

Build Your Own Paradox 2

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Dedicated to all those people who can't leave well enough alone!

Galileo

Newton

Pascal

Franklin

Orville and Wilbur Wright

Armstrong (Invented FM radio, vacuum tubes and super-heterodyne receiver)

Marconi

Edison

Tesla

...

...

...and the many other, as yet unknown, inventors working on dreams of their own.

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1 Warnings

This document details only one of many ways to build the Paradox 2 device.

Please read all the manuals of all tools and equipment that you will be using. If any of the operations presented in this text are not considered safe according to the instruction/safety manuals of the equipment, tools, or materials that you are using then DON'T DO IT!

Exercise all safety precautions, this includes wearing goggles.

If you are not experienced using the equipment/tools discussed in this book; find someone to help you.

The operations presented in the book should only be attempted by someone who has at least passed a high school shop class.

The following picture shows a completed Paradox 2 Experiment



2 Introduction

Welcome, in this text you will find detailed step-by-step instructions for constructing a Paradox 2 Experiment.

The Paradox 2 Experiment demonstrates a magnetic phenomenon that is not predicted by classical electromagnetic theory. This new magnetic phenomenon combined with classical theory forms what is known as New Magnetism. New Magnetism shows that magnetic fields are spherical in geometry, not toroidal as described in classical theory. The Spherical geometry is simpler to use and easier to learn than the more complex toroidal geometry. Furthermore, the spherical geometry resolves all of the known Paradoxes and contradictions of classical theory. If you would like to learn more about New Magnetism, please see our website at www.distinti.com.

This book introduces the required parts and tools as the text progresses. For a consolidated parts list, see Appendix A. A consolidated tool list is found in appendix B.

These step-by-step instruction show advanced construction techniques that can be applied to other projects.

3 Step by Step Instructions

For parts list see appendix A.

3.1 Shafts and Bearings

Definition: Stator: The part of a generator that remains stationary.

Definition: Rotor: The part of a generator that rotates.

In this section we will construct three components: The Drive shaft, the Rotor Bearing and the Stator Bearing. The following photo shows the Rotor removed and set upon its side. The Rotor Bearing is essentially the bottom axel of the rotor. It fits into the Stator Bearing to form both a mechanical and electrical contact (notice the attached wires to both bearings). The drive shaft and drive motor form the upper axel.

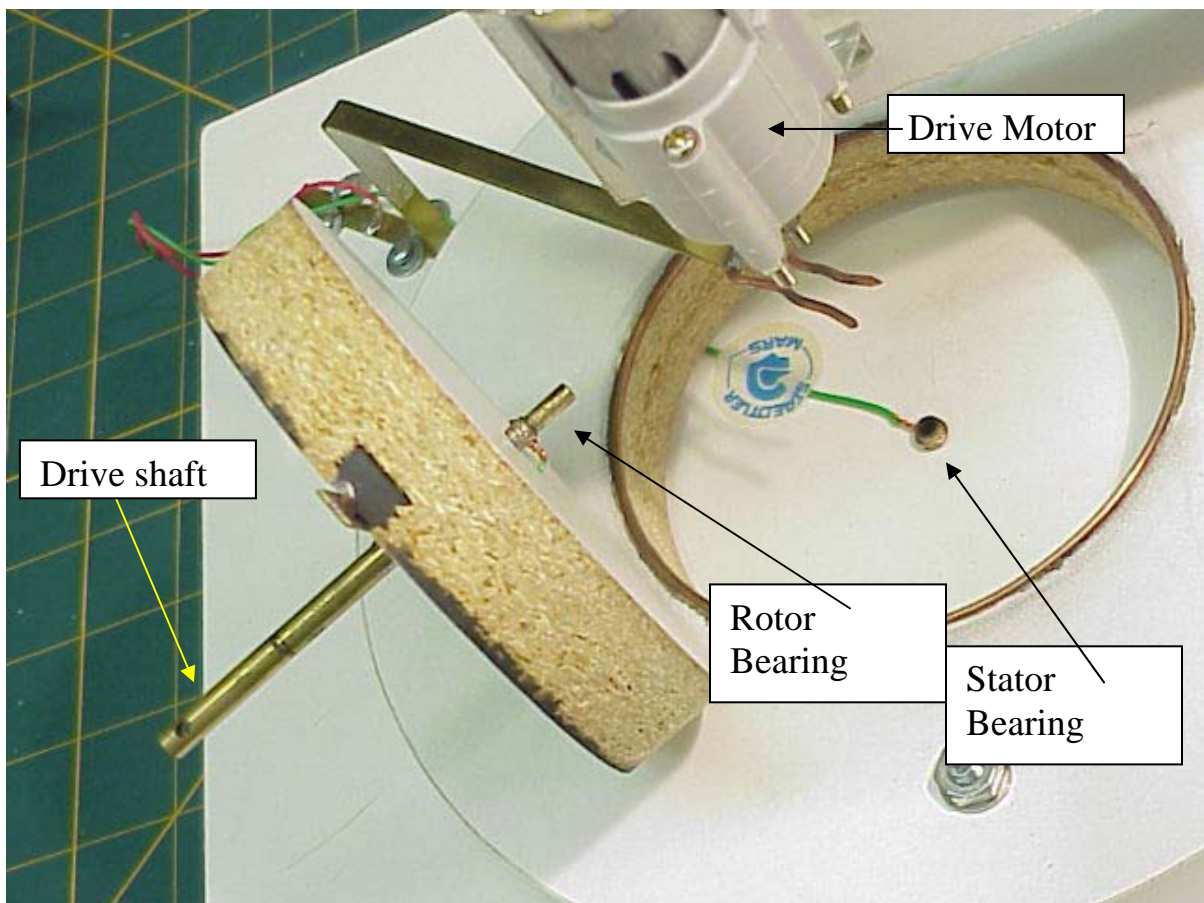


Figure 3-1: Photo of rotor removed to expose bearings

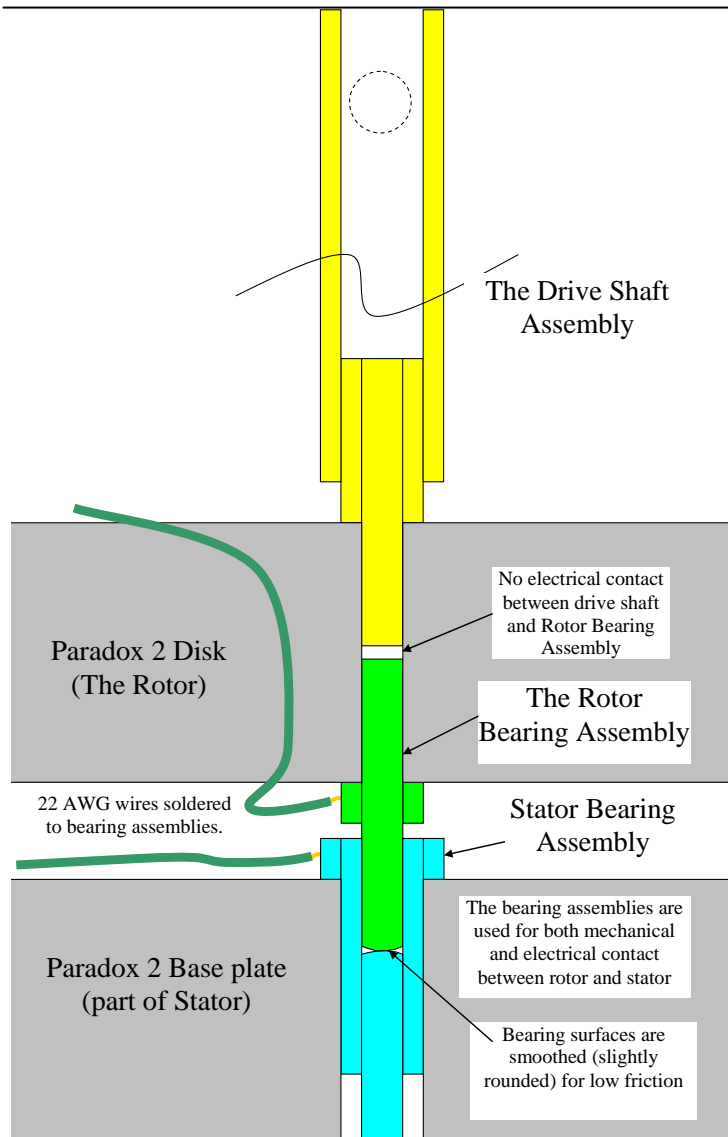


Figure 3-2: Shafts and Bearings cross sectional view

Figure 3-2 shows a cross section of the three finished parts and how they fit into the system. The driveshaft (yellow) connects the motor to the rotor; for all intents and purposes, it is the “upper axel” of the disk. The Rotor Bearing (green) is mounted in the bottom of the rotor (disk) and provides the “lower axel.” The Stator Bearing (blue) is mounted into the base plate; it provides the “socket” for the Rotor Bearing.

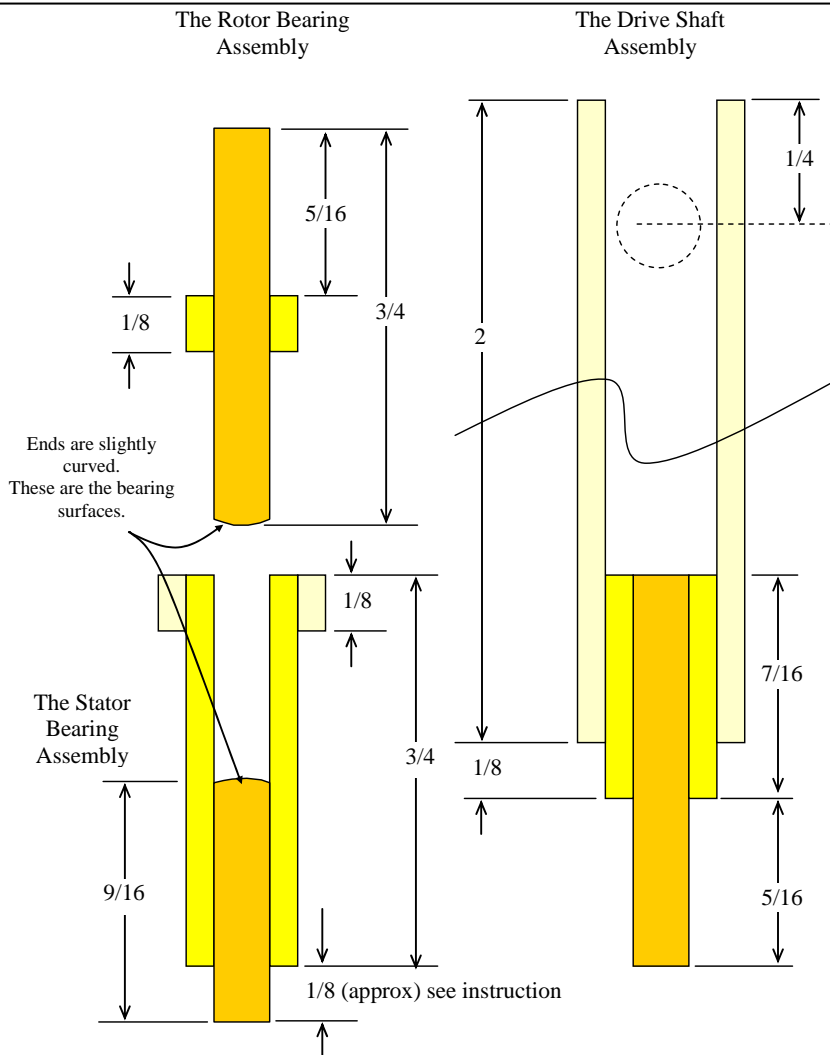


Figure 3-3: Dimensions of assemblies (inches)

3.1.1 Cutting and shaping the parts

The Shafts and bearings are the mechanical parts that enable the rotor to spin freely. The Shafts and bearings are constructed from brass tubing and rod material that can be obtained from hobby stores that cater to model train and RC airplane enthusiasts.



Raw Parts

- #1 1/8 (OD) solid brass rod
- #2 5/32 (OD) brass tube
- #3 3/16 (OD) brass tube

Definition: Raw Part. The raw part # is the identifying line number in the parts list in appendix A. Many of these raw parts are cut into one or more finished parts. For example, if you cut a certain length off of raw part #1 (Part #1 for short) to make a bearing, then the new part is called “the bearing”. The remainder of part #1 is set aside and may be used for other finished parts later. You will have raw parts left over.

From the Brass material listed above cut the following (see cutting instruction below):

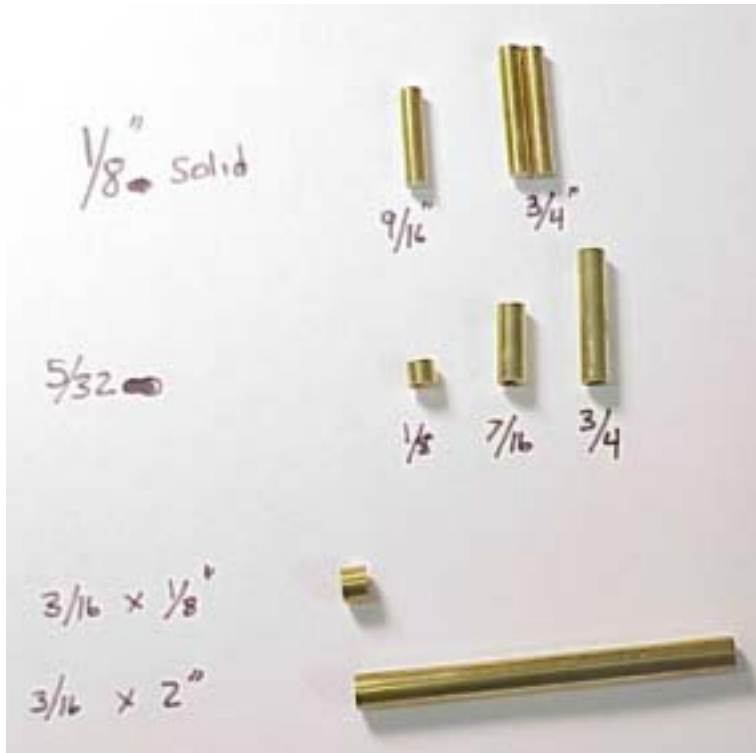
From	First part	Second	Third
#1 1/8 solid	9/16	3/4	3/4
#2 5/32 OD	1/8	7/16	3/4
#3 3/16 OD	1/8	2	(none)



Cutting instructions:

Carefully measure and mark the desired length to cut. Place the raw part in a vice and grip the part to be cut with pliers (don't crush the part). Using a rotary tool (such as Dremel) and a small “cut off wheel,” cut the part. Do not handle the part until it cools.

Use a fine file to clean up and de-burr the cut ends as required. Here is what you should have:



Of the solid brass parts, take one of the $\frac{3}{4}$ inch lengths and the $\frac{9}{16}$ inch length. The ends of these two parts are going to be the bearing surfaces (they are going to rub against each other). In order to minimize the friction between these two parts, we are going to put a slight curve on one end of each. To do this, lock each of the two parts into the rotary tool and using sandpaper (cloth backed) and the bottom of an empty soda can as a form, sand one end of each as shown in the following.



You should obtain a nice gently curved end like shown in the following



Using a sharpie marker, draw a band around the end of the nicely curved ends so that you can easily identify them. Put them aside.

Next, using a drill (preferably a drill press) cut a $\frac{3}{32}$ inch hole in the side of the 2 inch length of $\frac{3}{16}$ inch tube. The hole should be $\frac{1}{4}$ inch from the end.

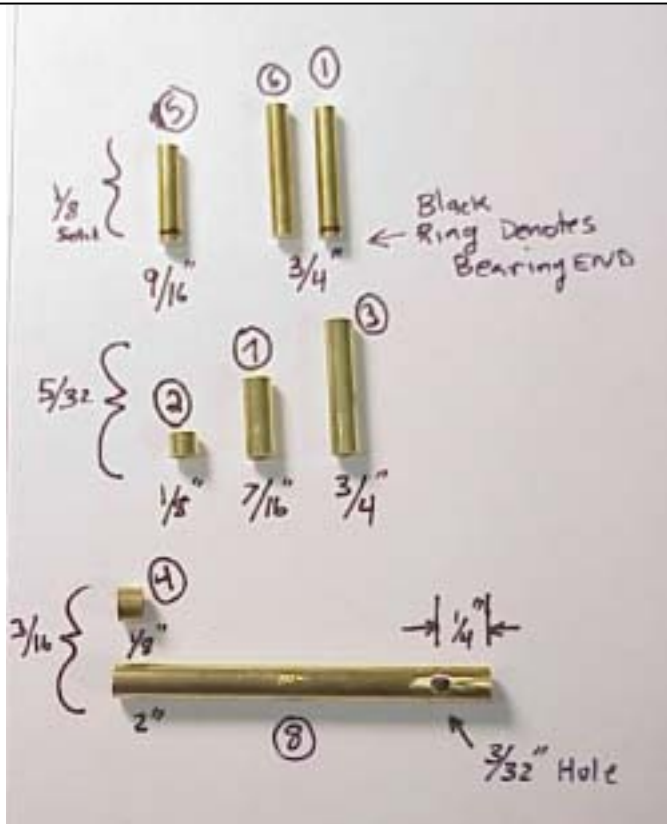


Figure 3-4: cutting and shaping complete

The above photo shows what you should have at the end of the cutting and shaping operations. The parts above are numbered to help identify them in the assembly section that follows.

3.1.2 Assembly

In this section we assemble the shafts and bearings from the parts that were cut and formed in the previous section.

The assembly process uses solder weld (solder paste) to hold the parts together. In order for the solder to adhere to the brass, the brass must be cleaned with steel wool (only clean those areas that will be soldered).

For cleaning the inside of tubes (when called for), use a pair of needle nose pliers to hold a small wad of steel wool as shown in the following photo.



Figure 3-5: cleaning the inside of tubes (usually just the ends)

The Rotor Bearing

The Rotor Bearing is assembled from parts (1) and (2) shown in Figure 3-4.

- 1) Clean inside of part (2) (the 1/8 inch length of 5/32 tube) as shown in Figure 3-5.
- 2) Using steel wool, clean the non-bearing half of part (1). Do not clean the other half since the tarnish and other residue (like finger oils) will protect this end from solder should a mistake be made.
- 3) Slide part (2) over part (1) 1/3 of the way from the bearing end as shown in Figure 3-6. Then apply a small bead of solder paste as shown



Figure 3-6: The Rotor Bearing Step 3

- 4) Using a ruler, slide the ring into the solder paste such that 5/16 of the bearing end is exposed and clear of solder paste as shown in Figure 3-7

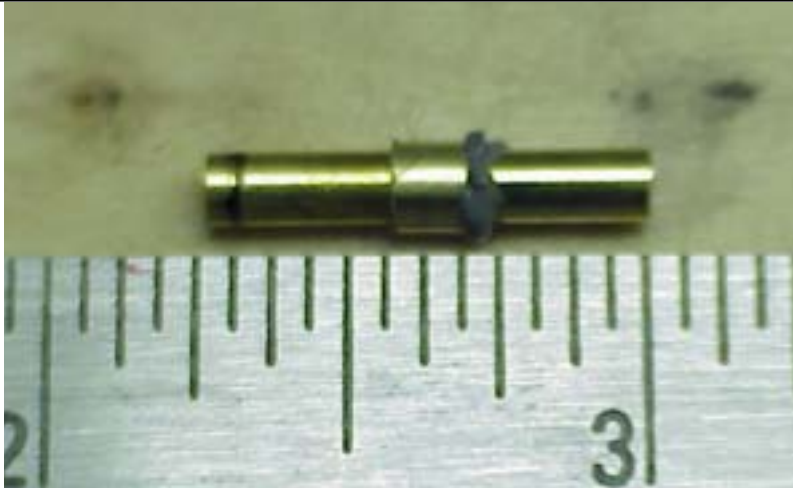


Figure 3-7: Rotor Bearing Step 4

- 5) Using a soldering iron with a large tip, heat the ring until the solder turns to a shiny liquid and seeps into the joint (Figure 3-8). Remove the iron and let the part cool before touching.



Figure 3-8: applying heat

Once the part has cooled, put it aside.

The Stator Bearing

The stator bearing is constructed from parts (3), (4), and (5) of Figure 3-4.

- 1) Clean the inside of part (4) and the outside end of part (3). Then, using the soldering techniques demonstrated in the previous section; solder part (4) (the short 1/8 inch long tube) flush to the end of part (3) (the long tube) as shown in Figure 3-9. Let it cool before continuing.
- 2) Clean the inside of the other end of part (3) as far in as you can (no more than a 1/4 inch).
- 3) Clean the non-bearing half of part (5).

- 4) NOTE: STEPS 6-8 are performed in rapid succession; please read them completely before attempting. Have your needle nose pliers handy.



Figure 3-9: Stator Bearing step 1

- 5) Take the Rotor Bearing (complete in previous section) and insert it bearing end into the end of the part (3) as shown in Figure 3-10. DON'T INSERT IT ALL THE WAY IN, allow about a 64th inch of clearance such that the sleeves do not come in contact. Then put a band of solder paste around the middle of part (5)



Figure 3-10: Stator Bearing Step 5

- 6) Insert part (5) into the end of part 3 until it comes in contact with the Rotor Bearing. Then apply heat.



Figure 3-11: Stator Bearing Step 4

- 7) After the solder melts and seeps into the joint, get your needle nose pliers and gently remove the rotor bearing (we don't want it soldered in). Then remove the heat Figure 3-12. Allow the items to cool before handling.



Figure 3-12: Stator Bearing Step 7

Put these parts aside.

Drive Shaft

The drive shaft is constructed from parts (6), (7), and (8) of Figure 3-2.

- 1) Clean inside of part (7) and outside of part (6).
- 2) Place solder bead around end of part (6) and slide part (7) over (6) and apply heat. Make sure that 5/16 of part (6) remains exposed as shown in Figure 3-13. Let cool before continuing.

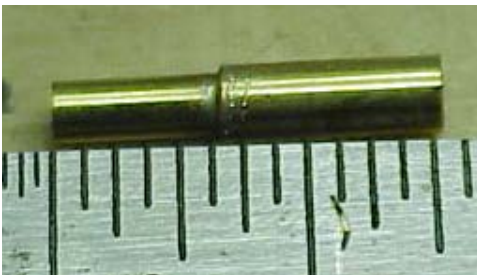


Figure 3-13: Drive Shaft Step 2

- 3) Clean outside of part (7) and inside the end of part (8) which is opposite the hole. Apply a solder paste bead around part (7) and slide the assembly into the end of part (8) with part (6) and 1/8 inch of part (7) exposed as shown in Figure 3-14. NOTE: We do not want to apply heat to melt all of the solder paste at the same time. This heat will cause the joint between parts (6) and (7) to loosen. Instead, apply heat until only one side (or less) melts then let the part cool. Roll the part to the next

section and apply heat in the same fashion. A better technique is to use wire solder instead of paste as shown in Figure 3-14. Again, only one small section should be heated at a time to prevent the joint between (6) and (7) from being affected.



Figure 3-14: Drive Shaft Step 3



Figure 3-15: The completed drive shaft

Final step

Using 22 AWG insulated wire; solder a 10 inch length to the rotor bearing and a 20 inch length to the Stator Bearing. The point of connection should be the sleeves as shown in the following photo. For best results, strip about an inch of insulation from the wire and wrap the wire completely around the sleeve. Then twist to form a tight loop. This will hold the wire to the sleeve while you are soldering it.

NOTE: Solder only one small section of wire to the sleeve at a time. Otherwise you could melt the solder joint that holds the sleeve in place. We recommend that you use wire solder for this connection since it has a slightly lower melting point than the solder weld.



Figure 3-16: Bearing Wires

Put all of the shafts and bearings aside for later.

3.2 Pre-Cutting the Wood (Melamine)

In this section we precut all of the melamine parts (that we may call wood parts for short).

The melamine board is found in the shelving section of a home improvement store. It is almost 12 inches in width, 36 inches in length and $\frac{3}{4}$ of an inch in thickness. It has melamine coating on all sides and edges.

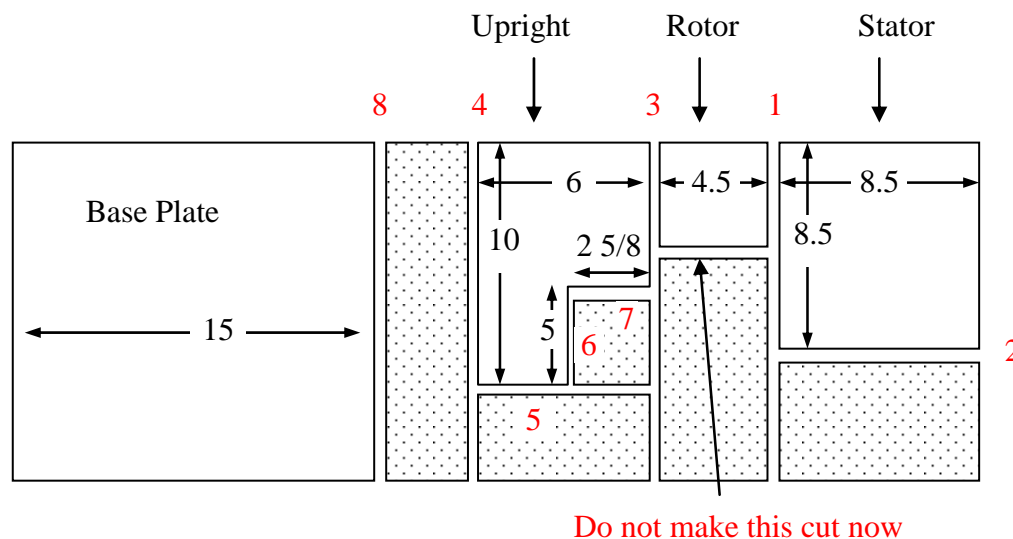


Figure 3-17: Melamine cuts (dimensions in inches)

Figure 3-17 shows the dimensions of the parts to be cut from the melamine board. The red numerals indicate the preferred order in which the cuts should be made. The slightly shaded sections are leftovers that may be discarded or saved for other projects.

Note: The 4.5 inch square will become the Rotor. The reason why the square is not cut from the rest of the 4.5 wide sections at this time is to have plenty of board to clamp while routing the magnet holes. If you make the cut now, you will have to come up with a fancy way of immobilizing the board while routing out the magnet holes.

Set these melamine sections aside.

3.3 Making a circle cutting tool

Cutting precision disks for generators is best accomplished using a special routing table that can be made from a flat piece of plywood. We used a scrap piece of plywood with clean smooth surfaces (free of knots and seams). You can use melamine board for this as well.

Referring to Figure 3-18, using a pencil, draw a centerline down the middle of the board (length wise). Then draw a perpendicular line about 3 inches from one end. Using the intersection of the two lines as a center-point, draw circles every half inch from 1 inch to 4.5 inches with a drawing compass.



Figure 3-18: Setup for circle tool

- 1) Drill a $\frac{1}{4}$ inch diameter hole at the intersection; preferable with a drill press.
- 2) Flip the board over.
- 3) Remove the $\frac{1}{4}$ inch drill bit from the drill press and lock it into your router. We are going to use the drill bit to align the router shaft to the hole that was drilled in the board.

- 4) (DO NOT TURN ON ROUTER) With the board flipped over (such that the circles are face down), guide the $\frac{1}{4}$ inch drill bit through the hole in the board (ensure that the hole hangs over the edge of your work table).
- 5) Using hot melt glue and sections of yardstick (or trim), “cage in” the router. Refer to Figure 3-19. DO NOT GLUE THE ROUTER TO THE BOARD. These sections of yardstick will retain the alignment of the router to the hole.

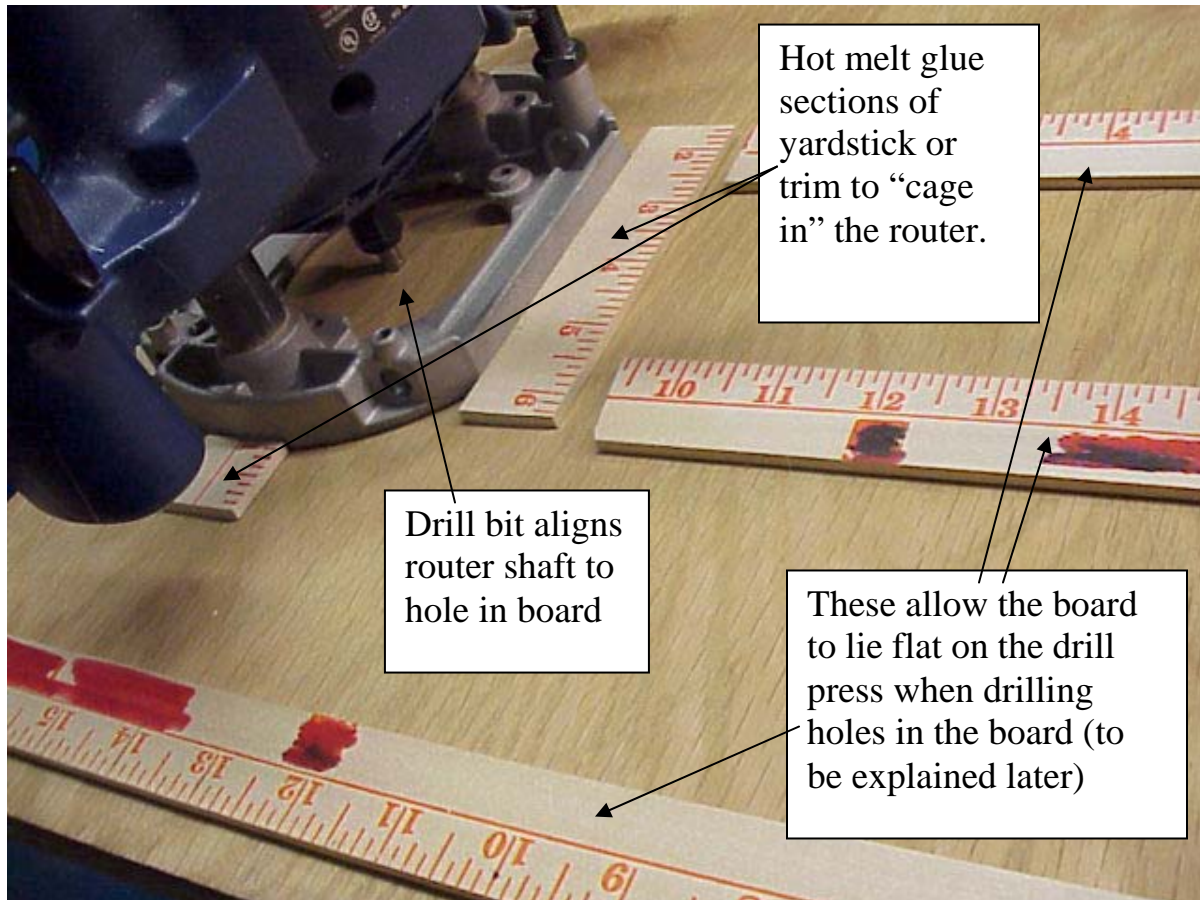


Figure 3-19: "Caging in" the router on bottom

- 6) Remove the router from the “cage”, install a $\frac{3}{4}$ inch routing bit that is capable of plunge cutting.



7) Return the router to the cage and plunge cut the hole as shown

8) Replace the bit with a $\frac{1}{4}$ inch bit that is capable of plunge cutting. The $\frac{1}{4}$ inch bit is the one we will use for milling the disk parts for the Paradox 2.



9) Lock the router into the cage using the best method possible.

We are using #10 $\frac{3}{4}$ inch long sheet metal screws and $\frac{1}{4}$ inch washers at four locations around the router. But this is only a suggestion since each router has different and diverse ways of mounting to a router table. Please choose the method that is the most secure and safest. See your router's owners manual for the recommended way of mounting the router to a routing table.

Remove the router and flip the board so that the circles are up. Using the circles and a ruler, precisely locate and drill four $\frac{1}{8}$ inch holes. The hole locations are as follows: $4 \frac{1}{8}$, $1 \frac{7}{8}$, $1 \frac{13}{16}$ and $2 \frac{1}{32}$. These locations are the radial distance from the intersection of the two lines (before we cut the intersection out). Figure 3-20 shows what is being described.

Since the radial distance is all that matters, the holes do not have to be in the same radial line from the intersection. As such, the circles traced out enable us to “slide” the locations around such they do not overlap.



Figure 3-20: 1/8 inch holes for cutting

Note: Our board shows other holes from other projects.

Reattach your router with a $\frac{1}{4}$ inch strait routing bit that is capable of plunge cutting. Then clamp (or bolt) the routing board to your bench top as shown in the following photo.



Figure 3-21: The routing table is ready to go

Note: We used drywall screws to fasten the routing board to the bench top.

3.3.1 How to use the Routing table

These instructions are for cutting a simple disk.

- 1) With the router off
- 2) Set depth of cut (height of bit above table) **WARNING NEVER TRY TO CUT ALL THE WAY THROUGH IN ONE PASS.** The router can impart a lot of torque on the part and it can get out of control and cause damage or injury. Never cut more than 1/2 inch depth at a time.
- 3) Using a drill (preferably a drill press), cut a 1/8 inch hole into the center of the part that you want to make into a disk (it is best if the part is cut square first).
- 4) Using 1/8 Diameter **SOLID** steel or brass rod, insert the rod into the hole in the part and then into the appropriate hole in the routing table (see Figure 3-22).

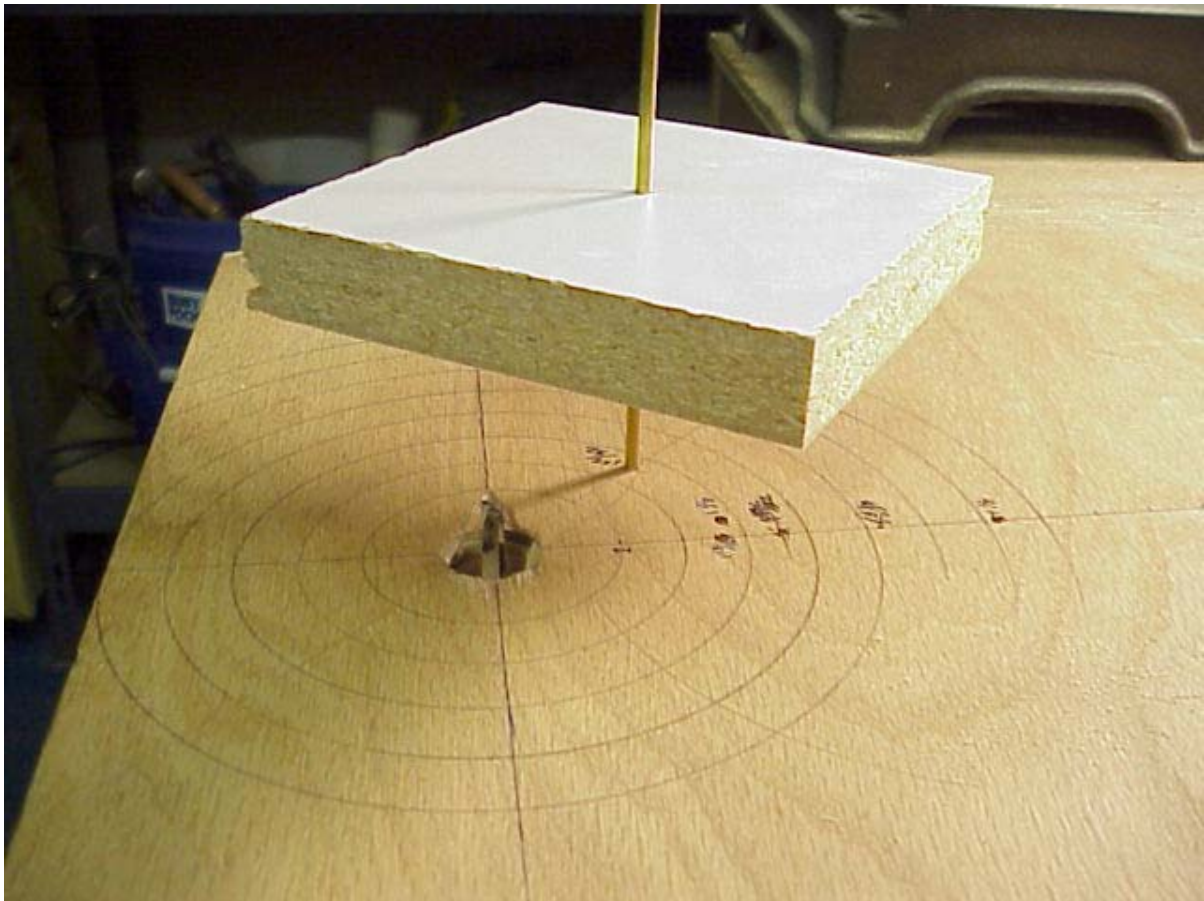


Figure 3-22: Using the routing table

- 5) Turn the router on and slowly lower the part onto the spinning blade
(Keep your hands away from the spinning blade at all times)
- 6) Slowly rotate the part in the clockwise direction against the torque that the router imparts.
- 7) Once you are sure that the cut has been made all the way around; then turn off the router.
- 8) Flip the part over and repeat steps 4 through 7.

You will have a very precise disk.

3.4 Constructing the Stator Ring

Get the 8.5 inch square melamine board that we cut earlier.

NOTE: The following photo shows the stator ring being laid out on a board larger than 8.5 inches square. This is due to the fact that our 8.5 inch square board was inadvertently mixed into the discard pile.

- 1) Using your drafting skills, locate the center of the board and draw two perpendicular lines from it.

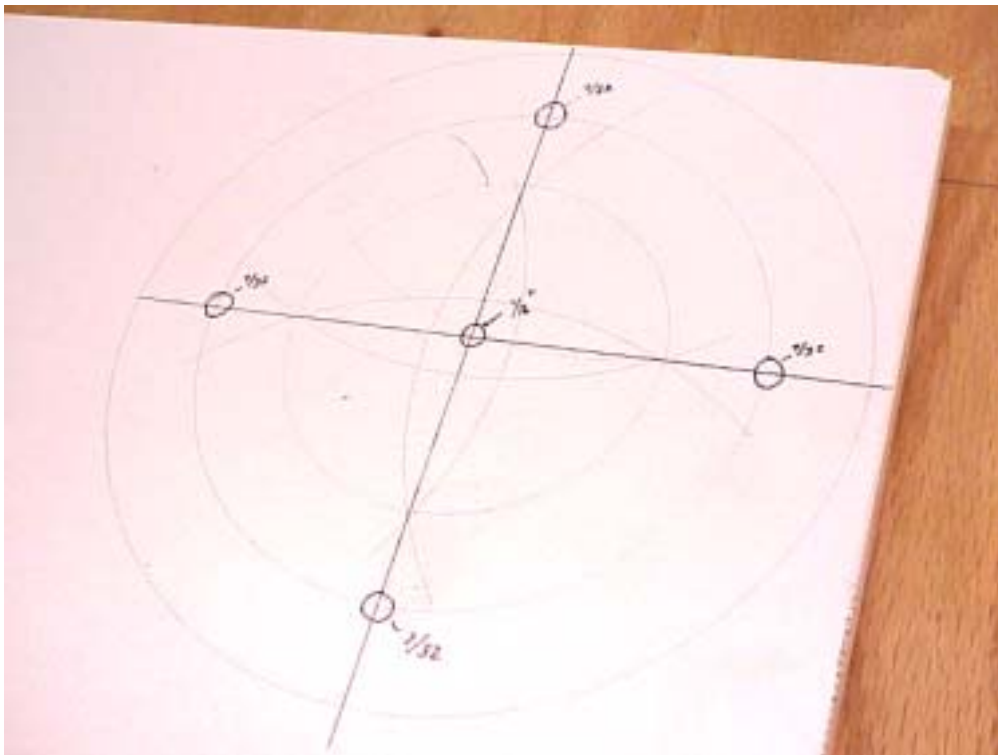


Figure 3-23: Layout of Stator Ring

- 2) From the center, draw three circles, 4, 6 and 8 inches in diameter.
- 3) Where the 6 inch circle and perpendicular lines intersect, drill 7/32 inch holes.
- 4) Drill a 1/8 inch hole at the center.
- 5) On the routing board, adjust the cutting depth to just more the half the thickness of the board. Remember we do not want to try and cut all the way through on the first try because this is not safe.
- 6) Using the hole located at 4 1/8 inches from the center cut the disk as specified in section 3.3.1. You will end up with an 8 inch (diameter) cleanly cut disk as shown in the following photo.

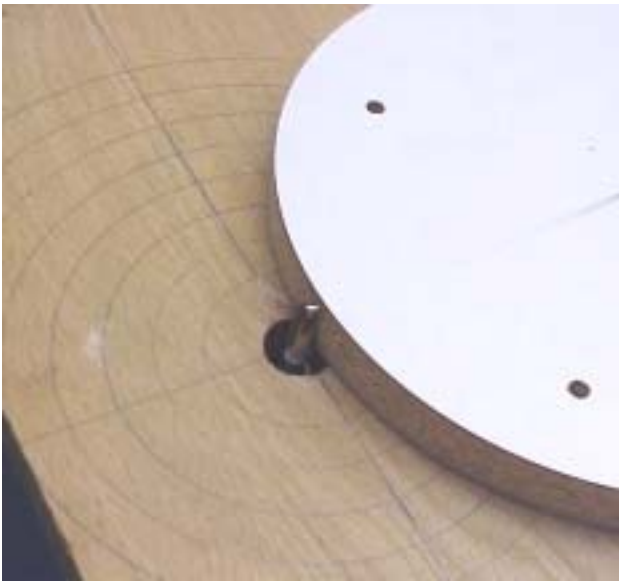
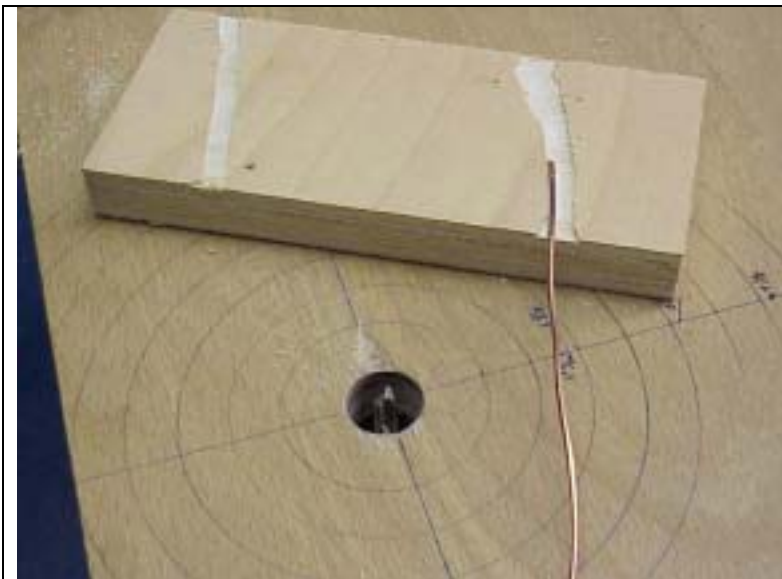
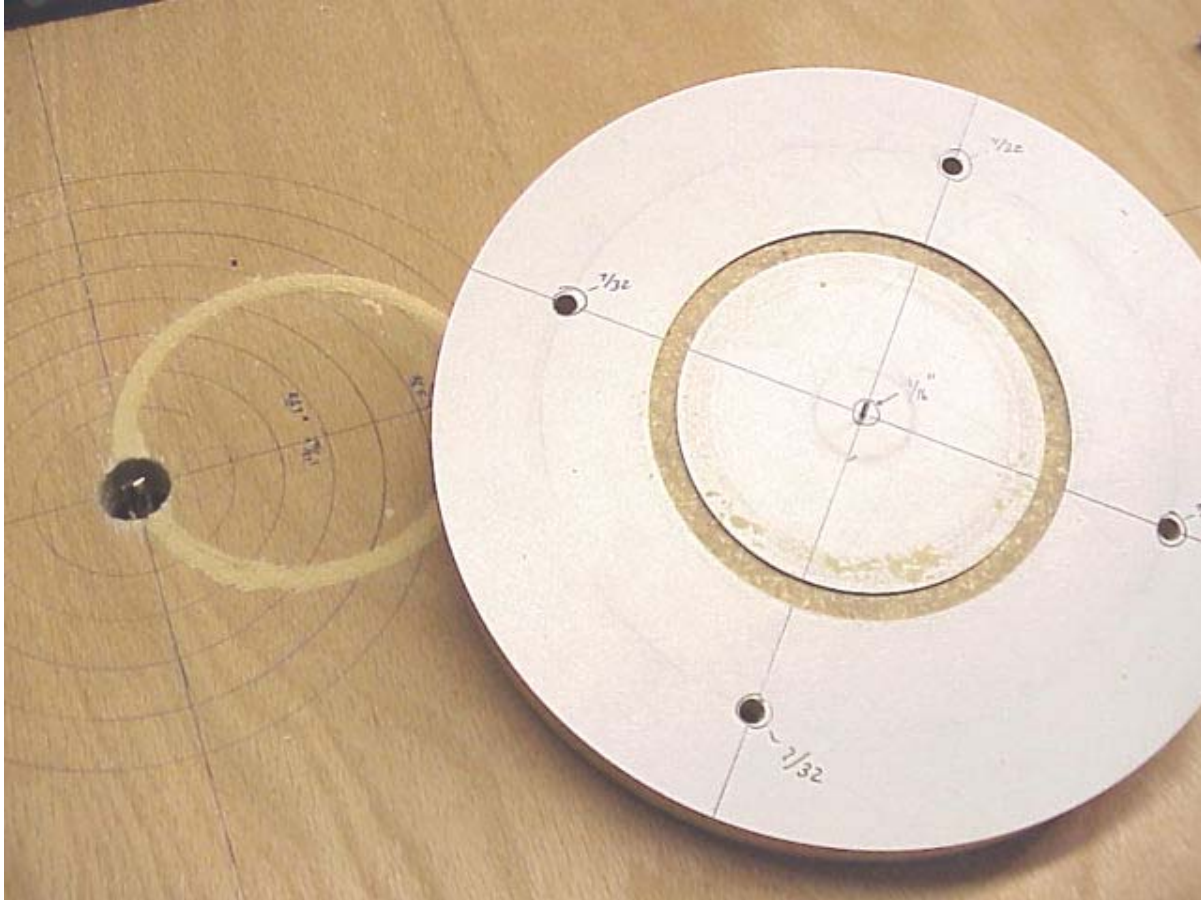


Figure 3-24: the 8 inch disk



7) Set the cutting depth to $\frac{1}{2}$ the diameter of the bare 14 Gauge wire. Use scrap wood to test the cut depth and adjust accordingly.

8) With the depth set to $\frac{1}{2}$ the wire thickness, we are going to cut the wire channel that holds the conductive ring. This operation only needs to be done on the top side of the disk (it is ok if you accidentally do both sides). Using the hole that is $1\frac{7}{8}$ inches from the center; cut the wire channel. You should obtain the result shown below.



- 9) IN THE FOLLOWING STEPS WE SHOW A NON-STANDARD CUT used to remove the center of the disk. PLEASE READ ALL OF THESE STEPS (9-14) CAREFULLY BEFORE ATTEMPTING.
- 10) Set the cut depth of the router table to about $\frac{1}{16}$ inch LESS THAN HALF the thickness of the board. For a $\frac{3}{4}$ inch board this works out to $\frac{5}{16}$ of an inch. It is OK if the cut depth is slightly smaller.
- 11) Using the $1\frac{13}{16}$ hole, cut a trench in the top of the disk as shown in the following photo.

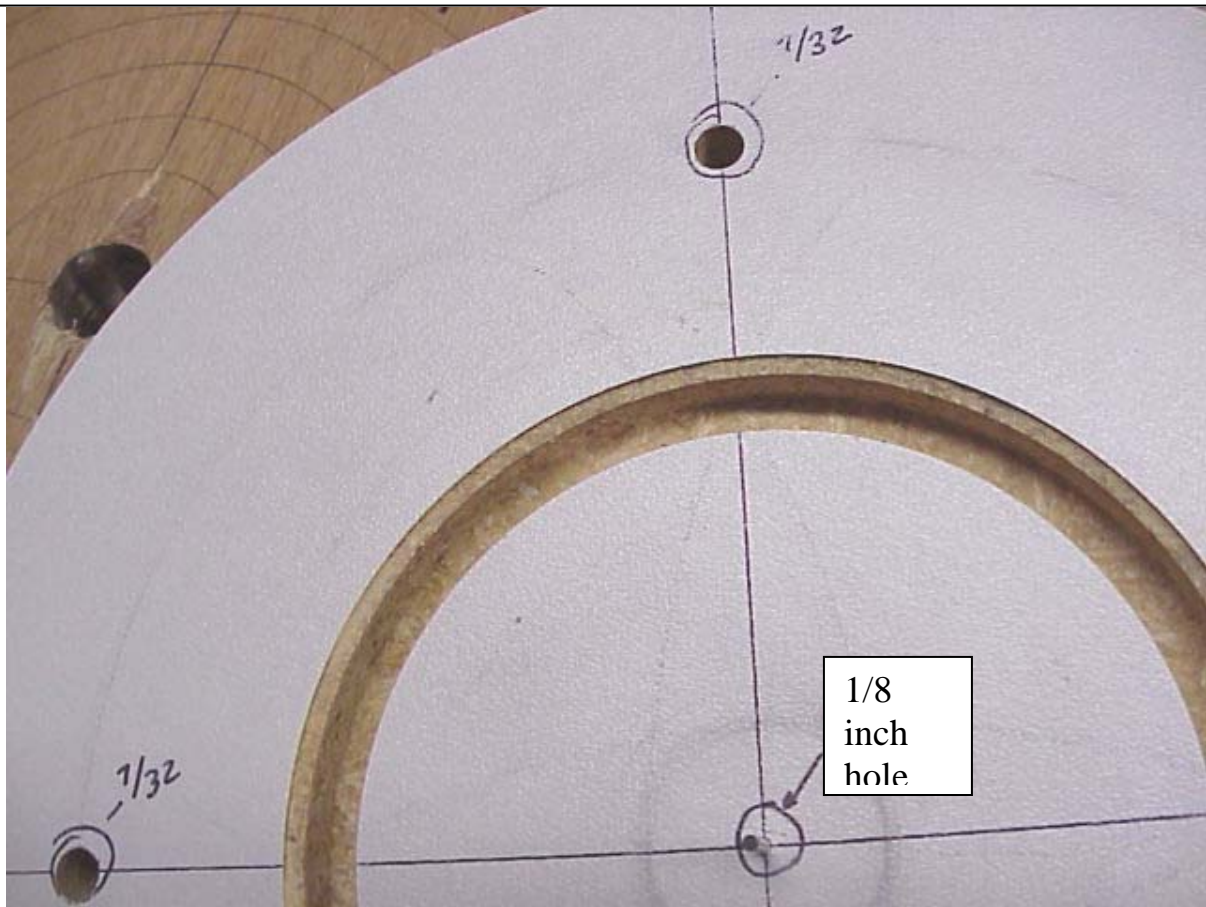


Figure 3-25: Cut trench into wire track

12) Flip the disk over and cut the other side. Turn off the router and remove the part.



13) To remove the center disk, use a flat head screw driver and hammer to gently break through the remaining material in the trench.

Discard the center portion.



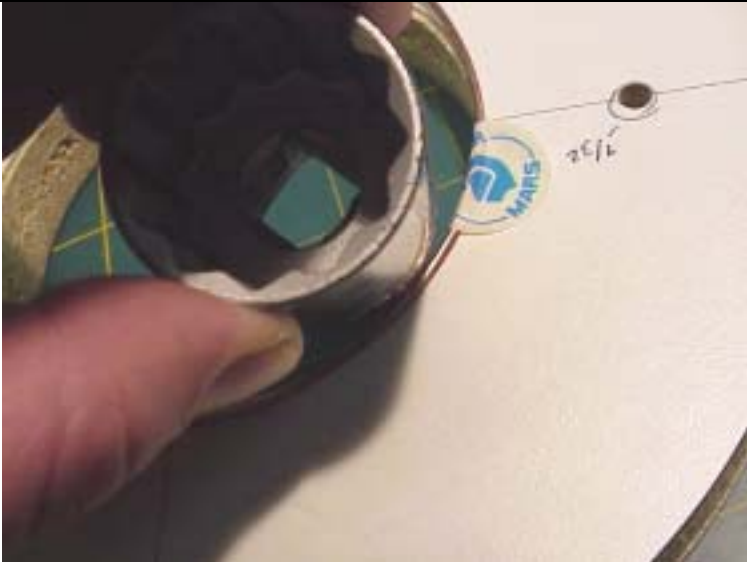
14) With a hobby knife carefully trim the remains.



15) get your contact cement and bare 14 AWG wire (strip the insulation)



16) Apply a thick bead of contact cement to the wire channel and allow it to set according to the instructions.



17) Apply the wire to the channel using a large socket (from a socket wrench set) as a “circular” hammer.

Copper is a wonderful material. Gently tap it into the channel and it will take the shape of the channel.

Hold in place with tape as you go along.



18) Where the wire meet snip carefully



19) This is what you should get.

DO NOT SOLDER THE JOINT YET.



20) Place a flat board on top of the wire ring and weight it down with at least 20 pounds.

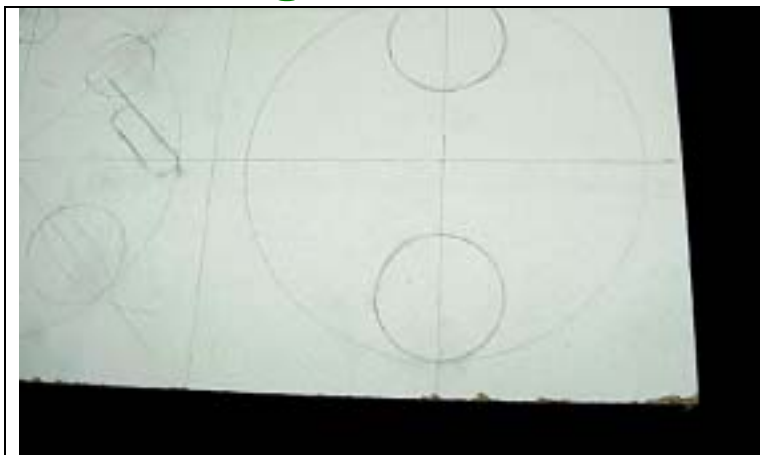
LET this cure according to the length of time specified by the contact cement manufacturer.



21) Once cured, solder the joint and smooth out with a fine file.



Set the Stator Ring aside.

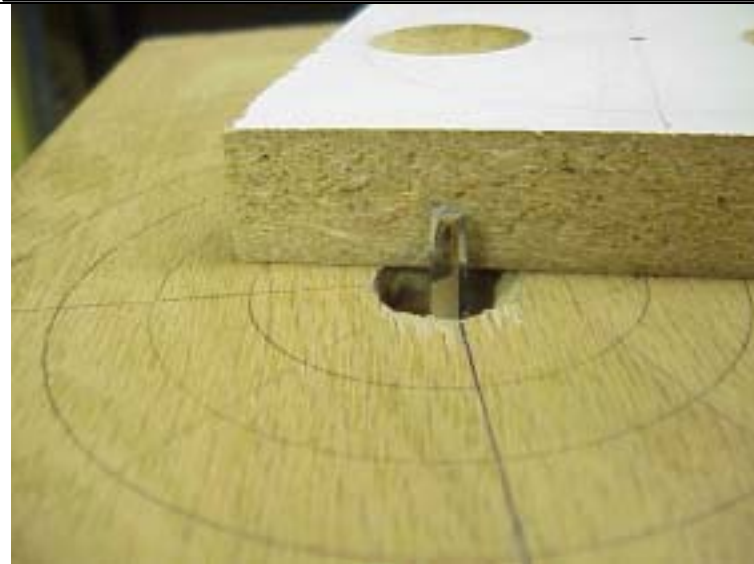
3.5 Milling the Rotor Disk



Note: we are creating another disk to the left

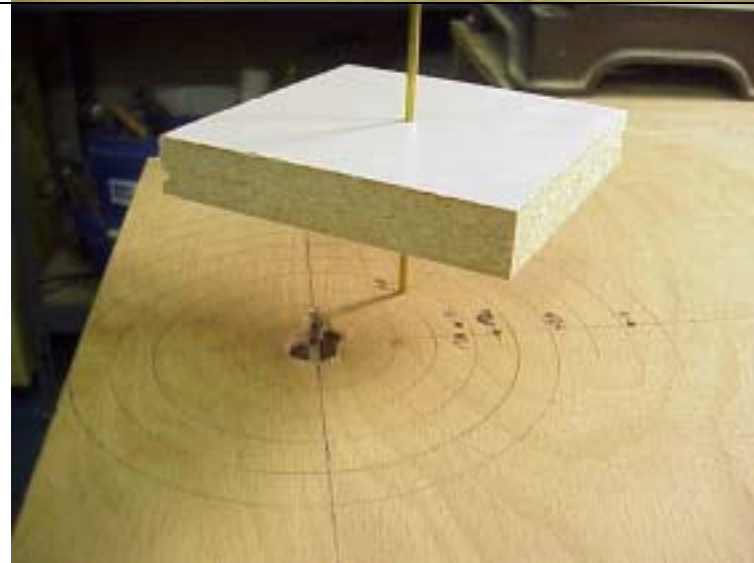
1) Obtain the 4.5 inch wide board that was cut earlier. Draw a line 4.5 inches from the end to make a square area. Find the center of the area and create two perpendicular lines from the center. Using your compass draw a 1-15/16 diameter circle. Use the magnets as templates to draw the magnets holes.

No Photo	2) Drill a 1/8 inch hole at center position.
No Photo	3) Remove the router from the routing table.
	4) Set Plunge depth of router to the thickness of the magnets. A simple way to set the depth correctly is to place the magnets under the router and depress the bit until it touches the table.
5) Clamp the board to the table to keep it from moving. Then freehand route out the magnet holes. Be careful!	6) Check the magnets to see if the fit into the holes.
	7) Cut the square from the rest of the board. Note: We made another board (left) in order to test out other magnet shapes.



8) Put router back into routing table and set cut depths to just more than $\frac{1}{2}$ the board thickness.

SAME INSTRUCTIONS FOUND IN Section 3.3.1



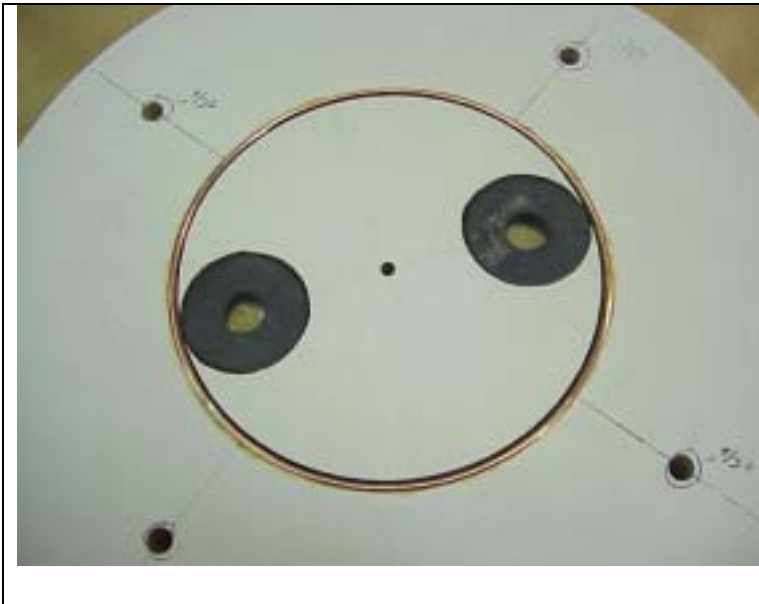
9) Using a $\frac{1}{8}$ inch rod, and the $2 \frac{1}{32}$ inch hole, mill out one side.

SAME INSTRUCTIONS FOUND IN Section 3.3.1



10) Flip over and repeat the other side.

SAME INSTRUCTIONS FOUND IN Section 3.3.1



Finally, make sure that the disk (with magnets inserted) can fit into the Stator Ring.

If the disk is too large then make a new hole position in the routing table and trim the disk. You may have to cut a new set of magnet holes (use the opposite side of disk as top or make entirely new disk if you are a perfectionist like us)

3.6 The Upright Wire Hide (Optional)

This optional step is used to cut a channel in the top of the upright to hide the wires that drive the motor. See Figure 3-26.

- 1) Set the routing table cut depth to about $3/16$ of an inch. Then clamp a yardstick, or some other strait edge, $1/4$ inch away from the blade ($3/8$ inch a way from center of blade).
- 2) WE ARE GOING TO CUT FROM THE FRONT TO BACK
- 3) Locate the entry point with a marker on the top left side 1 inch from the front. This is where the wire channel will begin.
- 4) Place the upright, top edge down, on the router table with the entry point facing the blade. DO NOT START ON THE BLADE.
- 5) Turn the router on.
- 6) Slide the upright sideways into the blade at the entry point until the upright comes flush against the strait edge.
- 7) The pull the upright along the strait edge until the blade exits the back
- 8) Turn the router off
- 9) Place the red and blue 22 inch wires into the track such that 3 inches of wire extend from the front hole.
- 10) Tack the wire in place with hot melt glue at the entry an exit points

Set this part aside for now.

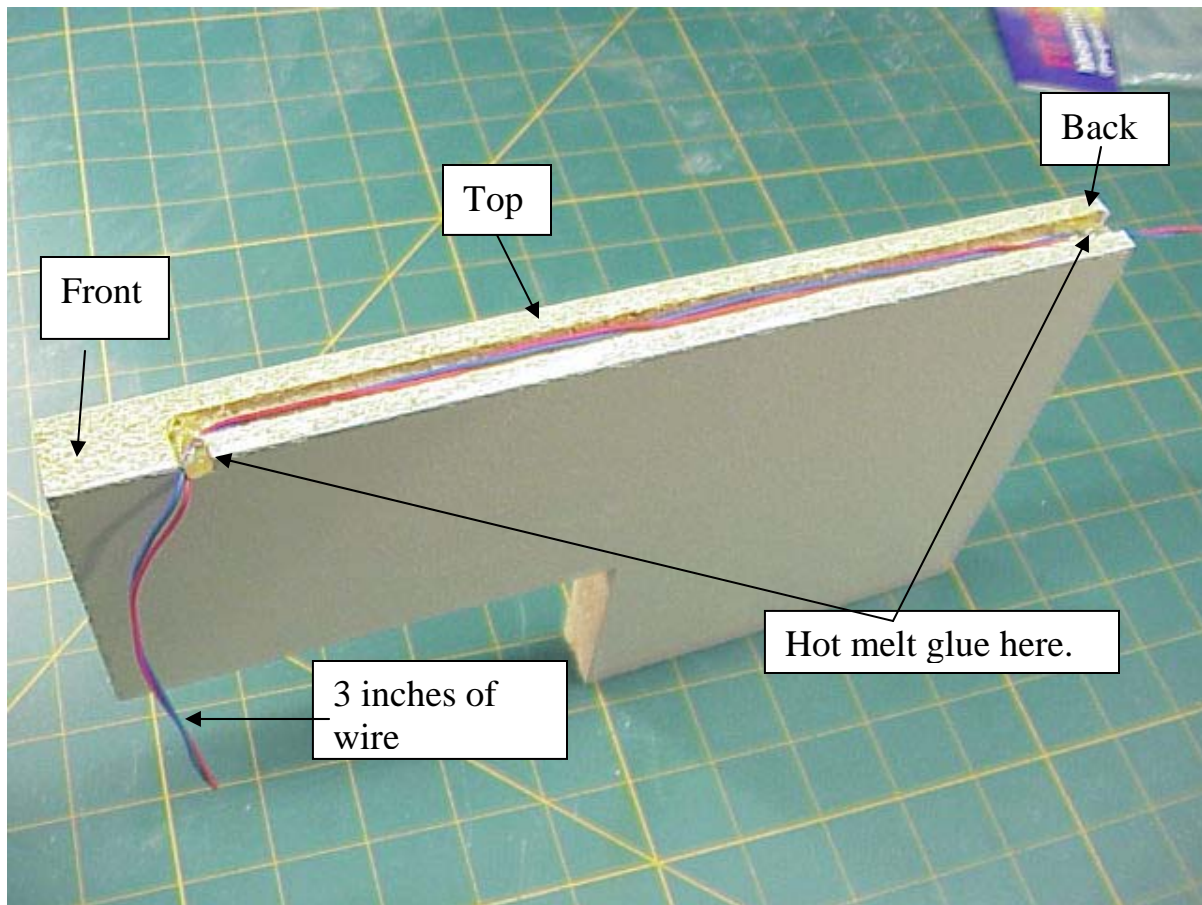


Figure 3-26: Wire hide

3.7 Edging (Optional)

In this step we apply melamine edging to give the project that professional look.

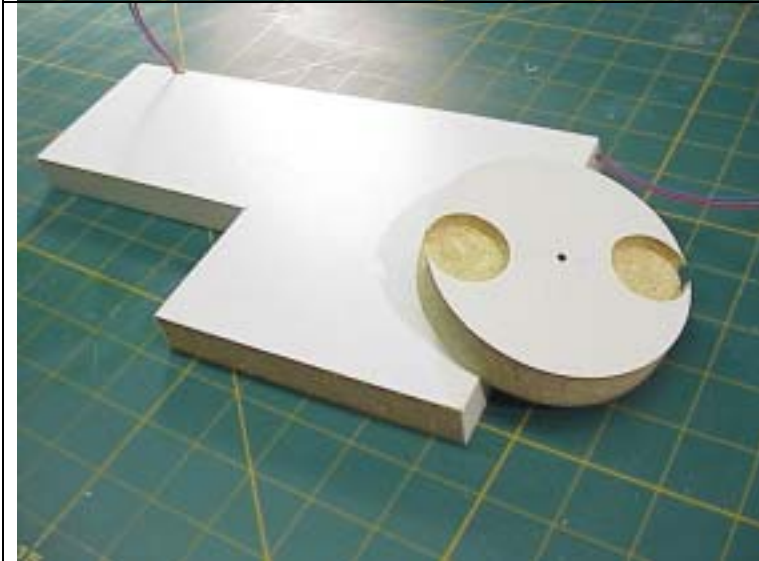
Note1: Melamine edging is always too wide for the material that you are edging. When applying, align one side and trim the other side with a hobby knife.

Note 2: The edging material is ironed on with a clothes iron. Since irons vary in temperature, you may want to practice on the discarded melamine sections in order to discover the proper setting for your iron. For our iron we use the middle setting.

Note3: In case your edging material is different than ours, please follow the instructions that come on your edging material package.



1) Apply edging to Base Plate edges and outside edge of Stator Ring.



2) Apply edging to all sides of upright except the bottom.

3) No edging for the Rotor Disk.

3.8 Completing the Rotor

1) From the flat brass stock (1/4 inch wide by 1/32 inch thick---raw part #4) cut two Rotor Brush Vanes as shown in Figure 3-27.

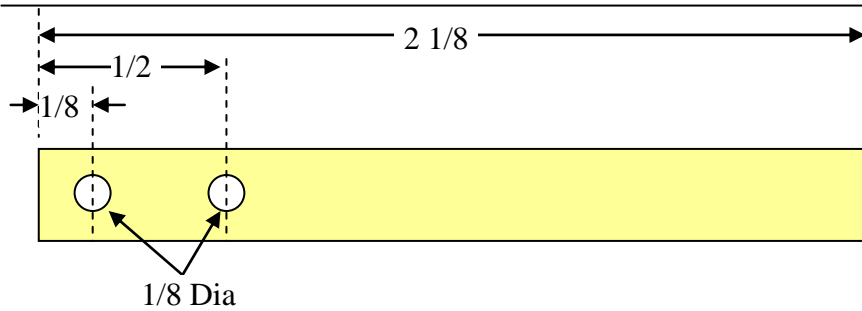


Figure 3-27: Rotor Brush vanes

2) Using a $\frac{5}{64}$ inch drill bit drill 5 holes in the top of the rotor as shown in the next photo (Figure 3-28).

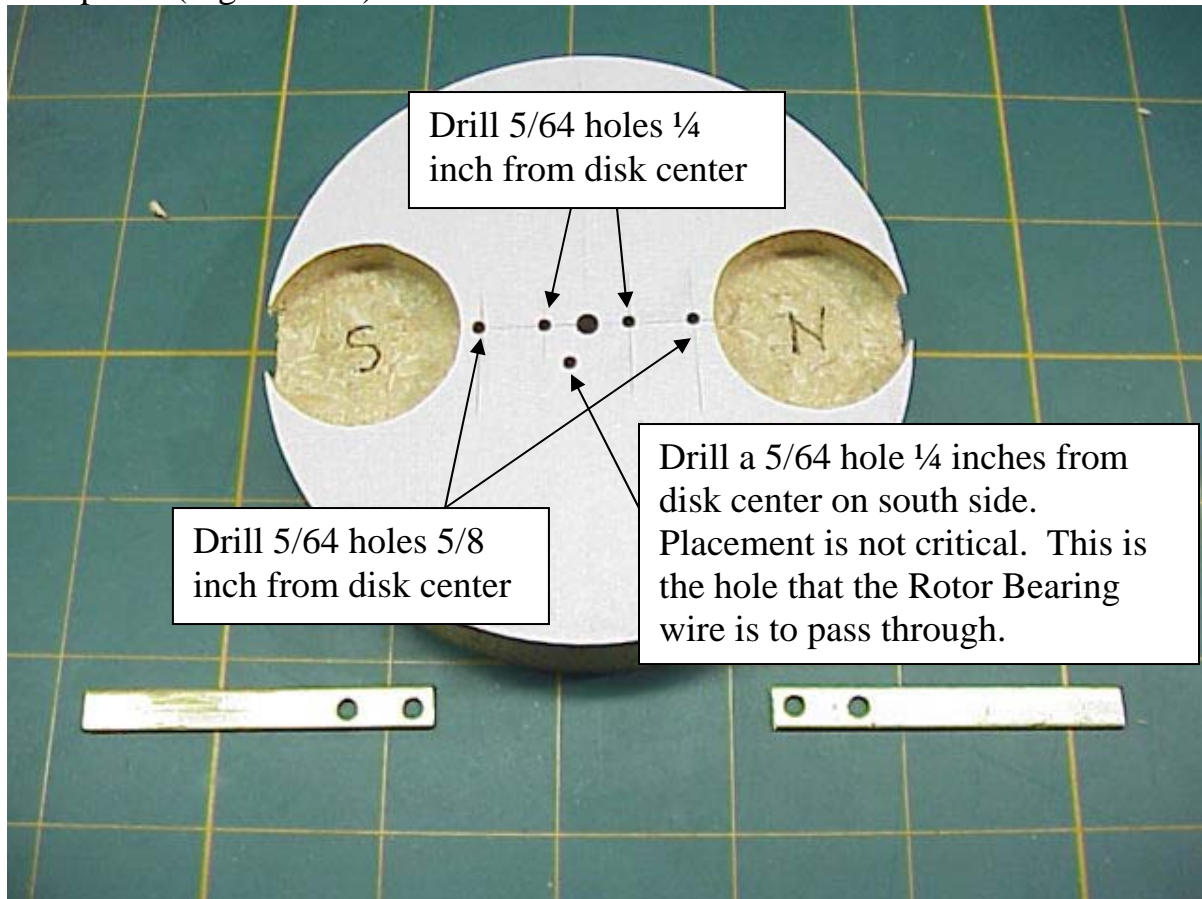


Figure 3-28: Drilling and marking Rotor top

3) insert the magnets; then, using four #4 $\frac{3}{8}$ inch sheet metal screws, attach the vanes to the rotor as shown in the following Photo

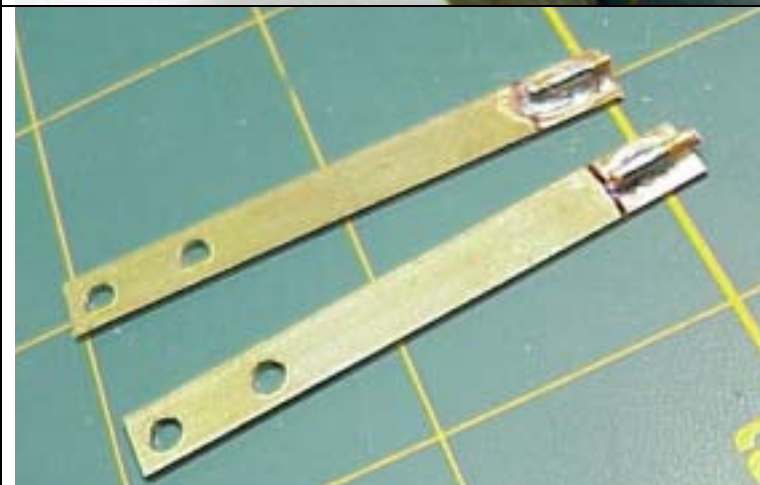


4) Mark the vanes to keep from mixing them up.



5) Flip the disk over and mark each vane as shown. This marks the available space on the end of the vane.

6) Remove the vanes

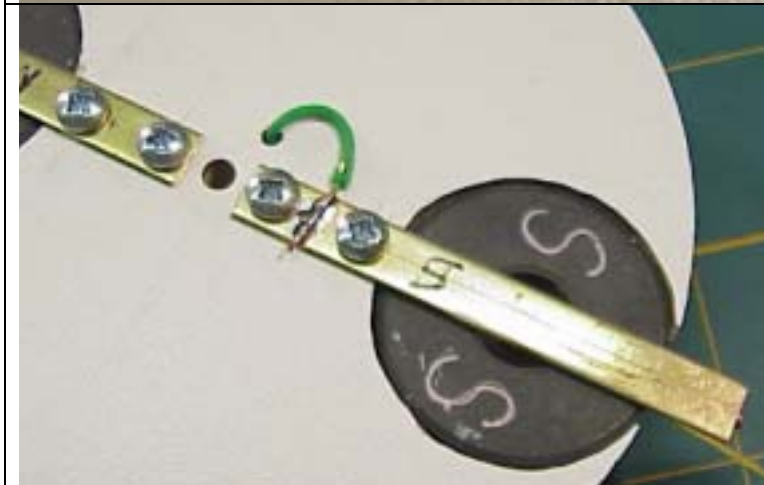


7) Solder a short length of 14 AWG wire on the end as shown making sure not to touch the line.

The thickness of the sharpie marker is adequate clearance.



8) Insert the Rotor Bearing curved (banded) end out into the bottom center hole of the rotor. Gently tap it in with a hammer. Then feed the wire through the hole as shown.



9) Reattach the vanes and solder the wire to the south vane as shown. Note: Trim the wire to correct length before soldering.

Set the rotor aside for now.

3.9 Base Plate Assembly

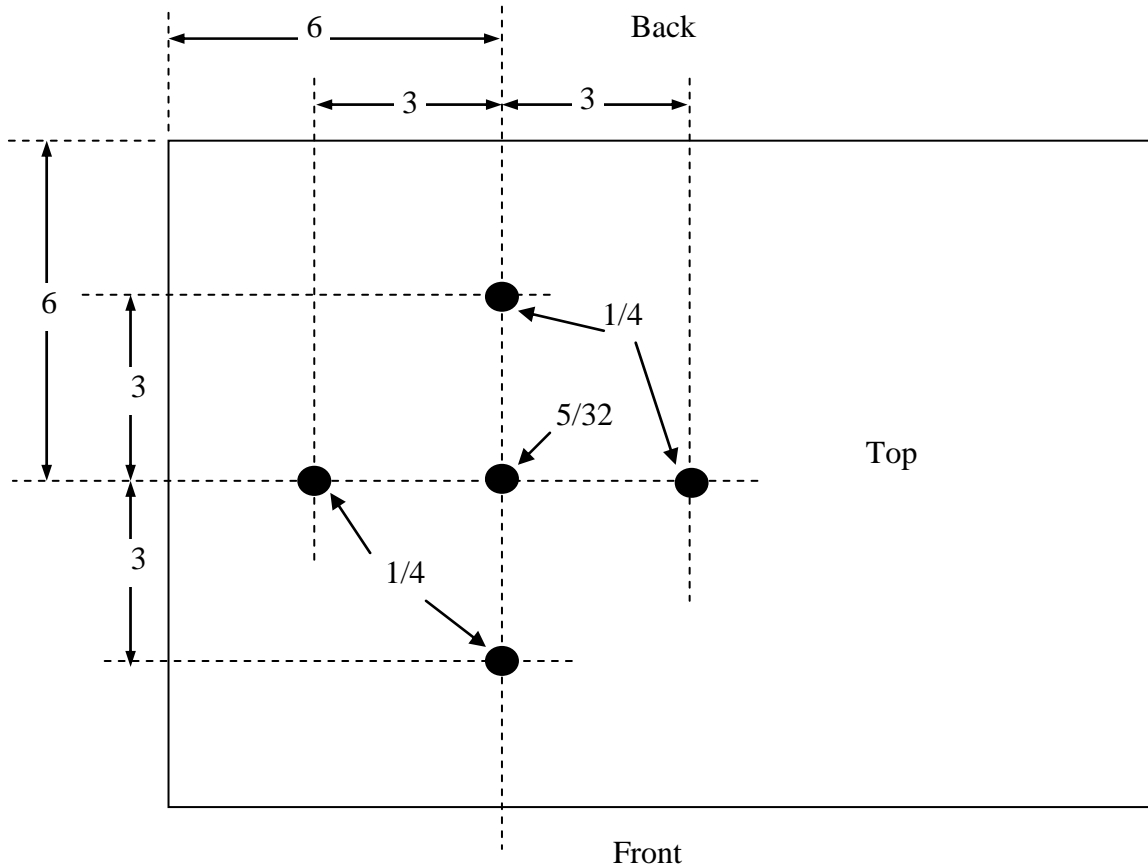
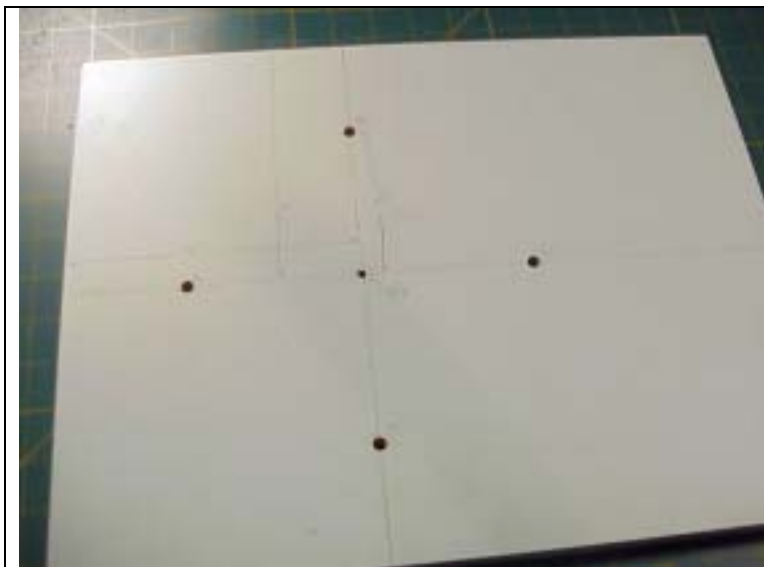


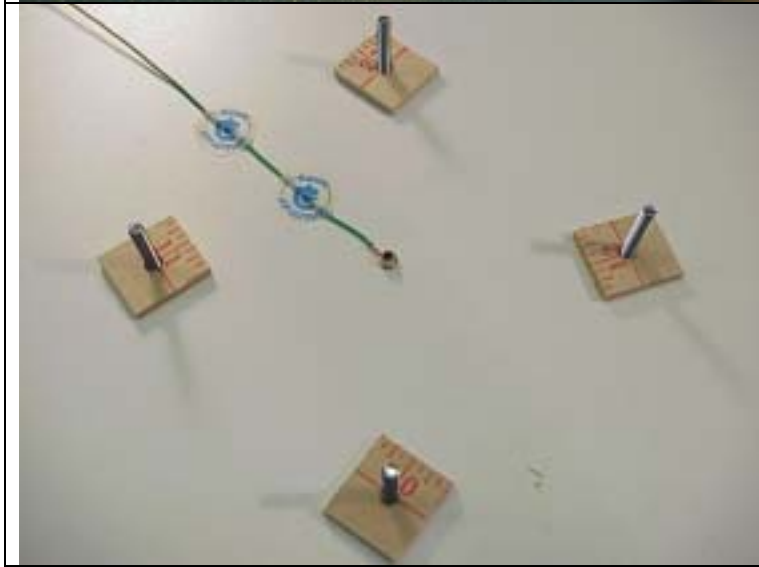
Figure 3-29: Drill Holes in Base Plate



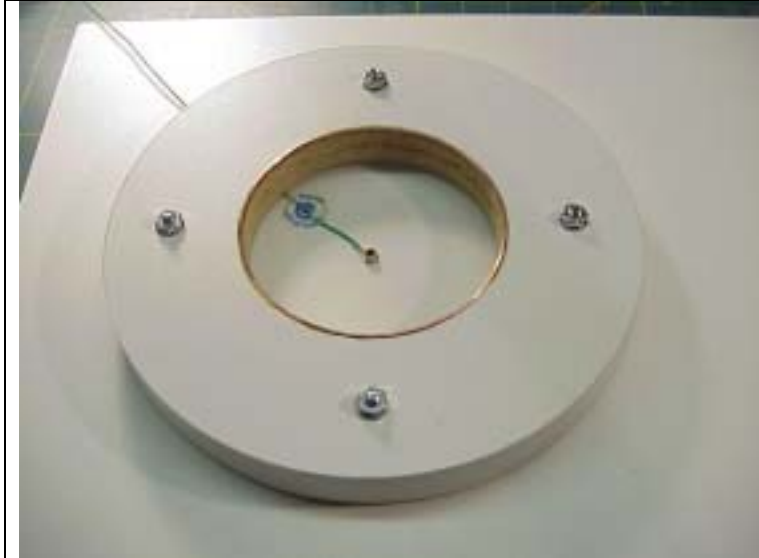
1) Drill holes in the base plate as specified in Figure 3-29



2) Flip the board over and apply cushion feet to the bottom.



3) Flip the board top up again.
4) Gently tap the Stator Bearing into the center hole and tape the wire lead off to the back left corner.
5) insert four #10-24 x2" machine screws (WITH WASHERS) through the bottom.
6) Make 4 spacers from Wood yardstick and place them as shown.

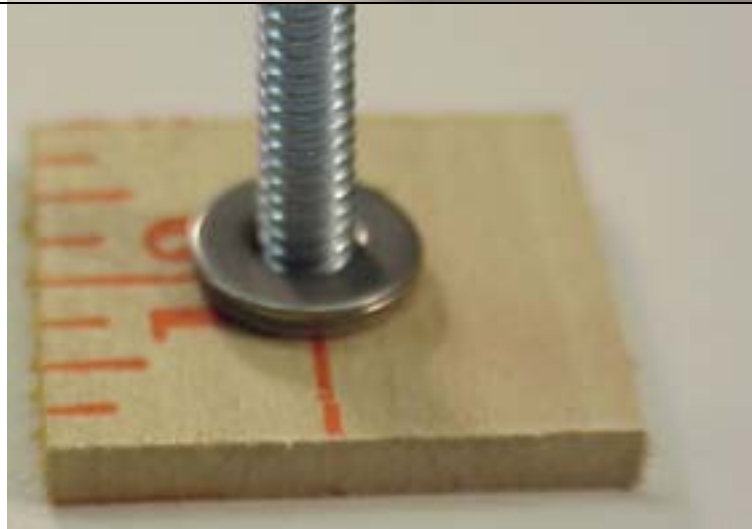


7) Place the Stator Ring over the four screws and GENTLY (use finger force only at this time) fasten with washer and hex nut.



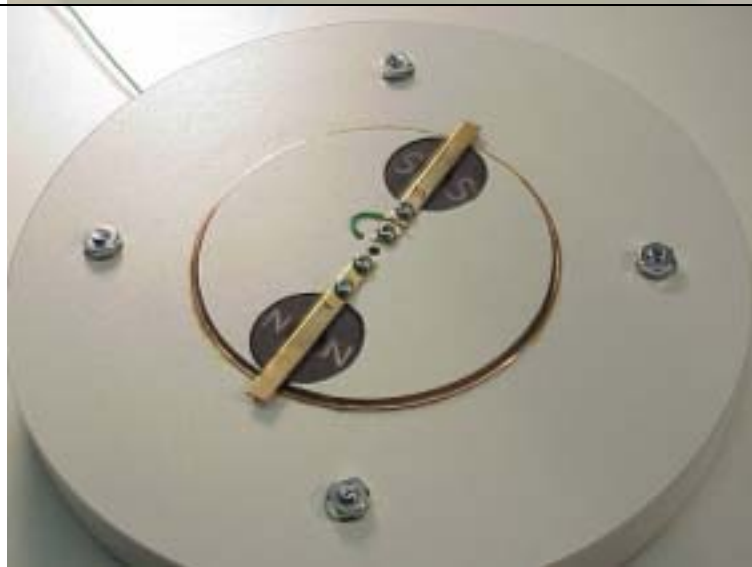
8) Insert the Rotor and observe the distance between the copper ring and the brushes.

9) Remove the rotor and the Stator Assembly



10) With the Stator Assembly removed, add #10 washers to make up the distance.

NOTE: IT IS BETTER TO HAVE ONE TOO MANY WASHERS THAN NOT ENOUGH. The wood spacers are compressible; therefore, any extra height can be adjusted (To be explained later)



11) Replace Stator and Rotor. **DO NOT CLAMP DOWN** on the Hex Nuts. This may over compress the wood spacers. Tighten the hex nuts with your fingers for now. We will explain how to adjust them properly at a later time.

3.10 Motor and Upright Assembly

Selecting the proper motor/gearing combination for the Paradox 2 is difficult. The main reason for concern is the rotor brushes which drag along the outer stator ring. These brushes require a lot of torque to overcome the friction.

The original prototype used the TAMIYA high speed gearbox which was set up for 11.6:1 gear ratio (low torque/ high speed). In order to get decent speed, we had to drive the motor from a 6 volt battery. This eventually burns out the motor since the motor is only rated for 3 volts. Since the motors are only a few dollars we always keep replacement motors handy.

For the Production unit we have switched to the TAMIYA planetary gear box which is set up for 16:1 gear ratio. We also replace the 3V RC260 motor which comes with the unit with an RC280 motor which can handle 6V.

In this book we are going to use the Planetary Gear box unit set to 16:1 with the original RC260 motor.



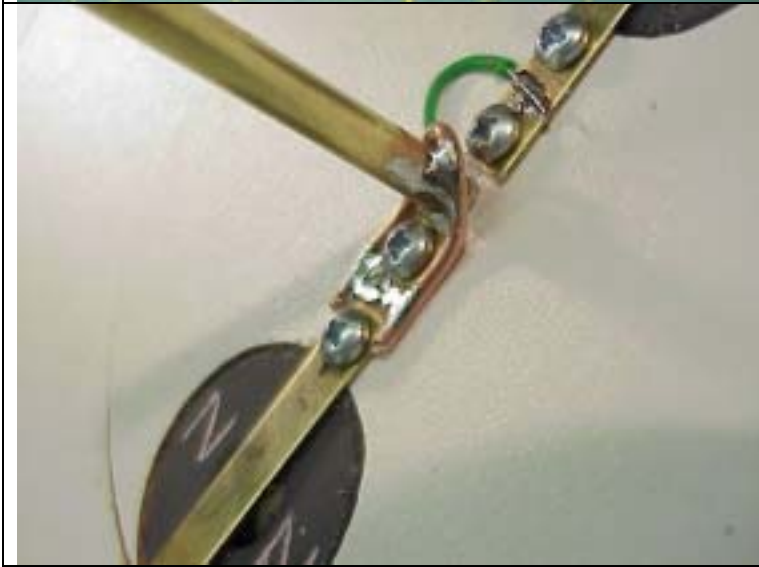
1) Select a motor/gearbox assembly. Assemble according to instructions that come with the unit.

We prefer the Planetary Gear box set to 16:1



2) Test fit the drive shaft to the gear unit. If you select the planetary gear box unit you will have to trim the end of the shaft in order for the shaft holes to align.

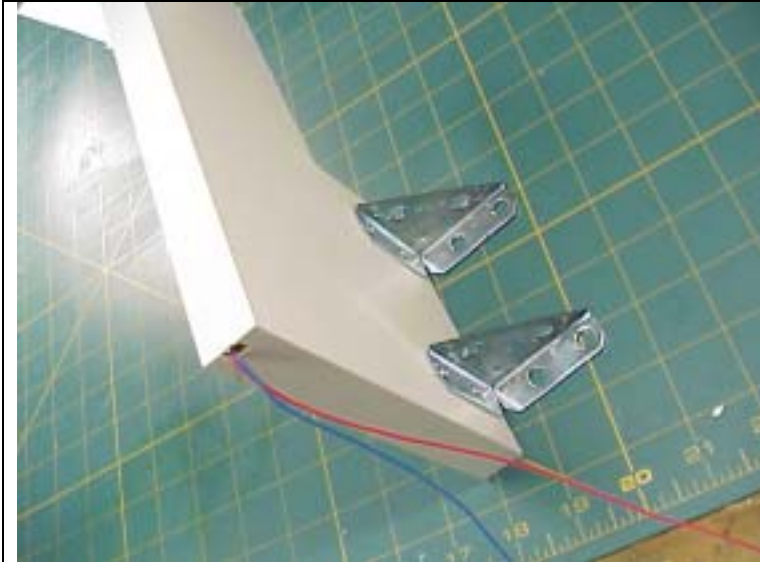
Tap the TAMIYA gear box shaft hole for a 3-30 machine screw. If you can't get a 3-30 tap then use a 3-30 screw as a tap (the shaft metal is soft enough).



3) Remove the shaft from the motor and insert into the rotor. Use a length of 14 AWG copper wire and form it as shown at left. Solder it to the north Brush vane between the screws and to the drive shaft only on the sides. Soldering it in these locations leaves enough play to adjust by bending. Make sure you clean the spots to be soldered.



4) Using the notched end of a floppy disk, ensure that the drive shaft is as perpendicular as possible. If you need to, gently force the drive shaft to the perpendicular (the copper wire should have enough play to allow small corrections in this manner).



5) Apply Two corner braces to the upright as shown. The hole locations (the screw holes) for the corner braces are 1" from the edge.



6) Place the upright on the base plate as shown (Do not screw it in yet)
7) Insert the motor into the drive shaft and insert the 3-30 screw that holds the drive shaft to the motor.
8) position the upright so it is just touching the motor



9) Insert only one screw as shown.



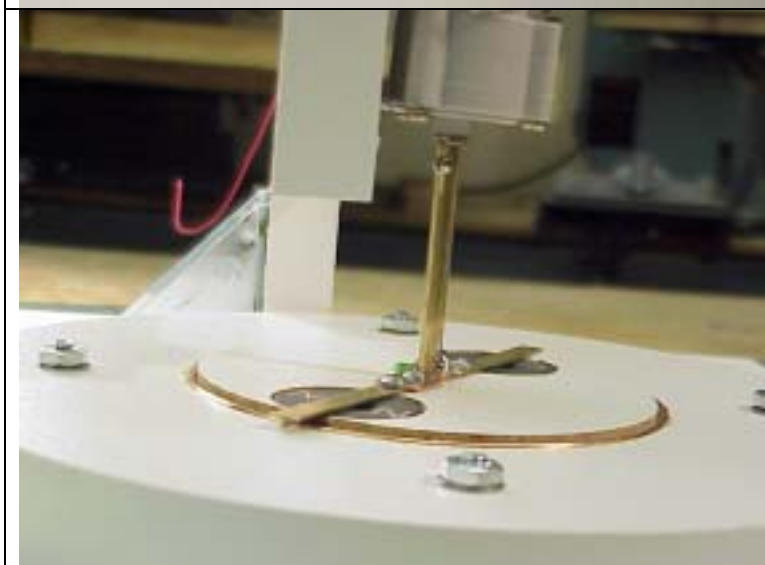
10) With the brush assemblies aligned with the east-west hex nuts, gently slide the motor assembly from east or west until you see even tension in the brush assemblies. Then insert only 1 #4x3/8 sheet metal screw in the middle bottom motor mount (see next photo). You should be able to rotate the rotor 180 degrees and still see even tension. If you do not then your drive shaft is not perpendicular.



11) Align the brushes with the north south screws (as shown) then pivot the upright about the screw that we inserted in step 9 until you see even tension in both brushes. You should be able to rotate the drive shaft 180 degrees and still see even tension; if not, then the drive shaft is not perfectly perpendicular.



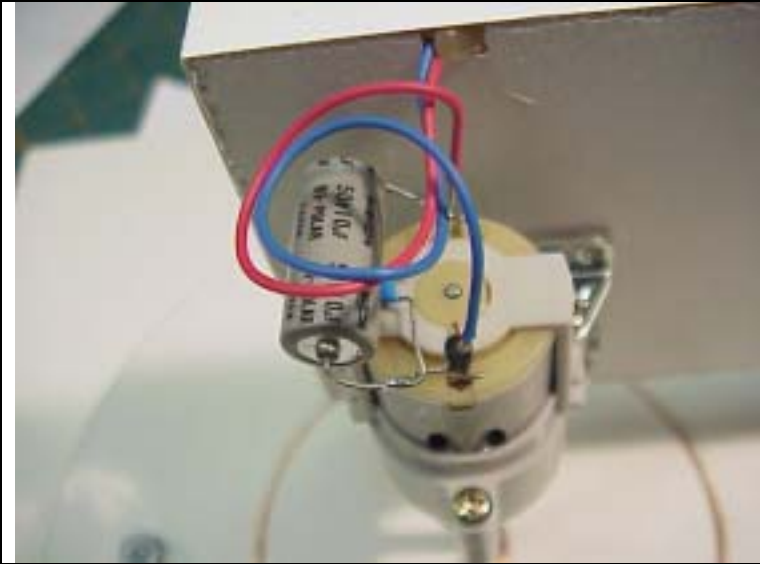
12) After you have been able to establish even brush tension in the north-south directions, then we know that the upright is in the correct pivot position. At this time Insert the second screw as shown.



13) At this point you should be able to rotate (by hand) the disk and not see perfect alignment all the way around. If not, identify the misalignments and correct them.



14) Once the misalignments have been corrected, then insert the remaining screws. **Notice the shim inserted under screw number 4.** Mark the screws in the order that they were installed. This will enable you to re-install the screws in the correct order should you need to take the upright off.



- 15) Remove the factor wires from the motor.
- 16) Attach (using wire solder) the upright wires to the motor.
- 17) Solder a 10uF bipolar electrolytic and 0.1 uf monolithic capacitor across the motor terminals.

The capacitors help reduce brush transients.

3.11 The Drive Shaft Brush Assembly

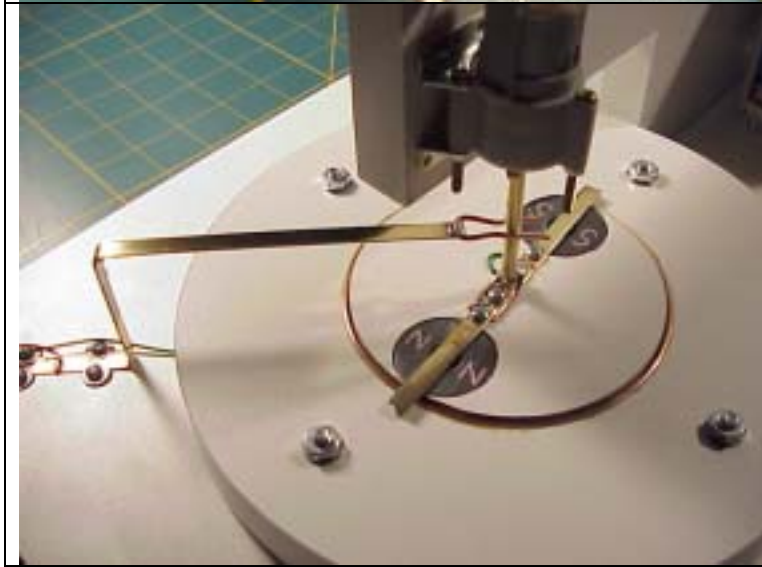


- 1) From the flat brass material, bend an 8 inch section as shown.

2 inches along bottom
2 Inches up
4 Inches along top



2) Fashion a “clip” from 14 AWG wire that will “clip” onto drive shaft. Then solder it to end of top.



3) Slide it into opposition



4) Then attach it with four #4 x3/8” sheet metal screws and four #10 washers.

5) Solder a 10 inch length of 22 AWG wire (red insulation) to the section between the screws as shown.

7) Twist the red and green wires together.

3.12 Adjusting Tension

The hex nuts located on the Stator were simply hand tightened in the previous sections. With only hand tightening, the wood spacers are uncompressed and the Stator Ring should ride high and actually lift the Rotor Brushes as shown in the following photo. The distance of the lift (prior to adjustment) should be about the thickness of 1 washer between the rotor surface and underside of brush vane at the edge of the rotor. This lifting of the Rotor Brushes we will call TENSION for the sake of simplicity. The more tension there is, the better the contact between the brushes and the wire loop; and, the more friction that the motor must overcome.



Figure 3-30: Stator Ring tension before adjustment

When we are done adjusting the brush tension, the brushes will just barely be lifted by the ring as shown in the following photo.



Figure 3-31: Proper brush tension

The following is the procedure for adjusting the brush tension

- 1) Align the brushes with the east-west (left-right) hex nuts.

- 2) Adjust east and west hex nuts until you can barely detect tension in either brush assembly
- 3) Rotate Rotor 180 degree and check tension again.
- 4) If you need to, then back off a hex nut to ensure there is some tension.
- 5) Repeat steps 1 through 4 for the North -South positions.

3.12.1 DVM continuity check

- 1) Connect a DVM in continuity check mode across the red and green (output) leads.
- 2) Gently rotate the rotor to check that the brushes always make contact.
- 3) If at anytime you lose continuity then press down on each brush with your finger to identify which brush is riding high. Mark this position. It represents the beginning of a dead spot. Then continue rotating the rotor until continuity is reestablished. Mark this as the end of the dead spot. Move the rotor to the center of the dead spot and then back off the closest screw* until continuity returns.
- 4) Repeat steps 1 to 3 until all dead spots have been eliminated.

* If the center of the dead spot is between two screws then back off the two screws slowly, equally and simultaneously. Use your best judgment.

Tension is very critical

Too much tension and the motor will have a hard time driving the disk.

Too little tension and the brushes will “hydroplane” on the lubricant (at about 15 rps) and the output of the generator will diminish.

There needs to be just enough tension to resist hydroplaning.

NOTE: As the brushes wear out, you will lose tension (It takes a long time for the brushes to wear so don't worry too much about this).

3.13 Lubrication

Lubrication of the Stator ring is critical to preserving the longevity of the brushes and the driving motor.

Conductive grease is preferred; however, you can make decent grease by grinding up a pencil lead into a small cup and adding a drop or two of household oil. The consistency of the mixture should be that of toothpaste.



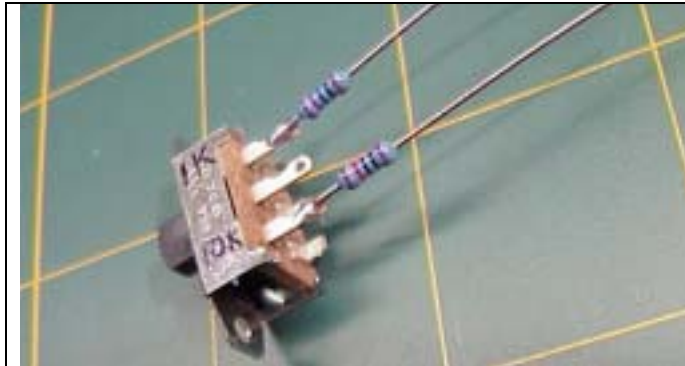
Use a small paint brush to apply the grease around the Stator Ring as shown below.



This grease easily doubles the speed of operation.

4 Measurement ensemble

For a schematic of this circuit and principle of operation, see the paper <http://www.distinti.com/docs/paradox2.pdf>. This circuit allows you to select either a 1K or a 10K shunt (for shunts spurious pickup). In most cases you only need the 10K ohm. The 1K shunt is for noisy environments such as television studios. In these noisy environments, the Paradox 2 will behave as an antenna and pick up a lot of spurious AC interference. Though this AC interference will not be noticed on a DVM, it will cause the trace of an oscilloscope to become very fuzzy. The 1K shunt selection will greatly reduce the fuzz by shunting this spurious energy.

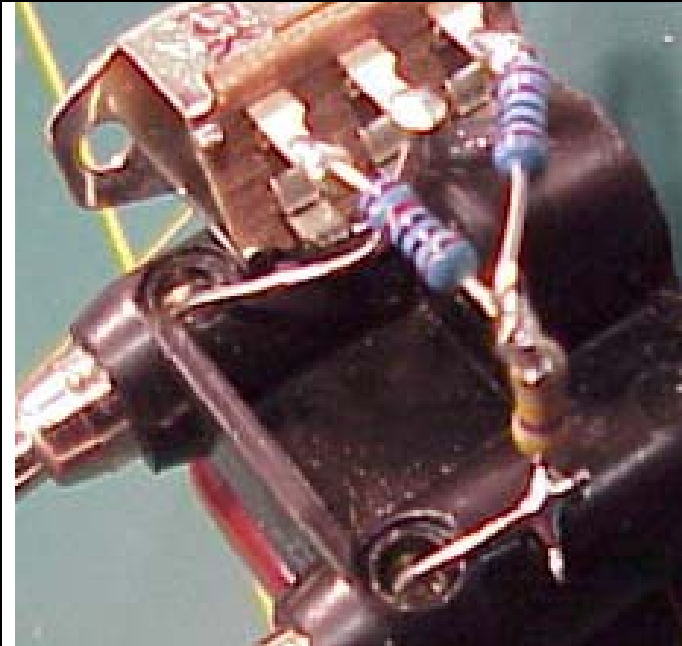


1) Solder a 1K ohm and a 10K ohm resistor to a single pole double throw switch.



2) Clamp a 0.33uF Polypropylene capacitor into the terminals of a dual banana plug.

You must use a polypropylene capacitor. Other types develop thermal emfs that can cause faulty readings. See our paper http://www.distinti.com/docs/cap_and_m.pdf for more details.

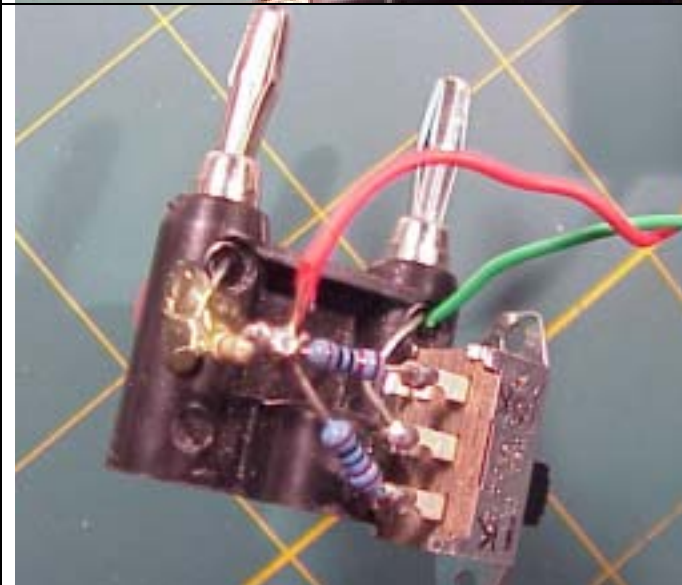


3) Hot melt glue the switch to the plug on the side marked GND.

4) Solder the lead of the capacitor on the GND side to the switch common.

5) Solder the other lead to a 470k resistor.

6) join all resistor leads together as shown.



7) The Green lead from the Paradox 2 is then clamped into the GND side terminal with the GND side capacitor lead.

8) The Red lead from the Paradox 2 is soldered to the junction of the three resistors.



Use a DVMx1000 to amplify the output of the Paradox 2 such that a DVM or Oscilloscope can display the signal.

5 Operational Notes

The Paradox 2 requires a lot of torque from the little motor; as such, the motor needs to be driven from a 6 volt source in order to develop enough torque and to overcome the friction and develop enough speed. There are a number of things to keep in mind:

- 1) The motor that comes with the gear boxes that we have specified are only rated for three volts; therefore, in order to extend the motor life, do not run the Paradox 2 for extended periods.
- 2) The motor in the original Paradox 2 lasted through 15 demonstration sessions (over a 4 month period) where the attendees were encouraged to operate the device themselves after the formal demonstration. We always bring extra RC260 motors and tools just in case.

We will update this section as we learn more.

6 Your comments are welcome

If you find errors or confusing sections of this document, please contact us using the following email address:

build_pdx2@distinti.com

We will update this document at reasonable intervals with any information that we get.

Also, if you would like to share your variations of the Paradox 2 with the world then please send pictures and text. Just do not send us any proprietary or confidential information.

Appendix A. Consolidated Parts List

Note 1: Blinn's is a store that caters to RC modelers and train enthusiasts.

Note 2: The primary source for all parts is a home improvement/hardware store unless specified otherwise in the "Store" column.

#	Qty	Description	Manufacturer/ supplier Part Number	Store	Notes
1	1	BRASS 1/8 dia inch solid rod	K&S Engr Stock #164	Blinns	
2	1	BRASS 5/32 (OD) 1/8(ID) tube	K&S Engr Stock #128	Blinns	
3	1	BRASS 3/16 (OD) 5/32 (ID) tube	K&S Engr Stock #129	Blinns	
4	2	BRASS 1/4 in width 1/32 in thick flat stock	K&S Engr Stock #240	Blinns	
5	1	Melamine Board (or plywood) 3/4 inch thick approx 12 inches width approx 26 inches length	Melamine shelf from shelving section is what we use since it is finished on all sides		
6		Solder Weld from Radio Shack or Solder paste used in surface mount	Radio Shack 64-029	Radio Shack	
7	3 in	Wire Solder		Radio Shack	
8	80 in	22 AWG SOLID wire (colors are optional) --10 in. Green Figure 3-16 --15 in. Green Figure 3-16 --22 in. Blue --22 in. Red --10 in. Red		Radio Shack	

9	20 in	14 AWG SOLID wire --13 in. for Stator Ring -- 5 in. for drive shaft brush -- 1 in. for Rotor Brushes			
10	1 oz	Contact cement			
11	Roll	Melamine edging (optional)			
12	1	Plywood ¾ x 18 x24 inches (Smooth surface both sides)	For routing board		
13	4	Wood yardsticks			
14	1 set	Router mounting hardware for mounting to routing table. (depends upon you router)			
15		Clamping hardware to clamp routing board to bench top. We used two drywall screws.			
16	2	1000 amp disk magnets	Radio Shack	Radio Shack	
17	5	Rubber (cushion) feet	Radio Shack 64-2342	Radio Shack	
18	2	Corner Braces	Stanley 75-5550/ cd992		
19	1	#3-30 x1/4" machine screw	Mounts the drive shaft to motor shaft		
20	8	#4 x3/8" Sheet metal screws	For Mounting brush assemblies		
21	4	#10-24 x2" Machine screw			
22	4	#10-24 hex nuts			
23	20	#10 washers			
24	1	10uf 10V Bipolar Electrolytic cap	Motor Bypass	Radio Shack	We used 50v
25	1	0.1 uF monolithic or ceramic disc capacitor	Motor bypass	Radio Shack	

26		Graphite pencil lead			#2 pencil will do
27	Few drops	Household oil			
28	1	1K Ohm resistor (any wattage)		Radio Shack	
29	1	10K Ohm Resistor (any wattage)		Radio Shack	
30	1	470K Ohm resistor (any wattage)		Radio Shack	
31	1	0.33 uF Polypropylene capacitor	IT MUST BE Polypropylene otherwise you will get spurious results (see text)	Digi-key	
32	1	Dual banana plug (SPC technology 6-101-B)		Newark Electronics	

Appendix B. Consolidated Tools List

Tool	Notes	Source (if not obvious)	
Hearing and eye protection			
Dremel			
Small cut off wheel for Dremel			
Ruler			
Fine point/needle nose pliers			
Soldering iron			
Fine point Sharpie marker			
Sand paper (cloth backed)	The blue stuff found in plumbing dept for copper pipes is best.		
Empty soda can	Used as sanding form		
Drill or drill press			
5/16 inch metal drill bit			
3/32 inch metal drill bit			
5/32 inch drill bit			
1/8 inch drill bit			
1/4 inch drill bit			
7/32 inch drill bit			
Fine steel wool (no soap)			
Small file			
Hobby knife	(xacto)		
Clothes Iron (Optional)	For applying the melamine edging		
Wood Saw	For cutting the melamine board. (We used table saw)		
Hot melt glue gun (and hot melt glue)			
Plunge Router with capability to mount to routing table			
3/4 inch strait routing bit			

	capable of plunge routing			
	¼ inch strait routing bit capable of plunge routing			
	Assorted screw drivers and hex nut wrenches			
	Drawing compass	A tool for drawing arcs and circles.		
	Small hobby paint brush			