THE WOOD-AX

We've had lots of response in regard to the wooden windmill I built last spring. It was built almost completely from wood, and was actually capable of around 100 watts of output. It was good for fun, and demonstration - but only barely produced usable power and due to the wooden bearings and small shaft, it was not really suitable for permanant installation. This page is about a recent windmill I made, mostly from wood, and capable of about 3 times the output. Although mostly wooden, the ball bearings and thicker shaft should allow it to stand up to the elements for some time to come! The alternator is of an axial design. It's a smaller version of the VOLVO DISK BRAKE ALTERNATOR I built in the fall of 2001. It produces 200 watts in a 30mph wind - maybe not the most efficient wind generator in the world, but nice, simple and reasonably effective!

Stuff I used

12" long 3/4" shaft

5 1/2" diameter steel gear for the armature

2 3/4" ball bearings on pillow blocks

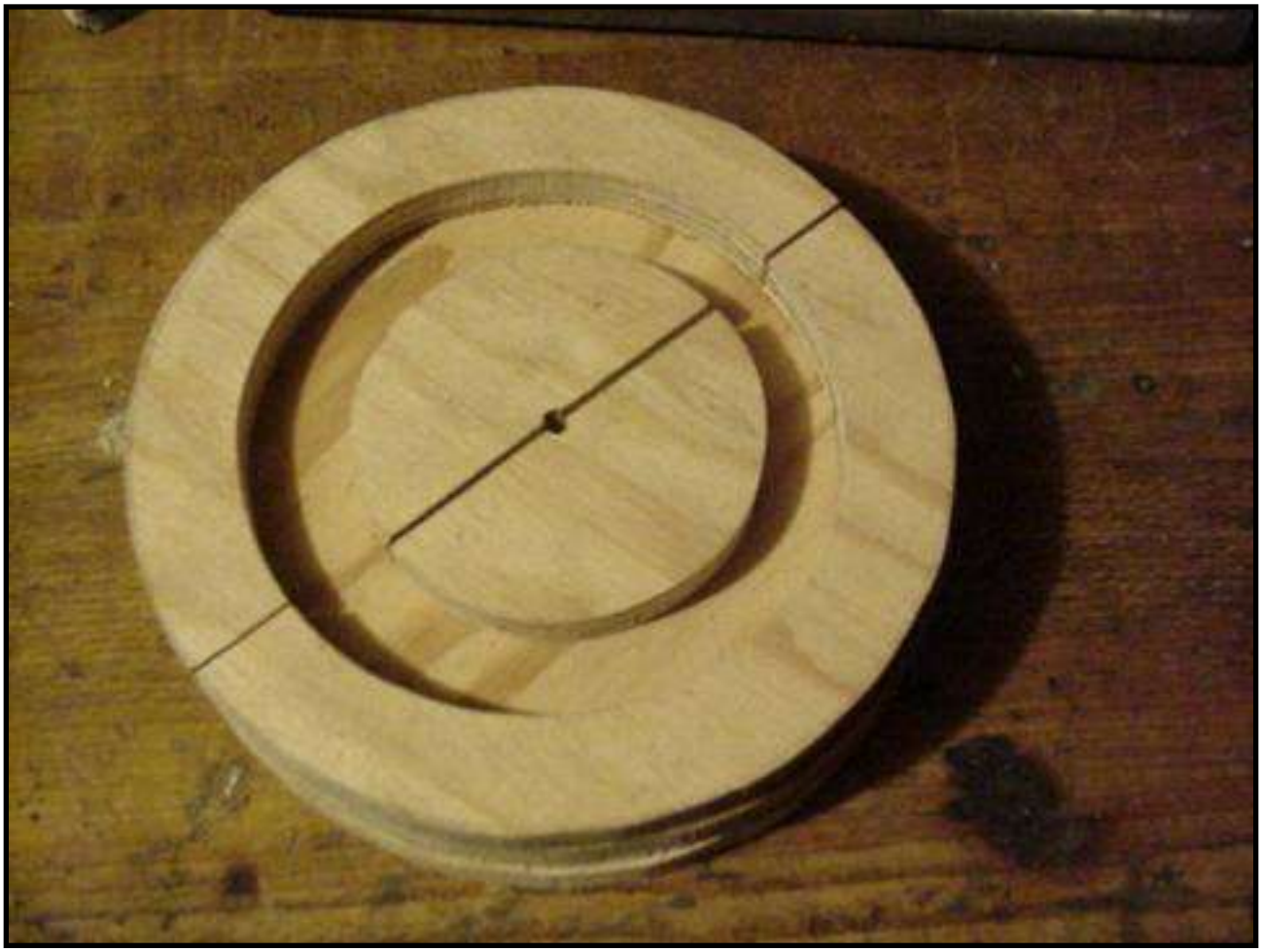
AWG 18 magnet wire - about 2 pounds

12 NdFeB magnets, 1" diameter X 3/8" thick

Some plywood and other lumber

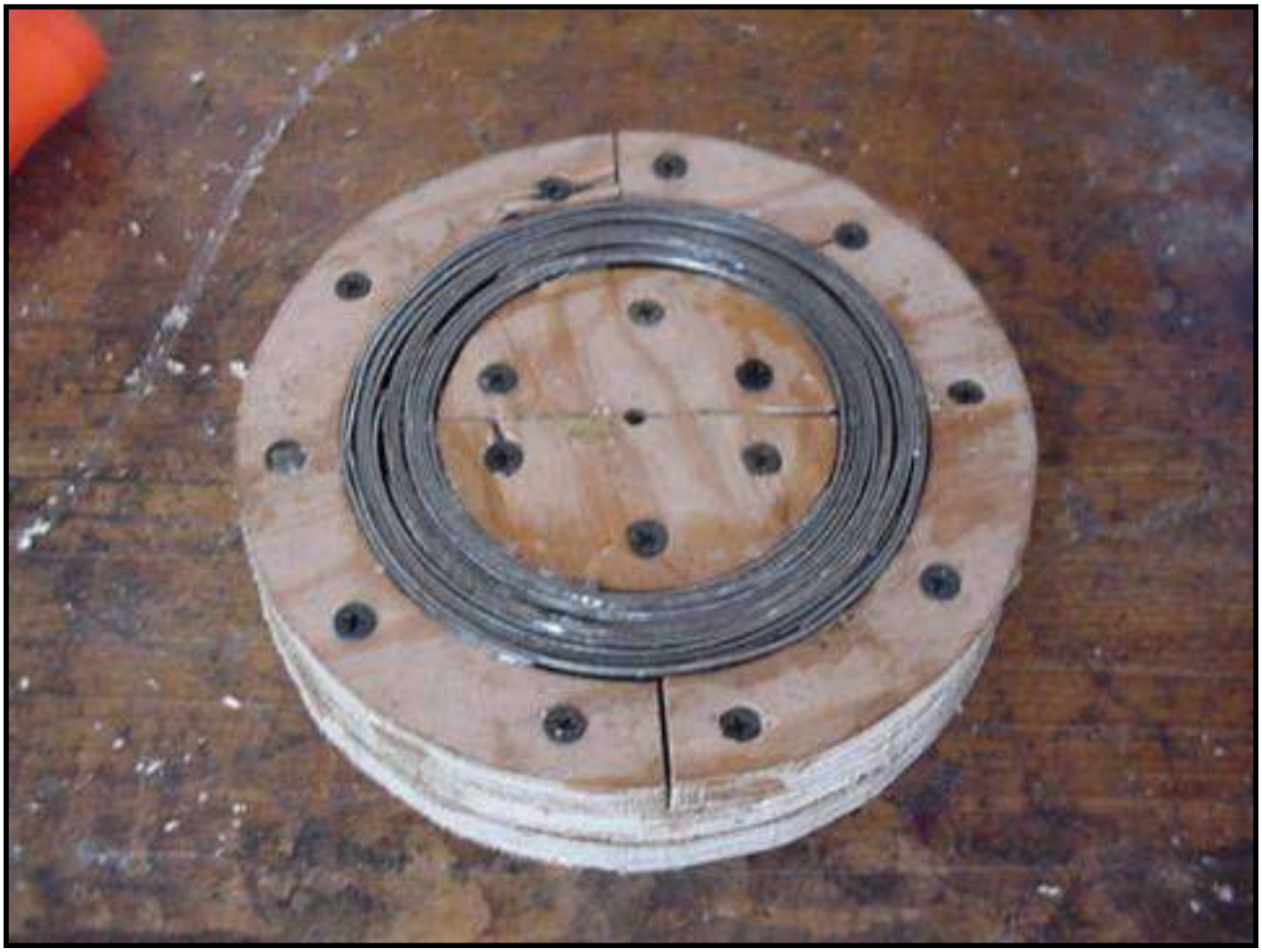
lots of epoxy, wood screws and linseed oil

I cut a slot in the gear 1" wide, and about 1/8" deep to hold the magnets in. The magnets must be evenly spaced around the circle, and once they were, I glued them in with epoxy. This is very similiar to the Volvo disk brake alternator I made - so check that page out for more detail. The polarity of the magnets around the circle alternates, so each magnet has the opposite pole up as its neighbor.



The stator (part that contains the coils and does NOT move) is made up from plywood laminates. It includes 2 disks, each 6" diameter with a 1" hole through the center (to allow the shaft to pass through). There are also semicircular pieces which sit on the top to provide a cavity for the steel laminates to be glued in. The cavity for the laminates has a rough inner diameter of 4.5" and outer diameter of 5.375" - basicly, it is immediately behind of the ring of magnets on the armature and a hair less than 1" wide.

Show above is the plywood stator, glued, and screwed together. You can clearly see the cavity into which the laminates will be glued in. The laminates are made up of 1/2" wide strips of 20 gage cold rolled steel sheet metal. The strips I used are 4' long, and before installing them, I covered 1 side of each strip with tape so that each piece would be insulated from the one beside it! This is very important to reduce eddy currents.



Pictured above you can see the stator, with the laminates glued in. I glued the strips in with epoxy, and when I could no longer fit 4' long coils in the slot, I started cutting shorter segments and tapping them in with a hammer. Unfortunately, gluing these in with epoxy is a nasty, sticky messy job, and I wish I could find a "nice" way to do it - all I can say, wear some rubber gloves and don't try gluing these in untill you have a lot of patience! After the laminates are glued down, it is important to cover the whole surface of the laminates with a coat of epoxy. This provides some insulation between the laminates and the coils and makes it less likely that the coils should short out to the laminates! If 2 coils shorted out to the laminates - in the process of gluing/clamping them down - it would ruin the alternator.

The coils are glued (with epoxy) on top of the stator - right over the top of the steel laminates. Before making the coils I made a very simple winding form - simply a handle, with a small plexiglass form on top (where the coils would be formed), and a cap, which is held on with a nut. I could hold it in one hand, wind the coils with the other, and when the coil is done the top is removed so the coil can slide off.

Above is shown the same coil winder with a finished coil on it. Each coil is made up of 40 turns of AWG 18 magnet wire. Once the coils are finished, I twisted the ends tightly together before removing them from the winder.

The coils are layed out in their places on top of the stator. It's very important that they be in exactly the right spot. One could lay out with a pencil exactly where they go, but I simply put a coat of epoxy down, lay out the coils as shown above, and then put the armature over them and carefully line up each coil with the magnet above it. This is not the most precision way of doing things - but it's quick, simple - and I've had fine luck with it so far. Once the coils are tacked in place, they are generously coated with epoxy. I cover the whole stator with wax paper, and clamp the coils down very hard - the point being to make them as thin as possible, as the gap between magnets, and the steel laminates behind the coils must be kept to a minimum! In the case of this alternator, the coils were smashed to about 1/4" thick. The thicker they are, the less effective the alternator will be, and a little difference in coil thickness will result in a big change in alternator performance.

Once the coils are glued down nice and flat and thin - the alternator is pretty much finished except for the base. In this case, the windmill is made from solid walnut, about 2.5" thick and 6" wide. The pillow blocks are bolted down to it, and the stator is glued, and screwed to the front of it. The shaft passes through the stator, and the armature is set on the end. It's important to keep in mind that the armature is full of very powerful magnets, and it's attraction to the steel laminates behind the coils (or anything else made of iron or steel) is very strong! So - the shaft must first be tightened down at the ball bearings. Then, a spacer (I used a compact disk) should be placed over the coils so that the armature can never touch them. Then, the armature is placed on the shaft, up against the spacer and the set screws tightened. Once everything is tight, then the spacer can be removed. Again - I used a compact disk, so the gap between the magnets and the coils just over 1/16". The gap must be kept as small as possible. Once all this is together and tight - it should be possible to test the alternator! One should easily be able to spin it up to around 6 volts by hand. Although the alternator is functional - it's not quite ready for the abuse a prop would put on it. Some further insurance should be added to make sure nothing can move - set screws are not enough! In my case, I welded a small tab on the shaft just in front of the rear bearing so the shaft could not be moved back, and I welded the armature (The gear) to the front of the shaft. These were light, "tack" welds. A better job would be to use key slots and keys, and make spacers - although welding is quick, easy - and it still allows

for complete disasssembly of the machine. Should the shaft need to be seperated from the armature, the welds are such they could easily be ground off.

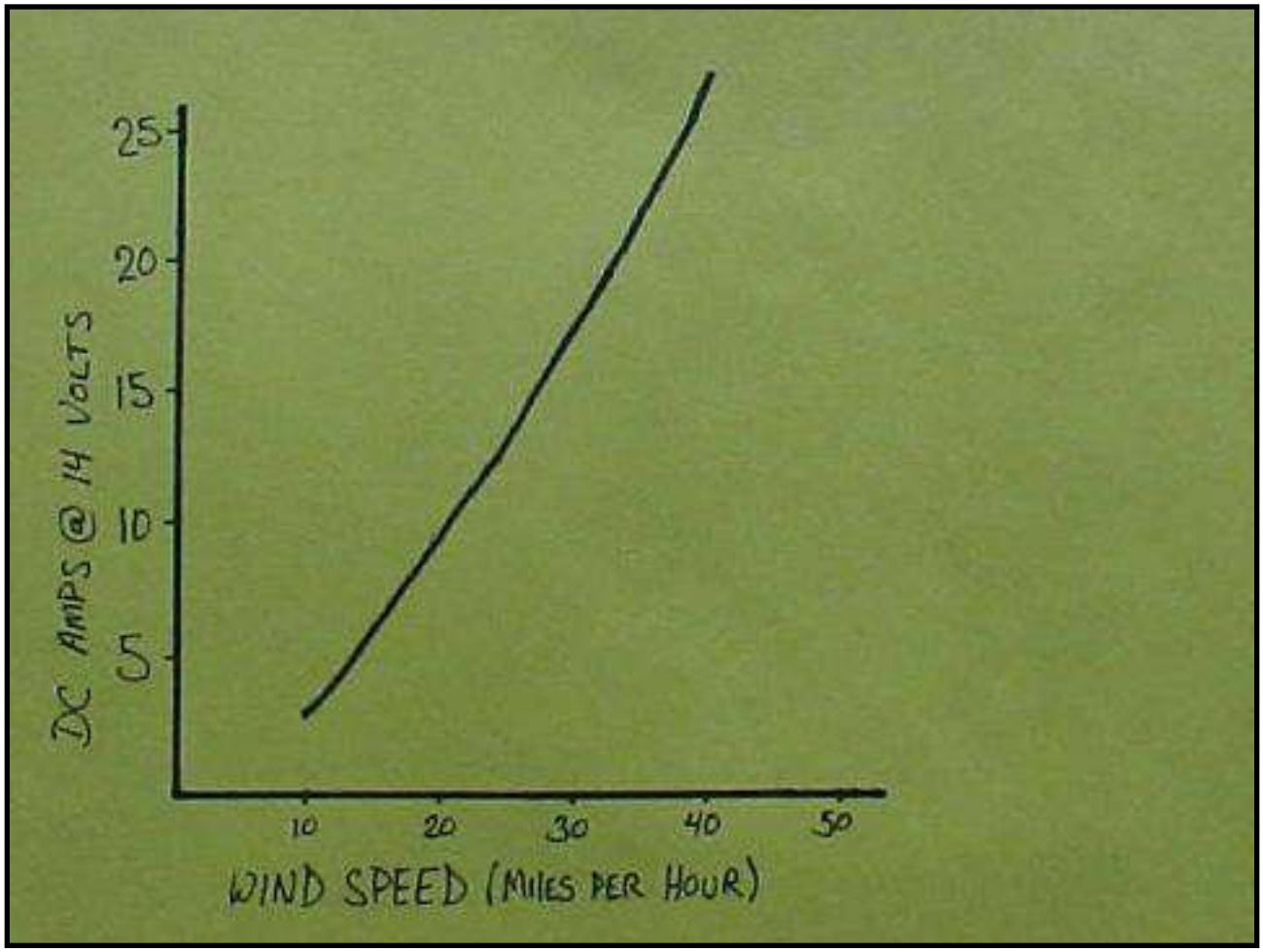
The prop is a simple "two blader", 4' long and pitched 5 degrees at the tip with a likely looking airfoil on the back side. Again - I'm no expert at prop design, seems like everything I put up works reasonably well though. Two blad props are quick, and easy. This one is made from a board 1" thick and 6" long, made from lodgepole pine. The blades are 2" wide at the tips, 4" where they meet the hub, and the part in the middle that bolts to the hub is 6" wide. The picture above hopefully explains this.

Check out some of our other wind generator pages for a little more info on prop making! Or...for a lot more info - find our links page and check out Hugh Piggots website! Again, this prop is pitched 5 degrees at the tip, and as steep at the hub as a 1" thick X 4" wide piece of wood will allow! (the wood I started with is 6" wide, but only at the hub, as soon as the "blade" starts - I cut it down to 4". Most of the blades are quickly knocked out with a power planer - or a hand planer, but near the hub it is necessary to chisel as a planer will not fit in there! I make lots of relief cuts with a handsaw, down to the depth which I must chisel, and the material comes off quickly and easily.

I drilled and tapped the armature to accept two bolts, with which the prop would be bolted down. The prop should be balanced well to avoid vibration, which would result in power loss and stress to the whole machine. A small 2 blade prop is easily balanced by simply hanging it from it's center. It will be obvious if one side is heavier than the other, and material should be removed untill both sides weigh the same. Once balanced, the prop, and the rest of the wind generator are coated generously with linseed oil. It may not be the best finish, but I have lots on hand...

To test it we simply put it on the mast which I keep mounted to the nose of my '70 F250 and go driving on a still day! We had wonderful results when we tested this, all of our test results came out very consistant - they all fall exactly on a nice curve which we plotted on graph paper. In the truck, we carry a 12 volt battery, a volt meter, and an ammeter. We watch the speedometer, vs system voltage (between 12-15 volts volts when charging) and the ammeter. Here is the bottom line...

It takes about 15mph to get it running, but then once spinning - we could slow down and it would continue to spin and produce power all the way down to a 10 mph wind.



It's a fun little windmill! Nice, simple and small - and actually somewhat useful! Were installing this machine at my parents weekend airstream trailer to keep the batteries topped off. It's a good size for a small, remote power system that mostly gets used only on weekends.

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