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Introduction

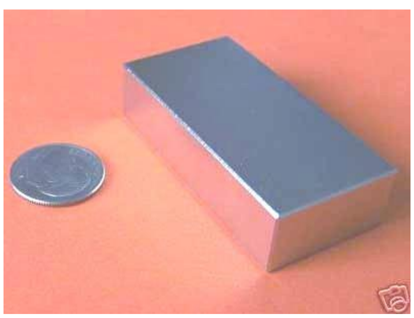
The 1000 Watt flux alternator was created as part of WISE Generator off grid power project. This unique steam engine uses a permanent magnet alternator to generate 3 phases to charge the battery bank. The WISE Generator works spinning 2 magnet discs on both sides of the coils to generate electricity. The act of moving magnets of opposite pols past a copper coil will generate an electrical current.

Attaching the Wise Generator to this type of alternator is the solution we suggest in order to generate electricity from steam.

Basic Principles

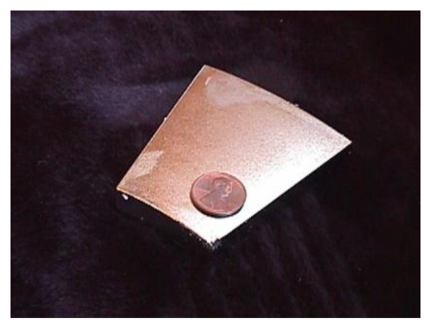
Magnets

The Neodymium magnet has been a key technological development that allows practical and efficient alternators to be built. The high strength of Neodymium is part of what makes computer hard drives so compact. Now the material is available commercially for all sorts of purposes. Many sizes now available are perfect for use in the DIY alternators. Below are pictures of some common sizes that are used:



2" x 1" x 0.5"

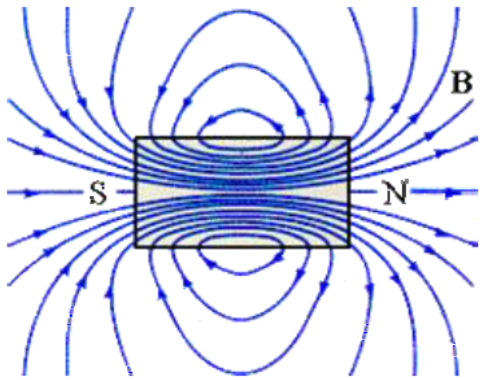
1" Diameter x 0.5"



Circular Arc

"Magnetic field" is the technical term for the lines of force that are often drawn to symbolize the magnetic field around the magnet. The magnetic field intensity is measured in either Teslas (after the inventor Nikola Tesla), or Gauss (after the mathematician). The symbol "B" is used for the field intensity (like "F" for force, "W" for weight). The intensity, B, gets stronger as you get closer to the magnet, since the lines get closer together.

There is always a North Pole and a South Pole. The magnets we prefer to use have poles on the faces with the most surface area. The example magnets shown above are more flat in one direction: the poles are on the broadest faces. Some types of magnets are longer on the polarized axis, but an axial flux alternator is efficient and lighter when the magnets are just big enough for the job, and no bigger.

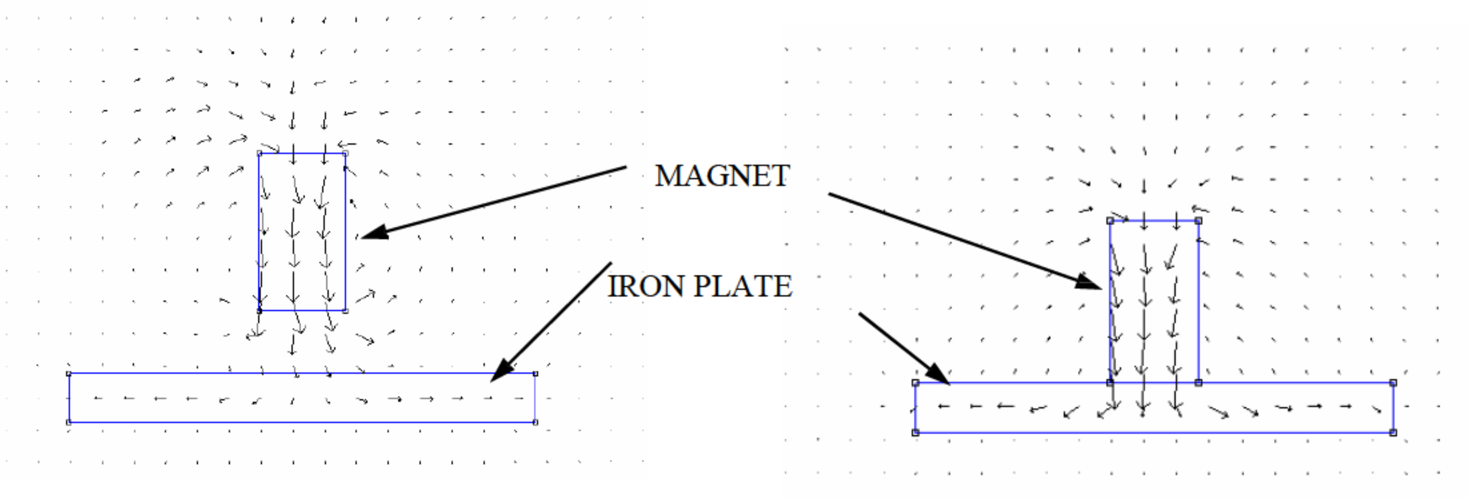


Magnetic Field Lines around a Magnet

When magnets are made, the magnetic poles are "frozen in" with an external electromagnet as the metal cools. If a magnet gets too hot, its strength will weaken.

Magnetic Fields

A few illustrations will improve the understanding of how magnetic fields are manipulated. When magnets are attracted to metallic objects, the attraction can be witnessed by a distortion of the field lines that we saw above. The lines are drawn to that object, in much the same way that the object itself is drawn to the magnet. As the magnet gets closer to the plate, field lines pass through the plate and get stronger. The increasing size of the arrows in the diagrams below illustrates this.



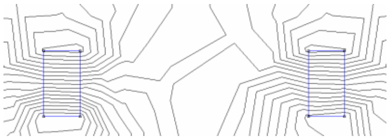
Flux Lines through a Object Attracted to a Magnet

Flux Lines through an Object in Contact With a Magnet

When the plate is in contact with the magnet, the field lines can become very concentrated in the plate. They concentrate themselves in the plate, and if the plate is thick enough, very few lines emerge out the other side. Through the neodymium magnet itself, the magnetic strength doesn't change much.

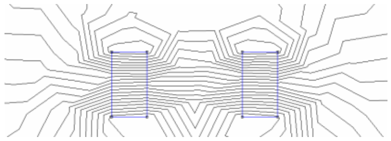
In a sense, holding a magnet beside the plate of iron is like holding a ball above the ground. The ball falls due to gravity, and it comes to rest at a lower potential energy. Same with the piece of iron; once it is in contact with the magnet, the potential energy is lower.

The magnetic field of the magnets is manipulated in this way. The next illustrations show two magnets that are close together. If similar poles are close together, then the lines diverge, and the effect is felt as repulsion. If their opposite poles are close together, then the lines converge (attraction). As they get closer, more lines get closer together, making the field more intense.



Magnetic Repulsion

Magnetic Attraction

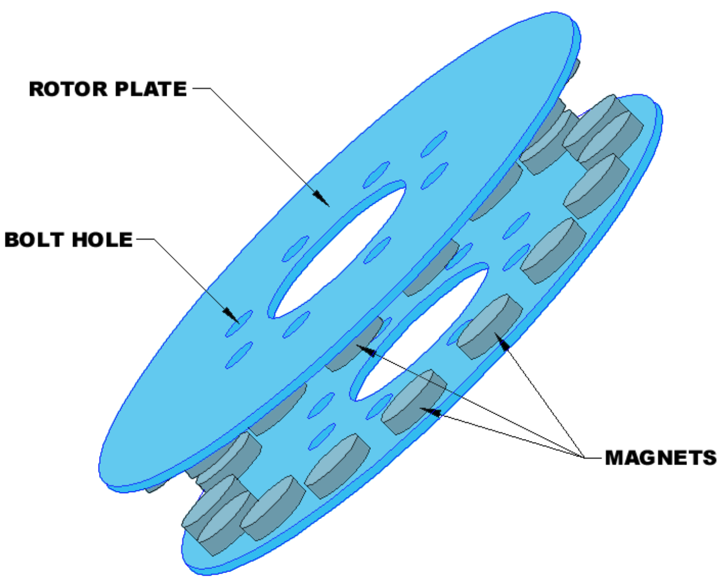


Magnets in Proximity
(Dense field lines)

Concentrating Magnetic Energy

The magnetic field is manipulated to our advantage, when making permanent magnet alternators. By concentrating the magnetic flux between two opposite magnet poles, and capturing the flux in iron plates that would otherwise be wasted, we direct as much energy as we can through the gap between the faces.

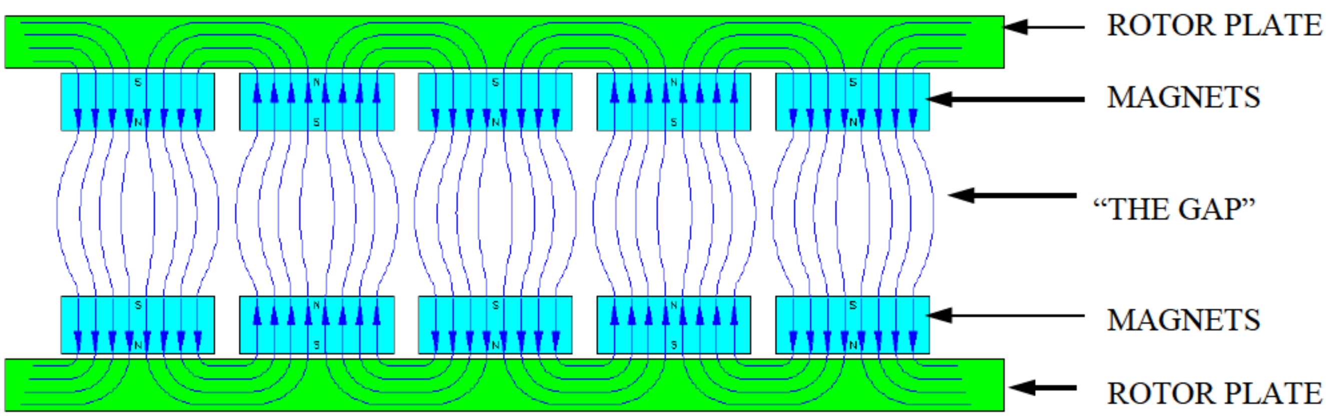
The final product usually looks like this:



Rotors of a Small Permanent-Magnet Alternator

This set of rotors features round magnets. This is common on smaller axial-flux alternators, but as they get larger, it is often more practical to use rectangular magnets, which are available in larger sizes, and the wire coils are more compact. It is important that the rotors be made of steel or iron, so that the magnetic flux is conducted by them.

The magnets are arranged in an N-S-N-S pattern around the circumference of the rotors. Opposite poles face each other. If you trace the lines of flux, they travel from one magnet face, straight to the magnet face opposite, then travel through the steel rotor plate to the next magnet, and back across the gap. Coils of wire in the gap capture the magnetic energy in those field lines.

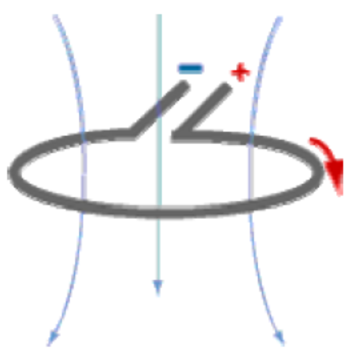


Flux Lines Traced Through a Dual-Rotor Permanent-Magnet Alternator

The path of magnetic flux should be clearer with the diagram above. The flux has been concentrated by confining it between the plates. The flux also alternates between North and South. A compass inside this gap as the rotors turn would flip back and forth frantically. A compass outside the plates is weakly affected, because the fields have been confined.

Harnessing the Magnetic Energy

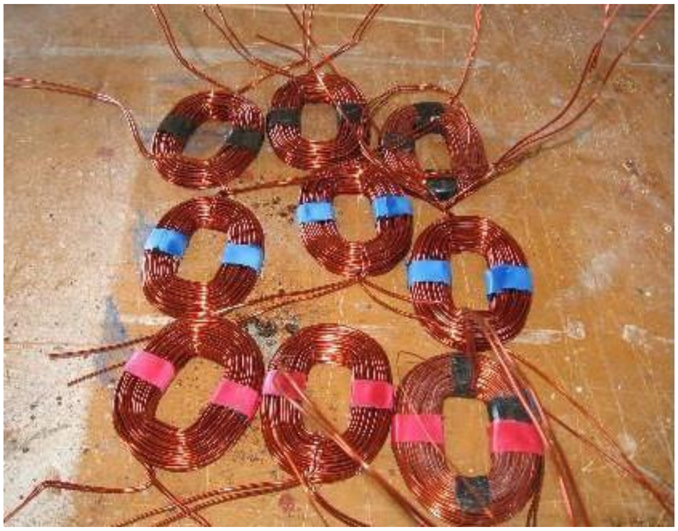
Now we come to the humble coil of wire. It doesn't do much on its own, but in the presence of magnetic fields, interesting things happen. A single loop of wire encloses a certain amount of area. The field passing through this area is a "magnetic flux". It is measured in Webers.



Not much happens when the surrounding magnetic field is sitting still, but when you put the system in motion, a voltage potential is produced. The more rapidly the magnetic field changes (either greater or lesser), the more voltage is created.

It doesn't actually matter how the field is changed for the phenomenon to occur. You may have magnets that get closer together, that oscillate back and forth, flip over and over, or perhaps you don't move the magnets at all, and instead flip the coil back and forth.

In our machine, coils of wire are held steady, while the magnets spin past on the rotors. Because the magnets were arranged N-S-N-S, the direction of the field flips each time a magnet goes by. Each coil sees a flipped magnetic field, and pulse of electricity is produced. When the field flips back, a pulse of opposite voltage is created. This coil is now producing alternating voltage.



Here is a set of 9 coils that were wound for a Permanent Magnet Alternator. They are all the same size, and have the same number of turns each.

Wire comes in a variety of sizes. The diameter (or "gauge") of the wire determines the maximum amount of current it can carry. Heavier wire can carry more current than thinner wire. The builder selects a wire size that allows the current required for his design, but no bigger.

If a single loop of wire captures a certain amount of voltage in a changing magnetic field, then more of those loops will capture more voltage. The builder wants many turns of wire to capture as much as possible. This objective conflicts with the objective of allowing more current, because heavier wire takes more space. Less turns of heavy wire, or more turns of thin wire. A balance is sought by the builder to meet his needs. Experienced builders know off-hand how to strike the right balance. It is more of a mystery to the new recruit. Hopefully the diagrams at the end of this document will help.

Coils of Wire in the Stator

If regular jacketed wire was used to wind coils, a lot of space would be wasted in plastic jackets. A solution was found a long time ago, and wire can be bought that is coated in a thin non-conductive enamel. When coils of enameled wire are wound, each loop is isolated from the other, and the maximum compactness occurs.

Connecting the coils of wire introduces an important question in the design of the Permanent Magnet Alternator: Will there be 3 separate phases or just 1?

Single phase alternators are simple to hook up – all coils are wired in series with each other, and they all work together to make one large pulse at the same time. While this is simple, the experiences quite an abrupt "bump" for each pulse. It can hinder performance and cause damaging vibration. Builders still use single phase when it's convenient, and adapt the design to resist the vibration. It is also more complicated to overcome the inefficiency when rectifying that voltage to put DC into a battery, but it can be done.

A more elegant solution is to wire up the coils for 3-phase operation. At any given point, only one third of the alternator is at peak power, the other two are either dropping or rising to their next peak. Vibration is reduced not only by having peak currents 1/3 as intense, but also by having them 3 times more often. When rectifying the 3-phase power so that a DC battery can be charged, the current is also much smoother. The cost of extra rectifiers should not be considered an obstacle. They will last a long time if properly selected.

When the coils of wire are cast together into one plate, they are supported as a unit called a "stator" (it remains "static" while the rotor rotates). Builders usually arrange the coils in a star-shaped pattern in a flat mould. Into the mould they pour a polyester or epoxy resin. Then they close the mould, and when it has cured, the stator comes out as one big disk with the coils encapsulated inside. All of the internal electrical connections were made in advance. Either they selected one particular 3-phase connection arrangement, or they have enough wires coming out to allow some external connection change.

Magnet and Coil Matching

In an alternator producing 3-phase power, then one group of coils is at peak current while the others are not. Therefore the magnets align with only one phase at a time. Instead of figuring out how this is done from scratch, here's the trick:

For every coil of wire in the 3-phase stator, there are 1.33 magnets.

No, don't go slicing a magnet in half. The absolute minimum number of coils in a 3- phase alternator is 3 coils. One for each phase. You would therefore need 4 magnets. Actually, that would be fairly clunky. Here are some typical combinations:

Coils	Magnets	# Coils Per Phase
6	8	2
9	12	3
12	16	4
15	20	5
18	24	6

Anything with more than 24 magnets is getting complicated, and the first-time builder should beware. Similarly, varying the proportion of magnets and coils begs trouble, unless you know how to avoid the pitfalls of making single-phase alternators (but you wouldn't be a newbie).

Building the alternator

The first step will be to build the magnet disk.

Using a piece of wood and a jig saw cut out slots equally spaced around the circle for your magnets, it is important to note when laying out the magnets be sure to adjust the polarity (N S N S N .. ect) For this design we used 24 magnets in total, 12 for each disc.

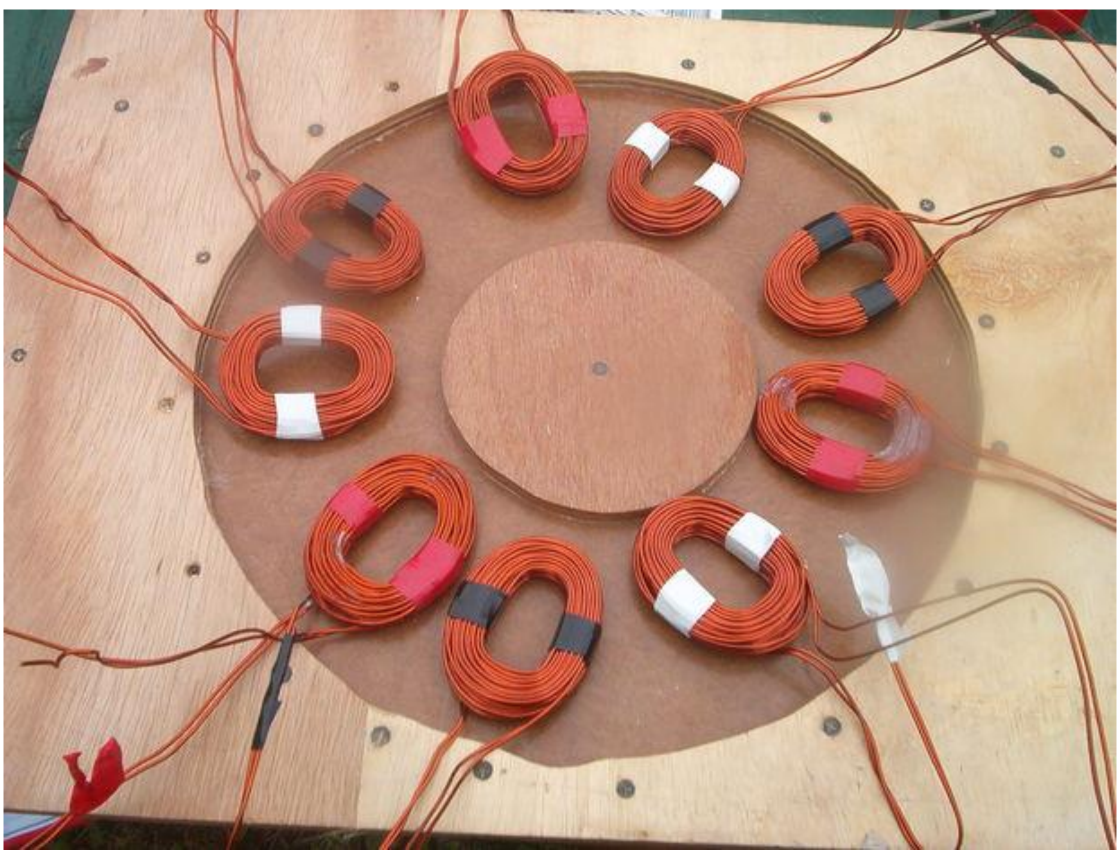
Once you have your template the next step is to lay the magnets in place on top of a smooth surface, use plastic or cardboard to build jacket around the circle of magnets. Note: you will want to build two of these disk, one for each side of the coil. For magnets you need to use either neodymium or rate earth magnets.

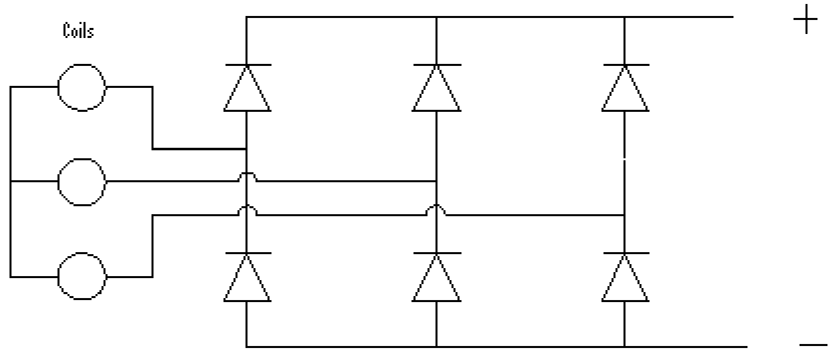
Once this frame is in place remove the wood template place a small cylindrical object the center magnets (a paper cup worked in this case!). Pour fiberglass resin into the mold and let dry. This will create a very solid disk to house our rotating magnets.

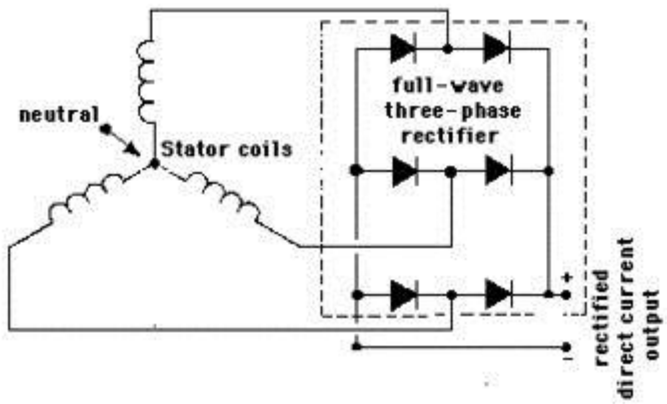
Now that we have our magnet disks hardening it's time to build the coils! When building the coils, it's a good idea to use 2 strands of wire per coil. A single strand would produce approximately half the output giving you 500W, so for maximum output double it up! Now you need to create 9 coils using 14 gauge copper wire. The coils are wired in a rectifying diode pattern in order to let the electrons flow one way. The number of turns of wire will depend on your desire output voltage.

Voltage to turn ratio is as follows 12v – 35 turns, 24v – 75 turns, 48v – 144 turns etc.


LASCO
Plastic
Pipe Fittings




Coils
+
—



Using a sheet of wood out a circle the approximate size of your magnet disc, affix the cutout onto another board to give yourself a “mold” to resin in your copper strands. Be sure to place a smaller circle in the center of the mold for your future shaft to go through. Since we have 9 coils we are creating a 3 phase pattern, every third coil (the corresponding matching tape) is wired together in series. Lay the wires in a 2 phase wye pattern, lay on some fiberglass matting and apply fiberglass resin.

Mounting the Rotor and Stator Together

The stator is fixed while the rotor turns. How do people usually put this together? The best way to start is to see how others have done it. There are several ways, but most resemble the hub of a motorcycle;

The hub is created by using two pipes and some Harley Davidson wheel bearings. The smaller pipe is placed inside of the larger pipe secured by the wheel bearings.

You can see 12 coils in these stators: There are 16 magnets on the rotors below:

Below you can see the process of assembly of the rotors and stator.

One Magnet Rotor Mounted to Hub
Jacking Screws Extend Up to Mount
And Adjust The Opposite Rotor

Rotor and Hub Mounted on Tower Head
Stator is in Position in Front of The Rotor

Second (Opposite) Rotor Being Lowered Into Position

Second Rotor in Position

The final step is to connect the output shaft of your WISE Generator to the hub of the alternator and let it do the job for you!

I hope you enjoyed this bonus guide.

To our Green Future!