



## Jacobs Turbine Repair

by Capt. Grey Chisholm  
1 October 2008

It has been odd seeing our neighbor's Jacobs wind turbine NOT turning. It is always a comforting sight to see her blades spinning. If the air has been still and we see Enid Cresson's turbine start to turn, Michele and I know ours will start soon after. Our machines are at about the same height, but the valley funnels the wind her way first. However, the blades to her machine have been quiet for a few days even when our Jacobs have been spinning happily. Then the telephone rings....

Just south of Madrid, New Mexico is an off grid community. Those of us out here affectionately call this area "The Land." Power lines, gas lines and telephone wires just aren't welcome. Yet we still like our conveniences. Every home has their televisions and microwave ovens. Therefore, every home has invested in renewable energy. For the sake of simplicity, solar panels are the rule, but several of us out here rely on wind either as primary or as a back up energy source. Three of the turbines out here are bunched in a triangle on what we call the "Left Fork."

So late this September, Enid gives us a call. She had secured her Jacobs because it was making an unusual noise and not charging. She'd called Positive Energy, the service provider who normally services her turbine, but they were booked. So she asked if I'd climb her tower and take a look. I collected my climber's safety belt, gloves, grease gun, spray oil, and tools.



I just don't like those blades moving while I am suspended 50-feet up on top of the tower. After buckling in for safety, I lashed the blades so they would not rotate. The first step was to grease all the zerts and wear points. Then I took a look at the brushes. To access the brushes, Enid briefly opened the vane as I slipped the back cover off. Then I examined the brushes.

**Uh Oh!** One of the brush holders had come loose! I discovered that the upper right "+" brush holder was loose and had rotated about 90°. There were also burnt wires on the upper



right brush holder. The wire to capacitor and the wire to the field winding had fried at the lugs. The jumper wire from the upper brush to the lower brush had melted off of its brass plate.

Once I had removed the brush holder, I discovered the bolt holding the brush holder had melted just outside of the turbine housing. Also, the insulating bushing isolating the bolt from the turbine body had broken into shards. I don't know whether the brush holder had come loose, causing arcing and melting of the electrical parts, or whether the insulating material had failed, shorting the brush to the body, melting the bolt and loosening the brush holder. But in any case, the brush holder was loose.



The upper left “-”, lower left “-” and upper right “+” brushes were all worn the same, about 3/4-inch to an inch. The lower right “+” brush did not move easily in its holder, was 1 1/2-inch long and its contact end was rough and pitted from arcing.

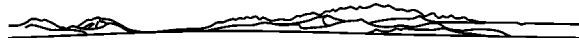
Once back on the ground, I explained my findings to Enid and we discussed options. At first we were thinking we would have to stop until we had ordered brushes from Helwig and waited for the brushes to be shipped. Then I remembered another neighbor who not only had two working Jacobs, but also collected Jacobs. I called Don Miller; he had a set of brushes in stock!

I drove over to Don Miller's (about five miles). We discussed the problem in specific and Jacobs in general. He has a great collection of Jacobs and Jacobs parts he has collected over the years. It was fun seeing all those machines and seeing the differences in them. As the turbines were being built over the years, they evolved. As Marcellus L. Jacobs, the turbine's inventor, came up with a little bit better design, he would incorporate the idea into his machines. In any case, I bought brushes from Don.

However, Don did not have any insulating bushings for the holder. My parents live just down the road in Sedillo (30 miles away). So I drove over. My father, Hap Chisholm has been the Chief Engineer of several observatories over the years, most recently the SOAR telescope on Kirtland AFB. Though retired, he is still active in electronic development in his own business as Hi-Lab Electronics. We went down to his machine shop. He grabbed a chunk of high density polyethylene plastic and in no time flat had turned me a new insulating bushing to isolate the brush housing from the turbine body.

That was enough for one day, so it was home for me and time to knock off.

The next day, Saturday, I was on site at Enid's tower early, but it was too windy and turbulent. Half way up the tower I called it off. I headed back home (Enid is our next door neighbor, so we are only about half a mile from each other).



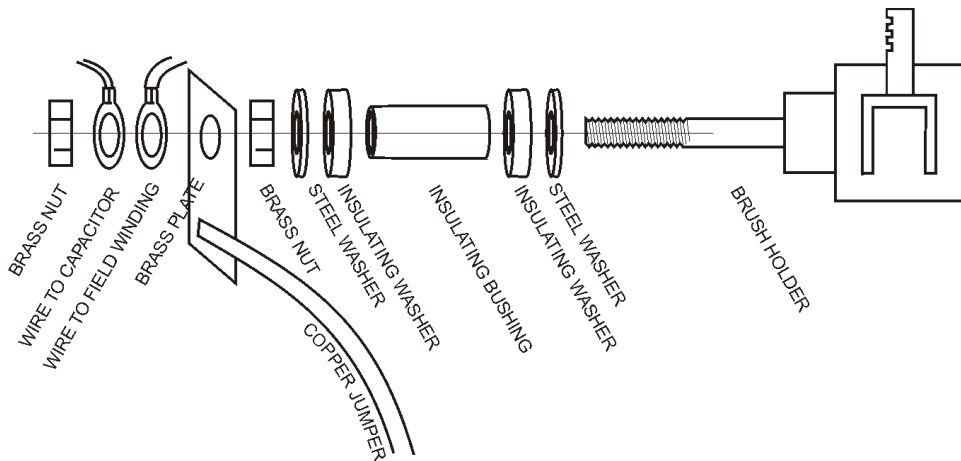
Sunday had some wind but was calmer so it was back up the tower. My plan was to complete the repair today and get Enid back generating electricity today. I tried to install the brush holder but something looked wrong. I examined all the other holders. Oops! This brush holder was missing an insulating washer on the outboard side of the brush holder bolt right where the bolt had melted. I knew my father could mill me a washer, but I did not want to drive to Sedillo and back and burn up all that time. Luckily, I had a plethora of bolts, nuts, washers and just stuff back at my place. So I came down from the tower and went to my shop to find or fabricate an insulating washer. Sure enough, I found just what I needed in my box of "stuff."

I'd pulled the wire from the capacitor to the turbine so while at my shop, I fabricated a new wire with crimped and soldered lugs. I would have to solder the lug onto the field winding and the brush jumper wire in place on the tower.

After lunch, I once again climbed the tower. Maybe this would be the last time. Soon, I had installed the insulating washer and tightened the brush holder in place. Installing the capacitor wire took only a moment. I tried to solder a lug onto the field winding wire, but my soldering iron was too small. What frustration!

I climbed down and once again drove to Sedillo. I borrowed a larger soldering iron from my father and headed back out to The Land.

It was getting close to supertime, but I was determined to complete the job today. Back up on the tower, I crimped and soldered the lug onto the field winding wire. I soldered the copper jumper to the brass plate. And finally I reassembled all parts.



Almost there!

Down to get the brushes and back up the tower to install the brushes. OOPS! Brushes do not fit! What an idiot I am! I had both the holder and the brushes in my hand all that time I was on the ground and I never tested them. So I climbed back down the tower. Enid and I discussed the situation.





Evidently, when Windy Dankoff installed the turbine, he had swapped out the Jacobs brush holders for smaller holders.



Jacobs brushes are:  $1\frac{1}{2}'' \times \frac{3}{8}'' \times 1\frac{3}{4}''$   
 Installed brushes are:  $1\frac{1}{4}'' \times \frac{3}{8}'' \times 1\frac{1}{2}''$   
 (estimated length based on holder size).

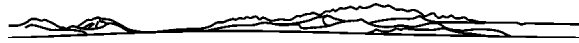
Oh well, I was not going to complete the job that day. I still had to go back up one more time to put the cover on the back and secure the turbine for the night. Then it was home for dinner.

Monday, once again I drove to Sedillo. I sure am lucky to have access to my father's machine shop and his skill at using them. Hap milled the brushes down to needed sizes. It was not a quick job. Graphite is very brittle; he milled maybe 20-thousandths off during each step so as not to break chunks off the edge. Hap milled one side until the brushes were 1/4-inch narrower and the end down a 1/4-inch and at the same angle they were manufactured. Milling the brushes chewed up one more day. But milling the brushes down was faster than ordering new ones.



That last Tuesday of the month, I got a bit of a late start. Late morning I was back up on the tower. I installed the brushes. They slid in like champs! I could have left them a bit longer. The upper left “-”, upper right “+” and lower right “+” brushes are made of graphite. The lower left “-” brush is made of carbon. Carbon is harder than graphite and you can see it is a darker color.

Then I lapped the brushes. That means I carefully cut a strip of sandpaper the width of the commutator. I taped the sandpaper to the commutator so the brushes would not catch. By leaning on the vane, I could turn the blades into the wind just enough to slowly turn and grind down the brushes. By releasing the vane, the blades would stop. I frequently checked the brushes. It took a while, but finally all four brushes were ground fully down and making full contact.



I tested the turbine. Once again, I leaned on the vane pushing the turbine into the wind. By controlling the angle, I could control the speed of the blades. While I turned the turbine into the wind, Enid measured amperage from the ground. We had 2-amps in the winds we had.

While I was working on the turbine, I had noticed some chipped insulation on the coils. I expect the damage happened when the brush holder came loose. I touched up the chipped insulation with liquid electrical tape.

Finally! I buttoned up the turbine for the last time and climbed down. I cleaned up all my tools, and called it a job well done. And it was time for lunch.

The next day, after a windy night, Enid called to let me know she had measured 42-amps the night before! That old Jacobs wind turbine was harvesting energy once again.



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