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AN URBAN AND RURAL DEMONSTRATION OF A WIND-POWERED WATER PUMP

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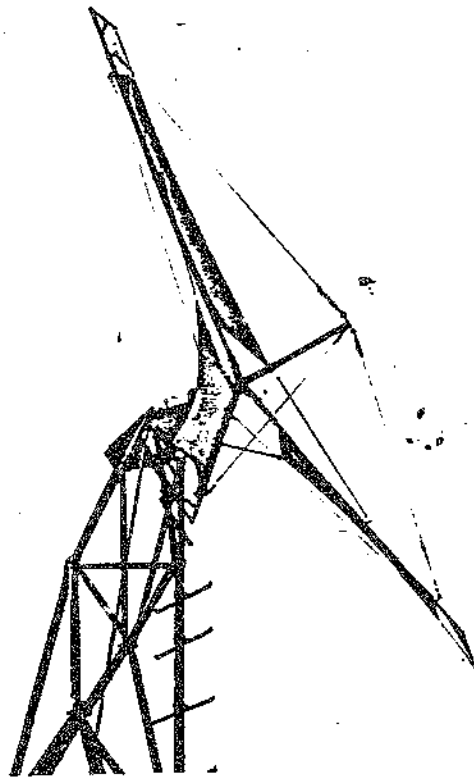
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Sailing Windmill at the Christian Herter Center, Allston, MA



Sailing Windmill at the Cape Cod Ark, Hatchville, Ma

Introduction:

The following report summarizes the progress and results of D.O.E. Grant #DE-FG41-79R110051, "An Urban and Rural Demonstration of a Wind-Powered Water Pump". The late submission of this summary is due to the fact that one of the two prototype windmills is still being modified, and the final results are not yet in. However, as the report describes, the project as originally proposed has been successfully completed.

Our original intent was to complete a four-year design effort so that the prototype Sailwing could be built by a do-it-yourselfer completely from off-the-shelf components. Once the design modifications were completed, we proposed to construct two mills - one at an urban community garden in Boston, the other at the Cape Cod Bioshelter in Hatchville, Massachusetts. Plans for the machine would then be published and made available in several forms. This report summarizes the project in order of these four efforts.

Phase 1: Technical Improvements on the New Alchemy Sailwing.

1. The Crankshaft.

Four years of research on "Big Red", New Alchemy's original Sailwing water-pumping windmill, had resulted in a working prototype which could be constructed at a low cost, but which required the use of specially machined crankshaft and pump shaft components. The first four months of this effort focused on the redesign and testing of various crankshaft configurations.

The primary design criteria were (a) to convert a rotating shaft into a 7-in total rotational displacement, (b) to withstand up to 2,000 ft-lbs of torque in an 18 mph wind, and (c) to be constructed with skills and equipment accessible to a typical do-it-yourselfer. The original crank (see Figure 1) met the first two criteria, but did not adequately meet the third requirement. Four months of research resulted in the design which is described in Figure 2. This proven crank requires conventional welding and drilling equipment and emphasizes off-the-shelf bearings which are commonly available. The first crank (see Phase 2) employed 1-in pillow block bearings, and the most recent design (Phase 3) saves money and welding time by employing 1-in flange mount bearings. The crankshaft has operated without fail on three Sailing windmills for a combined running time of eighteen months.

A comparison between the original and the final designs indicates the success of this design effort: --

	<u>Prototype Crankshaft</u>	<u>New Crankshaft</u>
Cost of Materials	\$45	\$44
Non-Professional and Welder's La- bor Hours to Con- struct	3	3½
Machinist's Time	3	0

2. The Pump Shaft.

The original Sailing prototype was employed in a high compression application with a large volume (1 gal) diaphragm suction pump.

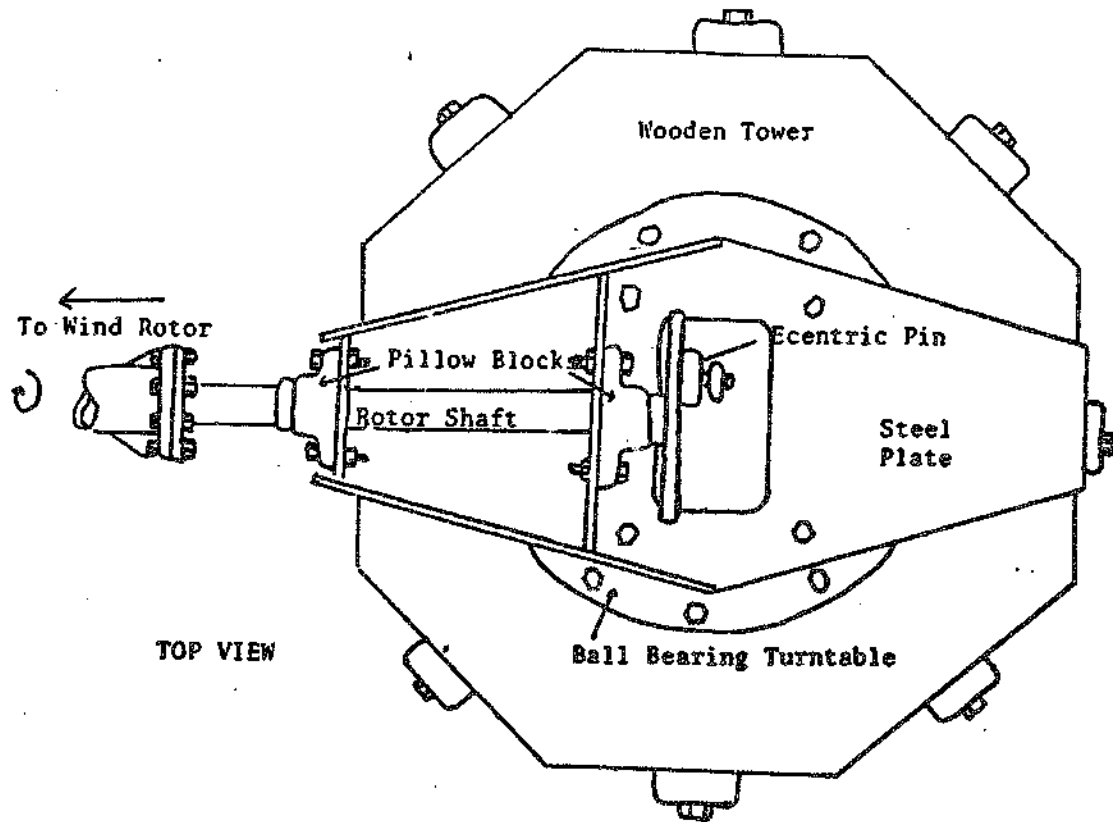
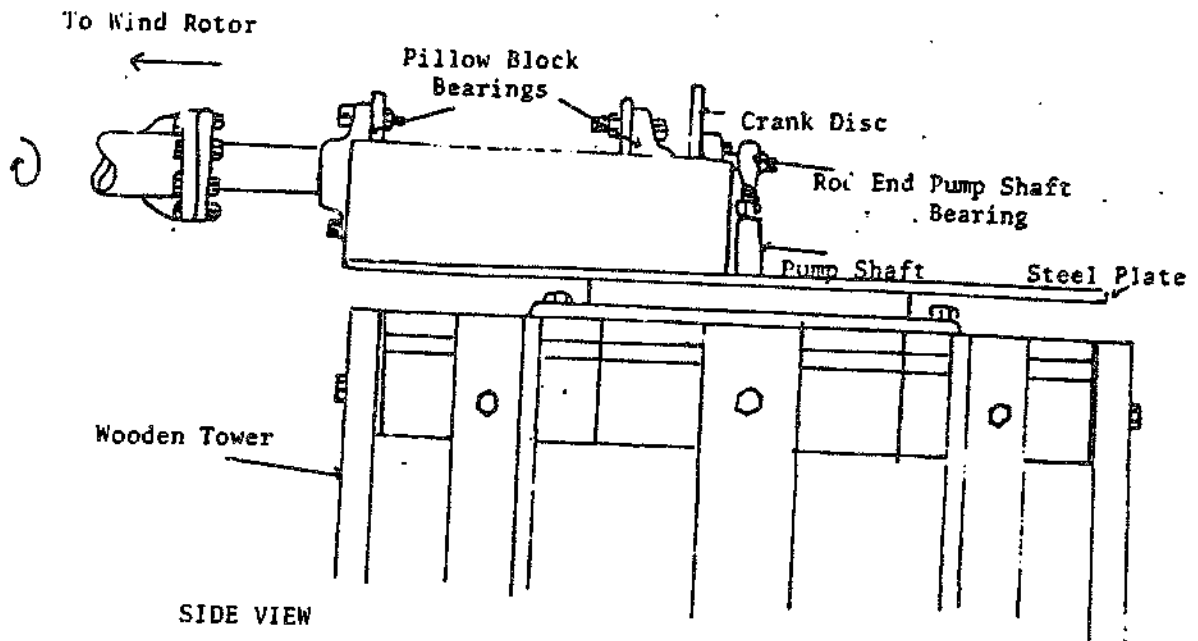
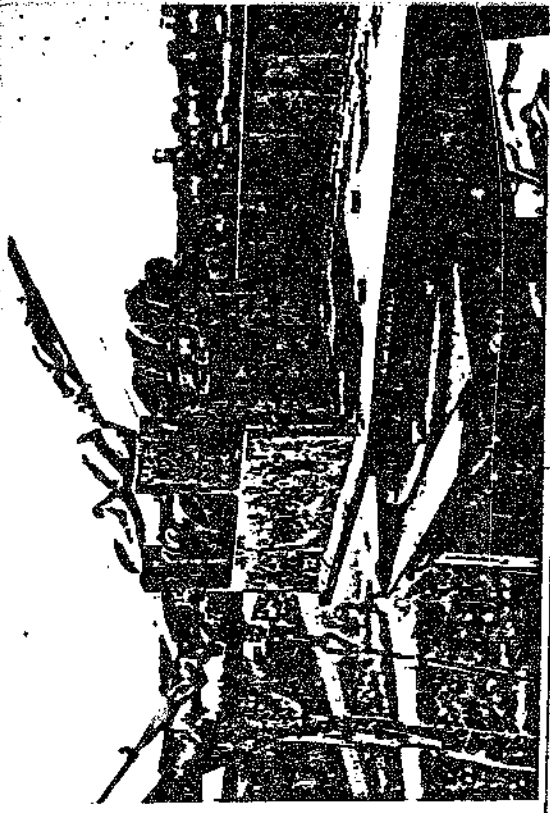
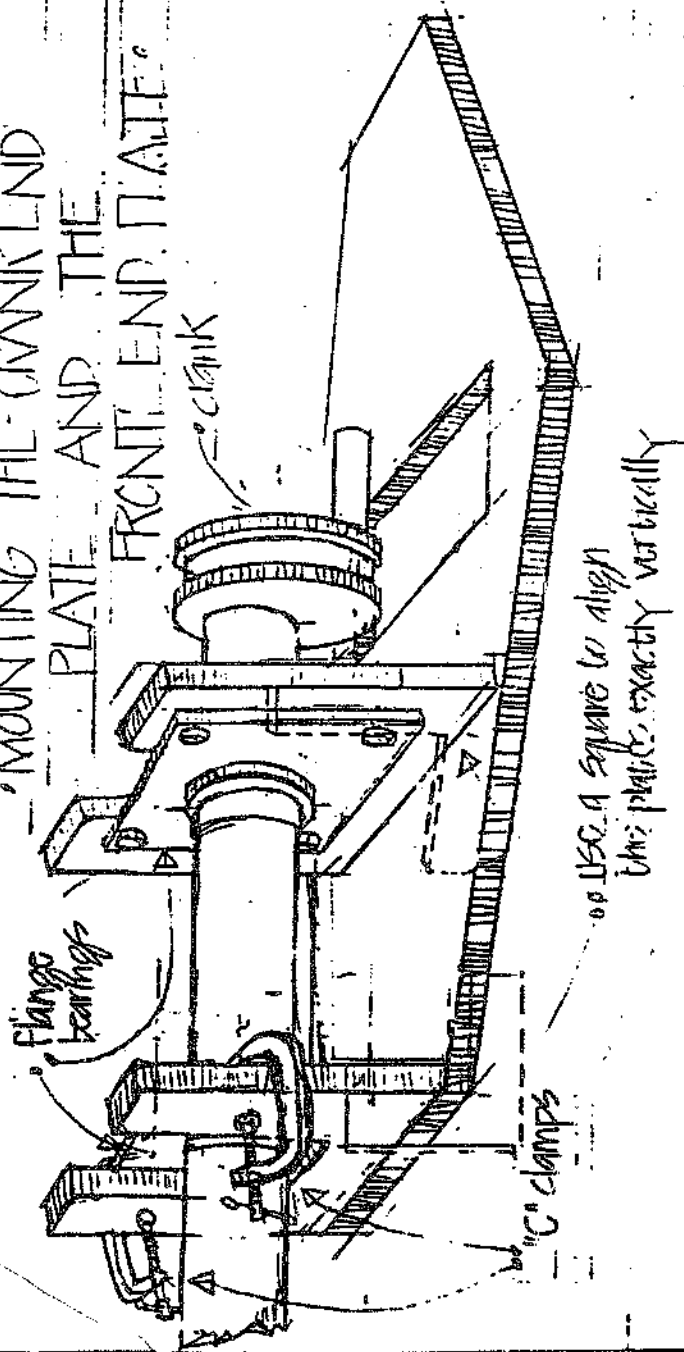


Figure 1 The Original Sailwing Crankshaft



MOUNTING THE CRANK END
PLATE AND THE
FRONT END PLATE



(Temporary) Figure 2 The New Sailing Crankshaft

The shaft required for this application was a sturdy, non-buckling design made from 3-in EMT and machined end plates (Figure 3). Since the typical anticipated application would require tension stresses rather than compression forces, we set out to design a pump shaft which could be constructed inexpensively using off-the-shelf components. The primary design criteria were: (a) ability to withstand tension stresses in excess of 500 lbs, (b) ability to adapt simply to crankshaft bearings on top, and polish rod on pump below, (c) incorporation of a swivelling capability to accommodate the wind rotor's yaw response to changing wind directions, and (d) ability to accommodate a simple pump rod guide for towers over 35 ft in height.

Our final design involved the use of a wooden red rod and a commercial windmill swivel plus 1-in of heavy wall conduit with several welded connecting sections. We are satisfied with the design, and it has performed flawlessly for eleven months of running time. (See Appendix 1 for construction details.)

3. The Brake.

The original Sailwing prototype did not have a brake. The operator of this experimental machine had to manually stop the rotor from mid-tower when furling or inspecting the machine. Two braking strategies were designed in this project, but only one is ready for wide-scale application.

The first, a manual turn-out lever, has performed beautifully on the Boston mill and on a Sailwing which we constructed in Yoro,

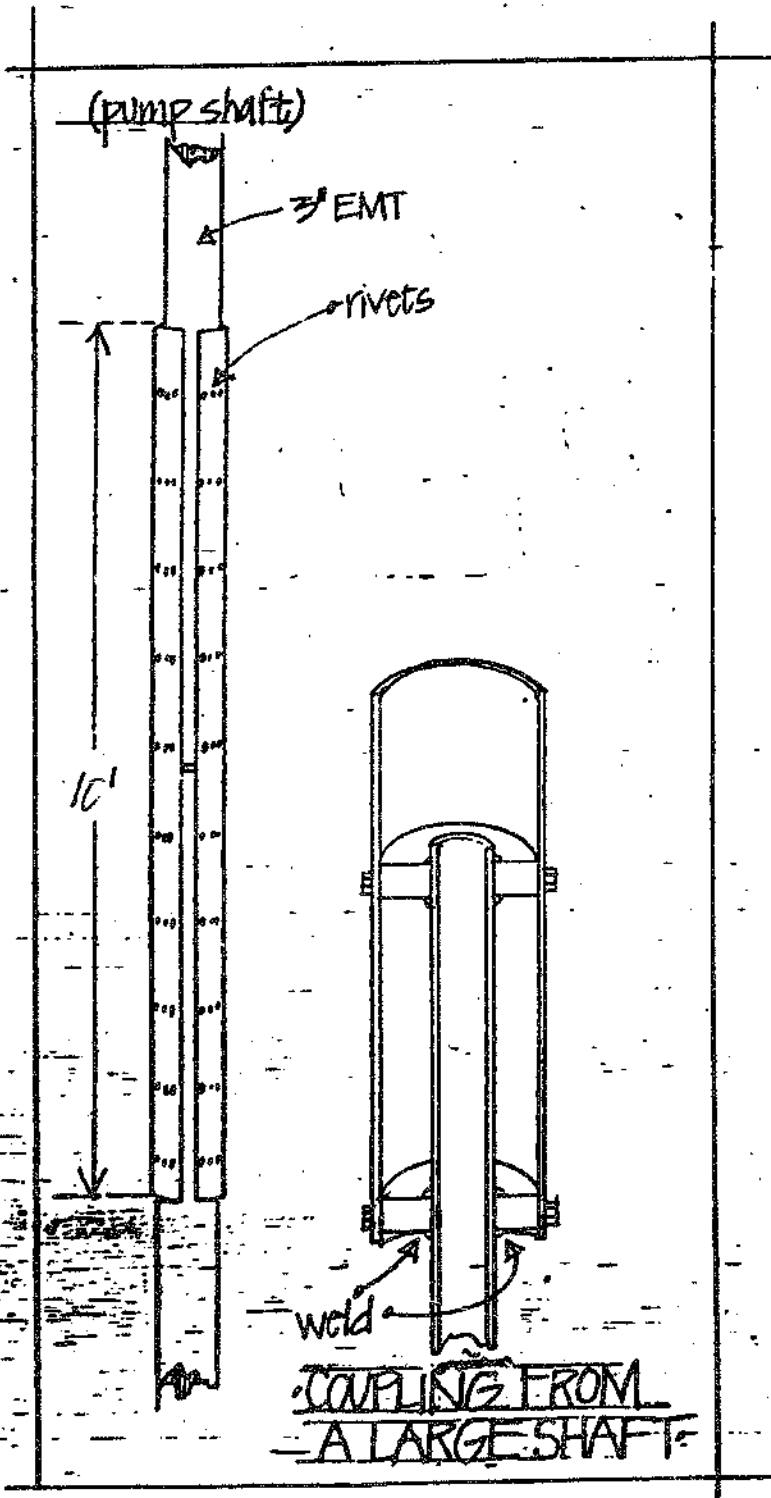
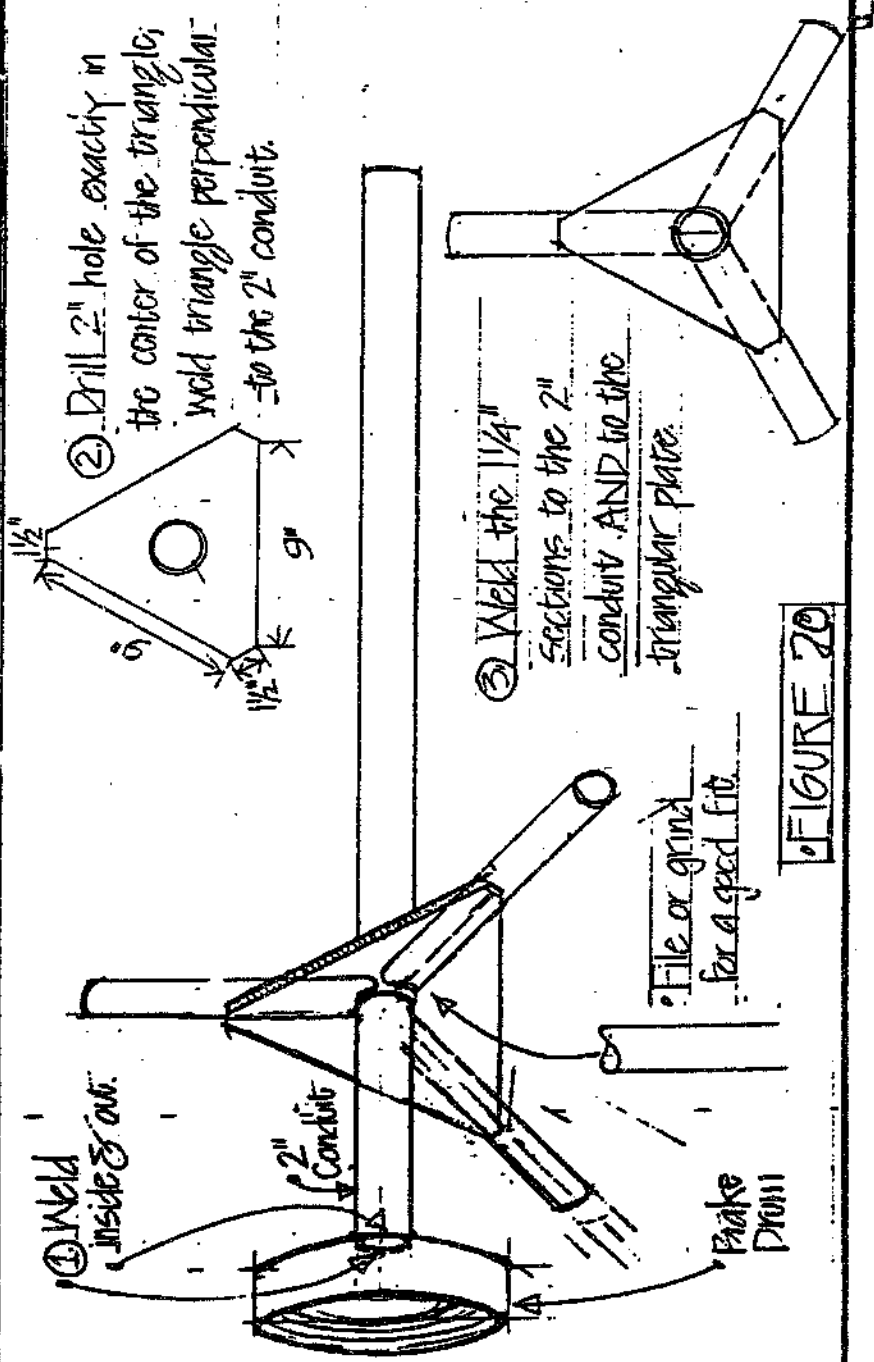


Figure 3 The Sailing High-Compression EMT[®] Pump Shaft



(Temporary) Figure 4 Position of the Used Automobile brake on the Sailing Rotor

Honduras, in January, 1981. The operator manually yaws the rotor out of the wind while standing at a position inside the tower and below the bottom on the wind rotor's stroke. Once the rotor is yawed parallel to the wind, it comes to a halt and the operator can manually furl the sails from the same spot. We are very pleased with this strategy and have found that it can be easily understood and performed by laypersons with no prior windmill experience.

The second strategy involves the use of a used rear wheel automotive brake (see Figure 4). The operator engages the brake from ground level and two 300 ft-lb springs bring the rotor to a stop in gusts of up to 28 mph. However, the brake and springs must be re-set on the tower top, and while we did construct a simple re-set lever, we are not satisfied with this potentially hazardous solution.

For the time being, the manual turn-out lever can be recommended as a safe, simple and effective braking strategy.

Phase 2: The Boston Windmill.

Construction and demonstration of the windmill at the former Christian Herter Center in Allston has been beset more by socio-political problems than by technical dilemmas. (See Appendix 2.)

The period from the time that M.D.C. Park Director Robert Williams gave formal permission (Appendix 3) to construct the windmill (8/9/79), until the windmill's pumping debut on April 30, 1980, was a chaotic and frustrating period. The humorous article in Appendix 2 describes several

of the problems we encountered during the mill's construction, most of which were the results of poor planning and poor communication from the project's inception.

First, the good news: The Herter Center windmill began pumping in April of 1979, a moment which was celebrated by visits from D.O.E. Regional Administrator Harold Keohane, and Massachusetts Energy Secretary Joe Fitzpatrick (Figure 5). Earth Day, 1980, brought over four-thousand visitors to the Herter Center, many of whom observed the Sailing pumping from a 5-ft head at an average rate of 700 gph in a steady 12 mph wind. The windmill continued to perform well with only minor repairs for over six months until the end of the 1980 growing season. One week after the mill was shut down for the winter, vandals smashed the pump and pump shaft, a situation which has not yet been corrected due to reasons which are described below.

During the windmill's inaugural season, two rounds of performance tests were conducted. Wind speeds were measured with a hand-held Dwyer anemometer from a position 6 ft upwind of the rotor hub. Pumping rates were measured by filling and measuring an empty tank for three, 15-minute intervals on both dates. The results are described below.

Performance Test Results

Sunday, June 15, 1980:

Winds: S-SW, Variable, 7-9 mph

Pumping Head: 5 ft Suction + 25 ft Elevation + 2.5 ft Friction =
32.5 ft Total Head

Gallons per Hour: Test 1 (10:00 am - 10:15 am) - 520
Test 2 (11:00 am - 11:15 am) - 490
Test 3 (11:30 am - 11:45 am) - 620
Average Pumping Rate - 543 gph

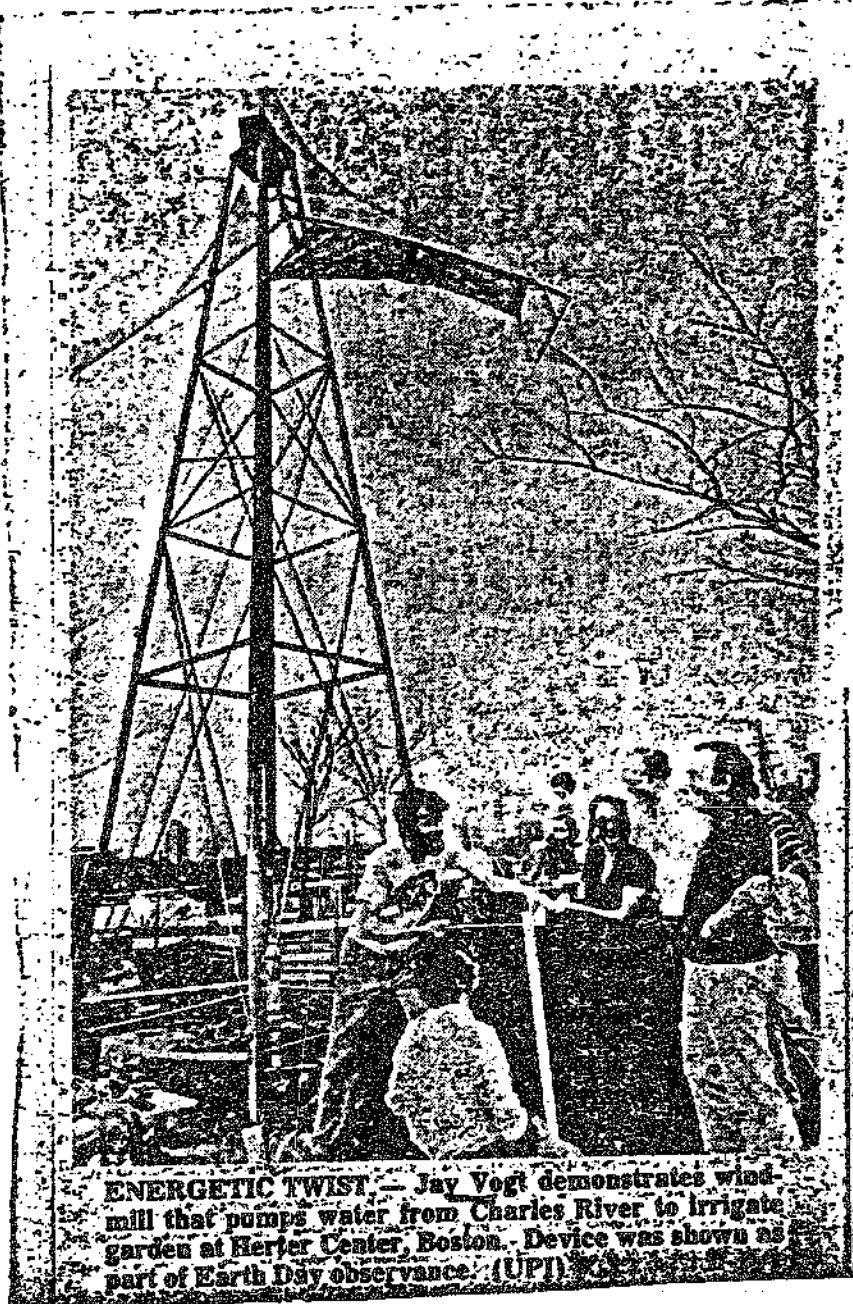


Figure 5 D.O.E. Regional Administrator Harold Keohane and Mass. Energy Secretary Joseph Fitzpatrick at dedication of Urban Sailing, 4/20/80
Clipping Courtesy of Springfield Daily News, 4/21/80

Sunday, August 10, 1980:

Winds: W-SW, Average 10-12 mph, gusting to 15

Pumping Head: Same, Total 32.5 ft

Gallons per Hour:	Test 1 (11:15 am - 11:30 am)	- 730
	Test 2 (12:00 pm - 12:15 pm)	- 685
	Test 3 (3:00 pm - 3:15 pm)	- 740
	Average Pumping Rate	- 718 gph

Major problems with this effort fall into two primary categories. The first, and most significant problem is a political one which could only have been avoided by selecting another demonstration site. As of this writing no resolution is in sight and the fate of the windmill is uncertain.

The Sailwing windmill is not a machine which can be left untended over long periods. The low construction cost carries with it the price of manual furling in anticipation of high winds. Unlike the more expensive conventional commercial multi-bladed water pumper which is self-tending and automatically furls to avoid damage in high winds, the Sailwing must be manually reefed by it's operator. Thus, the proper site for a Sailwing is one where the windmill's owner is available in case of storm conditions.

Furthermore, the windmill is not a flawless design. Cables loosen, sails flap, and rigging must be inspected. These factors, in conjunction with the high frequency of vandalism incidents in urban gardens, mandate that the windmill's owner be committed to occasional repairs and inspection.

In 1979, when this project proposal was written, New Alchemy Institute personnel and staff from the Suffolk County Extension Service surveyed the available urban community garden sites for candidate plots. The Christian Herter Center emerged as the outstanding candidate. They had a young, ambitious staff and a good, working rapport with the gardeners. Furthermore, their modest annual budget allowed for the expected repairs and parts replacement costs which would accrue. During the windmill's construction and the first year of operation, the Center's staff kept up their responsibilities and proved to be capable stewards. However, in March of 1981, the Center officially closed its doors and the buildings were slated to become a sports museum by the M.D.C. landlords. End of responsible stewards, repair budget, and windmill guardians.

As of this time, no clear scenario has emerged. As Appendix 4 indicates, discussions about the possible relocation of the mill have been initiated. In the meanwhile, the windmill cannot be operated.

The second major problem area concerns the windmill's water system - the well, distribution and storage components. The major problems here were that (a) these costs were not included in the original proposal and low budget, inadequate systems were installed, and (b) the M.D.C. was neither properly consulted nor generously forgiving regarding installation of the storage and distribution components.

1. The well - The original plan was to use the existing 3-in garden hand-pump well; however, the well was found to be too shallow (6 ft), and we were left without a budget to install an adequate well. As described in Appendix 2, we hand-drove and developed a 2-in well at a cost that was within the Herter Center's budget. This put us in the position of having to install an above-the-ground suction pump, rather than an in-the-well pump which would have been less prone to vandalism. The result of this unfortunate development was the vandalism and destruction of our 3-in cylinder in the fall of 1980.

2. The storage system - Virtually the same problem plagued the storage system. An inadequate budget forced us to purchase a low-cost wooden water cistern to be located on a nearby elevated hill. The tank was found to leak and deform due to inadequate structural reinforcement. Furthermore, the M.D.C. was firmly opposed to any tank on the site, citing aesthetic reasons, and only after relentless (and costly) persuasion by local officials did they finally allow us to install the tank.

3. For consistency's sake we should also mention that the water distribution system also proved to be inadequate for the same reasons. Because of the M.D.C.'s objections to an on-the-site elevated tank, we were forced to spend limited funds on the installation of a long, expensive pipeline from the garden to the tank at the M.D.C.-approved location 325 ft away.

Phase 3: The Cape Cod Windmill.

Building a windmill on our own home site proved to be a far simpler effort than the first part of this project. As described in the Progress Report of September 27, 1979, we decided to install the second prototype on a 52-ft octahedral tower adjacent to the Cape Cod Bioshelter (Figure b).

This windmill is largely the same as that described in Appendix 1, with three exceptions. First, as described in Phase 1 of this report, we have experimented with a used automobile emergency brake from a 1969 Plymouth Duster. We are not yet satisfied with this design and will continue to experiment during the summer of 1981.

Secondly, as part of our efforts to make wind-powered water-pumping as economical as possible, we have attempted an innovative pump configuration which could reduce the overall system's cost by 40 %. This cost reduction is achieved primarily through savings in the cost of the well.

A windmill's performance and pumping capacity is directly related to the water volume capacity of the submerged positive displacement pump cylinder. For a windmill with a known stroke length, one can calculate the appropriate diameter cylinder for any particular pumping application. Accordingly, commercial pump cylinders can be purchased off-the-shelf in sizes ranging from 1 7/8-in diameter to 4-in in barrel diameter.

However, one cost consideration which the pump manufacturers tend not to mention is the exponentially rising cost per foot for increasing

well diameters needed to accommodate larger pump cylinders. For instance, on Cape Cod a 3-in diameter cased well costs \$8.00/ft to install. The next available size in our region, a 6-in cased well, costs \$26.00/ft installed! What this means for a prospective windmill is that a pump larger than 2½-in diameter requires a well that costs more than three times greater than the next smaller available size.

Our calculations indicated that our mill would be able to pump more than the load of a 2½-in pump with a 7-in stroke. Faced with the dilemma of paying the cost of a larger well, we opted to increase the windmill's stroke by an on-the-ground lever arm mounted adjacent to the well.

The prototype apparatus is described in Figure 6. A 52-ft by 3-in cased and developed well was installed off-set from the center of the windmill tower. The lever arm (still under construction) is designed to operate by cable and weights from the windmill rotor and to connect to the polish rod in a manner that is similar to that of a commercial pump jack or oil field pump. We expect to achieve a stroke increase of 2.5X with this system.

The third and final feature that distinguishes this windmill from its predecessors is the sail design. We have developed a more efficient sail shape and have employed a heavier, 5.4-oz cloth with a new, experimental ultra-violet resistant coating. We have selected North Sails of Sniffden, Connecticut, as the first manufacturer of this sail. We allowed the rotor to spin unloaded for three weeks in October, 1980, and are very pleased with the sails. We will know in three-to-four years whether the ultra-violet protective coating actually is effective.

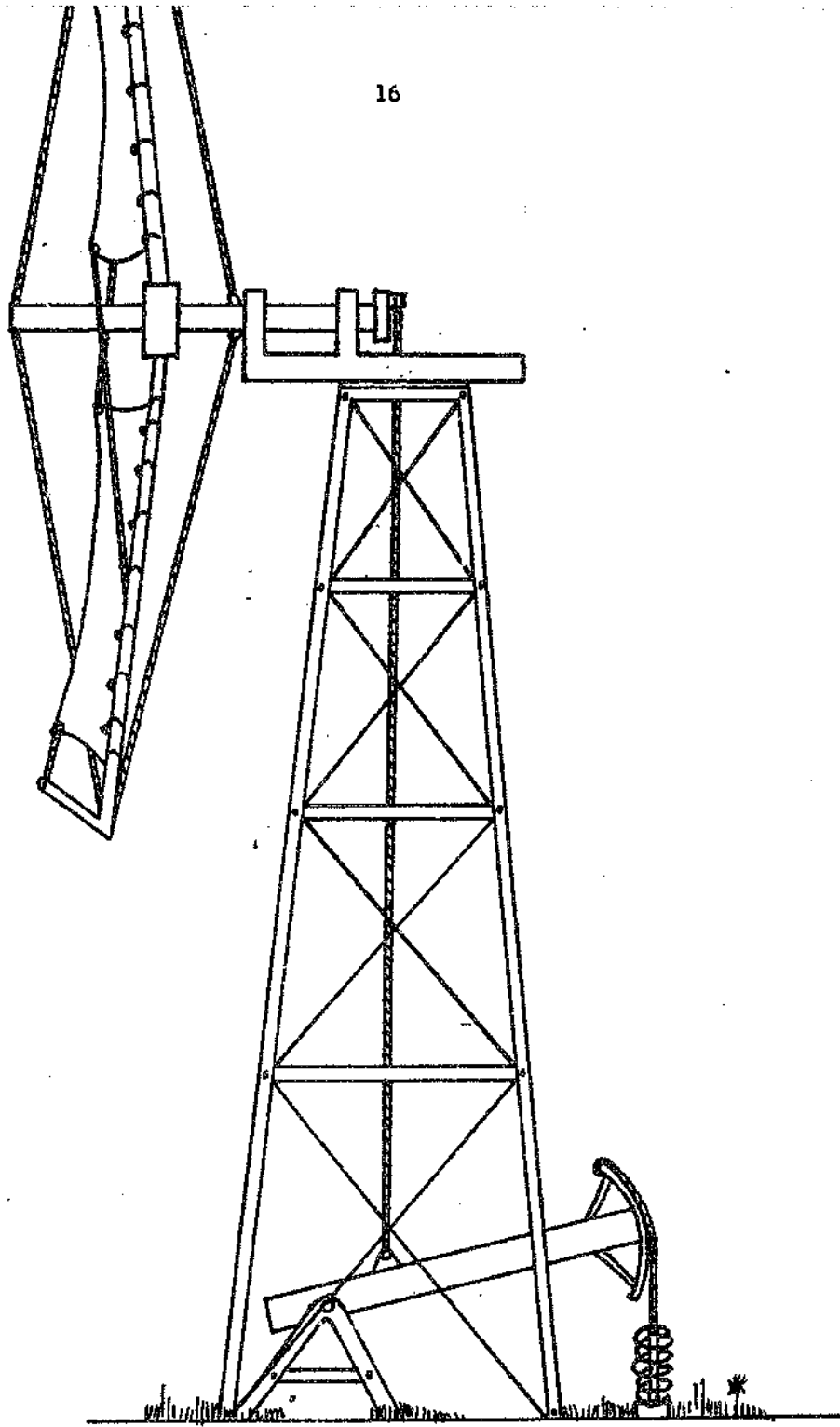


Figure 6 Schematic of cost-saving pump lever arm under construction at Cape Cod Sailwing

Phase 4: Educational and Related Efforts.

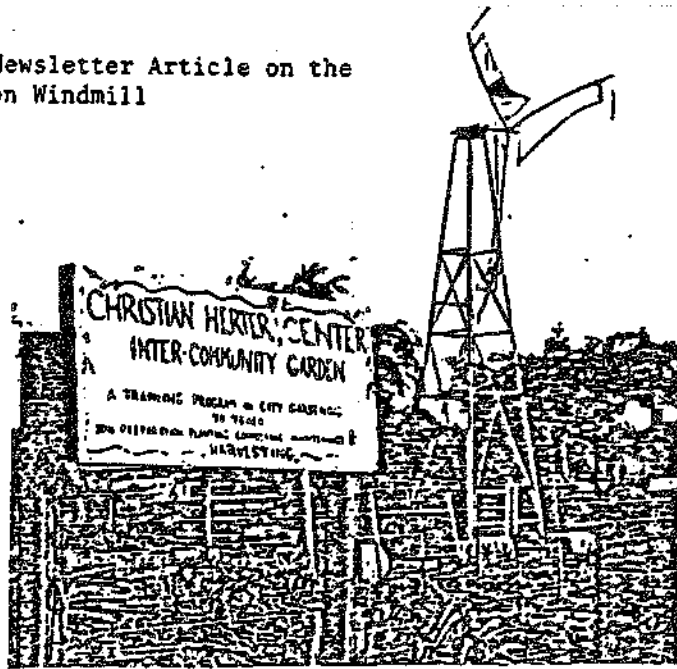
Three primary publications have been produced or are in production as a result of this effort. Appendix 1 is a set of plans which are being distributed to New Alchemy Institute members at a cost of \$5.00 for a limited printing of five-hundred copies. These plans are included in a second publication, "The New Alchemy Water-Pumping Windmill Book", by Gary Hirshberg, to be published by Brickhouse Publishers, Inc., in August, 1981. (See Appendix 5.) Finally, the plans are being included in a guide to water-pumping windmills for Boston's community gardeners which is being written in conjunction with the Suffolk County Extension Service. Cost and distribution information regarding this booklet is not yet determined, but it is expected that plans will be available to Boston residents at low cost by mid-summer, 1981.

Other related efforts:

- A slide show describing the Sailwing windmill has been prepared and is available upon request for a modest fee from the New Alchemy Institute. The show has been delivered to twelve audiences and over nine-hundred people.
- On-going educational efforts at the New Alchemy Institute and the Suffolk County Extension Service have exposed over 6,500 people to the windmill through workshops and courses. (See Appendix 6.)
- The Boston media have capitalized on the machine through television and newspaper photographs. (See Appendix 7.) At least two appropriate technology journals have documented the project. (See Appendix 8.)
- Perhaps the most exciting educational effort to result from this project has been the construction of a four-bladed Sailwing wind pump in rural Honduras, under contract with Volunteers in Technical Assistance (VITA). VITA officials

heard of the project through discussions with D.O.E. officials in Washington. As a result, Principal Investigator Hirshberg was sent to Honduras in March as a VITA consultant. There, he constructed a third Sailwing windmill for a small vocational school in Yoro (Figure 3). This very successful effort has been applauded by international technical assistance groups throughout the world and several more contracts are being negotiated. Incidentally, the vocational school is planning to manufacture the machine for commercial distribution throughout Honduras.

APPENDIX 2 NAI Newsletter Article on the
Boston Windmill



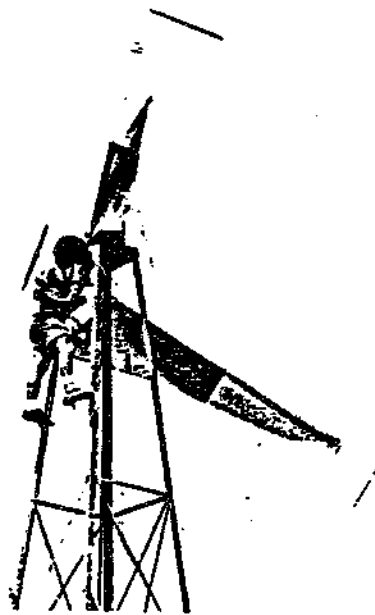
A WINDMILL FOR BOSTON'S URBAN GARDENERS

These days, outreach at New Alchemy takes many and diverse forms. New "how-to-do-it" publications, an expansion of the Saturday programs, and the proposed food and fuel cooperative (see page 1) are among our creative responses to an increased demand for our services. We recently completed our first effort in an entirely new dimension of outreach activities — the construction/demonstration of a New Alchemy technology in an urban area.

The project, which was sponsored by the Department of Energy Small Grants Program constituted the latest chapter in the saga of the New Alchemy Sailing windmill. Funds were provided for the demonstration of state-of-the-art urban and rural mills. The rural mill, which will be used to provide water for the Cape Cod Ark, is currently under construction.

The urban effort represents our first attempt to move from research into an off-site application of a working New Alchemy design. The windmill will be employed to provide water to one of Boston's many community gardens, a fifty-family plot along the Charles River in Allston. The garden is located at the Christian Herter Center for Energy and Ecology, and is now in its seventh season. It is small, roughly one acre, and is used by local families as a source of fresh produce. Like most of Boston's urban gardeners, they have resurrected undeveloped soils (their's is a landfill from Boston's subway tunnel diggings) to create an important food producing landscape. And, like most of the city's urban gardens, access to water was not a consideration in the garden's planning. The site is located on the banks of the Charles River, but the water quality of that water body is very much in question. After years of hauling water from their homes (by car), or from the Center's buildings (1/10 mile away), the gardeners installed a hand pump two summers ago. This had proved to be adequate for their needs, but was far from optimal, particularly for those on the opposite end of the site. The gardeners had attempted to construct a Savonius rotor for the job, but it had proved inadequate for the task. Out of desperation they turned to a number of local agencies for assistance.

Enter New Alchemy and the sailing windmill. Readers of *Journal 5* will remember that by 1978 we had evolved a machine which could be built by laypersons from local materials, but which still required a number of expensive machine shop components. Subsequent to that article, we redesigned the mill's machined



parts so that we had a windmill which was competitive with commercial machines, but which could be constructed totally from off-the-shelf components at a considerable cost savings.

We seized upon the opportunity afforded by the DOE Small Grants Program, to fund the new construction effort, and turned to Boston's Suffolk County Extension Service for help in selecting an appropriate urban demonstration site.

What a site we chose! The Herter gardens are located on a Metropolitan District Commission (MDC) recreation park, near a busy commuter artery. In addition to the hundreds of walkers, joggers, and roller skaters who pass by daily, the gardens and windmill are clearly visible to thousands of motorists who pass the site each hour. The winds off the river are magnificent and steady. Located close to the river, the water table is only five feet below the surface.

Let me say from the outset, that our first off-site demonstration was a thoroughly educational experience for all parties involved. In many cases, our most important tool was our sense of humor. Working in an urban—and yes, foreign—site posed a great many interesting obstacles. In fact, it was on the very first day, when the first shovelfuls of earth were being removed, that I knew we were dealing with an entirely new animal.

The project had begun innocently enough. We started by marking out the holes for our tower footings, and commenced digging under the hot August sun. The cameras snapped, the shirts flew off, and three of us charged into the task, delighted at last to be underway. But the euphoria was not to last terribly long. After digging one foot into the ground, we came upon a substrate which can only be described as "bolter plate" — a magnificent subterranean monument to the era of subway tunnel digging nearly one hundred years earlier. The earth would move for neither shovel, nor pick axe, leaving us no choice but to turn to that most appropriate of urban technologies — the jackhammer.

Renting the jackhammer proved to be a far less simple task than that to which we country bumpkins were accustomed. We quickly learned that credit cards and the other half-dozen identification plates which stuffed our urban friends' wallets did, in fact, have a function. Our rental man turned out to be a thoroughly skeptical character. From behind his Jimmy Carter grin, he

relentlessly harangued us on every aspect of our efforts. hours of haggling and explanations (yes, we really are but a windmill . . . yes, it *really is* for pumping water . . . no, v crazy . . .) we were back in our holes, communing with ter firma through the most exhilarating of media. All went rea well for at least two more feet when suddenly we learned deep the water table really was.

It seems that the water was particularly high at this time o due to water flow controls along the river. Perched in our built ponds, ankle deep in the now steadily flowing stream water, we paid the appropriate respects to Neptune, Bill McLamey, and Jacques Cousteau, contemplated the aqu prospects now available, and lost ourselves in a mire of alligator jokes from childhoods passed. In time, the reality absurdity) of the situation now very much upon us, sobriet gained control and we set out to complete our newly defi Jackhammering in two feet of water is an experience one not go without.

When we returned our trusty tool, our rental man let loose barrage of chatter from behind his grinning jaw, teasing ar slapping for almost twenty minutes: "Washed my machine haw, haw . . . Have a good time on your windmill, Don Qui . . . Haw, Haw." I would have left him behind after a minut he not had possession of my \$100 deposit. Besides I had l'd be seeing that silly grin again.

At last we escaped. Off to the bar to celebrate Day 1.

Things progressed in a similar fashion for several months! There were the months of waiting for shipment of the right finding it at the wrong depot, and then waiting for the rema components to find their way past trucker strikes and steel to the windmill site. When the tower finally did arrive, we fo be defective, but rather than wait for the predictable delays in another round-trip of shipping, we set out to build our o the available pieces. Fabricating our own version proved to an interesting task in light of the fact that the nearest electr (for drilling through the steel members) was several hundr away. Undaunted, we built ourselves a sturdy, improved, a somewhat vandal-proof tower, and then employed another appropriate urban technology to transport it to the windmill (see photo below).

Then there was the day that the concrete was delivered to 1 wrong MDC Park ("Whoops, sorry about that."), but that is another story.

By the time we had the hardware and masts erected on the tower, autumn was upon us. Responsibilities on Cape Cod, fact that the gardens would be dormant for months, and the convenient breaking of the principal investigator's ankle, ga reason to hold off on the project until warm weather returne

We set Earth Day, April 20, as the target date for completio the machine. Five-thousand Bostonians would be enjoying : day's celebration at the Herter Center and gardens, and the gardeners would be busy preparing their summer plots. It s the perfect day for a dedication, and a marvelous demonstr opportunity.

Five days before the celebration we set out to make the fina adjustments and to install the home-built, low-cost pump for christening. The new sails were rigged, and the rotor was ra Gardeners were put to work burying the pipe for the water distr system; indeed the site was buzzing with activity. We let her that day, anxious to get some test data before the Earth Day dedication. Gently, gracefully, she turned, her bright yellow/ sails luffing beautifully in the April breeze. Sure enough, fro below came that familiar gurgle. The water flowed forth in la bursts of spray — at a rate heretofore unmatched by any of earlier mills. It was a wonderful experience — it always is —

first few gushes of murky well water, the usual round of applause, back slapping, and plaudits all around . . . but we spoke too soon. The water ceased flowing. The wind rotor continued to turn, steadily, powerfully . . . but the problem was somewhere in the pump below. Off to the bar to assess the situation.

Day 2 was spent troubleshooting. After dismantling the pump, checking the leathers, and manually using it to lift water from the Center's toilets, we determined that the problem was in the well. The well's recharge capacity was not up to the pumping capacity of the wind machine. Simply put, the well would not draw water fast enough for the windmill.

A number of options are available to any do-it-yourselfer in this predicament. One can rent the appropriate-sized pump to "pump out and develop" a well for higher yields, or one can hire a professional well driller to approach the problem from any number of angles. However, on a Friday afternoon in Boston none of the traditional options were available. Well drillers had left the city during the era in which the subways were dug; the nearest driller was over thirty expensive miles away, and he had "enough work to keep me busy 'til my days are done." And you know the urban rental story; renting a pump was not an option. I could not face my grinning friend at the rental center, especially to rent a fossil fuel powered pump.

The time for ingenuity was upon us. We rose to the occasion in true Alchemical spirit. If the well would not provide for pumping on Earth Day, we'd just have to pump water from another source. My compatriots gave me that puzzled look I'd seen so often throughout this project. As I turned my gaze to the nearby river, it dawned on the group exactly what we must do.

Sucking water from the river forty feet away was the only obvious solution. Sure, the water quality is poor, but for the Earth Day demonstration we only needed to show that the mill could pump water.

Day 4, twenty-four hours before the celebration, dawned sunny and calm, a glorious day for ditch digging. The job at hand was simple. The only complication was the need to lay pipe beneath a ten-foot wide sidewalk which lay between us and the river. With three swings of the pick axe we realized that it was jackhammer rental time again. This time we were well prepared — our wallets overflowing with I.D. cards. Naturally, this turned out to be completely unnecessary as by now our identification was clearly stamped into our rental agent's memory. "Hello, windmillers," he grinned. "What's the matter, still at it?" I pondered a test run of the jackhammer, on that face full of grinning teeth, but reasoned that such behavior would not be useful to the task at hand.

That Saturday proved to be no different than any other day on the project. There were the wrong-sized pipes to contend with, and the many, many vital alterations needed to make the transition from the well to the river. There was the irate MDC policeman, who, upon seeing our half-completed jackhammered ditch across his sidewalk, threatened to ship us all up the river for life. We gently explained that getting to the river was exactly what we had in mind, and ameliorated his temper by elaborate explanations of our task. I fantasized Arlo Guthrie strolling in behind a chorus of Alice's Restaurant at that moment. In the end, it was the windmill's own charm which calmed our antagonist. He was last seen storming off, muttering something about Holland.

By day's end, the suction pipe was laid. We sent out to the local 7-11 Store for a pair of nylon panty hose, which were employed as a filter on the suction pipe intake. With sixteen hours to go, the end was in sight . . . or so we thought.

I should say at this juncture, that I am a most superstitious person. Were it not for the hectic nature of the day's events I would have taken the precaution of furling the wind rotor sails, so that they were out of the wind. But the day was calm, and the unfurled

sails gave the impression of a giant sunflower, a wonderful banner advertisement for the Earth Day celebration ahead. So left the sails unfurled that day, and tied one sail mast to the tower so that it would not spin and interfere with our pump work below.

It was at 5 P.M. on Day 4, sixteen hours before the celebration, that calamity struck. From out of nowhere, we experienced a gust of wind which confirmed all my beliefs in spirits, and particularly the ghost of one Christian Herter. We were hit with a wind which was so strong that it lifted wrenches and bolts off the work benches, bags of equipment, papers, and gardeners' clothing scattered in furious disarray. A garden cart was overturned, and a bottle blew over and crashed to the ground. And then, just as sudden it was calm again. Three seconds had passed, and during that interval, our attention had been drawn from the windmill, to the madness at ground level below. Our senses returned, and we began to gather up our now chaotically strewn materials, when I dared to glance at the rotor above. The rotor arm which had been tied to the tower, was bent like a pretzel. That mysterious and sudden gust had caught the sails, forcing the large and powerful machine to turn against its stay, bending the steel mast.

We sent out for beer. An all-nighter was upon us.

Hours later, the damaged mast straightened, we set out through the wee hours to strengthen the weakened member with guy wires and support hardware. By early morning, the task was nearly complete, and we gave ourselves a few hours to sleep and prepare for the final push.

Earth Day dawned sunny, clear, and windy as could be. The last few hours were spent bustling about at a dizzying pace. By now the crowds had gathered, and the job was at last completed.

Hundreds of people gathered below as I climbed to unfurl the mill. The brilliant sails stretched against the blue sky . . . the air was hushed in anticipation. As the last sail was connected and the machine began its slow, steady revolutions, the gathering swelled. All attention focused on the water pipe below.

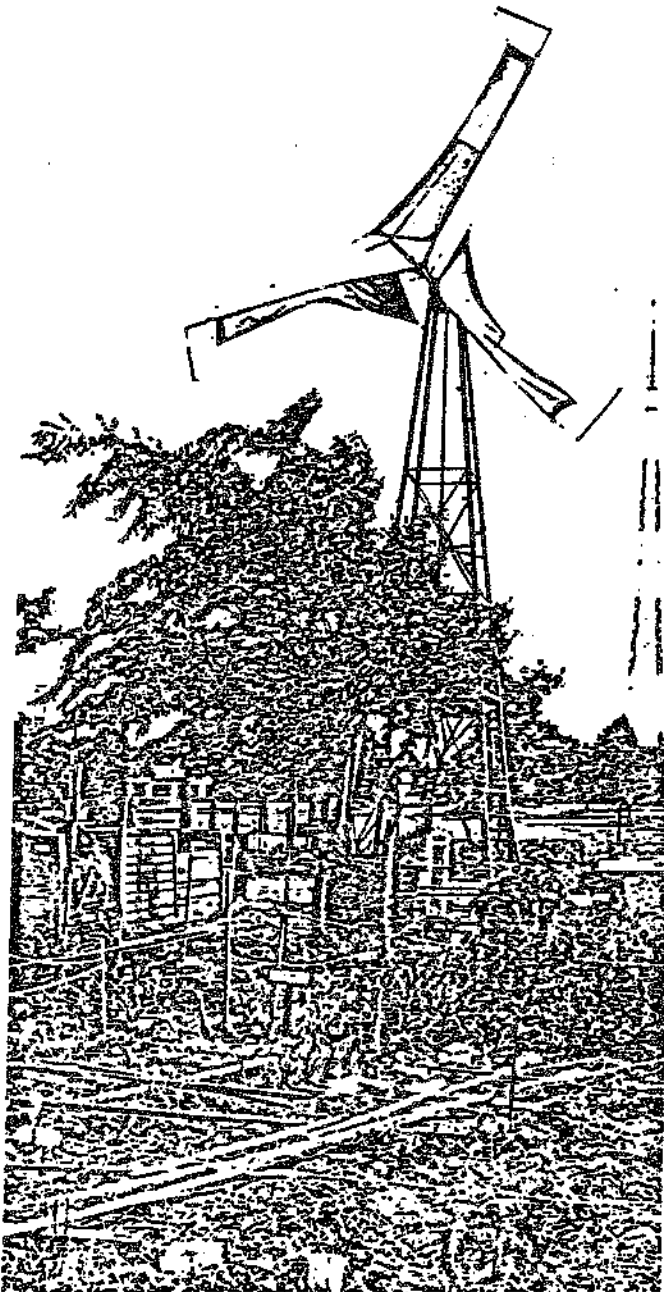
It takes a while for a pump to develop suction, particularly over a lift of that distance. But those minutes were pure agony. When last my patience wore thin, I placed my hand atop the exhaust pipe to feel whether, in fact, we had suction. Suddenly, that far vacuum was there. My hand slowly curled inward with the pump suction stroke, and then exploded upwards atop a tremendous surge of water. The crowd cheered and the windmill, as if encouraged by the attention, gushed forth hundreds of gallons in minutes.

By day's end five-thousand visitors had taken their turns at passing hands through the shower of wind-pumped spray. We were about spent and drunken with exhaustion.

The well is presently being developed, and the mill is set to begin running on a regular basis on May 26th. A limited number of plans for building and operating the machine will be made available to Boston's urban gardeners through the combined efforts of New Alchemy and the Suffolk County Extension Service. We expect that a large number of New Alchemy sailwings will be gracing the city's garden sites in due course.

In the balance, and despite all the hassles, it has been a most educational effort for all of us. We learned a lot about fine tuning the machine so that it is truly ready for mass applications. We learned a lot about offering technical assistance in community other than one's own. Projects of this nature require an extensive base of support and community participation. In the end, it was the countless number of local volunteers who pulled us through.

Perhaps the most satisfying personal moment in the entire process occurred late on Earth Day after most of the crowd had left. As I climbed the tower to furl the sails for the evening, I heard



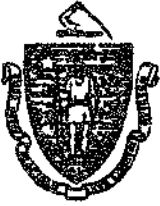
familiar voice call up from below. "You've really got something now, haven't you sonny?" I looked down, and knew at once why the voice was familiar. There, below me, beamed that rental man's grin.

— Gary Hirshberg

Plans for the sailing water pumping windmill will be available in two forms:

- (1) By August 1, 1980, a step-by-step construction plan (including a materials and components list) will be available to members of The New Alchemy Institute for a reduced fee.
- (2) In mid-winter, or spring, 1981, Brickhouse Publishers, Inc. will be publishing a Sailing "How-to-do-it" book entitled *THE NEW ALCHEMY WATER PUMPING WINDMILL BOOK*. This text, which will be available in both hardback and soft cover, will feature an extensive description of the Sailing windmill, including plans plus a complete primer on the history, use, and selection of water pumping machines. This book will be available for approximately \$5.00 U.S. at bookstores across the country.

SEP 4 1979



APPENDIX 3 M.D.C. Authorization Letter

The Commonwealth of Massachusetts

Metropolitan District Commission

Parks and Recreation Division

20 Somersel Street, Boston 02108

August 9, 1979

Mr. John Madama, Program Director
Christian A. Herter Center
1175 Soldiers Field Road
Allston, MA 02134

Dear John:

This is to give you approval to proceed with the Sail Wing Windmill project. It is my understanding that this project will be for pumping water for the vegetable garden.

The Herter Center is to assume all responsibility for the project including liability during construction and operation. Costs for all operation, maintenance and repair or replacement are also to be your responsibility. I assume you have made arrangements for necessary permits from the city as to zoning or conservation commission requirements.

The photograph and grant application is returned herewith.

Sincerely,

A handwritten signature in cursive script that reads "R. B. Williams".

ROBERT B. WILLIAMS
Park Director

REW/S
Encls.

APPENDIX 4 Letter to Susan Redlich, Mass. Dept. of Food and
Agriculture regarding future of Boston Windmill

April 28, 1981

Susan Redlich, Director
Division of Land Use
Department of Food and Agriculture
100 Cambridge Street
Leverett Saltonstall Building
Boston, Massachusetts 02202

Dear Susan:

This week I received a letter from the Christian Herter Center notifying me of their termination as tenants of the Allston Center. While this news does not come as a surprise, it does revive a fear I've long harbored regarding the windmill at the Herter garden.

For historical purposes, it is worth mentioning that the original decision to locate the windmill at the present site was predicated on the Herter Center's commitment to maintain and care for the wind machine (see enclosed contract). The Herter Center, in turn, expected that the gardeners would carry out their share of the responsibilities.

In fact, the windmill has never been properly maintained; what little maintenance was conducted was carried out by Herter staff, and never by the gardeners. Thus, my concerns emerge - without the Herter Center, what will happen to the windmill? My fear is that by the end of this growing season, a pile of useless hardware will be sitting in the middle of that garden.

I am completely sympathetic with the organizational problems associated with community gardens like the Herter group. I am by no means faulting those particular people. The original agreement was made with the Center, and not them. And yet I have never assumed at any time in the history of the project that the windmill would be useful without a committed, responsible, on-site maintenance person or crew.

The real purpose of this letter, which I have mailed to all of the parties listed below, is to encourage a "community" discussion of the windmill's future. It remains, and always will be, a valuable demonstration of an appropriate, non-polluting wind pump for urban and rural community applications. It may be that the Herter garden is simply not the right site at this time. All of the parties receiving this letter

Susan Redlich
Page 2
April 28, 1981

are involved in the community garden network. It is your windmill as much as anybody's. It would be wonderful if we could come to a positive, constructive resolution of the situation - either to work out a good maintenance arrangement at the Herter site, or to find a windy garden site with a committed, enthusiastic group of gardeners.

I am absolutely committed to seeing that the mill finds a good and useful home. I would volunteer weekend time to any proposed moving and re-erection effort. I would also be delighted to talk with any relevant parties about how to improve this situation. You should know that any move would probably cost about \$100-\$400, plus the costs of a well. And naturally, we'd be talking about a concentrated labor effort along the lines of solar barn raising jobs.

I hope we can move forward on this situation. I would suggest that you or any involved parties talk first with the Herter people and perhaps with parties advocating alternative sites. I'm available at any time to help on this matter.

Thanks terribly much for your time and consideration.

Yours,

Gary Hirshberg
Executive Director

Glick
Enclosure

cc: Charlotte Kahn, B.U.G.
Jay Vogt, S.C.E.S.
Melodie Elliot, Herter Gardens
Ed Goodell, Arboretum
Barbara Brandt, U.S.E.A.

The New Alchemy Water Pumping Windmill Book

Gary Hirschberg

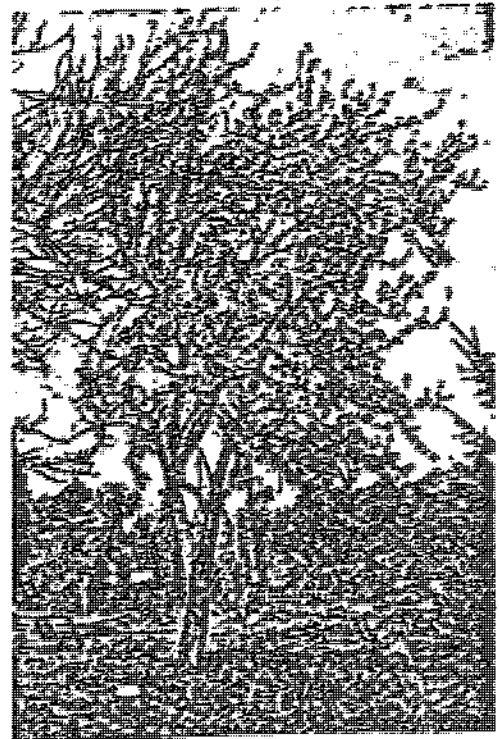
\$4.95 paper

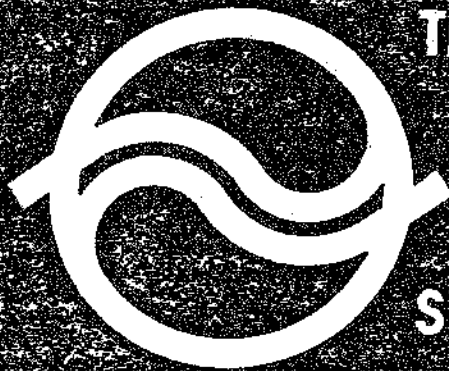
ISBN 0-931790-23-9

Approx. 128 pp. June 1981

6 This do-it-yourself construction guide to low-cost windpowered water-pumping windmills focuses on the NAI-designed machine. After noting the economics of wind power and the advantages of the NAI machine, Hirschberg tells you how to decide whether wind power will work for you, how to get started, and how to build a water-pumping windmill. The parts guide, step-by-step construction manual and the chapter on maintenance make this book the definitive guide to the subject.

Gary Hirschberg, the Director of the New Alchemy Institute, specializes in the design and testing of water-pumping windmills and wind-powered aeration systems. He is also an environmental education consultant for the U.S. Fish and Wildlife Service and for the National Audubon Environmental Expedition Institute.





The CHRISTIAN A. HERTER CENTER ENERGY AND ECOLOGY PROGRAMS AND EVENTS — SUMMER/EARLY FALL 1979

AUGUST

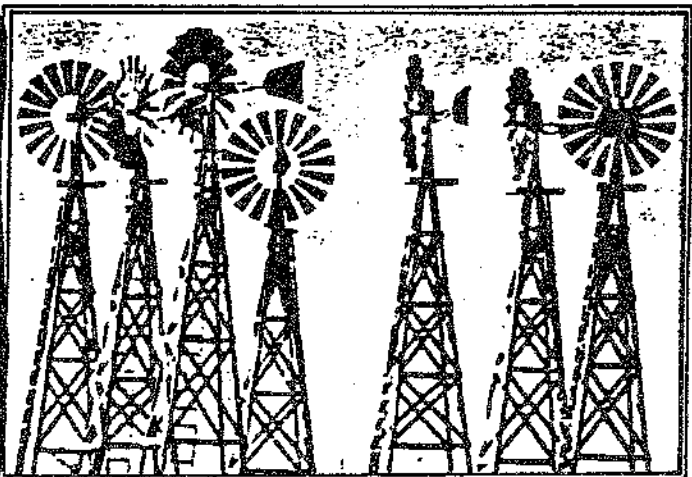
SAIL-WING WINDMILL

Construction of a water-pumping windmill to irrigate 50 community gardens at the Herter Center. Construction is planned for completion during the second week of August. Visitors are welcome to view the construction and ask questions.

WIND POWER LECTURE SERIES

Planned to coincide with the construction of our sail-wing windmill. Slides, films, lectures, and discussion in cooperation with Suffolk County Extension Service and New Alchemy Institute. All lectures at 8 p.m.

- August 6: "History of Wind Power" — A historical overview of wind power from Medieval Europe to the present. Ward Stoger, Department of Mechanical Engineering, University of Massachusetts.
- August 9: "Wind Power and the Third World" — Prospects and problems in using wind power in less-developed nations. Marcus Sherron.
- August 13: "A Water-Pumping Windmill Primer" — A basic introduction to the history and technology of water-pumping windmills, including the sail-wing being built at the Herter Center. Gary Hirschberg, New Alchemy Institute.
- August 16: "Wind Power in New York City: Barriers and Triumphs" — The still-unfolding story of attempts to construct a powerful wind generator in an urban area and the issues it raises. Ted Finch, Bronx Frontier Development Corporation.
- August 20: "Generation of the Wind" — A remarkable film about the people who designed and built the wind generator at Cuttyhunk Island, Mass., one of the largest wind turbine generators in the world.
- August 27: "Prospects for Wind Power in Massachusetts" — A discussion of the statewide potential for wind power development, with information on important new programs. Joe Fitzpatrick, Sandy Turner, Philip Rutger, Massachusetts Energy Office.



ADVANCES IN ORGANIC GARDENING

- August 15: Slide lecture on the latest research and methods in pest control, companion planting, and fertilizers. Colleen Armstrong, New Alchemy Institute. 8:30.

SOLAR ENERGY WORKSHOP I

- August 18: Includes basic concepts of solar energy such as space heating and cooling, active and passive systems, state-of-the-art technology, and present and past solar projects. Fee of \$35 includes *Solar Home Book* by Bruce Ar Jensen. Barbara Putnam, architectural designer, Total Environmental Systems, Inc. 9:30 a.m.-5 p.m.

OUTDOOR PERFORMANCE BY THE BOSTON BALLET

- August 23: At the Herter Center. 8 p.m.

GARDEN DEMONSTRATION TRAIL

A brochure-guided walk describing various gardening techniques and designs at the Herter Community Garden.

Earth Day — festive day of concern, celebration

By Gayle Pollard
Globe Staff

Environmental and energy concerns blended yesterday at a celebration of the 10th Earth Day held on the grounds of the Christian Herter Center in Allston.

An estimated 2000 people viewed exhibits at the program sponsored by 35 community and environmental groups.

Some listened to a specific energy message.

"There is an energy crisis. Everybody gets their gasoline bills and heating oil bills. This is a real problem," said Harold J. Keohane, the US Department of Energy's (DOE) regional director for New England. He predicted balanced energy production, "but not at the expense of the environment."

State Energy Secretary Joseph S. Fitzpatrick said, "People will become more aware as to how important the issues of food and energy are in the 80s . . . As for the state commitment, I don't see why 10 years from now, we don't have 25 percent (of energy) from renewables (sources such as solar, wind and hydro.)"

Since that first Earth Day, the federal Congress has passed "10 major laws having to do with protecting the environment," said Joan Nicholson,

public affairs director of the Environmental Protection Agency.

"I'm glad somebody's concerned" she said, "considering every one of us breathes 12,000 quarts of air in those two little lungs every 24 hours."

There were displays on oil production and consumption, low-income solar homes, urban farming, and zero population growth.

A tan DOE bus powered by alcohol ferried riders from Brattle Square in Cambridge to the celebration on Soldiers Field road.

Wind power turned the green and yellow sails of an irrigation windmill that watered a community garden. The breeze also sailed kites.

At the Boston Clamshell booth, Amy Flax of Boston, sat behind a table of T-shirts, pamphlets and buttons with slogans such as "Nuclear Power No Thanks," in English and Japanese.

"We're against nuclear power, because basically it is the most destructive thing we have on earth," she said. "It has the potential to destroy the earth."

The energy officials were asked about those concerns.

"The environmentalists' concerns are healthy," said DOE's Keohane. "They put pressure on government regulatory agencies such as the NRC (Nuclear Regulatory Commission). They sharpen the sensitivities of utilities . . . No doubt there are dangers in every utility."

Environmentalists have other concerns, said Barbara Gard Scheller, a staff researcher on solar energy for the state energy office.

"Environmentalists fear now we will go rushing into energy solutions that are not sound. A lot of environmentalists are afraid that because we're gaining out of comfortable sources such as gas and oil that we will turn to quick remedies rather than safe remedies," she said.

For some, Earth Day meant a good time on a balmy day.

A lightweight globe, about 20 times the size of a beach ball, bounced from hand to hand as a circle of people tried to keep the ball aloft. Some flew kites. Others tossed Frisbees and whizzers, similar toys made of parachute material.

Others listened to music, ranging from a classical brass ensemble to a contemporary jazz band. They snacked on chicken, and lasagna. They took free canoe rides on the Charles River.

Karen DeNitto of Cambridge, painted faces. She was asked how face-painting fitted in with Earth Day. "It's a celebration of life," she said. "I bring out the life in people's faces."



Tree acts as balcony for a youngster to hold the Cam-