Magniwork

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DISCLAIMER

Please take care when working on any of the projects outlined within this manual. By reading this manual you agree to that you are responsible for your own actions. Magniwork will not be held accountable for any loss or injuries.

Introduction

Since the world is gradually slipping into an energy crisis, it is of utmost importance for us to reduce our dependency on the sources of energy which are non-renewable. Clean Renewable sources of energy are those sources which are recurring, meaning when you produce energy you don’t exhaust any resources. Several examples of renewable energy are solar energy, hydro or water energy, and wind energy.

These sources of energy are freely available in our environment, and are often overlooked and unused. We need to take advantage of these sources of energy, thus we will make a step towards energy independence.

Solar energy i.e the Energy from the sun is the most abundant energy available on our planet. We should take advantage of this energy, by implementing a system which uses the solar energy to power our homes. We will reduce our power bills significantly and also contribute to a greener planet.

Water or Hydro Energy is a fairly effective source of clean renewable energy, and it is mostly produced on a large scale, meaning a lot of investment and time is put into building systems which will produce energy from water. The downside of hydro energy sources is that it is implausible for an average person to implement it in his home.

Wind Energy Sources have existed for more than 2000 years, they have been used for tasks such as pumping water, grinding etc. as the world has been industrialized, wind has become a common source for generating energy. Wind Turbines can be easily made and implemented even in individual residences, while helping relieve the power bill, by powering the more conventional power sources.

In this book you will also learn how to construct another alternative source of energy, which has not reached the mainstream media yet.

And in the end this guide will show you how to build a solar air heater, and solar water heater for your home. These two devices will significantly reduce your power consumption, since you spent most energy at home for air and water heating.

How to Reduce Energy Consumption

Even right now without a generator, solar panel, or wind turbine, you can lower your power bill by conserving energy. Below we will present some useful tips that will help you conserve energy, and produce more in the future.

- Change your regular light bulb with LED light bulbs. LED light bulb is 12 times as energy efficient as a tungsten bulb, and lasts for 100,000 hours. Also if you cannot find in your area LED light bulbs, you can use fluorescent light bulbs which are also more efficient compared to the regular light bulbs. Also don't forget to turn of the light when it's not needed.

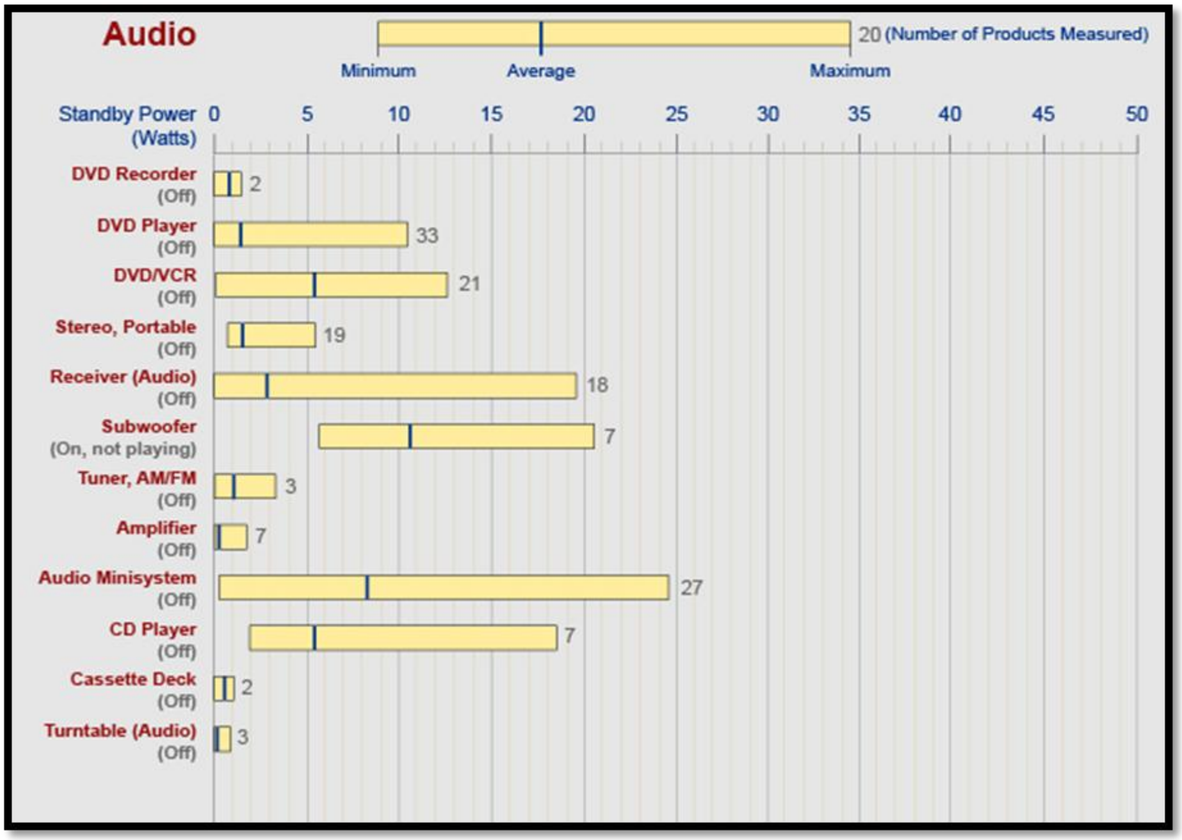
Figure 1

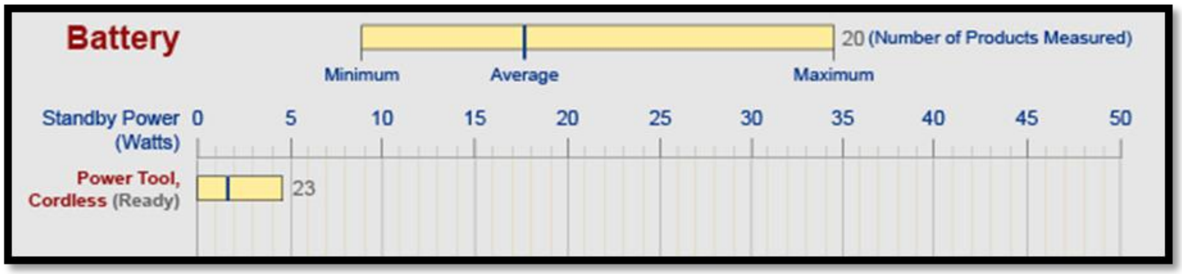
- When you turn off your TV, PC, or DVD, it still consumes energy. The standby mode does not mean it doesn't consume energy, as how much energy each appliance uses during standby mode, take look at the chart below. In order to eliminate the energy consumption you could either unplug the appliance or use a switchable power strip for clusters of computer or video products. That way you can switch everything to zero with one action. The magnitude of the standby power consumption should be taken very seriously, since it comprises from 10% to 15% of your power bill. Altogether, standby power use is roughly responsible for 1% of global CO2 emissions.

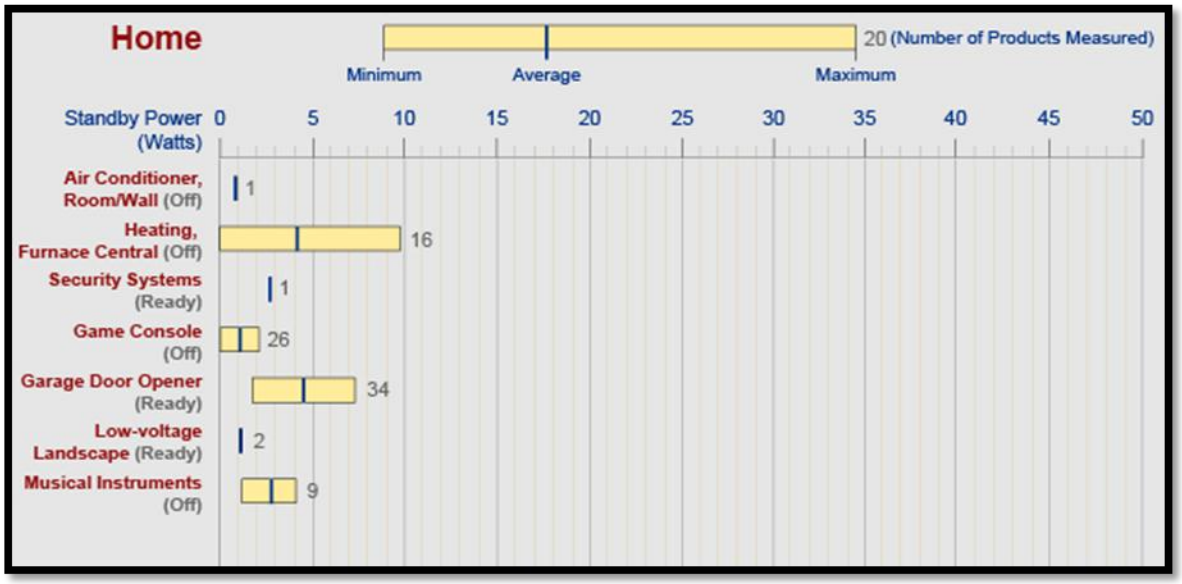
- Use your AC responsibly, the colder you want the inside to be the more energy you use, it’s same when you want to use it for heating. Keep it at a comfortable level and don’t overuse it. This way you will save at least 1,5Kw per hour if you have 3Kw AC. If the AC is used regularly in your home, it most likely comprises big chunk of your energy bill. Also make sure the windows and doors in your home are well sealed so no cold or warm air escapes or enters.

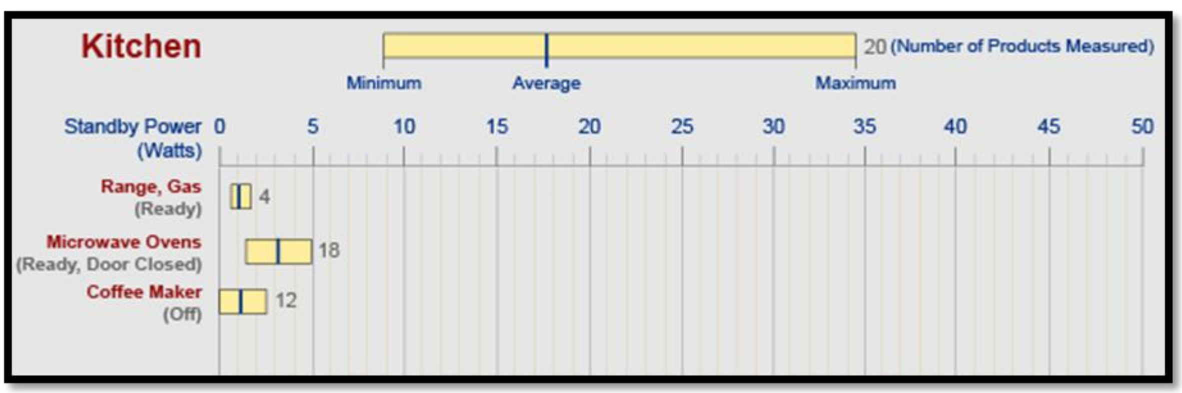
- Our last advice is that you air dry cloths as much as you can, since the dryer is “energy vampire”, also use the dish and cloth washer only when they are fully loaded, this way you will save energy and water.

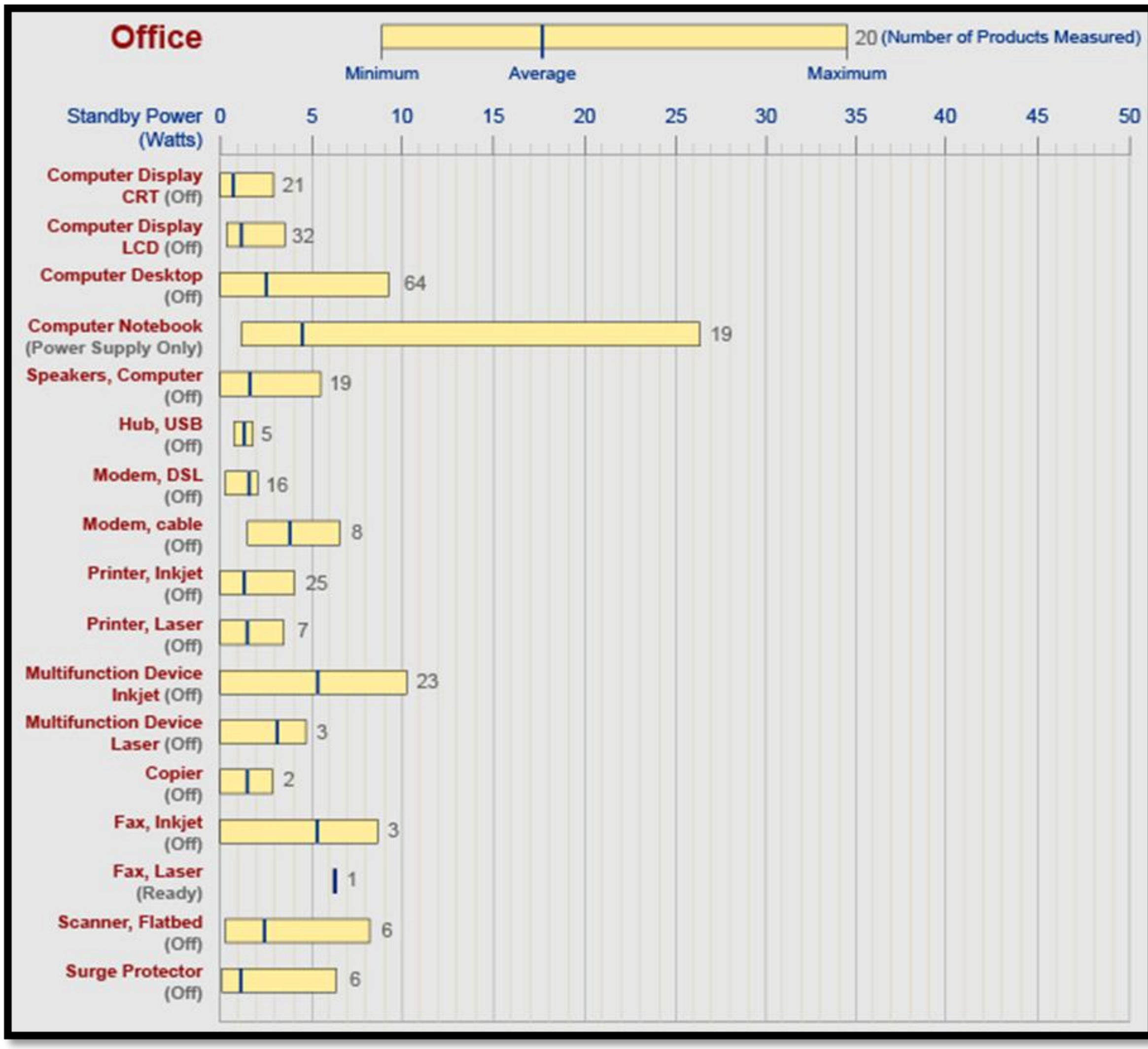
Stand By Energy Consumption Charts:



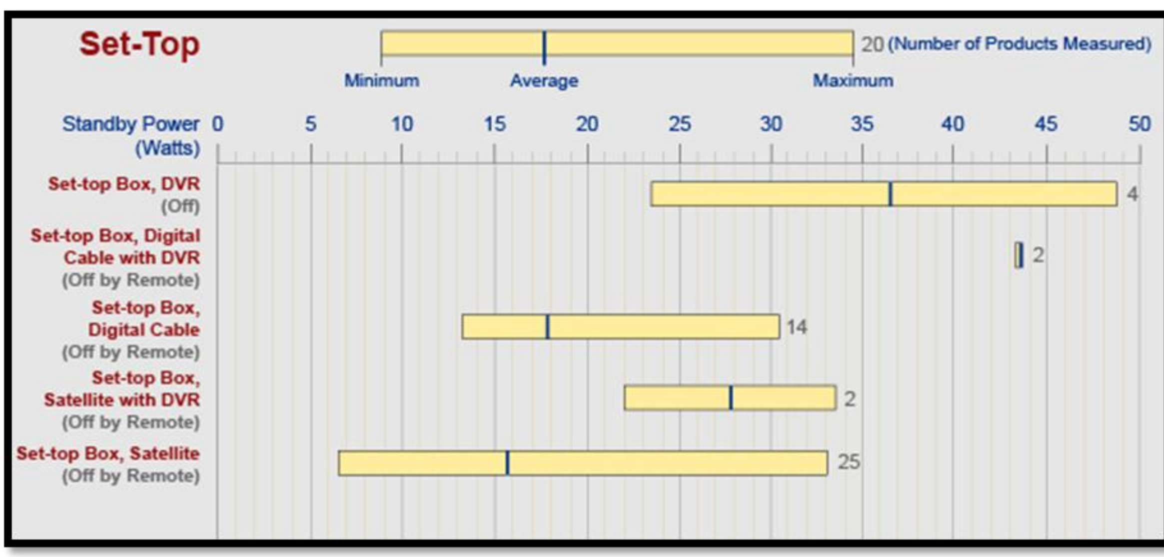



Home
20 (Number of Products Measured)
Minimum
Average
Maximum
Standby Power (Watts)
0 5 10 15 20 25 30 35 40 45 50
Air Conditioner, Room/Wall (Off)
1
Heating, Furnace Central (Off)
16
Security Systems (Ready)
1
Game Console (Off)
26
Garage Door Opener (Ready)
34
Low-voltage Landscape (Ready)
2
Musical Instruments (Off)
9

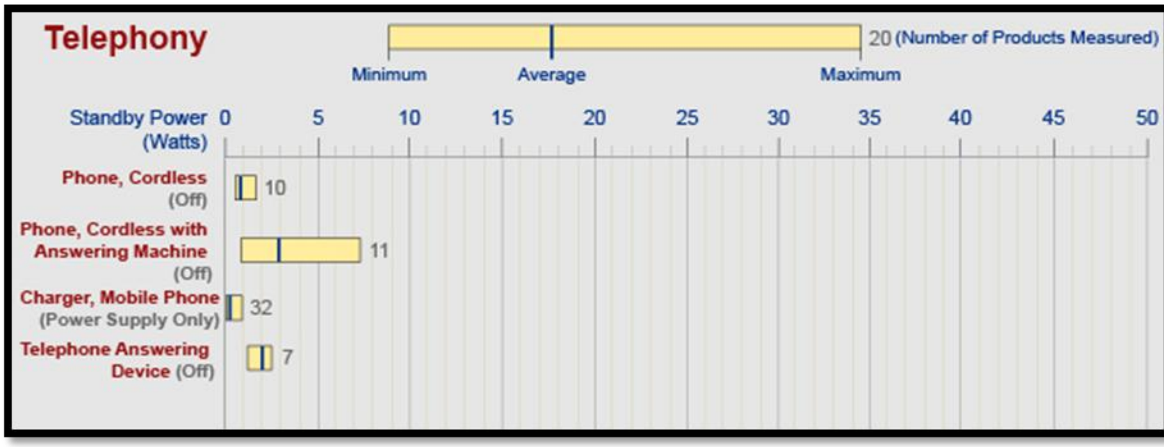

Kitchen
20 (Number of Products Measured)
Minimum
Average
Maximum
Standby Power (Watts)
0 5 10 15 20 25 30 35 40 45 50
Range, Gas (Ready)
4
Microwave Ovens (Ready, Door Closed)
18
Coffee Maker (Off)
12

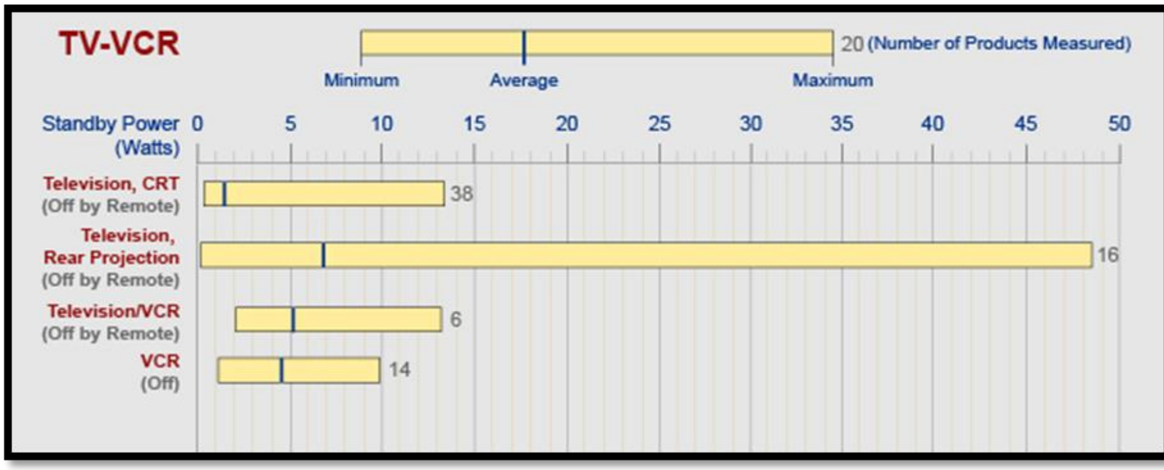


Office
20 (Number of Products Measured)
Minimum
Average
Maximum
Standby Power (Watts)
0
5
10
15
20
25
30
35
40
45
50
Computer Display CRT (Off)
21
Computer Display LCD (Off)
32
Computer Desktop (Off)
64
Computer Notebook (Power Supply Only)
19
Speakers, Computer (Off)
19
Hub, USB (Off)
5
Modem, DSL (Off)
16
Modem, cable (Off)
8
Printer, Inkjet (Off)
25
Printer, Laser (Off)
7
Multifunction Device Inkjet (Off)
23
Multifunction Device Laser (Off)
3
Copier (Off)
2
Fax, Inkjet (Off)
3
Fax, Laser (Ready)
1
Scanner, Flatbed (Off)
6
Surge Protector (Off)
6



Set-Top
20 (Number of Products Measured)
Minimum
Average
Maximum
Standby Power (Watts)
0
5
10
15
20
25
30
35
40
45
50
Set-top Box, DVR (Off)
4
Set-top Box, Digital Cable with DVR (Off by Remote)
2
Set-top Box, Digital Cable (Off by Remote)
14
Set-top Box, Satellite with DVR (Off by Remote)
2
Set-top Box, Satellite (Off by Remote)
25



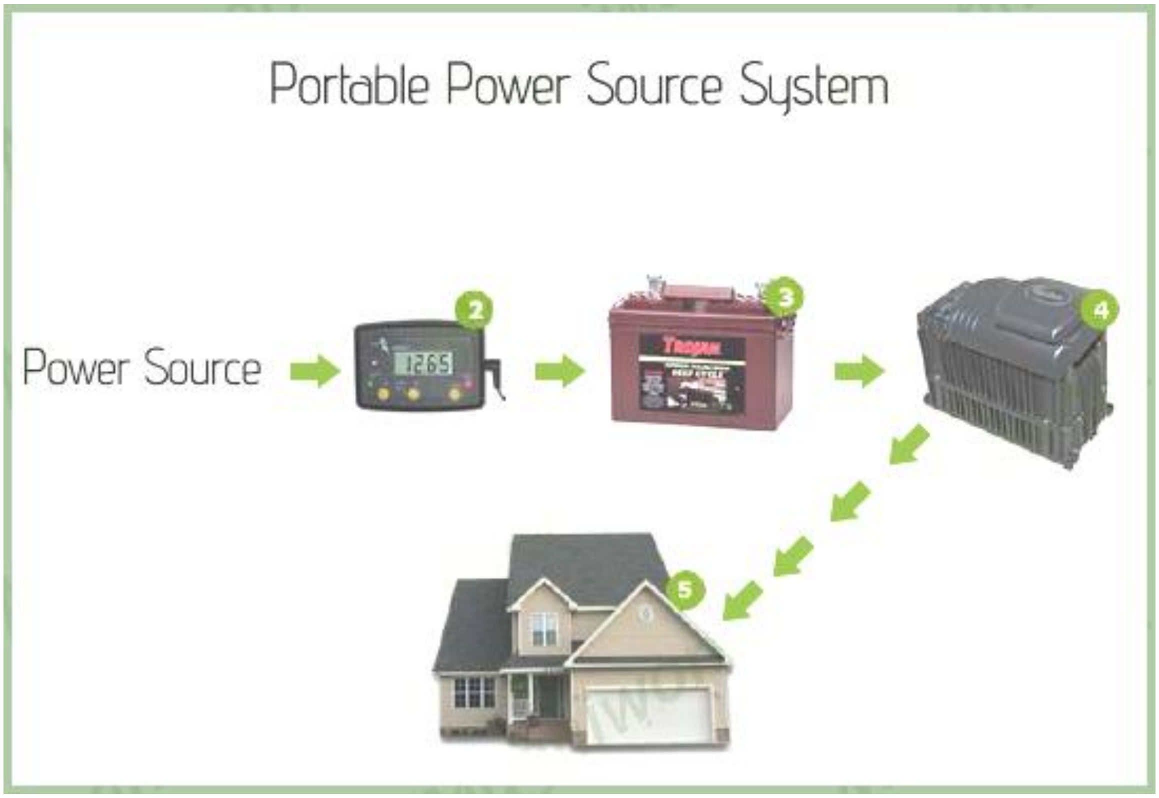


You should start implementing the advices we presented concerning the reduction of the consumption of energy, since there is no point of using renewable energy when your consumption is same. This way if you produce 50% of the energy you use, you can eliminate the other 50% with the advices above and then you can start thinking about producing energy and get the power company to pay you instead of the other way around. Besides the economical benefits of the said advices, don't forget that you are saving the environment also. These steps are easy to follow. Change the regular light bulbs with LED or Fluorescent light bulbs will lower the energy consumed for light as much as 12 times. Using the heating thermostat responsibly will save you as much as 50% of the energy spent on heating, and the same goes for the AC. Using the dish/cloth washer and dryer as advice will drastically lower you energy consumption. Finally eliminating the stand by energy consumption will reduce your power bill by at least 10%. Start saving now, before you implement an independent energy source.

Grid Systems

The following grid systems represent how you connect the external power supply to your house or grid. In the diagrams we are refereeing to the energy source a bit vaguely because the same system that is presented could be used for variety of power sources. By power sources we mean Solar Panels, Wind Turbines, and Energy Generators. As for how you will build your Solar Panel, Wind Turbine, Energy Generator, Air Heater, Water Heater, will get to it right after this.

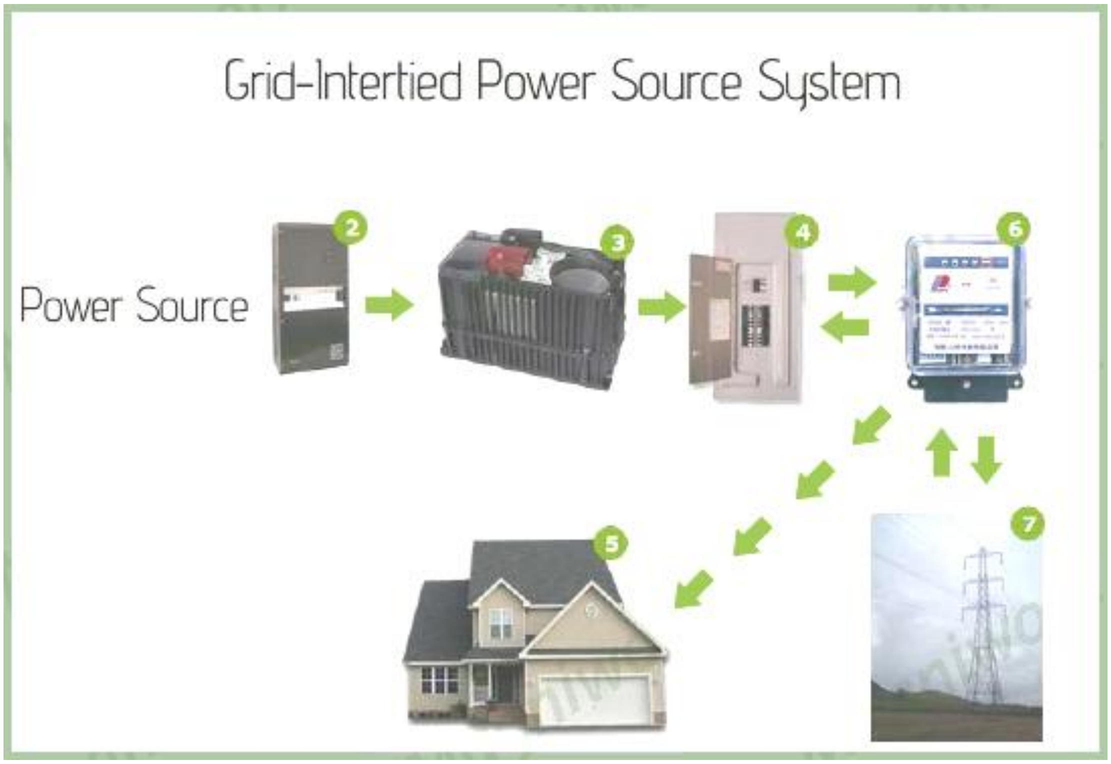
Portable Power Source System



1 Power Source; 2 Charge Controller; 3 Battery; 4 Inverter; 5 Household

This is the simplest system there is, it is great for outdoor use or alternatively for your garage or shed. With this system you can run appliances straight through the inverter.

Grid-Intertie Power Source System



1 Power Source; 2 Array DC disconnect; 3 Inverter; 4 AC Breaker panel; 5 Household; 6 Kilowatt per hour meter; 7 Grid

This is the system that you will most likely use in the beginning. This system is known as grid tied, or on grid. The key feature about this system is: if more electricity is produced by your solar system or wind turbine compared to what is used by the household, than the system will start turning the electric meter backwards. When that happens, credits will be added to your account which you can use for periods when you produce less electricity. You should consult your Electricity Provider for more information concerning “net billing” or “net metering”.

Grid-intertie Power System with Backup Battery

1 Power Source; 2 Array DC disconnect; 3 Charge Controller; 4 Deep cycle battery; 5 System meter; 6 Main DC disconnect; 7 Inverter; 8 AC Breaker panel; 9 Kilowatt per hour meter; 10 Grid; 11 Household

This system grid is tied just like the previous one but the key difference between this one and the previous is: this one has backup battery. The battery backup will be used when it's going to be cloudy or you are doing maintenance to the solar panels.

Off Grid Power System

1 Power Source; 2 Array DC disconnect; 3 Charge Controller; 4 Deep cycle battery; 5 System meter; 6 Main DC disconnect; 7 Inverter; 8 Generator; 9 AC Breaker panel; 10 Household

This system is off-grid, meaning you are not using even 1% electricity from a power company. In this setup you should also have a backup generator such as a gas power generator.

The Units of the System

Array DC Disconnect:

DC Disconnect is used in the system, so you can shut of the system much safer and easier. The reason for shutting off the system would be mainly maintenance.

Charge Controller:

The charge controller as the name implies is used to protect the battery from overcharging. When the battery bank is fully charged in order to protect it from overcharging the charge controller will interrupt the charging process.

Deep Cycle Battery:

This is the battery you will use in your system once you build the full scale generator. If you cannot afford a brand new battery, you can get on the cheap from old golf cart or forklift.

System Meter:

The system meter is used to monitor how much power is being used and how full your battery bank is.

Main DC Disconnect:

The main DC disconnect is used for disconnecting the Inverter for maintenance or emergency situations.

Inverter:

The Inverter is used to invert the direct current into alternating current or AC. This conversion is need since most appliances in the house use AC.

Gas Powered Generator:

If you are implementing complete off grid system, you should have Gas Powered Generator. There will be situations when you will shut down the system for maintenance, during that time you will use this generator.

AC Breaker Panel:

The AC Breaker panel is where all the electrical wiring is connected with your power provider. This panel is usually found in a utility room, garage, or outside the building.

Grid:

The main power line that comes to your house that comes from the power company is called Grid. The term Off Grid refers that you are energy independent from the power supply company.

Household:

When we referred in the previous diagrams to the household, we meant the household loads. This consists of everything that is connected to the breaker panel.

Legal:

Be aware each state and country has different standards for connecting alternative energy source to the AC panel. Also in most countries it is illegal to open this box by yourself, unless you are qualified electrician.

We recommend that you contact your power supply company concerning this issue and do not take matters in to your own hands before you do that.

If you do not want to connect your system to the breaker panel, you can run appliances just from the inverter which is much easier and cheaper option.

Introduction: Magnetic Generator

The working principle behind Edison's Current is to create a motor which highly efficient, but also supplement the circuit with the free electrons from the earth.

You might be wondering how this is possible, well the earth is a big capacitor, which contains free electric charges. It is possible to find or in our case create a potential imbalance between two points in the ground, and by doing so create an increase of the current flow between these two.

Early in his researches in Colorado Springs, Nikola Tesla wanted to collect free energy from the Earth capacitor between the ground and the ionosphere by the use of a parametric resonance with the TMT project (from Colorado Springs notes - 1899). It is speculated that this was derived from his earlier work with Thomas Edison on the DC. Later, Tesla has also found that it is possible to do the same process with only the use of the ground by using the natural imbalance of the ground potential produced by the telluric currents flow underground and Tesla has found that this can be done by the use of an asymmetric displacement of current...

"Minimal work is done in the system due to absence of translational movement in the displacement current. As small heat losses occur, oscillations are maintained by the surplus charge stored in the coil. Very low energy expenditure allows power delivery to a load over an extended time period without an external fuel supply. After an initial input of energy from an outside source, Tesla's new electrical generator would operate as a fuel less device." from "The Second Law Thermodynamics and Tesla's Fuel less Generator" by Oliver Nichelson.

Overview

Permanent magnet generators or magnetos have been employed widely for many years. Early applications of such generators include the supply of electric current for spark plugs in automobiles and airplanes. Early telephones used magnetos to obtain electrical energy for ringing. The Model T Ford automobile also used magnetos to power its electric lights.

The present invention differs from prior art magnetos in terms of its novel physical structure in which a multiplicity of permanent magnets and electrical windings are arranged in a fashion which permits high-speed/high-frequency operation as a means for meeting the miniaturization requirement.

Summary

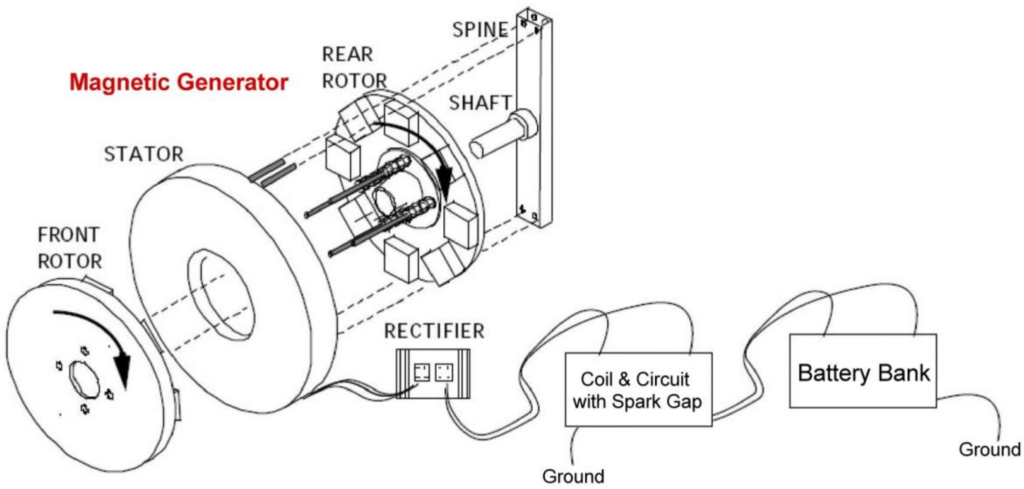
The magnetic generator is provided with a capability for delivering a relatively high level of output power from a small and compact structure.

It is, therefore, one object of this invention to provide an improved permanent magnet generator for the generation of electrical power. Another object of this system is to provide in such a generator a relatively high level of electrical power from a small and compact structure. A further object of this invention is to achieve such a high level of electrical power by virtue of the high rotational speed and high frequency operation of which the generator is capable.

The System provides such a high frequency capability through the use of a novel field structure in which the primary permanent magnets are carried through the centers of the induction windings.

Building the Magnetic Generator

Basic Description of the System



The System shown above consists of: steel spine and shaft, stator containing coils of wire, two magnet rotors, rectifier, and two separate ground points. First we are going to build the magnetic generator than the coil & circuit with spark gap.

The stator contains six coils of copper wire, cast in fiberglass resin. This stator casting is mounted on top of the spine, and it does not move. Wires from the coils take electricity to the rectifier, which changes the AC to DC for charging the battery. The rectifier is mounted on an aluminum 'heat sink' to keep it cool.

The magnet rotors are mounted on bearings, which turn on the shaft. The rear rotor is behind the stator, and enclosed within it. The front one is on the outside, fixed to the rear one by long studs which pass through a hole in the stator. Magnetic flux passes from one rotor to the other through the stator. This moving magnetic flux is what produces the electric power.

Building Process

This manual describes how to build the Magnetic Generator System. It is advised that you familiarize yourself with all the procedures before you start building.

Section 1 - is a list of materials and tools for the job.

Section 2 - explains how to build the special tools (called jigs) and the moulds which are needed. You can build more than one PMG with them. There are many possible ways to make these jigs and moulds, but there is only room in this manual to describe one way to do it.

Section 3 - is about the stator. It describes how to win the coils of enameled copper wire, and cast them in resin, using the jigs and moulds.

Section 4 - shows how to build the magnet rotors, using magnet blocks and steel disks, set in another resin casting.

Section 5 - shows how to assemble the parts into a whole PMG. It explains how to build the mechanical parts, how to balance the rotors and what is required to connect the wiring from the stator.

Section 6 - is about testing the PMG. It contains procedures for checking that it is correctly balanced and ready to use. It describes the options for connecting up the electrical output. It also explains how to connect the PMG to the battery.

Section 7 - contains additional information about the use of polyester resins, and about using the PMG for hydro power.

Caution

Take care when building and assembling the Magnetic Generator so that the magnets cannot come loose. This can happen under extreme circumstances. Loose magnets rubbing on the stator can easily damage the system.

- Follow all the instructions for casting the magnet rotors - do not simply glue the magnets to the steel disks.
- Do not hit the magnet rotors with hammers during assembly.
- Take care that there is at least 1 mm gap clearance between the magnets and the stator, on both sides. (For heavy duty, or high speed, use a larger gap.)
- Do not mount the rotor blade assembly directly onto the front magnet rotor disk, at any point away from the studs. Mount it only onto the studs and nuts themselves, which come through the disk.

List of Materials

Materials for PMGs	No. per PMG	Size	Total wt. grams
FIBREGLASS SUPPLIES			
Polyester resin (premixed with accelerator)			2700
Catalyst (peroxide)			50
Talcum filler powder			1200
Fiberglass mat (1oz/sq foot)		1 sq meter	300
Coloring pigment resin (if required)			50
Putty			
STAINLESS STEEL			
Stainless Steel Wire		2mm x 10 Meters	200
MAGNETS			
Grade 3 Ferrite Magnet Blocks (pre-magnetized)	16	20 x 50 x 50mm	4000
ELECTRICAL			
Enameled winding wire		14AWG or 1,7mm	3000
Flexible Wire (14AWG)		Same size x 6 meters	
Solder for connections			
1/2 inch masking tape			
Bridge rectifiers	2	25A 200V single phase	
Heat sink for rectifiers			250
STEEL			
Box section tube ('RHS') for spine	1	380 x 50 x25 x 4 mm	1100
Magnet disk (or octagonal) plates	2	6mm x 305mm Outer Diameter	6000
10mm threaded rod ('studding')		1000mm	500
10mm nuts	32		300
10mm washers	16		
8mm threaded rod		400mm	125
8mm nuts	8		50
5mm nuts and bolts for rectifiers	2	5mm x 20mm	
Shaft		25mm x 150mm	500
MECHANICAL			
Bearing hub to fit shaft	1		1250

Materials for Moulds and Jigs

- Composite floorboards (other ideas are possible) and wood glue.
- Sand paper & wax polish (Polyurethane varnish, and PVA release agent, if available.)
- Paint brushes, and thinners to clean them.
- 13mm Plywood for jigs and formers and stator mould centre.
- Steel rod, or pipe, for coil winding machine.
- Small pieces of steel plate or thick sheet metal.

Bolts (with nuts and washers)	**Diameter**	**Length**	**For**
2 with butterfly nuts	6 mm	60mm	Coil Winder
4	10mm	25mm	Balancing With Jig
1	12mm	150mm	Stator Mould

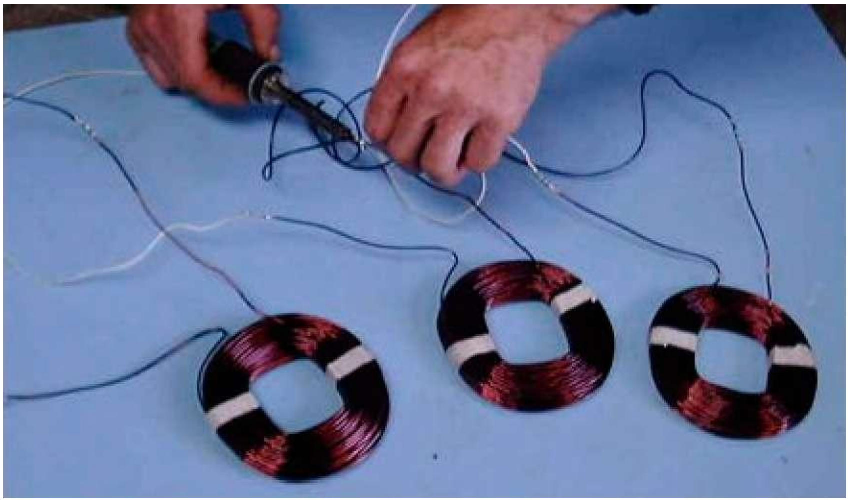
Tools

- Safety goggles face mask, gloves, etc. as required.
- Workbench with vice.
- Welder, Angle grinder, Hacksaw, Hammer, Punch, Chisel.
- Compasses, tape measure, angle gauge.
- Spanners: 8, 10, 13, 17, and 19 mm: two of each.
- Tap wrench and M10 taps for outer holes in magnet rotors.
- Brass wire to gauge the heights of magnets, and Pillar Drill Press.
- Drill bits 6,8,10,12mm
- Hole saws 25mm, 65mm
- Wood lathe, or a substitute as in Section 3
- Chisel for wood lathe.
- Jigsaw to cut wood.

- Scales to weigh resin. Dispenser for catalyst, plastic buckets, scissors.
- Soldering iron, resin-cored solder, wire cutters, sharp knife.

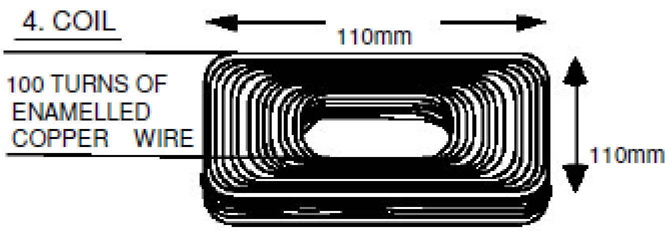
Moulds and Jigs

This section describes how to make the jigs and moulds for building a PMG. Once you make them, they can be used again, to build more PMGs.



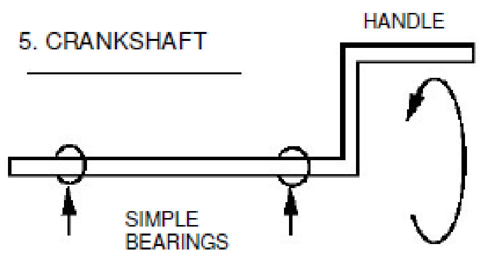
Coils for the Stators

The PMG stator contains six coils of copper wire (*Image 4*)



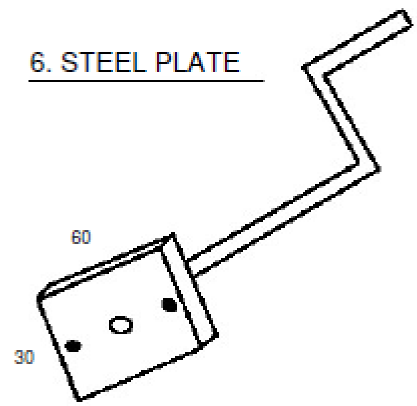
The coils will be wound on plywood coil-former. The former is mounted on the end of a crankshaft, between cheek pieces.

- Make a crankshaft, turned by a handle (*Image 5*).

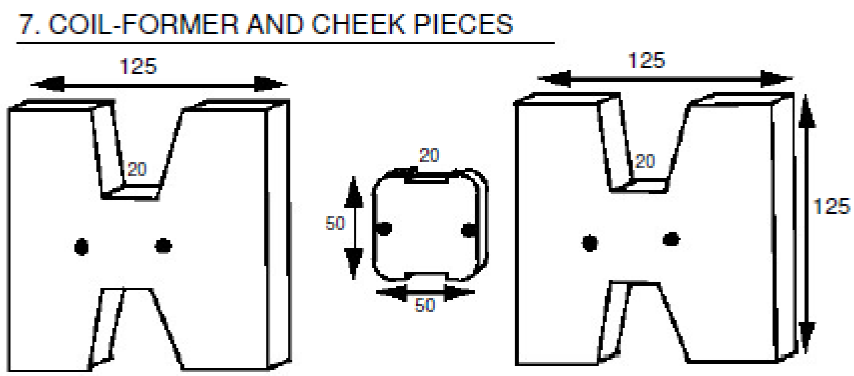


• Cut a small flat steel plate 60 x 30 x 6 mm (suggested sizes) and fix it securely or weld it to the end of the crankshaft. (*Image 6*)

• Drill 2 holes, 6mm diameter and 40mm apart, centered on the shaft.



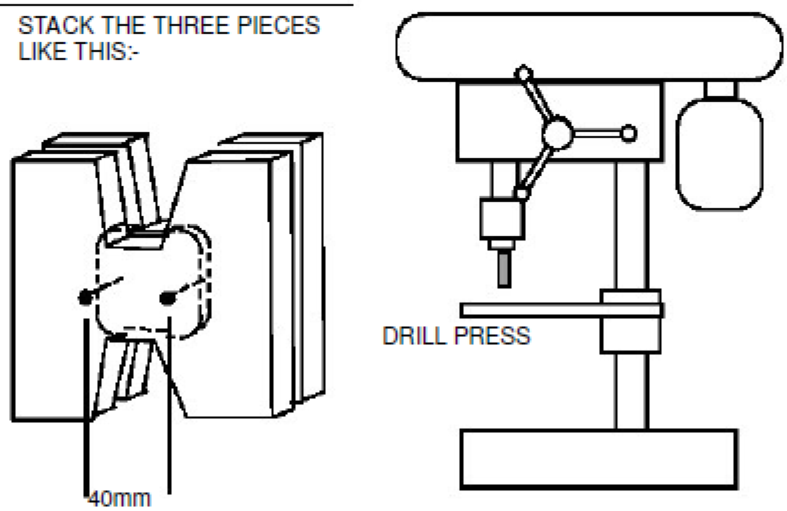
• Cut out 3 pieces of 13mm plywood. (*Image 7*)



The coil former is 50mm by 50mm by 13 thick. It has rounded corners. The two 'cheek pieces' are 125mm by 125mm. There are 20mm wide notches top and bottom in each. The notches are for putting masking tape under the coil, so that it can be taped up before removing it from the former.

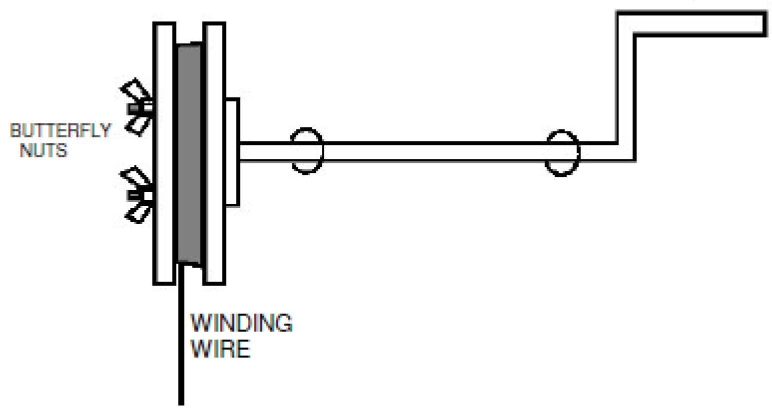
- Stack the pieces with the notches in line (*Image 8*), and drill holes for the mounting bolts. The holes are 6mm diameter and 40mm apart. Use a drill press to drill the holes exactly square to the plywood.

8. DRILLING THE 2 HOLES



• Pass two bolts through the holes in the flat plate, and bolt on the cheek pieces, with the coil-former between them. Use butterfly nuts if possible. (*Image 9*)

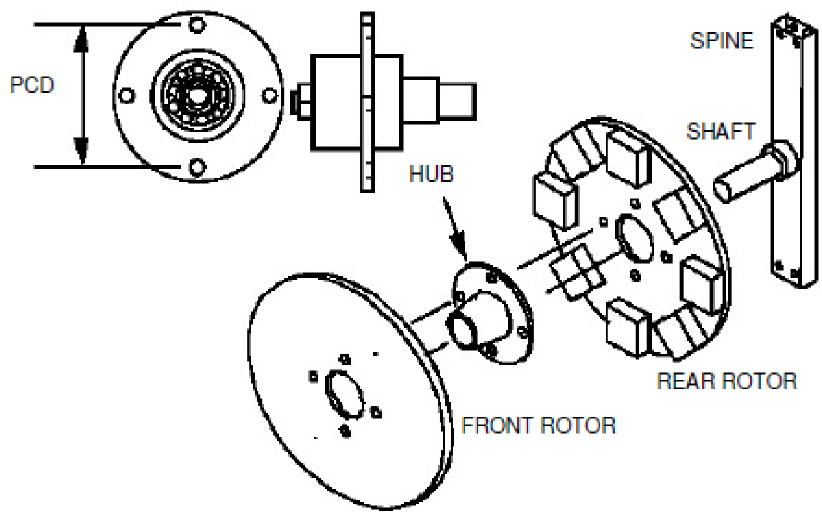
9. FITTING THE COIL FORMER AND CHEEK PIECES



Jigs for the Rotors

The magnet rotors are mounted on a bearing hub (*Image 10*). The hub has a flange with holes in it. For example there may be four holes on a 102mm (4 inch) 'pitch circle diameter' (PCD). Or you may have some other arrangement. This will depend on what kind of hub it is. Here we shall say 102mm PCD.

10. THE BEARING HUB PCD



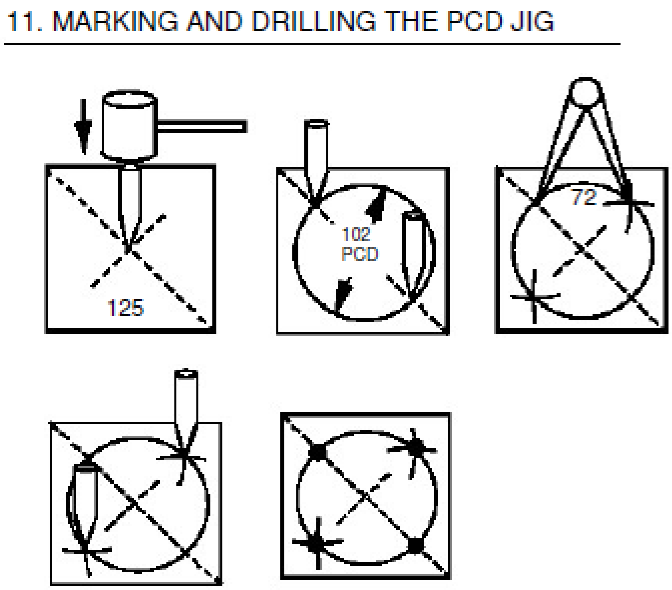
The PCD jig will be used to drill holes in the rotors etc.

It will also be used to balance the rotors.

The holes must be marked and drilled very precisely. (*Image 11*)

- Cut a square piece of steel plate 125mm by 125mm.
- Draw diagonal lines between the corners and mark the exact centre with a punch.
- Set your compasses at 51mm radius (or to suit whatever PCD). Draw a circle.
- The diameter of the circle is the PCD of the holes in the hub.
- Punch both places where one line meets the circle.
- Set your compasses at 72mm. Mark two points exactly this distance from the first two, on the circle. (If you have a different PCD, this size would not be 72mm. (Find the size by trial and error.)

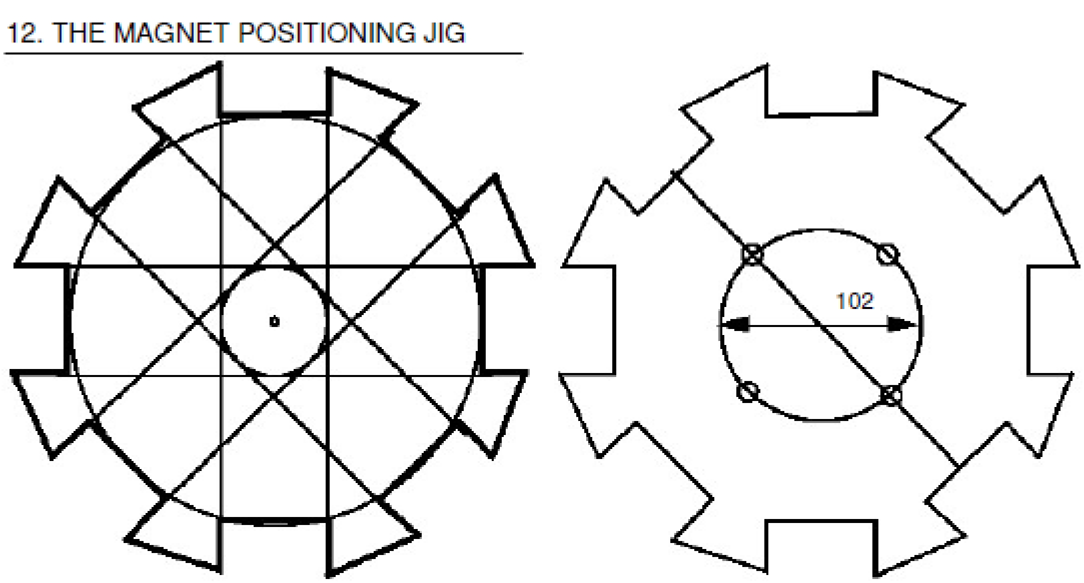
- Drill four holes exactly 72 mm apart on the circle. Use a small drill first and then a larger one.



Magnet positioning jig (*Image 12*)

This jig is for putting the magnet blocks into the correct places on the steel disks.

Only one jig is needed. Make the jig from 250x250 mm plywood or aluminum sheet (not steel).



- Mark the centre of the work piece.
- Draw three circles, with diameters 50mm, 102mm and 200mm, on this centre.

- Draw a pair of parallel straight lines, as tangents to the 50mm circle as shown.
- Draw 3 more pairs of straight lines at 45 and 90 degree angles to the first pair.
- Using these lines, mark the magnet positions, and cut out the jig along the bold lines as shown in the diagram.
- Draw a line connecting two opposite magnet centers.
- Place the PCD jig on top of the 102mm circle, aligned with the magnet centers, and drill four holes to match the four holes in the steel disks.

Making the moulds

Make moulds for the stator and rotor castings. They can be turned from wood or aluminum. Another method is to make plaster or clay plugs on a wheel, like a pot. The shape of the plug would be the shape of the outside of the stator. Then make a fiberglass mould on the plug. The surface of each mould must be perfectly flat.

The moulds need to be strong and smooth. It is not easy to separate the stator casting from the moulds. Hammer blows are usually needed.

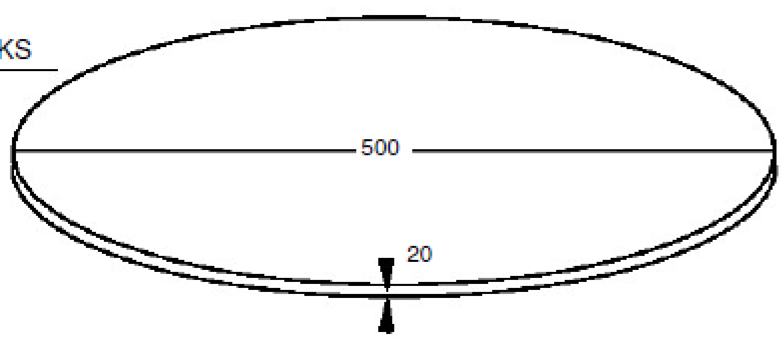
It is a good idea to wind one coil (*see section 4*) before making the stator mould. This coil should fit neatly in the mould.

Here is one way to make the moulds, from composite wooden floorboard sheets, using Wood-turning.

Stator Outer mould

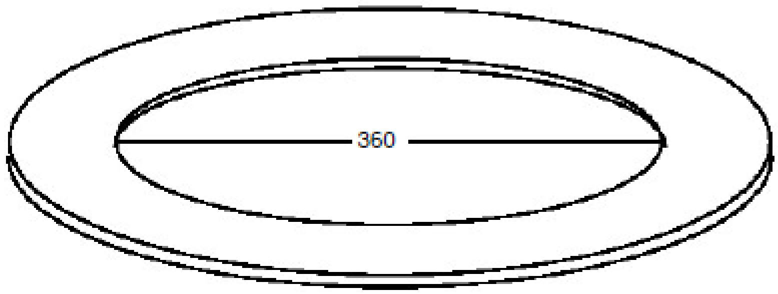
• Cut out several disks of flooring sheet (*Image 13*), approximately 500mm diameter.

13. DISKS



Take all but one of the disks, and cut circular hole in each, 360mm diameter to form rings (*Image 14*).

14. RINGS



• Draw a circle 360 mm diameter on the remaining disk

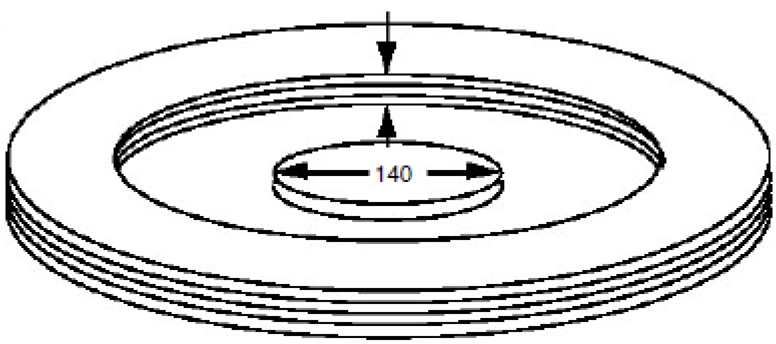
• Drill a 12 mm hole at the centre of this disk, to help with centering.

• Glue the rings on top of the remaining disk, to form a stack, with a hole 60mm deep (*Image 15*). Use plenty of glue at the insides of the rings.

• Cut out a small disk of 15 mm plywood, 140 mm in diameter, and drill a 12 mm hole at its centre.

• Placing a 12 mm bolt through both holes, glue the small disk into the exact centre of the hollow. Use plenty of glue at the edge of the disk.

15. STACK



• Mount another piece of wood or board onto a lathe, a motor or the wheel hub of a small vehicle (for example a 3-wheel taxi). This is a faceplate (*Image 16*).

• Spin the faceplate and use a pencil to make a very small circle at the centre.

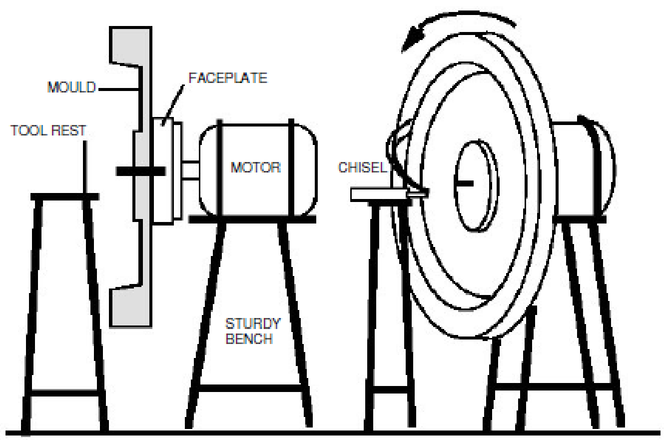
• Drill a 12mm hole precisely at this centre. Hold the drill parallel to the shaft.

• Screw the glued stack onto the faceplate, using a 12mm bolt to centre it. Use four woodscrews through the disk and into the faceplate.

• Check that the face of the mould runs true. You can do this by holding a pencil close to it while it spins. Where the pencil makes marks, the face is 'high'. Loosen the screws and insert pieces of paper between the faceplate and the stack, on the opposite side from the pencil marks. Tighten the screws and check again.

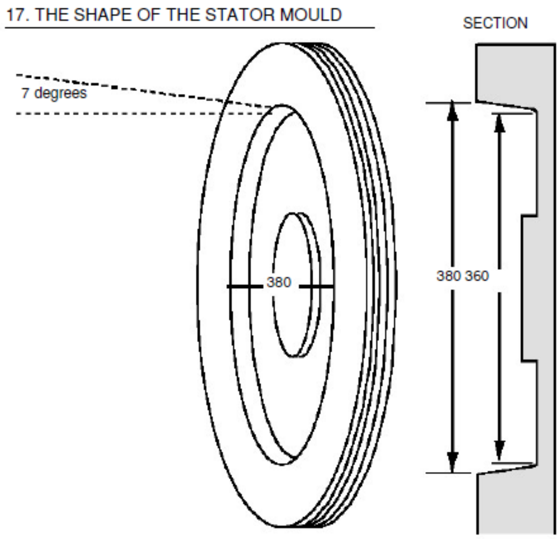
Turning a Mould

16. TURNING A MOULD

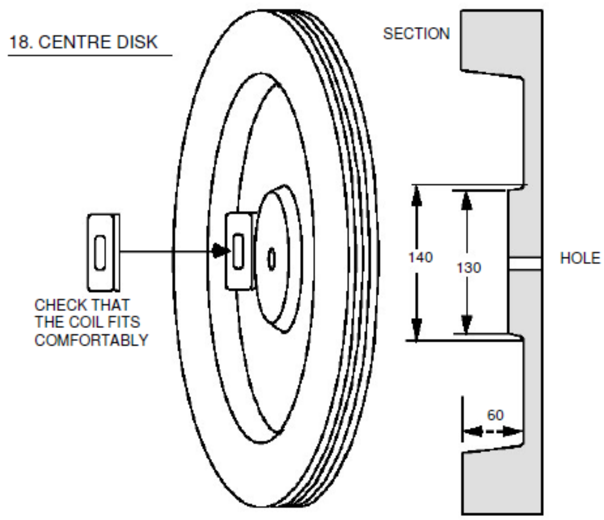


Now it is possible to shape the mould with a chisel. Wear a mask over your mouth to avoid inhaling the dust. Beware of loose clothing, which may become caught in the rotating mould.

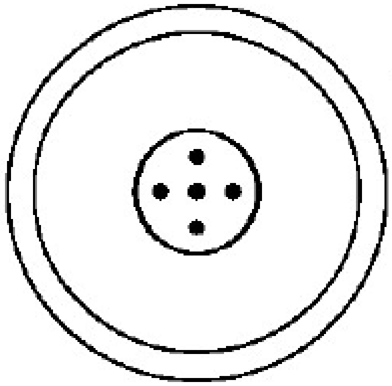
- Cut a smooth surface on the inner edges of the stack (*Image 17*).
- The surface tapers at about seven degrees.
- The overall diameter at the outer edge is 380mm
- The diameter of the flat face is 360 mm.
- The corner inside is smooth (slight radius) not sharp.



- Turn the inner disk down to 130 mm diameter on the face (*Image 18*), with a taper. The corners are rounded as before.



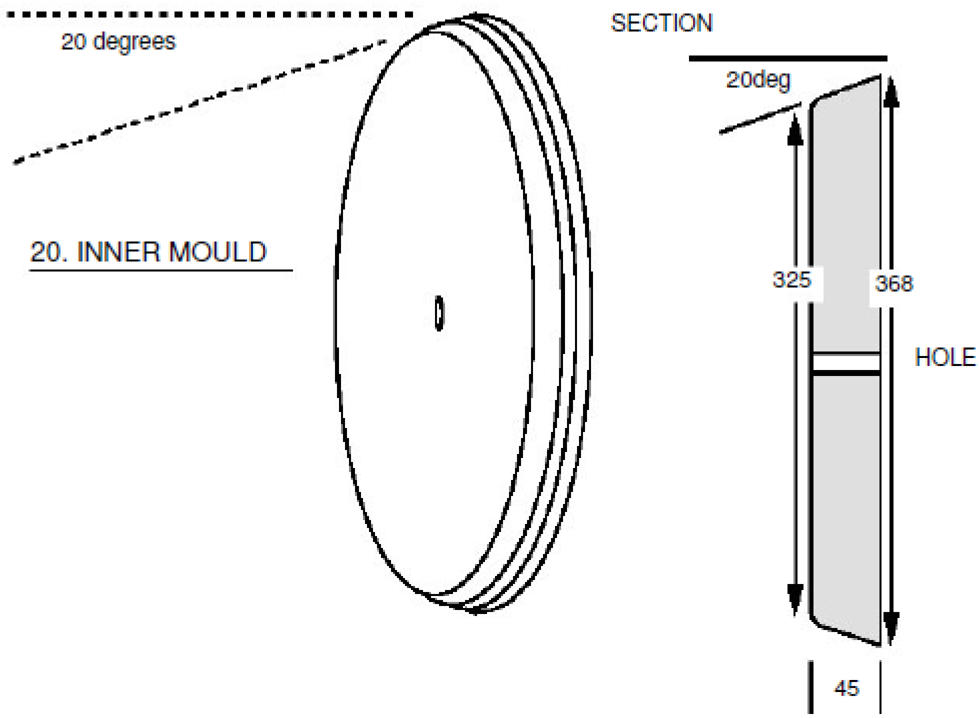
- Place a coil against the face of the mould and check that it fits comfortably – if not, then the hollow must be made a little larger, or the centre disk a little smaller. In the end, the coil's centre must be at 250 mm from the mould centre.
- Remove the mould from the lathe or motor.



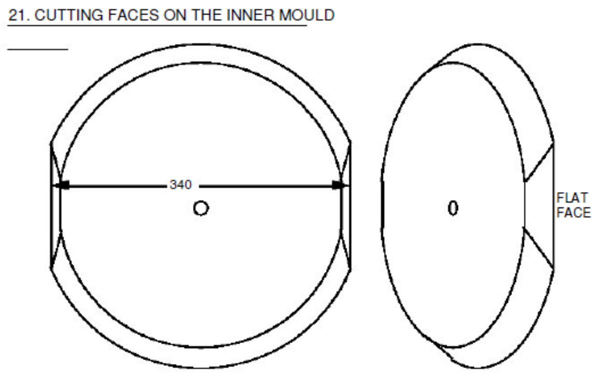
19.HOLES IN THE MOULD

Stator Inner mould

- Cut disks with diameter 370mm 20 degrees.



- Drill a 12mm hole at the centre of each.
- Glue them into a stack (*Image 20*), using a 12mm bolt to centre them.
- The stack is at least 45 mm thick, better 50 mm.
- Turn a 20 degree taper on the rim, and round off the corner, so that the diameter reduces.
- from 368mm to 325mm.
- Check that the outer mod fits over the inner mould, with a 6mm gap all around the edge.
- Then remove the inner mould from the faceplate.
- Draw 2 lines on the larger face of the mould, 340mm apart (*Image 21*)
- Cut two flat faces, as shown in image 21.

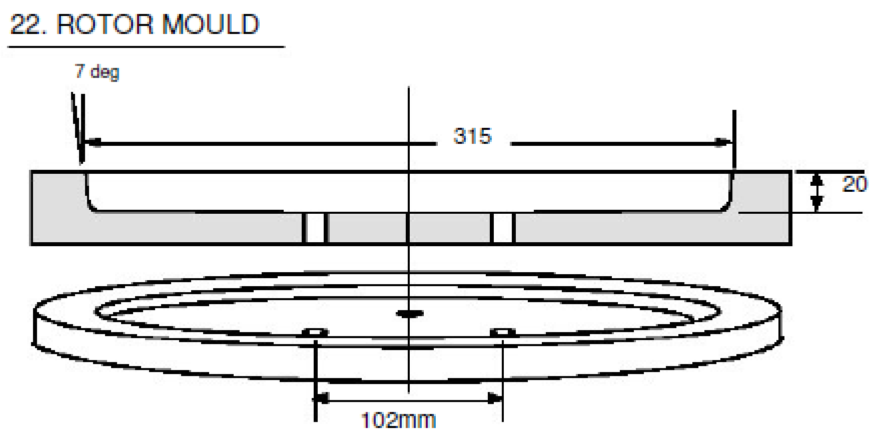


These two faces will create a thicker casting around the mounting studs.

Magnet rotor moulds

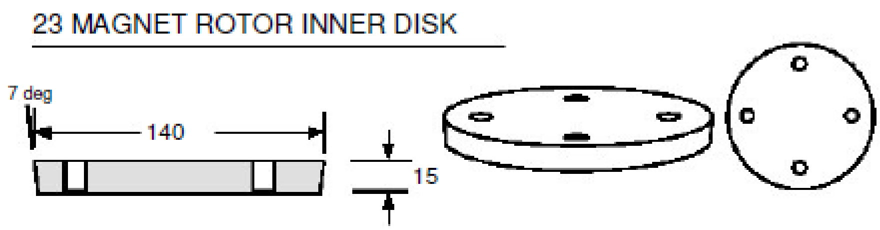
The PMG needs two magnet rotors. Only one mould is needed, but production is easier if there are two moulds, so that two rotors can be produced at one time.

The outer mould (*Image 22*) is similar to the stator outer mould, but simpler.



Use the PCD jig to drill four holes to match the holes in the magnet disks.

Each magnet rotor also needs an inner disk mould (*Image 23*), with the same pattern of four holes.



All moulds are sanded down to a very smooth surface and finished with polyurethane varnish and wax polish. Do not use ordinary paint on the moulds. The heat of the resin process will cause the paint to wrinkle and spoil the appearance of the casting.

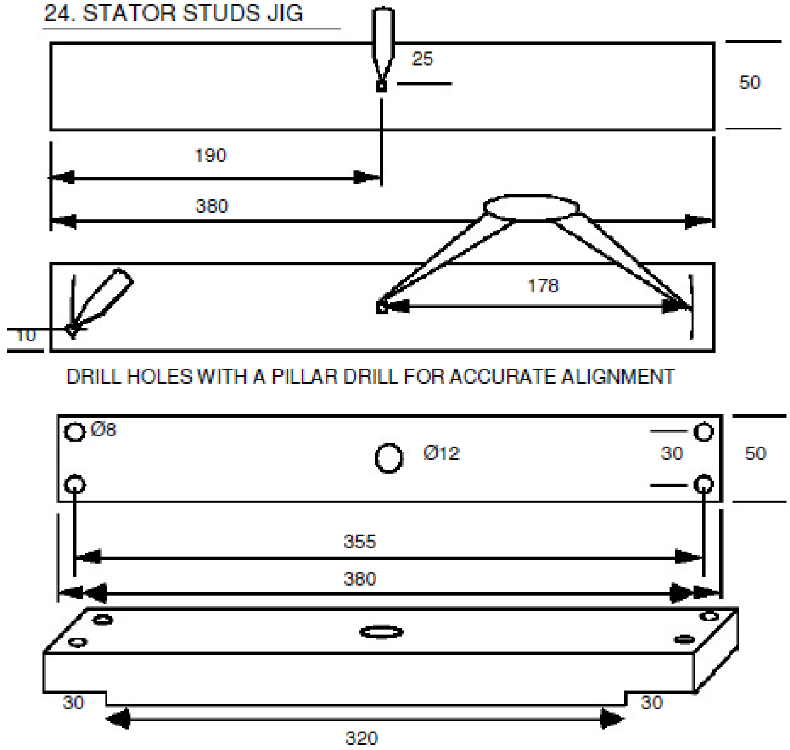
Jigs For The Stator

- Stator Studs Jig (*Image 24*)

The stator needs four 8 mm supporting studs cast into it. These studs need a jig to hold them in place, until the resin is set. This jig is made from wood 380 x 50 x 25mm. It must be made precisely, or the studs will not fit the spine later.

- Make a punch mark at the exact centre of the largest face (*Image 24*).
- Use dividers or compasses to mark arcs at a radius of 178 mm from this mark.
- Punch four marks on these arcs, 30 mm apart and 10mm from the edge.
- Drill through with an 8mm drill (using a smaller size first to be accurate). Use a drill press, to drill the holes truly square.
- Remove some of the underside of the ends of the piece of wood, so as to prevent contact with the fiberglass resin.

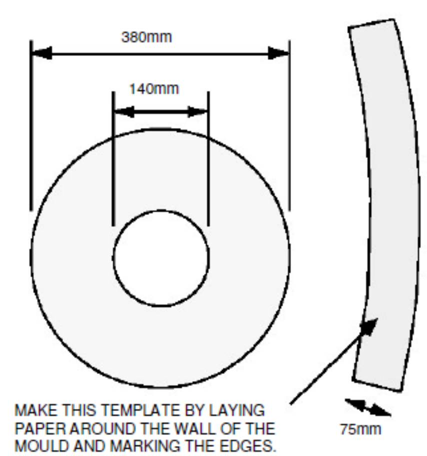
24. STATOR STUDS JIG



- Paper Templates (*Image 25*)

Fiberglass 'chopped strand mat' (CSM) is to be used in the stator. Make some paper templates for cutting out the pieces of CSM. Later you can lay the templates on the sheet of CSM, draw around them with a felt pen and then cut the pieces out.

25. PAPER TEMPLATES FOR GLASSFIBRE CSM

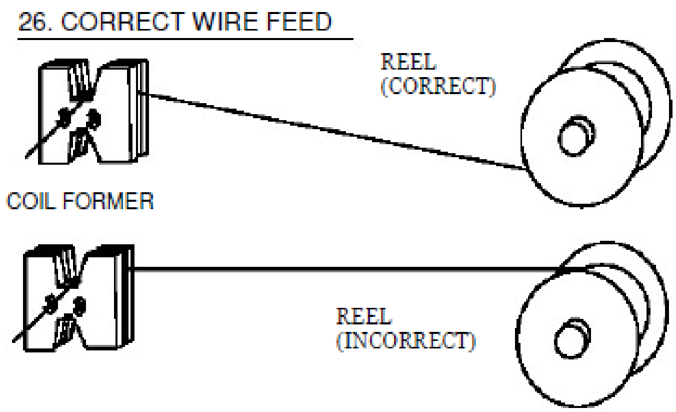


Stator Construction

This section tells how to make a stator, using the jigs and moulds from section 3. It is a good idea to wind a coil before making the stator moulds, so that the mould can be checked for correct fit.

Winding the coils

• Mount the reel of winding wire on an axle behind you, in line with the coil former.
The wire should form an 'S' bend as it winds onto the coil (*Image 26*).

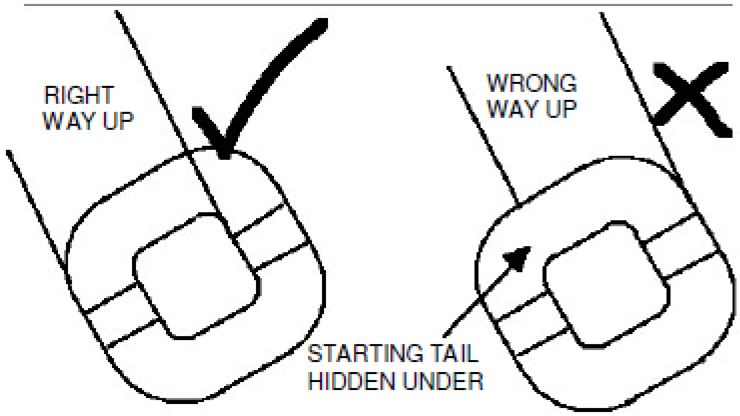


- Bend the tail of the wire 90 degrees, at a point 100mm from the end. Do not handle the bend any other part of the wire; leave it straight. Bent wire doesn't make a compact coil.
- Place this bend in the notch, so that the tail hangs out.
- Twist the tail loosely around one of the butterfly bolts.
- Grip the wire between the reel and the winder in a piece of rag to keep it tight.
- Wind the handle of the crankshaft.

The first turn lies against the cheek piece on the side where the tail comes out. The other turns lie against each other neatly, without crossing over. Build the coil up in even layers. Count the number of turns carefully. Normally there will be 100 turns.

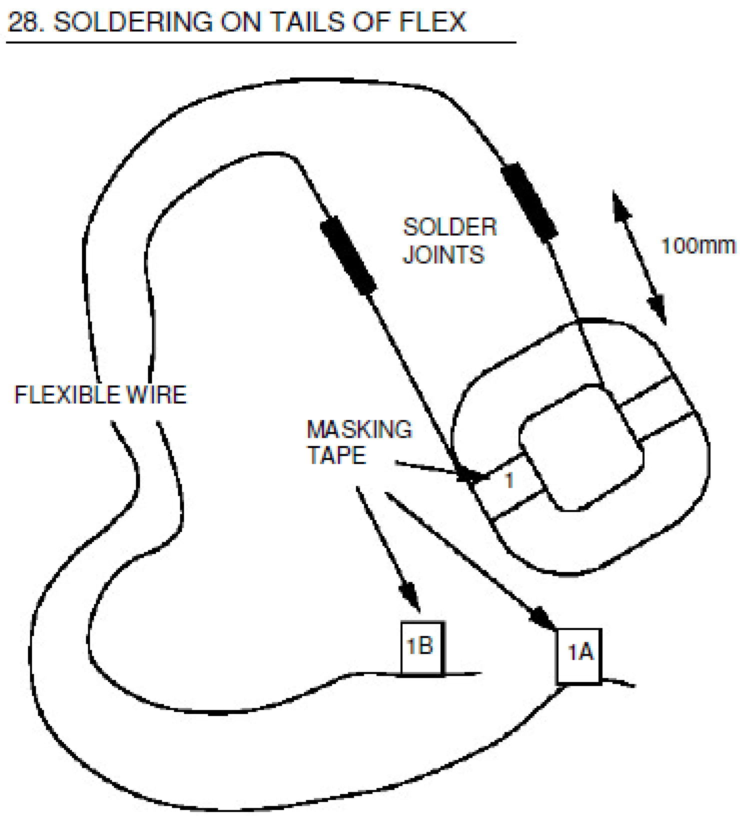
- When the coil is complete, pass a piece of sticky tape under the coil on both sides and bind it tightly. Do not cut off the winding wire until this is done, or the coil will spring out, and loosen. Cut the tail of wire 100mm away from the coil.
- Remove the coil from the former, and wind five more coils in exactly the same way.
- Place the coils on a table (so that they are all exactly the same way up (*Image 27*) Check that the starting tail is on the upper surface, and not hidden under the coil.
- Number the coils 1-6, writing on the masking tape.

27. THE COILS MUST ALL BE THE SAME WAY UP



• Scrape the enamel off the last 20mm of each tail of enameled wire, until it is all bright copper. (A hacksaw blade makes a very good scraper, when the edge has been sharpened with a grinder.)

• Solder on tails of flexible wire (*Image 28*).



Suggested lengths of flexible tails:

- coils 1 and 6 - 800 mm flex
- coils 2 and 5 - 600 mm flex
- coils 3 and 4 - 400 mm flex

• Cover the soldered joints with sleeving. Leave no bare copper showing.

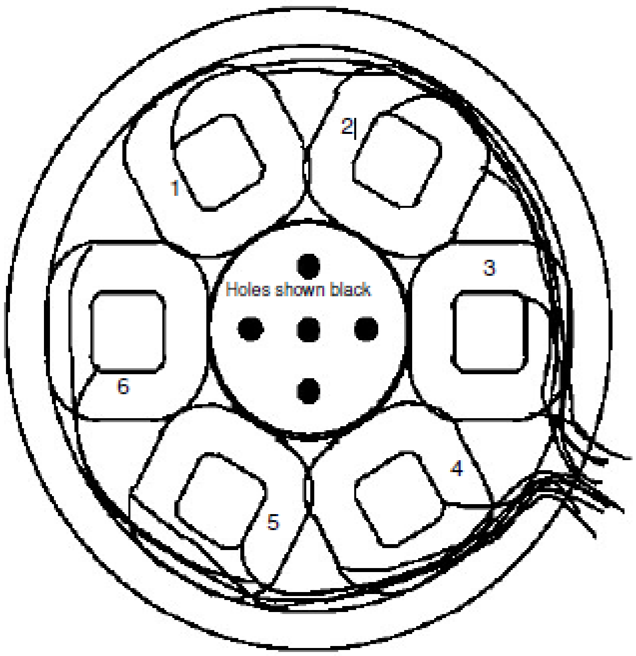
• Label the tails with the coil number and the letter A or B.

A is for the start of the coil, B is for the finish. Do not mix them up. Or use two colors: black flex for the starts and white for the finishes.

• Lay the coils out in the outer mould.

• Check that they will fit comfortably, and that the tails are long enough to remain within the mould until the exit point between coils 3 and 4. It is important to lay all the coils the same way up.

29. THE COILS IN THE MOULD



Preparations for stator casting

The stator casting will contain:

- •Six coils.
- •Polyester resin and talcum powder. (and perhaps pigment)
- •fiberglass mat (CSM).
- •Four studs of 8mm x 100mm threaded rod.
- Also, be sure to have the moulds prepared properly. Sand them, seal them, polish them. If PVA release agent can be got, then use it.

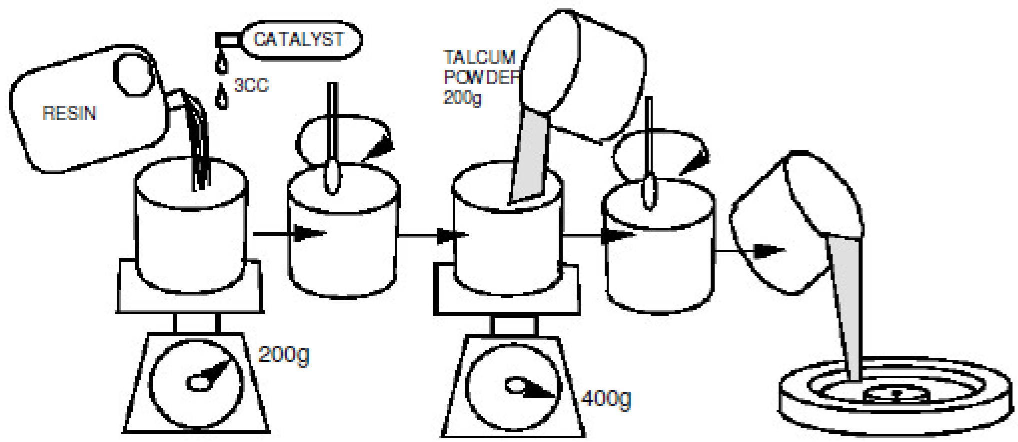
Cut out pieces of fiberglass CSM, using the templates. There will be 2 circular disks for laying flat in the outer mould. You also need enough curved strip pieces to cover the inside wall of the outer mould in a double thickness of CSM. Overlap 25mm between pieces.

When you are sure that you have everything to hand, start the resin casting process. It is a good idea to read through the procedure first, and check that you understand it all before you start. There are notes on polyester resins in section 8.

The stator casting procedure

Image 30 shows the procedure for weighing out the resin and the talcum powder. The talcum powder is only used for bulk mixes (not thin layers with CSM), to prevent overheating, and to thicken the mix. Different mixes use different weights – follow the step by step instructions below. Image 31 shows all the parts coming together.

30. MIXING POLYESTER RESIN

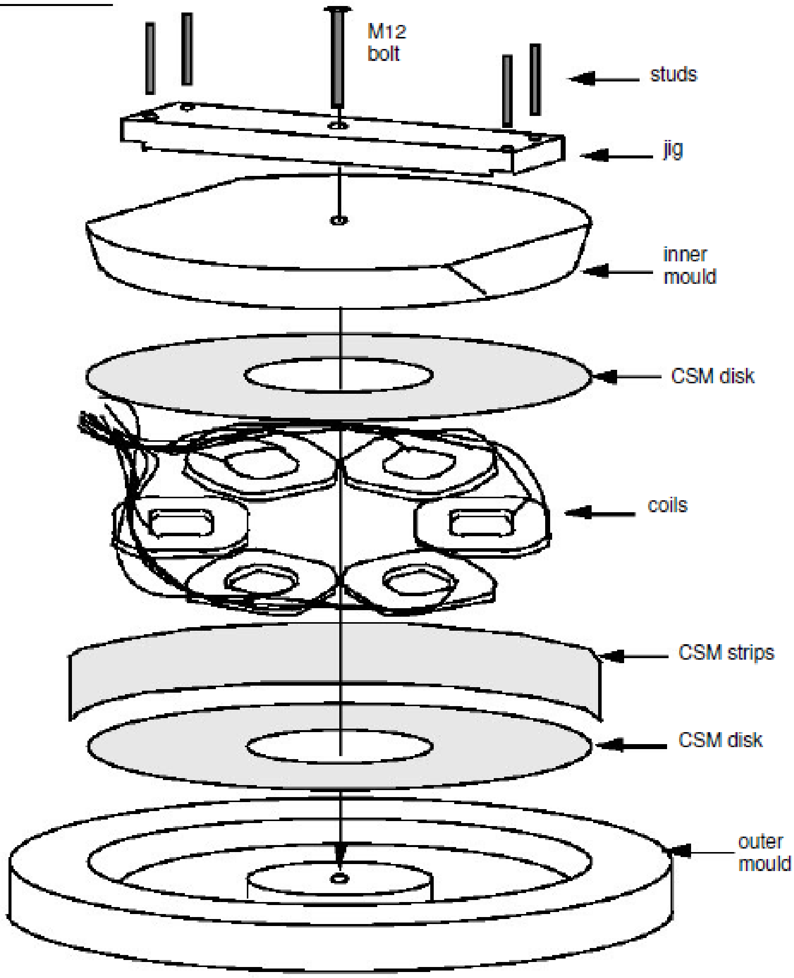


Mix resin with catalyst thoroughly but slowly to avoid churning in air bubbles. Add any talcum powder only after the catalyst is mixed. When the resin is mixed, use it at once. After a few minutes in the mixing bucket, it will heat up, and begin to set. Use exactly the right amount of catalyst. Resin casting needs less catalyst than normal fiberglass work (about half the time). When the workshop is hot, put in less catalyst. Casting thick layers of resin, put in less catalyst. If in doubt, make some trial mixes of resin, to find out the correct amount of catalyst. If there is no PVA 'release agent', then take care not to wipe the polish off the mould with brush strokes. Apply the resin with a 'prodding' action.

- Place the outer mould on some newspaper on a workbench.
- Mix 200g of resin, with 3cc of catalyst (and 15-30cc of pigment for color, if required). Use no talcum powder in the first two mixes.
- Paint this resin all over the inside of the outer mould. Do not paint it on top of the island in the centre.
- Apply one layer of fiberglass mat (CSM), and paint more resin over it again, with a poking motion to remove bubbles. Work the resin into the CSM.
- Apply a second layer of CSM to the wall, but keep one disk for later.
- Put the coils into the mould. The wire tails all come out in one place, between coils 3 and 4.
- Mix another 100 g of resin with 2cc catalyst. Pour this over the wires of the coils so that it soaks in. Avoid making 'pools' of resin.
- Mix another 600g of resin with 9cc catalyst and 600g of talcum powder. Pour this mix into the spaces between the coils. The resin should fill the outer mould until it is level with the island at the centre.
- Shake the mould vigorously, to remove air bubbles. Rotary motion and vibration will help the resin to settle, and help any air bubbles to rise .
- Mix another 200g resin with 3cc catalyst and only 100g of talc. Put the second CSM disk over the coils and paint it with this mix. Thoroughly wash out the paint brush with thinners.
- Put the inner mould down inside the outer mould, and fit the 12 mm bolt though the centre of both. Tuck the wiring neatly into the space between the moulds. One flat spot on the inner mould sits over the part where the wires come out of the stator. The resin will rise up the sides. Some resin may spill out.
- If necessary, pour resin gently into the gap between the moulds until it rises to near the top of the female mould. You may need to mix another 100g of resin with 1.5cc of catalyst to do this. Keep notes of the amounts of resin used, for next time.
- Place the jig (for the studs - image 24) over the inner mould, with one end over the wire tails. Tighten the 12mm bolt with a nut. Insert the four 8mm studs into

the holes, with nuts on top. The studs should be immersed in resin for about half of their length.

31. STATOR CASTING ELEMENTS



The casting is now complete. It should become slightly warm, and harden within hours. If it does not begin to set within a few hours, then put it in a warm place to speed up the process. When the resin is fully hard, remove the casting from the mould. Be patient and gentle if possible. Remove the jig from the studs. Tap the two moulds apart, using a bolt in each of the holes around the central hole. Knock the casting out of the outer mould by turning it over and knocking the edge of the mould gently against the floor.

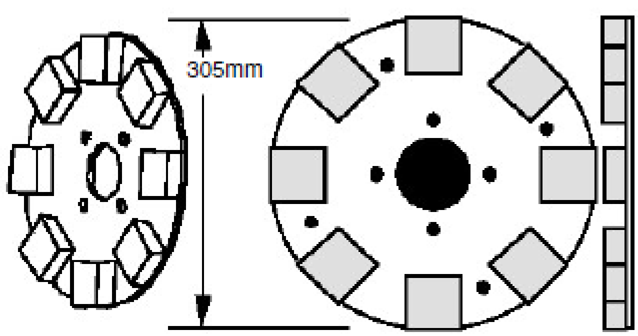
Rotor Construction

The magnet rotor is also a casting. There is also a procedure later for assembling the parts. First collect together the magnet plates, magnet blocks, stainless wire rope, etc. as described next.

Magnet plates

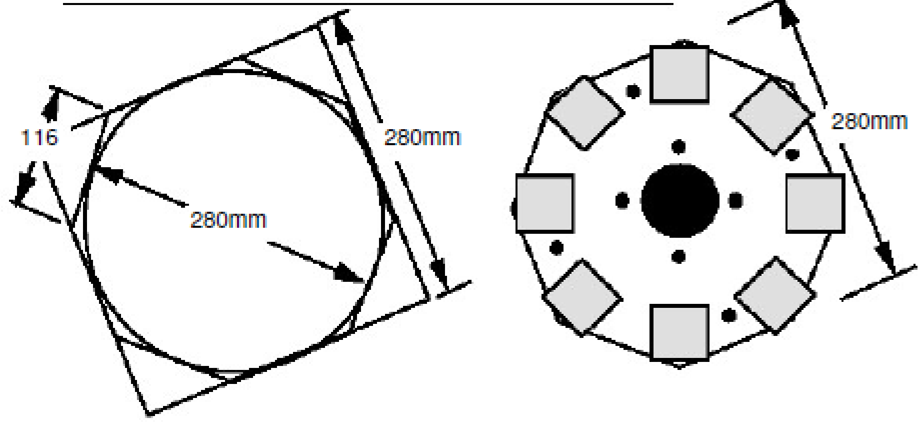
Each magnet rotor is built on a steel disk, 6mm thick. See Image 32. Do not use aluminum or stainless steel for this disk! The disks have to be made of magnetic material. The disk has holes to mount it to the hub - in this manual the hub has four holes, each 10mm diameter, on a circle at 4 inches (102mm) PCD. If a different hub is chosen, then all the jigs and moulds must match this hub. At the centre of the disk is a 65mm diameter hole. There should also be four holes drilled and tapped (threaded) for M10 rod between the magnet positions, at 220mm PCD. Screw four pieces of M10 rod, 20mm long, into these holes. These will bond to the resin and help to secure the casting onto the disk.

32. MAGNET ROTOR DISK



The magnet plates must be flat, not warped. It is not easy to cut the outer circle without warping the plate. A guillotine can cut steel plate into an octagon (*Image 33*), without warping the plate. This is an alternative way to make the rotor disk. First cut a square, draw a circle on it, and then cut off the corners at 45 degrees. The length of each edge is 116 mm. The magnets will be placed on the corners of the octagon.

33. ALTERNATIVE SHAPE : AN OCTAGON

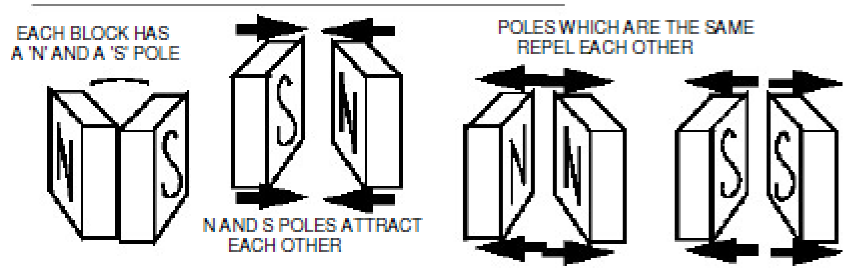


The central hole is made with a hole-saw or it can be cut out on a lathe. Grind the steel disks until they are bright and clean, just before putting them in the mould for resin casting. Remove any grease with spirits.

Magnet blocks

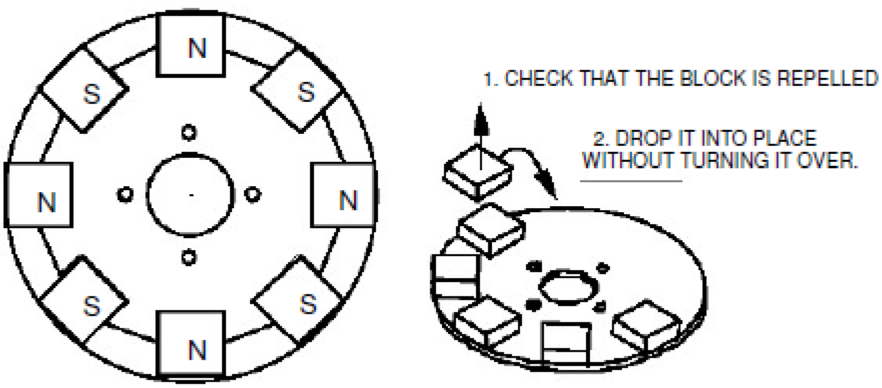
There are 8 magnet blocks on each rotor. Each block has a north pole and a south pole (*Image 34*).

34. POLES ON THE MAGNET BLOCKS



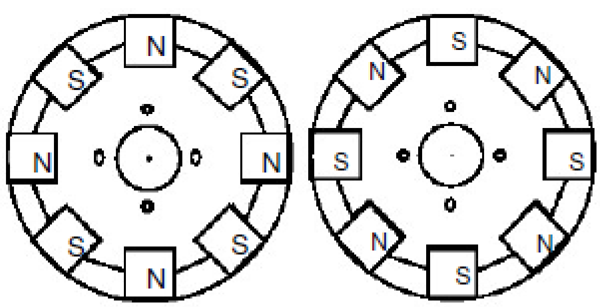
Take care when handling the magnets. Magnets can damage floppy discs, music tapes, credit cards and other magnetic media. Separate them from each other by sliding them sideways. They attract each other with strong forces. Take care not to let them fly together - they may break. Never use a hammer to assemble the PMG. You may break a magnet or break the resin holding it. The top faces of the magnet blocks on the disk must alternate N-S-N-S-... There is a method to check that you are doing this correctly, as follows. Each time a magnet block is placed, hold it so that it repels the one before (*Image 35*). Then place it without turning it over. When they are all in, check with another magnet: it will be attracted, repelled, attracted, and repelled, by each magnet in the circle.

35. PLACING THE MAGNET BLOCKS



The two magnet rotors must attract each other when the mounting holes are aligned. Check that the magnets next to the holes on one rotor are different from the ones next to the holes on the other rotor (*Image 36*).

36. THE TWO ROTORS ARE NOT THE SAME



Stainless Steel wire

When the PMG is turning, the magnets will try to fly off the rotors. There is a large centrifugal force pulling the magnet blocks to fly away. When we started building these PMGs, the magnet blocks were simply glued to the steel disks. When the PMGs turned fast, the magnets flew off, and the generators were destroyed. Now we embed the magnets in a resin casting. Resin alone is not strong enough to hold the magnets. It should be reinforced. Wrap wire around the outside of the magnet rotors to hold the magnets in. Steel wire is strong enough, but steel would take the magnetism from the magnet blocks. We use stainless steel because it is not magnetic and it does not spoil the effect of the magnets. Stainless steel wire cable is used on fishing boats. Before using any resin assemble the parts dry. Put the stainless steel rope around outside the magnets five times, and cut it off with a grinder or chisel. Tape it in several places so that it is in a coil, ready to drop into place later.

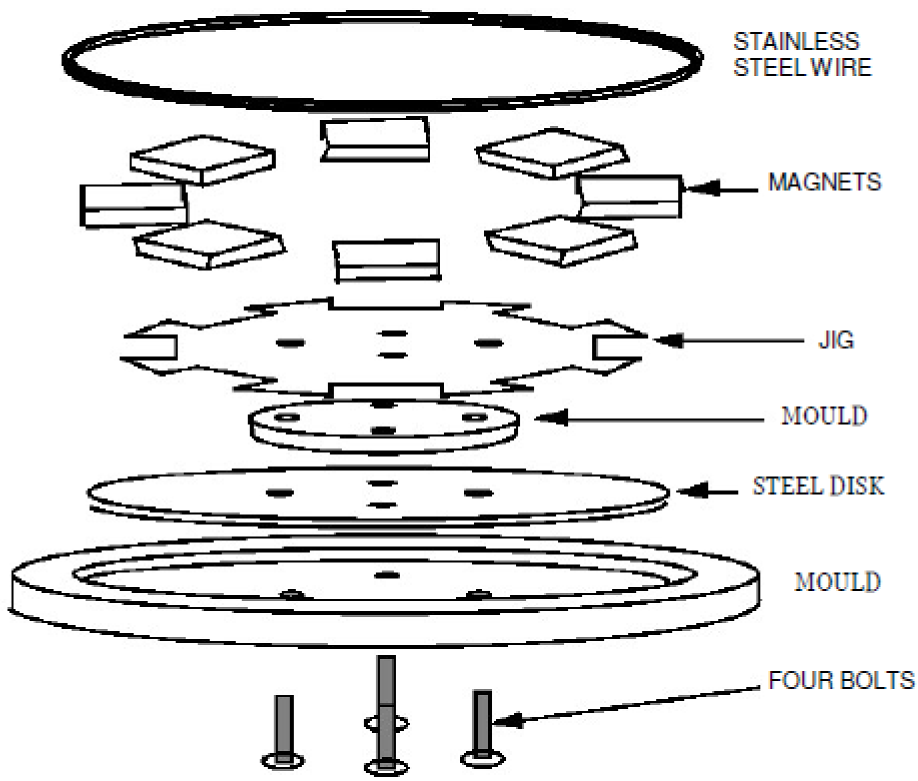
Rotor casting procedure

Before starting, check that everything is ready:

- The moulds are prepared with polish or release agent,
- The magnets and the magnet disks are clean and bright (no grease),
- 16 strips of CSM are ready to fit between the magnets
- The stainless steel wire is cut to length and taped
- The magnet positioning jig is ready

The amounts of resin mentioned in this procedure are enough for two magnet rotors.

37. MAGNET ROTOR MOULD ASSEMBLY



- Place four bolts through the holes in the outer mould, from below (*Image 37*). Lay a steel disk in the outer mould. Place the inner mould on top. Check the taper, and place the smaller face down, so that it can be easily removed after casting.
- Mix 200g of resin with 3cc catalyst. Paint it all over the steel disk. Add 20g of pigment for color if required. Mix 100g talcum powder with the remains of the resin. Pour this mix around the edge of the disk until it fills the gap, level with the top of the steel disk.
- Place the magnet positioning jig onto the bolts. Place the magnet blocks on the steel disk, within the positioning jig. Take care that the poles of the magnets alternate - north, south, north, south.. Before you place a magnet on the disk, check that the underside of the magnet is repelled by the one next to it (*Image 35*). When all the magnets are in, remove the positioning jig, and use it for the next magnet rotor. Remember: position the magnet blocks differently, so that the two

rotors attract each other. Take care not to knock the magnets out of place, or they will slide together under the magnetic attraction.

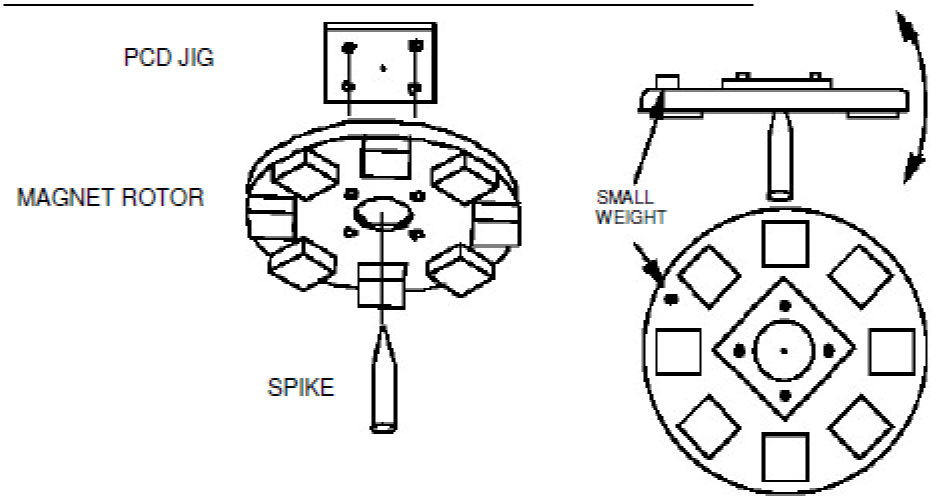
- Fit nuts to the four bolts and tighten the central disk down onto the steel disk.
- Mix 500g of resin with 7cc of catalyst. Add 300g talcum powder. Lay small strips of CSM between the magnets and into the gap at the edge. Add resin until the CSM is soaked. Poke it, or vibrate it, to remove bubbles.
- Lay the coil of stainless steel wire loosely around the outside of the magnets, below the top of the mould. Do not let the wire fall below the magnets. Let it sit on the CSM. Take care not to move the magnets around.
- Mix 500g of resin with 7cc of catalyst. Add 300g talcum powder. Fill the spaces between the magnets until the resin mix reaches the top of the mould.
- Leave the rotor castings to set hard (several hours) before you remove them from the moulds. Be patient when removing the rotors from the moulds. Do not use violent hammer blows which may damage them. Hit the mould, and not the rotor.

Assembly

Rotor balancing

Each rotor should be balanced, or the PMG will shake when it is turning. The whole PMG needs to be balanced again at the end, because the rotors may not be mounted exactly centrally. A different procedure is used for the final balancing in Section 6. To balance a magnet rotor (*Image 38*), first attach the PCD jig (from image 11), using four bolts. Then balance the rotor on a spike as shown:

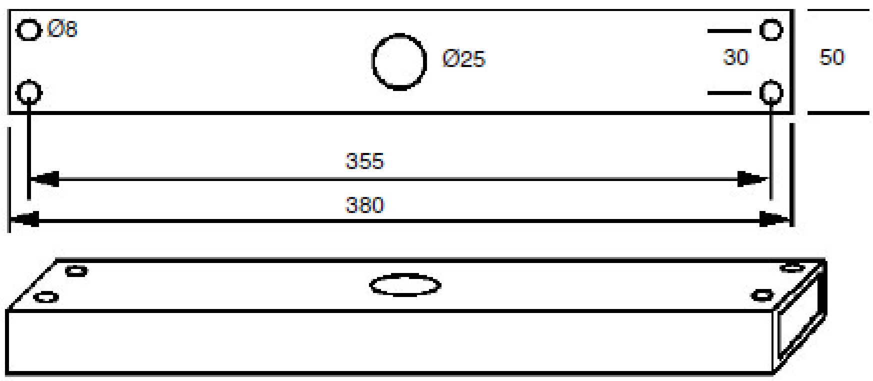
38. ASSEMBLY OF THE BALANCING JIG AND SPIKE



If the rotor will sit level, then it is balanced. If it will not sit level, then add small weights to it, or drill out some of the resin between magnets, until it will sit level. Turn the PCD jig around on the rotor, and check it again. Replace any weights with pieces of M10 threaded rod, screwed into holes in the resin between the magnets. PMG spine and bearing hub (*Image 39*) Make the spine of the PMG from a 380mm length of 'box section' steel tube 50x25x4mm (sometimes called RHS). Mark the exact centre of one large face, and then mark four 8mm holes, in the same way as for the 'stator studs jig'. It could also be possible to use the stator studs jig to help drill the holes. The hole at the centre is 25mm (or to suit the shaft used). Drill this with a hole-saw, or bore it on a lathe.

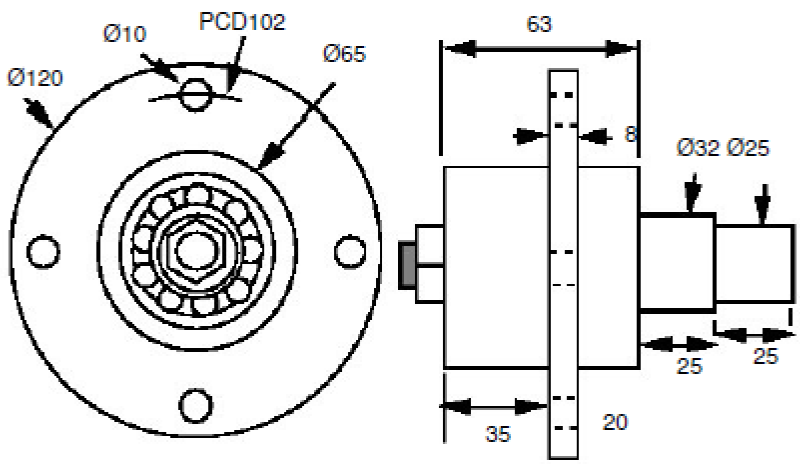
39. THE BOX SECTION SPINE

DRILL HOLES WITH A PILLAR DRILL FOR ACCURATE ALIGNMENT



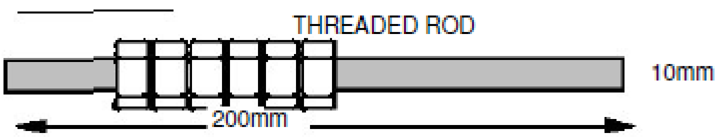
Weld the shaft in the 25mm hole. Take care to hold the shaft as square as possible (90 degrees) to the spine, when welding it. The bearing hub (*Image 40*) fits on the shaft. It has two 50x25 mm deep-groove ball races in it, with a spacer between them. It needs a plastic cap over the end to keep dirt out of the bearings. Do not forget to grease the bearings. Pack them with grease around half of their circumference only. Do not fill them entirely or they will become stiff to turn.

40. THE BEARING HUB



PMG assembly

- Cut 4 pieces of M10 threaded rod, each 200 long. They are used as studs to hold the magnet rotors to the hub.
- Put 6 nuts onto each stud (*Image 41*).
- Fit the studs through the holes in the bearing hub, from the front
- Put the rear magnet rotor onto the ends of the studs.
- Put a nut on the end of each stud, and tighten the other nuts down, so that the rear magnet rotor is attached to the back of the hub flange. The outer end nut should be sealed with paint or thread- sealant.
- Place the spine in a vice with the shaft upward. Place the hub onto the shaft. Do not hammer the magnet rotor while fitting. Fasten the hub to the shaft with a nut and split pin. Do not over tighten the nut. Fit a dust cover over the end of the bearing hub.



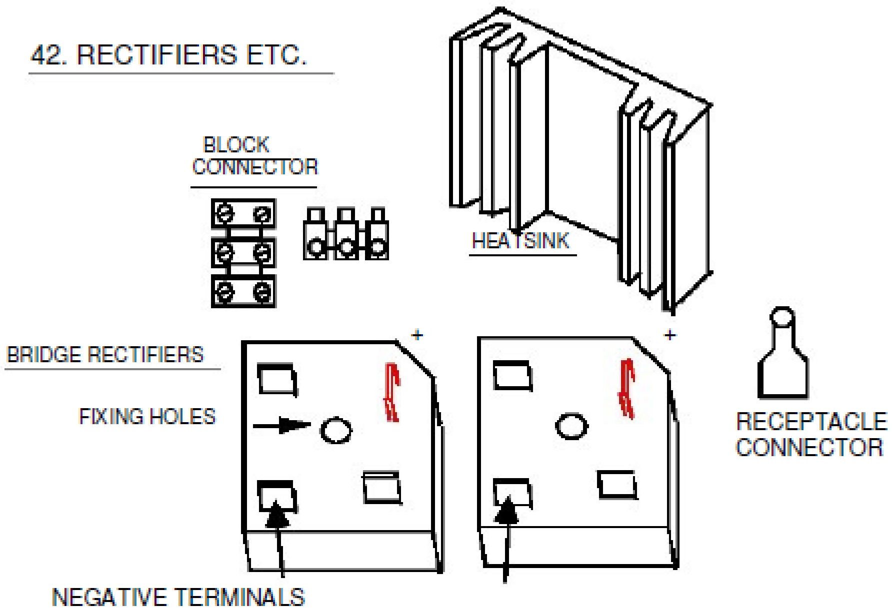
- Rotate the magnet rotor past a piece of brass wire. Do not use steel wire, because it is attracted to the magnets. The magnet faces should all be at the same height +/- 0.5mm. If not, use very thin shims between hub flange and rotor-disk, to adjust the rotor.
- Using a spirit level, adjust the spine in the vice until the magnet rotor is level. Check both ways: north-south and east-west.
- Take the stator. Fit one 8 mm nut onto each support stud. Screw them right down.
- Place the stator over the rear magnet rotor and fit its support studs into the holes in the spine. Fit more 8 mm nuts to the ends of the studs.
- Slowly lower the stator, and rotate the rear magnet rotor. Keep the stator level in both directions. You will hear a sound when the highest magnet touches the stator.
- Use the nuts to raise the stator equally 1mm on all four studs.
- Fit some washers to the 10 mm studs which hold the rotors. Always the same number of nuts and washers on each stud. A total of six nuts and two washers may be enough. Then fit the front magnet rotor.

• If the front magnet rotor is less than 1mm from the stator at any point, then add more washers under it. If it is much more than 1mm from the stator then remove washers. To find the correct number it is necessary to remove washers until it begins to rub the stator. Then add 1mm.

• When the front rotor is 1mm from the stator, then fit more nuts on top, and tighten them securely.

Electrical Parts

The next section (Section 7) will describe how to connect the rectifier to the stator. I recommend using two 'single phase bridge rectifiers' (*Image 42*). They come in blocks 30 x 30 mm. The positive terminals are both connected to the battery positive terminal. (They are often at right angles to the other three.) Both negative terminals are connecting to the battery negative. The remaining four terminals are for AC connection to the stator. You will probably only need to use three of these, connected as desired to suit the speed (see Section 7).



'Block connectors' are useful for connecting the wires from the stator. Alternatively soldering or crimping would be fine. Use solder, or crimped 'receptacle' connectors, to connect wires to the rectifiers. Take care not to overheat the rectifiers while soldering.

Bolt the rectifiers onto the heat sink, which will probably look like the one in the diagram, but can be any piece of aluminum approximately 250 grams or more in weight. Keep all the connections under a weatherproof cover.

Two bridge rectifiers

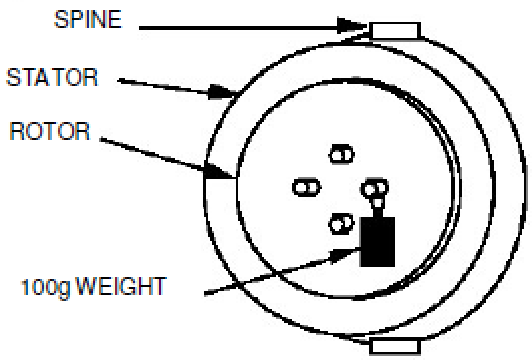
Testing and connecting

Check that the PMG has no faults before it is put into use. It will be much easier to correct the faults now, than to return the unit to the workshop later.

Mechanical testing

Mount the spine vertically in a vice. The magnet rotors are free to move. The shaft is horizontal, as it will be in a generator. Check that the wires are not touching each other, creating a short circuit which makes the PMG harder to turn. Check that the rotor will spin freely. Spin the rotor and listen for sounds. There should not be any scuffing or brushing of the rotor, as it turns. It should spin freely for several seconds and gradually come to a halt. If it slows down rapidly then there may be an electrical fault, or the bearings may be over-tightened. Grasp the stator with both hands. Push one side backward while pulling the other side forward, while the rotor is spinning. It must not touch the rotor. If there is a rubbing sound, then it may be necessary to disassemble the PMG and assemble it more carefully, with more space between the rotor and the stator. Or it may be possible to correct the problem by making minor adjustments to the stator mounting studs. Stop the rotor with one of the studs in the 3 o'clock position (*Image 43*). Hang an object weighing 100 grams on this stud. The rotor should begin to turn clockwise. If it will not turn, then the bearings may be over-greased or too tight.

43. HANG A WEIGHT ON ONE OF THE STUDS



Checking the balance

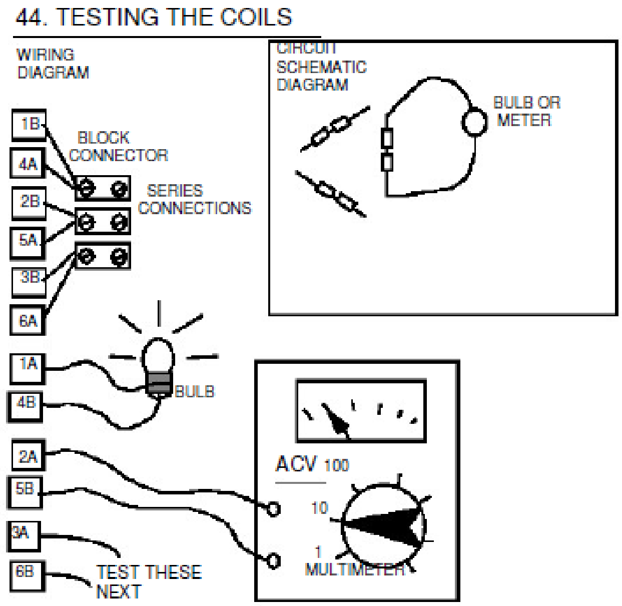
The rotors have already been balanced in section 6. When the unit is assembled, you should check the balance again using the new procedure below. This is necessary because the rotor disk may not be perfectly central on the PMG shaft. Repeat the starting test (*Image 43*) with each of the four rotor studs in the 3 o'clock position. Try different weights, and find the lightest weight which will start the rotor turning. If one stud needs much more weight than another, then the rotor is not balanced. Fix small weights to the rotor until the balance is correct.

Electrical testing

- **Coil connection test**

It would be helpful to have a multimeter when testing the PMG, but it is possible to do some basic tests with a 3 volt torch bulb, check image 44.

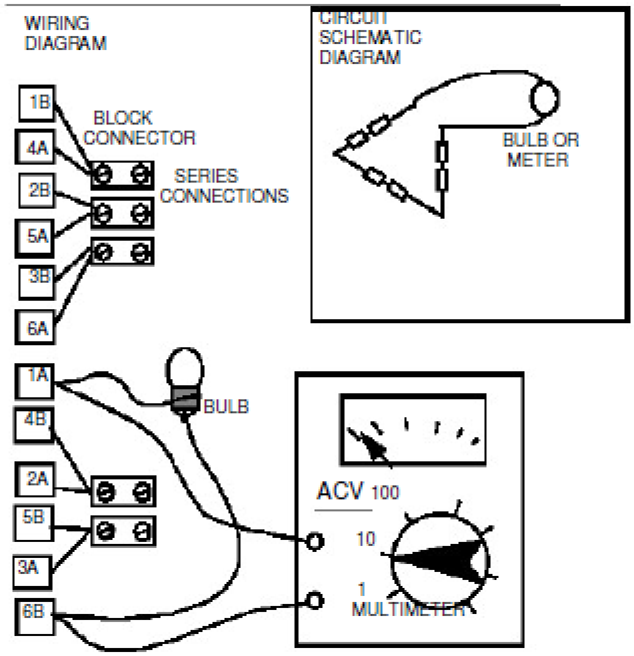
- Connect the wires 1B to 4A, 2B to 5A, and 3B to 6A. (Series connections of pairs of coils which are in the same phase.)
- Set the multimeter to '10VAC' or similar (if you have one).
- Connect the meter, or a bulb, between the wires marked 1A and 4B.



- Rotate the PMG slowly by hand, about one revolution per second.
- The meter should give a reading of about two volts, or the bulb should flicker.
- Repeat the test with two more pairs of wires: 2A and 5B, 3A and 6B.

In each case the result should be the same. If there is no reading, or a very low reading, then check that the series connections (1B-4A, 2B-5A, 3B-6A) are correct. If all these connections are good, then it is possible that one coil has been reversed (placed upside-down). If any coils have been reversed, then it is necessary to do another test (*Image 45*), to find out which one is at fault. Connect 4B-2A and 5B-3A as shown in the diagram. Now test between 1A and 6B. There should NOT be more than a very small voltage. If there is a voltage, or the bulb lights up, then reverse the connections (swap A for B) on the coils until the voltage drops to a very low level. When the faulty coil has been found, label the tails again, with A and B at the correct ends.

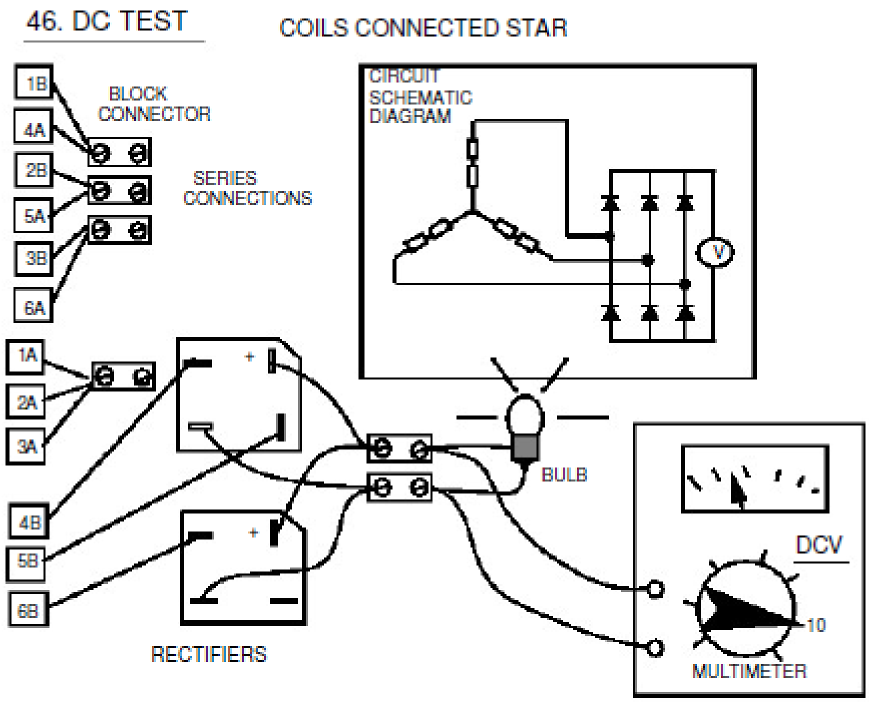
45. CHECKING FOR A REVERSED COIL



There will always be a small voltage in this test, because the coils are not perfectly positioned in the mould. If the test gives more than one volt, then it should be possible in future to make a better stator by placing the coils at exactly equal distances apart in the mould.

DC output test

When these tests have been completed and the results are correct, then connect the rectifier, as shown in image 46. Connect the tails 1A, 2A and 3A together. Connect each of 4B, 5B and 6B to any three of the rectifier AC terminals (marked with 'S' symbol). This is the 'star' connection. Connect a bulb to the output, if possible, also a multimeter on 10 VDC (or similar).



Rotate the rotor by hand as before, approximately one revolution per second (60 rpm). The meter should show a steady reading around 4 volts DC (or 3 volts with the bulb present). The bulb should glow with a steady light, not flickering as before. If there is no reading, or the bulb flickers, then there is a faulty connection or a faulty rectifier.

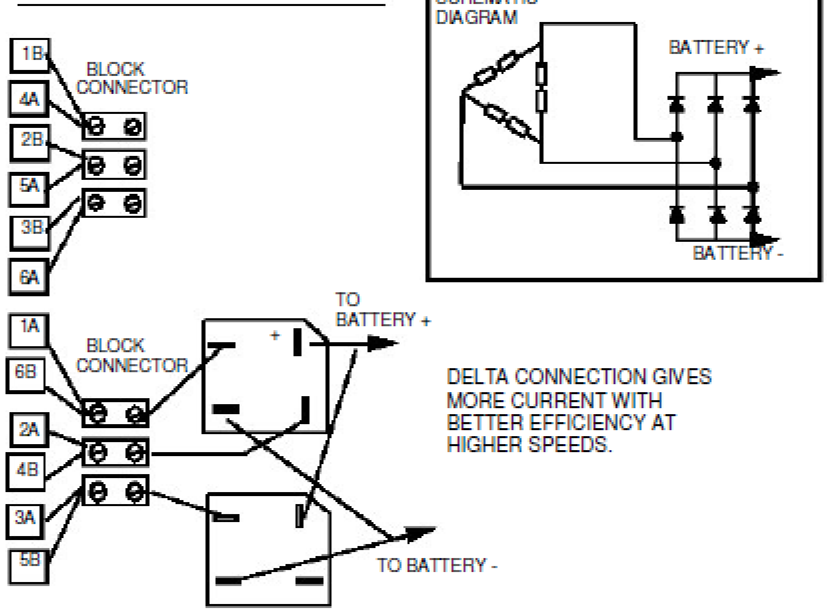
- Check the connections carefully.
- Try another rectifier.
- You can also test the PMG without a bulb or a meter.
- Simply connect the positive and negative wires from the rectifiers together (all four) in a 'short circuit'.

Now try to turn the PMG. It should be stiff but smooth to turn. If it trembles as you turn it then there is a fault.

Connecting the PMG to the 12 volt battery Star and Delta connections.

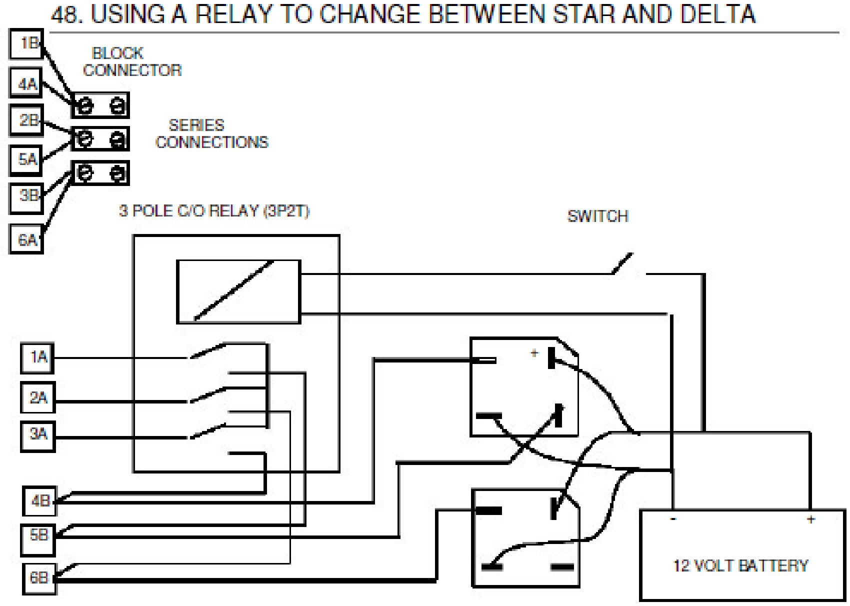
For low output requirements, connect the coils 'star' as above. For a higher current output, connect the coils 'delta', as in image 47.

47. DELTA CONNECTION



It is also possible to wire a relay (*Image 48*) which will switch the connections from star to delta and back as desired.

48. USING A RELAY TO CHANGE BETWEEN STAR AND DELTA



Yet another option for connecting the stator At the time of writing this document, the above arrangement (using a relay to change the connections) is still under development. Later, an electronic control circuit will be available to automate the changeover. This is all very complex, and it so it can go wrong.

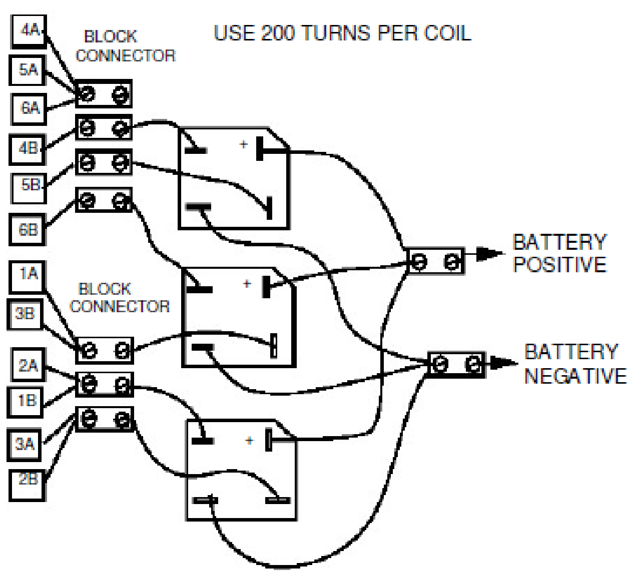
If you do not wish to have to change the connections between low and high speeds, then the PMG will still work. However, the efficiency will be slightly less.

Three are two options:

• If you expect mainly low speeds, then you can simply use the star connection shown in image 46.

• If you also need higher power in at higher rotational speeds, you can use a 17AWG wire (1.2 mm diameter) to wind coils with 200 turns each. Then you can connect one group in delta and one group in star as shown in image 49. Note that you need six AC terminals on the rectifiers so you will need three rectifier blocks.

49. STAR/DELTA CONNECTION



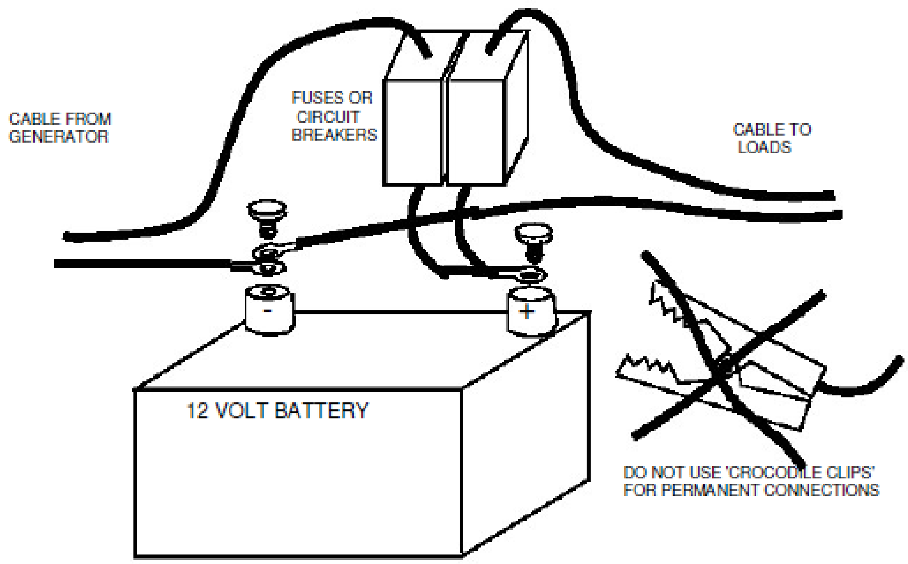
PMG-to-Battery Cable size

The cable from the PMG to the battery can be either three-phase-AC or DC. This is only slightly more efficient than three phase AC.
At 12 volts, the size of the cable must be large. Even if the current is only 15 amps, it is advisable to use a heavy cable. For a distance of 20 metres, the recommended size is 6 mm 2 (10AWG). The diameter (thickness) of each copper wire is about 3mm. A 15 amps current flowing in this cable will lose 15% of the as heat in the cable. If the cable is longer, it should be heavier, in direct proportion.

Electrical Safety

There is no danger of electric shock from a 12 volt battery. But if the generator is disconnected from the battery, and running fast, then the voltage will be higher than 12 volts, maybe as high as 50 volts. Do not run the PMG at high speed without a battery connected. The battery contains stored electrical energy. When there is a short-circuit fault in the wiring from the battery, for example the positive and negative wires touching each other, this energy is released in a very high current. The cable will heat up and burn. Therefore it is necessary to use a fuse or a circuit breaker on every wire which attaches to the battery positive terminal. Use one fuse for the generator and a separate one for the cable to the load (the lights, or whatever uses the power). See image 50.

50. CONNECTING THE BATTERY



Battery acid is bad for the clothes and the skin. Do not splash it. Be especially careful of the eyes. If there is an accident, the best cure is to flush with plenty of water. Batteries produce hydrogen gas, which is very explosive. Do not make sparks near a battery or it may explode, and throw acid in your eyes!

Battery Charging

Lead acid batteries should be kept in a charged condition. But be careful not to discharge the battery too deeply, or to keep it too long in a discharged state, or it will be damaged (sulphated) and become useless. Stop using a battery before it is fully discharged. If there is a problem with the generator, then charge the battery from another source within two weeks. Charging the battery too hard will also damage it. At first, when the battery is discharged, it is safe to use a high current, but later the current must be reduced or the battery will overheat and the plates will be damaged. The best way to fully charge a battery is to use a small current for a long time. Watch the battery voltage. If the battery voltage is below 11.5 volts, then it is being discharged too much. If the voltage is high (over 14 volts) then the battery charging current is too high. Use less current or more current in the loads to correct these problems. If there is no voltmeter available, then the user should watch the brightness of the lights and follow these rules:

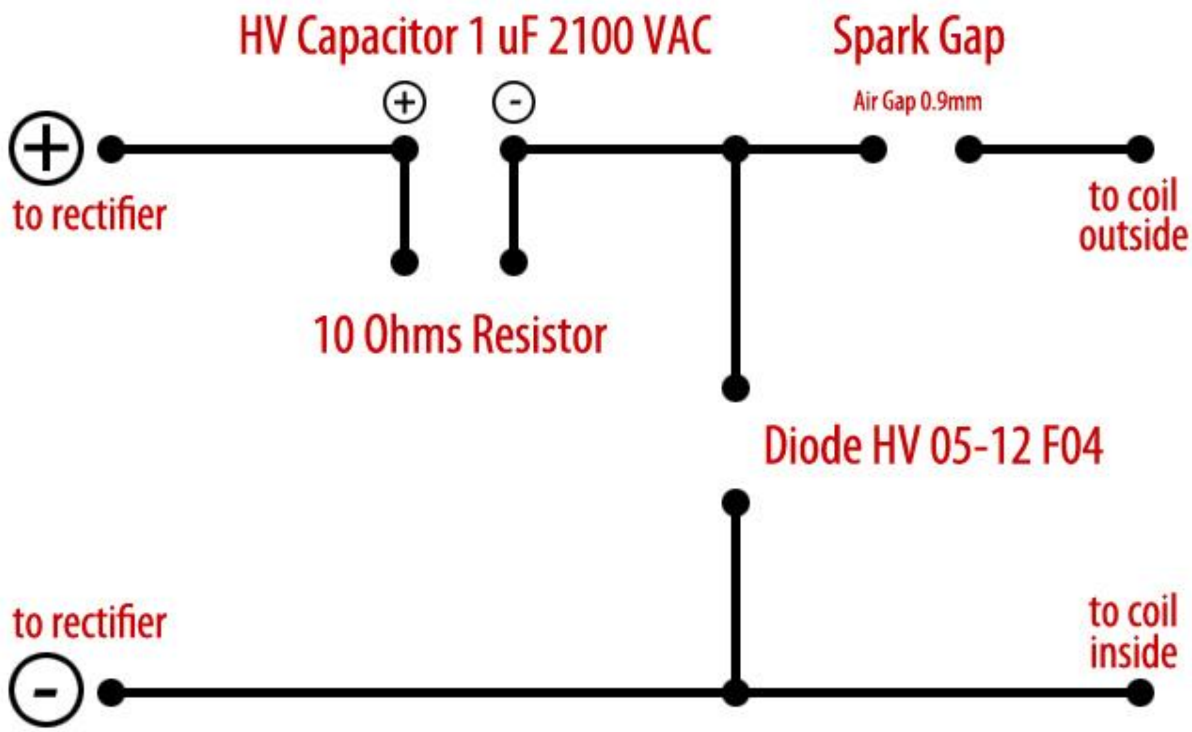
• Dim lights, mean low battery. Use less electricity!

• Very bright lights mean too much power. Use more electricity!

There are simple electronic circuits which can regulate the battery voltage automatically. They are called 'low voltage disconnects' and 'shunt regulators'. If the user is not willing to watch the battery voltage, then it is necessary to fit a disconnect and a regulator.

Building the Circuit & Coil

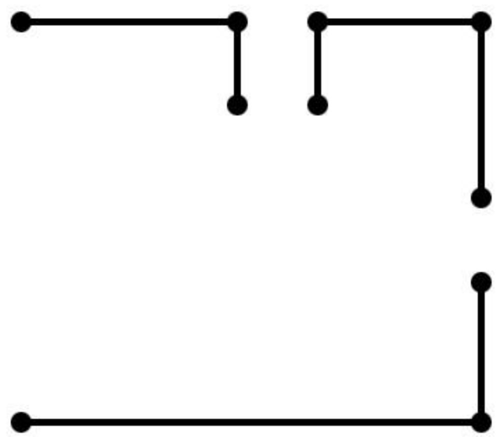
Building the Circuit Board



First you will need to acquire a circuit board. Circuit boards are about a dollar apiece, and are simply a layer of copper over an insulator. The typical size is usually 3.5 inches by 5 inches. Then you will need to draw the appropriate schematic on it, which is quite simple. All that is required is an indelible marker, such as a Sharpie and a ruler.

Drawing

Draw out the following circuit on your board with the Sharpie. Keep in mind that copper cannot be between components, for example, when connecting an LED, there must be a gap in the copper between the positive and negative points of connectivity. Without a gap, the electricity would flow around the LED, as opposed to through it. Remember laws of electricity, all circuits must end at either a negative or ground, or no current will flow.



(Draw on circuit board)

Use thin lines, but lay the ink on thick, it is important that the copper is dissolved before the ink, and that there are no thin patches in the ink exposing copper. Also the schematic which you will draw on the board, does not have to be equal in size as in this paper, it just has to be closely proportional.

Etching

For this part you will need:

• A non-metallic basin that is deep enough to submerge the circuit board

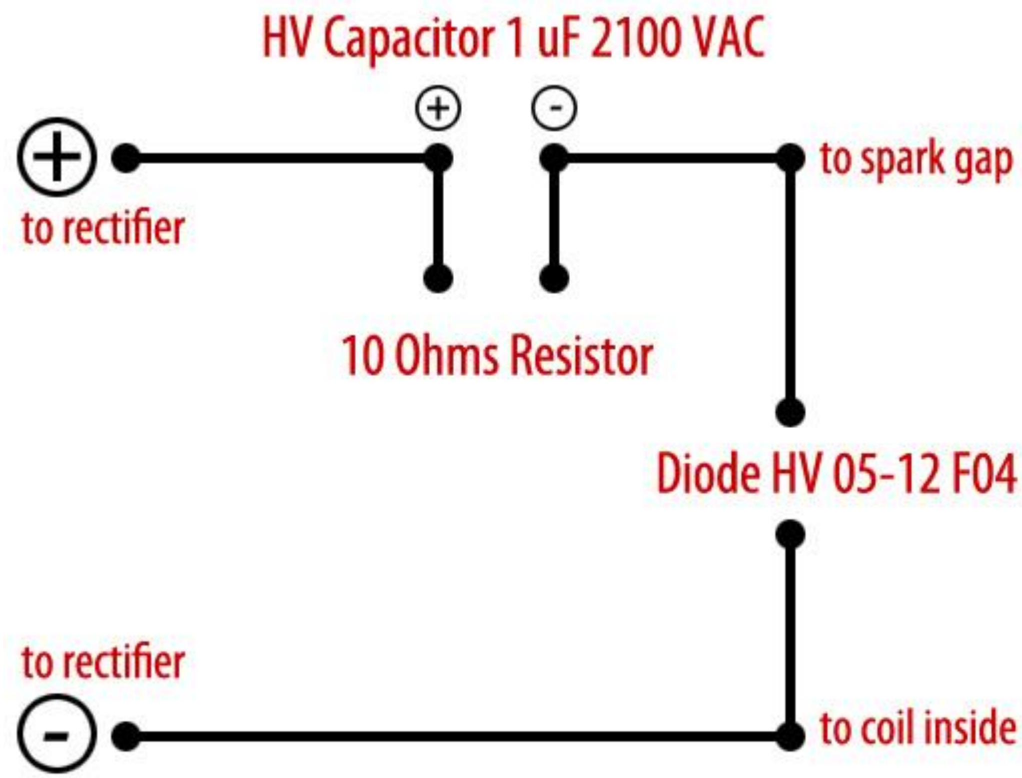
• Non-metallic containers for mixing

- Goggles
- Vinyl or Latex gloves
- A device used to agitate the circuit board (a stick)
- Hydrochloric Acid (Muriatic Acid)
- Hydrogen Peroxide
- Rubbing alcohol
- Acetone or mineral spirits

After you acquire the materials need you will need to do the following process in a well ventilated room, since we will be mixing chemicals which produce hazardous fumes.

1. Put on the Goggles and Latex or Vinyl Gloves.
2. Mix two parts hydrogen peroxide for every one part hydrochloric acid. When mixed, they form a substance that is a severe skin irritant, and will produce toxic chlorine gas.
3. In a non-metallic basin pour enough of the solution to completely submerge the circuit board.
4. Drop in the circuit board and agitate it for about ten to fifteen minutes. Continue stirring until all copper has dissolved, and the solution has taken on a slight green tinge.
5. For cleanup, make sure you are wearing gloves. Wash the board off in cold water to remove any etching solution. Then use a paper towel or rag to dry it off completely. Set it aside. Assure that there is no solution in the workspace or containers then remove the gloves and goggles.
6. Mix a one to one ratio of acetone and rubbing alcohol. Take a paper towel, dip it into the solution, and gently rub it over the surface of the board. The permanent marker will begin to come off. Continue rubbing until all marker is gone. You should see that your circuit is now inscribed in the copper.

Assembly



Now you will solder the appropriate components on the circuit board, for reference what and where it is needed follow the image above.

Also for this part of the build you will need the following tools:

- Hand-held Drill or Drill Press
- Various drill bits
- Soldering iron
- Solder

1. Before drilling, locate all the positions of the through-hole components, practically you will need to drill at every dot that you drew on the circuit board.

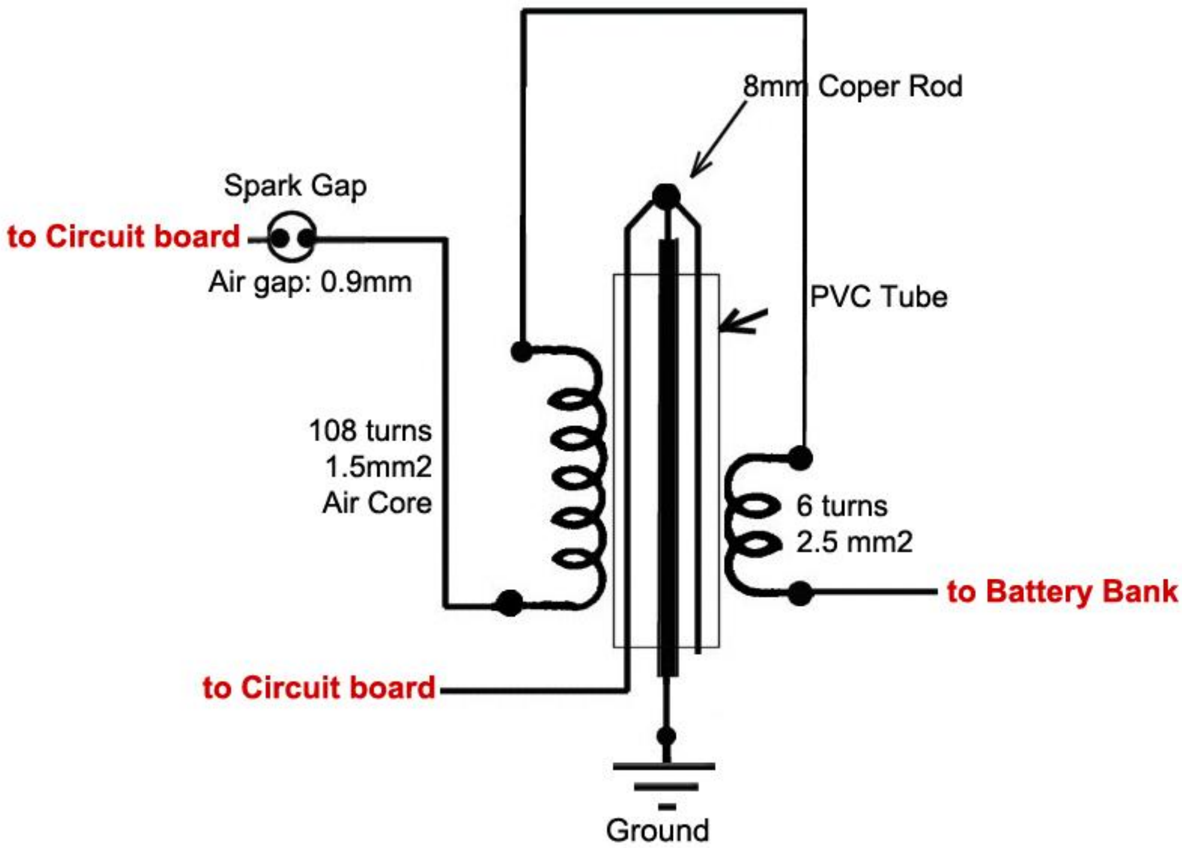
   (***Note: Copper dust is toxic, wear a dust mask.***)

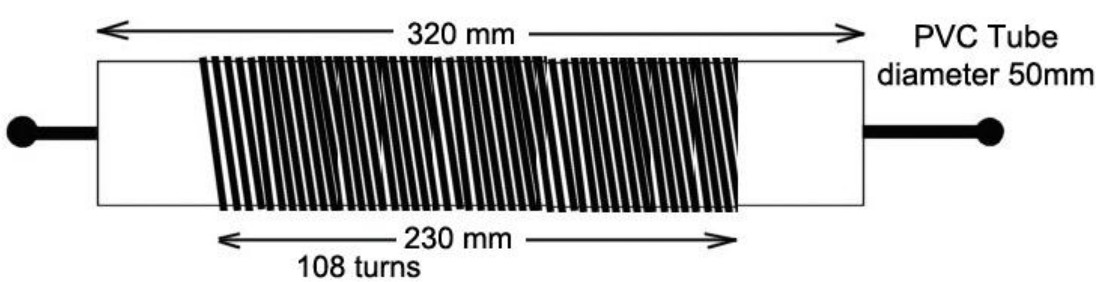
2. Drill through the board with a bit wide enough to accommodate whatever part must be placed at that location. Remember not to make the hole to wide, or soldering will be very difficult.

3. Place the components on to the circuit board at their designated locations. Gently bend the legs of the component against the underside of the board, to hold the part in place. Make sure parts with polarity are lined up correctly with the corresponding positive and negative. Check and double-check the location of all parts before soldering.
4. Soldering is a skill that requires practice, although it is not inherently difficult.

Test your circuit board before installing it into its permanent location. Use a multimeter, if possible, to diagnose connection problems. A de-soldering gun can be used to make minor switches and repairs.

Building the Coil



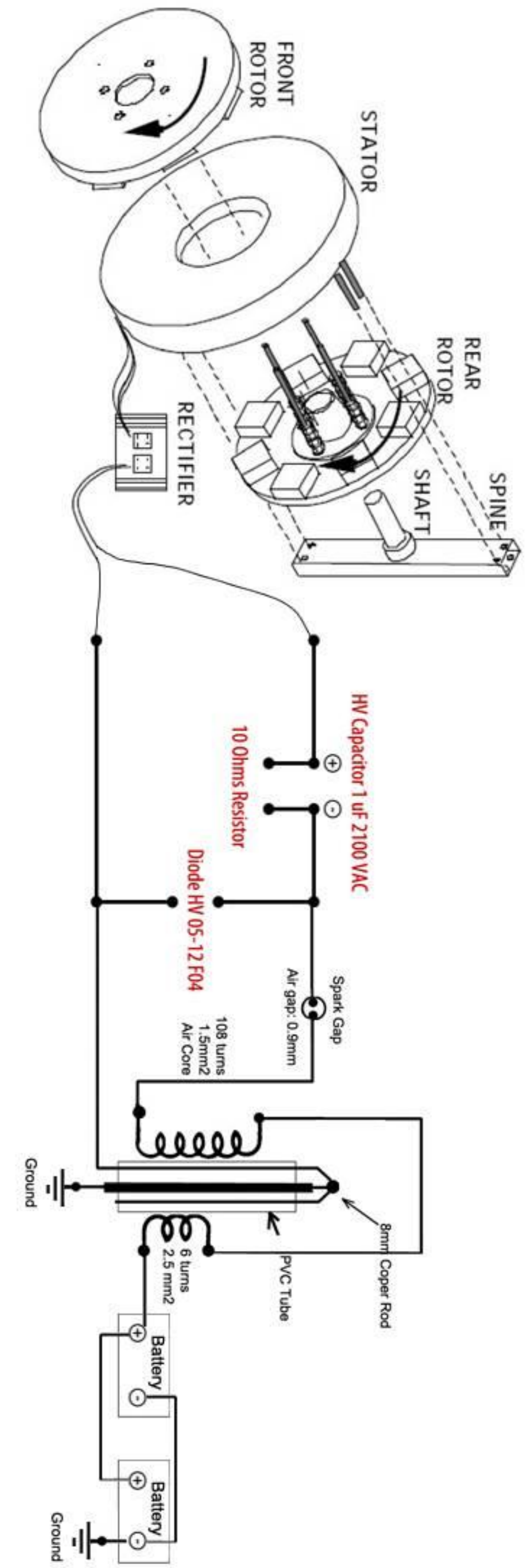


This is the simplest part of the whole building process, for this part you will need:

- PVC tube: 50mm diameter, 320mm length.
- Copper rod: 8mm diameter, 400mm length.
- 2m of 2.5mm2 copper wire.

- 30m of 1.5mm2 copper wire.

What you need to do here is, wind the copper wire on the tube as described in the image above, and interconnect the coil with the rest of the components as described in the image on the next page.


FRONT ROTOR
STATOR
REAR ROTOR
SPINE
SHAFT
RECTIFIER
HV Capacitor 1 uF 2100 VAC
10 Ohms Resistor
Diode HV 05-12 F04
Spark Gap
Air gap: 0.9mm
108 turns
1.5mm2
Air Core
Ground
8mm Coper Rod
PVC Tube
6 turns
2.5 mm2
Battery
Battery
Ground

Additional Information

Using polyester resin

Polyester is the plastic substance used in fiberglass work for building boats, car body parts, etc. Various things are added to it to make it work better for various jobs. Talk to your supplier and explain what the resin is to be used for. Your supplier should be able to help you.

Hardeners

There are two systems used to harden polyester resin, and each system uses two chemicals. For resin casting and most fiberglass work we use peroxide and cobalt. ('Body filler pastes' use the other system.) Cobalt is a purple fluid. Ask the supplier to mix the right amount of cobalt into the resin. After it is mixed, the resin must be stored in the dark, or it will harden. Peroxide is a hazardous chemical. Avoid contact with skin. Store in a PVC container, in the dark, below 25 degrees C. Never mix it with cobalt (except for the cobalt already in the resin), or it will explode. Mix very small quantities (about 1-2%) of peroxide with resin or it will overheat. Wax-free 'Air inhibited' resin 'B' This type of resin is used for 'gel-coats' on boat moulds, where the resin is going to be built up in stages. We do not recommend using this resin for the PMG. Any exposed surface will remain tacky indefinitely. Ask for resin 'A', or better still 'casting resin'.

Additive

A special powder of very light silica is often added to resin to make it thicker, so that it is easier to spread it with a paint brush. This powder is not needed for casting resin. If it is already added, it does no harm.

Styrene monomer

Approximately 35% of the resin as supplied is styrene monomer. This is used for thinning the resin. It causes the smell. It is possible to add a little more styrene monomer (10%) to make it more liquid.

Pigment

Pigment is used to color the casting, if a colored finish is desired. Add pigment to the first mix, which will be on the outside of the casting. Add no more than 10% pigment to the mix. It is not necessary to add pigment to the resin. Without pigment, the casting is transparent and the coils are visible.

Fiberglass

The resin has almost no strength without fiberglass. It is available in sheets of 'chopped strand mat' (CSM). It is also possible to buy just chopped strands, and to mix them with the resin. This is useful for the magnet rotor castings. Add a little resin to the fiberglass, and press out all the air bubbles, before adding more resin.

Talcum powder

Talcum powder is cheap filler which can be mixed with the resin after the peroxide has been added. It makes the resin mixture much cheaper, and a little thicker. Resin can be mixed with up to twice its own weight of talcum powder. The powder also helps to reduce the heat build-up in large resin castings.

Mould preparation & Polyurethane varnish

Ordinary paint should not be used on moulds. Better to use nothing. If possible, use polyurethane varnish. This will prevent moisture coming out of a mould made from wood, plaster or clay. Smooth the varnish off with sandpaper before polishing it.

Polish

Polish the mould several times before using it first time. Rub all the polish off with a rag and then leave it some hours and do it again. Silicone polish is not compatible with PVA release agent. Use wax polish. PVA Release agent Paint this over the mould and let it dry. It forms a sheet of PVA, which greatly helps.

Constructing a Solar Panel

Introduction

In this chapter you will learn how to build a solar panel that will cost around $152. The solar panel will be made out of 36 (3"x 6") Solar Cells laid out on a 3 x 12 grid, and will produce from 60 to 85 watts. This panel is small and very portable, and easy to build, in the future you can build with this same guide a bigger solar panel if you want or even in a different grid, or alternatively what we recommend, you can build more solar panels like this one and connect them in parallel and get bigger output. In the end of this chapter we will discuss how you can connect more solar panels like the one in parallel. For this solar panel we spent:

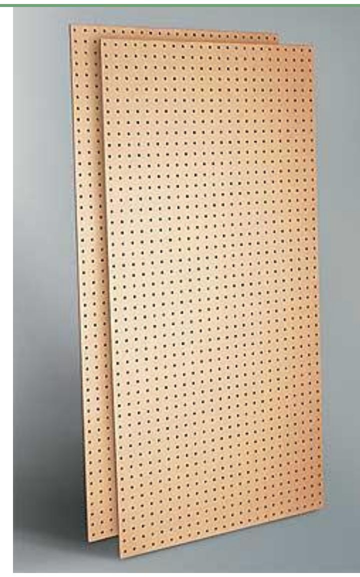
Part:	Origin:	Price:
Solar Cells	EBay	$79
Misc. Lumber	Home Depot	$30
Plexiglas	Home Depot	$30
Screws & Misc.	Home Depot	$10
Silicone	Home Depot	$3

Needed Materials

- ***Mono-Crystalline Solar Cell***
- ***Quantity:*** **36 minimum**
- ***More Info:*** **The cells are 3" x 6" in size, 36 are needed for one panel which will produce 60 watts of power.**

- ***Plywood***
- ***Quantity:*** **1**
- ***More Info:*** **The plywood will be used as a base for the solar panel. The dimensions are: 3/8" thick, 78" long and 26" wide.**

- ***Pegboard***
- ***Quantity:*** **1**
- ***More Info:*** **You don't have to use a peg board any non conductive ridged material will be fine as long as the dimensions are: 78" long and 26" wide. The solar cells will be attached on the pegboard than the pegboard will be attached on the plywood.**



- ***Batten Wood***
- ***Quantity:*** **4**
- ***More Info:*** **The batten wood will be used as a border around the cells, also the glass cover will be fixed on it. The dimensions are: 3/4" thick, 78" x 2 and 26" x 2.**

- ***Plexiglas or Glass***
- ***Quantity:*** **1**
- ***More Info:*** **This will be used to cover the cells. The dimensions are the same as the plywood. Keep in mind if you buy glass it should be non reflective. We recommend you use Plexiglas since Glass is much more fragile.**

- *Copper Wire*
- Quantity: Depends
- More Info: The copper wire will be used for connecting the cells, if you can you should get two different colors so you can more easily tell the positive from the negative.

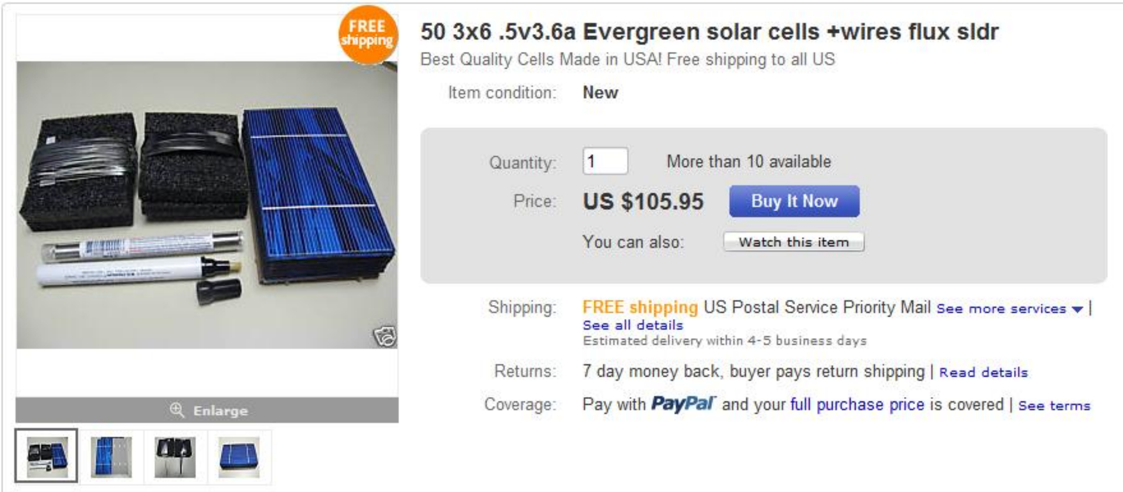
- *Silicone*
- Quantity: 1 Tube
- More Info: The silicone will be used to hold the solar cells in place and also to stick the Plexiglas on to the border.

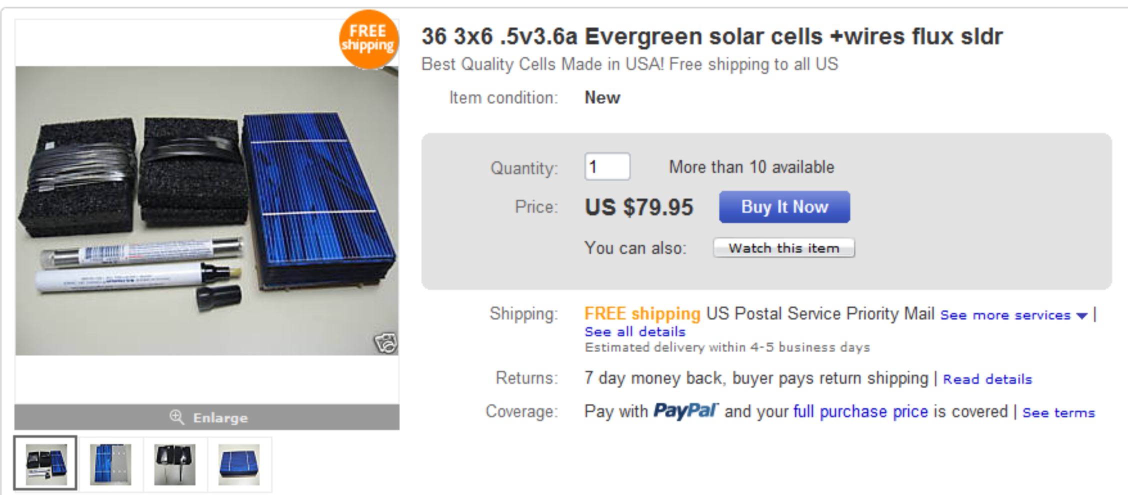
- *UV Protector*
- Quantity: 1
- More Info: The plywood needs to be protected from the sun so it lasts much longer.

- ***Solder***
- **Quantity: 1**
- **More Info: You will need the solder, in order to solder the copper wire on to the solar cell.**

Solar Cells

If you have hard time finding solar cells for low price, the best market for solar cells is eBay. Here are some good finds from EBay.





- ***Wax Dipped Solar Cells:***

Some vendors dip the solar cells in wax so they don't get damaged during the shipping process, if you notice wax on your solar cells you should remove it before you use them. We recommend that you ask the vendor if the cells are dipped in wax so you don't go through the following process of removing wax. Here is a quick guide how you can remove the wax without damaging the cell.

Put the brick of cells in cold water, and heat the water gently. It is very important that the water doesn't reach boiling point, since it will damage the cells and the bubbles from the boiling will jostle the cells against each other violently.

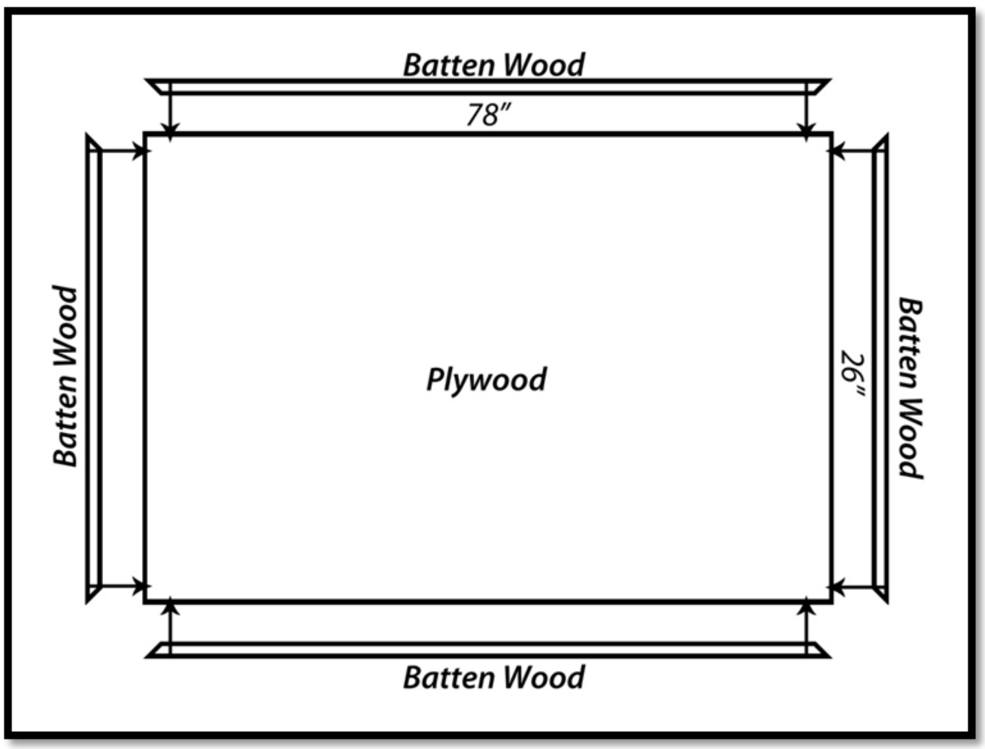
Plastic tongs and spatulas come in handy for teasing the cells apart once the wax melts. Try not to pull too hard on the metal tabs or they may rip off.

The initial hot water bath for melting the wax is in the right-rear pot with the cells still inside. In the left-front pot is a bath of hot soapy water. In the right-front pot is a bath of hot clean water. All the pots are just below boiling temperature. First you should melt the wax in order to separate cells apart from the brick, in the hot water bath on the right-rear pot. After you separate the cells transfer them one at a time to the soapy water bath on the left-front to remove any wax on the cell. Then the cell would be given a rinse in the hot clean water in the right-front pot. The cells would then be set out to dry on a towel. You should change the water frequently in the soapy and rinse water bath pots.

Don't pour the water down the sink though, because the wax will solidify in your drains and clog them up. Dump the water outside. This process will remove almost all the wax from the cells. There might be very light film of wax on some of the cells, but it doesn't seem to interfere with soldering or the working of the cells.

Step 1: Constructing the Frame

Once you acquire the plywood and batten wood you should cover it with coating of UV protection so it can last longer and don't fall apart after the first rain. If you are going to use a pegboard cover it with UV coating also. You should also coat with UV protection the batten wood which you will use for the boarder. After everything is coated and dried up, you should attach the batten wood on the edges of the plywood so the end result resembles a photo frame. For reference see the photo and the diagram bellow.



(Attach the Batten Wood on the Edge of the Plywood)

(UV Coated Plywood with Attached Batten Wood Border)

Step 2: Connecting the Solar Cells

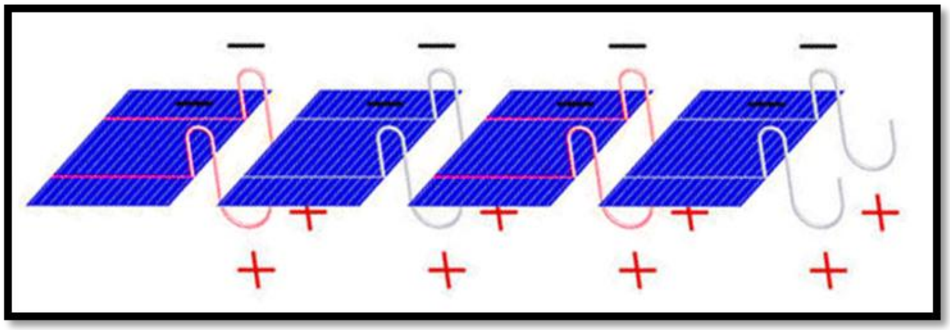
In this step we are going to solder the solar cells together, but before we do that we will present you with more information about the solar cells and the possible ways to connect them.

Depending upon what type of solar cell you will buy, you will either have clear lines on the bottom or you will have tabbed cells. The tabbed cells look very similar except that the back will have metal squares instead of full lines. Both types of solar cells will work for building your own solar panel.

Furthermore there are two ways to connect the cells, in parallel or serial. There is a big difference how you connect the cells together so let’s examine the difference.

Serial Connection

The voltage and wattage of each cell will be added together, but the total current (Amps) will remain the same. If one cell is capable of 0.5 Volts, then 36 cells in series are capable of 18 Volts, or around 63 Watts.



1 Solar Cell = 0.5V, 1.75W, 3.5A

Voltage for 36 in Series:

36 x Volts = Total Voltage

Ex.: 36 x 0.5V = 18 Volts

Wattage for 36 in Series:

36 x Watts = Total Wattage

Ex.: 36 x 1.75W = 63 Watts

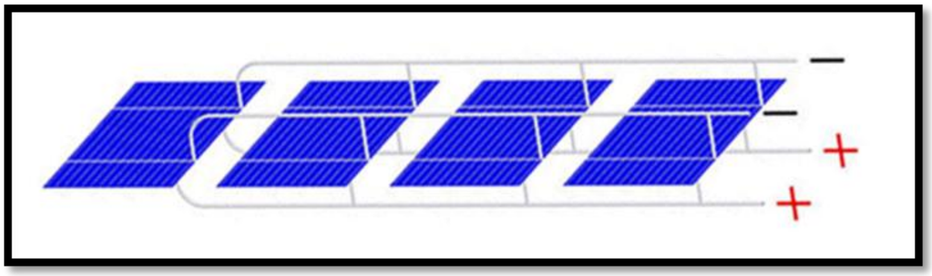
Amperage for 36 in Series:

Watts / Volts = Amperage

Ex. 63W / 18V = 3.5 Amps

Parallel Connection

The current (Amps) of each cell will be added together, but the voltage will remain the same. If one cell is capable of 3.5 Amps, then 36 cells in parallel is 126 Amps at 0.5 Volts.



1 Solar Cell = 0.5V, 1.75W, 3.5A

Voltage for 36 in Parallel:

0.5 Volts

Ex.: 0.5V x 1 = 0.5 Volts

Wattage for 36 in Parallel:

36 x Watts = Total Wattage

Ex.: 36 x 1.75 = 63 Watts

Amperage for 36 in Parallel:

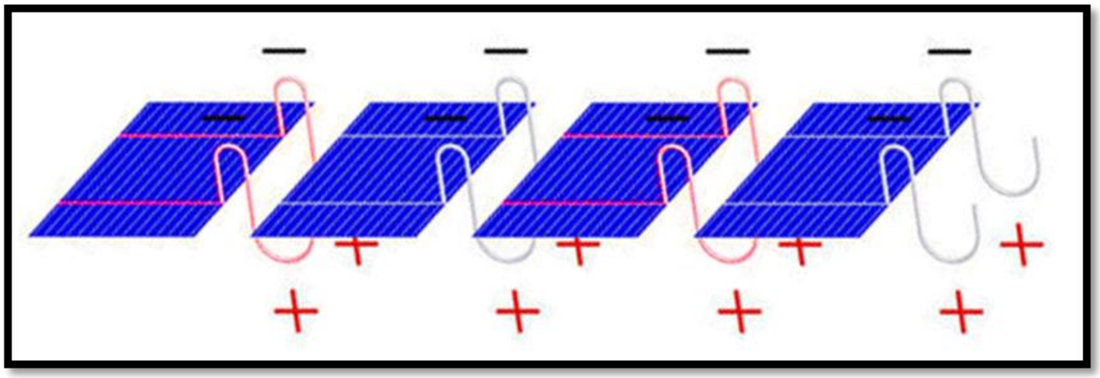
Watts / Volts = Amperage

Ex.: 63W / 0.5V = 126 Amps

Connecting the Cells in Series

In the setup presented here we are going to make serial connection since the result gained by serial connection is desired by significantly more people than what the parallel connection produces. But you can if you want, connect the solar cells in parallel.

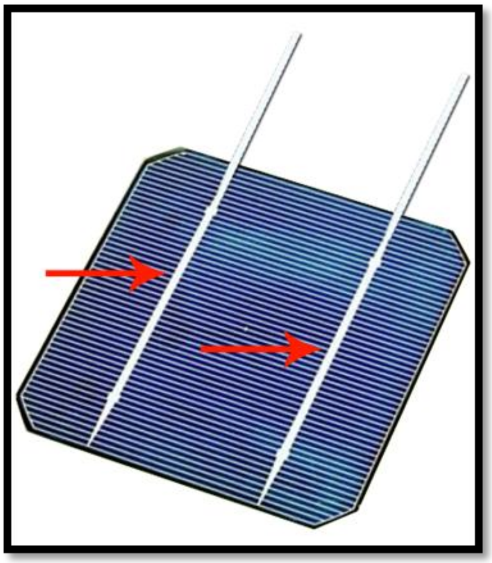
Now we are going to solder the solar cells in serial configuration.



Serial Configuration

As you can notice from the image above, the top of the solar cell is negative and the bottom is positive. You are going to solder the tab wires like this:

First take you flux pen and run it right on the lines on the top side of the solar cell. You want your tab wires to be twice the length of the cell. You basically measure the cell and double the tab wire over. It's a good idea to do all of your tab wires in advance, that way you don't have to come back and do this step. Then solder half of the tab wire right on the lines on the top side of the solar cell. You want the half of the tab wire to be soldered on to the solar cell, not just 3 points and call it day. Don't get confused, half of the tab wire will be left unused for now, but the other half of the tab wire is soldered completely on to the solar cell. Your end result should look like the picture below.

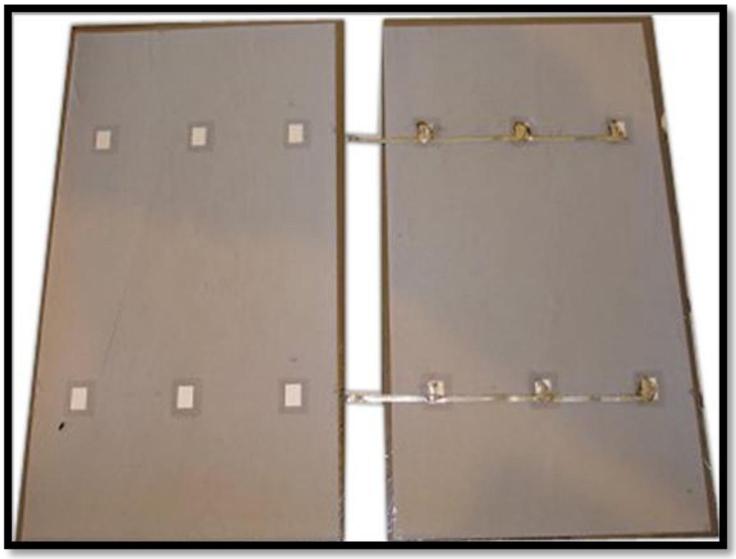


(Solder the tab wires on top of the lines that the red arrows are pointing on)

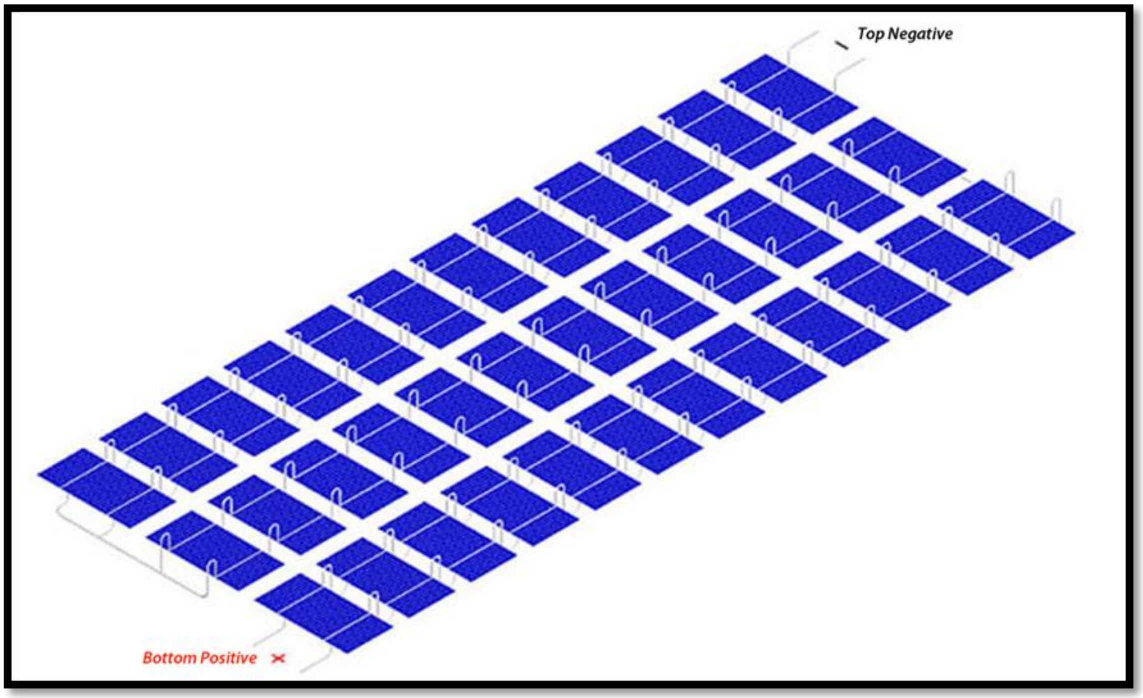
(Note: Some solar cells come with the top tab wire already in place if this is the case with your solar cells skip the previous step)

Now you should have two tab wires coming from the top of the solar cell that are as long as one solar cell. That left over tab wire you have, will be soldered on the bottom of the next solar cell. If the bottom of the solar cell has lines, solder the tab wire along the lines completely just like you did for the top part, if it has 2 or 3 squares, you will solder the tab wire only on those squares. Don't forget to run the places where you are going to solder with a flux pen.

After you connect the first two solar cells, get a volt meter and point the two solar cells towards the sun. The top of the cell is negative the bottom is positive, so if you are getting 1 volt on the meter you have done everything correctly.



(Notice that the tab wire that is soldered on the bottom of the right cell is coming from the top of the left cell)



(The following diagram is representation of the final arrangement of the solar cells)

Now you will need to repeat the soldering of the cells one to another in the arrangement represented in the picture above.

As you can see from the image the arrangement of the middle row of the solar cells is flipped horizontally compared to the other two rows. The purpose for that arrangement is so the connection between the two rows is made easier without wasting tab wire.

The next step will deal with attaching the solar cells on to the casing. We recommend that you connect the three rows of solar cells to each other after you do the next step. But don't forget to attach the tabbing wire to the ending cells of the rows before we attach them on the pegboard. Since the solar cells will be attached on the pegboard with silicone, you won't have a second chance to add a tab wire on the bottom of the cells, so solder the tab wire on the ending cells that need tab wire on the bottom before you attach them on the pegboard, and after the three rows are attached on the peg board you will do the connection between the three rows.

Tip: Experienced solar panel builders, solder the bottom tab wire first on every single solar cell, then they attach every solar cells on to the pegboard, and in the end they connect the solar cells to each other. With this method you will end up with neater solar panel that will have more equally spaced solar cells than with the previously described method.

Step 3: Finishing the Solar Panel

By now you should have constructed the frame for the solar panel, and have three rows of 12 solar cells. Now we are going to connect all the remaining dots and have a complete solar panel.

Right now you need the pegboard and one row of solar cells. First cut the peg board so it would fit inside the frame you constructed earlier. Than measure and mark the pegboard where you are going to place the 3 rows of solar cells so they would be approximately equally spaced. Don’t forget that you will need around 2 inches of space on the sides of the pegboard so you can connect the 3 rows of solar cells to one another, and also you will use the same space to screw the peg board on to the plywood frame.

After you have measured and labeled everything, you are going to attach the first row of solar cells on to the peg board. You might want to ask someone to give you a hand for this step so you won’t break the cells. You will now put a small blob of silicone on to the back of every solar cell of the row. Put the blob of silicone right in the middle of the solar cell and nowhere else, then gently press the solar cells right in the middle (remember the solar cells are very fragile), while the cell is on top of the peg board. The reason for gluing the solar cells only in the middle is: the cells and the panel they are mounted on will expand, contract, flex and warp with changes in temperature and humidity. If you glue the cells too tightly to the substrate, they will crack in time. Gluing them at only one point in the center allows the cells to float freely on top of the substrate. Both can expand and flex more or less independently, and the delicate solar cells won't crack. Now repeat the same process with the other two rows of cells, but remember the middle row should be flipped horizontally compared to the other two rows.

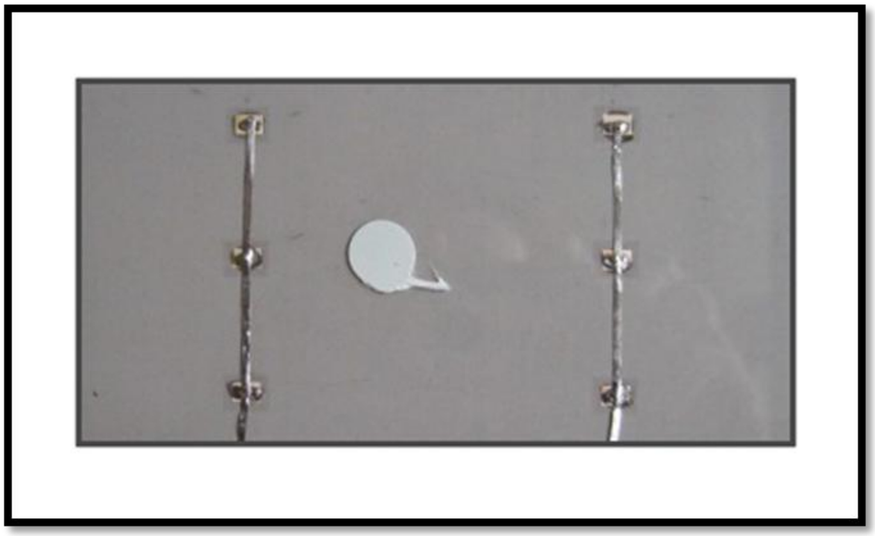
Now you will connect the 3 rows to each other. You will do this just like you were connecting the cells in the previous step. Take the tab wire from the ending cell and solder it to the ending cell of the other row. In the end the 3 rows are connected in a snake like pattern. Starting from the left bottom corner, there will be your first cell which won’t be connected anywhere, and then the cell that is in the right bottom corner will be connected to the cell that is just above it, in the middle row on the most right. Then the cells from the middle row on the most left side will be connected to the cell in the top left corner. The cell in the top right corner won't be connected anywhere.

Now the cell in the bottom left corner will have tab wire coming from the bottom that is unused. You will solder a copper wire on this tab wire, while the copper wire is long enough so it can get out from the casing. This wire will be positive, use a colored wire so it is easier to distinguish it from the negative. The cell in the top right corner will have a tab wire coming from the top of the cell. Solder a copper wire to this tab wire, and again it should be long enough to get out of the casing, this wire will be the negative.

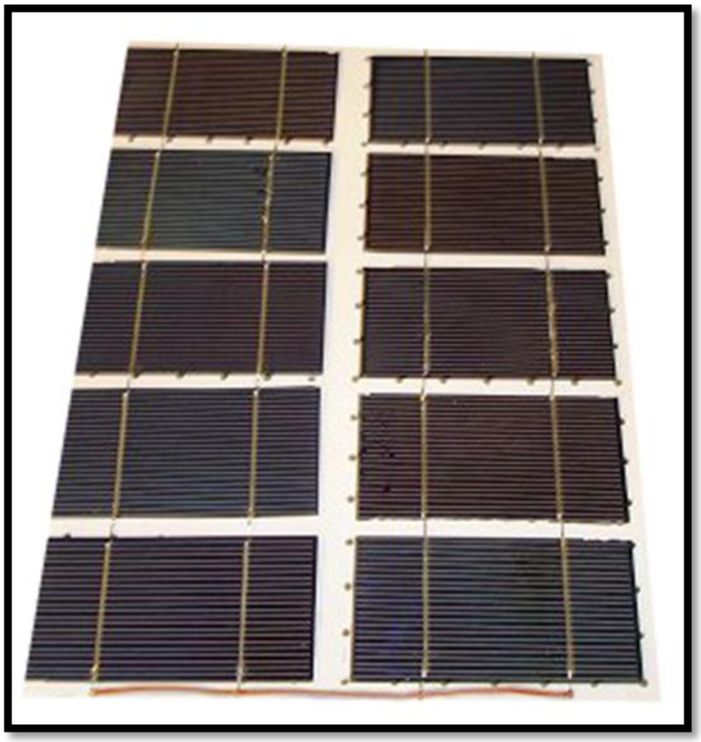
Now you should have all the wiring done for the solar panel, all you need to do now is screw the pegboard on to the plywood. After you screw the pegboard on the plywood, drill two small holes on the edge of the panel. Put the positive and the negative wire through a separate hole, and add a little silicone so the holes get air tight, but drill another hole that will be at the bottom of the border and leave it open for breathing, so the panel wont condensate. You should now anchor the positive and negative wires on the pegboard so they are not floating around or get over the solar cells. Leave the panel as it is for a day so the silicone gets dried properly.

After the silicone dries properly, put a line of silicone all over the border of the panel more specifically on the batten wood, and place the Plexiglas on top of the batten wood sandwiching the silicone in the middle. Alternatively you can drill over the Plexiglas, but with using silicone there is no danger of the cracking the Plexiglas. Now your solar panel is complete, leave it for a day so the silicone can dry properly.

Take a look at the following pictures for reference concerning what was said in this step.



(The silicone is only in the middle of the solar cell and nowhere else)



(The connection between the two rows here is done with a single copper wire, but you can do it with a tab wire also)

(The Plexiglas on top of the frame with silicone)

Step 4: Using and Maintenance

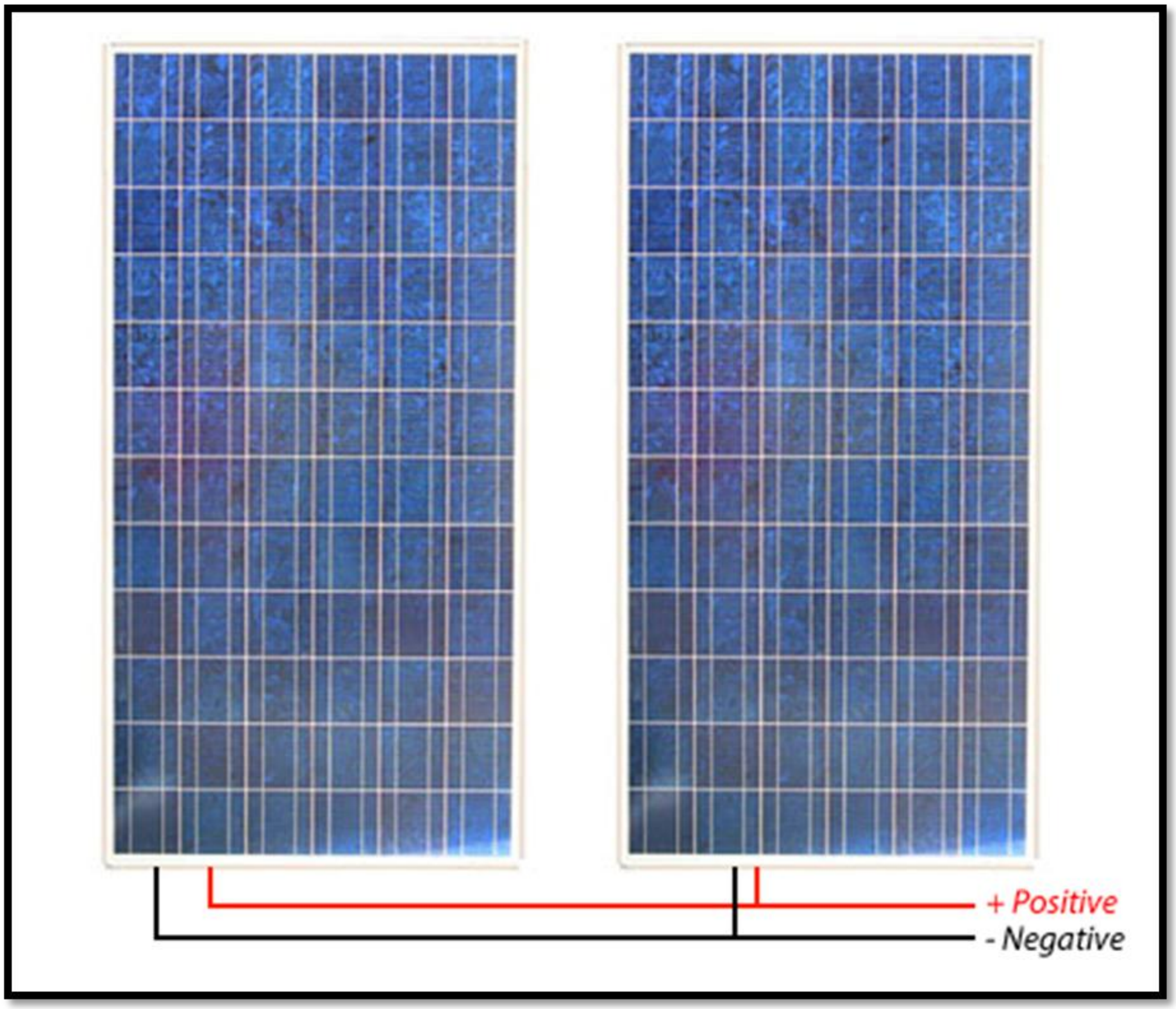
Now since your solar panel is complete it is time to put it in use.

As you have already seen in chapter 2, there are various ways to integrate you free energy source in to your system. The simplest system and most logical to use for a single solar panel is the portable system.

All you need to do is connect the solar panel to a charge controller, and the charge controller to a battery. If you are looking for a cheap charge controller I recommend you search EBay, it will cost you around $20. If you make more solar panels we recommend you take a look at the other systems presented in chapter 2.

In order to clean the solar cells you should use non-abrasive cleaner and a soft towel. You should clean the solar cells once a year. For the solar panel (the Plexiglas) it depends from region to region. The environment you are in to determent how often you will have to clean the panel, but in most cases it should be done around once or twice a month. The amount of power a single panel will produce is determined by the amount of sun light the cells will get. If your solar panel is dusty you will lose from 20 to 50 percent of the usual output power.

In the future if you want to connect more solar panels to your system all you need to do is connect them in parallel. Follow the diagram below for reference.



Wind Turbines

Introduction

Wind turbines are another resource for alternative energy that you can utilize and build yourself. A wind turbine is a rotating machine which converts the kinetic energy from the wind into mechanical energy. If the mechanical energy is then converted to electricity, the machine is called a wind generator.

Commercially available wind turbine sufficient enough to supply average sized home with energy cost from $5000 to $20 000. With such a wind generator you can expect power bill reduction from 50% to 90%, with this in mind the wind generator will pay for itself after 7 to 15 years. You can build a wind turbine for around $200, but first you should check the following numbers.

In order to get sufficient power from your wind turbine you want the average wind speed in your area to be at least 10mph, anything less than this wind turbine wouldn’t make much sense.

Needed Materials for the Wind Turbine

Unlike the previous project, this one is easier to make, for the ones that hate soldering the good news here is that there will be almost no soldering at all.

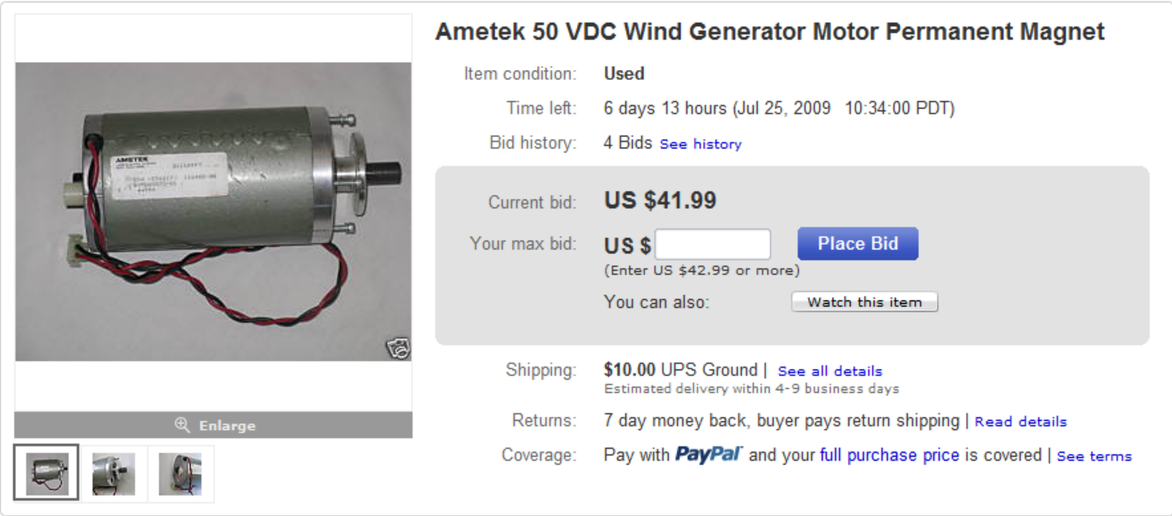
The materials needed for this project will cost you around $150 you will be able to find most of them on EBay and at your local hardware store. The wind turbine we are going to build will produce around 500watts, and will have blade diameter of 4ft. For such an output we will need wind speeds at around 20mph.

Part:	Origin:	Price:
DC Power Motor	EBay	$40
Pipe for blades	Home Depot	$20
Misc hardware	Home Depot	$8
Conduit	Home Depot	$19.95
Rope	Home Depot	$6
Hub	Junk Yard	$5

DC Power Motor

The DC Power Motor is the main component in this project, just like the solar cells in the previous one. The DC Motor is the one here producing energy. The principles behind it are very simple, in most applications where it is used it uses energy in order to spin, but if you spin the same motor in the opposite direction it will produce energy, and the very same energy will go back through the wires where the power used to get from.

The DC Motor needed for this project needs to have high Voltage, High Current and low RPM rating. The reason for the low RPM is: we want to spin it over the rated RPM in order to achieve the rated voltage.



The best place to look for DC motor is EBay, and it will cost you from $30 to $50. The prices recently are going up for this type of motors since the sellers learned that people use them for wind generators and therefore need them, on the good note on most products that are good for wind generators the seller is saying so. Single advice for buying motors from EBay is, buy only from reputable sellers.

If you need more help choosing the right motor for you CLICK HERE.

Tower for Wind Turbine

For the tower you have great variety of what you can use. You can use a pipe that is 4”-5” thick and about 10ft tall which can be very easily anchored to the ground.

Rotor Blades

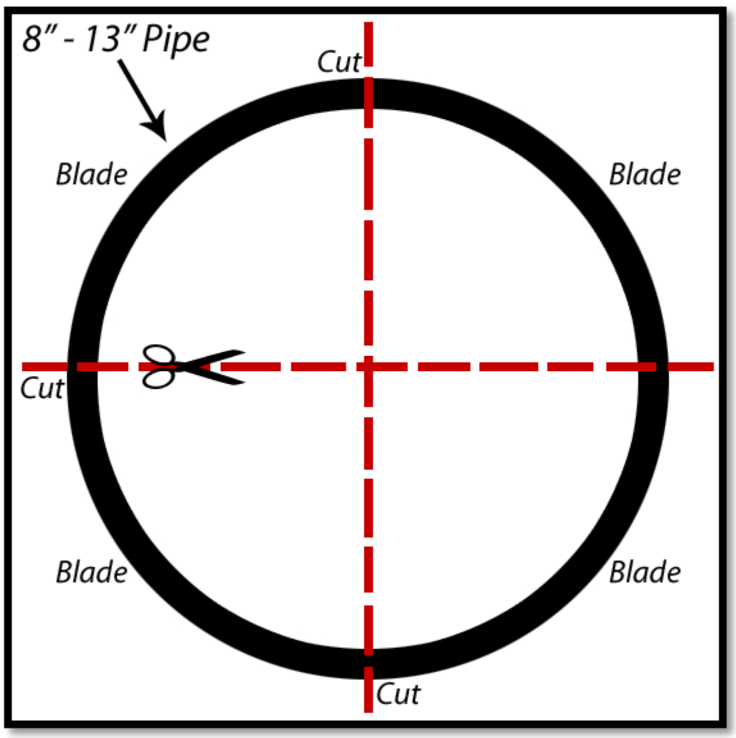
The rotor blades will be constructed from a PVC or ABS pipe which will be around 8” and 13” in diameter. If you aim for 500 watt of energy, you will need 3 blades while each blade measures at around 2ft which in turn the diameter is 4ft, and you will need wind speeds at around 20mph. If you don’t have space for such a big wind generator, scale down the blades as much as it suites you.

Building a Wind Turbine

Constructing the Blades

As we said earlier this project will deal with a wind generator that has its blades 8ft in diameter, but you can scale down the blades so it suite your needs.

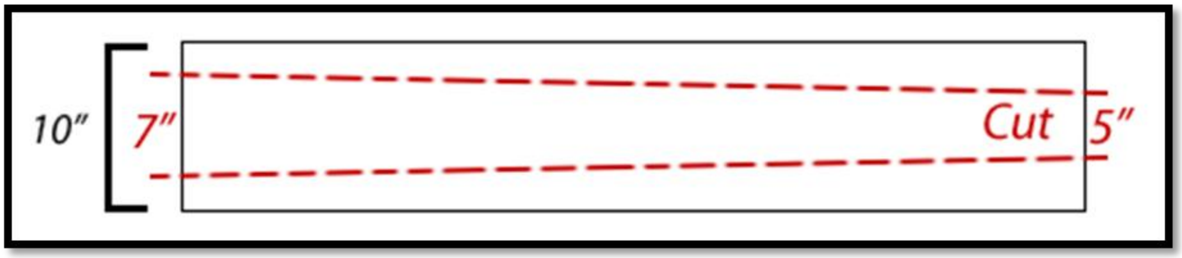
After you acquire PVC pipe which has from 8" to 13" diameter, cut it in quarters as represented in the diagram below.

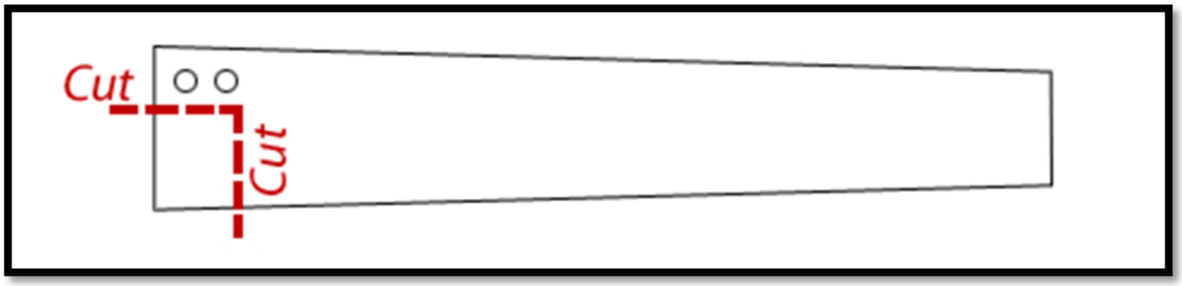


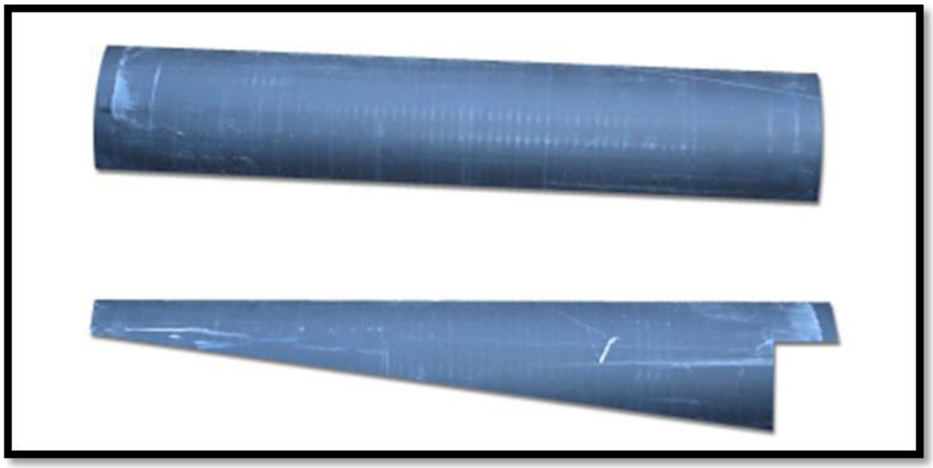
After you cut the pipe in to 4 separate pieces, you can already see the blades coming along. Now from these 4 pieces we will fabricate 3 blades. The next figures will be represented for a 10" pipe so you can easily calculate the difference if you are using different size of pipe.

For a 10" pipe, the quarter of the pipe you have, you will cut it so at the hub is 7" and at the tip 5", for reference take a look at the diagram below.

After you have cut the blade as represented in the diagram below, you will need to make one more cut on the side and drill two holes. This cut is necessary so the blade can be attached to the hub. Follow the diagram below as a reference.







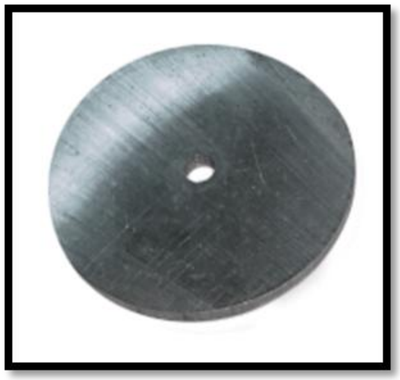
Now the blade is almost done, all you are left to do is, take a sand paper and smoothen the edge of the blade so it can cut through the wind more easily, and at the same time it will make the wind generator more efficient.

After you are done with the first blade, repeat the same process for the other 2 blades. In the end paint the blades with protective UV coating, since the PVC pipe is expected to be used indoors or underground.

The Hub

The hub is the center piece of your wind turbine. The hub will transfer the kinetic energy from the blades to the generator.

Before you start constructing a hub, you can get one for a small price at your local hardware store or junk yard. The most important thing about the hub is: it should fit very tightly on the DC motor shaft in order to turn the motor without loss of power.



All you need to do on the hub for now is drill a hole at the dead center, the size of the hole should be exactly the same as the shaft of the motor. In case the hole on the hub is not in the dead center, when the blades start spinning the whole turbine will shake and rumble wildly, that mechanical stress might take the whole wind turbine down and possibly injure someone.

After you drill the hole on the hub, you will need to attach your blades on the hub equally spaced at 120 degrees.

Balancing the blades and hub

We have already said you need to balance the hub and blades, in order to make the wind generator more efficient, and produce the expected output. Furthermore if the blades and hub are not balanced, they will almost certainly destroy the motor over time.

The method for balancing out the blades and hub is very simple. The first thing you need to do is label every single blade, than put the blades with the hub on a pole. Now give the blades a spin and write down which blade ended on the bottom. Now give the blades another spin with approximately the same force and write down again which blade ended on the bottom. Repeat this process 10 to 15 times, and if most of the times there is only one blade ending on the bottom, that blade is most likely heavier compared to the other 2. In order to balance the blade now, all you need to do is shave a little bit from the metal bars that are holding the blade to the hub. Than repeat the process of spinning the blades, and see the result.

Mounting the Hub with the Blades on the Shaft

Now you have your blades and hub balanced, all you are left to do is mount the hub on the shaft. This part is important since the hub should not shake or slide back and forth on the shaft, so it needs to be tightly secured.

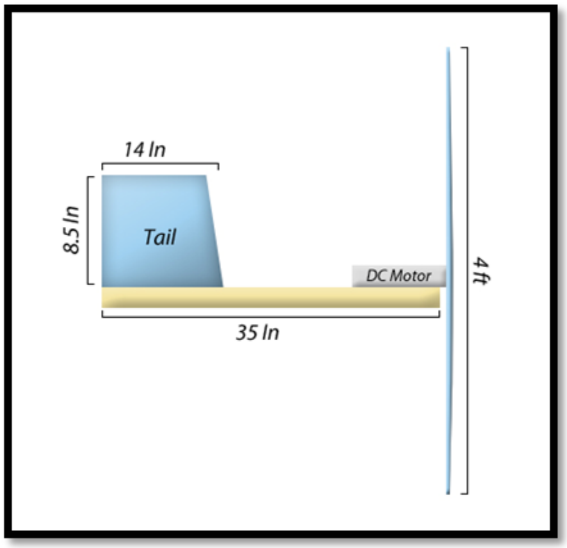
First put the hub on the shaft and push it as far as possibly. The next step you should take is: drill a hole through the shaft as far down as possible. After you drill the hole, put a bolt through it in order to secure the hub on to the motor.

Now you have a working wind generator, but we are not done, we should make few more modifications in order for the wind generator to follow the direction of the wind, because now the generator is stationary.

NOTE: Do not take the wind turbine in your hands and point it towards the wind to see how it will spin, since the wind turbine might start spinning very fast and injure you.

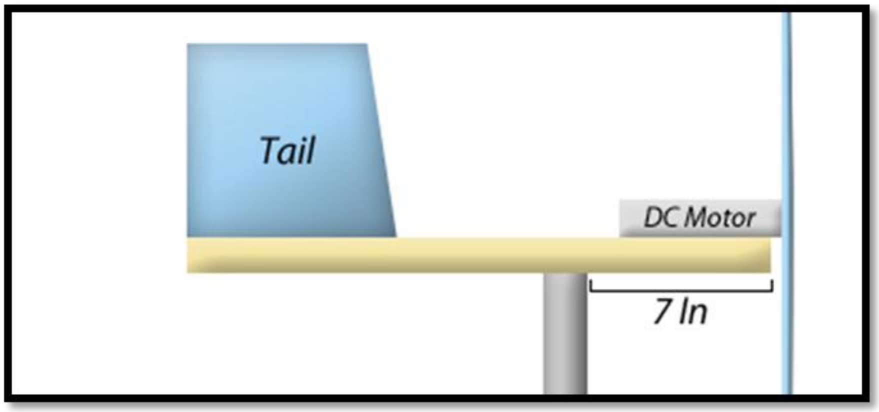
The Axis

As I said earlier the only thing we are left to construct is the axis, and the tail. The axis is needed in order for the wind turbine to turn and face the wind at all times. But the problem is that we don't want the wind turbine to endlessly spin around since it will tangle the cords.



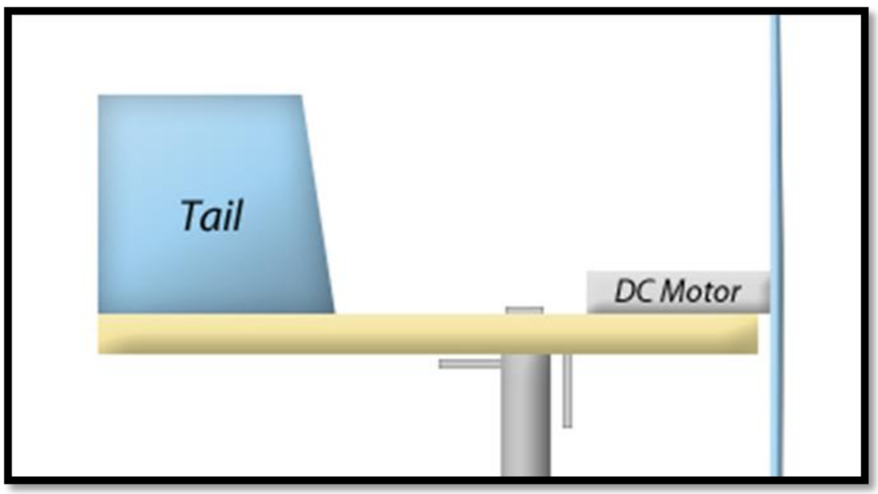
You can see from the diagram above the base is 35 inch and is made out of wood. Give it a coat of UV protection before you mount anything on it. First thing you will do is mount the DC Motor on the base. Then you will make a tail piece from a sheet of aluminum, loosely based on the form presented in the above diagram.

Now you will mount the base on the tower, follow the diagram below for reference.



As you can see from the image above you mount the base on to the tower 7 inches from the beginning on the side of the DC Motor. Depending your tower there are various ways to mount the base. But one thing to keep in mind is that the base should be able to spin 360 degrees with ease. The easiest way to do this is, if you have a tower that is from metal, you can weld a bolt on top of it or a small pipe, than drill a hole through the base and lubricate the inside of the hole, and place it on top of the bolt. Just don't forget to secure it from the top so it won't fly away.

The last thing we are supposed to do is, restrain the base from spinning more than 360 degrees, because if it spins more than 360 degrees it can tangle or cut the cables. Also if there are strong winds we don't want the base to spin endlessly. We are going to achieve this by putting one bolt placed horizontally on the tower and another bolt placed vertically on the base. This way the base will be able to spin 360 degrees, but only 360 and no more.



From the image above you can see the bolts that were previously mentioned. You can see the bolt that is connected to the base of the tower which is secured on top, the vertically placed bolt on the base, and the horizontally placed bolt on the tower.

Now you have completely functional wind powered generator. The usage of the wind turbine is the same as the solar panels. Follow the diagrams presented in chapter 2 based on your needs and setup.

Solar Air Heater

Introduction

Air collectors can be installed on a roof or an exterior (south facing) wall for heating one or more rooms. Although factory-built collectors for on-site installation are available, do-it-yourselfers is better way to go if you have time.

The collector has an airtight and insulated wood frame and a black painted aluminum sheet for absorbing heat with black soda or beer cans and glass in front of it. Solar radiation heats the aluminum which, in turn, heats the air in the cans. An electrically powered fan or blower pulls air from the room through the collector, and blows it back into the room.

Roof-mounted collectors require ducts to carry air between the room and the collector. Wall-mounted collectors are placed directly on a south-facing wall, and holes are cut through the wall for the collector air inlet and outlets.

Simple “window box collectors” fit in an existing window opening. They can be active using a fan, or passive. In passive types, air enters the bottom of the collector, rises as it is heated, and enters the room.

The difference between DIY and commercial available one is almost nonexistent since both solar collectors use the same principles for heating air. As you can see here http://www.cansolair.com/, commercial available solar collector will set you back around $2695.00, and if you read the main page you must have noticed that 240 aluminum cans comprise the core of each RA240 SOLAR MAX. The price is simply not worth it, since you have all the needed materials available right in front of you and you will need only 4 hours to complete this project.

Before Building the Solar Air Heater

First you will need 72 large soda or beer cans (“tall boy”), the cans will be laid down in 8 x 9 grid. The moment you acquire the cans we suggest you stack on top of one another 8 cans. After you are done stacking, measure the height of the 8 cans, than measure the width of a single can. The reason for this is since all cans differ by few mm, we cannot present you with exact dimension for the casing, and therefore you will need this measurement for the fabrication of the case for the cans.

You will need enough plywood to construct a frame for the tin cans. The measurements of the inside of the case will be: the height of the 8 tin cans stacked on top of one another + 1”, and the width of a single can x 9. With these measurements you can fabricate tight enough casing which should just fit the tin cans. Just to get an idea how the casing should look when it’s done take a look at the first image in the next chapter.

You will also need an aluminum sheet that will lie inside the casing which the soda cans will be attached to, and a glass or Plexiglas to cover the casing once the cans are inside it.

And finally you will need matt black paint to paint the tin cans and the aluminum sheet, and silicone to attach the cans to the aluminum sheet and the Plexiglas or glass to the casing.

Building a Solar Air Heater

- ***Step 1: Building the Case***

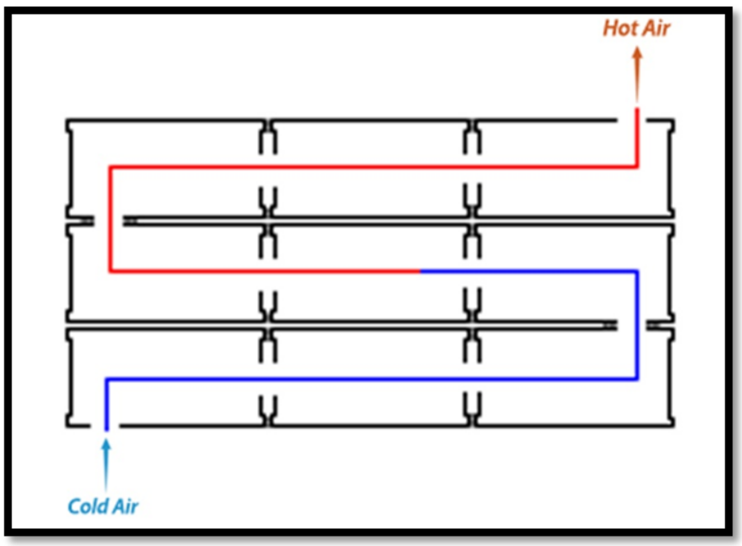
First of all make a box out of plywood. Set the dimensions of the width of the interior of the box exactly the same as the width of 9 tin cans next to each other, and the height as 8 cans on top of each other plus one inch.

For increased efficiency, you should insulate the box to prevent heat escaping through the plywood. If so, size your box so that the cans and insulation will fit snuggly.

- ***Step 2: Drilling the Cans***

For the air to pass through a column of cans, holes must be drilled into them. Since there is already a hole at the top of each can for drinking, you will only need to drill a hole through the bottom of the cans.

The bottom and top can of each column a 1/2 to 1 inch hole is drilled in the side. This is done so the air can flow from column to column. Take a look at the images below so you can see the arrangement of the cans and the size of the holes.



- ***Step 3: Building the Can Columns and Painting***

The cans of each column are glued together using silicon adhesive and painted using black paint to help them absorb the sun's energy.

The inside of the box must also be painted with the same paint before the columns of cans are glued into position using silicon adhesive. The outside of the box should be treated with preservative, varnish, or paint to help it survive the elements for many years.

- ***Step 4: Sealing the Solar Heating Box***

Ideally the whole unit will be sealed with a sheet of tempered glass. This glass is very strong and resilient to heat. However, tempered glass is also very expensive. Therefore Plexiglas can be used, but it will degrade far more quickly.

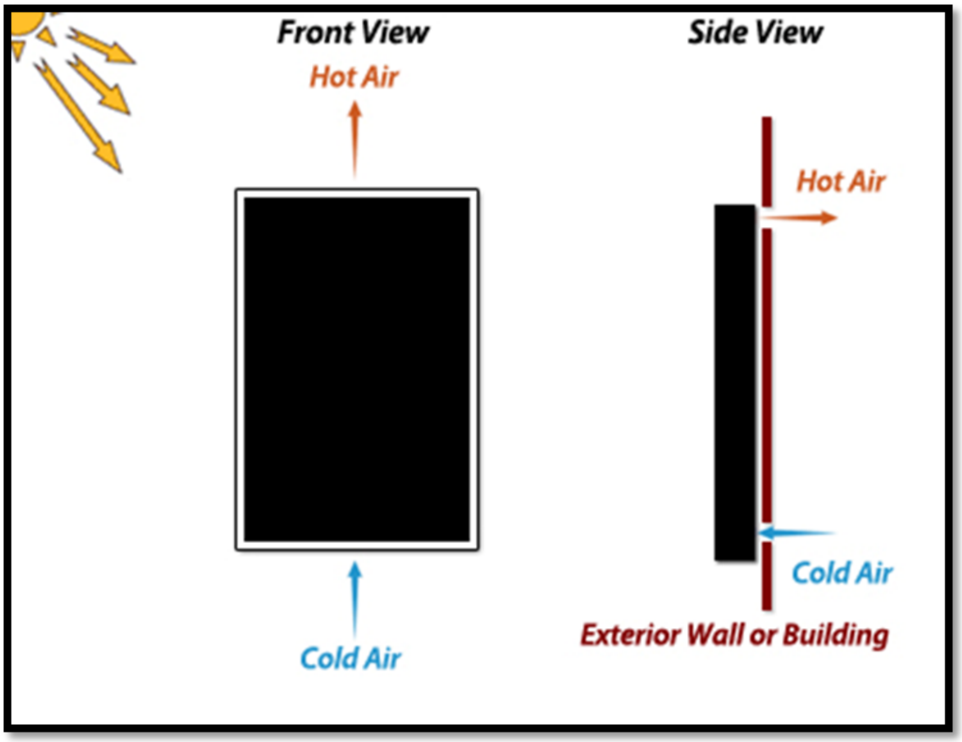
A hole at the top of the box is drilled so it acts as the hot air outlet and can be connected to the building/room to be heated using an insulated pipe.

- ***Step 5: Mounting a Fan (Not mandatory)***

A PV Electric Solar Panel could be used to power a small fan to drive air through the snake. The final temperature achieved would be lower, but having a large quantity of 30 degree Celsius air entering a room is much better than a much smaller quantity of 50 degree Celsius air.

- ***Step 6: Mounting***

You will mount the Solar Air Heater on a south wall or the roof facing the south. On the top of the solar air heater you should drill a hole from which an insulated pipe will come out and will go in the room through a wall. This pipe will bring the hot air inside the room. The same thing should be done with the bottom of the solar collector. The difference between the top and bottom pipe is that the top pipe is used to bring hot air inside the room while the bottom pipe is used to bring cold air inside the collector. If you decide to mount a fan on the collector it should be mounted only at the top pipe.


Front View
Hot Air
Cold Air
Side View
Hot Air
Cold Air
Exterior Wall or Building

Solar Water Heater

Introduction

In order to heat water using solar energy, a collector is fastened to the roof of a building, or on a wall facing the sun. In some cases, the collector may be free-standing. The working fluid is either pumped *(active system)* or driven by natural convection *(passive system)* through it.

The collector could be made of a simple glass topped insulated box with a flat solar absorber made of sheet metal attached to copper pipes and painted black, or a set of metal tubes surrounded by an evacuated (near vacuum) glass cylinder. In some cases, before the solar energy is absorbed, a parabolic mirror is used to concentrate sunlight on the tube. Some systems are capable of converting light to heat and therefore are not as reliant on outside temperature.

A simple water heating system would pump cold water out to a collector to be heated, the heated water flows back to a collection tank. This type of collector can provide enough hot water for an entire family. Heated water is stored in a hot water tank.

When a solar water heating and hot-water central heating system are used in conjunction, solar heat will either be concentrated in a pre-heating tank that feeds into the tank heated by the central heating, or the solar heat exchanger will be lower in the tank than the hotter one. However, the main need for central heating is at night when there is no sunlight and in winter when solar gain is lower. Therefore, solar water heating for washing and bathing is often a better application than central heating because supply and demand are better matched.

Before Building the Solar Water Heater

The solar water heater is a simple system, you will first build a grid of copper pipes, than cover them with aluminum sheets which will act as absorbers which will transfer the heat from the sun to the copper pipes, and in return the copper pipes will heat the water inside them.

More specifically, a copper pipe grid will be built with traditional top and bottom manifolds with vertical riser tubes spaced about every 6.5 inches. The absorber will be made from 6.5 inch wide aluminum strips with grooves that snuggly fit over the copper pipe. Than in the end the whole system will be fitted inside insulated casing.

The Absorber (Without the aluminum fins on top)

The Absorber (With the aluminum fins on top)

Final Result

the Absorber - Painted in black, inside an insulated case, cover with glass

Building the Solar Water Heater

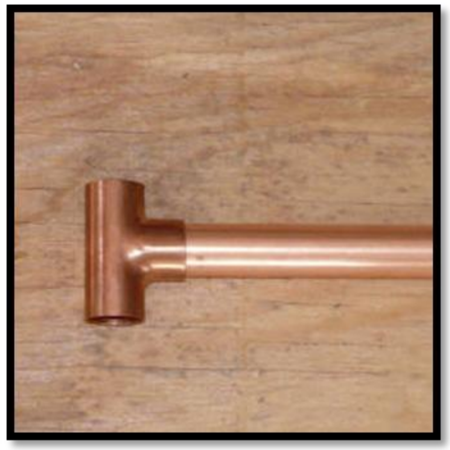
- ***Step 1: Building the Absorber***

The size of the absorber is 46 inches wide by 94 inches high, if this is too big or small, you can scale the absorber accordingly.

You might have already assumed what you will need but here is a list of what you will need for now. You will need ½ inch play wood which will be 46 inches wide by 94 inches high. Also you will need 7 copper pipes which are ½ inch thick and 88 inches long, 2 copper pipes which are ½ inch thick and 50 inches long, and finally 12 T and 2 elbow fittings.

The finished copper grid will look like the picture presented above. The plywood will act as a base for the copper pipes and the aluminum fins. The cold water will come from the lower left corner, and it will flow through all 7 of the riser tubes, and exit at the upper right corner.

Since the copper is the single most expensive element in this project, you should buy just enough copper pipes, so you don’t get left with scrap in the end, if needed you can always get more.



You will need to cut the pipes so you have about 2 inches of unused space at the top and the bottom of the plywood. After you are done with the cutting, loosely fit the T fittings on the pipes. The pipes on the upper left side and the lower right side will have elbow fittings on them.

Now you will need to mark the plywood, the markings will represent where each pipe needs to be. The pipes should be spaced at about 6.5 inches. Once you secure the pipes in the places you marked on the plywood, you can measure the exact space between each T fitting, so you can start cutting the 2 pipes that were 50 inches long, in order to interconnect each T fitting like in the picture above. Remember you should do this for both ends of the pipe, and the elbow fittings should be diagonally from one another, in order to end up with elbow fittings in the lower right corner and the upper left corner.

Now you will need to solder the fittings with the pipes. Soldering copper pipes is not as hard as you might think here is a video guide (click here) how to solder the pipes. In the end after the soldering you should end up with something like this.

As you can see pipe will come in the lower left corner which will bring cold water, and again at the top, but in the right corner hot water will go out. The 7 pipes are interconnected with each other at the top and at the bottom.

After you are done soldering, in order to test if there are any leaks. Stand the grid up, and plug up the outlet on the low end, after that fill the grid with water. Come back after a while and check the level of the water inside, inspect every soldered connection for leaks. If there are leaks you will have to re solder that connection again.

- ***Step 2: Make the Aluminum Fins***

Now you will need soft aluminum about 0.018 inches thick, aluminum like this runs about $1 per 1 sq ft.

First you will need about 3 inch wide strip of aluminum laid below every copper pipe. Then you will need about 6.5 inches wide strip of aluminum with a grove in the middle. The aluminum with the grove in the middle will be fitted on top of the copper pipe and secured in place with silicon and stainless still staples. The end result should look like this.

Making a grove in the middle of the aluminum strip is easier than it seems. After you get the fins cut to the right width, use a tool like the one shown below to expand out a groove that fits snugly over the copper pipe. The steel rod is 5/8ths inch diameter. The groove tool is made by screwing and gluing two pieces of 5/8 inch plywood to a base piece of plywood. The two 5/8th pieces should be spaced 5/8s apart. Make sure they are securely attached with screws and glue. It is important that it fits around the copper pipe snugly.



After you are done making the fins you will need to attach them on the copper pipes. You will run a bead of silicone caulk on each side of the copper tube that fills the area between the copper tube and the aluminum strip. Then run a very light bead of caulk further out the aluminum strip on each side of the copper pipe. Finally staple the aluminum on to the plywood.

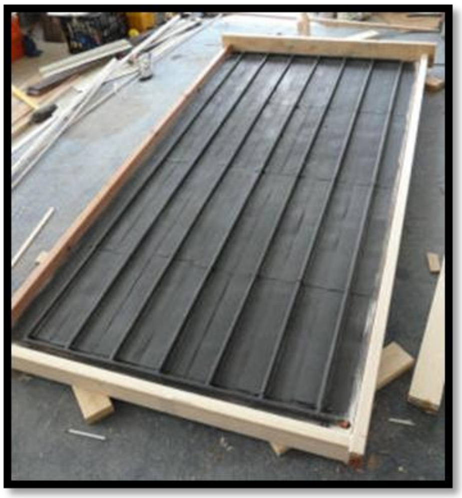

After you are done covering the whole grid with the fins, you should end up with something like in the picture below.

- ***Step 2: The Case***

Now you will need to construct a case for the grid that is laid on the plywood. Measure the grid you have constructed and build a case of plywood that will fit the grid inside tightly.

The case should look something like this.

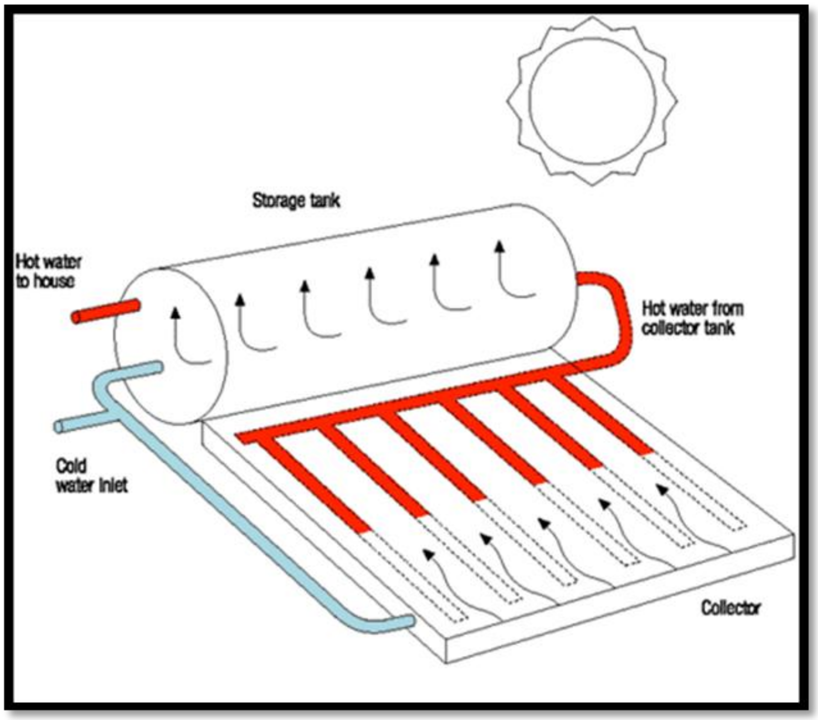
You should take into consideration that the back of the case should be insulated from the cold weather. You can easily insulate it with a sheet of Styrofoam. Then you will lay the plywood grid on top of the Styrofoam and secure them with screws on the wooden case. Then final paint the whole grid matt black like in the picture presented below.



All you are left to do is cut opening in the case from where the pipes for hot and cold water will go, attach the pipes on the grid, and cover the case with glass. Alternatively instead of glass you can use SunTuf corrugated polycarbonate glazing. It has a high temperature capability, good transmission, is very tough, and has a layer to filter out UV. This is all good for a solar collector. It costs a little over $1 per sqft, many Home Depots carry it. In the end your solar collector will look like this.

Using the Solar Water Heater

You will need to connect the solar water heater to a water tank. The water tank will store the hot water, ideally the water tank should be inside the house, but if that is not possible you can build insulated box and place the water tank inside it. Than all you will have to do is, bring two pipes to the house, coming from the tanks. One pipe will bring hot water to the house, the other pipe will bring cold water to the tank once the water inside the tank is depleted. “Two” more pipes will come out of the tank, one pipe will supply the absorber with cold water, and another pipe which will bring hot water to the tank. In order to understand the system, take a look at the diagram below.



Minimizing Our Oil Dependency

Some of the bigger issues we encounter when we try to reduce the consumption of energy are to reduce and minimize the use of gas we use for our vehicles.

Oil is widely used for transportation, home heating, and energy generation.

There are several ways to tackle this problem. The automotive industry has already taken action, and is great cars with a very reasonable gas mileage. The Industry now must meet certain regulations, and the production of typical gas guzzling vehicles is reduced.

Most diesel power cars, with only a minimal conversion, are capable on running with leftover fryer fat. Meaning, you can simply go to McDonalds, and ask for the leftover oil of the fryer.

Although it sounds incredible, the vehicle will run without a problem this way, and it won't damage the engine or the fuel lines of the vehicle.

The downside of this is that the car will have a bad odor, and smell like fried potatoes. This is what can be called a 'rough biodiesel'.

In order to create a better fuel, the waste frying oil/fat can be processed so that it gets refined. The refined product knows as biodiesel, and it shares almost the identical properties of the Diesel. The car will have the same performance as will regular diesel and behave the same.

In most conventional diesel vehicles, you can use a refined bio-diesel without applying any kind of conversion kit. Besides refining waste fat, Biodiesel can be produced from fat from pork, poultry, beef or oil from vegetables.

Another way to reduce oil dependency is with the use of electricity to power a car. Hybrid Electric Vehicles are getting more and more popular, and starting to take a significant share on the road. These vehicles combine a common car engine with a battery. They capture kinetic energy when breaking, this kinetic energy is used to recharge the battery. The Hybrid Electric Vehicles can be considered eco-friendly, due to their low emission, and a good gas mileage. Common Examples of these vehicles are the Toyota Prius and Honda Insight

A Step forward from the HEVs, are the fully electrical cars. It relies on the sole use of electric motors to propel the vehicle. These vehicles don't use an Internal Combustion Engine. The fully electric cars might be considered the vehicles of the future, but today, they're still in development, and have limited practicality.

Although they are able to run solely on electricity, they have a limited range. Recharging the vehicle is much cheaper than gas, but the main problem is that the batteries cannot store enough energy to propel the vehicle for longer ranges. This technology is very promising, and there have been several vehicles that are fully electrical that have went into production.

Free Energy Generators on a Larger Scale

Significant changes in energy generation aren't going to occur until the governments and large corporations start becoming involved and look into alternative sources of energy.

A Free Energy generator could well be the solution to these problems. It can be implemented in the following way:

- Each household has its own free energy device, they generate electricity independently from the power company.

OR

- The Energy Companies replace the current sources of generating energy like non-renewable sources of energy, and implement large-scale free energy generators, which would supply the grids with power. Since the energy will only require minimal resources for it to be produced, this would result in a significantly lower price of energy.

However, the government and the big corporations aren't showing interest in such devices, they are the once that have the real funds necessary to really make this happen. Perhaps, the outcome of a world where electric energy is free isn't something the big corporations would like to see. This would mean they would lose trillions of dollars. It would mean the collapse of two of the biggest corporative industries The Oil and the Energy Industry.

If the US Government spent only a small fraction of what they spend on the military to the development of free energy, it could totally revolutionize the world. We have already given you a small-scale free energy device THAT WORKS. That proves that this technology really works. All it needs to be done is for this technology to be used on a larger scale, and to become wide-spread. This will reduce the energy crisis.