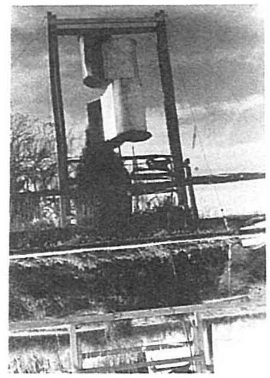
Photo by Hilde Atema Maingay

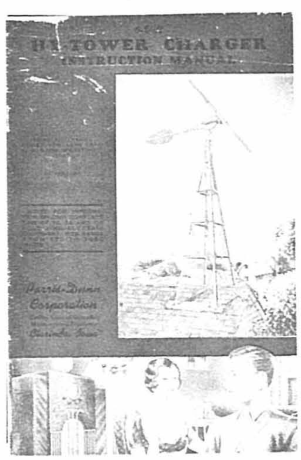
Energy



One of the great advantages in being closed for half of the year is that it gives us some time to assess the performances of the various systems for the season just past and to ponder possible modifications or changes in strategy. This is particularly true of the windmill work. In addition to pioneering new ideas, we are concerned that already existing models continually be evaluated and improved. Earle Barnhart's articles in this section discuss modifications on windmills that have been described in previous Journals and report on new systems as well. "An Advanced Sailwing for Water-Pumping Windmills" is about Big Red, the first windmill to catch one's eye on arriving at New Alchemy. Big Red is modelled on Marcus Sherman's "Water Pumping Windmill That Works" (Journal Two) but the sails and rigging have been designed by Merrill Hall to withstand the Cape's gusty coastal winds. The old oil drum Savonius shown in Journal One has been succeeded by a silver J-wing model which Earle describes in "The Savonius Rotor." Our solar work is covered in his discussion of the solar heater component of the mini-ark.

Finally, Jim Bukey, one of the authors of the "Energy Primer" has compiled a photographic essay on one of his favourite subjects: old windmills. In this case, "old" should be considered a relative term, as it does not cover ancient windmills of China or Crete or even the grinding mill of several generations ago in Europe and North America. His interest is in American electricity-generating and water-pumping windmills of the nineteen thirties and forties. The electricity-generating mills had achieved a high degree of efficiency before they were usurped by the rural electrification program. Jim's affection and admiration for these old mills is evident in his writing. It has taken a concrete form in the Wincharger which he has installed for us at the Cape Cod farm. It seems perfectly at home in a line with the Savonius and Big Red, and we like the idea of the best of the past being represented side by side with contemporary and future designs.

— NJT



An Advanced Sail-Wing for Water-Pumping Windmills

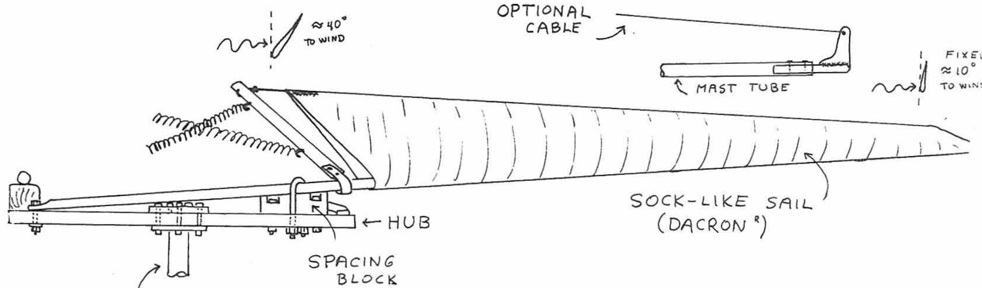


Figure 1
Simple sail-wing windmill details (one sail of three).

The development of sail-type windmills at New Alchemy was initiated by Marcus Sherman. The prototype was a water-pumping windmill which he had built in Southern India in 1972 to aid in irrigation. His windmill in Madurai used cloth sails, bamboo masts, teak pole tower legs and an ox-cart wheel (1). In 1973 Marcus built a similar windmill here on Cape Cod employing cloth sails to which had been added a spring-operated self-feathering mechanism (2). We have continued to develop the sail-wing windmill using it for aquaculture circulation and irrigation, and have found it to be, for our purposes, a workable and adaptable power source.

The vital part of the sail-wing windmill is the sail-blade, which consists usually of a fabric surface supported by a rigid mast. We have used Dacron (R) as a sail material because of its strength and durability. Figure 1 illustrates how the sail is slipped onto the mast like a sock and attached to the movable boom. The boom keeps the sail taut yet allows it to adapt to changes in the wind. Our first windmills had fixed-angle tips and feathering roots as illustrated.

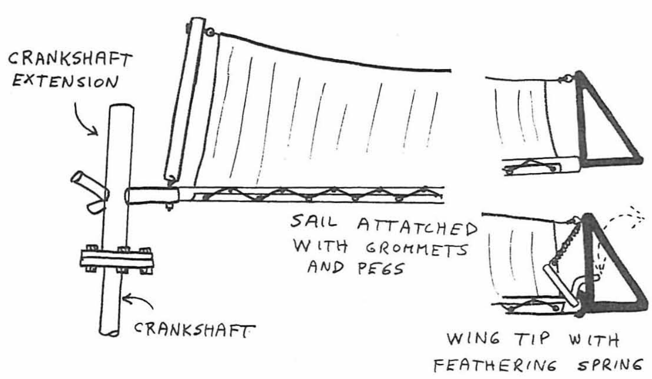


Figure 2
Advanced sail-wing details.

Figure 2 shows a later version of the sail-wing. An extension shaft holds the blades further from the tower. The sail is rigged with cord as on a sail boat, and the tip bracket has a feathering mechanism. Figure 3 shows how stabilizing cables may be positioned to prevent flexing of the blades.

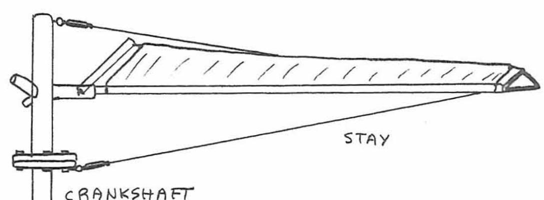


Figure 3
Stabilizing cables on advanced sail-wing.

The sail-wing windmill which we used for circulating water in the mini-ark in 1974 was strong enough to use two three-inch diameter piston pumps simultaneously. Figure 4 shows how the two pumps were connected by a swivel to the pump rod. The cast iron pumps were inexpensive. The packing boxes on each were fabricated from plumbing supplies (Fig. 5) (3). The double pumps were undersized for the strength of the windmill, however, and were replaced later by a higher capacity, more compact diaphragm pump which could be placed below ground (Fig. 6) (4). Figure 6 shows the buttresses on each leg of the windmill tower. It was felt prudent to strengthen the tower in order to give adequate support to the additional weight of the crankshaft, extension, cables and other hardware that were added subsequent to the original design.

The automobile crankshaft bearings used in the early windmills were adequate for the lighter type of blades, but required periodic lubrication on the

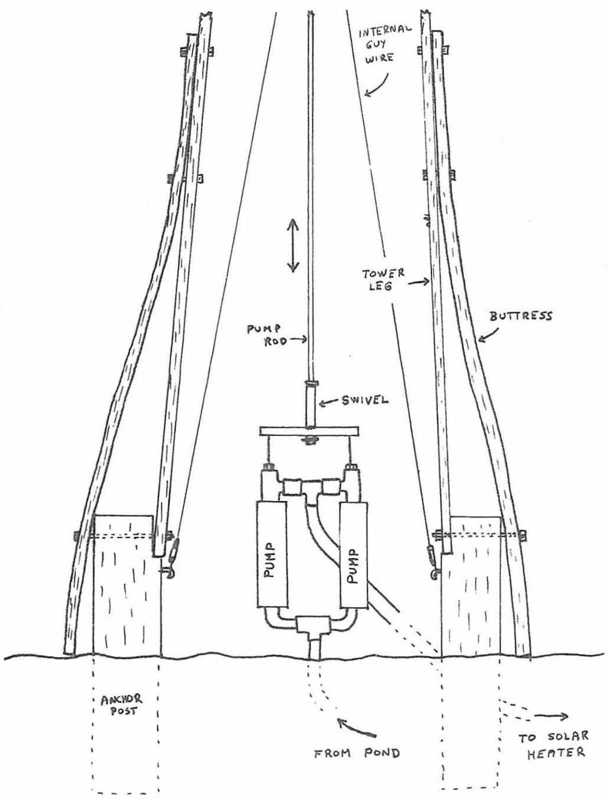


Figure 4
Sail-wing windmill with buttresses and two pumps.

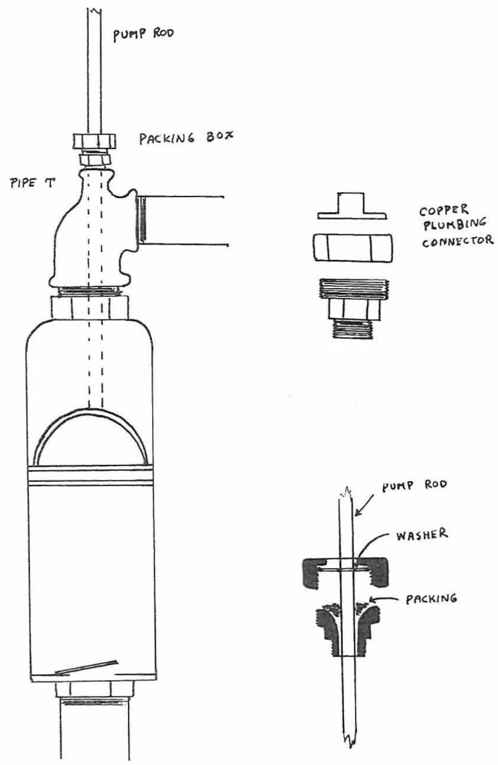


Figure 5
Inexpensive packing box for piston pump.

heavier models. Grease fittings are easily placed in each bearing clamp (Fig. 7). During one stormy period lasting several days, although there was no pumping load on the windmill, the extended period of high speed turning caused the bearing surfaces to wear through on the heavier blade end. It is advisable to balance the weight on each end of the crankshaft to maintain equal forces on the bearings.

The design for the latest windmill is moving into the realm of a heavy duty, long-lasting machine. Merrill Hall has constructed an experimental sail-wing windmill with several new features. The major change is that, for the first time, the blades face the wind. Previously, all of our sail-wings have trailed downwind. A tall, narrow tail tracks the blades into the wind. The main shaft, which has a two-inch diameter, runs in sealed bearings. Fitted to the end of the shaft is a plate on which a pin is fixed, offset from the shaft center point, to convert rotary motion of the shaft into cranking motion required for the vertical travel of the pump rod. The sail-wings are spring feathered at the base and centrifugally feathered at the tip. The results of these most recent innovations will be discussed after a season's operating experience.

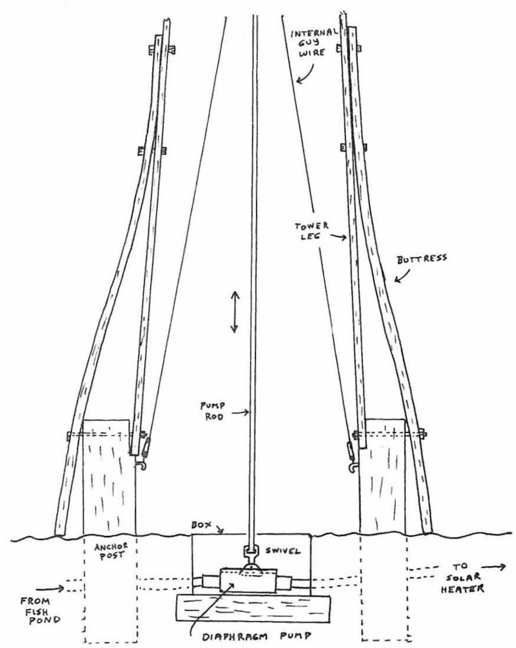


Figure 6
Sail-wing windmill with diaphragm pump.

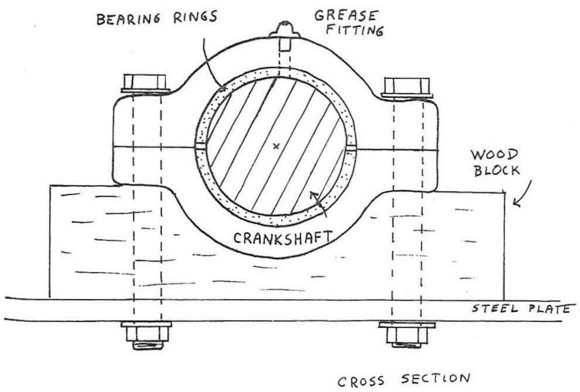


Figure 7
Windmill bearing showing grease fittings on crankshaft axle.

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3. Model No. 350 - Shallow Well Cast Iron Cylinder from Mid-West Well Supply Co., Huntley, Illinois - $18.50 (1974).
4. Large capacity hand-operated diaphragm pumps. Edson Corp., Inc., 460 Industrial Park Road, New Bedford, Massachusetts - about $100 (1974).

– Earle Barnhart

Savonius Rotor

One of the most reliable yet simplest windmills at the Cape Cod Center is the Savonius rotor. It is used to pump fresh water out of the ground into our open aquaculture pond, intermittently displacing a portion of the pond water and stirring it in the process. Our first experience with the Savonius rotor was with a simple rotor comprised of steel drums, based on the Brace Research Institute's design (1, 2). It worked well, but its small size resulted in a comparable limitation in power. In his original developmental work on the rotor Finnish engineer, Sigurd J. Savonius, eventually decided that semi-cylindrical wings such as those made with steel drums may not be as efficient as wings resembling a modified J (3, 4, 5).

When we decided on a second Savonius rotor, we built a larger more efficient rotor of three tiers, each oriented 60° from the others. This results in an even starting and turning force regardless of wind direction. Each of the three tiers has curved sheet-metal wings, three feet high and four feet in diameter. The special curves are formed by attaching the sheet metal to curved plywood templates. There are plywood discs placed between each tier and at the top and bottom of the rotor, which direct the wind through the rotor. The three segments and five discs are slid onto a ten foot shaft. Each one is attached with a flange to the shaft. The rotor assembly is then mounted on bearings inside a rectangular wooden frame.

The simplest and sturdiest tower for the Savonius rotor consists of a set of two permanent wooden posts, set in concrete, between which the rotor frame is placed. Each post has three guy wires. Two large bolts pass through the posts at chest level and through the rotor frame. This enables the rotor to be swung upright, as though on a hinge, for securing at the top. This method is a variation of the hinged tower used by Earthmind, a group doing valuable research on vertical axis windmills (6).

One difficulty we have encountered in pumping water with a Savonius rotor is in tracking down a suitable pump. A diaphragm pump, as suggested by the Brace Research Institute, will not lift more than six feet. Centrifugal pumps invariably require very high RPM's. Rotary impeller pumps generally are quite hard to turn. Reciprocal pumps require some sort of mechanical linkage such as gears, cranks, V-belts, etc., which begin to get complicated. When one's water source is not directly below the windmill, the situation is even more difficult.

Our current plan is to have the Savonius rotor turn a small air compressor, to pipe air to the well, and to pump water with compressed air. This strategy solves the problems of variable speed and power input, freezing of pumps and pipes, and transmission of power from one place to another. While compressing air is somewhat less efficient than other means of energy transmission and storage, the simplicity and durability of the mechanism is an advantage. It is, however, no small matter to find a compressed air-driven water pump. We are aware of only one commercial model (7), which is excellent, but expensive. We are working on a pump which is less efficient but much cheaper and combines the merits of a diaphragm pump with a simple air-control device. The pump design evolved from three sources; the commercial diaphragm pumps (8), C. J. Swet's solar pump (9), and the Stauffer's compressed air pump (7). In operation, compressed air forces the rubber diaphragm down simultaneously forcing water out. Eventually the pressure on the diaphragm pulls the exhaust plug from the exhaust opening, letting the pressure out and allowing the diaphragm to pull in new water. When refilled, the stopper seats in the exhaust opening and the cycle repeats.

It should be mentioned here that while this pump can undoubtedly be improved, its present form lends itself well to home-scale manufacture. Interestingly enough, enameled wash basins and metal dish pans have the appropriate shape and wide lip for such a pump. Inner tube rubber is also suitable.

Our future work in the development of the rotor/compressor/pump system will include using compressed air for other uses, such as fish pond aeration and circulation, and investigating the benefits of compressed air storage to cope with the fluctuation of the winds.

— Earle Barnhart

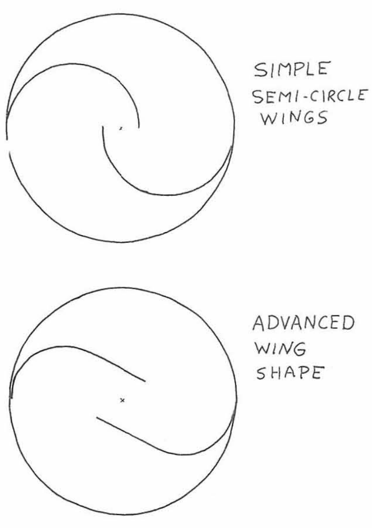


Figure 1
Simple and Advanced Shapes for Savonius Rotor Wings.

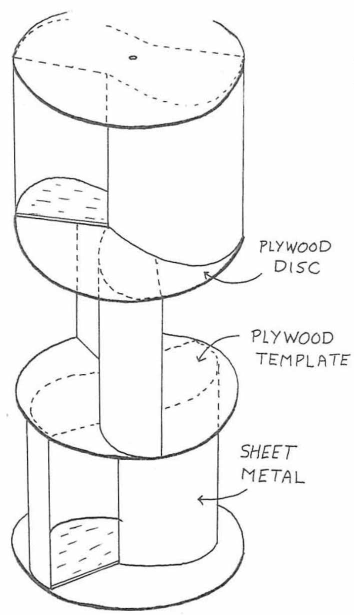


Figure 2
Three-tiered Savonius Rotor Showing Wing Templates and 60^o-60^o-60^o Twist.

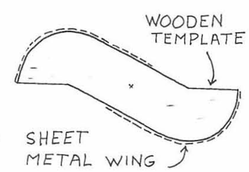


Figure 3
Use of Plywood Template to Form Complex Curves on Savonius Wings.

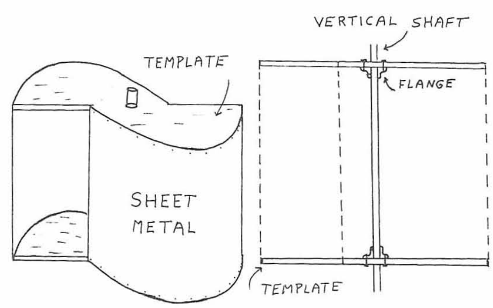


Figure 4
Savonius Wing Assembly.

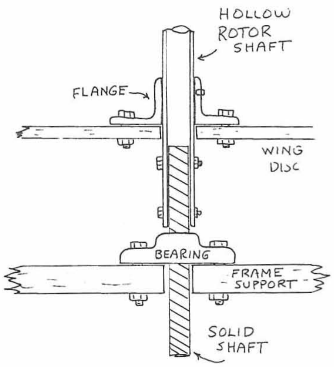


Figure 5
Details of Savonius Rotor Bottom Bearing and Wing Attachment.

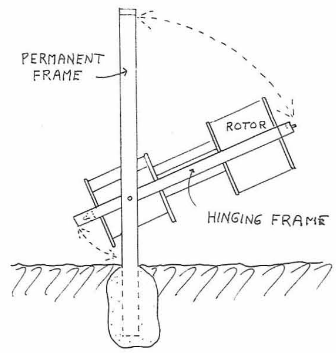


Figure 6
Savonius Rotor Tower — Permanent Outer Frame and Hinging Inner Frame.

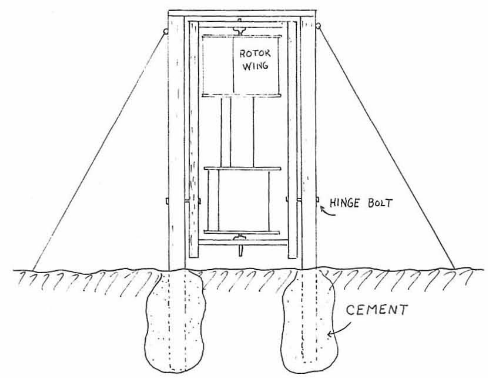
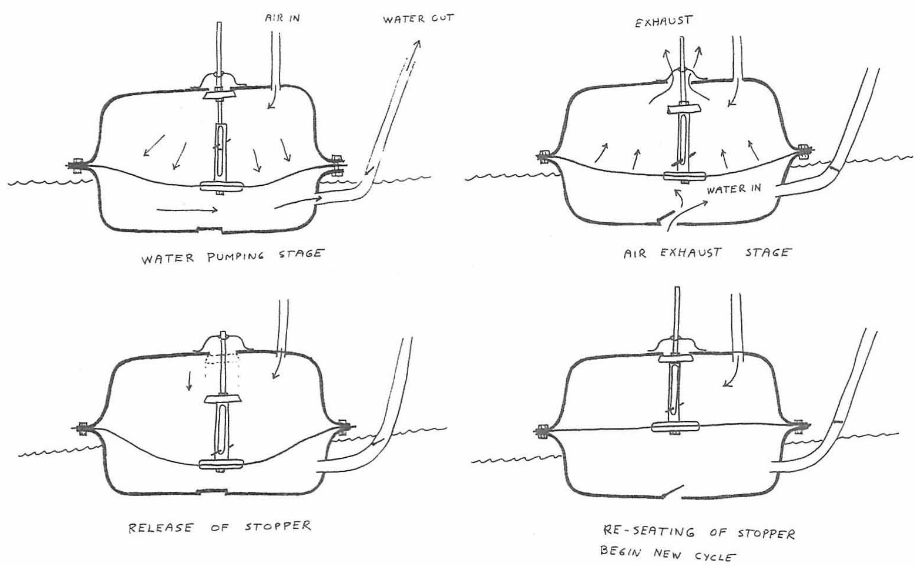


Figure 7
Savonius Rotor Tower — Rotor is Swung into Position.



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Solar Collector for Heating Water

The water in the mini-ark where the fish are raised is warmed in two ways. It receives heat directly from the sun's rays striking the pond surface, and from water which has been pumped through a solar collector. Our solar collector is a simple Thomason-type water heater in which water flows downward over a solar-heated black metal surface and is warmed in the process (1, 2). This collector is

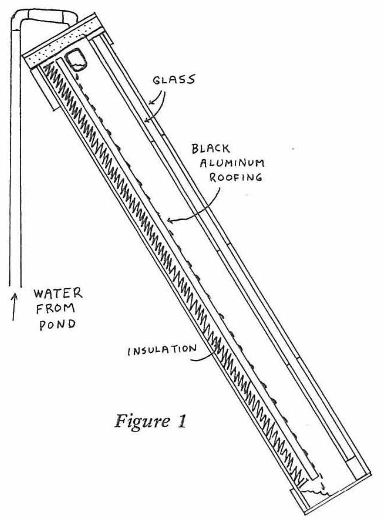

Figure 1

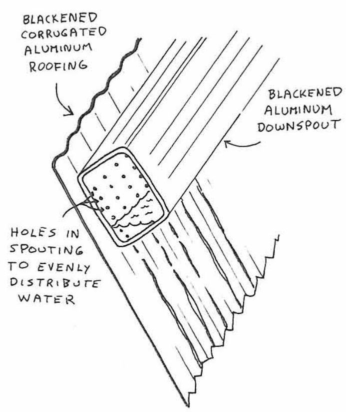

Figure 2
Aluminum downspout used as header in solar water heater.

simple to build, unlikely to freeze in winter and capable of operating with the variable water flow from the windmill. Our experience with this type of collector has resulted in a number of changes which have increased its effectiveness.

Insulation. The black corrugated aluminum plate which acts as the solar absorber will reach very high temperatures unless cooled by flowing water. Even in the spring the plate can reach 180° F. by 10:00 A. M. Because styrofoam insulation panels in contact with the black metal melt and shrink, we find it is better to use fiberglass insulation which can withstand these high temperatures.

Water Distribution. To distribute water along the surface of the collector, we originally used rigid PVC pipe with holes along its length. Copper pipe, which would normally be used for this purpose, is toxic to fish. Unfortunately, rigid PVC pipe softened at the high temperature in the collectors and began to sag between supports resulting in uneven water distribution. Originally we had fed the main distribution pipe with water at two places one-quarter of the distance from each end and had drilled one row of holes along the bottom of the pipe. This is the normal distribution pattern of the Thomason collector. We found that the supply pipes, which were below the distribution pipe , remained filled with water at night, liable to freezing. The single row of holes were inadequate for the occasional high flow rates from the windmill. We replaced the PVC pipe with aluminum down-spouting feeding from the center of the top. The aluminum down-spouting is relatively cheap to work with and when painted black is an excellent heat absorber. To cope with our variable flow, we punched several rows of holes, one at the lowest point, and the others progressively higher on one side. This results in even distribution through the bottom holes at low flow rates and even distribution through successive rows of holes as the flow increases. The down-spouting has proved efficient and is kind to the fish.

Controls. While the windmill which normally pumps the water was being re-adjusted we attached an electric pump to the collector. Switching the pump on in the morning and off in the evening was not sufficiently responsive to abrupt weather changes. To remedy this, we used a type of thermostat normally found in hot water heaters to monitor the temperature in the solar collector and to control the pump automatically (3). A thermostat mounted directly on the collector plate does not work since the plate's temperature drops drastically as the water flow begins, causing the thermostat to switch on and off constantly. The thermostat sensor is best placed inside the collector near the top attached to its own small black absorbing plate, which duplicates the temperature of the main (4) plates but is separated from it. Once installed the thermostat was set to turn on the pump at 100°F and turn it off at 95°F. The pump comes on in response to morning sun, stopping if clouds pass over for more than one minute and shutting off in late afternoon. The precision of automatic control is impressive and its convenience is a real advantage.

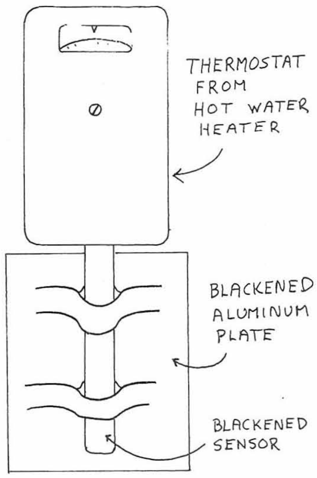

Figure 3
Solar collector thermostat absorber plate attached.

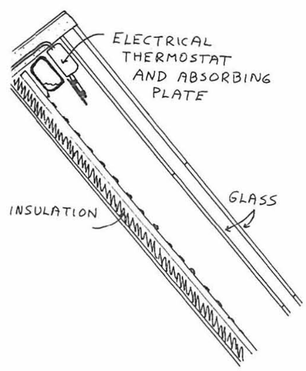

Figure 4
Position of thermostat in solar collector.

While the collector was connected to the electric pump, we tested some of its heating capacity. The area of the solar collector is approximately one hundred and twenty-eight square feet (four feet by thirty-two feet), a small portion of which is non-collecting wooden supports and edges. Our pump circulates 8.125 gallons per minute over the collector. On a very sunny spring day, the rise in temperature of water passing through the collector can reach 8°F around solar noon, and normally will be about 6°F from 10:00 A. M. to 3:00 P. M.

Measuring output of the collector when it is connected to the windmill is more difficult, as the flow rate is changing constantly. A simple and inexpensive method is to place a container at the point of outflow from the collector. Such a container should have a V-shaped opening cut on one side. The level at which the water flows out of the V indicates the rate of flow from the collector. This method of determining flow rates can be used for many other purposes, such as water supply or irrigation control (5).

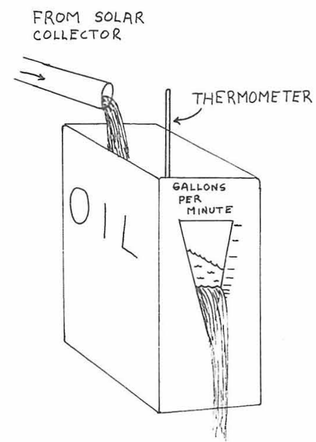

Figure 5

A five-gallon oil can works well for this, and the V opening can be marked in gallons per minute, pounds per minute, or any convenient unit. The flow from a garden hose can be used to calibrate this instrument initially. This is done by turning the hose into the can, marking the overflow level on the V and measuring the flow for one minute. Several repetitions at various flows will provide a scale. A tall, narrow V gives more precise measurements than a short, wide one.

To test the heating performance of the collector, a thermostat is placed in the can and simultaneous readings are taken of the water temperatures and the flow rate. By subtracting the input water temperature, which does not change very quickly, the rate of energy collection is easily calculated.

— Earle Barnhart

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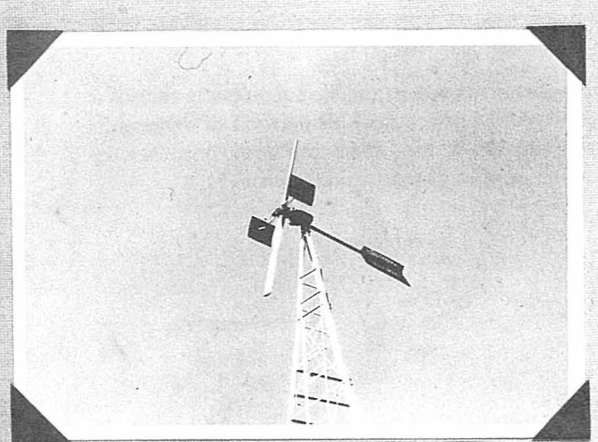


PHOTO 1. *Wincharger 650 Watt - 32 Volt - Model 321 - 1936*

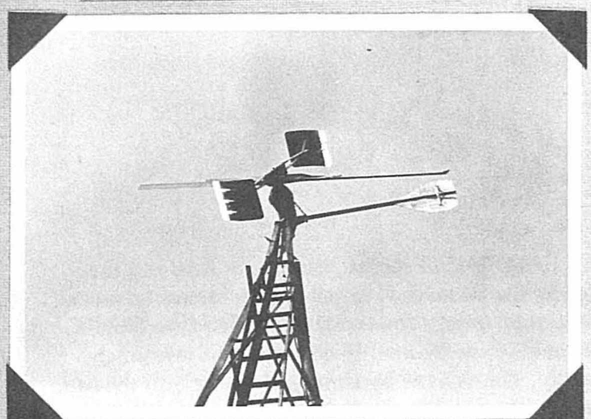


PHOTO 2. *Wincharger 1200 Watt - 32 Volt - Model 3214 - 1940*

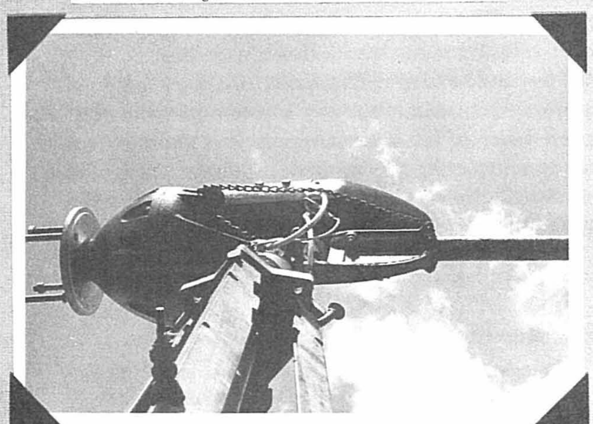


PHOTO 2A. *Wincharger 1200 Watt - 32 Volt - Model 3214 - 1940*

PHOTO 3. *Wincharger 1200 Watt - 110 Volt - 4 Bladed*

Earth Breath: Wind Power

"Wind, water and solar power are running to waste."
1-14-1903 – DAILY CHRONICLE, England

The recently published book "Energy Primer" by Portola Inst. *et al*, listed a few of the companies that manufactured wind generators in the U. S. A. from 1910-1970. The largest number of them were doing business in the 1930's-1940's. Examples of most of these wind generator systems have been found, rebuilt and restored into working condition. The photos and copy that follow come from a portion of that finding.

The Wincharger Corp. of Sioux City, Iowa, was started in 1927 by the Alberts brothers, John and Gerhardt. The wind generators pictured were constructed between 1928 to 1940. Photo number 1 is a 650 watt, 32 volt Wincharger produced around 1937. This unit has the bucket type governing system that Wincharger used for almost all of their two-bladed machines. The gearing system in this model was a fibergear and steel pinion with a 6 to 1 ratio in order to step up the RPM's delivered from the blades to the generator. It is interesting to note that in 1936 the generator for this wind system cost $27.50. A comparable size generator at 1975 prices would cost around $225.00.

Photo number 2 is a 1200 watt, 32 volt, model 3214 built around 1940. This was the largest model offered by Wincharger at that time. This unit had a gear ratio of 5.25 to 1 (note: Wincharger in their lifetime produced several hundred thousand wind generators). In the close-up picture the chain extending from the rear of the generator through the pulley and proceeding from there down the tower is used to collapse the tail of the machine out of the wind in high-wind, storm conditions.

Photo number 3 is a 1200 watt, 110 volt, four-bladed Wincharger. Photo 4 shows the hub configuration used on the four-bladed units. Photo number 5 shows a cast aluminum mounting of one of the later models of the four-bladed type which used extruded aluminum blades.

Photo number 6 is a 1974, 200 watt, 12 volt model 1222H. It is the only unit still produced by Wincharger which is now Dyna Technology Inc. Photo number 7 is a 1930's-1940's, 200 watt, 6 volt, model 622 Wincharger. This shows the bucket governing system and the brake used to shut the plant down in high-wind conditions. These smaller units were originally used to power radios manufactured by Zenith Radio Company and others.

About the same time that Wincharger was producing their small 200 watt wind plants, two other companies not quite so well known were also producing small wind generators to be used for running radios. They were Delco (photo 8) and Paris-Dunn (photo 9). Paris-Dunn also produced a 2000 watt, 110 volt wind generator.

In 1937 a small company by the name of Rurallite began producing a number of wind generators of which

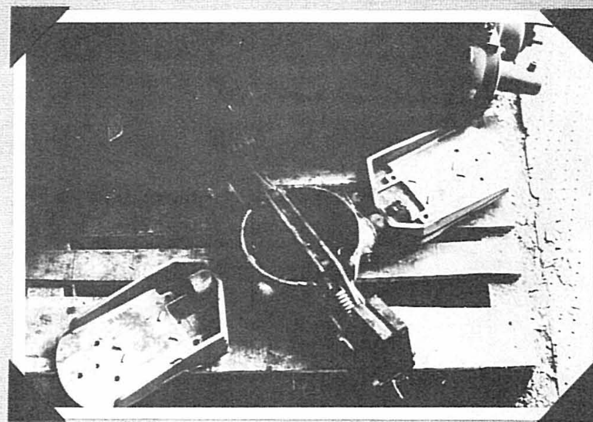


PHOTO 4. Wincharger Governor

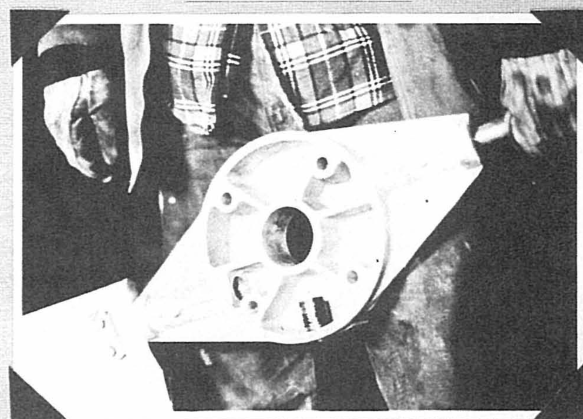


PHOTO 5. Wincharger Hub - Cast Aluminum

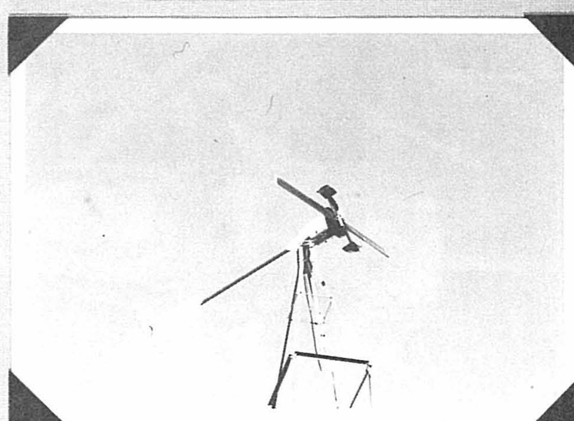


PHOTO 6. Wincharger 200 Watt - 12 Volt - Model 1222H - 1974

PHOTO 7. Wincharger 200 Watt - 6 Volt - Model 622 - 1950

photo number 10 is an example. The hub and blades are removed. This unit was a gear-driven unit, 1250 watts, 32 volts. Photo 11 shows the governor used by Rurallite. It is the fly-ball type geared to the blade shafts.

Around the same era, not far north of Iowa in Minneapolis, Minnesota, the infamous Jacobs Wind

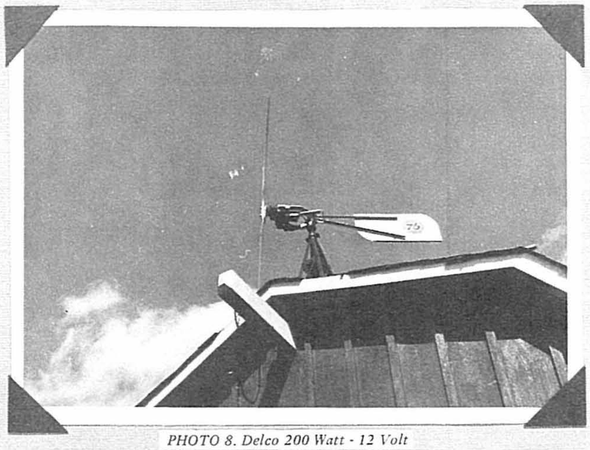


PHOTO 8. Delco 200 Watt - 12 Volt

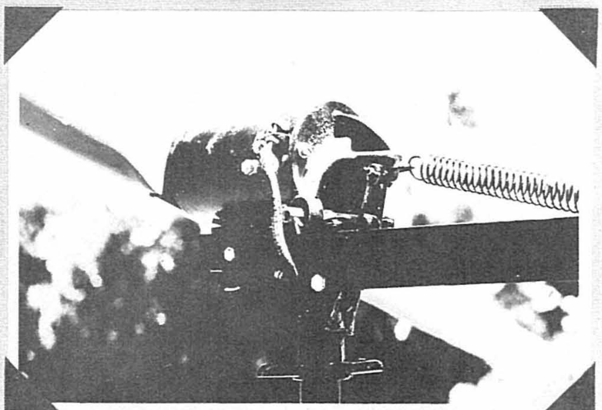


PHOTO 9. Parris-Dunn 170 Watt - 6 Volt

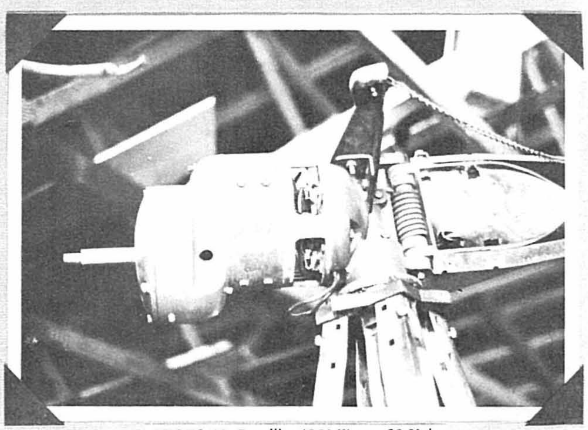


PHOTO 10. Rurallite 1250 Watts - 32 Volts

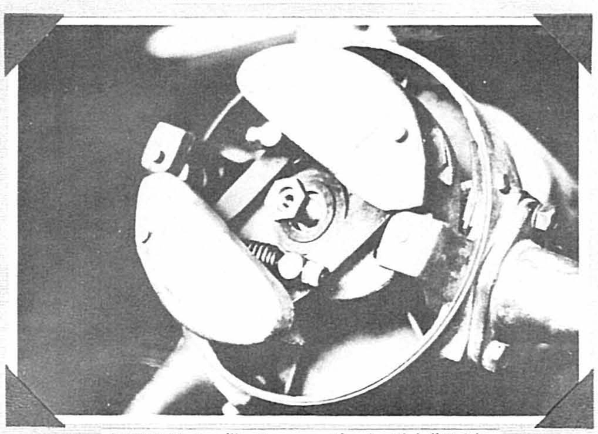


PHOTO 11. Rurallite Governor - Showing Flyball Weights

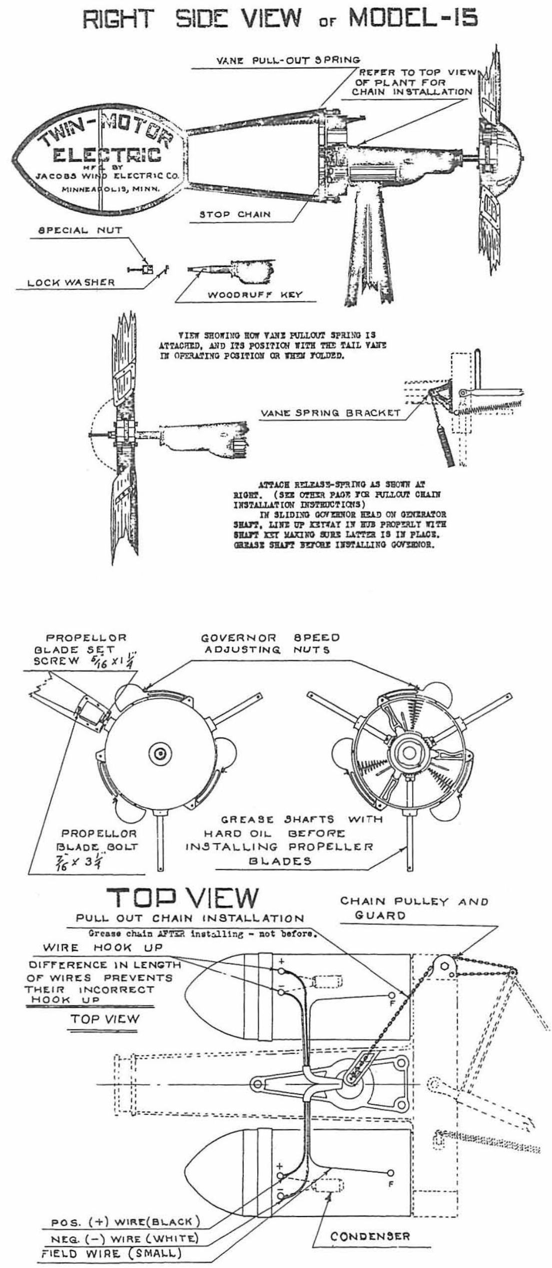


FIGURE B
Jacobs Twin-Motor 1500 Watt - 32 Volt - Model 15

Electric was engaged in producing another style of wind generator known mostly for its direct drive models. They produced gear driven models as well. From what we can tell, these models out-produce in Kw hrs/mo. the direct drive units. Photo number 12 shows a complete Jacobs 2500 watt, 110 volt direct drive unit. Photo 13 shows the brushes, end-bell and capacitor of a Jacobs 1800 watt unit which is not any different in configuration from the 2500 watt (see photo 13). Figure B shows a side view of the Jacobs twin model 15, 1500 watt, 32 volt unit. The Jacobs wind generators were much larger than the Wincharger units and more expensive.

Photos 14, 15 and 16: One of the more novel designs was produced by the Air Electric Company of Lohrville, Iowa. This was a 2000 watt generator in which the cowling and the tail were a continuous fuselage. Holes were drilled in the end of the tail which created a syphoning action thereby cooling the generator. The generator had, in addition, an 80 pound fly-wheel on the front of it which smoothed some of the choppy action of the two-bladed machine. It used paddle-air deflectors for the governing system and had a brake. Another model made by the Air Electric Company was an enormous 3000 watt, 32 volt generator with fly-wheel and paddle-type governor (photo 17).

In Iowa there was still another company known as Windpower, which produced a simple down-wind design, the more popular models being the 1250 and the 1800 watt direct drive. The only problem these machines apparently had was a very long shaft connecting the blades to the generator which had a tendency to bend. The feathering system allowed the blades to feather by attaching the roots of the blades to flyballs, so that when the blades are turning as fast as safety allows, the centrifugal pressure forces the blades to turn about their axis and spill the wind. Photo 18 shows the generator and feathering system with blades and flyballs removed. To shut the plant down in storm conditions, a brake located between the generator and the hub system under the "cowling" was used (see Fig. C).

The possibility for participation in the riddle of inter-relatedness of the natural world reveals a perspective beyond one's own. In any attempt of exchange – and this writing should be viewed as such – the medium is the message. (It is both medium and message that are one, kindness is wisdom, sound and silence, matter and energy, earth and breath, are one.) The connecting link between any two paradoxi is in itself a paradox. The set of belief structures, or concepts which are based on simul-sensory input, is apparent only when one realizes that immediate interpretation is not completely one's own, and that sensory input consists of much more than one's own amplification.

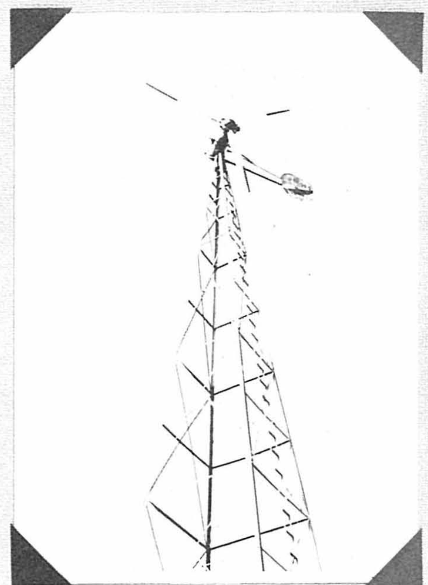


PHOTO 12. Jacobs 2500 Watts - 110 Volts - 1950

PHOTO 12a

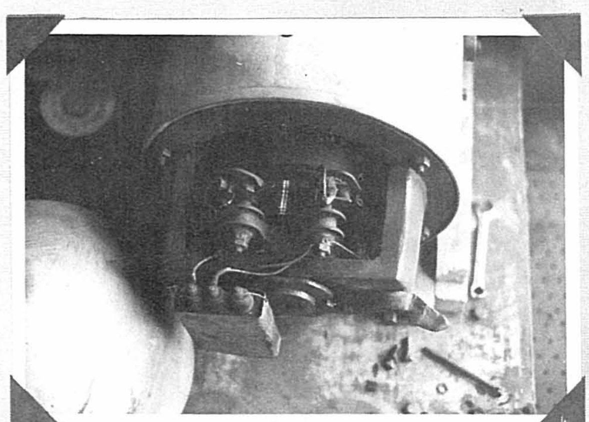


PHOTO 13. Jacobs End Bell - Showing Brushes and Capacitor

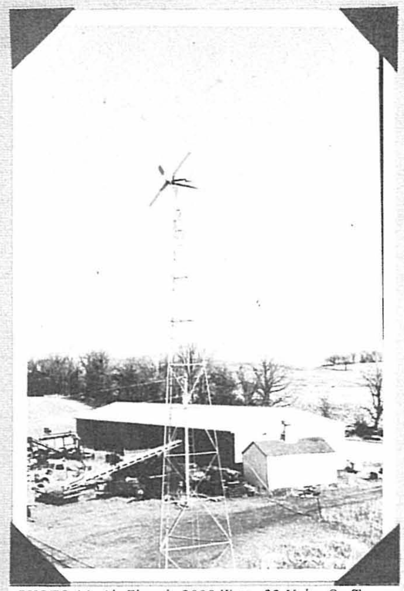


PHOTO 14. Air Electric 2000 Watt - 32 Volt - On Tower

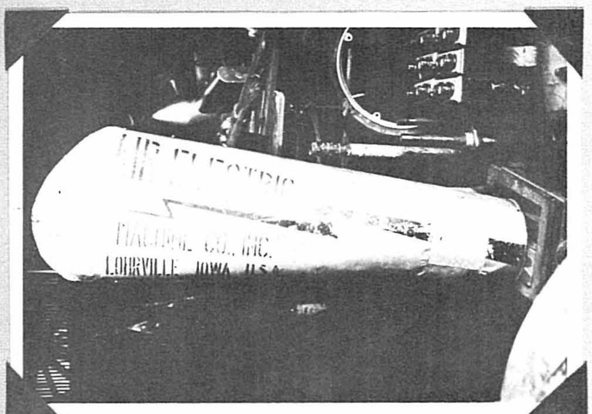


PHOTO 15. Air Electric 2000 Watt - 32 Volt - Tail Section

PHOTO 16. Air Electric 2000 Watt - 32 Volt - Generator Against Batteries

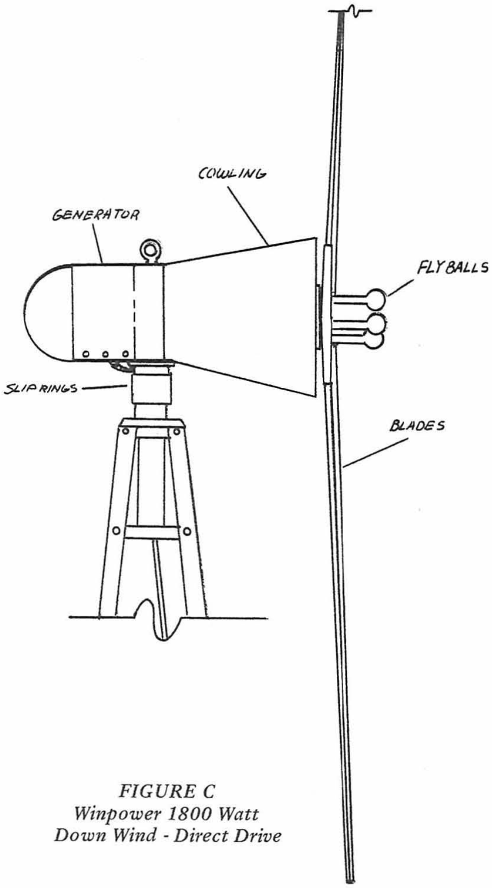


FIGURE C
Winpower 1800 Watt
Down Wind - Direct Drive

The joy of our riddle or paradox does not lie in "the answer", but in the perception of the interrelatedness of that which appeared unrelated.

One always gets what one needs –

– *Jim Bukey*

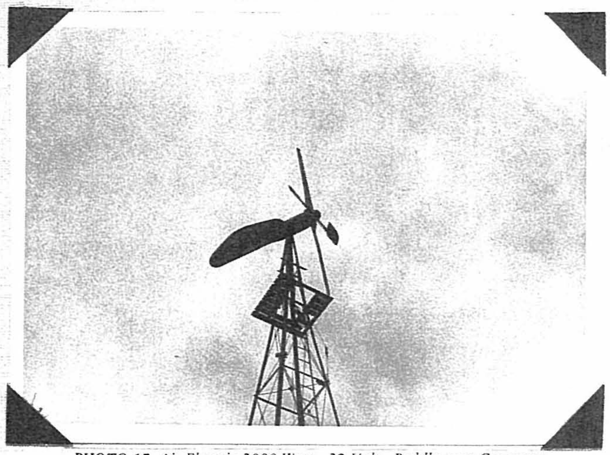


PHOTO 17. Air Electric 3000 Watt - 32 Volt - Paddle type Governor

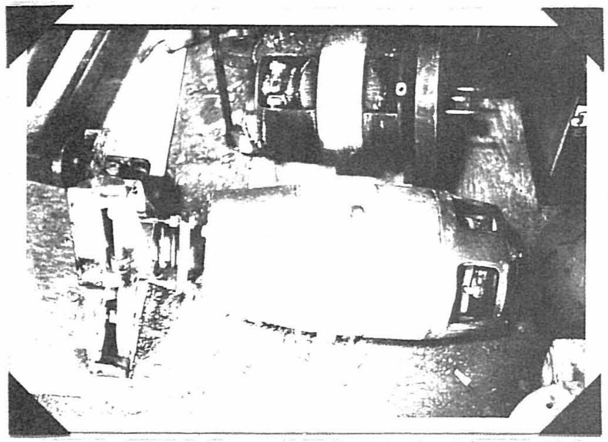
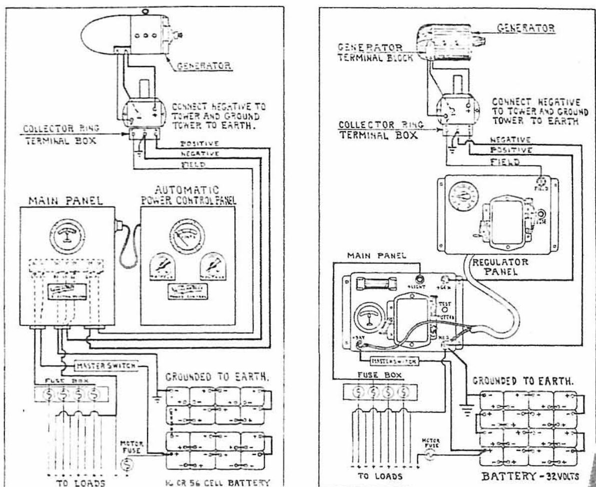


PHOTO 18. Win Power 1800 Watt - 32 Volt - 1952 - Direct Drive, Down Wind



Two different wiring systems used by Wincharger