Toroid Winding Kit from Hydrogen Garage LLC

Winding the Toroidal Transformer (updates 8/09)

Your Responsibility:
If you decide to construct an electrolyser of this, or any other design, you do so wholly on your own responsibility, and nobody is in any way liable for any loss or damage, whether direct or indirect, resulting from your actions. In other words, you are wholly responsible for what you choose to do. I say again, this document must not be construed as an encouragement for you to construct this or any other electrolyser.

Bob's electrolyser splits water into a mixture of gases, mainly hydrogen and oxygen. That gas mixture, which will be referred to as "hydroxy" is highly explosive and must be treated with respect and caution. A fairly small volume of hydroxy gas exploded in air is quite liable to cause permanent hearing loss or impairment due to the shock waves caused by the explosion. If hydroxy gas is ignited inside a sealed container, then the resulting explosion is liable to shatter the container and propel shrapnel-like fragments in all directions. These fragments can cause serious injury and every precaution must be taken to ensure that an explosion of that nature never happens. Bob uses two bubblers and a one-way valve to protect against this occurrence, and details of these are given in this document.

To make the water inside the electrolyser carry the necessary current, potassium hydroxide (KOH) is added to distilled water. This is the best electrolyte for an electrolyser of this type. Potassium hydroxide is also known as "caustic potash" and it is highly caustic. Consequently, it needs to be handled carefully and kept away from contact with skin, and even more importantly, eyes. If any splashes come in contact with you, it is very important indeed that the affected area be immediately rinsed off with large amounts of running water and if necessary, the use of vinegar which is acidic.

This electrolyser design uses a toroidal transformer to interface the electronics to the electrolyser cells. It is vital that this transformer be used very carefully. Under no circumstances may this transformer be powered up by the electronics when connected to anything other than the filled electrolyser cells as they act as a safety buffer. When driven by Bob's electronics, this transformer draws additional energy from the environment. While this is very useful for electrolysis, there are sometimes unpredictable energy surges which can generate as much as 10,000 amps of current. If one of these should occur when the transformer is not connected to the electrolyser which is able to soak up this excess, the resulting electrical conditions can be very serious. If you are lucky, it will just burn out expensive components. If you are not lucky, it can cause a lightning strike which is liable to hit you. For that reason, it is absolutely essential that the toroid transformer is never powered up with the secondary winding connected to anything other than the filled electrolyser.

Patenting:

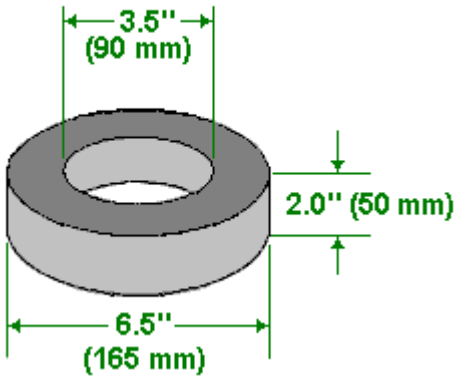
Info at : http://hydrogengarage.com/PWM3g

Winding the Toroidal Transformer:

The transformer in Bob's system is a very important component. It is an inductor, a transformer, and a source of energy-form conversion, all rolled into one. The transformer has been successfully duplicated and used by others, driven with Bob's triple-oscillator board, to achieve a resonant drive to the cells which results in a performance which is well beyond the maximum stated by Faraday.

The reason there are no step-by-step instructions for constructing the transformer is because it must be wound to match the load/impedance of the cells it will be driving. There is no "one-transformer-fits-all" solution for this. Bob uses a powdered iron core of 6.5" diameter for units up to 100 cells. The larger the diameter, the greater the power. Ferrite is fine for lower frequencies, but for this application, a powdered iron toroid core is essential.

The Micrometals T650-52 Toroidal Core



The primary of the transformer is 3-phase, while the secondary is single-phase. As most current flows along the outside of wires rather than through the middle of the wire, the choice and size of the wire chosen to wind the transformer is most important. Bob uses **solid** teflon-covered silver-plated copper wire. It is very important that this wire is solid core and **not stranded** as stranded wire does not work here (due to the generation of inter-strand, phase-differential induced eddy currents). Machine winders can't stand this Teflon coated wire, their machnes, just don't like it, it tears up the Teflon coatings. Also machine winders do not understand making a toroid for a radiant energy device, they are used to wrapping magnets for motors, & transformers. This project is unlike traditional transformer design. So we are back to winding them by hand. From a a grass root level in a cave. (Watch a long movie while winding by hand.) The toroid iron core, now needs no winding of transformer tape before starting. We have found that this part is now unnecessary, it makes the first winding of the 16 awg wire to be easier and you can get it smoother. And the materials to be used are collected together, namely, the tape, the wire, the beeswax and the heat gun:

Of paramount importance with the toroid is that unlike traditional transformer design, the secondary is wound first, and the windings must be evenly spaced where they fan out from the center of the core. This means even though they are tightly packed right up against one another at the center hole, they must not be wound so that they bunch up and gap open around the periphery. Mistakes here will cause field errors that will lower the overall efficiency.

Rules of hand winding.

1) Don't let go, otherwise you may create a wire bee's nest.
2) Kinks are your enemy. Pull the wire taught to get rid of kinks.
3) Drink beer while winding, it helps the nerves.
4) Realize this is not a fun task, set before you. It is tedious work. Once finished you will be happy.
5) Your goal here is to allow a flat smooth surface for the top wind of 3 parts of the 20 awg wire.
(Primary winding is on top in 3 parts.)
6) Follow these instructions very, very closely if you want to obtain resonance frequencies. Many factors than stop it from working correctly. Bad wind job, uneven surface for the top winding. Wire not lined up like diagram. Wires are not coming straight off the top and bottom sides to posts on outside of the alum.cage.

Hydrogen Garage Kit has provided a winding bobbin, it fits thru the hole and allows you to pull it tight. On the first wrap of the thicker wire (Secondary winding) You will wrap as many wraps as you can get onto the core. The inside wire will touch each other tightly. You will manage about 136 turns, (mas or manos)
Don't worry if you got one or two more or less. Give yourself about 6" of extra wire, coming out the top and when you finish give you self 6" coming off the bottom, going directly out. Later you will mount the wrapped iron core in a Faraday cage, an aluminum box, with a circle of alum. about .5" to one inch away from the core all the way around it. The cage is to keep out any RF waves that might effect the current inside the core and windings. See photo below. Also note that all connections will go directly straight out to a electrical post outside your cage.

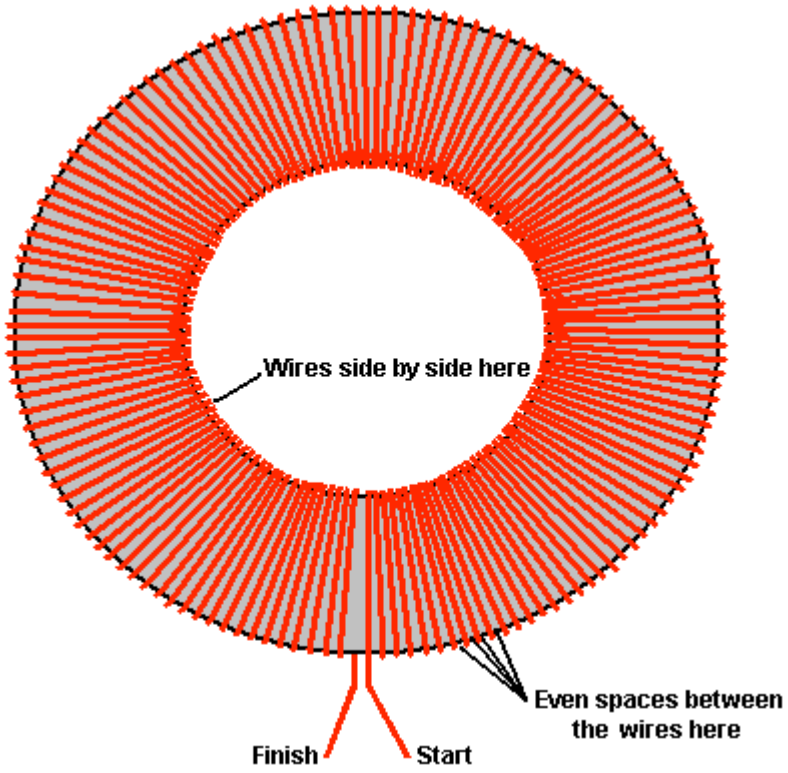
As you can see here, Bob uses short lengths of plastic strimmer cable as spacers for the outside of the toroid, though the picture above has been taken to show what a partially prepared secondary winding looks like when its windings are being moved into very accurate positions. The weed wacker spacers help you get accurate

You will notice that Bob has wrapped the toroid in tape before starting the secondary winding, but is not necessary, The Teflon coating on the wire will work fine, for isolation purposes, and is more important to get a smooth flat lie of wire. Kinks are your enemy. Pull the wire taught to get rid of kinks. . So no yellow tape as below to start winding your coil. We should just 86 this photo, but tihis left to show the progress and preparation. It will come out smoother and easier to lie flat is the reason for the change.

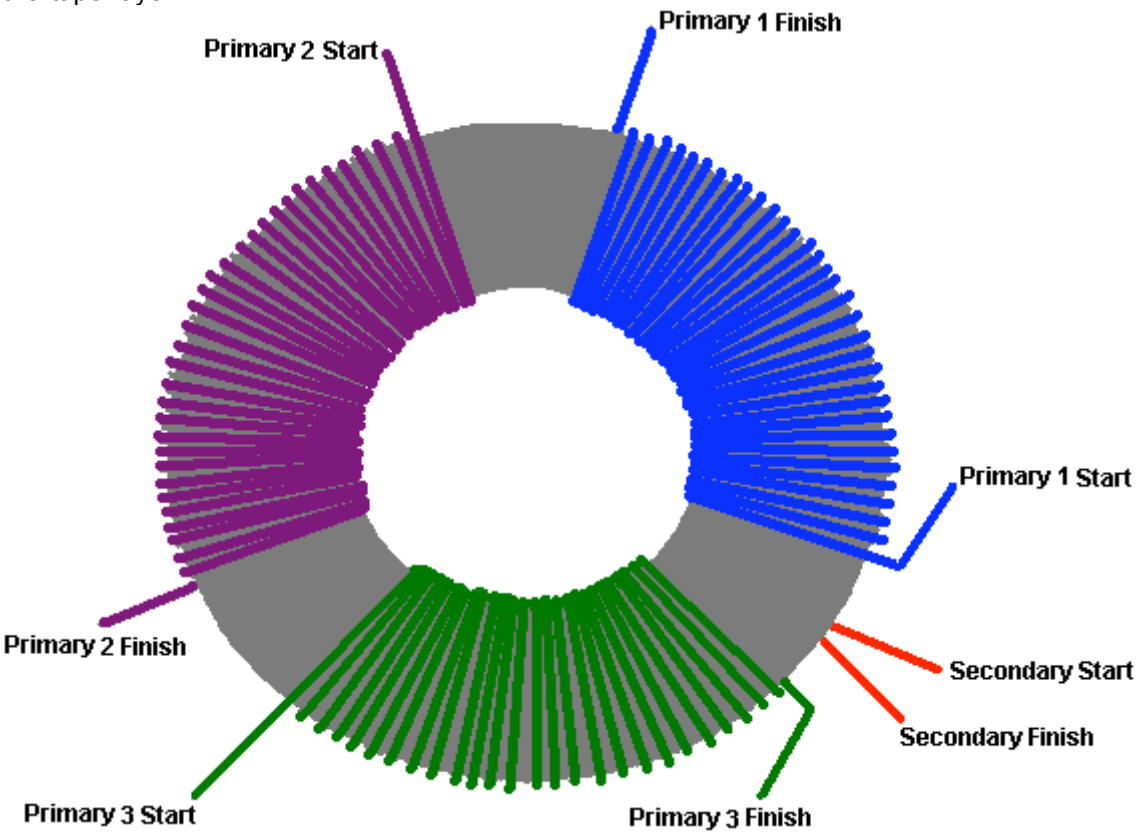
Bob also uses a jar to assist in applying beeswax to the accurately positioned turns of the toroidal transformer:

The photo above shows the topside with the bee's wax, to be perfectly spaced and the bottom half looks like shit. It should look like the top half when finished. The bee's wax is to hold it in place. You want the bee's wax to then flow into the wire to create a flat, flat, flat surface for your next winding, so it does do get all jumbled up and shitting looking. Perfect winding is essential here. Also melt the bee's wax flat into the wire with the tops of the wire exposed not drowned in wax. You just want to fill the grooves between the wires.

When the windings are completed, correctly spaced and encased in beeswax, each layer is finished off with a layer of tape. We now have provided in the kit the proper winding tape. Brown packing tape will NOT due. You must buy this special yellow colored transformer winding tape. We have provided enough of this tape in the kit. Just for winding after the first wind. The bee's wax is to hold the wire in place and also to smooth out the gaps so when you wrap the primary wirings on top they will lie real smooth and even. Bob says: "I use a single wrap of PVC electrical tape stretched very tightly over the secondary winding. But be aware, that the tension in the tape has a tendency to make it unwrap. A layer of the yellow 1P802 winding tape secures the electrical tape and holds it firmly in place, bridging the triangular gaps between adjacent turns. Big warning here !!!! **DO NOT USE FIBERGLASS WINDING TAPE !!!!** A big box of 3M winding tape was ordered by accident so I tried it to see if it would work. It not only suppressed the acoustic-resonance response of the entire wound toroidal core, but for some strange reason it also caused the electrostatic pulse response of the secondary to **reverse polarity** and reducing the signal amplitude to a mere 10% of what it was !! It totally negated the benefit of the Teflon insulation. I had to unwrap it and rewrap it with the yellow 1P802 winding tape. We had to return a whole box of this 3M winding tape and order more of the "right stuff" in bulk from Lodestone Pacific. So be warned, the 3M fibreglass winding tape will totally ruin the behaviour of the toroidal windings". So, to recap, the toroid is wrapped in tape, the secondary wound extending the entire way around the toroid, the windings carefully spaced out so that the gaps around the outer edge of the toroid are exactly equal, the winding encased in beeswax, and then the beeswax covered with a thick layer of tape:



For the great majority of systems, the secondary winding is a tightly wound, single layer, full-fill wrap of 16 gauge, single-core, and silver-plated, teflon-insulated copper wire. There will be about 133 - 136 turns in this winding, though it can vary from 127 to 147 turns due to manufacturing tolerances in the insulation. Don't worry how many you got, just write it down for alter calculations. This will need a wire length of about 100 feet, and the whole of the toroid is covered by this 'secondary' winding. You will use about 92' of wire. Bob says to try and get the wire as tight together as possible but no over wrapping at al allowed. Count the exact number of turns in your actual winding and make a note of it. This secondary winding is held in place with melted beeswax, and when that has hardened, the winding is then wrapped tightly with a good quality tape. This makes a good base for the primary windings which will be wound on top of the tape layer.



* Please note that every winding starts by passing **over** the toroid, proceeds in a **counter-clockwise** direction, and finishes by passing **under** the toroid. Leave your self 6" leads coming out for later hooking up to posts that are directly out of the cage to an adjoining post. Terminal electrical connection. Every winding is created in this way and the quality of workmanship is very important indeed when making these windings. Each winding needs to be tight and positioned exactly with turns touching each other in the centre of the toroid and positioned on the outer edge with exactly equal spaces between each turn. Your construction work **has** to be better than that of a commercial supplier and needs to reach the quality demanded by the military, which would cost thousands of dollars for each toroid if it were to be made up for you by professionals.

*Also note Counter-clockwise is for the Northern hemisphere people, if your **live down under** than you will wrap it **CLOCKWISE. Southern hemisphere** people will wrap it **clockwise.** What do you do if you live at the equator? I dunno know? Ask Bob. Sorry we cannot give out his phone number. He spends enough time on the phone as it is.

The three primaries need to be wound on top of the tape wrapping which covers the secondary winding. These three windings are spaced out equally around the toroid, that is, at 120 degree centres and the leads of the secondary winding exit through the gap between two of the primary windings and **not** in the middle of a secondary winding. The primary windings are held in place with beeswax, and then tightly taped. The primaries may need more than a single layer, and they are wound with the same direction of winds as the secondary, and the same care for even winding spacing as the secondary needed. Tape the entire core well with tightly-stretched PVC electrical tape after winding, to ensure that the primary windings do not move and then add an outer layer of winding tape. Bob uses the 1P802YE type on 3" rolls, both the 1" and 2" widths from: http://www.lodestonepacific.com/distrib/pdfs/tape/1p802.pdf

This is where the generic information ends. The exact details of the primary windings must be determined from the operational characteristics of the cells. This means that you must build, cleanse and condition your cells prior to making the operational measurements. This is done as follows: After full plate cleansing as described earlier, condition the plates until the cell stack reaches at least 150% but ideally 200% or more of Faraday's maximum power efficiency (2.34 Watt-Hours per Litre per Hour). Then, allow the cell stack to cool to room temperature. The cell stack is then powered up with a variable-voltage power supply and the voltage adjusted until the cell current is exactly 2 amps. Write down the voltage needed to give this 2 amp current flow, and do it promptly before the cell starts to warm up again.

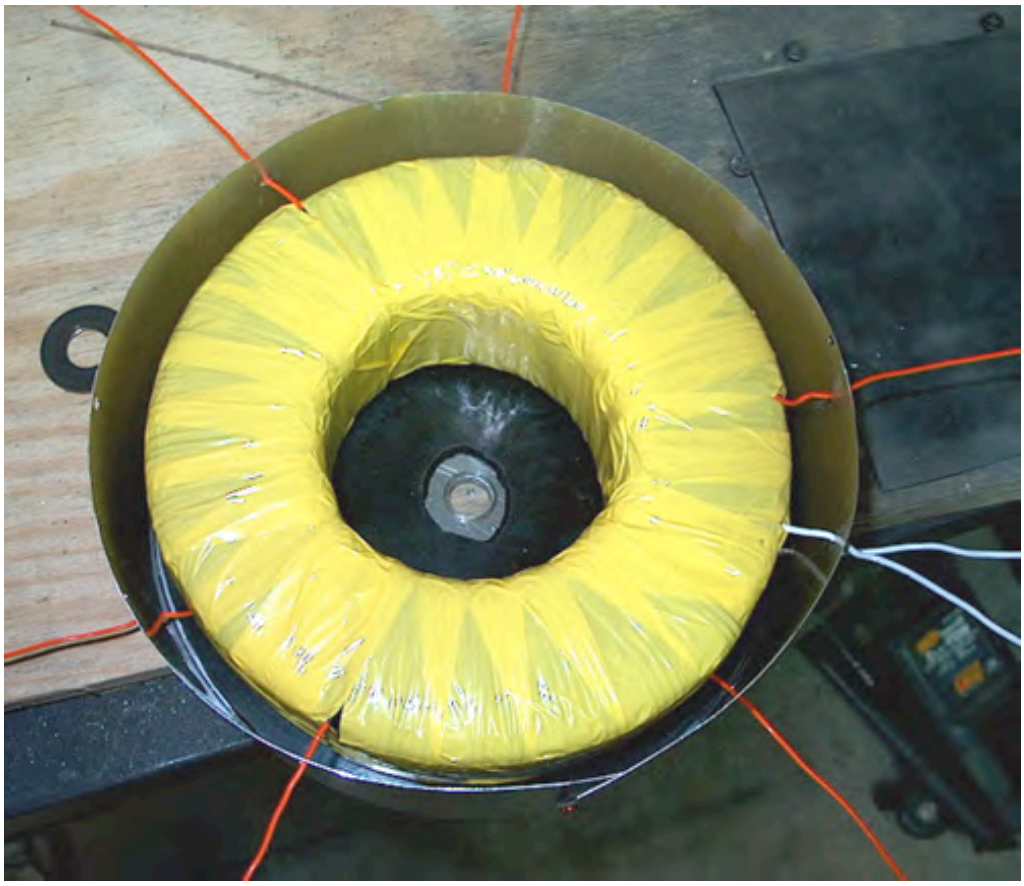
The objective here is to have the complex waveform generated by the electronics, produce voltages of about 25% of this measured voltage, so divide your measured voltage by four. The output from the electronics board is about 12.5 volts, so divide again by 12.5 to get the turns-ratio for the toroidal transformer. This is normally in the range of 3.0 to 3.5 and that means that the secondary winding needs to have that times as many turns in it as each primary winding does.

For example, (and **example** only) say your measured voltage happens to be 155 volts. Then the turns ratio would be 155 divided by 4 which is 38.75, and then divide that by 12.5 which gives 3.1 which is the turns ratio. If your secondary winding has, say, 134 turns in it, then the number of turns in each of the three primary windings would be 134 / 3.1 which is 43.23 turns. Round this upwards to give 44 turns.

If the number of turns which you use is off by one turn, then the tuning of the electronics board can compensate for it. If the number of primary turns is off by two turns, then it is possible that you might just be able to compensate for the error by tuning the board, but it is unlikely that you will. If the number of turns is three or more away from the optimum number calculated, then the impedance of the primary windings will be too far out for the board to tune it.

Normally, the diameter of the wire used in the primaries will be greater than that of the secondary because it will be driven by a much lower voltage and so will need a much higher current, but that is not the case here. Now that you have cleansed and conditioned the plates in your electrolyser, power up your inverter with your vehicle engine running at 2000 rpm or so, and measure the DC current taken by the inverter. This is the level of current which the primary windings have to carry, so the wire size can be selected from this measurement. Each primary winding is pulsed, so it is not carrying current all of the time, also, the final primary current is the sum of the three pulsing signals, so a reduction can be allowed for that. While the wire diameter for the primary windings of each toroidal transformer need to be calculated separately, a common diameter turns out to be AWG #20 (21 SWG). The wire length for the primaries will be greater per turn as the turns are now being made over the secondary winding. Forty-eight turns of #20 wire are likely to require at least thirty-five feet and that is for each of the three windings, assuming that all turns can be laid flat side-by-side. If it is necessary to make each a two-layer winding, then the wire length will increase further.

If you would like a 360 degree template for marking the positions of the primary windings, then there is one available at http://www.thegsresources.com/files/degree_wheel.pdf



Please note the wires coming straight out, you will add posts on the cage itself, or place in another alum. box a rubber matt is on the bottom. Notice the wires coming off the top and bottom of the core, this is also important.

Power Limits:

At the present time, the largest available iron-powder toroid commercially available is the Micrometals 6.5" unit. This sets the upper power limit for a Bob Boyce design electrolyser at 32 square inches of plate area. Bob's present design uses six inch square plates, but the electrolyte level is maintained at just three inches and some area is effectively lost where the plates enter the walls and base of the housing. This 101-plate unit, when built with precision and conditioned and tuned correctly, can generate 45-50 lpm continuously and short bursts of up to 100 lpm. That is about one litre per minute of hydroxy gas per cell. This should be sufficient to run an internal combustion engine with a one litre engine capacity, but engines vary so much, that there can be no rule of thumb for the gas production rate needed for a given engine size.

Why use the coil? It is a form of Tesla's radiant energy device, it gets energy from the air. Bob says it is getting "longitudinal" energy, not static electricity, not the magnetic pull of the earth. Longitudetional energy meaning it goes straight up from the earth to the sun., or straight up. Tesla called the "ether" energy. The Joe Cell people call it "orgone" energy. Energy that can be tapped into for our use. What is cool, is that you don't have to pay somebody money for it. If we are to survive as a race on this planet, this energy will someday be widely used. If it is depressed for much longer, than I'm afraid the banks will eventually take over with their greed. It is already way out of hand and in balanced and boy is Jesus the Lord of the Universe is pissed, but he His Father is slow to anger, but I can tell his anger must be boiling at this point. The flood did happen, there is evidence all over the planet. I would take heed and repent. Follow your heart and live, make a toroid coil for the sake of your children , grand children. People who succeed in obtaining resonance keep it quite for now. Guys on the forums usually complain like babies, when they can't get it to work. Many have never gone down this path, so we have few experts in this field. Bob is one of few. Why would the US DOD hire a civilian, to do this research?

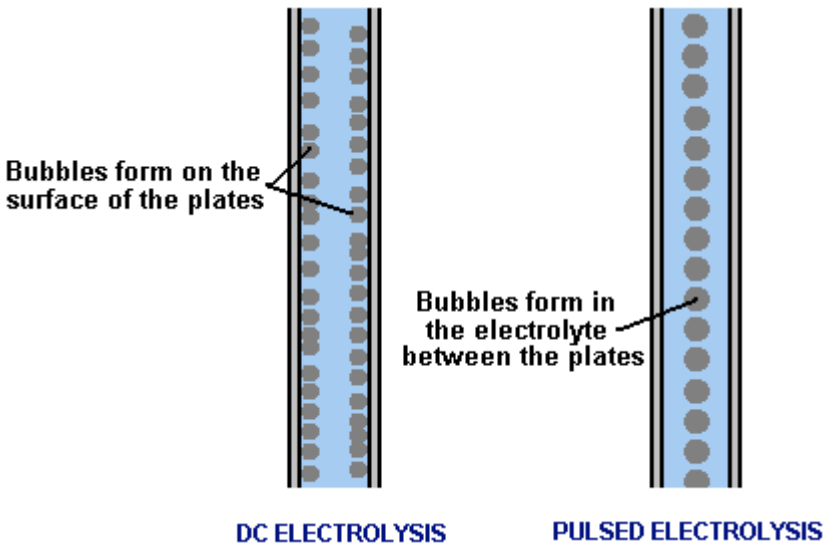
Back to the Cell

The optimum operating voltage for his 101-plate electrolyser has been established by Bob as being 1.5 volts per cell. However, the power limitation of the 6.5 inch toroid does not prevent the voltage being raised. So, if we opt for using a 220 volt inverter rather than the 110 volt one already described, then the number of cells can be doubled. This extends the case from about twenty inches in length to around forty inches. This might be suitable for use with vehicles up to two litre engine capacity and the unit can be located on the flatbed of a truck or the boot (trunk) of a car or beside a generator if it is being used to power an electrical generator. Electrical generator engines are usually incredibly inefficient with an overall efficiency of as little as 10% when the generator is considered. Consequently, running a generator on hydroxy gas alone is by no means as easy as it looks on the surface. If an electrolyser is installed in a vehicle, it is **very** important that no pipe carrying hydroxy gas is routed through any passenger area and a bubbler positioned close to the engine. The number one priority must always be safety.

Increased gas output can be got by increasing the width of the plates while maintaining the plate area covered by the electrolyte. One possibility is to make the plates nine inches wide and keeping the electrolyte at a four-inch depth, giving thirty-six square inches of plate area. The plate size would then be 9" x 6" or any other height up to 9" x 9".

The reason why a Boyce electrolyser can give 1,200% of the maximum possible gas output determined by Michael Faraday, is that this unit pulls in large amounts of additional power from the environment. So, the vehicle electrics is used primarily to power the pulsed toroidal circuitry which taps this energy, and the conversion of water to hydroxy gas is performed primarily by energy drawn from the environment.

Plate surface preparation is very important and is described in detail. However, the way that the plates operate when used for straight DC electrolysis is quite different from the way that they operate when being used in high-efficiency pulsed-mode:

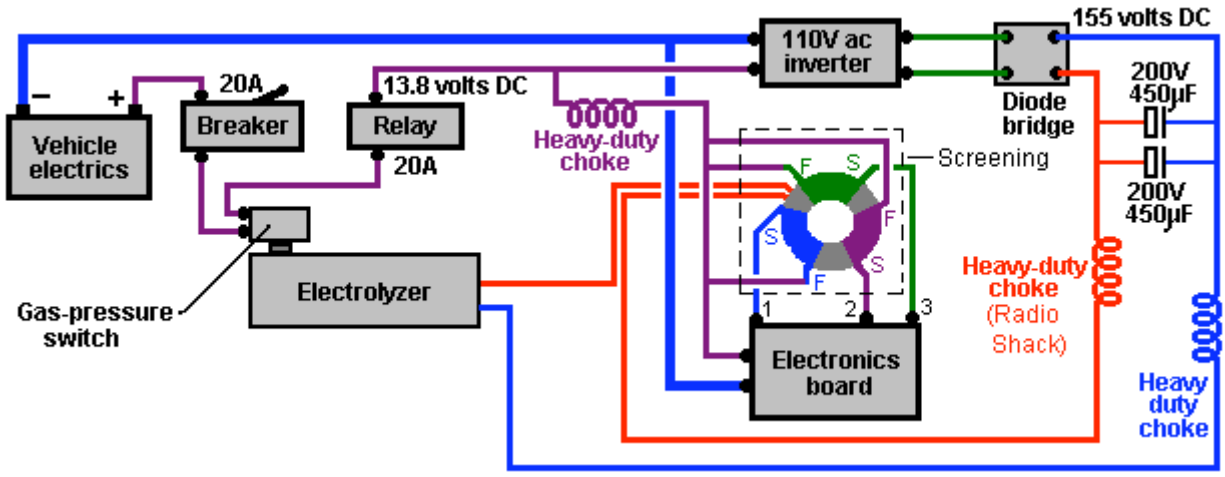


With straight DC-electrolysis, the bubbles of hydroxy gas form on the face of the plates and break away, helped by the thousands of microscopic, sharp-peaked mountains created on the face of every plate by the two-direction scoring with sandpaper. With the pulsed technique, the hydroxy bubbles form in the electrolyte itself, between the plates and give the visual impression of the electrolyte boiling.

It should be realised that with the large gas volumes produced with the 101-plate and 201-plate electrolysers, that a considerable pipe diameter is needed to carry the gas, and even more importantly, the two bubblers used need to be a considerable size. It is important that the bubbles streaming up through the water in the bubbler do not form a continuous column of hydroxy gas as that could carry a flame straight through the bubbler and defeat the protection which it normally provides. A good technique to combat this and improve the scrubbing of electrolyte fumes out of the gas, is to put a large number of small holes in the sides of the pipe carrying the gas down into the water in the bubbler. This creates a large number of smaller bubbles and is much more effective.

Connecting the Electrics:

Bob has specified that the primary windings are connected between the board outputs and the positive supply for the board like this:



It is important to include heavy-duty chokes (coils) in both sides of the high voltage power supply and in the 13.8 volt positive lead coming from the vehicle electrics. These choke formers are available from Marlin P Jones, not Radio Shack in the USA, as stated in the drawing above. GO to http://mpja.com and buy 3 – 7840-TR (only $7.75 each) use only one side leads, not both sides. It is perfectly ok to wind these chokes on laminated iron pieces taken from an old mains power transformer frame.

If all is well and the 20-amp contact-breaker (or fuse) is not tripped, the electrical power passes through to the gas-pressure switch mounted on the electrolyser. If the gas production rate is greater than the engine requirement and as a result, the gas pressure inside the electrolyser gets above 5 psi. then the gas pressure switch disconnects the electrical supply which in turn, cuts off the generation of more gas until the pressure inside the electrolyser drops again as the engine uses the gas. If all is well, the gas-pressure switch will be closed and the electrical power is then passed to the relay's switch contacts. The relay is wired in such a way that the relay will be powered up if, and only if, the engine is running. If all is well and the relay contacts are closed, then the power is passed through to both the inverter and the electronics board. The inverter output is 110 volts AC so it is passed through a diode bridge which converts it to pulsing DC with a peak value of about 155 volts. This voltage and the output of the electronics board toroidal transformer are passed to the electrolyser to break down the water and generate hydroxy gas. The wire connecting the vehicle negative to the electronics board should be very heavy duty as it is carrying a large current.

There is a lot of power stored in a charged battery. It is important therefore, to protect against short-circuits in any new wiring being added to a vehicle, if this electrolyser is to be used with a vehicle. The best overall protection is to have a circuit-breaker or fuse connected in the new wiring immediately after the battery. If any unexpected load occurs anywhere in the new circuitry, then the circuit will be disconnected immediately.

It is also important that the electrolyser is only connected and operating when the engine is running. While the gas-pressure switch should accomplish this, it is no harm to have additional protection in the form of a standard automotive relay in the power supply line as shown in the diagram above. This relay coil can be connected across the electric fuel pump, or alternatively wired so that it is powered up by the ignition switch being turned on.

Positioning the Electronics

The descriptions and diagrams have been presented with the objective of helping you understand in broad outline, what Bob Boyce's electrolyser is and very roughly speaking, how it operates. There are practical details which you should discuss in the WorkingWatercar forum as there experienced people there who will help builders get the details right.

It should be realised that the strong, rapidly pulsing currents generated by the electronics, cause very powerful magnetic fields. These magnetic fields can disrupt the operation of the circuitry. These fields flow around inside the toroid core and this creates an area of very reduced magnetic activity in the space in the centre of the toroid. For that reason, it would be ideal if the circuit board were placed in that area with the toroid surrounding it. However, the electronics board size does not allow this at the present time, so instead, Bob places the toroid inside a custom, circular housing, something like a biscuit tin made of aluminium which operates as a "Faraday Cage" to protect against the magnetic fields produced.

The only problem with this present system is that the "G" board can obtain resonance freq. But keeping it in tune for long periods, is task informing. You have to watch the bubbles and tune the adjustment Screws as you watch the bubble activity. One could design a automatic resonance obtainer. Bob did this in his Hex Controller, but his Hex Controller is dangerous. The PWMG3 board will capture radiant energy/ voltage spies and ground them to the cell and therefore make more egas. S the Hex Controller is a positive system and the vortex goes out to the sky, it actually will create alitle more gas up to 75 LPM, but can do other damage. There fore Bob does not let his Hex Controller out to anybody or to the body of experimenters. TO read more go to : http://hydrogengarage.com/pwm3g and download " bb101.pdf"
