorted Sizes (Radio Shack, Catalog #: 278-1610)

Material Sources:

National Magnetics Group
1210 Win Dr
Bethlehem, PA 18017-7061
Phone: 1-610-867-7600
Fax: 1-610-867-0200

MWS Wire Industries
31200 Cedar Valley Dr
Westlake Village, CA 91362
Phone: 1-818-991-8553
Fax: 1-818-706-0911

Acton Technologies
100 Thompson St
PO Box 726
Pittston, PA 18640
Phone: 1-570-654-0612
Fax: 1-570-654-2810

Radio Shack (Nationwide Stores)



Note: There is a need for close attention to detail when building an efficient and reliable coil. The system coil is actually wound by hand around a ferrite toroid core with insulated high temperature copper wire. Millions of coil configurations exist and it is a great place to experiment because it takes artistic ability as well as science. The International Coil Winding Association, based in England, is an organization dedicated to the craft. Winding any coil is tedious as the wire is turned 2,000 times and wrapped around a circular magnetically sensitive core.

Using Teflon insulated wire is recommended as it handles heat very well and it is virtually indestructible. Although it isn't cheap, it is worth the cost.

It can be ordered from the MWS wire industries, who have over 25,000 different magnet and speciality application wires. You will need extra heavy insulation, 23 AWG in a length around 550 feet.

When you have finished building your coil you should coat it with a few thin layers of CPVC cement. This will ensure that it will last forever as it will be practically bomb proof. It will also be easily to attach it firmly inside the housing with CPVC cement. One problem though is that it is very difficult to get anything to stick on Teflon. It requires chemical etching and this can be done at home inexpensively with a product called FluoroEtch. The process is simple – warm the FluoroEtch to about 130 degrees, slosh the coil in the solution for around 1 minute, then slosh the coil in isopropyl or methyl alcohol for a minute, wash it in warm soapy water and then rinse with warm water and air dry.

1. It is recommended that the magnet wire is cut into four 100 foot lengths and one 150 foot length. This avoids having to drag 550 feet of wire through the core 2,000 times. If you do, it works out to just over 104 miles of wire dragging (and a very sore arm!) Cutting the wire so reduces the wire dragging to 22 miles but you will need to make four solder splices to the wire. Avoid the temptation to wrap the wire around the core several times and pulling the rest of the wire through, because all that will happen is that the wire will break before you are finished making the coil.

To make a 3.5 inch OD x 2 inch ID Toroid Coil you need about 250 turns of wire per wrapped layer. Each wrap uses about 3 inches of wire because the coil builds in size as it is wrapped. Therefore, 100 foot of wire will make 400 wraps so the 550 feet will build an 8 layer coil of at least 2,000 turns.

Note: Keep the 150 foot length for the last layer to avoid having to splice the wire near the coil entry. Whenever you have to stop coiling, wrap a strip of electrical tape tightly around the coil to secure the last wrap. Because Teflon is so slippery, you will want to avoid returning to your work to find that the coil wraps are loose.

The first complete wrapping of the whole coil diameter forms layer #1 for the inner core and is the only critical layer. This is because each layer after it will automatically position itself by nesting between the wires of the previous wrap.



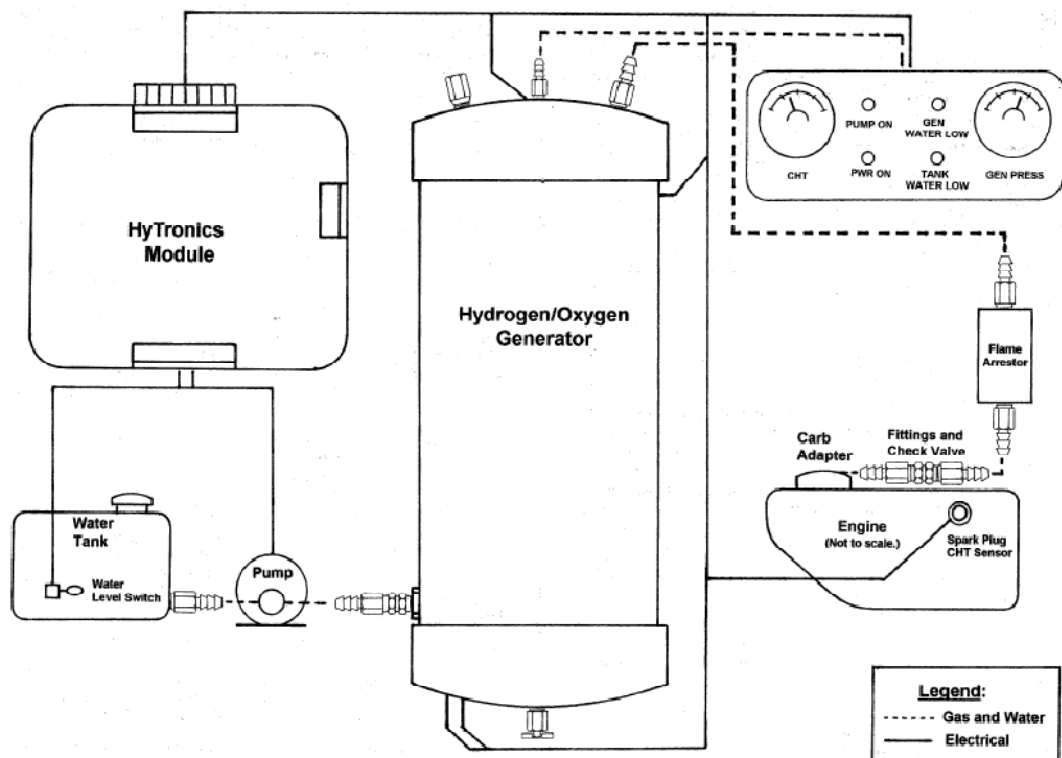
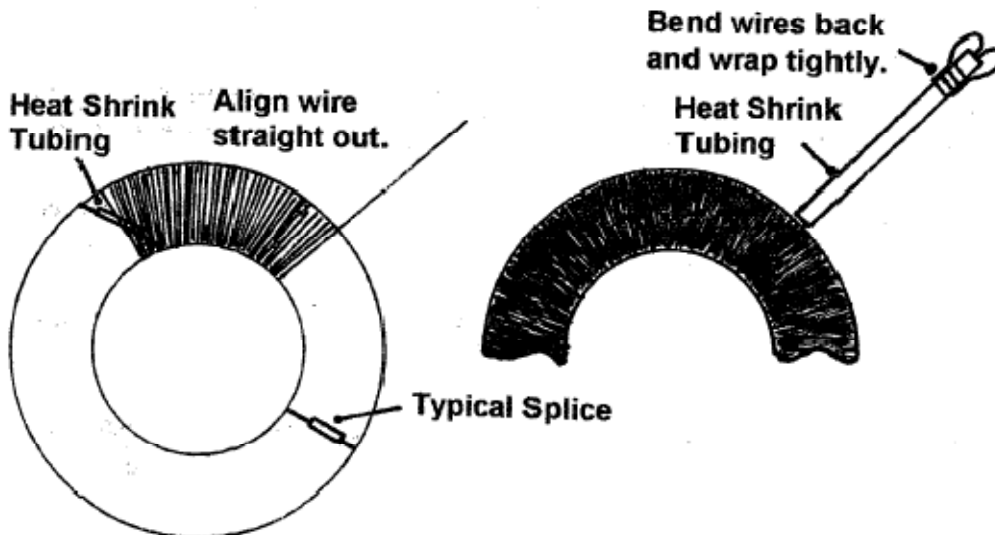


Figure 18

2. (See Figure 19) Approximately 4 inches on to the magnet wire, slip a 1 inch piece of small heat wrap tubing and apply heat to shrink it into place. Right-handers will probably wrap the coil clockwise whilst holding the core in the left hand. If this is so, lay the shrink tubing on the top of the core at an angle to the left of about 30 degrees as shown. Commence the first wrap over the tubing about mid way. This will be the start of the first layer for the inner core. Make sure that the wire wraps are kept tight against each other with no overlapping. Maintain tension on the wire, ensuring that it always points straight out from the core. There is little effect to the overall performance of the coil if the wire is wrapped precisely; however, the precise wrapping determines the positions of subsequent wrappings. In short, if you have a sloppy first layer, all of the coil will be sloppy, so take care to do the job properly. Continue wrapping until you have completed a full turn (layer #1). Wrap a piece of electrical tape tightly around the wire and the coil entry wire at the end of this layer.
3. If the coil is wrapped perfectly there will be a .019 inch gap between any two wires. Since this is virtually impossible, you can compromise by using a short piece of coil wire as a feeler gauge. If the feeler gauge wire is able to touch the core between two wires, the gap is too wide. You can use a fingernail or other blunt object to gently push the wires together so that the feeler gauge wire is unable to touch the core. Also remember that if there is a too wide gap in one place, there is one that is too narrow elsewhere and so you may have to move these wires further apart. Once you have



checked the coil a few times like this, you should be able to visually detect any wires that are out of position.



**Toroid Coil Details
Figure 19**

4. Mix a ½ ounce batch of epoxy (eg J-B WELD). Carefully apply a thin layer of the epoxy on to the outer edge of the coil with a small brush, taking care to apply the epoxy with a motion that is parallel to the wires so that you don't move any. Hang the coil by its wires and leave it so that the epoxy can cure, at least 8 hours before proceeding.

Note: Count and record the number of turns whilst wrapping coil layer #2.

5. Commence wrapping coil layer #2, being careful to place each wire into the gap formed between the layer #1 wires on the inner and outer edges of the coil. Count and record the number of turns. Continue this way until about one foot away from the end of the wire and then secure the wire by wrapping electrical tape tightly around both the wire and coil.

Note: The thickness of the coil tapers down between the inner and outer edges. So as to reduce the inner coil thickness, place wire splices either on the top or bottom of the coil half way between the edges. (see Figure 19)

6. For two or three more turns, temporarily wrap the wire and cut it ½ inch short of the outer edge. To enable splicing of the next length of wire, unwrap the wire and, using



a sharp knife, scrape the Teflon away from about ½ inch of both wire ends, making sure to keep the knife blade at a right angle to prevent damage.

7. Push a ½ inch length of heat shrink tubing over the end of the new wire, making sure that the tubing is large enough to fit over a wire splice. Twist the ends of the wire about 7 or 8 turns (together) to form the splice. The next step is to cut the splice to about ¼ inch and bend it back flush against the coil wire. Solder this splice and then push the shrink tubing centrally over the splice before applying heat to shrink the tubing. Once the splice is cool, proceed to the next step.
8. Remove the electrical tape from the coil and complete the wrapping of layer #2, making sure to record the number of turns.

Note: Although the total number of turns is not a critical point, most coils need a total of 8 wire layers.

9. Taking note of the number of turns that were required to complete layer #2, calculate the number of coil layers required to finish the coil with a total number of between 1,800 and 2,100 turns.

Note: Make certain that the last coil layer ends near the beginning of layer #1, not half way.

10. Repeat steps 5 to 7 until you have finished the last layer. Cut the last wire to a length of about 12 inches.
11. (See Figure 19) Temporarily place a 5 inch length of heat shrink tubing over the ends of the coil wires. Bring the tubing snugly against the outer edge of the coil and bend the coil leads towards the coil at the outer end of the tubing. Wrap each coil wire about 4 or 5 turns tightly around the tubing about 1 inch from the end and then twist the wires together for at least 5 or 6 turns.

Caution: Take great care so as to prevent damage to the coil wires during the following procedures.

Do not handle the coil with bare hands after etching so that proper bonding of CPVC cement and the coil occurs. Wear cotton gloves if the coil must be handled.

12. Suspend the coil by the heat shrink tubing and etch the surfaces of the Teflon coated coil wires with FluoroEtch, closely following the directions on the product label. The coil should always be suspended by the tubing from etching through to the final warm water rinse. Use paper toweling to soak up any water that drips from the bottom of the coil until the dripping stops. Allow the coil to air dry for at least 4 to 5 hours before proceeding.
13. Coat the entire surface of the coil in a thin and even layer of CPVC cement using a soft bristle brush. Wipe away excess cement that may drip from the bottom of the coil using cotton swabs until the dripping stops. Allow the cement to air dry for at least an hour and then apply a second thin coat of CPVC cement in the same way.



14. Repeat step 13 until you have applied a total of 5 or 6 layers of cement, waiting for at least one hour between coats. The final layer should be left to air dry for at least 8 hours before proceeding.

Caution: Be careful that you do not pull the coil exit wire away from the coil whilst removing the heat shrink wrapping.

15. Remove the heat shrink tubing from the coil wires by unwrapping the wires then cut a 1 inch length of heat shrink tubing that will fit snugly over the coil wires and the shrink tubing of the coil entry wire. Bring the tubing tightly up against the outer edge of the coil and apply heat to shrink the tubing.
16. Apply, using a soft bristle brush, a thin bead of CPVC cement approximately $\frac{1}{4}$ inch wide around both the coil end of the tubing and the surface of the outer coil edge. Wait for the cement to air dry (approximately 1 hour) and then apply a second bead over the first.
17. Suspend the coil by the end of its wires and allow it to air dry for at least 24 hours before proceeding.
18. Trim the coil wires to a length of 3 inches from the coil.

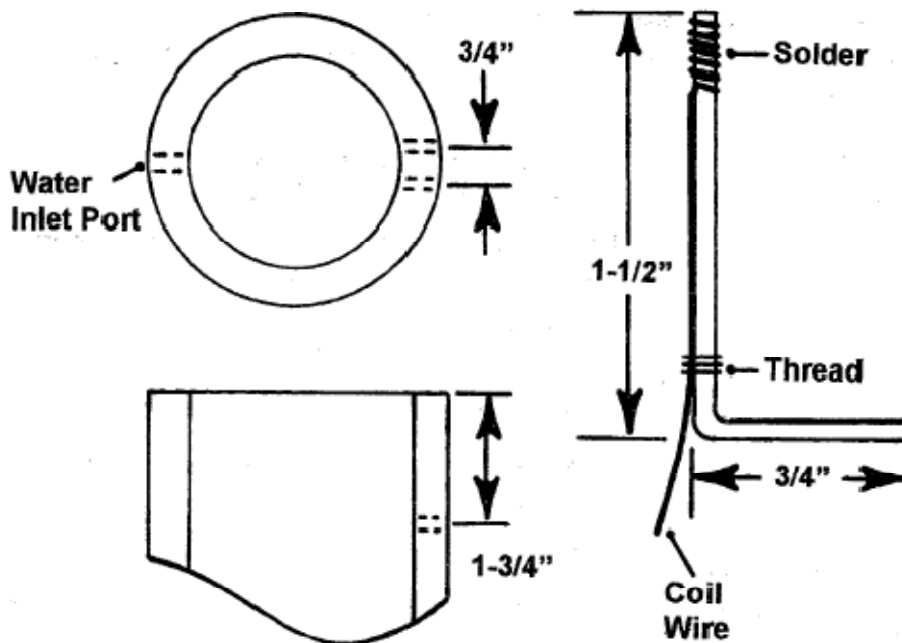
Toroid Coil Installation

Note: It is advisable to locate the coil electrical connections on the side of the housing directly opposite the inlet port for the water pump, as this reduces the possibility of coil wire connector fatigue that result from water turbulence at high pump pressure.

1. Drill two holes in the housing wall at the positions indicated on Figure 20, using a #41 drill bit.
2. Cut two 4 inch lengths of $\frac{3}{32}$ inch bare stainless steel welding rod. Put a 90 degree bend in one end of each of these rods to form one leg approximately $1\frac{1}{2}$ inches long (see figure 20) and cut the remaining leg to a length of $\frac{3}{4}$ inch. Square off each end and deburr, using a file.
3. Scrape the Teflon coating from approximately $\frac{1}{2}$ inch of each end of the coil wire, using a sharp knife that is kept at a right angle to prevent damage.
4. Making at least 4 or 5 turns, wrap each coil wire end around the top of the $1\frac{1}{2}$ inch rod leg and solder each wire to the rod leg with silver bearing electrical wire. Trim any excess wire and create a wire strain relief at the bottom of the leg by wrapping a heavy gauge thread around the leg for at least 2 or 3 turns, securing the thread with a knot on the outside of the rod bend.
5. Clean the areas that have been soldered using a soft bristle brush and warm soapy water, then rinse with warm water and allow the thread to air dry for at least an hour before proceeding.
6. Apply an even layer of CPVC cement along the entire length of the long rod leg, allowing it to dry for approximately 15 minutes before applying a second coat. Then allow this coat to air dry for another 15 minutes before proceeding.



7. Install the coil temporarily on top of the three support brackets within the housing. The coil should be in a position where the wires and rods are pointing towards the holes drilled in step 1. Three strips of electrical tape should then be temporarily attached on to the top of the coil to mark where each support bracket will be.



**Toroid Coil Installation
Figure 20**

8. Take the coil out of the housing and coat the bottom of the coil, at the 3 marked positions, with primer followed by CPVC cement. The top of each support bracket then needs the same treatment. The coil is then installed onto the support brackets, ensuring that the wires and rods are pointing towards the two #41 drilled holes. The coil can be moved slightly to center its outside edges within the housing. The cemented rods and wires then need to air dry for at least an hour before proceeding.

Note: You will need to countersink the two #41 holes sufficiently deep to clear the radius of the inside bend of each rod and allowing the soldered leg of each rod to lay flush against the housing wall with this leg pointing up.



9. Take the three tape strips from the top of the coil and deburr the inside ends of the #41 holes with a countersink tool or large drill bit. Check that the inside bend radius of the rod ends clears the edge of each hole when you insert the rods and adjust the countersinking if necessary until they do clear.
10. Polish the surface of the unsoldered leg of each rod with #400 grit or finer sandpaper. Mix a small quantity of epoxy, such as J-B WELD, apply a thin coat of it to the unsoldered leg of each rod and then, using a toothpick or precise tool, coat the inside of each #41 hole.
11. Coat the soldered leg of one rod with a heavy layer of CPVC cement and fully insert the rod into the #41 hole, ensuring that the soldered leg points directly up. Hold the rod in place for around 5 minutes until the cement is dry enough to hold it in place. Clean epoxy from the rod end using a soft clean cloth and solvent eg MEK or acetone whilst you are waiting for the cement to partially dry and repeat this procedure for the other rod. Allow the epoxy to cure for at least 8 hours before proceeding.

Note: A number of layers of CPVC cement are applied to secure the coil to the housing brackets, the rods and wires to the housing wall and to ensure that the rods are sealed against possible gas and/or water leakage through the holes in the housing.

12. Place the coil wires so that they are in contact with the housing wall as much as possible. Put the housing on its side and coat the wires and soldered leg of each rod with a thick layer of CPVC cement, making sure to extend the cement layer to form a puddle approximately ½ inch around each hole. The cement then needs to air dry for at least 15 minutes before proceeding.
13. Put the housing on its end and apply a thick layer of CPVC cement over and around the coil surface above where it comes into contact with the three support brackets, using a soft bristle brush, ensuring that the layer extends the width of each bracket. Allow the cement to air dry for at least 15 minutes before proceeding.
14. Repeat steps 12 and 13 at least 4 or 5 times to get the desired thickness of cement, allowing each successive layer to air dry for at least an hour between coats.
15. Once the epoxy had cured for at least 24 hours, remove any epoxy residue from the rod ends using #400 grit or finer sandpaper.

Unthreaded End Cap Installation

Note: The efficiency and function of the generator will not be affected by the rotational position of the unthreaded end cap.



1. Ensure that the mating surfaces of the end cap and the top of the housing are clean and free of debris of any kind and if necessary clean them with a soft clean cloth and isopropyl alcohol.
2. Once you have worked out the position for the end cap, apply primer followed by CPVC cement to the mating surfaces mentioned above and slide the parts together ensuring a firm seating.
3. To minimize the amount of excess cement running into threaded holes in the end cap, stand the housing on end and leave it in that position for at least 1 hour whilst the cement air dries.

Generator Final Assembly

1. Trim the two rod ends protruding through the bottom of the threaded end cap to a length of ½ inch and then square and deburr the edges using a file.

Note: Pipe joint compound is recommended to be used on all threaded generator housing components to prevent water and/or gas leakage.

Caution: Do not apply excessive torque to components whilst installing. Thread damage that results can cause water and/or gas leakage and possible system failure.

2. In accordance with the product label directions, apply a light coating of pipe joint compound to all threaded holes in the generator housing and the end caps.
3. Apply the same to the threads of the drain cock and then thread the cock into the 37/64 inch threaded hole in the bottom of the threaded end cap, ensuring a firm seat. Repeat this procedure to install the following components:
 - One 3/8” Barbed Hose Fitting into 37/64” hole in housing doubler.
 - One 3/8” Barbed Hose Fitting into 37/64” hole on top of housing.
 - One 1/8” Barbed Hose Fitting into “R” size hole on top of housing.
 - One Pressure Relief Valve into 37/64” hole on top of housing.
4. Force a small amount of Silicone sealant (RTV cement) into the hole in the end cap, through which the water level switch passes, using a toothpick or similar. Create a smooth, small fillet of sealant around the leads and end of the hole and allow the sealant to cure for at least 24 hours before proceeding.
5. All surfaces and components of the housing and end cap should be visually inspected to confirm their integrity and to allow for any necessary correction of defects.
6. Flush the interior of the generator housing thoroughly with warm tap water, then stand the housing on end and allow for the excess water to drain for at least 15



- minutes. Dry the exterior of the housing, the threads of the housing and the end cap with a soft, clean cloth.
7. Apply a light coat of pipe joint compound to the housing and end cap threads, thread the end cap onto the housing and firmly tighten.

In-Dash Indicator Panel Assembly

Note: The layout of the panel gauges and LED indicators is a personal choice. During the assembly of the panel, refer to Figures 5, 6 and 7.

List of materials:

- One cylinder head temperature (CHT) gauge kit, 2-1/16" diameter, (includes spark plug mounted thermocouple sensor) (Bus boys Part #: VDO-310901).
- One 2-Gauge Custom Console (Bus Boys Part #: VDO-1108720).
- One pressure gauge, 2-1/16" diameter (Auto Meter Products Model #: 2360).
- Two bulb and socket sets, 2 watt (Auto Meter Products Model #: 2357)
- Four LED indicators: two green (Radio Shack Part #: 276-304), one yellow (Radio Shack Part #: 276-351), one red, blinking (Radio Shack Part #: 276-308).
- Three 55' spools 18 gauge insulated, stranded hookup wire (Radio Shack Part #: 278-1220)
- One 9-position male interlocking connector (Radio Shack Part #: 274-229).
- One 9-Position female interlocking connector (Radio Shack Part #: 274-239)
- Two packages crimp-on snap connectors (each: 5 male, 5 female) (Radio Shack Part #: 64-3085 and 64-3086)
- One package assorted ring terminals (Radio Shack Part #: 64-3032).
- One package assorted grommets (Radio Shack Part #: 64-3025).
- One 10' length 1/8" silicone braid reinforced tubing (US Plastic Stock #:



54051).

– Twenty (20) small stainless steel worm thread hose clamps (Local Hardware Store)

– One package small nylon tie-wraps (Local Hardware Store)

Material Sources:

Bus Boys, Inc
183 Lake Blvd East
Redding, CA 96003
Phone: 1-530-244-1616 Fax (7/24): 1-530-224-0933

Auto Meter Products Inc
413 W Elm St
Sycamore, IL 60178
Phone: 1-815-895-8141 Fax: 1-815-895-6786

Radio Shack (Nationwide Stores)
United States Plastic Corp
1390 Neubrecht Road
Lima, OH 45801-3196
Phone: 1-800-537-9724

Note: The simplest, fastest and often most attractive way to mount gauges and LED's is to obtain a prefabricated console that is attached to the top of the dash panel. There are other methods, but the VDO-1108720 Custom Console, molded from ABS plastic is attractive and durable and is therefore recommended.

1. Mount the CHT and pressure gauges temporarily into the console. Referring to Figure 2, decide on the best locations for the 4 LED's and mark reference points for these on the outside of the console and then drill a 7/32 inch hole at each point. Roughen the interior surface of the console immediately around the area of the drilled holes with sandpaper to enable proper adhesion of silicone sealant.
2. Disconnect the CHT gauge thermocouple lead temporarily to enable the gauge to be mounted in the console. Apply a light coating of pipe joint compound to the 1/8-



27 threads of the pressure gauge and the 1/8-27 barbed hose fitting, thread the two together and tighten firmly. Slip the 1/8 inch silicone tubing completely onto the barbed fitting and secure it with two small stainless steel hose clamps, making sure that the clamps are firmly tightened and then mount the pressure gauge into the console.

Note: The sorter of the two LED leads is always the anode (+) lead.

3. Identify the anode (+) lead for each LED and cut them to a 1 inch length. Cut 4 lengths, each of 3 feet, of 18 gauge hookup wire and strip 1/2 inch of the insulation from each end of each piece of wire. Solder after wrapping the stripped end of each wire around each anode lead. Slide a 1 1/2 length of heat tubing over each wire, flush against the LED and heat shrink the tubing.
4. Identify the location for each LED on the console (see Figure 2). Attach an identifying label to each anode wire – masking tape works well. Use the following as a guide:
 - Green, PWR ON
 - Green, PUMP ON
 - Yellow, GEN WATER LOW
 - Blinking Red, TANK WATER LOW
5. Cut two lengths of hookup wire to be used as jumper wires between the bulbs and the gauge sockets. After stripping 1/2 inch of insulation from both ends of each wire, solder one wire to one socket center connector. Slide a 1 inch piece of heat shrink tubing onto the wire and as far as you can onto the socket base. Heat shrink the tubing. Cut a 3 foot length of hookup wire, strip the insulation 1/2 inch from one end and twist this end and the end of the soldered jumper wire together. Slide a 1 inch piece of heat shrink tubing onto the wires then solder the wires to the other socket center connector. Shrink the tubing once you have slid it as far as possible onto the socket base and label the wire “Positive” (+).
6. Cut a 6 inch piece of hookup wire and repeat step 5 to connect this wire to the jumper wire between the two socket base connectors. Strip 1/2 inch of the insulation from the end of the 6 inch wire.
7. Trim the cathode lead of the green “PWR ON” LED to 1 1/2 inches in length and the cathode lead of the yellow “GEN WATER LOW” LED to 1 inch in length. Cut a length of hookup wire to act as a jumper lead between these two cathodes, stripping 1/2 inch of insulation from each end of the wire. Solder one end of the jumper wire to the yellow LED cathode, then slide a 1 1/2 inch piece of heat shrink tubing over the wire, flush against the LED and heat shrink the tubing. Twist both the stripped ends of the jumper wire and the 6 inch wire from step 6 together, slide a 1 inch piece of tubing over the wires and then solder these wires to the green LED cathode. The tubing is then slid flush to the LED and shrunk. Cut a 3 foot length of hookup wire, strip 1/2 inch of insulation from one end and



solder this wire to the green LED cathode. Slide a 1½ inch piece of tubing over the wire and as far as it will go onto the LED lead, shrink it and label this wire as “Ground”.

Trim the cathode leads of the two remaining LED to 1 inch in length. Cut two three foot lengths of hookup wire and strip the ends as before. Solder the wires to the LED cathodes, slide a 1½ inch piece of heat shrink tubing over the wire, flush against the LED and shrink it. Label the green LED wire as “PUMP ON CATHODE” and the red LED wire as “TANK WATER LOW CATHODE”.

Note: A chemical reaction with oxygen and water moisture in the air cures silicone sealant and it the reason why it is sometimes called RTV (Room Temperature Vulcanizing) cement. You can shorten the curing time by putting a damp cloth within the console interior and then placing the console into a plastic bag that is left unsealed. This is a handy hint for dry climates.

8. Place each LED in its correct mounting hole on the console. Slide one of the LED's about 1/16 inch back from the console's interior surface and place a small amount of silicone sealant into the gap between the LED flange and the surface of the console. Put the LED back into place, flush with the surface and then apply a thick bead of the sealant around the flange and about ¼ inch onto the console surface. Repeat this procedure for the other 3 LED's and then wait at least 24 hours for the sealant to cure before proceeding.
9. The bulbs and sockets are then installed into the gauges. Gather the seven LED wires and the bulb socket wire together a little way from the LED's and tightly secure the bundle with a tie-wrap, then cut off the excess strap.
10. Create a hole in the engine compartment firewall at an appropriate place by either drilling or grinding and after smoothing the edges, install a 5/8 inch grommet to enable the routing of the HyTronics wire, thermocouple lead and pressure gauge tube. Push the thermocouple lead through the grommet from the engine compartment side and reattach it to the CHT gauge terminal.
11. Permanently attach the console to the dash at the best location for the driver and then secure the wires, thermocouple lead and CHT tube bundle together with a tie wrap at 6 inch intervals along the bundle's length. Ensure that the pressure gauge tube does not collapse by not overtightening the tie wraps.
12. Trim the ends of the 8 wires to identical lengths and strip ¼ inch of insulation from each. Attach each wire to a separate pin on the 9-position male interlocking connector by either crimping the wires or soldering.
13. Take out a spark plug from the engine and plug the hole with a soft clean cloth. Polish the spark plug contact area with #400 grit or finer sandpaper to ensure that there is good electrical contact for the thermocouple and then carefully remove the cloth plug. Slip the thermocouple ring over the spark plug threads and reinstall the plug, taking care to tighten it to its normal torque value.

Water Tank and Pump



List of materials:

- One rectangular polyethylene tank, 16 gallon, 21" x 14" x 14" (US Plastic part #:8658).
- High-low temperature silicone tubing, 3/8" ID, 20' (US Plastic stock #: 54037).
- Silicone braid reinforced tubing, 3/8" ID, 20' (US Plastic stock #: 54055).
- One high-head pump, 12 vdc, 75 psi (minimum) (Flojet)
- One brass bushing, 3/4" PTF male x 3/8" PTF female (Fastener Hut part #: 3220X12X06A).
- One package crimp-on butt connectors (Radio Shack part #: 64-3037).

Material Sources:

Radio Shack (Nationwide Stores).

Fastener Hut Inc – (Ordering information listed on previous pages)

Flojet Corporation

20 Icon

Foothill Ranch, CA 92610

Phone:1-949-859-4945

Toll-Free:1-800-235-6538

Fax:1-949-859-1153

Note: Whilst the actual capacity of the water tank is not critical, you should aim for one that holds at least 5 to 10 gallons. The tank in the materials list is highly recommended: it has a 16 gallon capacity, is well made and is fitted with a 3/4 inch FPT outlet fitting.

1. A thin film of pipe joint compound is applied to the internal threads of the 3/4 inch x 3/8 inch bushing and the threads of a 3/8 inch barbed hose fitting and the fitting is then firmly threaded into the bushing.
2. Another thin film of pipe joint compound is applied to both the external threads of the bushing and the internal threads of the water tank fitting. The bushing is then firmly threaded into the tank.

Note: The water level switch can be installed half way up either of the tank's side walls. Its location will be based on where the electrical leads are routed and the trunk layout. One switch lead needs to be grounded to the frame of the vehicle somewhere in the trunk and the second lead will be connected to the HyTronics module.



3. A $\frac{5}{8}$ inch hole is drilled into the side wall of the water tank half way along its length and 4 inches up from the bottom. Flush the tank with tap water to ensure there are no plastic shavings remaining.
4. Remove the tank cap, drill a $\frac{37}{64}$ inch hole through its center and then thread this hole with a $\frac{3}{8}$ -18 tap. Remove any plastic shavings by flushing the cap with water. Thread and seat firmly a $\frac{3}{8}$ inch barbed hose fitting into the tapped hole. Cut a 6 inch piece of high-low temperature silicone tubing and slip the tubing onto the fitting. Secure it with two stainless steel hose clamps that have been tightened firmly.

Caution: Never try to control power to any electrical device directly through the water level switch as this will either damage or destroy the switch.

Note: The water level switch is fitted with very high quality magnetic reed contacts and will operate reliably through millions of cycles when it is connected to an LED.

5. Strip $\frac{1}{4}$ inch of the insulation from the ends of the water level switch leads and connect ohmmeter leads to them. Pivot the switch float until it is flush against the switch body and confirm that the ohmmeter reads that the switch contacts are closed. If they are not closed, the switch is defective and needs to be replaced.
6. Pivot the switch until it is within 10 degrees of its stop and confirm that the contacts are open. If they are not, the switch is defective and needs to be replaced.
7. Dry the tank's side wall around the $\frac{5}{8}$ inch hole with a soft clean cloth. Pipe joint compound is then applied to the threads of the switch body and mounting nut and their respective mating surfaces with the tank wall. Ensure that the switch is installed in the tank so that the float pivots upwards and the pivoting axis is parallel to the tank's bottom. Once this is done, tighten the switch mounting nut firmly.
8. Confirm that the switch contacts are closed by attaching the ohmmeter leads to the switch leads. Plug the outlet fitting on the tank and fill the tank with water until the switch contacts open, then for another 2 inches after that. Confirm that the contacts remain open. Remove the plug from the tank outlet and confirm that, when the water level falls to approximately $\frac{1}{3}$ full, the switch contacts close. If they do not, check the installation of the switch and that the float pivots freely. Confirm that the float is at least $\frac{1}{4}$ inch away from any part of the tank. If the switch has been correctly installed and still does not work properly, it is defective and needs to be replaced.
9. Drain water from the tank and install the cap, making sure that it is firmly tightened. To secure the tank against sliding in the trunk, construct a wood frame of 3 to 4 inches height, making sure to cut a notch or drill a hole large enough to clear the tank outlet whilst the tank is being installed or removed. It may also be necessary to do the same for the switch mounting nut and wires.
10. Install the frame on to the trunk floor in the desired location.
11. Find a convenient spot on the chassis close to the water tank and drill a $\frac{3}{32}$ inch hole. This will be the grounding ring attachment hole for the tank switch. Remove



any dirt or debris from around the hole with a clean rag and solvent. Use sandpaper to remove any paint or other insulating material from the area surrounding the hole. Prepare a ring terminal for later installation by stripping $\frac{1}{2}$ inch of insulation from the end of one switch wire and crimp a large ring terminal to it.

Note: If the water pump is to be installed within the engine compartment as recommended, then high-low temperature silicone tubing will be used to connect the tank and pump. If, however, the pump needs to be installed in the trunk, the tube connecting the pump to the check valve will be pressurized (up to 85 psi) and silicone braid reinforced tubing is necessary. A non self-priming pump must be installed in the trunk.

12. Measure the length of tubing required to reach from the pump or water tank to the engine compartment. For engine compartment installation, go to step 14. For trunk installation, go to step 13.
13. Secure the pump at its desired location in the trunk. Measure and cut the length of high-low temperature tubing required to attach the tank to the pump. Slide the tubing onto the tank fitting and secure it with two small stainless steel hose clamps. Slide the tube onto the pump inlet fitting, slide the hose clamps over the fitting and firmly tighten. Slide the braid tubing over the pump outlet fitting, then slide two small stainless steel hose clamps over the fitting and firmly tighten. Go to step 15.
14. Measure and cut the required length of high-low temperature tubing and slide onto the tank fitting, securing it with two small stainless steel hose clamps that are firmly tightened. Slide the tank into its wooden frame.
15. Attach the tank ring terminal (prepared in step 11) to the $\frac{3}{32}$ inch hole in the chassis with a sheet metal screw and then apply a heavy layer of either petroleum jelly or grease over the terminal and screw.
16. From the end of the remaining switch wire, strip $\frac{1}{2}$ inch of insulation and then crimp a butt connector onto the wire. Measure and cut the length of hookup wire needed to extend at least 3 feet into the engine compartment, then strip $\frac{1}{2}$ inch from the end of this wire and crimp it to the butt connector. If the pump is installed in the trunk, repeat this procedure to splice an equivalent piece of hookup wire to each pump power lead.
17. Using a $\frac{3}{4}$ inch grommet wherever an access hole is required, route the tank and pump wires through the structure of the vehicle, using tie-wraps every 6 inches to secure the wire and tubing bundle. Be careful that you do not over-tighten the tie-wraps as this may crunch the tubing.
18. If the water pump was not installed in the trunk, securely mount it in the engine compartment. Slide two small stainless steel hose clamps onto the high-low temperature tubing, push the tubing onto the pump inlet fitting and firmly tighten the hose clamps.

HyTronics Module



Materials List:

– Purchase specific electronic components as called for in schematic diagrams of Figure 5, Figure 6 and Figure 7(pages 14 & 16). (Available at Radio Shack).

Materials list – Continued:

- Two 12-position male interlocking connectors (Radio Shack part #: 274-232).
- Two 12-position female interlocking connectors (Radio Shack part #: 274-242).
- One universal component board (Radio Shack part #: 276-168).
- One PC board kit (Radio Shack part #: 267-1576).
- One enclosure 8” x 6” x 3” (Radio Shack part #: 270-1809)

Materials Source:

Radio Shack (Nationwide Stores).

Note: Considering that both the electrode circuit (Figure 5) and coil circuit (Figure 6) operate at relatively low frequencies, the physical layout of the HyTronics model components does not have to be “by the book”. You can either mount the components using the universal component board or design your own PC board layout using the PC board kit. This even includes the necessary chemical solutions. An enclosure that is recommended gives the HyTronics circuits protection, is attractive and easy to mount. It is possible to build the electrode, coil and indicator circuits on either the same or separate boards.

1. (See Figure 5) Using the components as detailed, build the electrode circuit.
2. (See Figure 6) Build the coil circuit using the detailed components.
3. (See Figure 7) Using the detailed components, build the indicators circuit.

Note: To route the wires to the 9-position indicator panel connector, a hole has to be drilled into the HyTronics module enclosure. To route wires to two 12-position connectors for all other system components, a second hole has to be drilled. Ensure that an appropriate sized grommet is used in each case.

4. Drill a hole in the enclosure and install a $\frac{3}{8}$ inch ID grommet. Measure and cut eight 1 foot lengths of hookup wire and strip $\frac{1}{2}$ inch of insulation from one end of each of the wires. Route one wire through the grommet, solder it to the HyTronics “Ground” (-) bus and then label the wire. Solder the seven remaining LED and bulb socket wires as follows:

PWR ON – Figure 5

All other LED’s – Figure 7

Positive (+) bulb socket center connector wire – Figure 7



Be sure to label each wire.

5. Trim the eight wires to an equal length and strip $\frac{1}{4}$ inch of insulation from each end. Connect the wires to the 9-position female interlocking connector and take care that the position of each wire and its label correspond to both the male and female connectors. Once this has been confirmed, remove the labels and secure the wires with a tie-wrap at 3 inch intervals.
6. Drill a second hole in the enclosure and install a $\frac{1}{2}$ inch ID grommet. Cut and measure nineteen 1 foot lengths of hookup wire and strip $\frac{1}{2}$ inch of the insulation from one end of each wire. Solder two wires to the relevant terminals for both the generator electrodes (Figure 5) and the generator coil (Figure 6). Solder one wire to the relevant terminal of the pump circuit (Figure 7) and one to the relevant terminal for the generator water level switch (Figure 7). Solder five wires before the fuse connection (the battery + side of the power bus as shown in Figure 5) and five to the negative (-) bus. One wire is then soldered to the throttle 10K resistor (Figure 5) and two wires for the tank water level switch (Figure 7). Make sure that each wire is labeled.

Note: There is provision for future additions or modifications with two spare connectors, so as such you should ensure that the male and female locking connectors are both 12-position to avoid accidental connections.

7. Trim the nineteen wires to equal length and strip $\frac{1}{4}$ inch of insulation from the end of each wire. Choose and connect any nine wires to a 12-position male interlocking connector and connect the remaining wires to a 12-position female interlocking connector, Secure the wires as before with a tie-wrap at 3 inch intervals.
8. Install the HyTronics module as far forward as possible under the dash panel and connect the 9-position interlocking connectors of the module and dash indicators.

Carburetor Adapter

Note: It is recommended that a carburetor adapter is purchased from Impco as there are literally hundreds of carburetor variants. Impco deal almost exclusively in gasoline engine fuel conversion systems and have thousands of options available. They have also been in business for almost 50 years. Enquire about the possibility of installing a Beam-Garretson Carburetor Adapter.

Impco Technologies
16804
Gridley Place
Cerritos, CA 90703
Phone: 1-562-860-6666
Fax: 1-562-820-3088



1. Source and install an appropriate carburetor adapter on your engine.

Throttle Assembly

Note: The HyTronics throttle uses a high quality precision pot (potentiometer) that has been designed for reliability and durability (over 5 million complete revolutions). Cheap pots will soon fail or cause problems; do not substitute a cheap pot.

List of materials:

- One precision pot, series 578, 100k (Clarostat part #: 578 X 1 G 32 P 104 S W).
- One 1-foot length CPVC Rod, 3/4" diameter (US Plastic part #: 43182).

Materials Source:

State Electronics
36 Route 10
East Hanover, NJ 07936
Phone: 1-973-887-2550 Toll Free: 1-800-631-8083
Fax: 1-973-887-1940

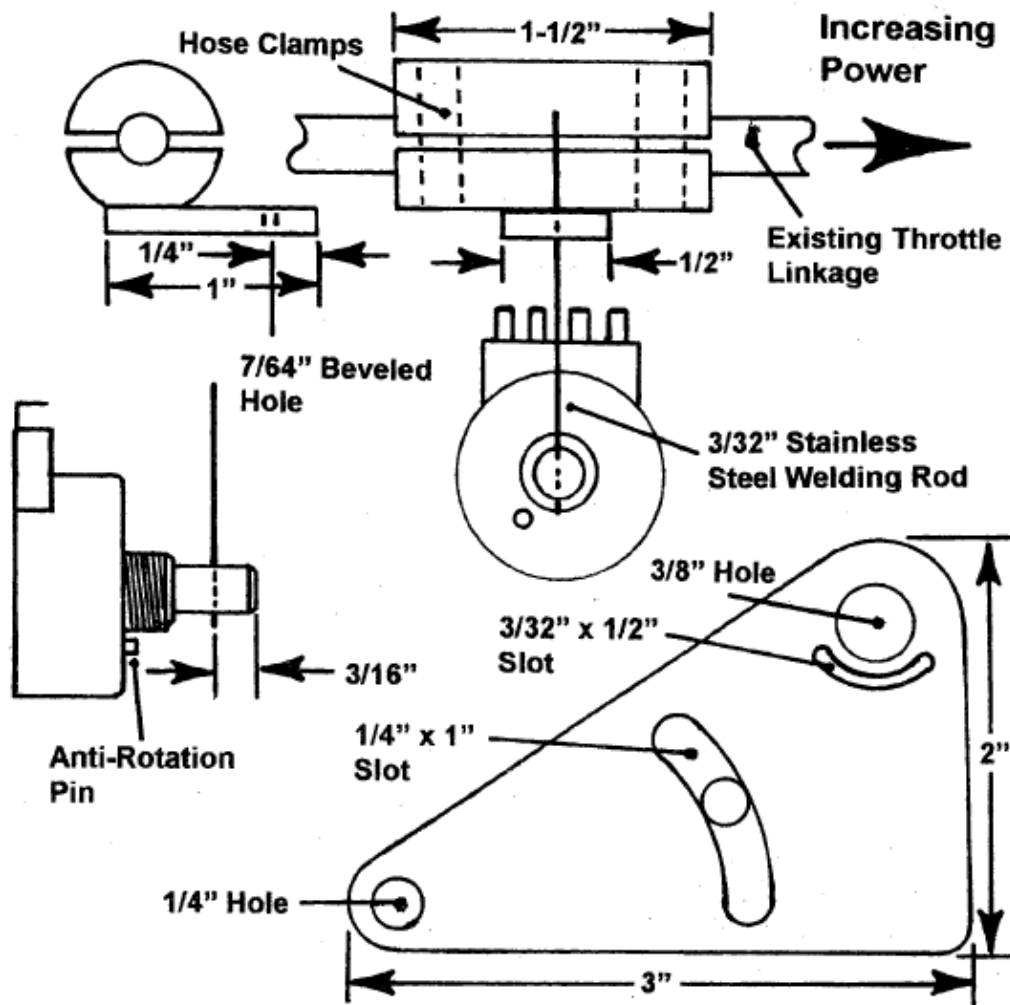
Note: Figure 21 shows a typical HyTronics throttle assembly. Because there are hundreds of various throttle linkages, the following procedure is to be used as a general guide. The pot mounting bracket is designed to allow the pot to center (housing rotation) and precise adjustment of throttle sensitivity (bracket rotation). The throttle linkage sleeve allows for precise pot rotation limit adjustments (ie idle to maximum revs) when combined with bracket rotation.

1. Decide upon the best location in the engine compartment to install the sleeve and arm assembly and the pot mounting bracket.
2. Make a pot mounting bracket of the dimensions shown in Figure 21 from 1/8 inch CPVC sheet, modifying the bracket size and points of attachments to suit your vehicle, if necessary. Do not cut the 3/32 inch slot as yet.
3. Cut a 1 1/2 inch piece of 3/4 inch diameter CPVC rod and measure the diameter of the existing throttle linkage. Locate a convenient place and drill a hole the diameter of the linkage lengthwise through the rod. Cut the rod in half lengthwise using a thin blade saw and then, using a belt sander, sand a flat surface of at least 1/4 inch wide onto one rod half.



4. Cut a $\frac{1}{2}$ inch x $1\frac{1}{4}$ inch sleeve arm from $\frac{1}{8}$ inch CPVC sheet. Drill a $\frac{7}{64}$ inch hole in one end of the arm approximately $\frac{1}{4}$ inch from the hole and, using either the drill or a countersink tool, bevel each hole to a depth of about $\frac{1}{16}$ inch. Apply primer followed by cement to the mating surfaces of the arm and sleeve and join the parts. Once the parts have air-dried for at least 2 hours, dress the cut edges of all throttle parts with sandpaper.
5. (See Figure 5). Position the shaft of the 100k throttle potentiometer (pot) at the half way point of its rotation range and, using a marker pen, mark an alignment line between the pot shaft and bushing at the point shown in Figure 21. Using a #41 drill bit, drill a hole in the shaft at a point in line with the shaft alignment mark, $\frac{3}{16}$ in from the end of the shaft.
6. Cut a 6 inch piece of $\frac{3}{32}$ inch stainless steel welding rod and temporarily install the pot into the $\frac{3}{8}$ inch hole in the mounting bracket. Slide the welding rod into the shaft hole, ensure that the shaft and bushing marks are aligned and rotate the pot body so that the rod points directly upwards and parallel with the bracket front edge. Place a mark where the anti-rotation pin comes into contact with the bracket and then remove the pot and rod from the bracket.
Cut a curved $\frac{3}{32}$ inch wide slot extending $\frac{1}{4}$ inch from each side of the marked point (see Figure 21). Install the pot into the bracket temporarily and ensure that the anti-rotation pin fits into the slot but does not catch as the pot body is rotated. Use a fine-tooth file, if necessary, to file the slot until the pot body rotates freely and then dress the slot edges with sandpaper.





Throttle Assembly Details

Figure 21

7. Attach the pot to the bracket using the furnished nut and lock washer and temporarily install the rod into the shaft hole. Align the rod parallel with the front bracket edge by rotating the pot body and then firmly tighten the mounting nuts. Square off both ends of the rod with a file and deburr it with sandpaper. Thoroughly clean the pot shaft and rod using MEK or acetone and a soft clean cloth, then flush the hole in the shaft with MEK or acetone.
8. After mixing a small quantity of high quality epoxy such as J-B WELD, coat the shaft hole with said epoxy using a precision instrument eg a toothpick. Apply a thin layer of epoxy to one end of the rod and insert it into the hole ensuring that it extends about 1/8 inch beyond the end of the hole. Form a small fillet of the epoxy



- around the junction of the rod and shaft at both sides of the shaft and allow the epoxy to cure for at least 24 hours before proceeding.
9. (See Figure 21) Using a small hose clamp at either end, attach the sleeve and arm assembly to the throttle linkage. Place the pot directly below the arm with the rod protruding through the hole in the arm and move the bracket back and forth until the rod is square with the sleeve arm and parallel with the front bracket edge when the throttle linkage is approximately 60 degrees each side of center as the throttle linkage moves through its full range.
 10. Attach the bracket to the structure using two ¼ inch bolts and adjust it precisely for fit by placing the bolt at approximately the mid point of the slot. Ensure that the bolt does not snag in the slot at any point and if necessary file the slot until the pot body rotates freely. Dress the edges with sandpaper.
 11. Ensure that the pot rod moves freely in the arm hole as the throttle linkage travels its full range, making any necessary adjustments by rotating the pot slightly up or down or sliding the sleeve assembly either backwards or forwards. Firmly tighten the bracket bolts and sleeve hose clamps.

Preliminary Assembly and Testing

Caution: Under no circumstances attempt to solder wires directly to the four generator electrode and coil pins as excess heat will damage the epoxy bond, possibly resulting in gas and/or water leakage.

1. Onto each of the four electrode and coil pins of the generator, install a male crimp-on snap connector. Using ¼ inch bolts, washers and locknuts, securely install the generator in the engine compartment. Ensure the generator is level with the vehicle frame. If the water pump is installed in the trunk, proceed to step 3. If it has been installed in the engine compartment, proceed to step 2.
2. To connect the water pump outlet to the ⅜ inch fitting on the side of the generator housing near the bottom, cut a length of silicone braid tubing, allowing some slack in the tubing.
3. If the water pump is fitted with an internal check valve, slide two small hose clamps onto the water tubing and install onto the ⅜ inch barb fitting on the side of the generator housing close to the bottom. Allow some slack in this tubing and tighten the clamps firmly. If the pump is not fitted with an internal check valve, install a check valve in the tubing a few inches from the barb fitting in the side of the generator. Allow some slack in this tubing and using two small hose clamps on each barb fitting tighten them firmly. Ensure that the check valve is installed so that the flow direction arrow on the valve points toward the generator.
4. Cut two 3” pieces of the braid tubing and attach these to each end of a check valve with small hose clamps, tightening the clamps firmly. Attach a valve hose to the carb adapter on the engine, using two small hose clamps, with the valve arrow pointing towards the adapter and tighten the clamps firmly.



5. Attach the flame arrestor to the check valve hose with two hose clamps and firmly tighten the clamps. Cut a length of braid tubing to connect the $\frac{3}{8}$ inch barb fitting on top of the generator to the flame arrestor. Slide four small hose clamps onto the tubing and connect the tubing between the generator and flame arrestor, allowing for some slack in the tubing and then tighten the clamps firmly.
6. Attach the pressure gauge tubing to the $\frac{1}{8}$ inch fitting on top of the generator with two small hose clamps, allowing for some slack in the tubing and then tighten the clamps firmly.
7. Measure and cut four 5-foot pieces of hookup wire and strip $\frac{1}{2}$ inch of the insulation from one end of each wire. Twist the stranded ends of two wires together and trim the ends to a length of $\frac{3}{8}$ inch. Crimp a ring terminal to the spliced wires and attach the terminal to the HyTronics power switch. Repeat this procedure for the other two wires and then mount the switch at a convenient position on the dash. Route one pair of switch wires to the vehicle positive (+) power bus that is always "hot" (the battery side of the bus as shown in figure 5). Trim the wires to length and strip $\frac{1}{2}$ inch of the insulation from the wire ends. Twist the wires together, trim to $\frac{3}{8}$ ", and crimp a ring terminal to the wire ends. Do not attach the terminal, or other connector, as yet.
8. Measure and cut two 5 foot lengths of hookup wire and splice them together with a ring terminal as in step 7. Find a convenient place in the engine compartment where the ring terminal can be attached to the chassis and drill a $\frac{3}{32}$ inch hole at that place, attaching the terminal following the same procedure as for steps 11 and 15 in the Water Tank and Pump installation.
9. Send the two wires through the grommet installed in the firewall of the engine compartment and cut the wires to length in order for them to reach the two 12-position connectors of the HyTronics module, allowing for some slack. Trim $\frac{1}{4}$ inch of insulation from the end of each wire and connect each wire to a negative (-) bus position on either of the 12-position interlocking connectors.
10. Route the remaining pair of switch wires to the connectors and cut them to length, allowing for some slack and then connect these wires to the connectors at two of the battery positive (+) power bus positions as was done in step 9.
11. Cut for wires of sufficient length to connect the tank water level and generator water level switch wires to their relative positions of the HyTronics connectors. Strip $\frac{1}{4}$ inch of insulation from one end of each wire and solder each wire to the pot terminals, then slide a 1 inch length of heat shrink tubing onto each wire and over the soldered terminals before it is shrunk.
12. (See Figure 7) Connect the tank water level and generator water level switch wires to their relative positions of the HyTronics connectors. Splice hookup wire to the switch wires as needed to reach the Hytronic connectors, using butt connectors.
13. Cut two pieces of hookup wire to connect the throttle pot to the HyTronics connectors. Strip $\frac{1}{4}$ inch of insulation from one end of each wire, solder each wire to the pot terminals and then slide a 1 inch piece of heat shrink tubing onto each wire and over the soldered terminals until it is shrunk.



14. Route the pot leads to the HyTronics connectors and trim the ends of the leads to equal length. Strip $\frac{1}{4}$ inch of insulation from the end of each wire and connect one pot lead to a battery positive (+) power bus connector position and connect the other lead to the connector position leading to the 10k resistor lead. Rotate the pot shaft to its midpoint position.

Caution: Do not connect the water pump leads and do not add water to the tank until the Final Assembly.

15. Confirm that the HyTronics power switch is in the OFF position using an ohmmeter. If this is not so, place the switch in the OFF position.
16. Connect the switch ring terminal to the battery positive (+) power bus.

Caution: In step 18, power will be applied to the system and any incorrect electrical or electronic connection may lead to system or component failure or damage. Ensure, therefore that all electrical and electronic connections are double checked before power is applied.

17. Double check all electrical and electronic connections in the system and correct any errors as needed. Connect the two 12-position interlocking connectors of the HyTronics module to the matching system connectors and confirm that all system connectors are properly engaged. Remove the HyTronics module enclosure if it is still in place.

Caution: Do not attempt to start the engine at this stage as this is a preliminary test to confirm that the basic system is functioning. If there are any problems, shut off the power immediately.

18. As soon as you have applied power, check the following system responses in the order in which they are listed:
 - No smoke or electrical sparking
 - No system component overheats (electrically)
 - Check that the LED's are functioning properly – "PWR ON, PUMP ON and GEN WATER LOW" LED's are lit and "TANK WATER LOW" LED is blinking.
 - Confirm that the gauge lights are lit.After this, flick the power switch to the ON position and confirm that no problem exists. If there is a problem, shut everything down immediately.
19. Proceed to the next step if everything checks OK. If there is a problem, troubleshoot to find the problem and repair or replace anything that is faulty. Return to step 18 when this is completed.
20. Check that there is no evidence of overheating by applying your fingers. If everything is fine, proceed to the next step and if there is evidence of overheating, turn the power off and return to step 19.



21. Ensure that the vehicle gas pedal is in the full idle position and connect a digital voltmeter to pin 6 of amplifier LM741 (Figure 5) and record the voltage level. If there is voltage, proceed to the next step. If there is no voltage something is defective and needs replacing. Once the faulty component is replaced, return to step 18.

Note: You should expect an increase in the voltage as the gas pedal is moved from idle to full power, from around 1VDC to 4 VDC.

22. Move the gas pedal to full power and record the voltage again, comparing this one to that recorded in step 21. If it has increased by at least 1 VDC, proceed to the step, otherwise, there is a defective component that needs replacing. In this case, after the faulty part is replaced, return to step 21.
23. Rotate the “Throttle Adjust” pot from one stop to the other and confirm that the voltage at pin 6 varies as the pot rotates. If it does vary, proceed to the next step, otherwise there is a faulty component that needs replacing. Repeat this procedure after the part has been replaced.
24. Set the “Throttle Adjust” pot to its mid rotation point.

Note: The NE555 produces a stable square wave pulse. The input voltage to the controller from the LM741 amplifier increases as the gas pedal travels towards full power and in turn this results in an increase of the pulse width ration of the controller square wave output at pin 3.

25. After an oscilloscope lead has been attached to pin 3 of the NE555 controller, confirm that there is a square wave pulse and that the ratio increases according to the increase travel of the gas pedal. If all is OK, proceed to the next step, otherwise a component is defective and needs replacing. Repeat the procedure after replacing the faulty part.
26. Rotate the 2K “pulse width adjust” trim pot from one stop to the other and confirm that the pulse width varies as the pot rotates. If this is so, proceed to the next step, otherwise there is a defective component that needs replacing. Repeat this procedure after the faulty part is replaced.
27. Set the 2K trim pot to its mid rotation point.

Note: The frequency range of the square wave pulse is 15KHz to 20KHz. The trigger oscillator circuit provides variable frequency input pulses to the NE555 controller, responded to adjustment to the 2K trim pot and dip switch settings.

28. Attach the oscilloscope lead to pin 3 of the NE555 controller and confirm that the square wave frequency changes in response to the rotation of the oscillator 2K pot. If this is so, proceed to the next step, otherwise a component is defective and needs replacing. Repeat the procedure after replacing the fault part.
29. Set the oscillator pot to its mid rotation point.



Note: As shown in Figure 6, the frequency of the coil circuit is controlled by the CD4059A Divide by N Counter and is in the range of 15Hz to 20Hz. The electrode circuit sends input to the counter (see Figure 5). The frequency of the coil circuit changes in response to changes in the electrode circuit frequency. Pulse width of the coil circuit is adjusted with the 10K “pulse width adjust” pot.

30. Attach an oscilloscope lead to pin 8 of the NE555 controller, rotate the “pulse width adjust” pot from one stop to the other and confirm that the pulse width is changing. If this is so, proceed to the next step, otherwise a component is defective and needs replacing. After the faulty part is replaced, repeat the step.
31. Set the “pulse width adjust” to its mid rotation point.
32. Attach a digital voltmeter lead to pin 8 of the NE555 controller, rotate the 10K “strength adjust” pot from one stop to the other and confirm that the voltage level changes. If this is so, proceed to the next step, otherwise there is a defective component that needs replacing. Repeat the step after replacing the faulty part.
33. Set the “strength adjust” pot to its mid rotation point.
34. (See Figure 5) To obtain a frequency between 15KHz and 20KHz, set the dip switches according to the manufacturer’s instructions for the oscillator CD4069. Attach an oscilloscope or frequency meter lead to pin 6 of the oscillator to confirm the frequency, if necessary adjusting the 2K “frequency adjust” pot to obtain it. If the correct frequency cannot be found, it is most likely that the CD4069 oscillator is defective. Find and replace the faulty part and return to this step.
35. (See Figure 6) Confirm that the pulse frequency appearing at the collector of component 2N3055 is between 15 Hz to 20 Hz, using an oscilloscope or frequency meter. If this is so, proceed to step 37, otherwise, proceed to step 36.
36. According to the manufacturer’s instructions, set the “divide by N” counter for an N factor of 1,000 and confirm that there is a frequency of 15 Hz to 20 Hz at the collector of component 2N3055. If this is so, proceed to the next step, otherwise a component is defective and needs replacing. Return to step 35 after replacing the faulty part.
37. Shut power off.

Cylinder Head Temperature

Note: Because hydrogen burns at a slightly high temperature than gasoline, it is to be expected that this system would result in a higher CHT. It is highly recommended that CHT reference point when running on gasoline are established first, as is the use of a high-quality fast response CHT gauge which senses CHT directly from a spark plug base.

1. Drive your vehicle on open highway for approximately 15 minutes (30 minutes in cold weather) to reach normal operating temperature, then record the CHT under each of these driving conditions:
 - parked at full idle in “neutral” for 3 minutes.
 - at least two minutes of traveling at 25 mph in residential areas.



- at least 30 seconds at 60 mph in a steep grade.

Final Assembly and Testing

1. Regarding installation of the water pump in the trunk, the positive (+) power lead is to be connected to a battery positive (+) power bus connector position. For engine compartment installation, splice a hookup wire to its positive (+) power lead with a butt connector and connect it to a battery positive (+) power bus connector position. Connect the pump negative (-) power lead to the connector position leading to the collector lead of the E3055T switch (see Figure 7) in the same way.
2. Fill up the tank with water. Ensure no water leaks from the tank or any of its tubing connections. Correct or repair any leaks.

Note: Your vehicle is now ready to run on water for the first time! For initial operation, it's best to have the engine already warmed up to normal operating temperature. If it is not up to normal operating temperature, drive on gasoline power for at least 15 minutes.

3. Park your vehicle on a level surface, ensuring that the parking brake is engaged and the transmission is in neutral. Lift the trunk lid if the water pump is installed in the trunk and lift the hood, or engine compartment cover.
4. Set the carburetor adapter for hydrogen operation according to the manufacturer's instructions.

Caution: Keep a close watch on the pressure gauge. If generator gas pressure exceeds 70 PSI, shut power off immediately. As a safety precaution, pressure exceeding 85 PSI is vented by the pressure relief valve, but do not depend on the relief valve to relieve excess pressure.

If any system problem exists, shut the power off immediately.

Note: The gas pressure should be in the range of about 12 PSI to 28 PSI at idle and at full power, about 28 PSI to 62 PSI.

5. (See Figure 5 and 6) Set the "throttle adjust," "pulse width adjust" (one in each circuit), "frequency adjust," and "strength adjust" pots to their midpoint of rotation and straight after applying power, check for the possibility of any of the following problems and if any exist shut power off immediately.
 - Smoke and/or electrical sparking.
 - Generator pressure exceeds 70 PSI.
 - Electrical overheating of any system component.
 - Gas and/or water leakage from the Generator.
 - Water leakage from tubes, fittings and other components.



- Turn the power ON and wait for the generator pressure to reach at least 25 psi. If the generator pressure will not reach at least 25 psi, proceed to step 7. When pressure reaches at least 25 psi, start the engine and run it at idle speed and wait further instructions. Ensure that none of the problems noted above exists. If any do, immediately shut power off and proceed to step 6.
- Check the following “If” conditions:
- If the engine starts, proceed to step 26.
 - If the engine will not start, proceed to step 7.
 - If any of the problems noted at the beginning of this step occur, proceed to step 6.
6. Confirm that power is off. A system component has either failed or is defective. Troubleshoot to find the faulty components. Repair or replace the faulty component and return to step 5.
 7. Shut power OFF and using a small bucket or large container, open the generator drain cock and drain until it is empty. Shut the drain cock. If no water has drained, proceed to step 8. If at least some water drained, proceed to step 14.
 8. Turn power ON and confirm that the water pump is running. If it is, proceed to step 9. If the pump does not run, turn power OFF and proceed to step 25.
 9. Confirm that water is reaching the pump inlet. If it does, proceed to step 13. If water does not reach the inlet, proceed to step 10.
 10. Disconnect the tubing from the pump outlet and confirm that water now reaches the pump inlet. If it does, proceed to step 12. If water does not reach the inlet, proceed to step 11.
 11. Turn power OFF and check for restrictions in the tubing leading to the pump inlet. If a restriction is found, repair as necessary, reconnect tubing and return to step 5.
 12. Confirm that water is flowing from the pump outlet and turn power OFF. If water was flowing, the check valve is either defective or has been installed backward. Either replace the check valve or reinstall it with the flow arrow pointing towards the generator, reconnect tubing, and return to step 5.
 13. Turn the power ON and confirm that no water is present in the tubing connecting the generator to the flame arrestor then turn the power OFF. If water was present, proceed to step 15. If it wasn't, proceed to step 17.
 14. (See Figure 7) Cut the generator water level switch wire connected to the HyTronics positive (+) power bus within about 6” of the generator and strip ¼ inch from each end of the cut lead. Connect an ohmmeter lead to the wire leaving the generator and the other lead to vehicle ground (-) and confirm that the ohmmeter shows that the switch contacts are open. If they are open, proceed to step 16. If they are closed, the switch sloop has not been installed correctly. Referring to step 9 in installing the sloop shield, remove the sloop shield and reinstall it making sure the shield is accurately centered around the switch float. Reconnect the switch wires with a butt connector and return to step 5 in the same section.
 15. Reconnect the switch wires with a butt connector and if a defective component exists in the pump control circuit replace it and return to step 5.



16. Confirm that the check valve in the tubing leading to the engine is installed with the flow arrow pointing towards the engine. If it is not installed correctly, remove the valve from the tubing and reinstall it correctly. Return to step 5.
17. Place the water container on a level surface, mark the water level on the side of the container and dispose of water. Shut the generator drain cock.
18. Disconnect the gas outlet hose from the generator and, turning the power ON, wait until the water pump ceases to run then shut the power OFF. Open the drain cock and completely drain any water from the generator into the container and then close the drain cock again. Measure the amount of water in the container and dispose of water. If the level was higher than the same marked in step 18, proceed to step 20. If the water level was around the same, proceed to step 26.
19. Reconnect this tubing and disconnect the tubing from the carburetor adapter. Turning the power ON, wait until the water pump ceases to run and then shut the power OFF. Open the drain cock and drain all water from the generator into the container, then close the drain cock again. Measure the amount of water in the container and dispose of water. If the level was higher than the same marked in step 18, proceed to step 21. If the water level was around the same, proceed to step 22.
20. The carburetor adapter (or its associated parts) is either defective or needs adjustment. Either adjust the adapter following the manufacturer's instructions or return it to the manufacturer for adjustment or repair. Once this is completed, reconnect the tubing and return to step 5.
21. Reconnect this tubing and disconnect the tubing between the flame arrestor and check valve. Turning the power ON, wait until the water pump ceases to run and then shut the power OFF. Open the drain cock and drain all water from the generator then close the drain cock again. Measure the amount of water in the container and dispose of water. If the level was higher than the level marked in step 18, proceed to step 23. If the water level was around the same, go to step 24.
22. The check valve is defective. Replace it, reconnect the tubing, and return to step 5.
23. The flame arrestor has been incorrectly built. Remove it from the tubing, remove its end fittings, and dispose of it. Revisit the "Flame arrestor" procedure and, following the instructions there, build a new flame arrestor. Allow the CPVC cement to air dry for at least 24 hours and put a thin coating of pipe joint compound onto the tapped threads in the ends of the flame arrestor and fittings. Thread these fittings into the flame arrestor and firmly tighten it. Install the new flame arrestor into the tubing and return to step 5.
24. Turn power OFF. The most likely reason for pump failure is the pump itself. Cut the pump negative (-) bus wire and check operation whilst it is disconnected from the HyTronics module. If the pump still does not run, or is drawing current in excess of 15 amps during start up, repair or replace it and reconnect the pump wires using butt connectors. Also check if the main fuse has blown (see Figure 5) and if so, replace it and return to step 5.



If the pump is working normally, reconnect the wire with a butt connector and confirm that the E3055T switch (see Figure 7) has not failed due to pump current overload. If it has failed, replace it with a switch of higher current capacity and return to step 5. If it has not failed, cut the generator water level switch wire connected to the HyTronics positive (+) power bus within about 6" of the generator, strip ¼ inch from each end of the cut lead and connect an ohmmeter lead to the wire leaving the generator and the other lead to vehicle ground (-). Confirm that the ohmmeter shows that the switch contacts are closed. If they are closed, either the pump is defective, a pump circuit component is defective (see Figure 7), or there are errors in the wiring. Troubleshoot to find the problem and repair or replace wherever necessary. After the problem is corrected, return to step 5.

If the switch contacts are open, the switch slosh shield has been installed incorrectly. Referring to step 9 of the slosh shield construction, remove the slosh shield and reinstall it. Ensure that the shield is accurately centered around the switch float then reconnect the switch wires with a butt connector and return to step 5.

25. Confirm that no water is present in the tubing leading from the generator to the flame arrestor and, if water is present, turn the power OFF and return to step 15. If water is not present, read the following notes before proceeding to step 27.

Note: This system is designed to operate consistently over a wide range of different electronic settings and adjustments. Short of grossly inaccurate adjustments, it is tolerant of just about anything. However, since each engine has unique requirements, obtaining optimal performance is mostly a matter of making adjustments to a simple "trial and error" formula.

The following are some general guidelines for gaining optimal performance by a very effective method known as "tweaking":

- At idle, generator pressure should be 12 PSI to 28 PSI.
- At full power, generator pressure should be 28 PSI to 62 PSI.
- For each driving (or idle) condition, be sure CHT never exceeds 40 degrees more than the value recorded previously.
- Be sure CHT never exceeds 400 degrees.

Tweaking the system is easier, safer and quicker if another person does the driving and allows you to do the tweaking.

26. Park your vehicle ensuring that the engine is at idle, transmission is in neutral and the parking brake is on. Wait until generator pressure stabilizes and proceed to step 30.
27. Drive your vehicle at 25 mph in residential areas. If the "frequency adjust" pot is rotated clockwise to increase generator pressure, proceed to step 30. If this pot is rotated counter clockwise to increase generator pressure, proceed to step 37.
28. Drive your vehicle at 60 MPH (or full power) on a steep grade. If the "frequency adjust" pot is rotated clockwise to increase generator pressure, proceed to step 30. If it is rotated counter clockwise to increase generator pressure, proceed to



- step 37.
29. Referring to Figure 5, rotate the “frequency adjust” trim pot fully counter clockwise and then slowly rotate clockwise. If generator pressure increases before rotating about 90% of total rotation, proceed to step 31. If the pressure does not increase, proceed to step 37.
 30. Slowly rotate clockwise until pressure is no longer increasing. Rotate another 10 degrees and wait until pressure stabilizes and record pressure. Slowly rotate counter clockwise until pressure starts to decrease and then slowly rotate clockwise again until the pressure reaches the recorded value. Record that the “frequency adjust” pot is rotated clockwise to increase pressure. If your system is being tuned whilst the engine is idling, proceed to step 32. If your vehicle is being tuned whilst driving, proceed to step 43.
 31. Rotate the “pulse width adjust” trim pot fully counter clockwise and then slowly rotate clockwise. If the pressure increases before rotating about 90% of total rotation, proceed to step 33. If it does not increase, proceed to step 39.
 32. Rotate slowly clockwise until pressure is no longer increasing, rotate another 10 degrees and wait until pressure stabilizes and record pressure. Slowly rotate counter clockwise until pressure starts to decrease then slowly rotate clockwise until pressure reaches the recorded value. Record that the “pulse width adjust” pot is rotated clockwise to increase pressure and proceed to step 34.
 33. If you are tweaking the system with the engine at idle, proceed to step 35. If you are tweaking the system whilst driving, proceed to step 36.
 35. (See Figure 21) If it is necessary, adjust the engine idle speed by loosening the hose clamps and sliding the arm and sleeve assembly either fore or aft then retighten hose clamps firmly. If pressure exceeds 28 PSI, proceed to step 41. If pressure is 28 PSI or less, return to step 28.
 35. If pressure exceeds 62 PSI, proceed to step 42. If pressure is 62 PSI or less, proceed to step 44.
 36. Rotate the “frequency adjust” pot fully clockwise then slowly rotate counter clockwise. If the pressure increases before rotating about 90% of total rotation, proceed to step 38. If it does not increase, rotate the pot clockwise to its midpoint and return to step 32.
 37. Rotate slowly counter clockwise until the pressure no longer increases and rotate another 10 degrees. Wait until the pressure stabilizes and record pressure. Slowly rotate clockwise until pressure starts to decrease and then slowly rotate counter clockwise until pressure increases to the recorded value. Record that the “frequency adjust” pot is rotated counter clockwise to increase pressure. If the system is being tuned whilst idling, return to step 32. If it is being tuned whilst driving, proceed to step 43.
 38. Rotate the “pulse width adjust” pot fully clockwise then slowly rotate counter clockwise. If pressure increases before rotating about 90% of total rotation, proceed to step 40. If it does not increase, rotate the pot clockwise to its midpoint and return to step 34.
 39. Rotate slowly counter clockwise until pressure no longer increases and rotate



- another 10 degrees. Wait until pressure stabilizes and record pressure. Slowly rotate clockwise until the pressure starts to decrease. Slowly rotate counter clockwise until pressure reaches the recorded value. Record that the “pulse width adjust” pot is rotated counter clockwise to increase pressure. Return to step 34.
40. Place an alignment mark on the “frequency adjust” and “pulse width adjust” pots with a marker pen and determine the amount of pressure exceeding 28 psi. (For example, if pressure is 32 psi, excess pressure is 4 psi). Reduce pressure to 28 psi by alternately rotating each pot in the correct direction a few degrees at a time. Divide the excess pressure as equally between the two pots as possible. (For example, if excess pressure is 4 psi, reduce pressure 2 psi with each pot.) Return to step 28.
 41. Place an alignment mark on the “frequency adjust” and “pulse width adjust” pots using a marker pen. Determine the amount of pressure exceeding 62 psi. (For example, if pressure is 70 psi, excess pressure is 8 psi). Reduce pressure to 62 psi by alternately rotating each pot in the correct direction a few degrees at a time. Divide the excess pressure as equally as possible between the two pots. (For example, if excess pressure is 8 psi, reduce pressure 4 psi with each pot.) Proceed to step 44.
 42. If the “pulse width adjust” pot is rotated clockwise to increase generator pressure, return to step 32. If it is rotated counter clockwise to increase generator pressure, return to step 39.
 43. If you have just finished tuning after driving 25 mph in residential areas, proceed to step 45. If you have just finished tuning after driving 60 mph (or full power) on a steep grade, proceed to step 67.
 44. (see Figure 21) Ensure that the throttle linkage moves through its full range of travel from idle to full power without binding the rod within the arm. Perform the procedure of step 66 below before proceeding.
Drive the vehicle at 60 mph (or full power) on a steep grade. Listen closely for the sound of engine pre-combustion (“Ping”). If the engine pings, proceed to step 46. If it does not ping, proceed to step 56.

Note: The procedures of steps 45 to 65 tune the coil circuit to create the best mixture of parahydrogen (created by the coil) and orthohydrogen (created by the electrodes). Low (too lean) levels of parahydrogen can result in excessively high cylinder head temperature (CHT) which is a common cause of engine pre-combustion (“ping”). High (too rich) levels of parahydrogen result in low CHT, cooling combustion, reduced efficiency, and possible engine roughness.

Optimal mixture is achieved by leaning parahydrogen to the point of making the engine “ping” and then slightly richening until the “ping” disappears. You will be “fine tuning” two different pots in sequence. It's very important to closely monitor CHT whilst leaning to prevent excessively high CHT. Refer to the CHT that was recorded earlier for driving 60 mph (or full power) on a steep grade and ensure CHT does not exceed this recorded value by more than 40 degrees. Never allow CHT to exceed 40 degrees above the previously recorded value.

45. (see Figure 6) Rotate the “pulse width adjust” pot fully counterclockwise. If the



- engine pings, proceed to step 47. If it does not ping, proceed to step 52.
46. Rotate fully clockwise. If the engine pings, proceed to step 48. If it does not ping, proceed to step 53.
 47. Slowly rotate counter clockwise. If CHT decreases, continue rotating counter clockwise until CHT is no longer decreasing. Proceed to step 49. If CHT increases while rotating counter clockwise, fully rotate counter clockwise and then slowly rotate clockwise until CHT is no longer decreasing. Proceed to step 49.
 48. Rotate the “strength adjust” pot fully counter clockwise. If the engine pings, proceed to step 50. If it does not ping, proceed to step 54.
 49. Rotate fully clockwise. If the engine pings, rotate each pot to its midpoint and proceed to step 51. If it does not ping, proceed to step 55.
 50. Turn power OFF. (see Figure 6), the coil circuit is not producing enough parahydrogen. Replace the 10k resistor connecting pin 3 of component NE555 to the base of component 2N3055 with a 10k pot. Adjust the pot for around 9k resistance. Return to step 45. If you have to repeat this step, adjust the pot for about 8k and return to step 45. If necessary, each time you must repeat this step, adjust the pot for about 1k less and return to step 45. If the pot is eventually adjusted for 2k or less, a circuit component is defective. Find and replace the defective component. Adjust the pot for 10k. Turn power ON and return to step 45.
 51. Slowly rotate clockwise until ping commences then slowly rotate counter clockwise until ping ceases and continue to rotate counter clockwise approximately 5 more degrees. If CHT is greater than 40 degrees higher than the value recorded previously, continue to slowly rotate counter clockwise until CHT decreases to 40 degrees above the recorded value and return to step 29.
 52. Slowly rotate counter clockwise until ping commences then slowly rotate clockwise until ping ceases and continue to rotate clockwise approximately 5 more degrees. If CHT is greater than 40 degrees higher than the value recorded previously, continue to slowly rotate clockwise until CHT decreases to 40 degrees above the recorded value and return to step 29.
 53. Slowly rotate clockwise until ping commences then slowly rotate counter clockwise until ping ceases and continue to rotate counter clockwise approximately 5 more degrees. If CHT is greater than 40 degrees higher than the value recorded previously, continue to slowly rotate counter clockwise until CHT decreases to 40 degrees above the recorded value and return to step 29.
 54. Slowly rotate counter clockwise until ping commences and slowly rotate clockwise until ping ceases and continue to rotate clockwise approximately 5 more degrees. If CHT is greater than 40 degrees higher than the value recorded previously, continue to slowly rotate clockwise until CHT decreases to 40 degrees above the recorded value and return to step 29.
 55. (see Figure 6) Rotate the “pulse width adjust” pot completely counterclockwise. If the engine pings, proceed to step 62. If it does not ping, proceed to step 57.
 56. Rotate completely clockwise. If the engine pings, proceed to step 63. If it does not ping, proceed to step 58.



57. Slowly rotate counter clockwise. If CHT increases, continue to rotate counter clockwise until CHT is no longer increasing and proceed to step 59. If CHT decreases while rotating counter clockwise, rotate completely counter clockwise then slowly rotate clockwise until CHT is no longer increasing and proceed to step 59.
58. Rotate the “strength adjust” pot completely counter clockwise. If the engine pings, proceed to step 64. If it does not ping, proceed to step 60.
59. Rotate completely clockwise. If the engine pings, proceed to step 65. If it does not ping, rotate each pot to its midpoint and proceed to step 61.
60. Turn the power OFF. (see Figure 6) The coil circuit is producing excessive parahydrogen. Replace the 10k resistor connecting pin 3 of component NE555 to the base of component 2N3055 with a 20k pot. Adjust the pot for around 11k resistance and return to step 45. If you have to repeat this step again, adjust the pot for about 12k resistance and return to step 45. If necessary, each time you have to repeat this step, adjust the pot for about 1k more resistance and return to step 45. If the pot is eventually adjusted for about 18k resistance or more, a circuit component is defective. Find and replace the defective component. Adjust the pot for 10k, turn the power ON and return to step 45.
61. Slowly rotate clockwise until ping ceases and continue to rotate clockwise approximately 5 more degrees. If CHT is greater than 40 degrees higher than the value recorded previously, continue to slowly rotate clockwise until CHT decreases to 40 degrees above the recorded value and proceed to step 66.
62. Slowly rotate clockwise until ping ceases and continue to rotate clockwise approximately 5 more degrees. If CHT is greater than 40 degrees higher than the value recorded previously, continue to slowly rotate clockwise until CHT decreases to 40 degrees above the recorded value and proceed to step 66.
63. Slowly rotate counter clockwise until ping ceases and continue to rotate counter clockwise approximately 5 more degrees. If CHT is greater than 40 degrees higher than the value recorded previously, continue to slowly rotate counter clockwise until CHT decreases to 40 degrees above the recorded value and return to step 29.
64. Precise throttle adjustment is simple using the special features of the system throttle assembly. (see Figure 21). Here's the method recommended:
 - A) Disengage the arm from the throttle rod and rotate the pot shaft through the complete range of rotation required to go from idle to full power. Using a ruler, measure and record the total distance traveled by the tip of the throttle rod as the pot is rotated.
 - B) Rotate the pot shaft to its mid rotation point and position the throttle linkage at its midpoint of travel. Slide the arm onto the throttle rod and attach the arm and sleeve onto the throttle linkage with hose clamps.
 - C) Raise or lower the pot by rotating its mounting bracket around the $\frac{1}{4}$ inch bolt until throttle rod travel is equal to that recorded in point A when the throttle linkage travels its full range. If necessary, to get added distance between the pot and arm, the arm and sleeve assembly can be inverted to put the arm above the linkage.



- D) To assure smooth operation without binding, ensure that the throttle rod is square with the surface of the arm when the linkage is at its midpoint of travel and if necessary, rotate the pot body within the limits of the 3/32 inch slot and rotate the sleeve about the axis of the linkage until the throttle rod is square with the arm.
- E) Adjust the idle to the desired speed and operate the throttle through several cycles to confirm that it is operating smoothly without binding.
- F) Firmly tighten the mounting bolts, hose clamps, and the pot retaining nut and, with the throttle at idle position, trim the throttle rod to length so that it protrudes approximately ¼ inch above the arm. Square the rod end with a file and deburr it with sandpaper. Mix a small quantity of epoxy, such as J-B WELD, and apply into the 3/32 inch slot in the area of the anti-rotation pin to prevent rotation of the pot.
66. Whilst driving, confirm that the four LED's operate as follows:
- Green PWR ON lights when power is ON and is not lit when power is OFF.
 - Green PUMP ON and yellow GEN WATER LOW both light when the water pump is running and are not lit at all other times.
 - Red TANK WATER LOW is not lit when the tank water level is more than about 1/3 full, and blinks when water falls below that level.
- If all four LED's operate properly, proceed to step 68. If not operating properly, refer to Figures 5, 6 and 7 and troubleshoot to find the defective component or wiring error. Repair or replace as necessary and proceed to step 67.
67. Congratulations, your water-fueled system is working perfectly! After around 24 hours of driving, ensure that the hoses clamps on all fittings are tight and happy driving!

Tips and Hints on getting the most out of your system

Mineral buildup will occur in the generator gradually, because tap water contains minerals. Periodically flush and clean the generator to prevent this. Mineral build up after a time can mean there is insufficient hydrogen and oxygen to power your engine. Flushing the generator every week or two is recommended. This is a simple and quick procedure. Simply open the drain cock and turn power ON for a minute or two then close the drain cock, wait for the generator to pump full, and turn the power OFF. Ensure that you keep the water tank topped up.

A more thorough cleaning of the generator is needed as a thin later of minerals will gradually coat the generator parts. It is recommend that this be performed every month or two using a mildly acidic deposit cleaner such as “CLR”. Ensure that the power is OFF, drain the generator, disconnect the outlet tube at the flame arrestor, and close the drain cock. Wearing protective gloves, mix cleaner about 50/50 with water and pour through the tube until the generator is full. Allow the cleaner to work for a few minutes and drain into a bucket or large container. Repeat this procedure once more and examine the drained cleaner and if necessary, repeat until the drained cleaner is reasonably clear.



Close the drain cock, fill the generator with fresh water through the tubing and drain. Repeat this twice and turn the power on and flush for a minute or two. Close the drain cock, wait for the generator to pump full then close the drain cock. Turn power OFF and reconnect the tube to the flame arrestor. Ensure that the tank is topped up.

Cold weather operation

If you are operating in temperatures below freezing, isopropyl alcohol should be mixed with the water to prevent it from freezing. As alcohol changes the dielectric properties of water, the system operating frequency must be changed by adjusting the “frequency adjust” trim pot for peak performance. (see Figure 5).

Stainless Steel

The only combustion product that this water-fueled system produces is water and we are all aware of what water, especially hot water, does to steel. Unless you have already installed stainless steel valves in your engine, you should investigate having them installed as soon as possible to prevent valve corrosion problems.

Fuel Injected Engines

This water-fueled system is based on carburetor equipped engines. There has been no really extensive research and testing performed to test its functionality for use with fuel-injected engines. But of course, there is no way it should not perform as efficiently with the removal of one obstacle which involves making or modifying injection system components previously lubricated by a liquid (gasoline or diesel fuel) operable with pure gas.

Corrosion of the injector itself is another problem which could be solved with ceramic coating as for the exhaust systems. Another solution would be the use of stainless steel injectors. With the advent of hydrogen engines using fuel cells, both these problems have already been overcome for specific applications, so hydrogen injected components may become “over the counter” items in the not too distant future. However, at this time, the easiest solution may be to simply convert fuel injected engines to carbureted engines which are compatible with this water-fueled system.

Remember: Always maintain a watchful eye on the CHT and pressure gauges. They can give you much information about how the system is performing at any particular moment.

And happy driving!

Please remember to tell your friends about this system - the more people that know, the better it will be for our environment and our wallets!

References – Wikipedia, Hydrostar, Stanley Meyer, Peter Lindemann,



Stephen Chambers, William S Power.

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Although these plans are designed to be 100% reversible and to work with the vast majority of motor vehicles, you acknowledge and understand that by carrying out these plans, you are assuming responsibility for all potential risks and damages, both incidental and consequential, relating to or resulting from use or misuse of these plans. Furthermore, you understand that there are inherent risks relating to any exploratory and pioneering mechanical technology.

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