Alternator

For Home Brew

Savonius VAWT

Design by Brad Hunter November 2006
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Well, if you are reading this I hope it is because you intent to start generating your own electricity. Even if only to supplement or offset grid power or the bill that goes with it. Every little bit helps reduce greenhouse gasses and moves us a step forward toward renewable energy.

Lets get started.

This design is not so different from others you have probably seen. The primary difference and is unique for this application is the diameter we will be working with and the orientation of the parts involved.

Ordinarily, an alternator or generator works in a complete circle and is designed to be compact. My design takes us the opposite direction. We will be building large and easy. Also the circle is not necessarily complete. This will make more sense when you see the design lay out. This simple design change causes the speed of the magnets over the coil to increase about three times. Normally you would do this with gears or pullys, but each time you make a mechanical conversion you lose some energy and add a point for breakdown. The rest of the difference will be gained from using more wire per coil and a lower AWG. This means we will not get the AMPs you would from a HAWT, but this design should make up for that by charging a lot more often and in a lot less habitable locations.

You will need enough magnet wire to produce at least 9 coils for a reasonably efficient VAWT alternator. These coils should be made with magnet wire of about 24 AWG and 30 feet of wire length. The VAWT design can be downloaded from http://www.homesopen.com/wind/savoniuscomplete.pdf

This alternator is designed around the VAWT described on the above link.

You will need 16 1”x2”x ½” Neodymium magnets charged N40 or better through the thickness. This means the facing surfaces are the North and South, not the two ends. These are the same magnets called for on other alternator designs and are easily found in bulk from otherpower.com.

You will need plexiglass or another non magnetic, strong, weather resistant material to make an “L” bracket from. I will be using plexiglass here. You can find plexiglass at maintenance facilities if they are willing to give you some scrap. Many will track material for recycle and will not be able to donate any to your cause. Check with local

glazers too. You only need about 25" x 7" and ¼" thick to do the job. A typical cut away is 32" x 7" x ¼" and is headed for the scrap pile anyway. Ask around I'm sure you can get this piece of material for free. Remember too, re-use is the best form of recycling.

You will need good glue and some packing tape or duct tape. Also for ease of marking you may want some wire with one pole marked, like speaker wire or extension cord. I also used a 25' out door extension cord as a sacrifice to get the power from my turbine to the charging station.

The materials list:

Magnet wire – 270 feet of 24 AWG or nine 30 foot spools of 24 AWG
16 Neodymium magnets - 1"x2"x ½" available through otherpower.com
Plexiglass – ¼" thick sheet about 25"x7"
Packing or Duct tape
Glue – not cyanoacrylate or any others with harsh solvents, but must be very strong and weather resistant I used Gorilla Glue and Liquid Nails small projects clear indoor outdoor
Extension cord – sacrificed for delivering power from turbine to charging location
Wire – used to make identifying ends easier, not required
Screws – must be weather resistant (I use the 1 ½" plated drywall screws, they are easy)
Large washers – used with the above screws for attaching coils to VAWT platform
Flashing – you only need a few feet and only about 1" wide piece

VAWT - on some type of platform you can sink screws into and where the bottom of the rotor is wood or another material you can sink screws into.

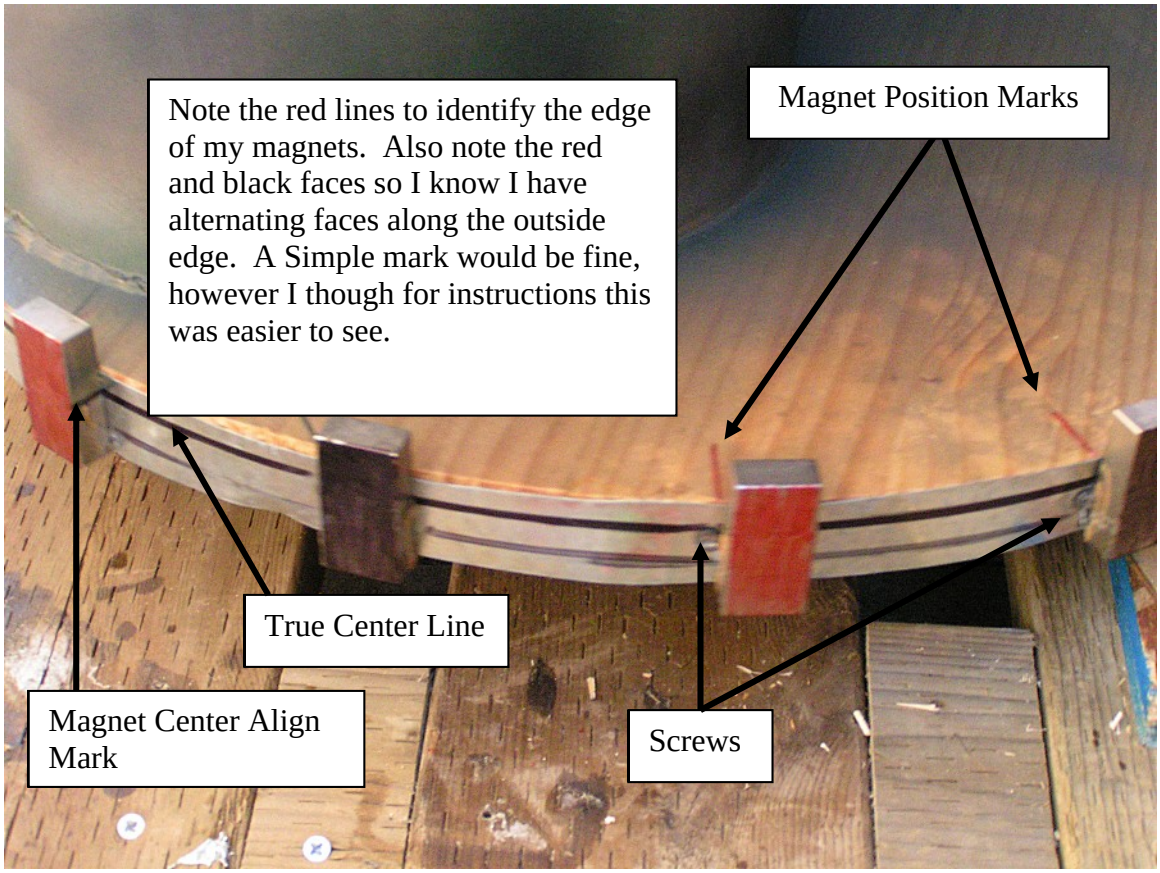
Tools:

Saw - for cutting plexiglass
Soldering iron or torch
Torch – for bending plexiglass (I use my soldering torch)
Drill
Screw Driver – for the screws on the materials list (probably a #2 Phillips)
Sharpie or good pencil
Square – for marking straight line on plexiglass (the edge of a book will work too)
Drill Bit – just a couple sizes too big for the shaft and thread of the screws above, you want some play room for the screw.
Red Marker
Black Marker
Tool to cut flashing
Drill Screw Driver Bit
Electrical Tape
Multimeter

Step 1: Mark one face of your magnets consistently. They will arrive stacked up, get them all in one big stack so you can mark all of one side the same. The object here is to know you have all North or all South. You will be gluing these to the VAWT in a NSNS fashion. It doesn't matter which side is actually North or South, so long as you mark them all the same.

Step 2: Cut your flashing down to a strip about 1" wide and long enough to go completely around the circumference of your VAWT rotor. Take the diameter and multiply it times 3.14 to get the approximate circumference. This will actually be a very close measurement. In a perfect world it would give you an almost exact measure, but the odds are if your rotor material says it's a 24inch diameter, it's only about 24inches. Also, you want an extra inch or two which you can cut off later.

Step 3: Mark magnet positions on the rotor where you will attach your flashing. On my setup, the alternator is built on the bottom of the rotor. You have 16 magnets if you are repeating my project as described here. Take your circumference measurement and divide it by 16 to know how often to mark for a magnet. Put a single line at the edge to identify a magnet position. Mark all 16 points where they will not be covered on the edge of the rotor. The following image is a completed rotor with magnets mounted.



Step 3: Attach flashing around the edge of the rotor. Put a screw in a starting point that is fairly centered between your magnet position marks. Work your way around the whole

rotor putting in a screw directly at the magnet position marks. Do not tighten screws down. Keep tension on the flashing as you put in each screw. The flashing will serve two purposes, first it will help prevent splitting of the wood, second it will give the magnet something to cling to while glue sets up. Leaving the head just above the surface without tightening it down first will keep the flashing tight and give the magnet something to press against on one side while gluing. This allows for easier alignment of the magnets.

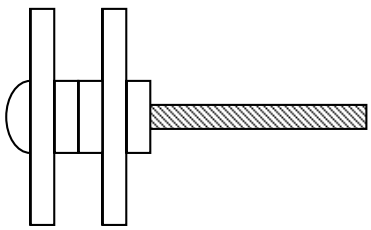
Step 4: Give the rotor a spin, and while bracing a marker on something that doesn't move, bring the tip up to the flashing to create a true level line all the way around the rotor. You can see I put my line off center to the top. Anywhere is good.

Step 5: Mark the edge of your magnets with a line to align on the rotor center line. See image above. This line should be measured to the same point on the edge of every magnet. This process will help true up your alternator stator and rotor alignment. The better the alignment of your rotor and stator, the more efficient your alternator will be. Take your time on this step.

Step 6: Use glue, Liquid nails, to attach magnets. Start by putting a dab of glue on the magnet. Bring the magnet up next to a screw head and roll it into position so that it is seated firmly against the screw head on one side and the flashing at the back. Peel it off and repeat. Now make sure your edge alignment mark is lined up with the true level line marked in step 4. Your magnet should be mounted like one in the photo above. Apply the same steps to all of the magnets that are the same, either all of the North or all of the South. Do all the Red and then all of the Black, or vise versa. The thing about doing all one type is that you have greater distance between the magnets and they are less likely to jump right off the glue at you. By the way, it hurts. Once you have done all of one type, give it an hour or two to set up firm. Then proceed to do the other group. As long as you align all magnets on either the right or the left of the screw this will be a very consistent setup with very evenly placed magnets.

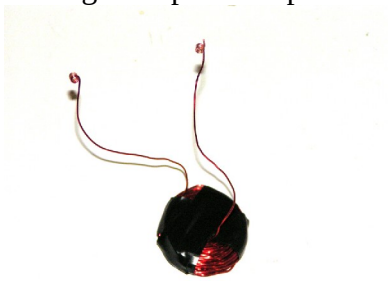
This is a good time to stop for about 24hrs and let all glue set up completely.

Step 7: Wind coils. I used a couple of plastic wafers, a thin machine screw and some nuts to make a jig for winding my coils.



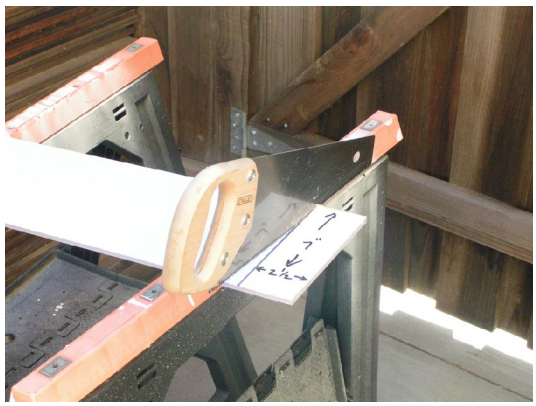
By inserting the threaded end into my drill chuck, I could simply pull the trigger to wind my coils. My coils consist of 30feet of 24AWG magnet wire. Leave about 6 inches out the side for starting your coil. Do not strip the magnet wire. To most of you that last comment seems silly, I did have someone write a comment on an instructable that he

stripped 130feet of magnet wire for a project that never worked. Hmmmm. If you don't know, you don't know. To get your coil off, remove the jig from your chuck and loosen the nut. Carefully slide the guide off one side and then remove your coil. You will want to tape up the finished coil with the start lead hanging out as well as another 6 inches of the finish lead. Make sure you wind all of the coils exactly the same way, direction of winding and all. Make sure to identify which lead comes from the center of the coil, your start lead. I simply let it stick out from the center and my finish lead stuck out from along the edge. Repeat this process until you have at least 9 coils.



Step 8: Coil brackets. This step requires plexiglass. This step is not safe if you are not extremely careful. IF YOU PERFORM THIS STEP, YOU DO SO AT YOUR OWN RISK.

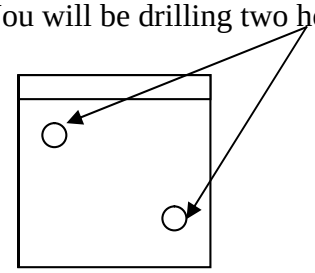
A) Measure and mark your plexiglass for 2 ½ inches wide by 7 inches tall and cut. Repeat so that you have one piece for each coil.



B) Peel the protective backing from both sides of the plexiglass

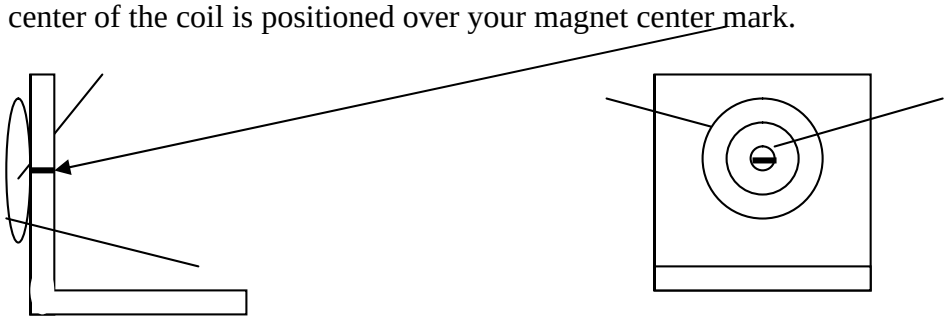
C) Use a torch like a soldering torch to heat the plexiglass. Move the torch flame back and forth in a line across the center so not to overheat or burn any one spot. When little bubbles or blisters start to appear, turn the piece over and continue on the other side until the same thing happens. Turn it over one more time for a few seconds. Turn off the torch and set it somewhere safe and non flammable like the cement floor. Bend the plexiglass to a right angle and hold it while it cools. If it doesn't bend relatively easy, heat it some more. It will only take about 10 full seconds to cool enough to hold its new shape. Set your finished plexiglass "L" aside and repeat for the remaining units.

D) Drill holes in the shorter leg of the "L". If you measured for center before bending then it doesn't matter. You will be drilling two holes off set from each other as diagramed below:



These holes need to be too big for your screws, but not too big for the washers. This will allow us to fine tune their positions later. These holes do not need to be measured for placement, just eyeball it.

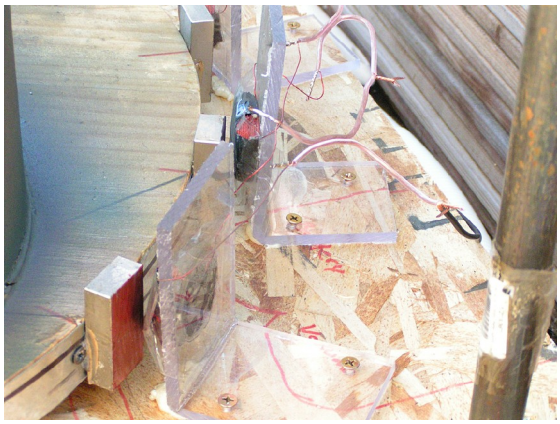
Step 9: Attaching coil to plexiglass bracket. Because the brackets are not perfectly consistent and our platform is also not perfect, each one will be unique. Follow this procedure one at a time. Take one "L" bracket and bring it up close to a magnet while holding it firmly down on the platform. Mark the center height of the magnet so you can position your coil accordingly. You will be gluing your coil to the outside face of the bracket so that the center of the coil is positioned over your magnet center mark.



Make sure your leads come out against the plexiglass. Apply glue and use some tape to secure the coil until the glue dries. Make sure your leads are coming out and the center lead is marked some how. It is a good idea if you always put the center lead to the same side. Make all your assemblies identical. If you use the plexiglass, you will be able to see the lead and its origin. Wait until the glue has time to set before proceeding. Do not bother removing tape. It will come off in time and removing it now will only stress freshly glued parts.

Step 10: Use some sandpaper to strip the last 1" of each lead. We are talking about the tip of the lead, not the part near the coil. You can scrape it with something else, but sandpaper is easy if you have it. Just get the last inch clean of insulation now while you're not bending over the turbine.

Step 11: Locating the coil attached to bracket, (coil assembly), on the VAWT. Take a coil assembly to the VAWT for locating. The first one will have to be done nearest an inconvenient location. This will make all subsequent coil assemblies easier to place. See the photo below for an example:

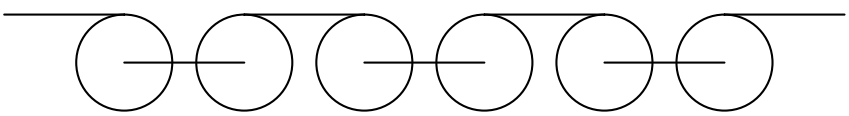


Putting the first coil assembly next to the support bar ensures we don't end at one where we might not be able to get our tools in comfortably. Bring your screws and washers along and a manual screw driver. You now have to do the most critical part. Mostly because it is hard to relocate the assembly once you put holes in the platform. Get the coil assembly as close to a magnet as you can without touching it. While holding it down, give the rotor a slow spin. Make sure no magnets bump the coil assembly. If they do, simply adjust to the magnet that sticks out the most. You want the coil as close as possible without touching. Now while holding it in the magic spot, put in a screw with washer at the back of the bracket, furthest from the coil. Doing the back hole first gives you the most room for last second corrections before putting in the second screw. Also, try to put the screw down the center of the hole in the bracket. This will also add to your correction ability. When you are satisfied, put in the second screw with washer. Give the turbine a slow spin and listen for any magnets bumping the coil. Adjust if necessary.

Coil number 2 will need to be positioned so that it is in front of a magnet at the same time as coil number 1. This is true for all subsequent coil placements. Repeat the previous step making sure the coils are all going to be in front of magnets at the same time.

Step 12: Wiring. Big subject. Whole books are written about this part. This is the confusing part. Right now, this is a keep it simple document. I don't want to go into anything complicated, so I'm going to instruct you on a simple single phase wire up of this alternator. This may seem like it goes against what should happen, but trust me it is very complicated why this works the way it does. Just do the following.

Start with your first coil, take the center lead and connect it to the center lead of coil number 2. Take the outside lead of coil number 2 and connect it to the outside lead of coil number 3. Take the center lead of coil number 3 and connect it to the center lead of coil number 4. Take the outside lead of coil number 4 and connect it to the outside lead of coil number 5. Take the center lead of coil number 5 and connect it to the center lead of coil number 6. Continue this pattern until you get to the last coil. On the last coil you will have the mate to the first coil….. The open, not connected, lead of the first coil and the same on the last coil are your power leads. Solder your contacts between coils.



Step 13: Cut the prong end off of a sacrificial extension cord. I used a 25 foot cord so that the turbine could be that far from my charging station. Remember, it's an extension cord, you can add them together for more length. Strip two leads far enough back to reach your two power leads. If you use a 3 prong extension, make sure you use the white and black leads, not the green lead. Label the female end of the cord "Wind" so you know that it is power from the turbine. Connect the two leads from the extension cord to your power leads coming from your coils. Solder them. The reason you cut off the male end of your sacrificial extension is so that you do not accidentally plug it in to grid power. Odds are you will not destroy something if you plug it into wind power accidentally. Don't find out.

Step 14: Check your power output. Make sure you are dealing with the wind power cord before using your meter. Put your meter on a setting of 50VAC if it has one and check your voltage. If the turbine is spinning slowly you may need to select 10VAC or 15VAC depending on what options your meter has. A digital meter is easy, just set it to AC. Put one test prong in each slit opening of the "Wind" power cord. Faster spinning should create higher voltage.

Step 15: Fine tuning. If you want to fine tune the alternator, you can increase voltage and current by re-adjusting your coils as close as you can to the passing magnets. Also, you may want to tap some toothpicks in behind the flashing to boost out any magnets that seem to be back from the group , use a wooden object to tap the toothpicks. This is a tedious process but time here adds up to a lot of power over the use of the machine. In the photo below you can see two of my magnets tweeked this way. When all is settled, I can put some glue over the toothpicks to weather proof and make them permanent. You can see it looks like my magnet is touching the coil, however it isn't. That is how close you can tune this setup. When I took this photo I had not added the washers to allow for adjustment. Fine tuning my machine made a difference of 2Volts in about 5MPH winds from 7VAC average to 9VAC average. The sooner you hit 13Volts, the sooner you start charging 12Volt batteries. You will need to set up a charge station before this can be done. Make sure you do not connect this power to anything but a multimeter or small night light bulb until it has been through a charge controller of some type. A 5Watt night light should get a nice red glow in a 5MPH wind if your VAWT is the same design as mine. Do not touch both leads while unit is spinning, it makes a fair amount of AMPs even at low RPM and could seriously hurt you.