

# Edison's Current

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## **Warning and Disclaimer**

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# Introduction

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

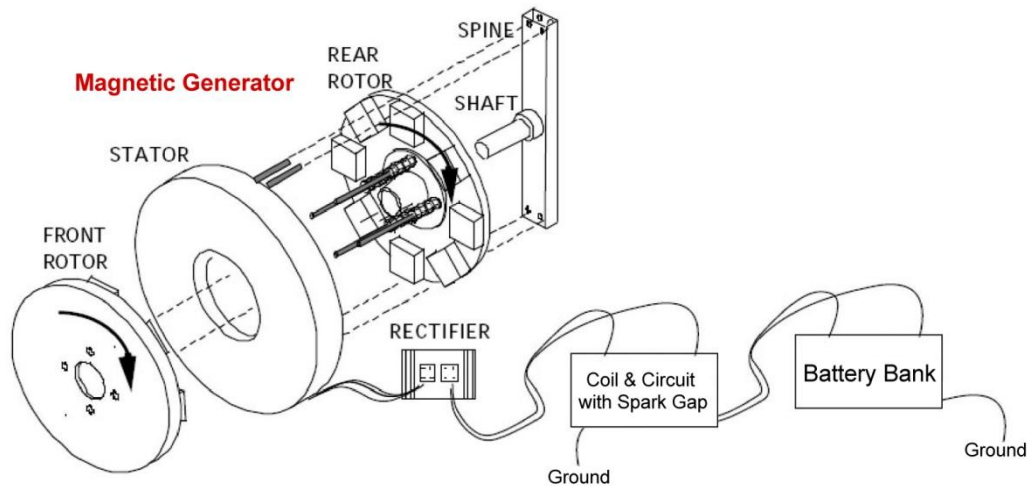
The magnetic generator is provided with a capability for delivering a relatively high level of output power from a small and compact structure.

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
<b>FIBREGLASS SUPPLIES</b>			
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			
<b>STAINLESS STEEL</b>			
Stainless Steel Wire		2mm x 10 Meters	200
<b>MAGNETS</b>			
Grade 3 Ferrite Magnet Blocks (pre-magnetized)	16	20 x 50 x 50mm	4000
<b>ELECTRICAL</b>			
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
<b>STEEL</b>			
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
<b>MECHANICAL</b>			
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.

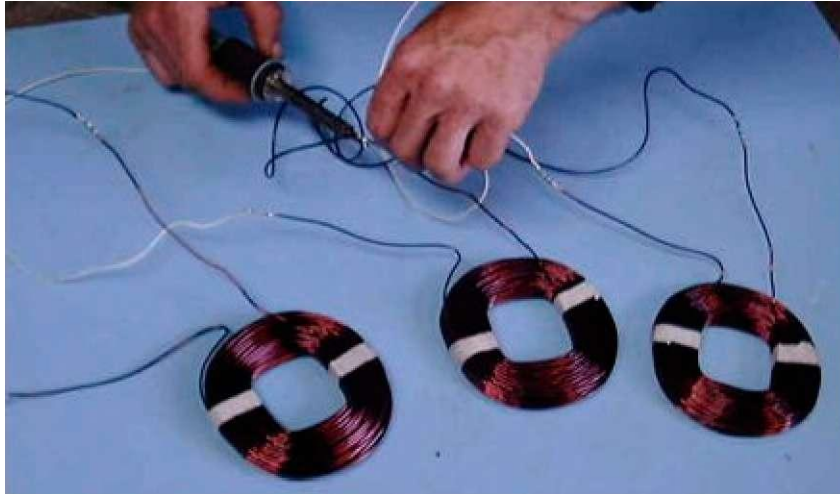
<b>Bolts (with nuts and washers)</b>	<b>Diameter</b>	<b>Length</b>	<b>For</b>
2 with butterfly nuts	6 mm	60mm	Coil Winder
4	10mm	25mm	Balancing With Jig
1	12mm	150mm	Stator Mould

## 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.
- 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.

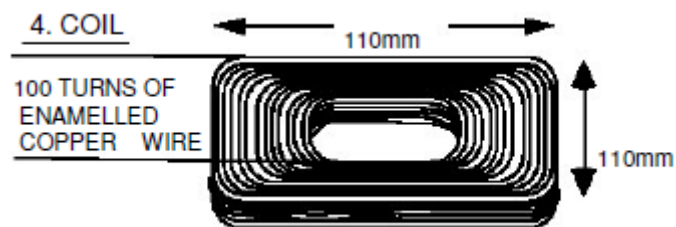
## Moulds and Jigs

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.



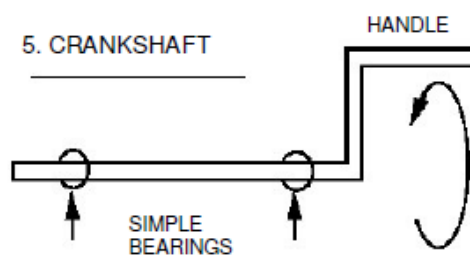
*Coils for the Stators*

The PMG stator contains six coils of copper wire (see 4.COIL)

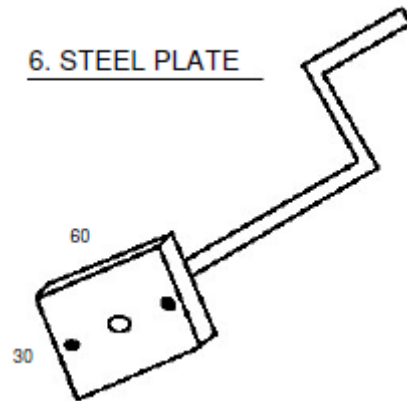


The coils will be wound on plywood coil-former. The former is mounted on the end of a crankshaft, between cheek pieces.

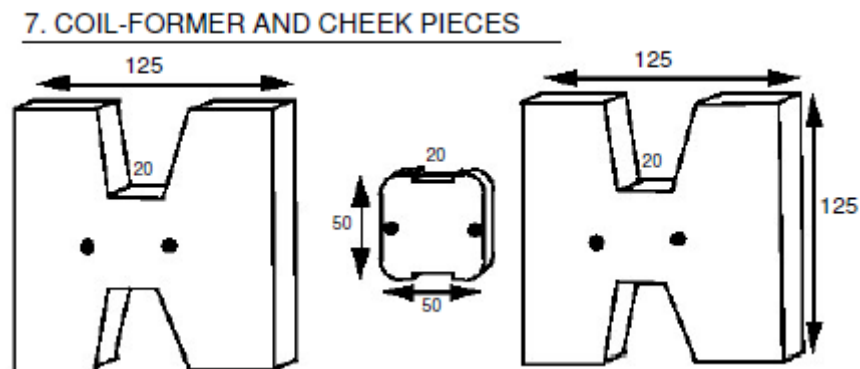
- Make a crankshaft, turned by a handle (see 5.CRANKSHAFT).



- 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. (see 6. STEEL PLATE)
- Drill 2 holes, 6mm diameter and 40mm apart, centered on the shaft.



- Cut out 3 pieces of 13mm plywood. (see 7. COIL-FORMER)

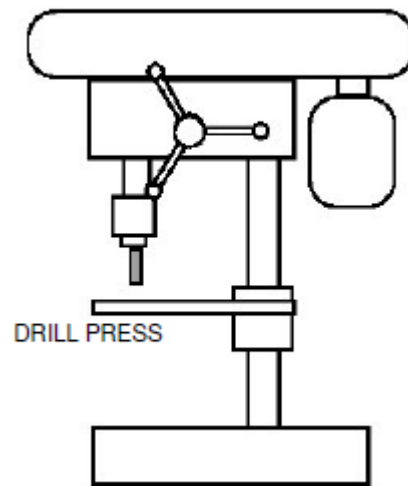
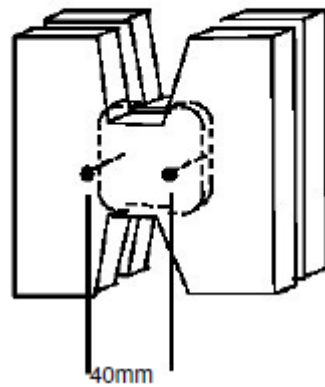


The coil former is 50mm by 50mm by 13 thick. It has rounded corners. The two 'cheek pieces' are 125mm by 125mm. There are 20mm wide notches top and bottom in each. The notches are for putting masking tape under the coil, so that it can be taped up before removing it from the former.

- Stack the pieces with the notches in line (see 8. DRILING THE 2 HOLES), 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.

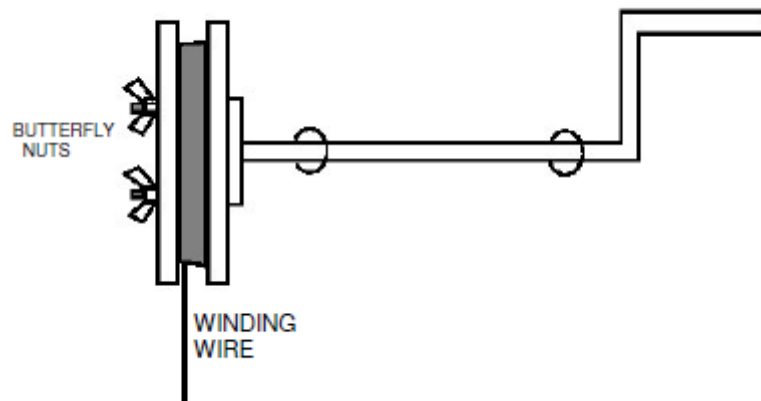
### 8. DRILLING THE 2 HOLES

STACK THE THREE PIECES  
LIKE THIS:-



- 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. (see 9. FITTING THE COIL FORMER)

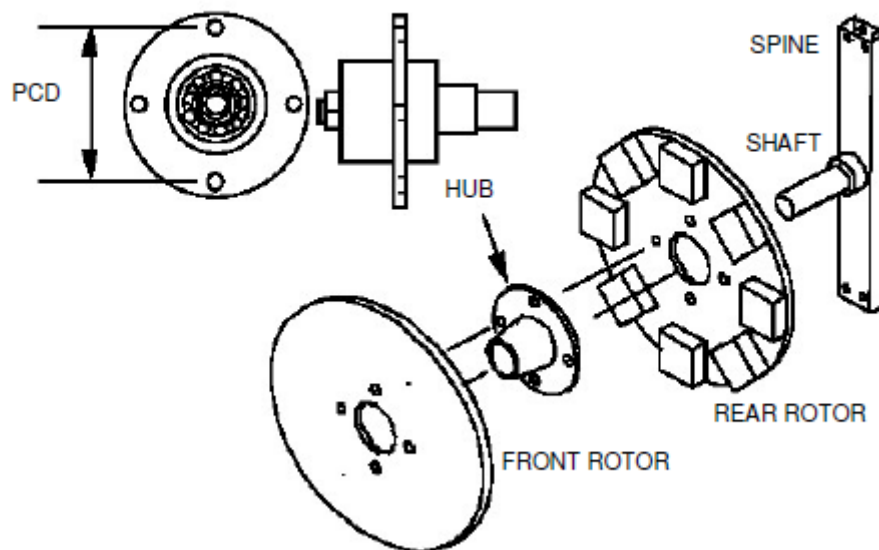
### 9. FITTING THE COIL FORMER AND CHEEK PIECES



## Jigs for the Rotors

The magnet rotors are mounted on a bearing hub (see diagram 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



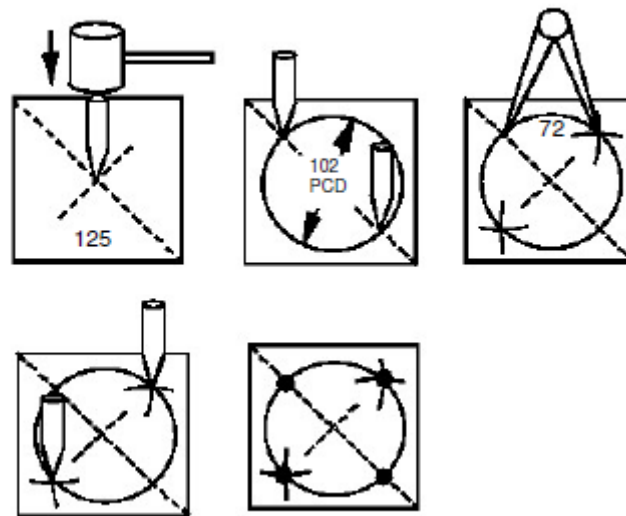
The PCD jig will be used to drill holes in the rotors etc.

It will also be used to balance the rotors.

The holes must be marked and drilled very precisely. (See diagram 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.

### 11. MARKING AND DRILLING THE PCD JIG

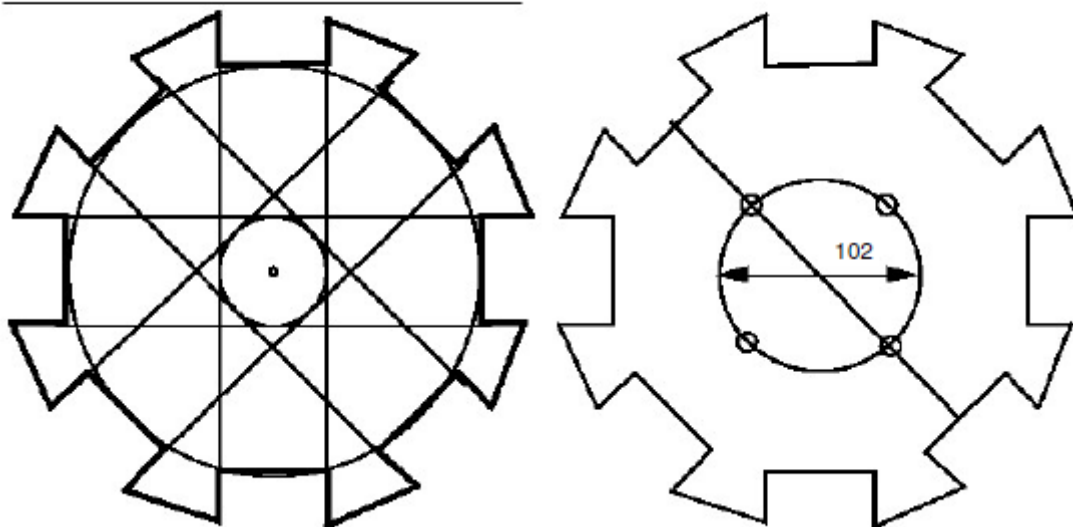


Magnet positioning jig (See diagram 12)

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).

### 12. THE MAGNET POSITIONING JIG



- 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.

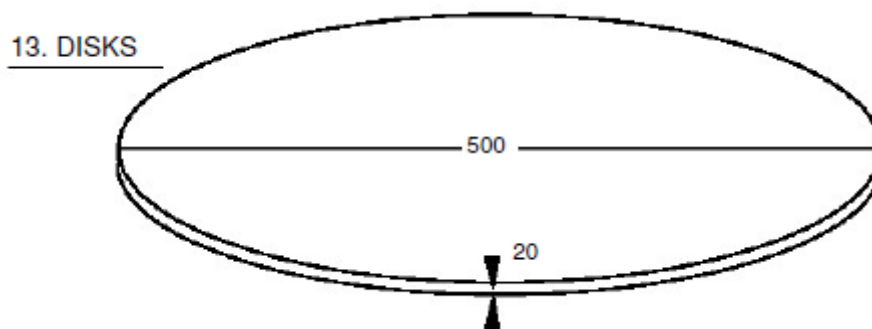
The moulds need to be strong and smooth. It is not easy to separate the stator casting from the moulds. Hammer blows are usually needed.

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.

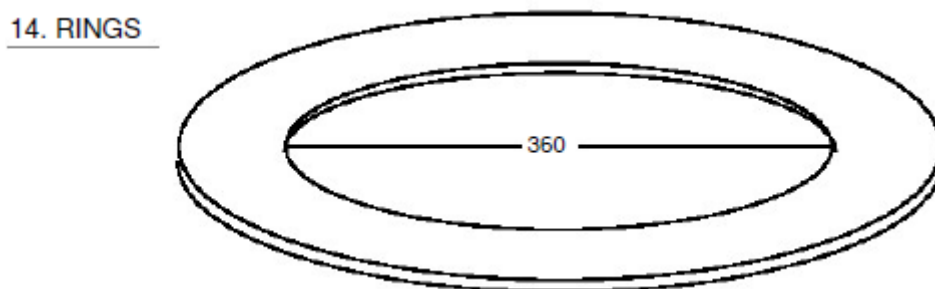
Here is one way to make the moulds, from composite wooden floorboard sheets, using Wood-turning.

### ***Stator Outer mould***

- Cut out several disks of flooring sheet (see diagram 13), approximately 500mm diameter.



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

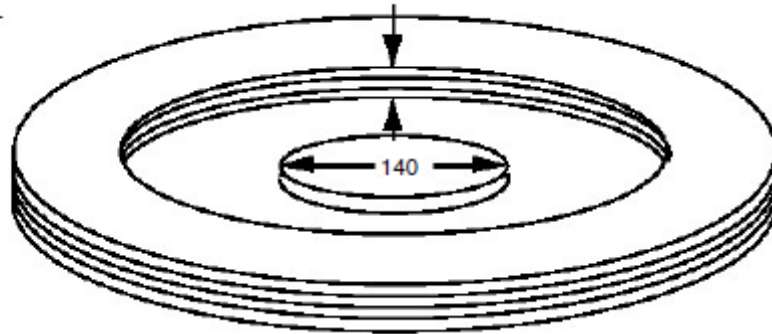


- Draw a circle 360 mm diameter on the remaining disk
- Drill a 12 mm hole at the centre of this disk, to help with centering.
- Glue the rings on top of the remaining disk, to form a stack, with a hole 60mm deep (diagram 15). Use plenty of glue at the insides of the rings.



- 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.

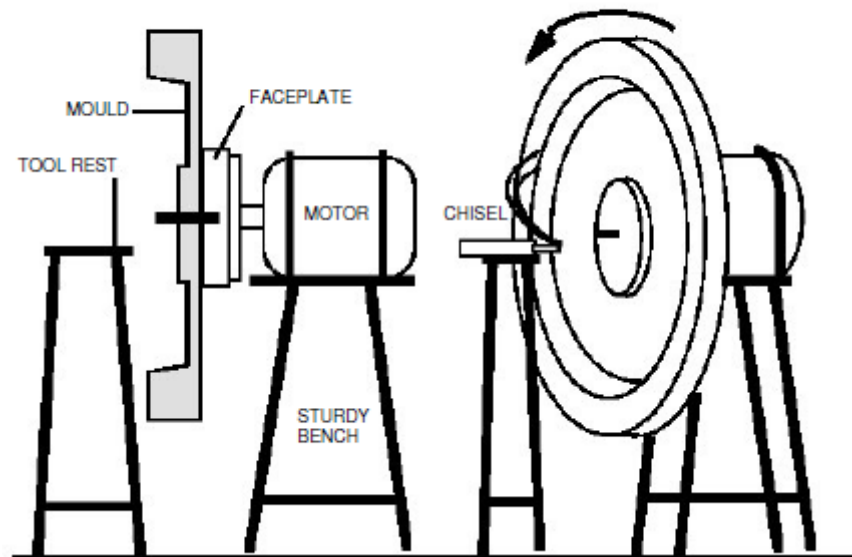
### 15. STACK



- 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 (see diagram 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

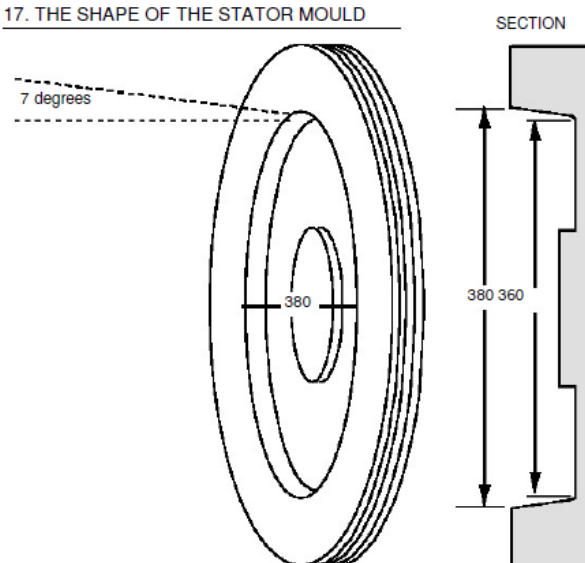
### 16. TURNING A MOULD



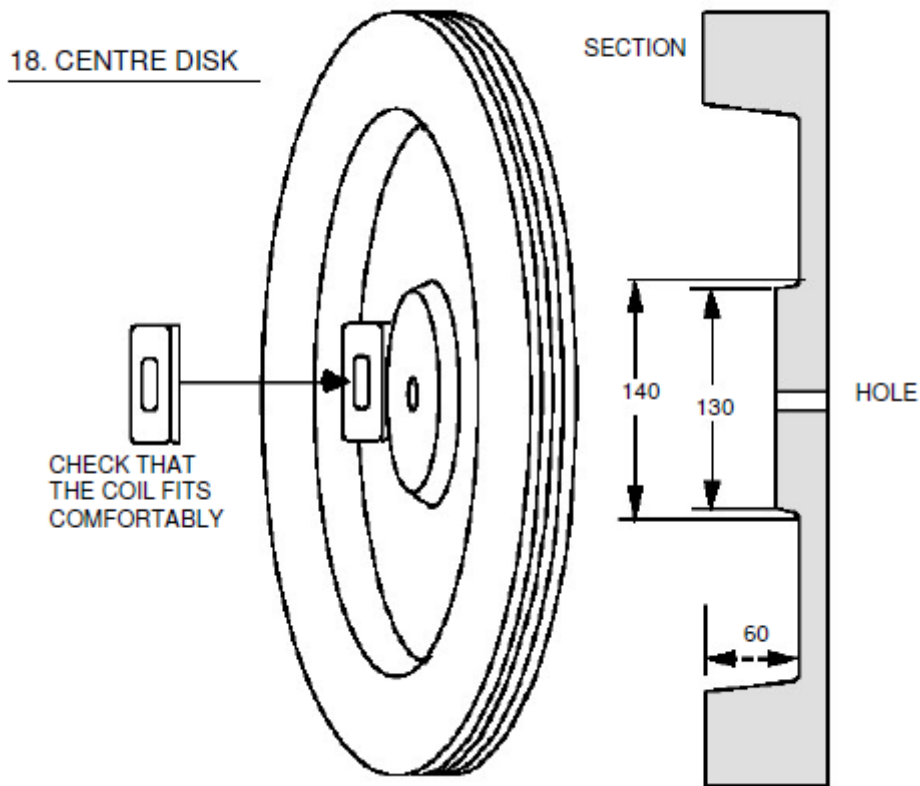
Now it is possible to shape the mould with a chisel. Wear a mask over your mouth to avoid inhaling the dust. Beware of loose clothing, which may become caught in the rotating mould.

- Cut a smooth surface on the inner edges of the stack (diagram 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.

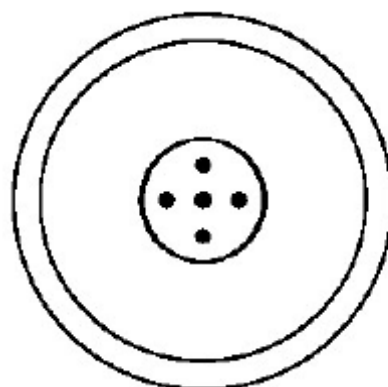
### 17. THE SHAPE OF THE STATOR MOULD



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



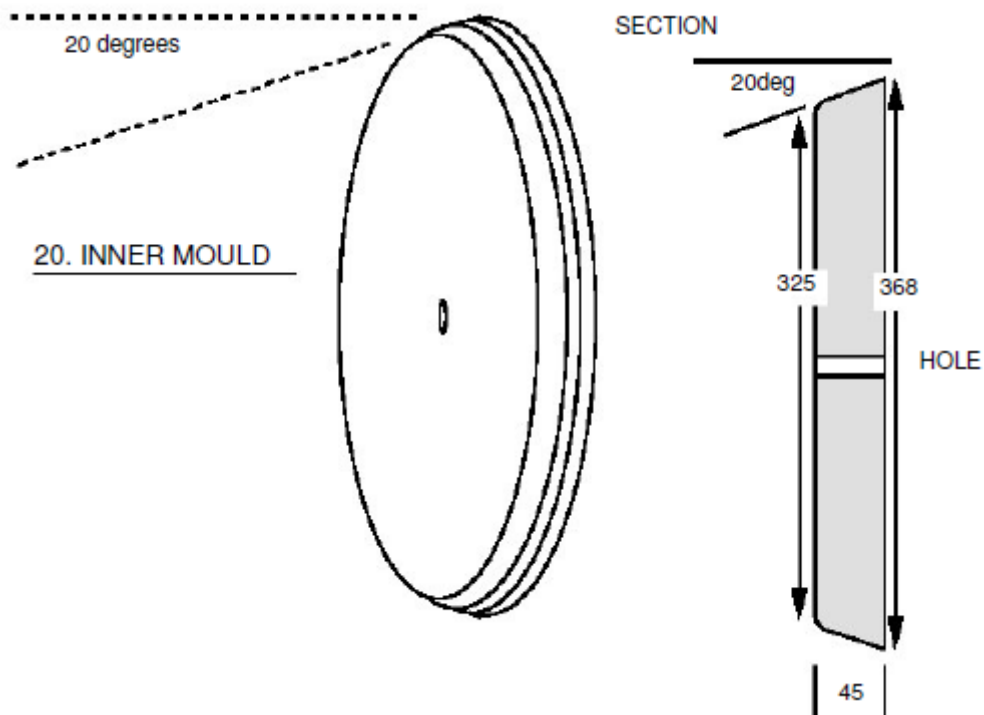
- Place a coil against the face of the mould and check that it fits comfortably – if not, then the hollow must be made a little larger, or the centre disk a little smaller. In the end, the coil's centre must be at 250 mm from the mould centre.
- Remove the mould from the lathe or motor.



19. HOLES IN THE MOULD

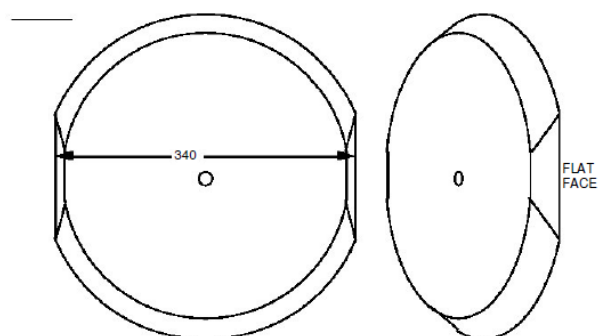
### Stator Inner mould

- Cut disks with diameter 370mm 20 degrees.



- Drill a 12mm hole at the centre of each.
- Glue them into a stack (diagram 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 (diagram 21)
- Cut two flat faces, as shown in diagram 21.

21. CUTTING FACES ON THE INNER MOULD



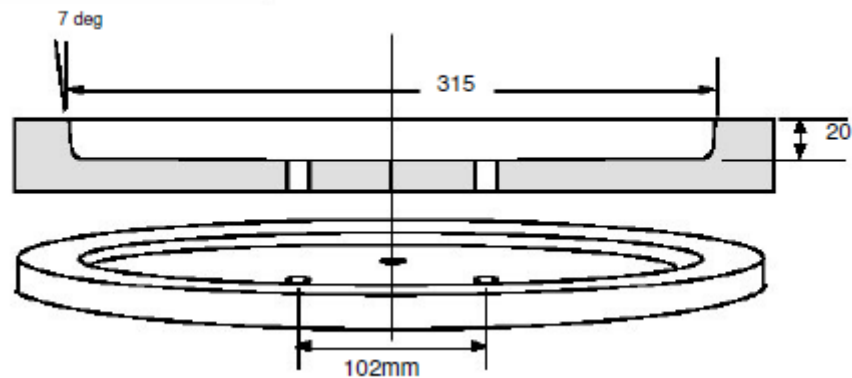
These two faces will create a thicker casting around the mounting studs.

### 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.

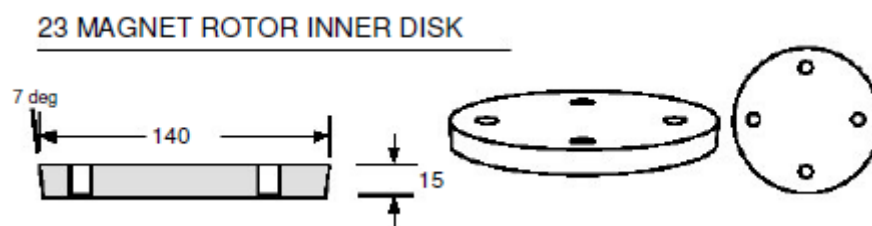
The outer mould (diagram 22) is similar to the stator outer mould, but simpler.

#### 22. ROTOR MOULD



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 (diagram 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.

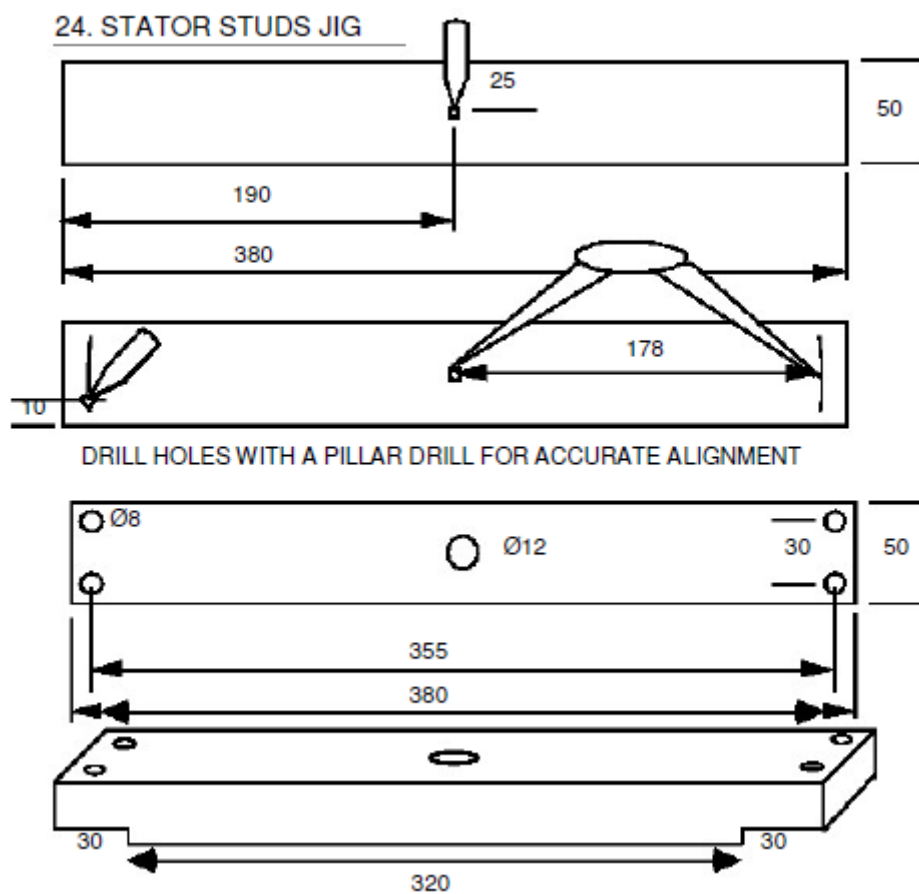


## Jigs for the stator

Stator studs jig (see diagram 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.

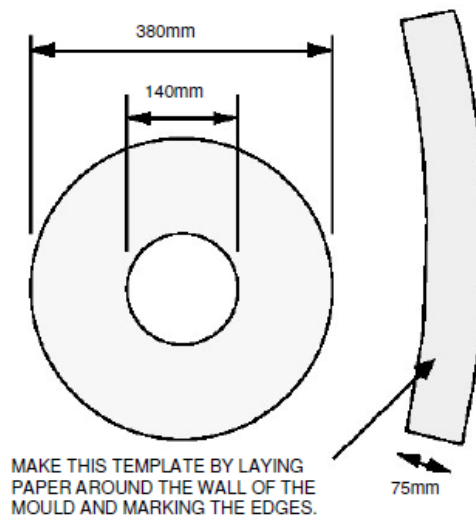
- Make a punch mark at the exact centre of the largest face (see diagram 24).
- Use dividers or compasses to mark arcs at a radius of 178 mm from this mark.
- Punch four marks on these arcs, 30 mm apart and 10mm from the edge.
- Drill through with an 8mm drill (using a smaller size first to be accurate). 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.



Paper templates (see diagram 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



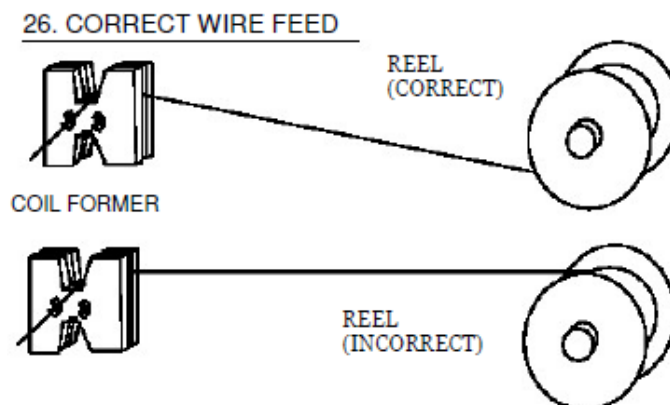
## Stator construction

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.

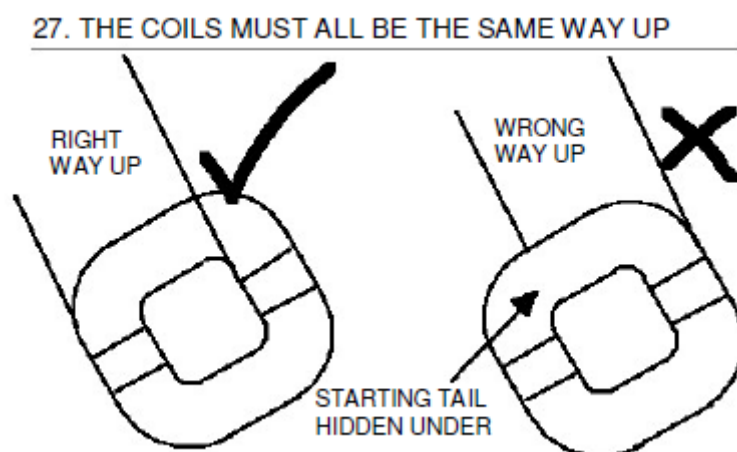
The wire should form an 'S' bend as it winds onto the coil (diagram 26).



- 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.

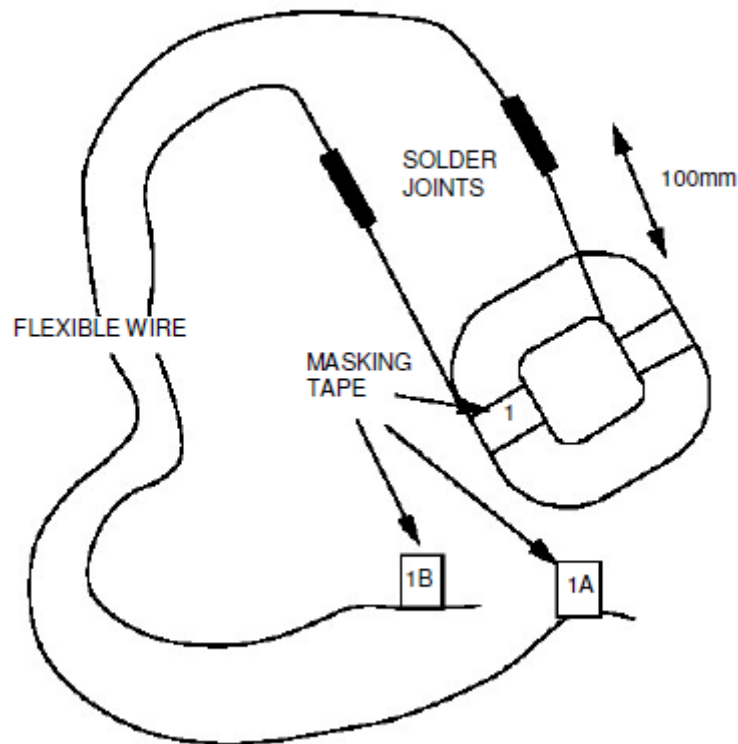
- When the coil is complete, pass a piece of sticky tape under the coil on both sides and bind it tightly. Do not cut off the winding wire until this is done, or the coil will spring out, and loosen. Cut the tail of wire 100mm away from the coil.
- Remove the coil from the former, and wind five more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



- 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 (diagram 28).



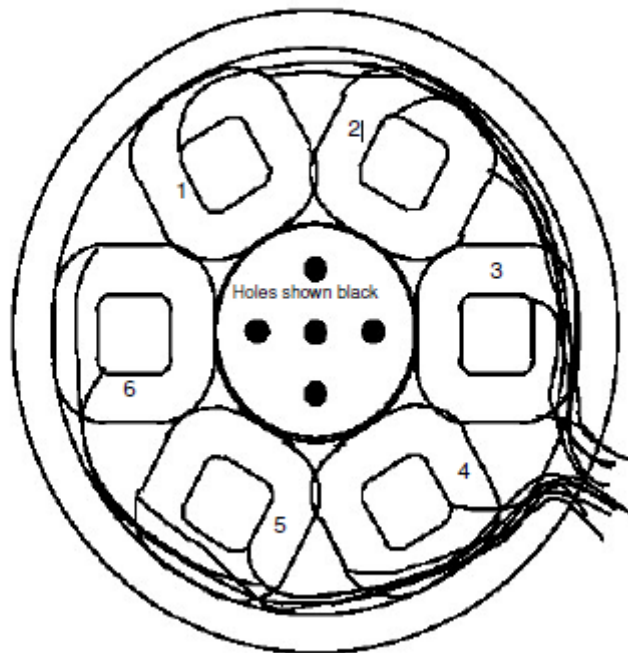
## 28. SOLDERING ON TAILS OF FLEX



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.

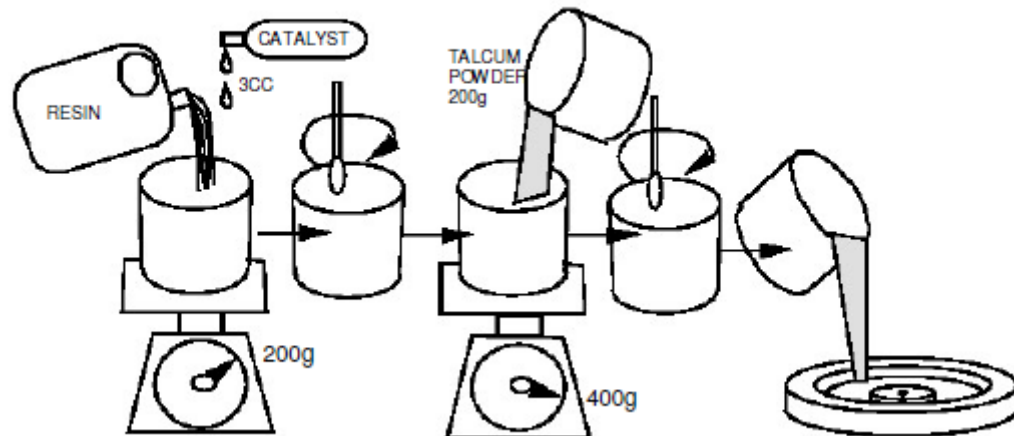
Cut out pieces of fiberglass CSM, using the templates. There will be 2 circular disks for laying flat in the outer mould. You also need enough curved strip pieces to cover the inside wall of the outer mould in a double thickness of CSM. Overlap 25mm between pieces.

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

Diagram 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. Diagram 31 shows all the parts coming together.

#### 30. MIXING POLYESTER RESIN

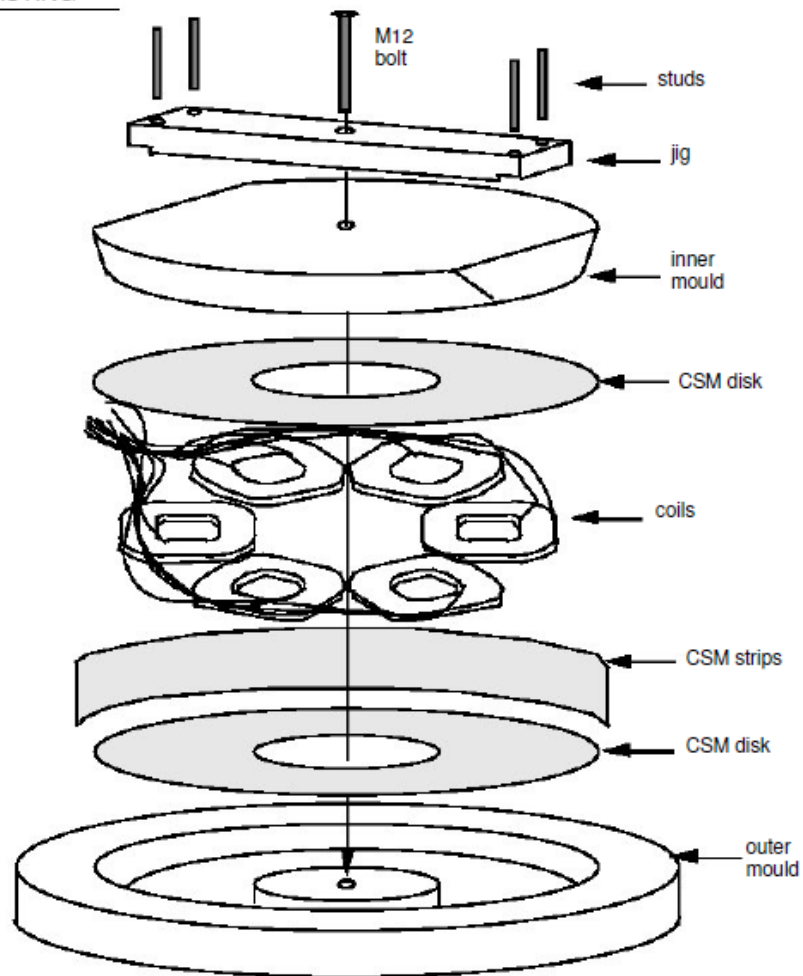


Mix resin with catalyst thoroughly but slowly to avoid churning in air bubbles. Add any talcum powder only after the catalyst is mixed. When the resin is mixed, use it at once. After a few minutes in the mixing bucket, it will heat up, and begin to set. Use exactly the right amount of catalyst. Resin 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 through 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 - diagram 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.

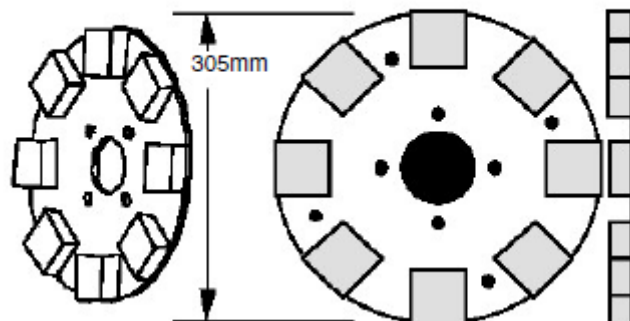
## Rotor construction

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

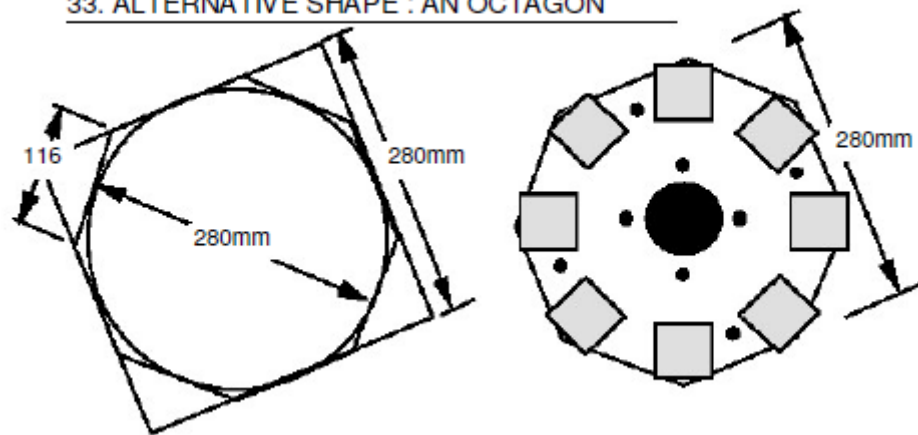
Each magnet rotor is built on a steel disk, 6mm thick. See diagram 32. Do not use aluminum or stainless steel for this disk! The disks have to be made of magnetic material. The disk has holes to mount it to the hub - in this manual the hub has four holes, each 10mm diameter, on a circle at 4 inches (102mm) 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 (see diagram 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.

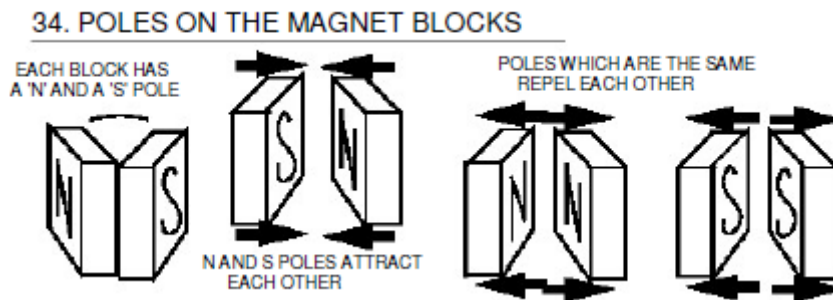
### 33. ALTERNATIVE SHAPE : AN OCTAGON



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

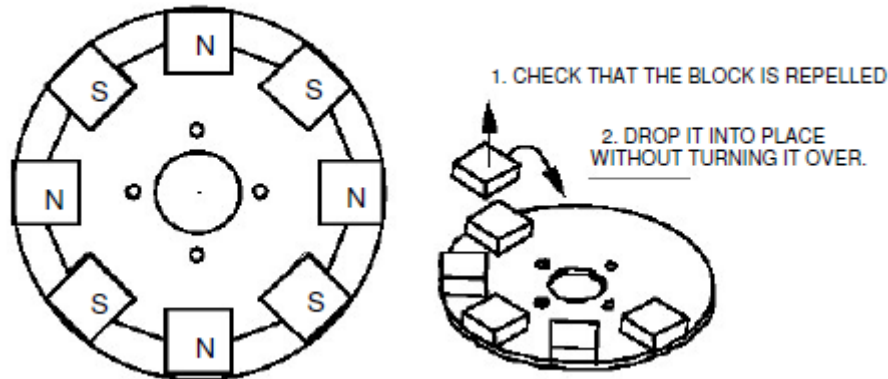
There are 8 magnet blocks on each rotor. Each block has a north pole and a south pole (see diagram 34).



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 (see diagram 35). Then place it without turning it over. When they

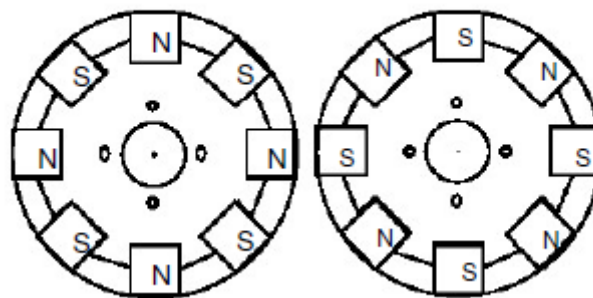
are all in, check with another magnet: it will be attracted, repelled, attracted, repelled, by each magnet in the circle.

### 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 (see diagram 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.

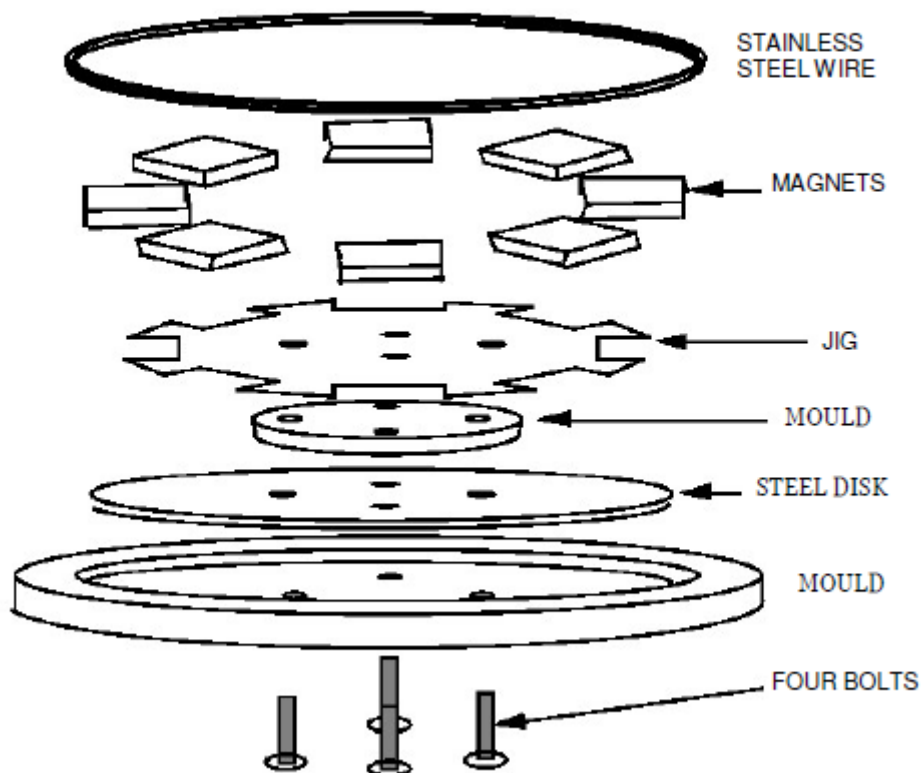
### Rotor casting procedure

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 (see diagram 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 (diagram 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.

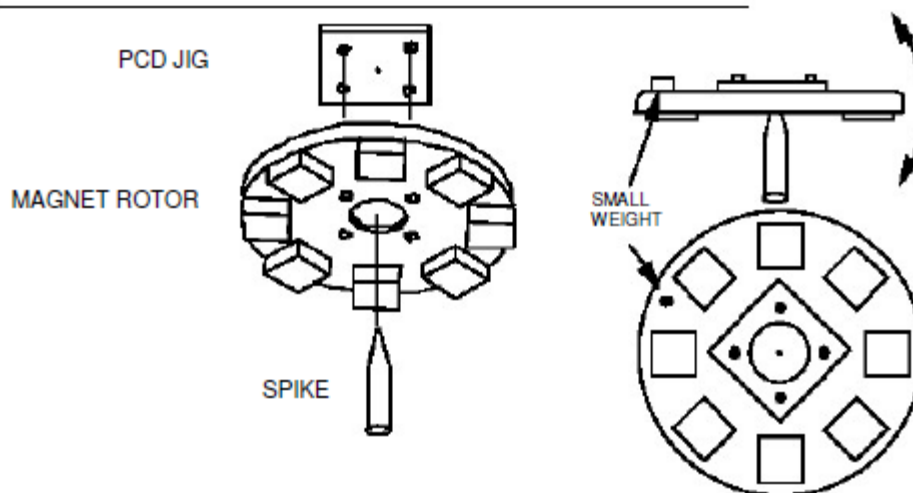


## Assembly

### 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 (see diagram 38), first attach the PCD jig (from diagram 11), using four bolts. Then balance the rotor on a spike as shown:

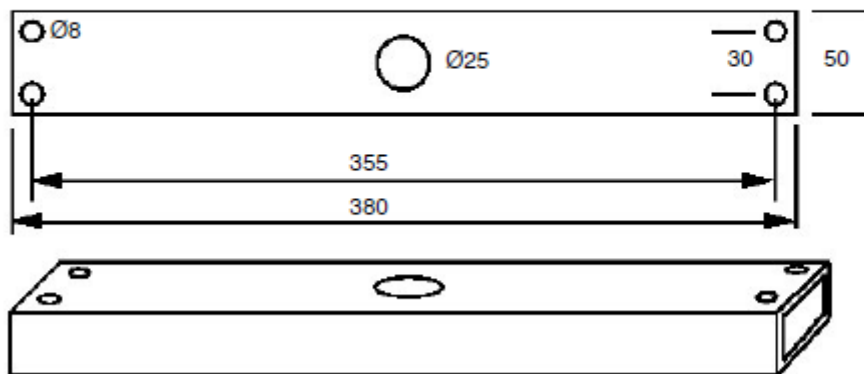
38. ASSEMBLY OF THE BALANCING JIG AND SPIKE



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 (see diagram 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.

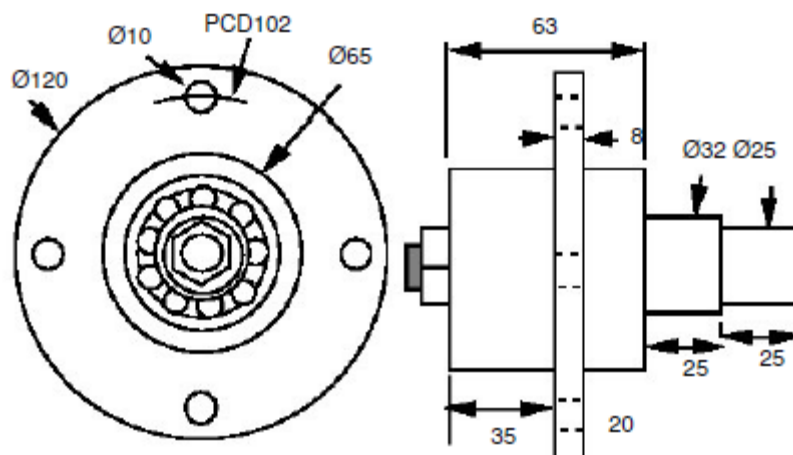
### 39. THE BOX SECTION SPINE

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 (diagram 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.

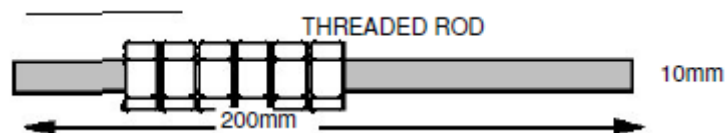
### 40. THE BEARING HUB



#### 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) see diagram 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  $\pm 0.5\text{mm}$ . 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

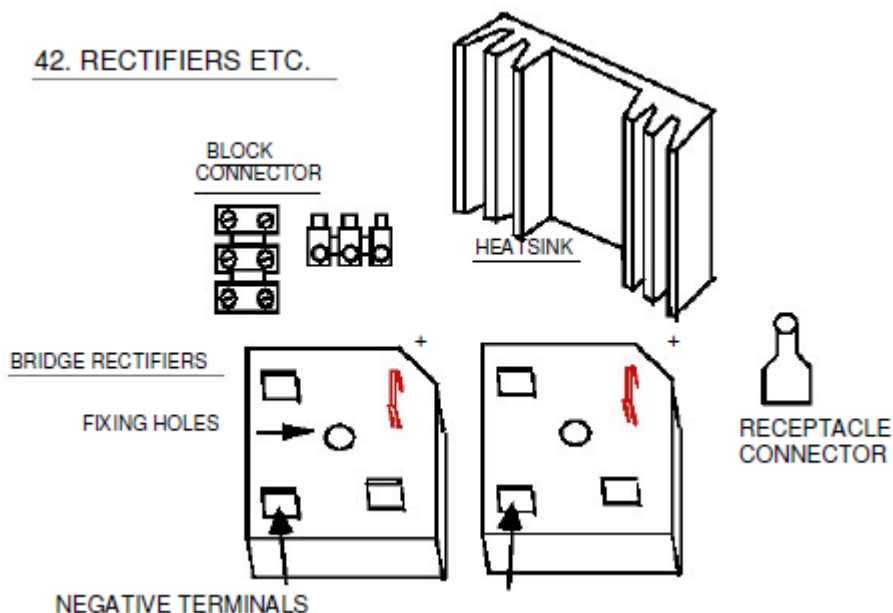
correct number it is necessary to remove washers until it begins to rub the stator. Then add 1mm.

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



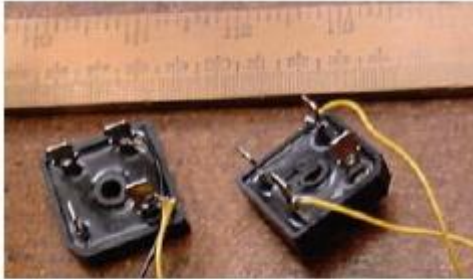
### Electrical Parts

The next section (Section 7) will describe how to connect the rectifier to the stator. I recommend using two 'single phase bridge rectifiers' (see diagram 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

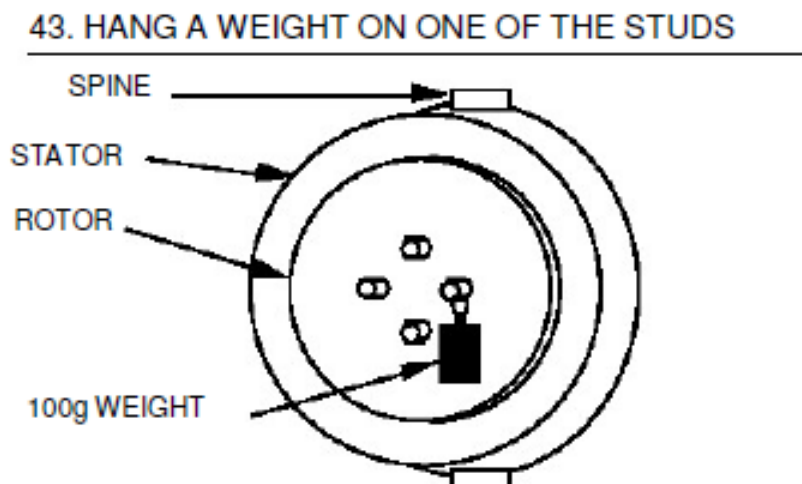


## Testing and connecting

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 (diagram 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.



## 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 (diagram 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.

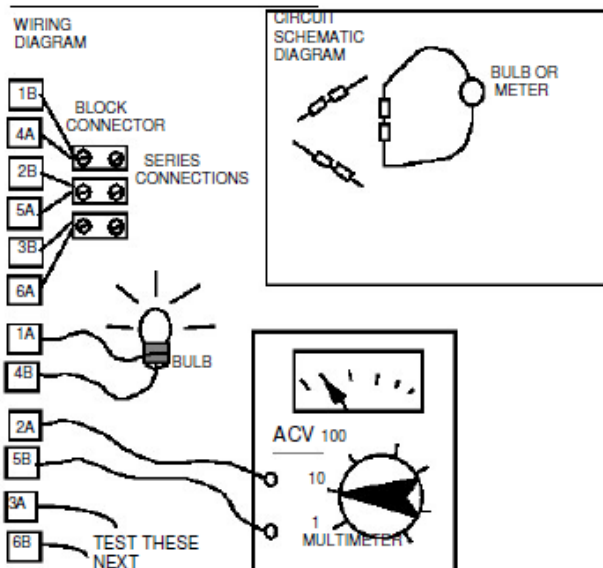
## Electrical testing

- **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. See diagram 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.

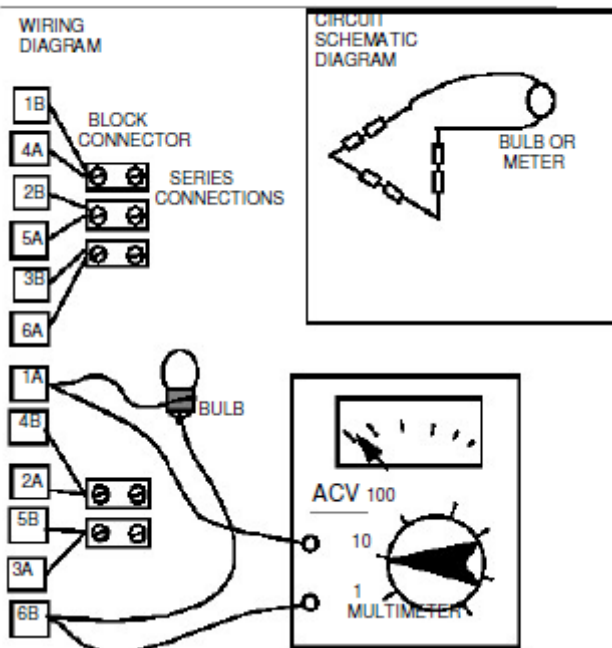
### 44. TESTING THE COILS



- 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 (see diagram 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.

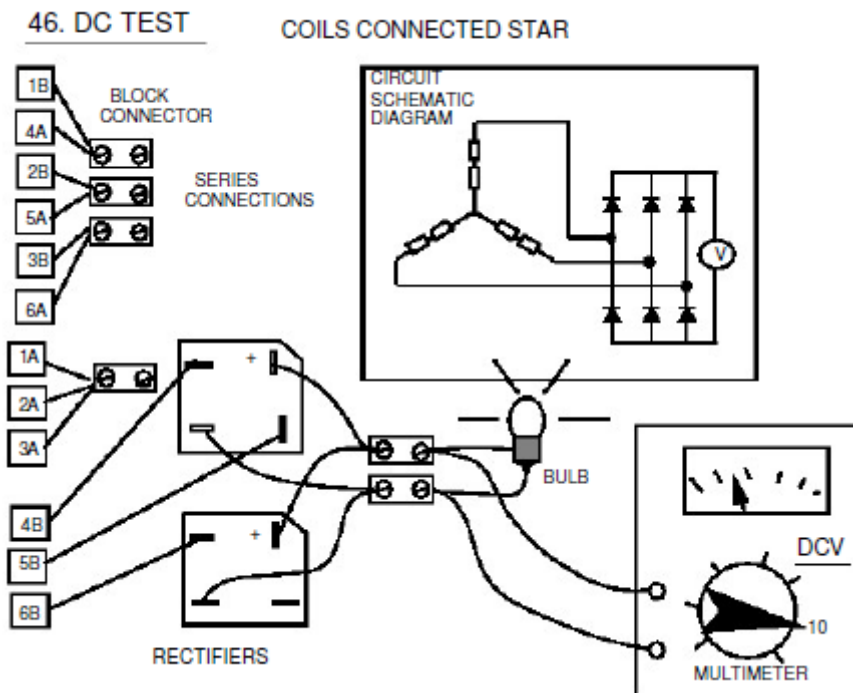
#### 45. CHECKING FOR A REVERSED COIL



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 diagram 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).

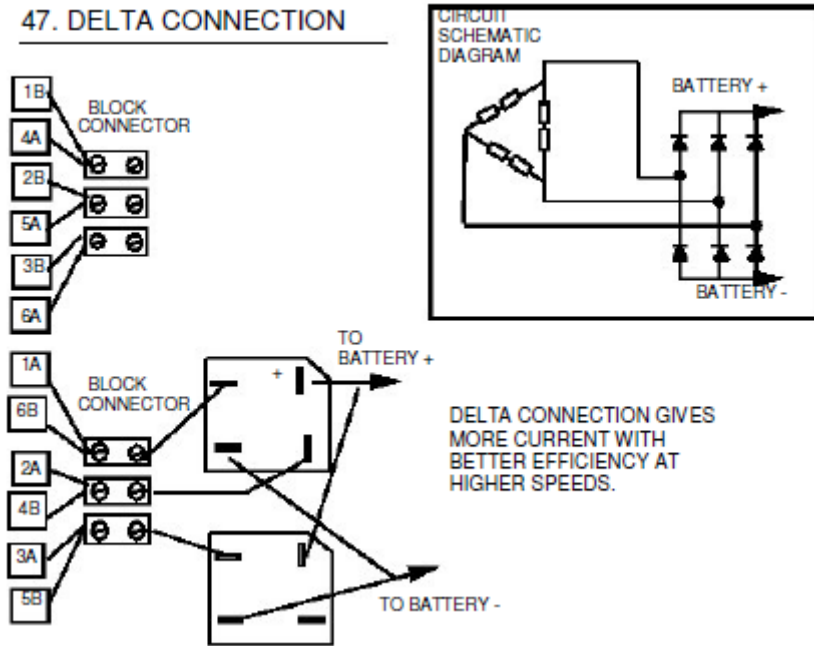
The meter should show a steady reading around 4 volts DC (or 3 volts with the bulb present). The bulb should glow with a steady light, not flickering as before. If there is no reading, or the bulb flickers, then there is a faulty connection or a faulty rectifier.

- 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'.

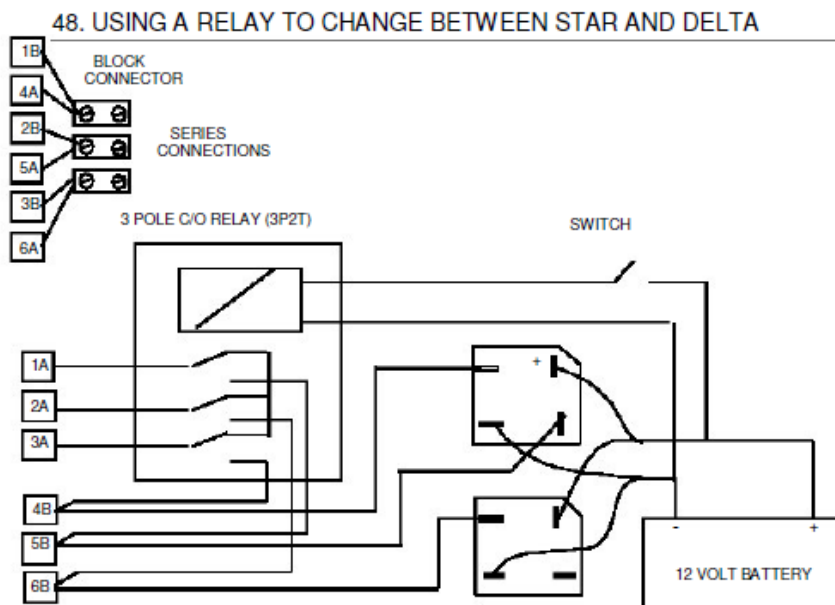
Now try to turn the PMG. It should be stiff but smooth to turn. If it trembles as you turn it then there is a fault.

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 diagram 47.



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

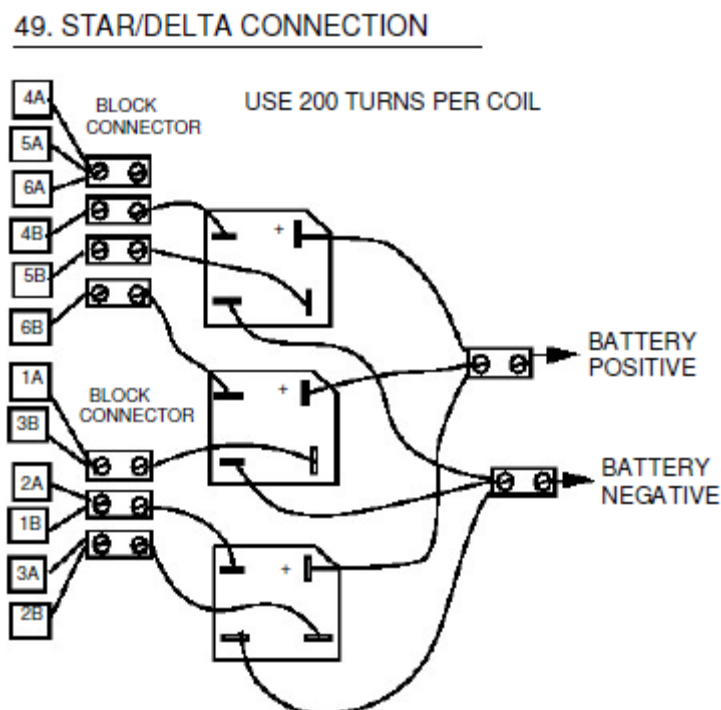


Yet another option for connecting the stator At the time of writing this document, the above arrangement (using a relay to change the connections) is still under development. Later, an electronic control circuit will be available to automate the changeover. This is all very complex, and it so it can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

There are two options:

- If you expect mainly low speeds, then you can simply use the star connection shown in diagram 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 diagram 49. Note that you need six AC terminals on the rectifiers so you will need three rectifier blocks.



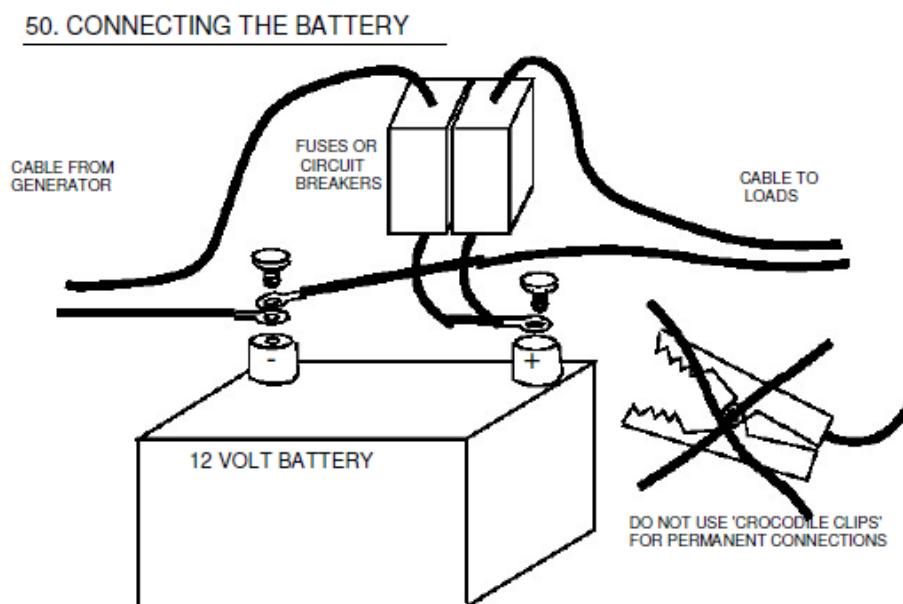
### PMG-to-Battery Cable size

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<sup>2</sup> (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 diagram 50.



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 the 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:

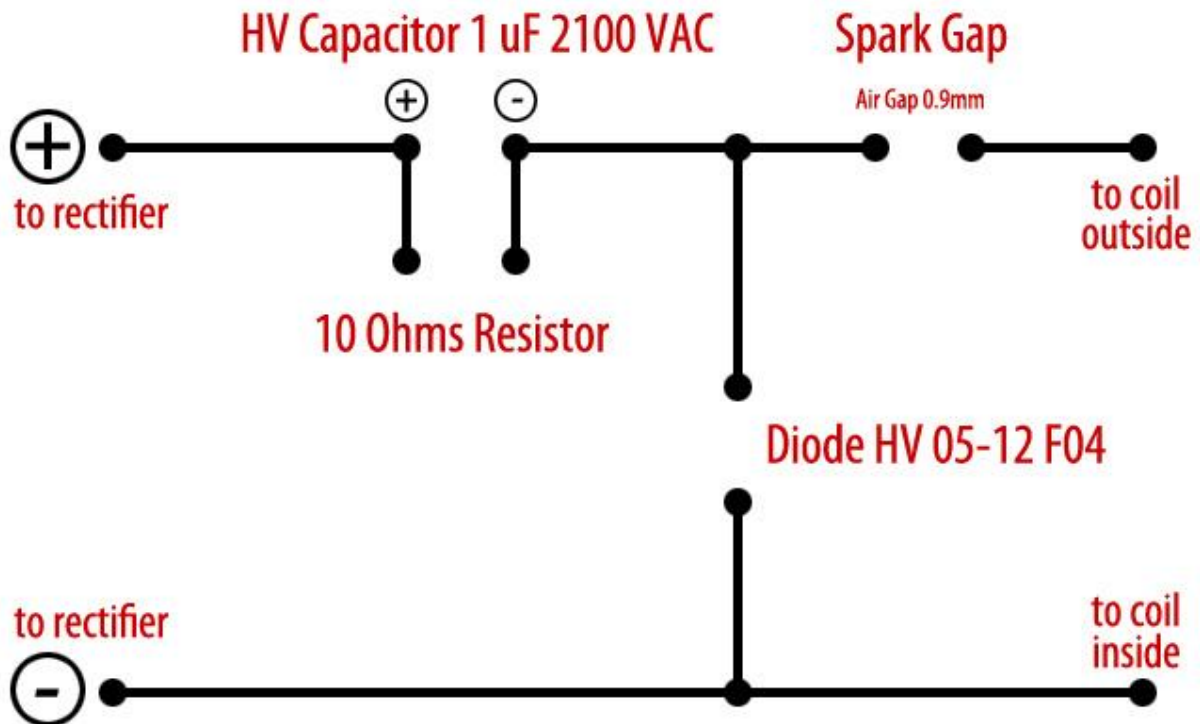
- Dim lights, mean low battery. Use less electricity!
- Very bright lights mean too much power. Use more electricity!

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

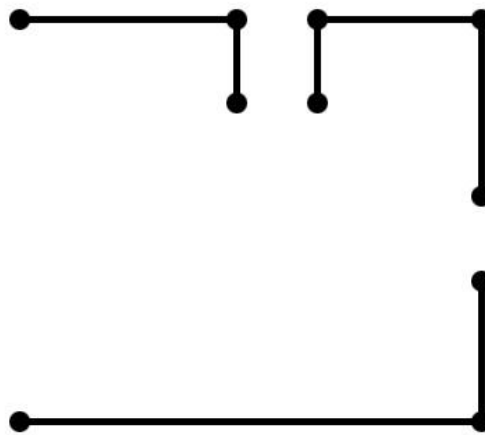
## Building the Circuit Board



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

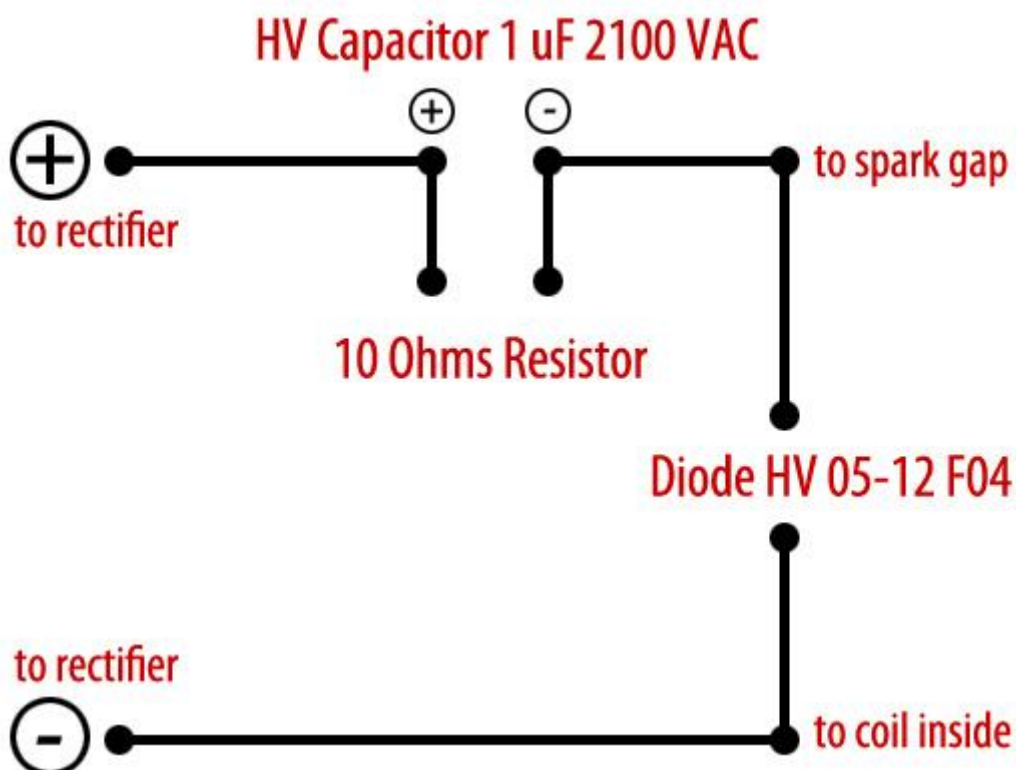
For this part you will need:

- 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:

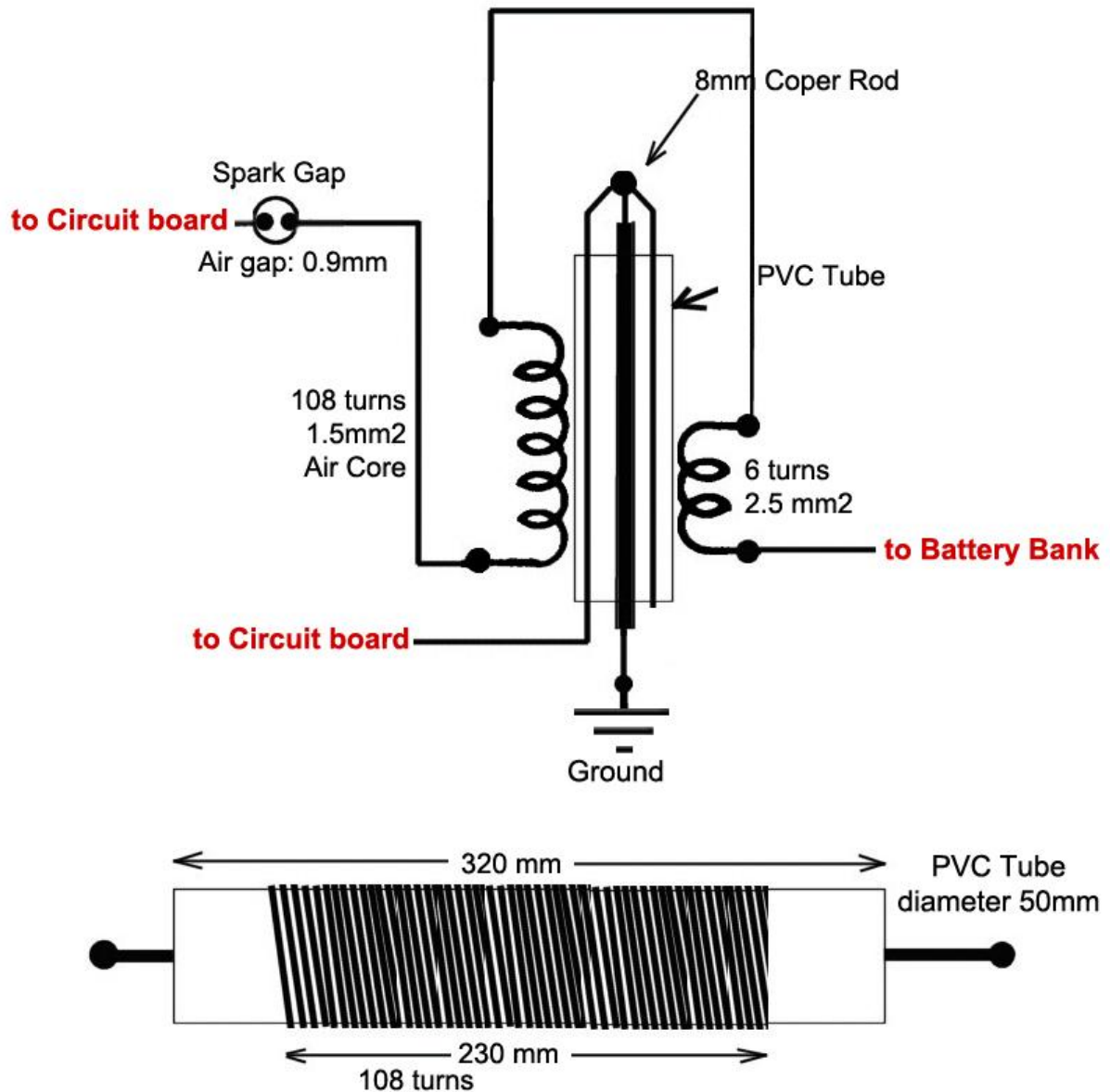
- Hand-held Drill or Drill Press
  - Various drill bits
  - Soldering iron
  - Solder
1. Before drilling, locate all the positions of the through-hole components, practically you will need to drill at every dot that you drew on the circuit board.

***(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 too 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.

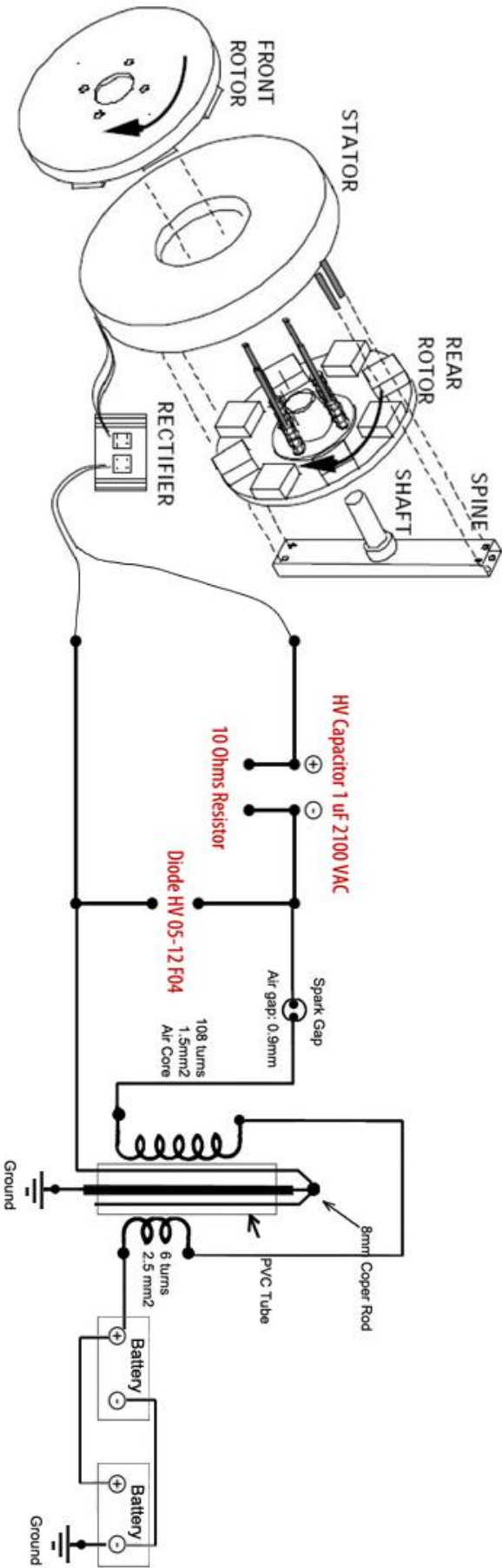
## Building the Coil



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 2.5mm<sup>2</sup> copper wire.
- 30m of 1.5mm<sup>2</sup> 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 below.



## 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.

