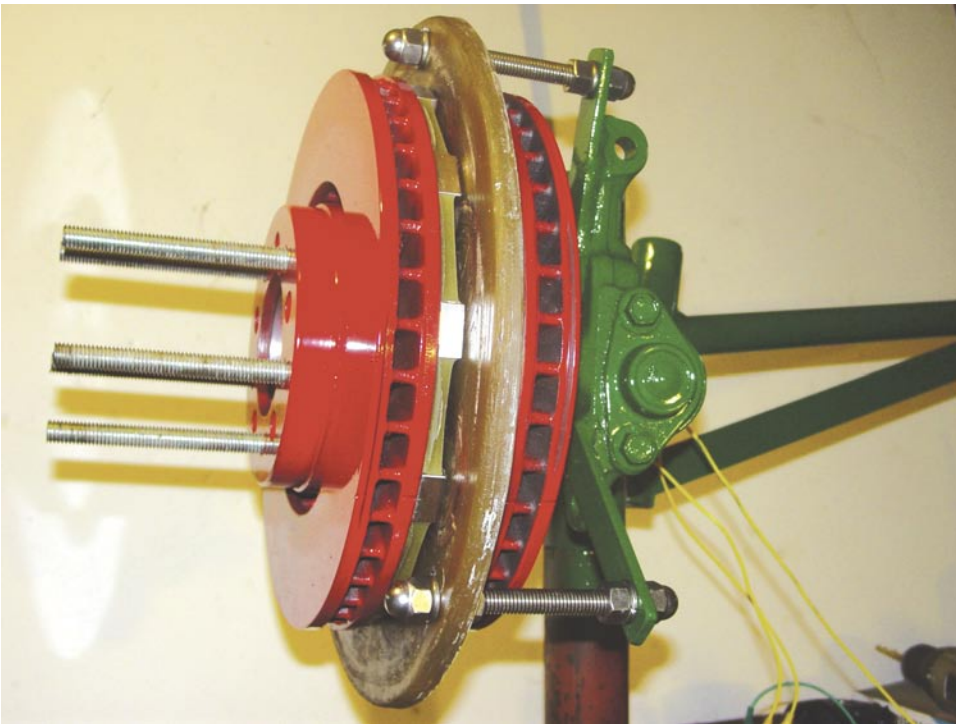


PHOTOS SUPPLIED BY AUTHORS

We'll now get into the fabrication of the permanent magnet alternator, which is unique in that it will generate power at about 150 rpm, or the equivalent of a six- to seven-mile-per-hour wind. It consists of two magnet rotors, a stator, and some enameled winding wire. There's also a winding process and a resin-casting procedure described in detail.

A Little Alternator Theory

The reason we build our alternators from scratch is that there are no commercial alternators available that are acceptable for use in a wind turbine application. Vehicle alternators need to spin very fast—1,000 revolutions per minute and greater—before they start making power, and we need to start making power at about 150 rpm and be at maximum output by 400 to 500 rpm. Car alternators also have inadequate bearings, and they require somewhere between 15 and 50 watts to excite their own field. In short, they are a poor choice for a wind turbine. Wind enthusiasts want a machine that will start spinning freely in the slightest breeze, and this homebuilt alternator does exactly that.

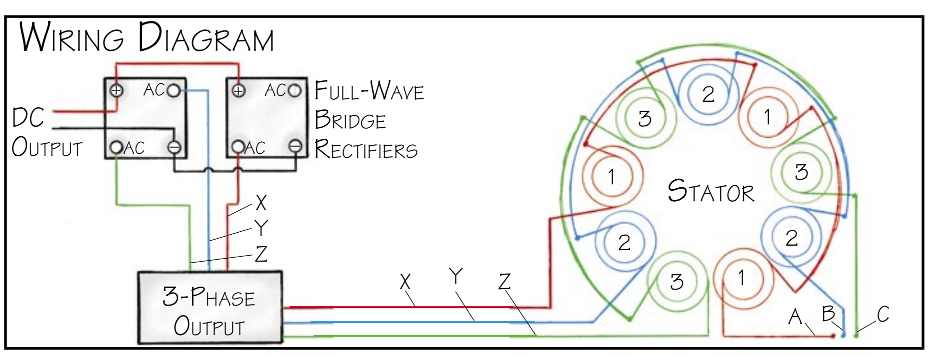
The wind speed in which a turbine starts rotating is called the start-up speed. This alternator will turn easily below five mph, which is better than almost any machine you could buy. In very low winds, it will sit there turning, ready to make power, as soon as the wind is ready. The speed at which the alternator starts charging a battery bank is called the cut-in speed. The voltage is directly related to the rpm. As the wind speed increases, so do the rpm, and cut-in happens when the alternator voltage gets greater than the battery bank voltage. At this point the battery is charging, which happens at about 150 rpm in winds between six and seven mph.

A permanent magnet alternator converts the mechanical energy from the rotating blades into electrical energy by passing alternating magnetic poles past coils of wire. The spacing of the magnets and the size of the coils are important to the design. The voltage produced is directly related to the following: the strength of the magnetic field, the number of windings in the coils, and the rpm. The design can be modified for use with 12V, 24V, and 48V power systems by simply using different sized wire and changing the number of windings.

This alternator is wired in three-phase star configuration, which gives significant advantages in power output and less vibration than single phase. The output is alternating current (AC) on three wires. This is sent through rectifiers mounted on a big heat sink. They convert the "wild AC" (called wild because it varies in voltage and frequency with the shaft rpm) into direct current (DC) for battery charging.

Building the Magnet Rotors

The 24 magnets we used in this design (see photo 8) are N-35 grade neodymium-iron-boron (NdFeB) blocks measuring 2" x 1" x 1/2" (see www.otherpower.com for ordering information). They are the most expensive component in the machine, making up about half the total cost. Their tremendous power and small size are what make this alternator design even possible. A word of warning: Use extreme caution when handling these magnets, and don't let children toy with them. They can jump to each other (or to any ferrous metal) from a surprising distance, and will shatter if this occurs. If your fingers are in the way, you'll suffer a painful blood blister or possibly even a fracture. After the magnet rotors are assembled, the combined force of 24 magnets and



STAFF ILLUSTRATIONS

Photo 8: Magnet rotor materials include a plywood jig, two brake rotors, 24 magnets, and cyanoacrylate glue.

steel would be enough to crush your hand to a bloody pulp if you accidentally got it between the rotors.

The brake disc rotors need to be 12" in diameter so the magnets will all fit. Used brake rotors are usually thrown away, and they will work fine for this project. The thick steel behind the magnets is actually an integral part of this design—it completes magnetic circuit, which substantially increases the magnetic flux through the coils.

We first face each brake disc rotor by turning it on a metal lathe. This gives a clean, smooth, flat surface on which to mount the magnets and also lets us leave a 1/16" lip around the rim to make aligning the magnets easier and to help keep them from flying off the discs from centrifugal force. You might need to drill a new set of five 1/2" diameter holes around the center of each rotor in between the existing holes if the old ones are so large in diameter that you think the rotors will wobble or if they came off another type of car and the holes don't match.

We built a plywood magnet alignment jig (see photo 9) to aid in placing the magnets, as they should be spaced perfectly. The polarity of the magnets must alternate N-S-N-S as you go around each rotor—opposite magnetic poles attract, and you want each magnet on each rotor to be intensely attracting its opposite on the other rotor. Check each magnet before placement—it should repel its neighbor when held over it, and then be mounted just the way it's sitting in your hand.

After all of the magnets are in place, check each rotor again by passing a handheld magnet over it. It should alternately repel and attract as it's moved around the rotor. Once you are positive that the magnets are placed correctly, hit the bottom of each one with a squirt of thin cyanoacrylate superglue and a squirt of glue accelerator to ensure they won't move during casting, and remove the magnet placement jig.

The two magnet rotors should also be perfectly aligned with each other, with an attracting magnet exactly opposite it on the other rotor. We ensure this by stacking both rotors up, facing each other and lining up the holes through which the studs will go. We can then mark the side of the rotor so that we're sure the magnets on each rotor will be perfectly aligned with one another. Once assembled, if we have a N pole on one rotor, we must have a S pole on the other facing it directly.

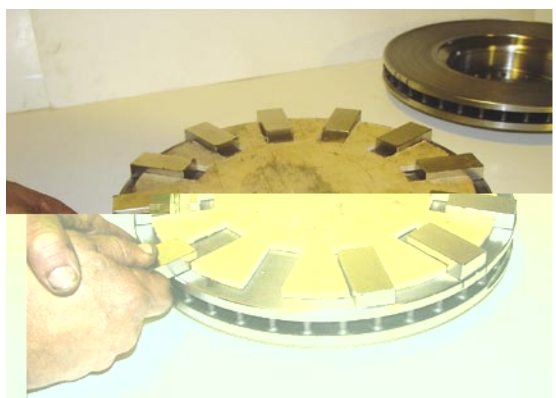
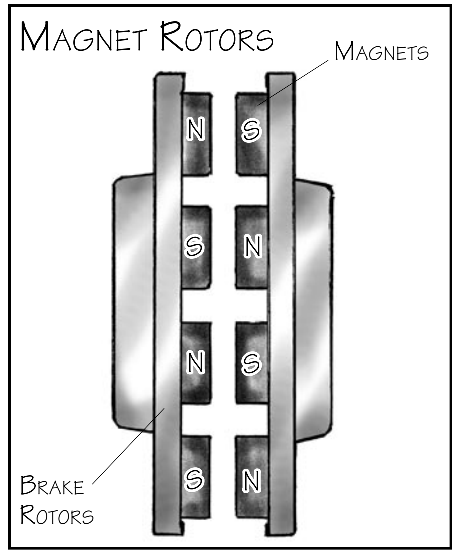


Photo 9: Magnet placement is aided by the jig.

After the magnets are placed and tacked down, set the magnet rotors aside in a safe place. If they should accidentally crash together through attraction, it would shatter the magnets and they'd be nearly impossible to separate again. A magnet rotor will also grab a wrench or knife out of your hand from a distance, so store the rotors at a safe distance until you're ready for casting.



Attracting magnets must face each other exactly on the rotor.

We usually cast the stator and magnet rotors in one operation. For molds to hold the resin around the magnet rotors, we use stainless steel mixing bowls in the centers and duct tape around the rims (see photo 10).

Building the Stator

The first step in building the stator is to wind the nine coils. We built a simple coil-winding jig (see photo 11) with an arm and handle that makes the process easy. The tapered insert ensures that the coils come out in the proper, tapered toroid shape and size. The magnet wire is specially designed

Photo 10: Molding the magnet rotors requires a stainless steel mixing bowl at the center and some duct tape around he edge to hold the resin.