

Maine-Built Windmills

From Scratch



Everett Russell

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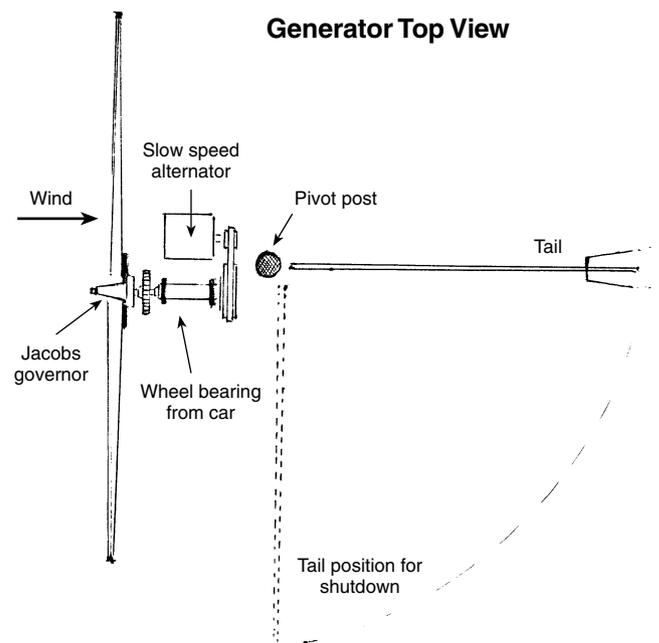
One of Everett Russell's two home-built wind generators with a 14 foot rotor diameter.

I have been building windmills since 1937. These windmills are strong and practical. Unlike many others, mine are built from scratch. Some people say building windmills from scratch is not practical. I disagree. I believe my machines are not only practical, they're rugged, they continue to serve me well, and they have passed the test of time.

Right now I have two working windmills—both 14 feet (4.3 m) in diameter and about 500 pounds (225 kg) each. They both generate at 120 volts. One puts out 10 amps, and the other generates 20 amps, at about 225 rpm in a 20 mph (9 m/s) wind. The alternator that puts out the 20 amps is a larger alternator; its rotor is 4-1/2 inches (11 cm) long. The 10 amp alternator rotor is 3-1/2 inches (9 cm) long and it has a smaller diameter as well. The total cost of each machine is less than US\$500.

The windmills power the machine shop where my approach to windpower continues to evolve. They also

run a variety of yard and garden equipment such as an electric lawnmower, chainsaw, and power tools. My wind power system is separate from the utility grid. I use standard utility service in my house.



The system is 120 volts DC. I have several strings of ten 12 volt batteries, salvaged from a junkyard. Many shop tools will run on 120 volts DC as well as AC, like drills, lawnmowers, light bulbs, grinders, electric saws, etc. My lathe, however, has two 40 V shunt-wound DC motors in series. I can drill holes all day in the shop without wind, using the energy in the batteries. But to work on the lathe, it is best to wait for a windy day. I can't use this system directly in my home because many of the appliances run only on AC—refrigerators, VCRs, TVs, and other things. But no inverter is needed for my shop tools.

My system for working on my windmills is a bit unusual. I climb to my 46 foot (14 m) windmill platform by a series of very secure stairways and ladders. Once I reach the top platform, there is one final ladder to climb. This last ladder is mounted on the main frame of the windmill itself. When the windmill turns into the wind, the top ladder pivots right along with it.

Built From Scratch

When I say my windmills are built from scratch, I mean it. They can be put together with material found in most any junkyard. Among the scrap metal parts that I've recycled to fabricate my present system are 4 inch (10 cm) channel iron, angle iron, pipe, and about 15 inches (38 cm) of the rear axle housing of a car. I use my 16 inch (40 cm) lathe to machine the taper into the extra 10 inches (25 cm) of axle (propeller shaft) to fit a Jacobs governor. I also thread the end of this shaft so the governor can be bolted in place.

The Jacobs governor governs at a certain speed whether it is loaded or not. If the alternator stops working, the machine is still protected from overspeed. This governor system is similar to a flyball governor, but the blades take the place of the flyballs. They move outward against three strong springs, and at the same time they turn, giving more pitch and slowing the prop. The prop can't

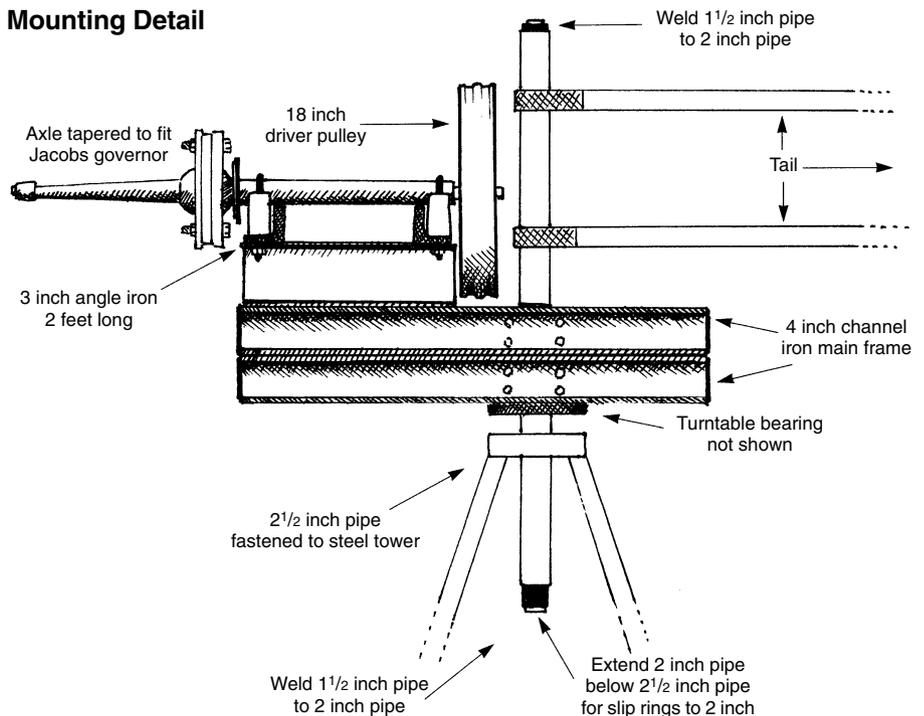


Looking up from below: the genny's tail structure is folded to the side.

turn faster than 225 rpm. Tom Hill has Jacobs governor and blade plans that he sells for US\$12.50.

I manufactured my own slow-speed alternator from plans I found in *Alternative Sources of Energy* magazine, volume #38. The alternator is made from a large three-phase induction motor (10 to 15 hp). A lot of machine work is involved. The stator has to be rewound for the voltage and speed you want. It has a wound

Mounting Detail



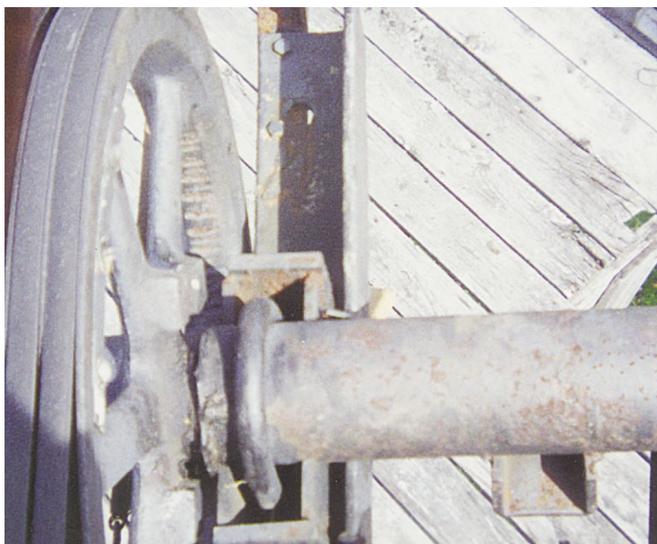


The top ladder section is affixed to the genny and yaws with it.

field, so it has sliprings and brushes. The brushes and sliprings are where I have had the most trouble.

I use a Jacobs-type shutoff. Pulling on a rope from the ground pulls the tail perpendicular to the blades so the prop faces into the wind. The rope is fastened to a cleat at the bottom of the tower. When the rope is unfastened from the cleat, a spring pulls the tail back 90 degrees so it is parallel with the blades. The blades are then edgewise to the wind, and the machine is shut down. There has to be tension on the rope to keep the machine running. If the rope breaks, the tail will swing back to the off position.

The cut end of the axle is bearing mounted and attached to an 18 inch drive pulley. The bearing housing is mounted with U-bolts to the bird's frame.



I use an 18 inch (46 cm) driver V-pulley on the propeller shaft. On the machine with the larger alternator, there's a 4 inch (10 cm) V-pulley on the alternator, which speeds the alternator up 4-1/2 times. The machine with the smaller alternator has a 3-3/8 inch pulley because of the machine's higher cut-in speed. I also manufacture the Jacobs governor and blades, but they could be bought, or a fixed blade, side-facing prop could be used.

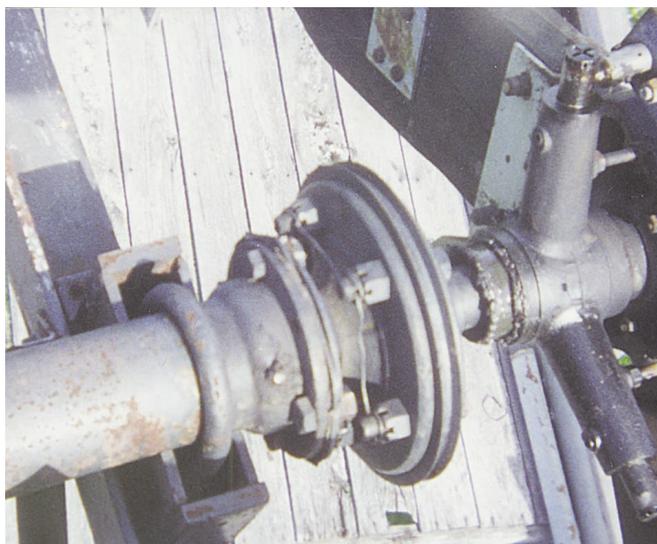
Machining the Parts

The main frame is made of materials from a salvage yard, such as channel iron, pipe, and angle iron. I don't have a steel tower. I have a 45 foot (14 m) center wood post with a 2-1/2 inch pipe bolted to the side with U-bolts. I am not happy with it,

since more pipe is needed and it's difficult to use sliprings. But I couldn't afford an all-steel tower.

Inside the 2-1/2 inch pipe, I use a length of 2 inch with 1-1/2 inch pipe inside that, cut longer than the 2 inch pipe and welded together at the ends. These two pipes are the yaw pipes. Then two lengths of 4 inch channel iron are welded to a 4 inch length of 2-1/2 inch pipe. By using four bolts, the channel iron is clamped to the 2 inch pipe with 1-1/2 inch pipe inside of the 2 inch pipe. Then another pair of pieces of 4 inch channel iron above the first two are also clamped to the 2 inch yaw pipe.

The other end of the axle is also bearing mounted and U-bolted. A short section of axle is machined to a taper that will accept a Jacobs governor.





**Detail of the underside of the drive shaft mounting.
The furling tail is visible in the background.**

Two more 4 inch (10 cm) pieces of channel iron are cut shorter, with two pieces of 3 inch (7.6 cm) angle iron bolted across them for the pillow blocks to sit on. These hold up about 15 inches (38 cm) or longer of the rear axle housing from a rear wheel drive car. It has to be the ball bearing type. This gives me a very rugged thrust bearing (wheel bearing), since it often goes the life of a car—like 150,000 miles. The housing is soft and can be cut off 15 inches or longer with a pipe cutter.

That end of the housing has to have a bearing, which has to be fitted, and the axle must be cut off at least 4 inches (10 cm) beyond the bearing. This is where the driver pulley goes. On the other end (where the wheel of the car used to go), fasten an extra length of axle cut about 10 inches (25 cm) long, which can be tapered for the Jacobs governor. To make the taper for the Jacobs governor, machine 1-1/4 inches to the foot (3 cm per 30 cm) about 3 degrees on each side of the lathe center line.

To fasten the extra length of the axle (10 inches long or longer) to the length of the axle in the housing, you will need to drive out the studs in both flanges and use 1/2 inch (13 mm) plate in between. Drill the same number of holes in the plate as in the flanges, and bore out the center of the 1/2 inch plate to just fit the little hubs where the car wheel went. Then bolt the two flanges together. This is simplified, but a machinist should be able to understand this description.

With the housing bolted down with U-bolts (9/16 inch (14 mm) diam.) to 3 inch (7.6 cm) angle iron with pillow

Jacobs Prop Speed vs. Alternator Speed

Prop rpm	Alternator rpm	
	For 4 inch Pulley (1 to 4.5 ratio)	For 3-3/8 inch Pulley (1 to 5.3 ratio)
100 *	450	533
120	540	640
150	585	800
200	900	1,067
225 **	1,013	1,200

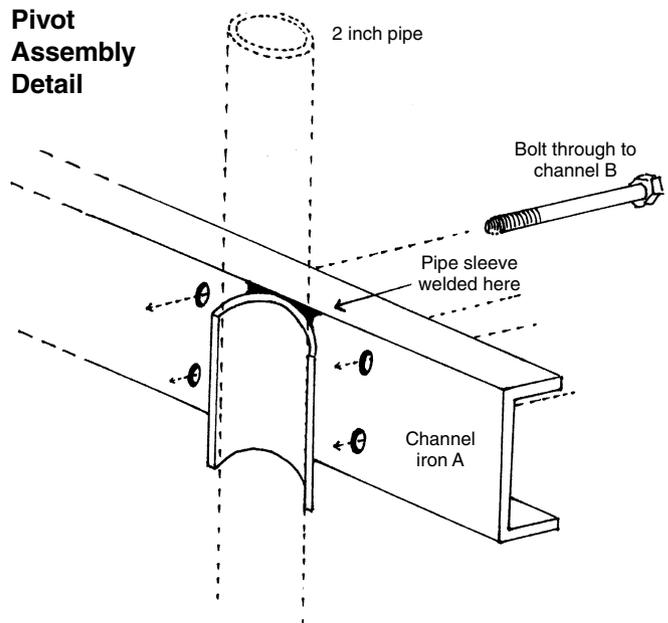
*10 mph wind
**20 mph wind

blocks between, you have a very solid machine. If you don't want a flyball governor and want to use a side-facing governor, you wouldn't need the short 10 inch axle. You could bolt the fixed blades directly to a plate which could be bolted on the long axle, the same as in a car. By the way, the backing plate is not needed, so cut it off, but leave the part between the end of the housing and the bearing retainer.

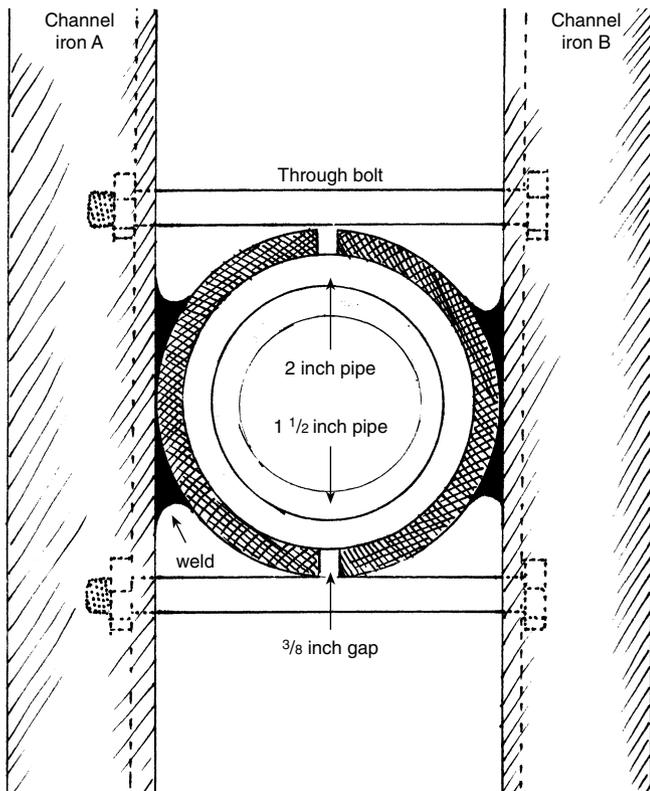
Bearings

A wheel bearing from a car is now a propeller shaft bearing. When about 15 inches (38 cm) of the housing is cut off, you have a bearing fitted in the housing already. This bearing has to be a ball bearing type—roller bearings won't do. A ball bearing is needed to take the thrust. On the other end of the housing, a ball bearing has to be fitted. Also, the axle has to extend out from the housing about 4 inches (10 cm) for the driver pulley to be mounted.

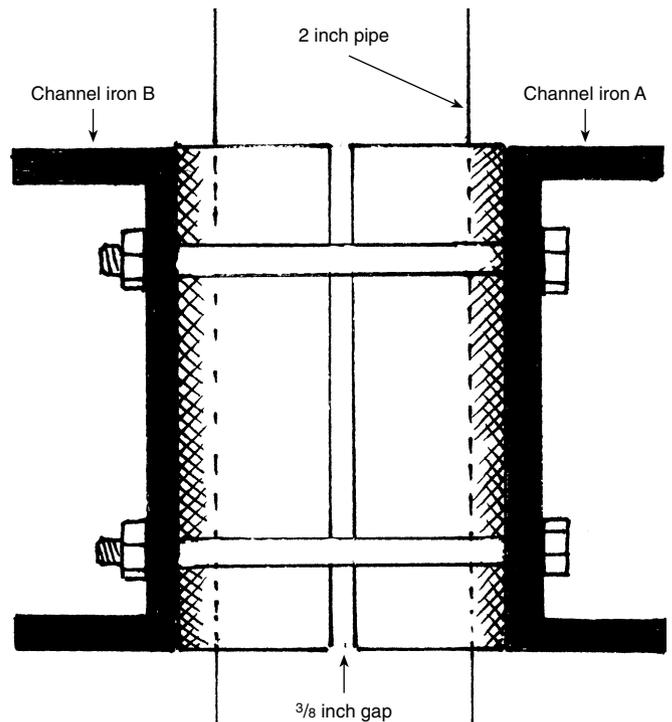
For the yaw bearing, I fitted a tapered roller bearing from a 1-1/2 ton truck at the top end of the 2-1/2 inch pipe (which is fixed in the tower).



Main Frame Assembly: Top View



Main Frame Assembly: Side View



Lifelong Passion

Back in the '30s when I first got interested in wind power, my father was not very happy about it. I was just a teenager at the time, and wanted to buy some windmill plans. The price of the plans had been marked down from \$2.50 to \$1. My father insisted that it was still way too much money to spend on such a thing.

Author Everett Russell: designer and builder.



But I went ahead and ordered the plans from J. Leo Ahart in Dow City, Iowa. Ahart was a contemporary of Duncan, editor of the classic *Autopower*. I have the original 1937 copy of *Practical Electric Magazine* in which I found the ad for the windmill plans.

My father was quite angry with me for spending a dollar that way. But the wind power bug had caught me. It wasn't long after this that I had a windmill down by the shore generating electricity to light a small cottage we had there. Over sixty years later, I'm still excited about tapping the power of the wind.

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