By Michael Hackleman and Craig Worthley

FINDING AND

RESTORING A 1930s WINCHARGER

By MIchael Hackleman

The windmachine hung precariously at the top of a tower. It was skewed on its mount, its tail tilted downward at a 30° angle. Minus its two blades and governor, it was an odd sight. The elderly woman in the farmhouse said the people from the REA (Rural Electrification Administration) would not hook up utility power unless the windplant was taken down. Too poor to hire someone to remove it, her husband had attempted what many of their neighbors in 1940 had already succeeded in doing—unbolting their windplants and letting them fall—to qualify for grid connection. For us, this solved the mystery of the fully assembled windplants we'd found in previous weeks, half buried in the ground or crumpled against the concrete base of a tower.

(Above) Two expeditions rendered parts to restore seven windplants.

(Right) Windy Dankoff checks out a restored Wincharger before it is bolted to a tower and raised.

(Left) A damaged Wincharger sits atop a tower in Wyoming. In a stiff wind, Michael Hackleman hoists it clear (inset) and lowers it. This is the machine Craig Worthley would restore.

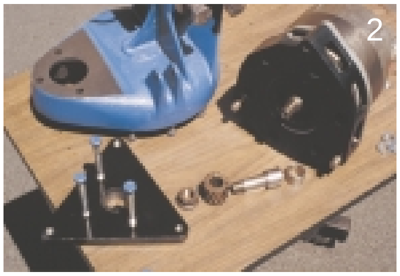
But something had gone wrong. The windplant should have toppled cleanly away. Instead, it twisted and jammed. Her husband was afraid to climb the tower again. The woman from the REA reassured the couple that their actions met the intent of the REA policy. Subsequently, their farm was hooked up to the new utility service.

A rescued Wincharger

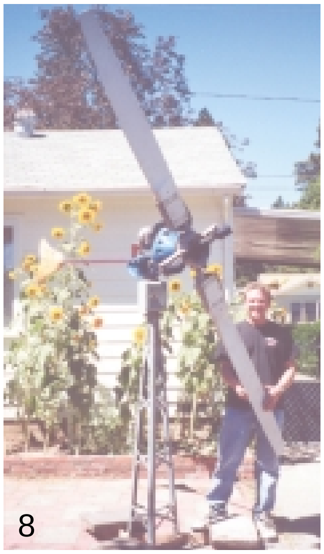
In 1974 and 1975, I conducted a series of expeditions to recover wind-electric machines of the pre-REA period from the midwest USA. Respectively the Rolls Royce and the Chevy of wind-electric machines, we found a few Jacobs and a multitude of Winchargers. Fortunately, most of these had been taken down and were stored in barns, cellars, and garages where it was easy to assess their good condition. Other equipment was not so fortunate. Machines lay out in fields or in pieces, buried in piles of junk. A few windplants were still on their towers. Some earned their keep, bladeless, acting as a windvane for the owner. Others were simply too expensive or dangerous to lower.

Forty years after it went into service, I sweated the damaged

Steps and hardware of the Wincharger restoration



1. A larger (1500-watt) Wincharger awaits its turn at restoration.
2. Adaptor plate and shaft extension for the alternator
3. The gear is mounted to the alternator.
4. The alternator is bolted to the gearcase frame assembly.
5. The gearcase is testfitted to a tower stub.
6. A fabricated propeller hub
7. Sliprings and brush assembly are mounted in a weathertight box.
8. Glenn Hackleman test-fits the blades. (A broom becomes a temporary tail.)
9. Craig Worthley and rebuilt Wincharger



Wincharger off the tower. Don't let the size fool you. It's heavy! The windplant is mostly cast iron, with some steel and copper. I came prepared on the expedition with a gin pole. (A gin pole is bolted to the tower stub and acts like a small crane to lift a windplant on or off the tower.) I had experience with raising machines to the tops of the towers, but never the reverse. I took lots of time rigging it. Fortunately, it came off smoothly even in high winds.

What's a Wincharger?

Let me describe the Wincharger design. First, it's a brand name, hence the missing "d" so that it is not confused with the generic term, windchargers, which describe a class of windplants that generate electricity. Second, Winchargers are rated 32 Volts dc (the standard of the day, even in the cities) and 800-1500 watts of output capacity. (There are exceptions such as the popular 12V, 200W Wincharger sold also as Zenith or Silvertone brands.)

Winchargers were built for the working person. While the Jacobs windplant had a generator which was best handled by an engine hoist, the Wincharger could be disassembled into recognizable parts: generator, a gearbox to translate a few hundred propeller rpm into the thousand-plus rpm needed by the generator, tail boom and tail, sliprings, a turntable, a furling mechanism to shut down the windplant, and a cast iron frame assembly to which all the components were attached.

Rated alongside the Jacobs, the Wincharger doesn't score as high on material use, engineering, and workmanship. It cost less to make and it sold for a lot less than a Jacobs windplant. Still, it is decisively more rugged than some designs and brands of windplants manufactured in the world, even today. As well, there were *many* other brands of windplants in the '30s, '40s, and '50s that produced electricity. Today their names are forgotten, so the Wincharger was the best bang for the buck if you didn't have a lot of bucks.

However, in 1975, after I'd pulled the Wincharger from the tower, its small size and poor condition put it at the end of the list of machines we would restore. Actually, it was more likely to be cannibalized for its parts or sold off "as is" to help defray expedition costs. My records show that its gearcase was rebuilt along with all the others we had restored. This means that its prop shaft had been checked for true. (We found many Winchargers concentrically out-of-round between bearing and propeller hub surfaces—a manufacturing error—and had new ones made.) New bearings were also installed. The gear's teeth checked good. The outer surface was beadblasted to the metal and given a coat of primer. After that, the windplant was put in storage when I left the farm in 1985.

The resurrection

In November of 1995, Meline "Mo" McHolland at Humboldt State University (HSU) in Arcata, California, introduced me to Craig Worthley, also a student at HSU. Craig was looking for a senior project and believed that restoring this windplant might qualify with his teacher. It did and the project commenced. I gave Craig a copy of my book, The Home-Built Wind Generated Electricity Handbook. It had chapters on finding and restoring Winchargers from my work 20 years before.

The next task involved getting Craig, myself, and a truck to storage up in the Sierras to get windplant parts and related hardware. Craig had a tough time recognizing the windplant for all the pieces it was in. However, Windy Dankoff and I had restored half a dozen of these machines in 1975, so I was able to identify and pull out all the necessary parts—if they still existed. I loaned a tower stub, a prop hub, a slip ring assembly, and several extra vital parts to Craig to assist him in duplicating these components.

Homecoming

After that, I just waited. The school year ended, and Craig called, wanting to bring the remanufactured pieces by. We met at my nearby storage unit to look over and actually assemble the Wincharger, photo-documenting the pieces and stages of this procedure as we went along.

I don't know what grade Craig's professor gave him for his work, but I'd give him an A+. There were some severe challenges in this restoration—the parts had remained parts for a reason—and Craig met them with tenacity and skill. More specifically:

1. Substituting an alternator for the original 32V generator. By paralleling some of the field coils, a 32V windplant will power a 12V system "as is" but its maximum current rating (about 35 amps) must not be exceeded. Connected to a 12V system, then, the generator is limited to 420 watts (12V x 35A).

Automotive alternators have 12V field coils and need only a limiting resistor (or some similar voltage regulator circuit) if interfaced with 24V, 32V, 36V, or 48V systems. A 100A alternator affixed to the Wincharger in a 12V system can safely produce 1,200 watts (12V x 100A).

2. Adapting the alternator to interface with the gearbox. The design and fabrication of the adaptor plate met every specification. The shaft extension for the alternator was cleverly executed. We had dismissed the idea of substituting alternators for missing or burned-out generators on Winchargers previously because their shafts were too short. Having the alternator rewound was also a smart move. This means higher power at lower voltages *or* windspeeds.

3. The design and fabrication of the slipring assembly, lollyshaft,

and related hardware. There is a lot happening at the junction of any windplant and tower. The tower must support the windplant and allow it to rotate. The generated electricity must pass from rotating machinery to stationary wires on the tower. The cable from the furling mechanism must pass through to the base of the tower. And the whole assembly, in this case, must be built for any type of tower. Craig fabricated basically a universal adaptor.

I am happy to see this machine progress slowly toward the day it will again fly. This Wincharger stands as testament to a time when people wanted power and found that taking it from the wind was a natural thing to do. It makes just as much sense today as it did more than a half century ago.

(Photos for this article were taken, in part, from The Homebuilt, Wind-Generated Electricity Handbook by Michael Hackleman, For a current publications list, send an SASE to P.O. Box 327, Willits, CA 95490. E-mail: mhackleman@saber.net.)Δ

THE RESTORATION

By Craig Worthley

In November of 1995, I was approached by Meline McHolland and Michael Hackleman. The three of us discussed a project—restoring a vintage 1930's Wincharger. As a senior in the Industrial Technology program at Humboldt State University (HSU), I welcomed this opportunity to fulfill the requirements of a senior project. I felt it would allow for me to utilize my skills in management, manufacturing, design, Autocad, and CNC programming.

After communication with the faculty at HSU, the project was accepted as a viable undertaking and met requirements for completing the program.

Picking up the pieces

On a Saturday morning in April of 1996, the project got underway. Michael and I were able to coordinate our schedules to actually make the 350-mile trip to the Sierra foothill town of Mariposa, California where the machine was stored.

We opened the door to the storage unit. The image of a complete machine in need of a little paint and new windings was shattered. Yes, there was a Wincharger in there but it was scattered and distributed among many boxes containing smaller cups which held the nuts and bolts of this assembly or that. We loaded all the parts that were available toward restoring a Wincharger and headed back. By Monday morning, it was one big pile on a table in the University's Jenkins Hall.

The strategy

I began the restoration of the machine by dividing it into its major sub-assembly groups. These assemblies are: governor, generator, gearcase, furling assembly, lolly shaft and slipring assembly, and the tail assembly.

Governor

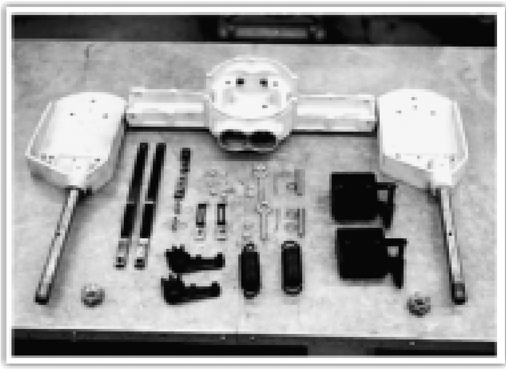
The purpose of the governor is to limit the maximum rpm of the machine. To have a 10-foot diameter propeller spinning uncontrollably high above the ground is not a safe condition. Through the use of weights, springs and gears, the governor changes the pitch of the blades, decreasing the area for the wind to act upon while resisting the free spinning of the propeller. Maximum speed of the blades is determined by the selection of different centrifugal weights and springs.

To put the governor back in working order, I first had to sand blast the years of grimy build-up off the aluminum casting. This unveiled the body of the unit that accommodates the weights, springs, blade paddles, torsion gears and thrust bearings. Cleaning up the rest of the assembly was mostly a matter of patience.

The paddle shafts were found to be true and in good condition. I merely had to re-thread the ends that accept the castle nuts.

The steel linkage bars that connect the weights to the torsion gears and from the gears to the springs have 3/8-inch holes at both ends for bolts. All of these holes were ovaled out after long years of use. To correct this condition, I machined some steel bar stock into bushings. These were drilled out and pressed into the holes I had enlarged in the linkages.

The governor assembly was designed to accommodate four timpken roller bearings, two on each of two shafts where they enter and exit the casting. Removal of the old races from the casting was the most challenging part of the replacement process. All the necessary nuts and bolts were purchased—as were roll pins and grease fittings—to complete the governor assembly.



Generator/alternator

The windplant's original generator was built to produce 32V, while most wind systems are designed around 12V. The choices were to rewind the original generator or replace it with a 12V generator or alternator.

I felt that the most economical alternative was to replace the 32V generator with an alternator that I found at a local shop. With the help of the shop owner, we determined that an alternator from a Detroit diesel was designed to produce electricity at 2000 rpm. This was close to what I was anticipating the machine would produce with a 6:1 gear ratio and a propeller spinning at 300 rpm. In addition, the power curve of an alternator is inversely exponential, while in a generator, it's linear. This should result in better voltage output from the windplant at low rpm.

I dissassembled the old alternator to be upsized to 100A. The same shop that gave me the old alternator fit it with new field windings and a voltage regulator as well as new bearings. It was tested on the bench and produced 105 amps.

To fit the alternator to the cast iron body of the machine, I designed a triangular flange (Figs. 2, 3, 4, 5, pg. 42) that would adapt the bolt pattern of the original generator to this alternator. This was fabricated out of ½-inch plate steel using CNC programming and a Bridgeport Vertical mill. I was able to accurately machine the bolt patterns for both the alternator and the cast iron gearcase.

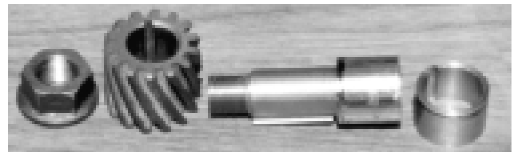
The flange was designed to provide for good airflow into the alternator. The cast-iron frame assembly was spot-faced to accommodate the round mating surface of the original generator. I refaced the casting on a surface grinder to accept the square bottom edge of the flange.

The alternator's shaft was considerably shorter than the original generator shaft. I came up with an extension to ensure proper alignment of the pinion and drive gears. To accomplish this, I machined a piece of steel bar stock on a lathe to an inside thread on one end to

(Above) At rated speed, the governor's weights arc outward, pulling the gears and prop shafts into rotation, preventing rotor overspeed.

(Left) Refurbished and new parts for the governor await re-assembly.

(Below) Parts for the alternator shaft extension



mate with the alternator shaft. On the other end, I machined an outside thread to accommodate the bolt that holds the gear in place. This part was 3½ inches long. I broached the keyway into the machined shaft and slowly removed material from the female end until the overall length made for perfect alignment of the gears.

Gearcase

The gear case is comprised of a cast iron case, propeller shaft and bearings, drive gear and pinion gear. The case is split vertically from the frame assembly and sealed with a thin gasket to prevent leakage of the oil bath.

The overhaul of the gearcase primarily involved bearing replacement in the nosecone section. The original ball bearings were an open style, lubricated by oil splashed about inside the casing. Bearing technology has come a long way in the last 50 years. It is my opinion that a sealed precision bearing would remain free from contaminants contained in the oil and, therefore, last longer. A very light oil is still needed in the gearcase to lubricate the gears.

I found it odd that the manufacturers had opted to use a straight roller bearing for this application. After all, the propeller shaft is subjected to considerable thrust. I explored the options for replacement bearings. I actually found a high-end roller bearing that was rated to accept well over twice the anticipated 1000-pound thrust of the blade and governor.

After pressing the new bearings onto the shaft and, in turn, the shaft into the casting, the woodruff keys were replaced and the drive gear mounted. The gear case was now functional.

Propeller hub

The next big component to manufacture was the propeller hub. The hub was manufactured in two pieces, and these were joined to make one component (Fig. 6)

The first piece was a 1½-inch cylinder that was bored out and broached to accept the key to mate with the outboard end of the propeller shaft (front of gearcase). This part served the dual purpose of spacing the rest of the hub from the gear case and distributing the load along a greater area of the shaft.

The second piece was a ½-inch plate that was CNC-machined to create an 8-inch disk. When the machining process was finished, it was penetrated in the center to accept the first part and it had a 4-hole bolt pattern to match the governor toward the outside of the disk. The center piece was introduced into the hub and welded in place. Trueness of the joined parts was ensured by mounting it on a mandrel and facing the surfaces on a lathe. When exact perpendicularity of the disk and shaft penetration was achieved, four ⅝-inch stainless bolts were introduced to the bolt pattern and welded into place with stainless welding rod.

Slipring assembly

The most time-consuming and challenging sub-assembly proved to be the lolly shaft & slipring assembly. The lolly shaft serves to support the machine and allow for 360° rotation of the windplant to face any wind. The difficult part is to transfer the generated power from the rotating unit to the stationary tower where it is connected to the batteries through wires. The sliprings do this job through rotating brushes and stationary rings.

I was able to salvage a set of rings from the collection of spare parts. I found a complete set of brand new brushes, too. In order to support and insulate the sliprings, I manufactured four circular mounts that sandwich the brass rings and fit firmly onto the lolly shaft. The mounts were machined of phenolic resin on a lathe which turned the shoulders and bore the hole to accept the lolly shaft. The pieces were then mounted in an indexing head which was set up on a knee-and-column mill. This allowed me to rotate the work while engaged with the tool.

I carved arched slots between the interior bore and the outside of the mount. These slots allow for the conductors to be soldered to the inside of the rings and pass through other mounts on their way down the tower. The conductors were sized by referencing the Uniform Building Code. Based on a 100-amp service, the recommended wire was size #6, 600-volt, multi-strand, copper conductor.

The lolly shaft, which is secured to the tower, does not rotate and neither do the sliprings. Inside of the lolly shaft is another shaft that rotates. This shaft extends past the top of the outer shaft and is bolted to the wind windplant itself. To secure the machine to this shaft, I milled a 4-inch long flat area on the shaft. When inserted into the machine, the flat area is aligned with two holes in the casting along the vertical axis of the shaft. Through these holes I slipped in two ½-inch stainless bolts which I also machined flat on one side.

The weight of the machine rests on a Timpken bearing housed in a bell-shaped casting which is supported on the underside by the lolly shaft. The whole assembly was slipped into a rain-tight sheet metal box which protects the sliprings from the elements (Figs. 5, 7). On the inside of the box, which rotates with the machine, I mounted the brushes. This design results in a water-tight environment for the electrical transfer device. When the door to the box is opened, the brushes are disconnected from the rings for safe servicing.

Furling assembly

The furling assembly allows an operator to mechanically rotate the tail from its position perpendicular to the propeller (operating mode) to a position parallel to it (shutdown mode) from the base of the tower. When the machine is in the furled position, the blades come to a stop because they are then in a plane parallel to the movement of air. This allows for safe servicing of the machine or temporary shut-down in the event of malfunction.

[Note: The furling system consists of two subassemblies. At the base of the tower is typically a crank and drum of cable equipped to ratchet in either direction, to furl or unfurl the windplant. At the top of the tower and attached to windplant is the furling assembly. The tail (fin and boom) is attached to the top of a casting with two galvanized U-bolts. This casting is hinged to the windplant's framework and is held by a heavy duty spring in the operating mode. On one side of the furling body is an arm with a pulley. It is bolted to the framework and aligns with the hole in the top of the lollyshaft. A wire attached to the tail boom passes over the pulley in the arm, over another pulley bolted directly above the lollyshaft, and down to a swivel joint. —mh]

Restoration of the furling system consisted primarily of disassembly, sand blasting, painting and replacing rusted hardware.

Tail assembly

The tail assembly is also a simple one. It consists of the tail casting, a spring that encircles the tail casting pivot in the frame assembly, a boom (pipe) and the tail (fin). The tail casting and spring were cleaned, sandblasted, and painted. The new boom will be a 6-foot piece of 1¾-inch steel pipe that bolts to the tail casting. The tail will be sheet plastic bolted to the boom. Δ