Small Savonius Wind Generator

5 Watt 12v DC

http://www.energybook.co.uk

http://www.wxtrade.com

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Introduction to the Savonius wind turbine

Wind units can be divided into two major types, horizontal axis and vertical axis machines.

Horizontal machines some times known as HAWT (Horizontal Axis Wind Turbines) are the traditional conventional design, they consist of a rotor with one to twenty blades driving a generator or a pump either directly or through a gearbox, chain or belt system. A tail vane or fantail is required to direct the machine into the wind.

They are usually more efficient than vertical axis units known as VAWT (Vertical Axis Wind Turbines). Savonius and Darius are two designs of vertical axis machines. This type of unit is often not situated on a tower and does not have to be directed into the wind. Materials and construction are usually cheaper than horizontal axis machines. The Savonius windmill was the brainchild of Sigrid Savonius of Finland. The racing driver of the 1930s said the secret of a good machine was to "add lightness and simplicate". A simple unit can be made by attaching two halves of vertically split oil barrel to a vertical axis this produces a low speed high torque unit that can be used for pumping water and through a gearing mechanism, generating electricity. This design also has the advantage of an aerodynamic effect called the "magnus principal", suction is formed by the air moving over the convex face of the rotor. This means that there is force acting on the face of the rotor pulling it into the wind.

About these plans

Small Savonius wind turbine made from a Sturmy Archer Dynohub 5 Watt 12vDC

This plan was developed to make use of the Sturmy Archer Dynohub a commonplace dynamo made in the 1960s and 1970s. The plan was originally written Peter Hanbury in the 1970s with the rights for reproduction in the 1980s. Since then many hundreds have been sold and successfully built. The plan is in its original form and may be a little difficult to read but if you have any difficulties after printing please email me plans@energybook.co.uk



Sturmy Archer Dynohubs are not made anymore. They are good for making wind turbines as the bearings are designed for heavy-duty wear as a bicycle wheel hub. Some were also designed with gearing for use on the back wheel. A description of the hub and how to maintain it is contained in this plan. Dynohubs come up for sale from time to time on www.ebay.co.uk , www.ebay.com

and www.wxtrade.com but can also be sourced from second hand bike shops. These can be found by searching through www.google.co.uk or www.google.com for example. A supplier of dynohubs in the UK can be found at http://www.oldbiketrader.co.uk .

There are several new dynohubs on the market. They will no doubt produce superior results to the Sturmy Archer unit but also costs a lot more money. They can be purchased from sellers on ebay and form bicycle shops on the Internet.

I hope you have great success and fun building your wind turbine. Please email comments, improvements and photographs of completed units to

richard.jemmett@energybook.co.uk

Making a simple Savonius wind turbine by Lance Turner

This wind turbine, which is built from an old 12v permanent magnet electric motor, was downloaded form the following site:

http://www.ata.org.au/articles/70byosav.htm

It is naturally free for anyone to download buy my experience has shown that often websites change the content and valuable information like this is lost. Lance Turner's full website which contains lost of great information can be found at@

http://www.ata.org.au/

SMALL WIND GENERATOR

This manual gives full details of how to build a small wind driven battery charger. It may be used wherever a battery requires trickle charging and will be of intrest to boat and caravan owners.
The generator will charge at 6v or 12v at up to about 400 mA depending upon the wind speed. It will start to charge a 6v battery at approximately 10 mph wind speed and a 12v battery at approximately 14 mph.
Maximum output is reached at about 30-35 mph.

Wind generators are notoriously tricky to build and this design has been kept as simple as possible to ensure success.
The design is a good basis for further development and constructors with well equiped workshops will no doubt be able to improve upon the mechanical aspects of this wind generator.
The dyno-hub generators used should be in good condition as their magnetism tends to deteriorate with age and reduce their output.

The Rotor

A vertical axis "Savonius" type rotor is used in preference to the conventional horizontal axis rotor blade.
There are three main reasons for using this design :-

(1) It does not require heading into the wind.
(2) It is easier and less critical to construct than a propeller.
(3) No slip ring assembly is required to bring the current from the generator(s) to the windmill base.

The rotor is constructed from 18 swg aluminium sheet which is light and easy to bend and 6 mm ($\frac{1}{4}$") plywood.
The dimensions of the rotor are a compromise between obtaining reasonable performance in light/medium winds and not getting the structure too large. However if size is not important performance can be improved by increasing the height of the rotor to 24 inches or more.

The Generators

Two bicycle front wheel dynohubs are used to generate the charging current. These have the advantage of giving full power at low rpm, and also good bearings for mounting the rotor on.

The "Sturmey Archer" dynohub, despite its name, is in fact a multi pole permanent magnet alternator. Because it is an alternator it produces AC current, and this must be rectified to DC current before a battery can be charged.

Each dynohub requires a bridge rectifier, and then the two rectifier outputs are added together to give I2 volts DC.

The output of a dynohub at normal operating rpm is 6v RMS at 0.3 amp. When two dynohubs are used together, they tend to operate out of phase with each other and the overall effect of this is that the dynohubs give 400-420 mA at I.4 times normal rpm.

This current which is achieved at approximately 250 rpm cannot be exceeded, either by increasing the rpm or short circuiting the output.

The dynohubs should be in good condition, especially the bearings. The bearings may be adjusted by tightening the inner nut at the hub end of the unit until the play in the bearings is <u>just</u> removed. Take care not to overtighten.

The Frame

The frame can be made from a variety of materials depending upon the workshop facilities available.

The simplest method is to use mild steel angle (or Dexion). This can be quickly cut to length and bolted together, or the frame could be made of 2" x I" timber.

One advantage of bolting the frame together is that together with rotor the whole wind generator can be dismantled for storage in about ten minutes.

A more professional job of the frame could be made with mild steel or aluminium tubing of square or round section welded together.

PARTS AND MATERIALS REQUIRED

	Description	Quantity
FRAME	Mild steel angle.(or "Dexion") $1\frac{1}{4}$" x $1\frac{1}{4}$" or 1" x 1"	
	30" long	2 off
	27" long	2 off
	18" long	2 off
	12" long	2 off
	11" long	2 off
	$\frac{1}{4}$" diameter nuts, bolts and washers.	As required
ROTOR	18 swg aluminium sheet. 18" x 18"	4 off
	6 mm($\frac{1}{4}$") plywood sheet. 24" x 24"	2 off
	Pop rivets or 2 BA screws.	48 off(approx.)
	$\frac{1}{4}$" or 0 BA nuts, bolts and washers.	20 off
	3/8" long wood screws.	As required (see text)
	$\frac{3}{4}$" diameter mild steel pipe (conduit) $12\frac{1}{2}$" long.	1 off
	Jubilee clip, $\frac{3}{4}$" diameter.	2 off
ELECTRICAL	Sturmey Archer bicycle front wheel dynohub.	2 off
	2 core electrical wire. (plain)	5 feet(approx.)
	2 core electrical wire. (Red & Black or Brown & Blue)	As required
	Crocodile clips.	2 off
	Small box. e.g. 2 oz tobacco tin.	1 off
	Bridge rectifier, 1 amp 50 volt rating.	2 off
	1 amp fuse in holder.	1 off
	Terminal block. (Cut one length into two halves)	1 off
	6 BA screws, nuts and washers.	4 off
	Rubber grommets, $\frac{1}{4}$" diameter hole.	2 off
PAINT	Polyurethane varnish. e.g. PU-15	Small tin
	Enamel paint. e.g. Humbrol	Small tin

BUILDING INSTRUCTIONS

Aluminium Rotor Blades (see fig. I)

(I) Take two of the I8" x I8" aluminium sheets and carefully mark out 4 semi circles to the dimensions shown. (i.e. one circle on each sheet).

(2) Using tin snips cut out the 4 semi circles and bend the side tabs 90 degrees. Thus making four end plates.

(3) Take the remaining two I8" x I8" aluminium sheets and put a curve in them by bending them around a suitable curved object of approximately II" diameter. e.g. 5 gallon oil drum.

(4) Pop rivet or bolt end plates to each curved sheet.

(5) Cut a 2" radius semi circle out of each end plate.(to accomodate dynohub).

Rotor Disc Plates (see fig. 2)

(I) Take the two 24" x 24" plywood sheets and mark out two circles of 3.6" and 22" diameter as shown.

(2) Using a jigsaw cut out the circles and check that the dynohub just fits the centre of the disc.

Rotor Shaft (see fig. 3)

(I) Cut a slot with a small hacksaw approximately ½" long at each end of the I2½" conduit tube.

(2) Fit two jubilee clips loosely onto the tube.

(3) Fit two nuts onto a dynohub shaft and push fit the first nut into the tube until it is just inside. Repeat this procedure with the other dynohub at the other end of the tube.

continued

(4) With both dynohubs on the tube, tighten the locknuts, and then tighten the jubilee clip on each tube end onto the first nut. Check that the tube turns true. Adjust as necessary until it does. This tube alignment is most important and must be right if the rotor is to run smoothly.

(5) Release the two locknuts and unscrew one of the dynohubs from the tube.

Frame Assembly (see fig. 4)

(I) Cut the ten lengths of angle to size.

(2) Drill a 5/I6" hole in the middle of each cross member.

(3) Using a round file, file each hole into an oval shape until the dynohub shaft will fit into it.
The shaft should fit slightly loose to allow some shaft misalignment, but the flat on the shaft must stop the shaft rotating in the hole.

(4) Bolt the frame together. (It is often better to only clamp the top cross member in position until the rotor is fitted , and its correct position is found.)

Rotor To Frame Assembly (see fig. 5)

(I) Fit the dynohub with the tube into the bottom cross member, fit a washer and nut and loosely tighten up.

(2) Fit a plywood disc onto the dynohub flange.

(3) Place the two aluminium rotor blades onto the plywood disc so that the cut outs fit around the dynohub.

(4) Place the second disc on top of the rotor blades, and then fit the second dynohub through the disc, and screw it into the tube.

continued

(5) Check that the rotors are square with each other, and then tighten the dynohub shafts until the plywood discs just grip the rotor. Fit the shaft into the top cross member, fit a washer and nut, and loosely tighten the nut up. Bolt the cross member to the frame.

NOTE : The top and bottom dynohub shaft nuts must only be tightened up lightly to avoid straining the dynohub bearings.
Since there is not sufficient thread for a locknut to be fitted, before the generator goes into service the nut must be stopped from undoing. Possible ways to do this are :-

(a) By fitting a anti-vibration nut.
(b) Use "Locktight" fluid on thread. (recommended method)
(c) Drill hole in shaft and fit a split pin.

(6) Bolt the aluminium rotors to the plywood discs with twenty $\frac{1}{4}$" or 0 BA screws. (5 on each end plate).

(7) Screw the dynohub flanges to the plywood discs with 3/8" long wood screws. (3 or 4 screws per hub is usually enough to hold them)

(8) Tighten the locknuts at each end of the tube and check that the rotor spins freely. (some resistance will be felt from the dynohub magnets.)

Rotor Balancing (see fig. 6)

Check the balance of the rotor by placing the rotor frame on its side, and noting which position the rotor comes to rest at.
Add weights equally onto the rims of the two wood discs until perfect balance is obtained.

Wiring Connections (see fig. 8)

(1) Connect a 2 core wire to each dynohub output terminals and bring the two wires to the base of the frame. (tape or clip wires to frame)

(2) Connect the two bridge rectifiers to the terminal blocks, and mount inside a small box (e.g. tobacco tin) with 6 or 8 BA screws.

(3) Fit a small rubber grommet at each end of the tin.

(4) Bring the two wires from the dynohubs through one of the grommets and connect to the terminal blocks as shown.

(5) Connect a 1 amp fuse to the terminal blocks as shown. (to prevent damage to rectifiers if battery is wrongly connected)

(6) Bring a Red and Black wire through the remaining grommet and connect to the terminal blocks as shown.

(7) Fit crocodile clips to the ends of the Red and Black wires.

Testing the Wind Generator

Set a test meter to the milliamp range and connect it across the two crocodile clips.
Spin the rotor by hand, the meter should read 200-300 mA.
Set the test meter to the DC volts range.
Spin the rotor by hand, the meter should read approximately 12 volts.

NOTE : If you do not have a test meter use a small torch bulb.
Connect the bulb across the crocodile clips.
Spin the rotor by hand, the bulb should glow dimly.
When you measure the charging current do not forget to multiply readings by 1.11 e.g. 200 mA reading is 222 mA true current.
(This is because a meter measuring rectified AC measures mean current and not rms current.)

Weatherproofing

(I) The plywood should have several coats of paint or polyurethane varnish.

(2) The steel should be painted with enamel paint.

(3) The aluminium blades do not generally require painting, however for added protection near salt water they can be coated with an etching primer paint.

(4) To stop water getting into the top dynohub a small cover of approximately 4 inches diameter should be fitted onto the shaft underneath the cross member. (The end cut off a plastic bottle is suitable)

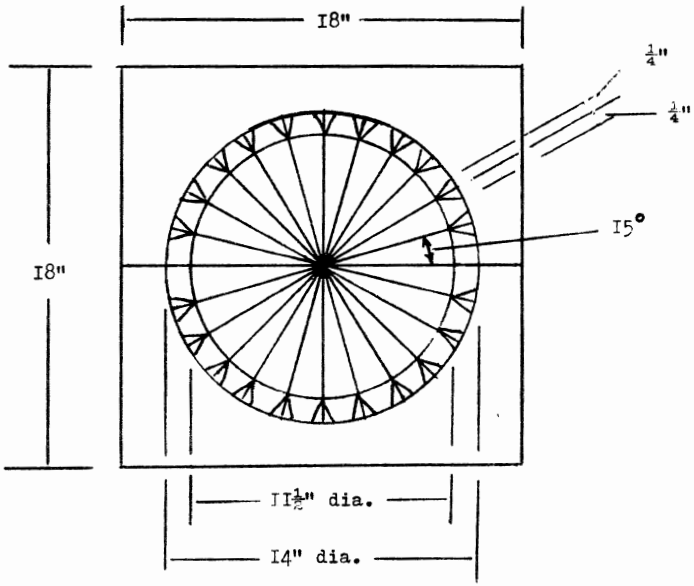
Using the Wind Generator

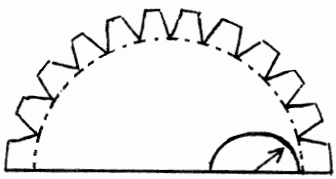
The generator frame shown in this plan is designed to be mounted on top of a flat roof of a boat, house or caravan. It must be firmly bolted in place. Within reason it does not matter how long the two wires to the battery are.
If the generator is erected on the ground, it should be fixed as high as possible, preferably IO feet or more in the air. The frame could be supported on two scaffolding poles held by guy ropes.

IMPORTANT NOTE

I. All the information supplied in these plans is given in good faith and believed to be correct. However, no liability can be accepted for any accident or injury resulting from their usage.

FIG. I - ALUMINIUM ROTOR BLADES

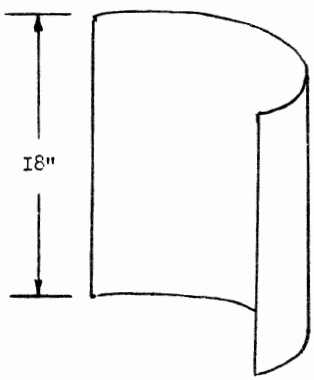


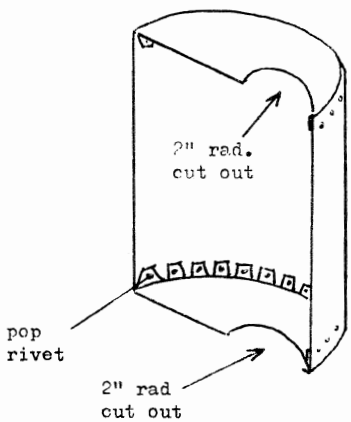


End Plate

(note: mark out 2" radius semi circle, but do not cut out until end plates are rivetted to sheet.)

Curved Sheet





Completed Rotor Blade

FIG. 2 - ROTOR DISC PLATES

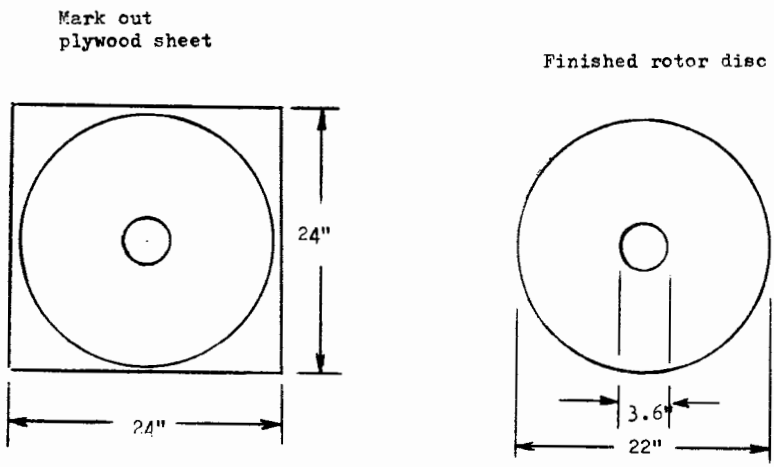


FIG 3 - ROTOR SHAFT

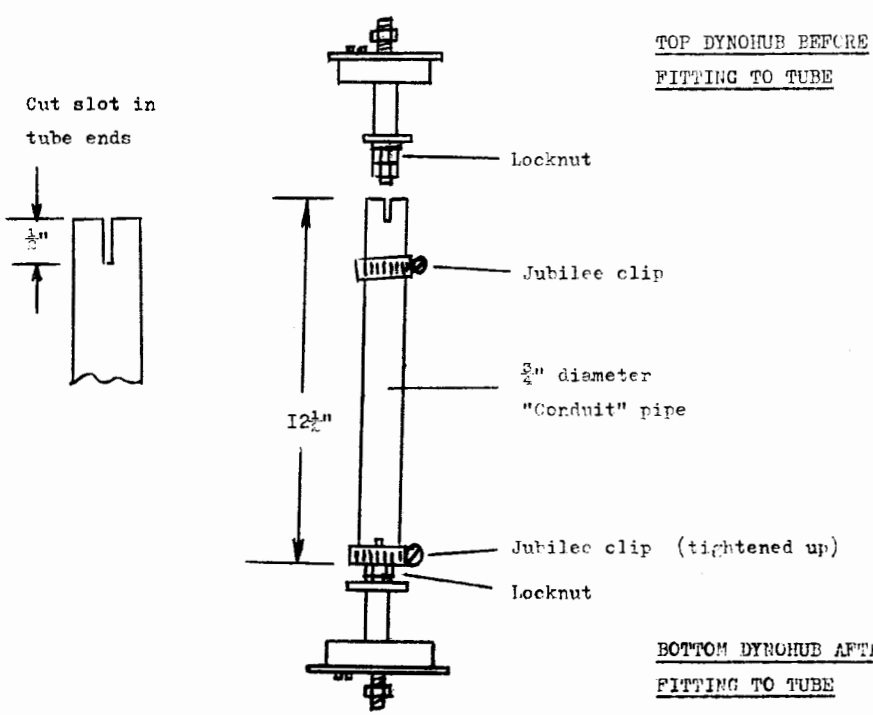


FIG. 4 - FRAME ASSEMBLY

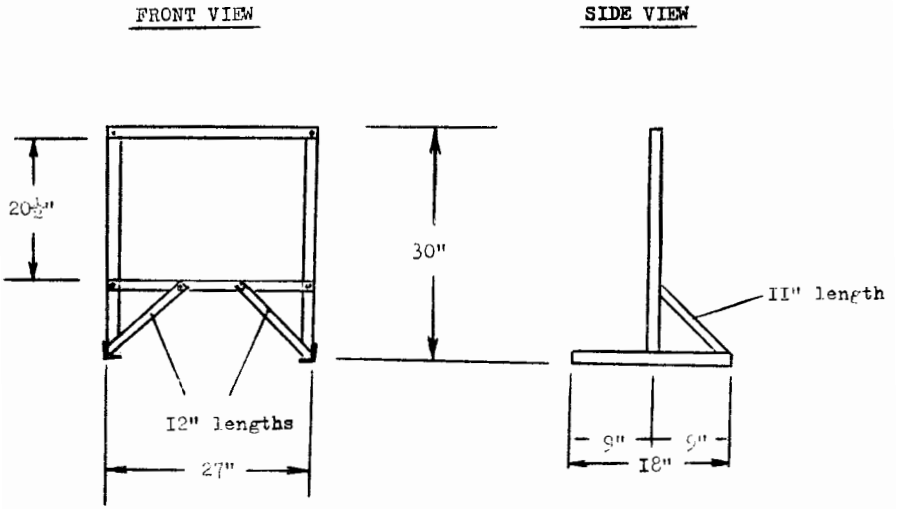


FIG. 5 - ROTOR TO FRAME ASSEMBLY

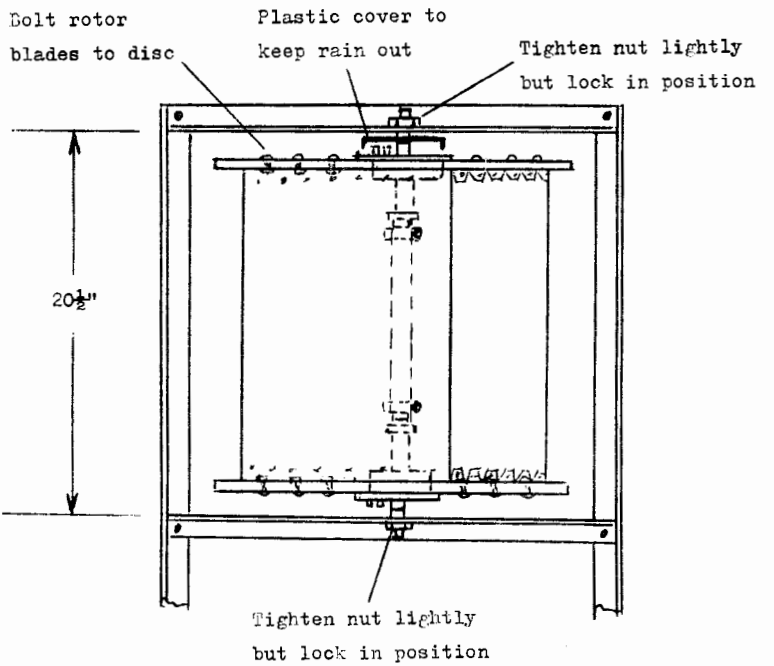
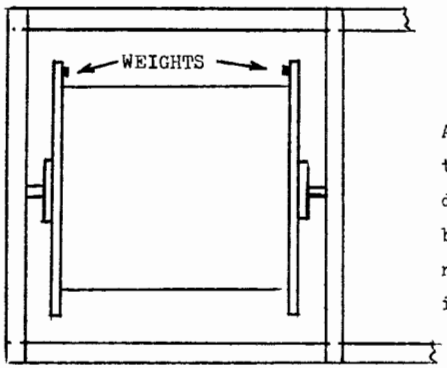


FIG. 6 - ROTOR BALANCING



Add weights equally to the each rotor disc until the rotor balances and shows no preference to stop in one position.

FIG. 7 - ROTOR PLAN VIEW

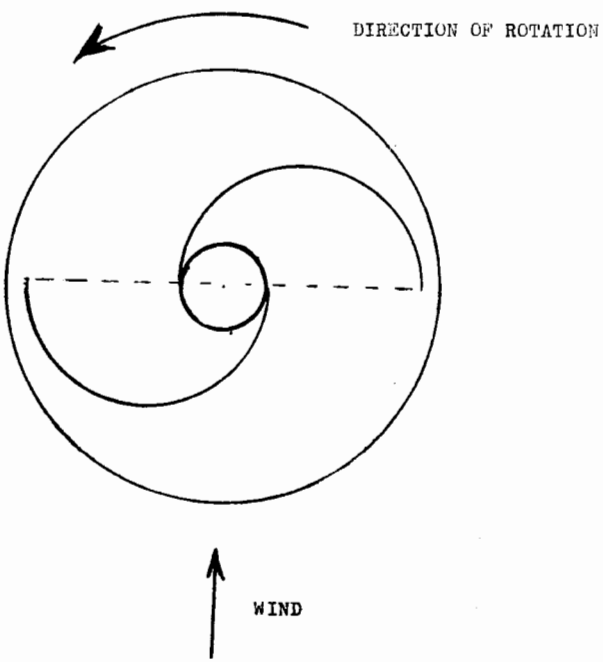
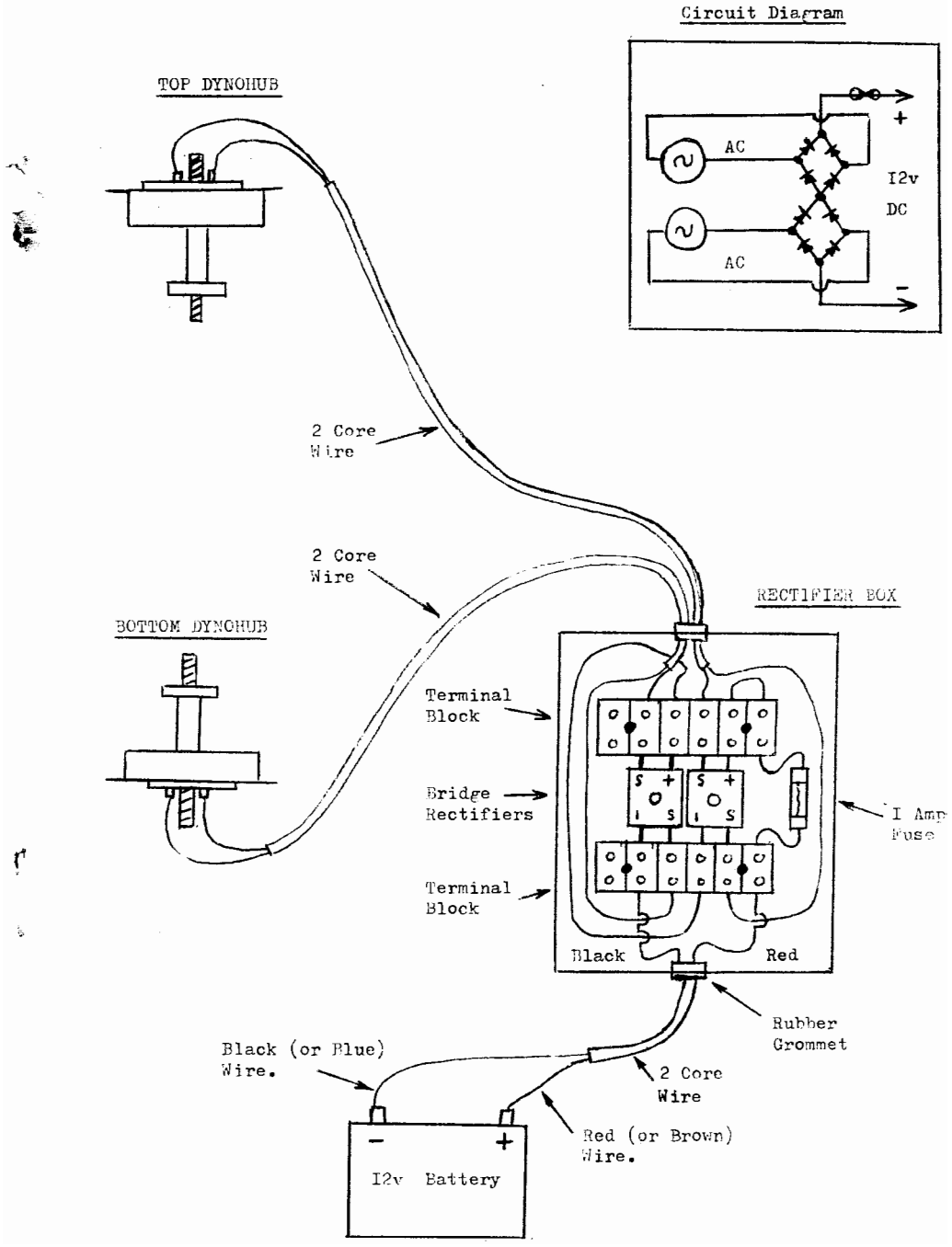


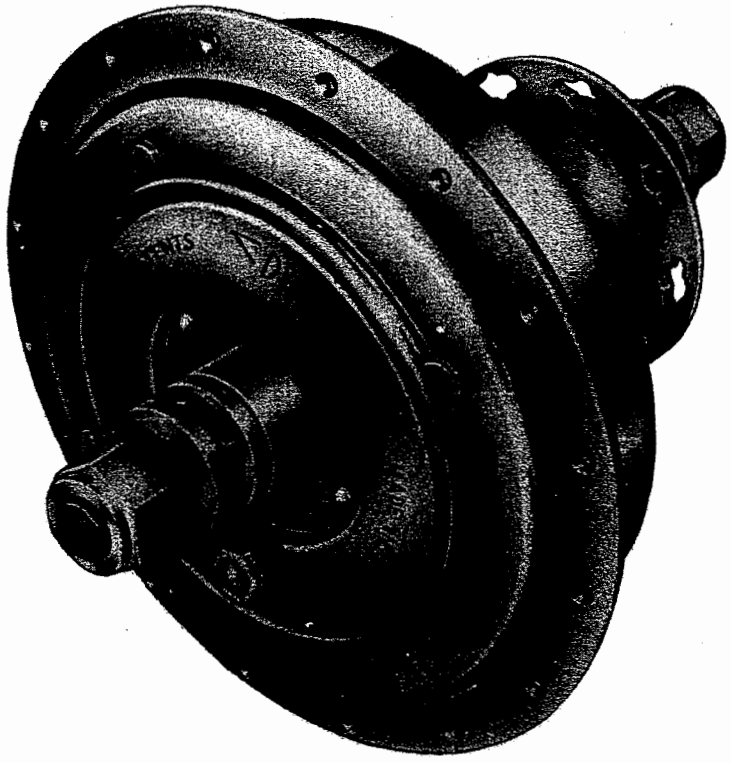
FIG. 8 - WIRING CONNECTIONS



STURMEY ARCHER

GH6 'DYNOHUB'

FRONT 6 VOLT LIGHTING UNIT



'Dynohub' lighting is bicycle lighting at its best.

Each lighting set consists of a hub generator, headlamp, rear lamp and connecting flexes.

The generator has no mechanical loss and electrically is highly efficient.

Other than the normal wheel bearings it is entirely without mechanical friction or wearing parts and the effort to propel is negligible.

It is silent and its position within the hub protects it completely from damage.

Attractive durable head and tail lamps provide high lighting efficiency.

CYCLE LIGHTING WITH A DIFFERENCE!

STURMEY-ARCHER GEARS LTD · NOTTINGHAM · ENGLAND A TI COMPANY

GH6 'DYNOHUB'

STURMEY ARCHER

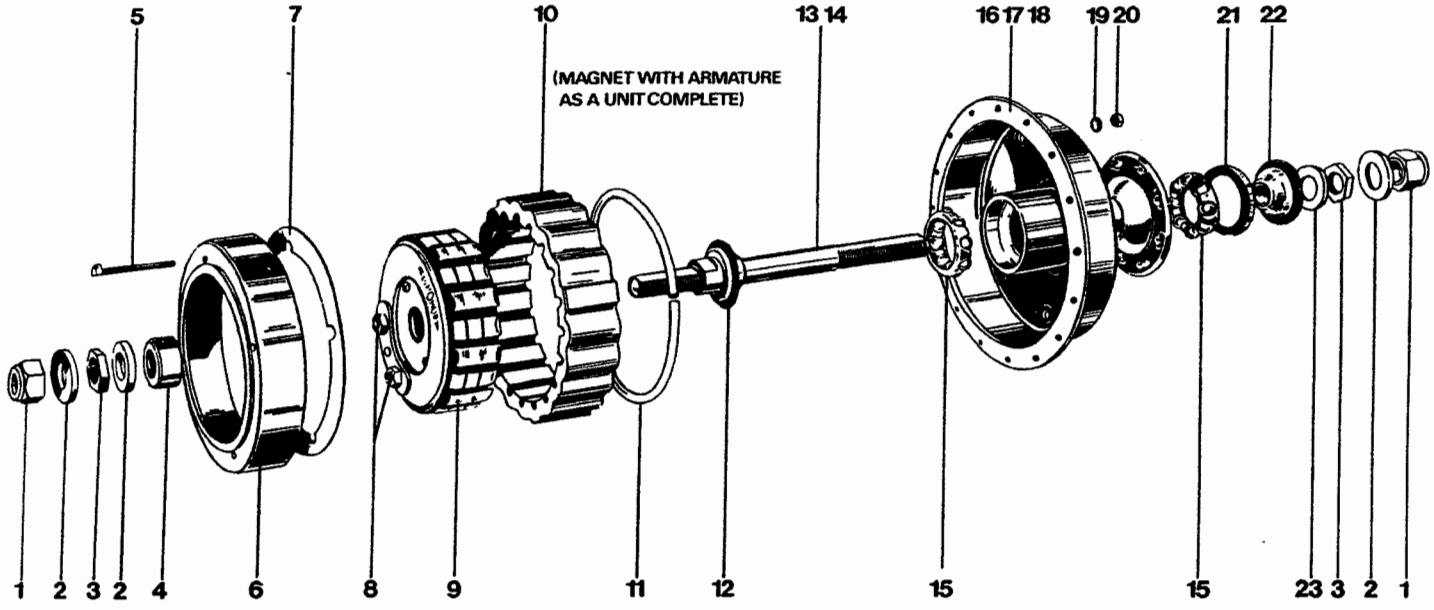


PHOTO No.	SALES No.	DESCRIPTION
1	HMN 118	Axle Nut
2	HMW 129	Spacing Washer – $\frac{1}{8}$"
3	HMN 137	Cone Locknut
4	HSD 301	Spacing Cup
5	HMB 135	Magnet Fixing Screw
6	HSD 302	Magnet Cover Plate
7	HSD 303	Card Disc
8	HMN 140	Terminal Nut – 2 BA
9	HSD 304	Armature, complete
10	HSD 425	Magnet with Armature Unit
11	HSD 306	Magnet Spacing Ring

PHOTO No.	SALES No.	DESCRIPTION
12	HSB 201	R.H. Cone
13	HSD 307	Axle – 5" long (127 mm.)
14	HSD 308	Axle – 4$\frac{3}{4}$" long (121 mm.)
15	HSA 284	Ball Cage
16	HSD 392	Shell – 28 Hole
17	HSD 309	Shell – 32 Hole
18	HSD 310	Shell – 36 Hole
19	HMW 158	Lockwasher } For magnet
20	HMN 141	Nut – 6 BA } fixing screw
21	HSA 102	Outer Dust Cap
22	HSD 379	L.H. Cone
23	HMW 146	Spacing Washer – $\frac{1}{16}$"

TO DIS-ASSEMBLE THE HUB

1. First remove axle nuts 1 and washers 2 from both ends of axle then unscrew right-hand (dynamo) side locknut 3, and take off washers 2, and spacing cup 4.
2. Unscrew (magnet-fixing) nuts 20, detach lock washers 19 and the magnet-fixing screws 5.
3. Hold the wheel, with the dynamo downwards (above the workbench). A few light taps with a mallet on the end of the axle will release the dynamo unit from the hub.
4. Lift out the magnet spacing ring 11 and ball cage 15 from the hub shell 16.
5. Remove the left-hand (adjusting) cone locknut 3, and unscrew the adjusting cone 22. Ease out (from the hub shell) the channel-section dust cap 21 (use a wide screw-driver). Lift out the ball cage 15.
6. Pull out the axle 13, (from the dynamo side) together with the right hand cone 12.

STURMEY ARCHER

GH6 'DYNOHUB'

POINTS TO CHECK

1. Bearing races and cones – for pitting and signs of wear.
2. Axle for straightness and damage to threads.
3. Magnet cover plate and between armature and magnet segments for grit and rust.
4. Continuity of armature winding.

NOTE – Unless it is essential, the armature and magnet should never be separated. If they are to be separated, a keeper ring is absolutely necessary, (an old armature will serve as a keeper ring). The magnet will lose its magnetism without a keeper. A moment's separation will cause loss of magnetism. (A spanner placed across the magnet is useless as a substitute for a keeper ring).

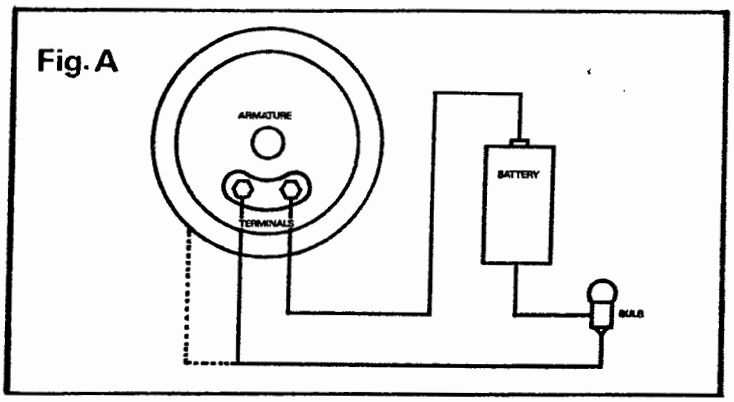
TO SEPARATE ARMATURE FROM MAGNET AND COVER PLATE

Hold the dynamo unit (terminal plate down) in the palm of the hand. Place a keeper over the armature – grip the edge of magnet with fingers and tap the keeper lightly – the magnet cover will slide off the magnet at the same time as the keeper replaces the armature.

ARMATURE CONTINUITY TEST

A battery and bulb should be connected as shown in the diagram 'A'. If the bulb does not light, a break in the armature winding is indicated.
A second test is to disconnect the lead from one of the armature terminals and touch the outer edges of the armature with a bare lead. If the bulb lights, this indicates a short circuit, and a new armature must be fitted.

Fig. A



TO REPLACE THE ARMATURE IN MAGNET AND FIT MAGNET COVER PLATE

Hold the magnet and keeper unit in the palm of the hand, place armature – terminals down – over the keeper and press the armature into the magnet. The keeper ring will slide out easily. Fit the card disc inside the cover plate – locate the notches in disc opposite grooves in magnet. Push magnet unit inside cover plate – chamfered edge of the magnet *inside* the cover plate.

TO ASSEMBLE THE HUB

1. Fit the ball cage 15 (with the ball-retainer ring facing outwards) into the left-hand (the smaller) end of the hub shell 16. Press the dust cap 21 (channel facing outwards) into hub shell. (If a new ball cage is fitted, the dust cap also should be new).
2. Fit the ball cage 15 (with the ball-retainer ring facing outwards) into the cup inside the hub shell. If the right-hand cone 12 (on the dynamo side) has been removed from the axle 13, replace cone and screw it TIGHTLY against the shoulder on the axle.
3. Insert the axle 13 into the hub shell from the dynamo-side.
4. Screw on the left-hand (adjusting) cone 22 and adjust the hub bearings. (A correctly adjusted wheel must have slight play at the rim – No play at the hub).
   Fit washer 23 and cone locknut 3 and screw it tightly against the left-hand cone 22.
5. Fit the card disc 7 inside the cover plate 6. Locate notches in card over holes in hub shell.
6. Fit the cover plate 6 over the magnet 10 (chamfer inwards), making sure that the four holes in the cover plate are in line with the notches in the card and the magnet.
7. Fit the metal spacing ring 11 into the hub shell 16.
8. Push the complete dynamo unit into the hub shell, making sure that the holes in the cover plate are in line with those in the hub shell.
9. Fit the magnet fixing screws 5, washers 19 and nuts 20.
10. Fit the spacing cup 4, washer 2 and dynamo cone locknut 3. Fit axle washers 2 and nuts 1

GH6 'DYNOHUB'

STURMEY ARCHER

'DYNOHUB' CORRECTION GUIDE

To test if 'Dynohub' is generating, remove wires from armature terminals, re-tighten terminal nuts and connect a bulb (known to be in good condition) across the armature terminals. Spin wheel smartly, – if bulb does not light satisfactorily, the armature may be faulty.

ELECTRICAL

SYMPTOM	CAUSE	REMEDY
Total failure	1. Faulty armature	1. Replace armature
	2. Broken wire in twin flex	2. Test each wire for continuity
	3. Burnt out bulb or broken filament	3. Test each bulb for continuity
	4. Incorrect wiring	4. Check wiring against appropriate diagrams
Low output (dim lights)	1. Magnet de-magnetised	1. Replace magnet/armature
	2. Bulbs which have been in use for a long time may not be 100% efficient	2. Test bulbs (with battery) against new ones
	3. Incorrect bulbs	3. Check bulb ratings (they must be correct).
	4. Incorrect wiring connections	4. Check wriing against appropriate diagram
	5. Corroded connections	5. Inspect all terminals and wire tags
Partial failure	1. Loose bulb or bulbs	1. Check if bulbs are fitted firmly
	2. Frayed ends of twin flex	2. Check each terminal point
	3. Terminal nuts loose	3. Check nuts for tightness (be careful not to use force)
Frequent burning out of bulbs	1. Loose contacts	1. Check all terminals in headlamp and rear lamp for tightness – bulbs must be firmly fitted in their sockets

MECHANICAL

SYMPTOM	CAUSE	REMEDY
Rubbing Noise	1. Usually caused by grit between cover plate and terminal plate	1. The groove should be cleaned and greased.
	2. Loose cones may permit armature and magnet to rub	2. Correct adjustment of cones
	3. Dirt between armature and magnet	3. The hub should be dis-assembled and cleaned
	4. The omission of the card packing disc which must be fitted between magnet and cover plate	4. Fit card disc

LUBRICATION

GH6 bearings are packed with grease – Shell Alvania No. 3.
Under normal riding conditions no further lubrication should be necessary.
When hub has been dis-assembled re-pack the bearings with Shell Alvania No. 3 grease or an equivalent good quality ball-race grease.

BEARING ADJUSTMENT

Left hand side (smaller end) of hub: loosen cone locknut and adjust cone suitably and tighten locknut.
A CORRECTLY ADJUSTED WHEEL HAS A TRACE OF SIDE PLAY AT THE WHEEL RIM – NO PLAY AT THE HUB

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Making a simple Savonius wind turbine

by Lance Turner



There are many situations where you might need a small amount of electricity, for instance running gate openers, safety lights, water level indicators and other low-power devices.

While solar would seem like the ideal solution, quite often this is not possible due to location and shading problems. Just such a situation arose when I decided to make our new gates automatic. There were just too many trees in the way for solar power to work, and I didn?t want to run power some 30 metres or so from the house, as it would have meant digging a trench for the cables, which is almost impossible in our rocky ground.

Why have automatic gates anyway? Well, our driveway and the one next door share a common entrance, so to open the gates we have to block their driveway. Also, the driveways are very steep, and starting off driving up from a standstill is not too good for the vehicle?s clutch. Besides, when an opportunity arises to install some form of new renewable energy device, how can I say no?

Anyway, I decided to provide power to the electric gate openers from a small wind turbine. While we don?t have many windy days, we do have one or two each fortnight where the wind blasts through for at least 24 hours solid, so I guessed that I should be able to power a device with such modest power requirements as a gate opener in this way.

The gate opener system itself is a home-made job, using car windscreen wiper motors driving long brass threaded shafts. These run through a nut which is attached to the gate via a steel tube, bolt and two metal rackets. The motors are hinged, and when they are run they either push the nut away from them or pull it toward them, thus opening and closing the gates. The control circuit for this is a kit purchased from Oatley Electronics in Sydney, and includes a courtesy light function, remote control, and motor current sensing.

Too much turbulence

I briefly thought about what type of turbine I could install and how it would look. Safety was another factor, having curious children who can climb just about anything. For these reasons I decided against buying a small horizontal axis turbine, they are too dangerous when close to the ground and in touching distance, so I decided to install a Savonius rotor instead.

This type of vertical axis rotor is very robust and durable if built correctly, is relatively slow turning and can be easily built at home, without the hassles of aerofoil blade design and other problems associated with horizontal axis ?propeller? type turbines.

What?s more, unlike a horizontal axis turbine, a Savonius is always facing the wind, and more importantly for this site, is not badly affected by turbulence, which is quite high where the turbine had to be located.

As can be seen from the photo, the turbine is mounted quite low due to it being on a residential block. While this is far from optimal, it should provide enough power for the gate openers providing it is used with a battery of relatively high capacity.

Making the turbine

The turbine was made from three disks of 1.2mm aluminium sheet 330mm in diameter and a length of 150mm diameter stormwater pipe about 600mm long. This was cut in half in both directions, across and lengthways, to provide four vanes for the turbine. These vanes were then assembled between the three disks as shown in the photo. Small aluminium angle brackets and stainless steel pop rivets were used to hold it all together. The two vanes in the top section of the rotor are rotated 90 degrees to the bottom ones. This ensures that there is always at least one vane in a position to catch the wind, so the turbine is self-starting.

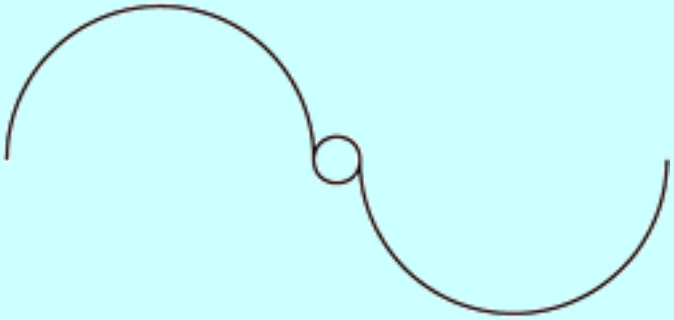
The axle for the rotor was a length of 40mm diameter water pipe. This runs straight through the centre of all three disks, and the inner edge of each of the rotor vanes are riveted to it.

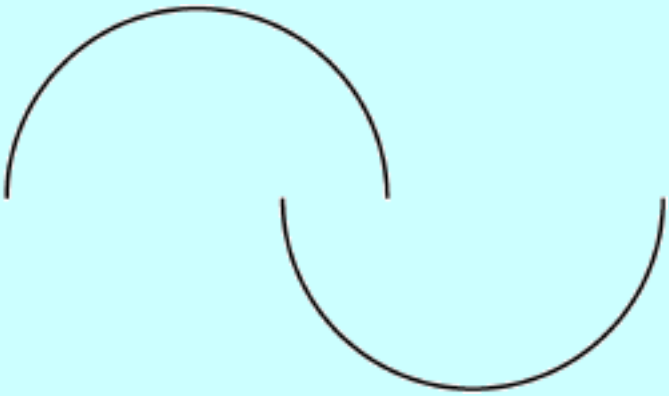
In the bottom end of the axle I pressed in (read hammered) an aluminium adapter bushing to allow the turbine to be connected directly to a generator. The final assembly was very strong and rigid and was surprisingly well balanced. While a central axle shaft is not considered optimal design for a Savonius rotor, it does have advantages, such as increasing turbine strength and allowing easy alignment in multi-stage rotors.

Savonius design

There are several variations of Savonius rotor that I have seen, all of which work well. The efficiency of a Savonius is only around 15 per cent but they are ideal for many situations. Some variations are shown below, looking down from the top of the turbine.

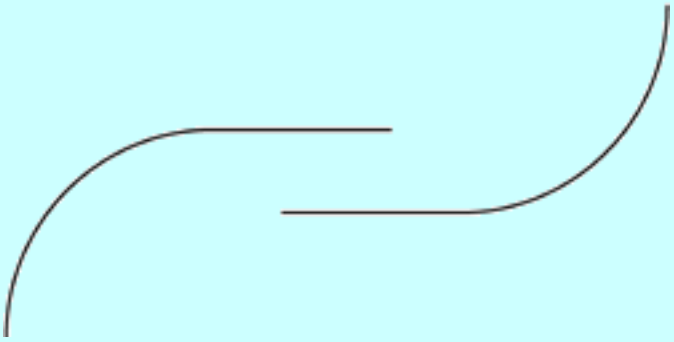
This is the design I used. It is very strong due to the central shaft, but sligtly less efficient than the other two. However, the extra strength allows the rotor to be supported at one end only.





This design is also very simple, and can also be made easily from metal drums or pipe sections. The design is slightly more efficient than the one above as some of the air is deflected by the second vane as it exits the first one.

This is the most efficient Savonius design. It not only has the advantage of air being deflected twice like the design above, but also that the vanes act partly like an airfoil when they are edge-on into the wind, creating a small lift effect and thus enhancing efficiency. This design is much more difficult to build, requiring vanes rolled from metal sheet instead of being cut from drums or pipes.



Generating the power

The generator I used was actually a large permanent magnet DC motor from an old vertical computer tape drive. These are very robust, well built motors about the size of a large car starter motor. They are simple and reliable, and as generators are extremely efficient?connecting one to a torch bulb causes the bulb to be blown by a quick flick of the shaft!

The rotor slides directly onto the end of the motor shaft, and is held in place with a stainless steel bolt. In this design, I decided to see if I could do away with having a top bearing. The bearings in the tape drive motor are at least as strong as the average car alternator bearing, and the local bearing shop gave me specs that indicate that most bearings this size will take a radial load (the load the wind would place on the bearing) of up to 450kg, and an axial load (the load from the rotor?s weight) of up to 45kg. This was heaps for my uses, so I decided to leave out the top bearing and see how the turbine went.

The mast

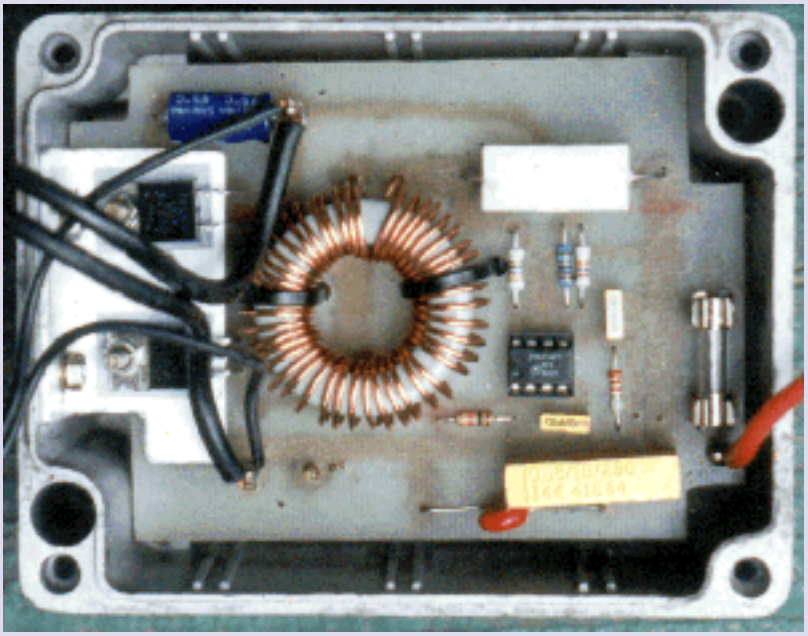
This was made from a 2200mm length of 150mm diameter PVC water pipe, just like the rotor. In

sections this diameter and this length, PVC pipe is quite rigid. The pipe was buried about 400mm into a hole and concreted into place. The mast does still flex a bit in a strong wind and if this proves to be a problem it can easily be made rigid by filling with concrete. The generator is mounted to the top of the pole by means of a stormwater pipe endcap. The face of the generator has four screw holes, so it was just a matter of drilling corresponding holes into the end cap, and one much larger hole in the centre for the shaft.

By itself, this would not have been strong enough, as the end cap would have flexed and eventually broken through, so I attached three short braces made from 25 x 25 x 3 plastic angle to the other end of the generator. These were fixed to the motor using machine screws into the bottom end plate, and point out away from the centre of the generator. The overall diameter of the circle they make is the same as that of the inside of the pipe, so that when the generator is slid into the pipe the whole assembly is quite solid.

Hopefully, this will be all that is required, but I suspect that the end cap may still not be quite strong enough, so I might have to replace it with a metal equivalent further down the track.

Voltage matching



The output voltage of the generator is actually quite low at the speeds it is likely to turn at attached to a Savonius rotor. At 200 RPM the output is only about four or five volts. While this is obviously not enough to charge a 12 volt battery by itself, a bit of clever circuitry solved the problem.

Some time back a circuit was published in one of the electronics magazines that allowed a 12 volt battery to be charged from another. This was used for charging small sealed-lead acid batteries from a car battery, and involved a switchmode step-up circuit to provide a regulated 13.8 volts or so from 12 volts from the car battery.

I have built several of these from various suppliers, and they work quite well. The one I used I already had from another disused project, so I tested it and found that it would output the required 13.8 volts from as little as four volts in. This kit was originally bought from Jaycar Electronics, who no longer sell it, but they do have a pre-built module called a solar power converter, cat# AA-0259, that will take an input voltage from one to ten volts and charge a 12 volt battery?perfect for uses such as this.

The unit seemed ideal for my turbine so I connected it to the generator and tested it. At under 200 RPM I was getting full charging voltage, with available current increasing as rotor speed increased.

Final assembly

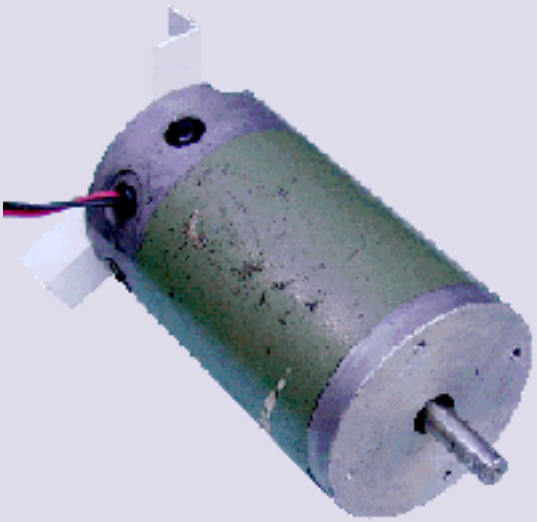
The circuit was housed in a box and slid down inside the tube before the generator and end cap were fitted. The cables from the output of the circuit run down inside the mast and out of a sealed hole at the bottom, through some flexible conduit to the box containing the gate opener circuitry.

The mast and turbine were both painted green to help them blend in with their surroundings. The photos show the turbine before its paint job.

To prevent water getting into the generator bearing, a skirt will be attached around the perimeter of the bottom of the turbine.

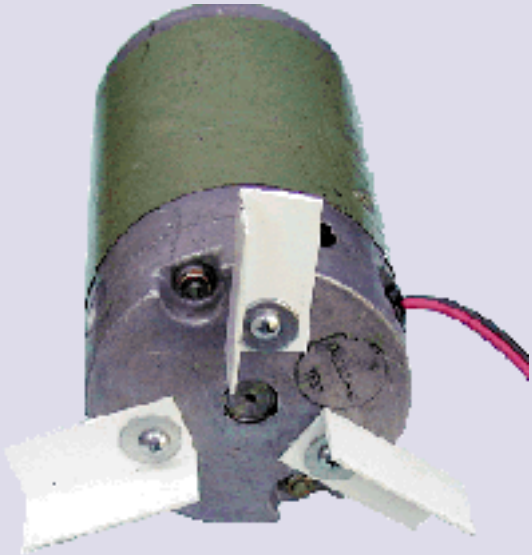


The DC motor fitted to the plastic end cap which holds it to the mast.



Front view of the motor. Note the threaded holes in the face plate.

This rear view shows the three plastic angle sections used to make the motor a tight fit in the mast.



Here you can see the whole motor and rotor assembly before fitting to the mast and painting. Note how the vanes in the top section are rotated 90? to those in the bottom section, and the motor does not yet have the plastic angle sections attached.



Costs

The turbine was very cheap to build, the most expensive part being the secondhand tape drive motor which cost $25. The voltage conversion kit cost $24 a couple of years back, and the rest of the material was free. The water pipe was salvaged second-hand from a building site, while the aluminium sheet was from some old signs I found in my workshop after we moved in.

The only other expenses were a dollar or two worth of paint and rivets and $5 for a bag of concrete.

