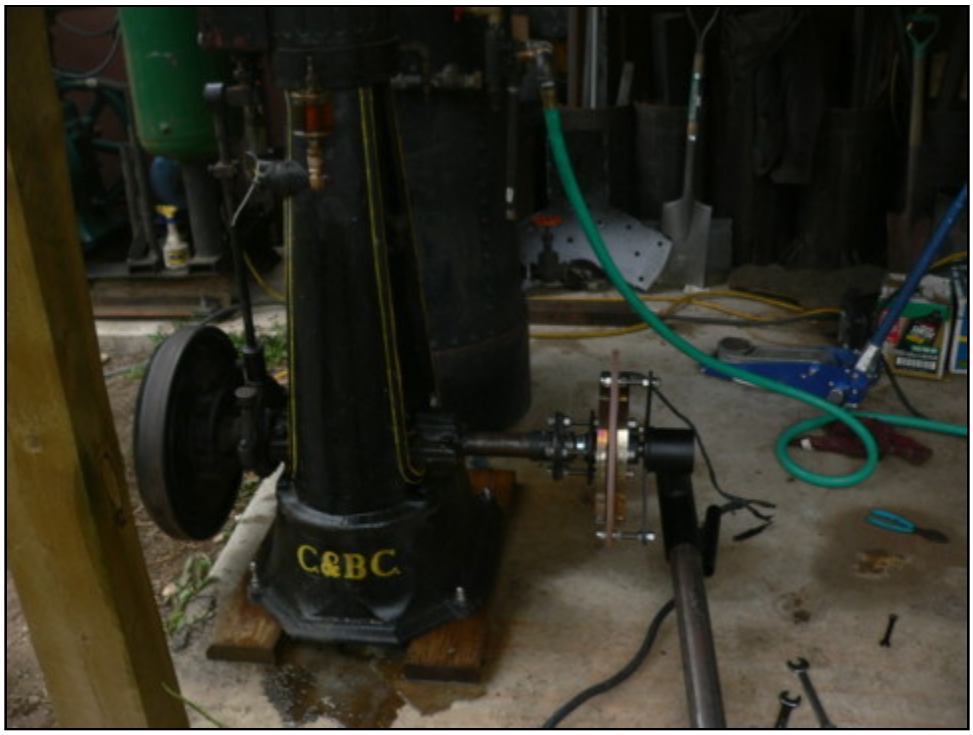
Steam Powered Battery Charger

This page is a diary about our effort to build a steam powered 'backup generator' to charge our batteries. For the most part we have all the power we could ever need from our small 600 Watt solar array and our 20' diameter wind turbine, but on occasion I do need to run a generator and I always figured that a steam engine would be the most fun, plus... I don't need to rely on petroleum - I have lots of wood all around me!

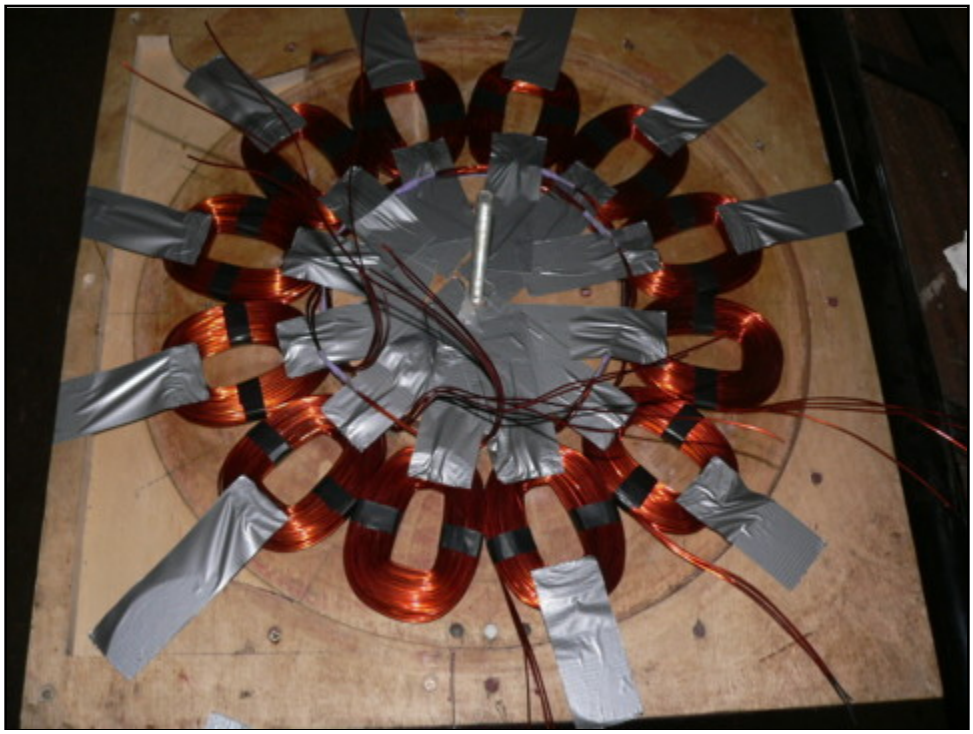
This project has moved forward slowly over the course of a year as we've gathered all the parts required. The engine is a 1903 C&BC 6 horsepower steam engine. I bought it at auction nearby (stole it) for less than $150. It's in very good shape, I believe it's been rebuilt and never run since. The boiler we got about a year later. I'm guessing it to be about a 4hp boiler. It was made by 'The Look Out boiler company' in 1940. It seems to be in good condition. First step was to hydrostatically test the boiler. We filled it all the way to the top (actually above the top because we put pipes above the boiler) with water, and then put 150PSI air pressure to it and looked for leaks. It held up well. The boiler is only rated for 100PSI and we'll run it a bit below that so we have some safety factor.

Pictured above are most of the other bits we need. A steam whistle is a must - this whistle is an 1880's Crane whistle. We also have a 3/4" Penberthy injector. The injector uses steam to inject hot water into the boiler when running. Also pictured above are two drip oilers to keep the crosshead lubricated, a steam gage and a check valve to sit between the injector and the boiler. Of course lots of other valves, pipes etc... are required. Critical parts not pictured are the pop off valve (the pop off valve is a safety that opens should the boiler get over 100PSI) and the lubricator for the engine that injects oil into the steam line and keeps the cylinder lubricated.

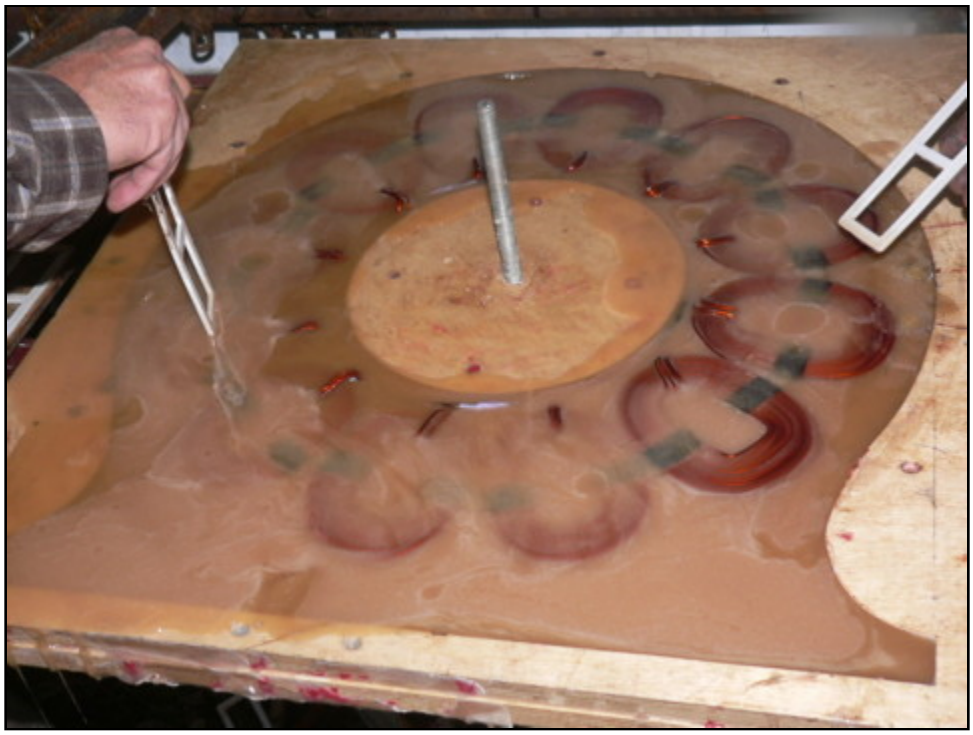
There is almost the full setup up and running. So far so good...



Our first test was to fit one of our 10' diameter wind turbines to the engine. This alternator is approx 50% efficient at 1000 Watts output. With this setup we could easily run at 1KW output - knowing full well that the alternator was also dissipating 1000 Watts of heat in the stator. So while it wasn't terribly efficient it was a fun test and I felt confident that with a larger alternator we could easily have 1500 Watts continuous output. With this alternator on it I could generate about 1KWH with 60 pounds of lodgepole pine as fuel. Not bad I didn't think...



So we got started building a larger alternator. Pictured above are the 12 coils completed for our 3 phase alternator. The stator is identical to those we build for larger 17' diameter wind turbines with the exception that we changed its shape (so we could mount it to a concrete pad) and wound the coils a bit differently. These coils are wound with 4 strands of #15 gauge wire (equivalent to 9 gauge wire) and there are 40 turns per coil.



Pictured above we're casting the stator with vinyl ester mixed about 50:50 by volume with ATH (alumina trihydrate) as filler.

There the stator is setting up in the mold - we've clamped a clear Plexiglas lid onto it.

The alternator will be a dual rotor axial flux type - just like the wind turbines we build. The steel magnet rotors are 18" in diameter and 1/2" thick.

There's one rotor with all its magnet on. Each rotor has 16 N40 grade NdFeB magnets on it, they measure 1.5" x 3" x .75". Again, this is about identical to a 17' wind turbine.

We take some 3/4" stainless steel strapping material, run it around the circumference of the rotors and cut it just about 3/16" short. Then we weld that together so we have a band that won't quite fit around the rotor. We heat that up with a torch until it just starts turning color (stainless will start to turn just

slightly golden at a certain temp). When it's hot it expands and we drop it over the rotor and it shrinks on there. This adds some insurance against the magnets every flying out.

Once the band is around the magnet rotors we put a wooden 'island' in the middle and pour a mixture of vinyl ester, ATH, and chopped fiberglass into the rotor right up to the top of the stainless band. Pictured above is a finished magnet rotor bolted to a trailer hub. This is the same Dexter 81-9A trailer hub we use on the 10' diameter wind turbines. For the steam engine, I had to knock out the bearing races and bore out the inner diameter so it would fit the shaft of the engine.

There is the back magnet rotor mounted to the shaft of the engine.

George and Tom bolt the stator between two pieces of 2" angle iron. The angle iron will serve as a base by which we can bolt the stator to the concrete pad.

Pictured above I'm fitting the stator to the back rotor - then I marked the location for the studs that we'd put into the concrete. We drilled out the concrete with a 1/2" bit/hammer drill and fit studs to mount the stator.

There it is all finished up. Time to fill the boiler, light a fire and see what happens!

Great fun to be able to use about anything that burns for fuel. Our best fuel in this area is lodgepole pine... wish we had Oak or something. I do know some folks with wood shops in town that can supply nice little chunks of hard wood though.

It takes about 40 minutes to go from a cold boiler to 80 pounds of steam, which is where I like to run this. Pictured above the engine is running with the governor on top. In my application, the governor is not really required because the alternator does keep a constant load on the engine. Should the alternator become disconnected in any way though, the governor would keep the engine from overspeeding.

This alternator starts to charge my 48V battery bank at 120 rpm. At 200 rpm we generate just over 2000 Watts. It's fairly exciting -- it's easy to maintain this level of power output with even the low grade wood we have around here. At this power level the alternator doesn't hardly warm up at all, and things seem very efficient. We did run it up to 3KW output for a short while, but I couldn't keep the pressure up in the boiler. Seems like the best we can hope for is about 2.5KW sustained... which is great! Much better than I'd hoped.

Lots of fun and I love it when things work out better than planned. Steam power is incredible stuff - it's amazing how much energy you can store in a gallon of water! Click Here to see a short video of the engine running! I'll post updates about this project as we tidy things up a bit more. While it is all working well now, there is still some work before I feel like this project is finished.

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