

# **Radial Dirods**

**Kevin M. Dunn**

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## **Radial Diodes**

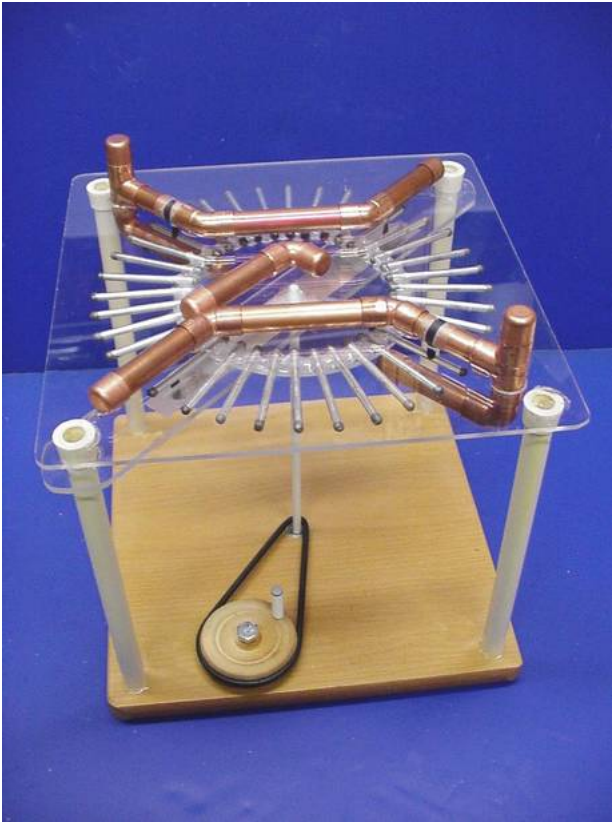
by Kevin M. Dunn

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# Introduction



Certainly one of the finest books ever written for amateur scientists was A. D. Moore's *Electrostatics*, recently reprinted by Laplacian Press, [www.electrostatic.com](http://www.electrostatic.com). This book should be considered a prerequisite to the current text. What you are holding is simply a construction manual. You should consult Moore's book for explanations of the principles of electrostatics. That said, I have tried to make the instructions thorough enough to be followed by someone without access to that excellent text.

Moore introduced to the world a variety of influence machine which he dubbed a *Dirod*, the name stemming from the combination of a *disk* with *rods*. He described two kinds of Dirods, the first having rods perpendicular to the disk, and the second, *radial* Dirod having rods parallel to the disk face like the spokes of a wheel.

I must confess I have become hooked on Dirods. Static electricity generators tend to be at the mercy of atmospheric humidity, but the Dirod is amazingly robust, both mechanically and electrically. While Moore gives instructions for the construction of four Dirod models, it is fun to tinker with the design, trying to get the most out of each system. For myself, I was interested in a design along the following lines:

- The device should occupy a cubic foot or less.
- It should be hand operated.
- It should be easy to build.
- It should be inexpensive.
- It should provide easy connections to accessories.
- It should produce the maximum voltage and current, given the other constraints.

I have made one major departure from Moore's radial design by mounting my disk horizontally rather than vertically. This design provides a little table for adding accessories like capacitors and motors. Wires and connectors are a potential source of corona loss and the horizontal design minimizes the distances to be covered from generator to accessory.

Models #6 was an extremely satisfying and reliable design. Dirod #7 is really nothing more than a big #6 with slight modifications to the inductors and collectors, and 48 rather than 36 rods. Because #7's inductors and collectors are farther apart, its ultimate voltage, and hence spark length, is approximately double that of #6. Model #8 returns to the footprint of #6, but because its collectors are farther apart it has very nearly the spark length of #7.

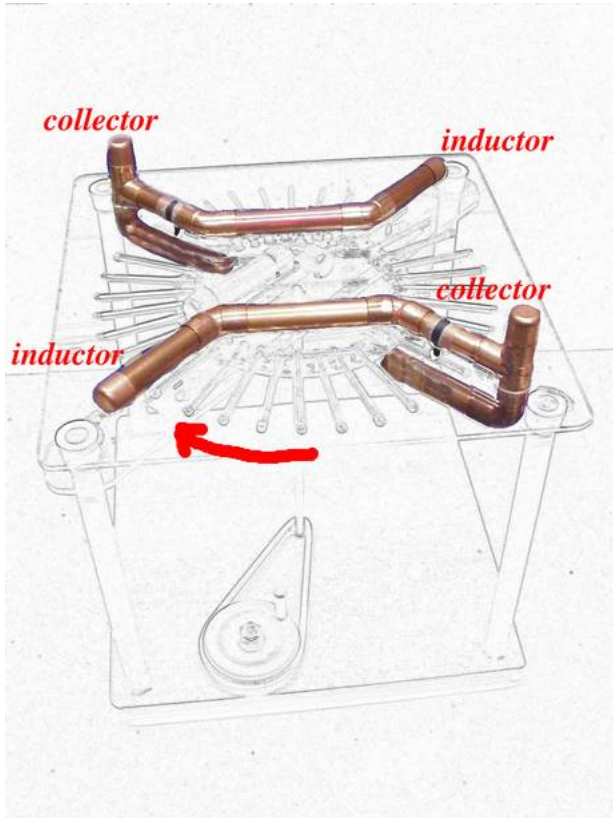
For all of my Dirods connections are made to the Dirod using 1/2-inch copper tubing, which drastically cuts corona losses compared to smaller diameter conductors. I am making #8 available primarily as a kit of pre-cut parts, though some may wish to buy the instructions alone and cut their own parts. Most of the raw materials are easy to get at any hardware store. My rods are cut from aluminum welding rod, the acrylic parts from 1/8-inch stock, the conductors are 1/2-inch copper tubing with plumbing fittings to fit. The belt is a sewing machine belt, and the neutral connection is cut from HVAC duct tape. If you cut your own parts, the dimensions will depend on those parts. However, as a rough guide, #6 uses a 6-inch disk, 36 2.5-inch rods, and a 12-inch square base and corona shield. #7 uses a 10-inch disk, 48 3-inch rods, and a 16-inch square base and corona shield. Model #8 uses an 11.5-inch disk, 36 2-inch foil "rods" and a 12-inch square base.

The most important material needed for Dirod construction is the brush material. This material must be thin, flexible, durable, and electrically conductive. I have experimented with a variety of materials, but the best so far has come from a kind of anti-static bag used to ship electronic circuit boards. My brushes have a resistance of about 25K ohms/inch. Feel free to experiment with different brush materials. If you find a better one, please let me know.

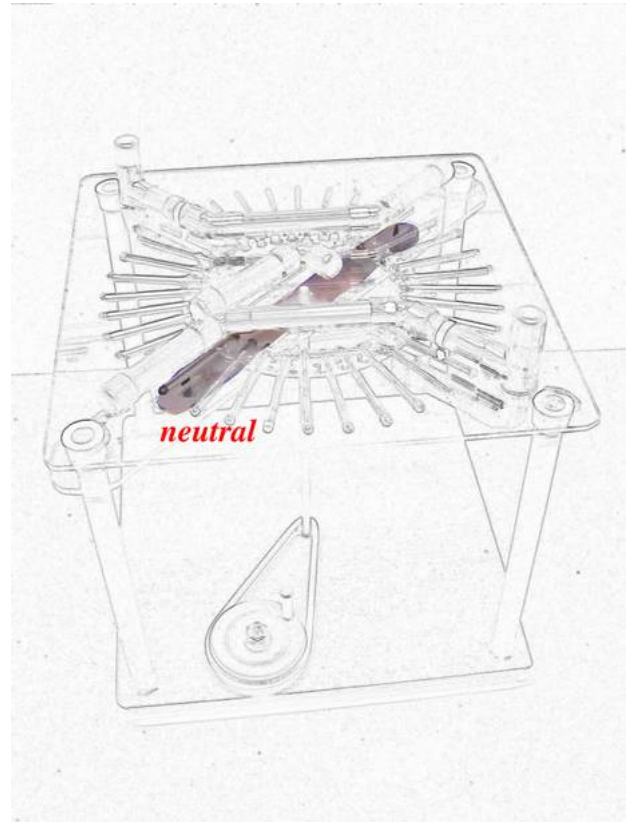
I hope you have as much fun with your Dirod as I have had designing it. Happy Sparking!

# Radial Dirod #6

## Principles



It is not my intention to present a complete description of the principles governing the operation of the Dirod. Moore's *Electrostatics* does a more than adequate job in this regard. But a brief analysis is in order as it will aid in the proper construction of the kit. First, it is important to note that any sharp metal surfaces will suffer corona losses which will limit the ultimate voltage and current produced by your Dirod. While metal edges can't be eliminated entirely, Dirod #6 makes every effort to round all metal edges. Whereas Dirod #5 used 1/4 inch copper tubing, Dirod #6 uses 1/2 inch tubing and suffers much lower losses than the previous model. Copper fittings add modestly to the cost, but provide for much lower corona losses than if the tubing had been cut or bent. In all of your considerations in building and using your Dirod, remember *round metal components are better than sharp ones*.



The Dirod conductors can be divided into 3 zones, each insulated from the others. The zones are separated from each other and from the disk by a square foot of acrylic, the *corona shield*. Without this shield, electrical current would flow more freely between the zones and the voltage produced would be limited.

Two of the zones lie above the corona shield, each consisting of a collector and an inductor. The collector makes contact with the rods via a brush that extends through the corona shield. Let's follow a rod as the disk spins. As each rod passes beneath the collector, it finds itself in a Faraday cage and gives up that charge to the collector. Let us suppose the front collector is negative. As a rod leaves the collector and approaches the inductor, electrons in the rod are repelled by the negative inductor.

As each rod passes beneath the inductor, electrons leave it via a brush to the neutral connector, the third of our zones, lying beneath the corona shield. As the rod leaves the inductor, now carrying a positive charge, it passes beneath the opposite collector, giving up that charge to the (now positive) collector via its brush. Now passing beneath the positive inductor, electrons are attracted to the inductor. Where will they come from? From the rod on the other side of the disk which is simultaneously passing beneath the negative inductor. Connection is made via a brush on the neutral connector.

The rod leaves the inductor carrying a negative charge. When it reaches the negative collector, it delivers up that charge via the collector brush and we have completed our cycle. Which collector will be negative and which positive is a coin flip. In fact, each time a spark snaps, the collectors reverse polarity.

## General Tips

While the Dirod kit comes with all its parts pre-cut, you will want to smooth the cuts with a little fine sandpaper for cosmetic purposes. The edges of the metal pipes can be sanded so they fit easily into their fittings. The base can be painted with enamel or polyurethane. Stay away from black or metallic paints, however, as the base should be non-conductive. I give mine a couple of coats of water-based polyurethane, but you may leave the base unfinished if you wish. You may wish to round the edges of the acrylic parts, again for cosmetic reasons. If you round the edges and corners of the base and corona shield with a little sandpaper, it will look nicer and you will avoid painful jabs when you bump into your Dirod. A little acetone will take the writing off of the PVC legs if you wish to do so.

You will need some glue to put your kit together and I can make some specific recommendations in this regard. You will need to finish the ends of the rods to prevent corona loss from the sharp ends. The easiest way to do this is to coat the ends with electrically conductive epoxy. I use "Poxy Weld" made by Power Poxy Adhesives. Most hardware stores will have an epoxy intended for gluing metals. It is usually metallic gray and, though not conductive at low voltage, it is at the high potentials generated by your Dirod.

You will also need a strong, flexible adhesive for bonding the various parts together. I have found no equal to "Plumber's Goop". Other "Goop" adhesives will also work. Loctite makes "Stik'n Seal" which looks quite similar, though I haven't used it myself. If you want to use other adhesives, it would be a good idea to try them out on scrap acrylic. The bond should be both strong and flexible. Clear epoxy will work in a pinch, but it is much more rigid than Goop and I have had epoxied rods break off the disk in use. This has never happened with Goop.

You will also need something mildly sticky to temporarily fix the rods to the disk template. I sometimes use double stick tape, other times spray adhesive. Rubber cement will also probably work. You will also need electrical tape, a pair of scissors, a knife, and a hammer. It takes me about 3 hours to assemble a kit, spread out over 3 days to allow the polyurethane and glues to dry. You can't rush

the glue; trying to do so will only lead to frustration. On the first day, I paint the base and seal the ends of the rods. On the second day, I assemble the disk, neutral support, and base, allowing the glue to dry overnight. I assemble the corona shield on the third day, and the Dirod is "ready to rip". Please read the directions twice through and check your assembly against the figures before gluing anything.

## Parts

Part	Description	Number
a	rods	36
b	disk	1
c	disk template	1
d	main axle, 9.5"	1
e	neutral support, 2"x14"	1
f	foil, 1"x9"	1
g	brush material	1
h	pulley	1
i	plastic handle, 1"	1
j	handle shaft, 1.625"	1
k	pulley shaft	1
l	washer	1
m	base	1
n	main bearing	1
o	belt	1
p	CPVC leg, 10"	4
q	CPVC socket	4
r	corona shield	1
s	copper tee	2
t	copper pipe, 2.5"	2
u	copper 45 degree elbow	4
v	copper pipe, 3.5"	2
w	copper pipe, 3"	5
x	copper endcap	8
y	copper street elbow	3
z	copper pipe, 1"	2

## Finishing the Rods

The rods must be sealed to prevent corona loss. Corona will issue from any sharp, pointy metal surfaces. Our goal is to make the ends of the rods as round as possible. One way is to chuck each rod in a drill and use a file to file the ends round. This method produces the most attractive rod, but is quite time-consuming. The method described

here uses metallic epoxy to produce a rounded end. While slightly less attractive, its performance is equal to that of filing and it takes considerably less time.



Mix up some metallic epoxy, often called "welding" epoxy, according to the instructions. If you absolutely can't find metallic epoxy, go ahead and use regular epoxy. With a paper clip, apply a dab of epoxy on each end. Allow the epoxy to cover the last 1/8th inch of the rod and form a small hemisphere at the end.



Place the rods (a) on a yardstick or ruler and allow the epoxy to set.

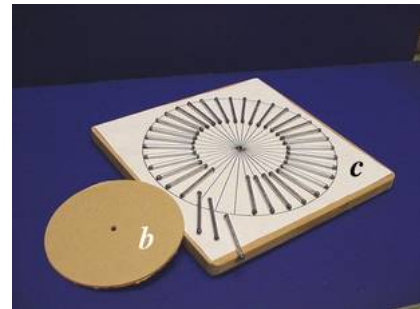


When the epoxy is no longer tacky, but still soft, roll each rod against a hard surface to remove any sagging.

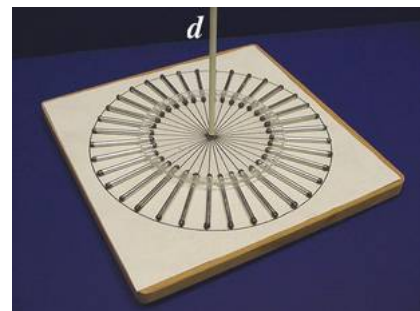


Use your fingers to reshape the ends into hemispheres. They don't have to be perfect, but should be as round as possible. *Let the epoxy cure overnight before proceeding.*

## Constructing the Disk

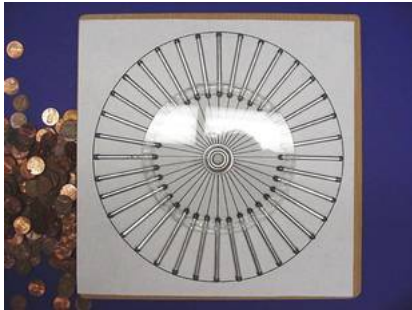


This disk template comes with the parts kit. For those cutting their own parts, half a template is reproduced at the end of this booklet. Make two copies, cut them out and tape them together. You will need to make your template (c) mildly sticky to hold the rods in place. I use spray adhesive or double stick tape. The goal is simply to prevent the rods from moving around, not to attach them to the template. Place the rods on the template as shown. Make sure the outer tip of each rod lies on the circumference of the circle.

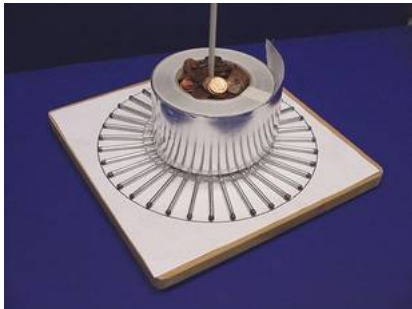


Peel the protective paper from the disk (b) and lightly apply glue to the outermost half inch on one side. Place the disk, glue side down, on top of the rods. Use enough glue

to hit all the rods, but not so much that you glue the disk to the template. You may use the main axle (d) to handle the disk, but don't permanently attach the disk to the axle yet.



Make sure that the rods still line up with the template and that the center of the disk is lined up with the center of the template.

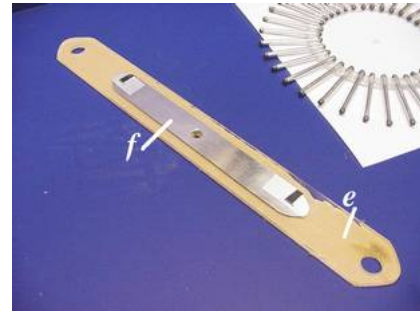


To make sure that glue contacts each rod, you will need to apply weight evenly to the disk. Use whatever you have at hand, but a roll of duct tape filled with pennies is perfect for the job.

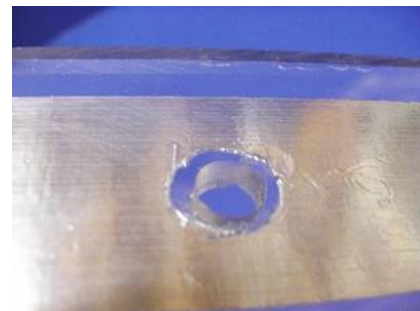


Allow the glue to set overnight. Then turn the disk over and apply a generous amount of glue to firmly seat the rods on the disk.

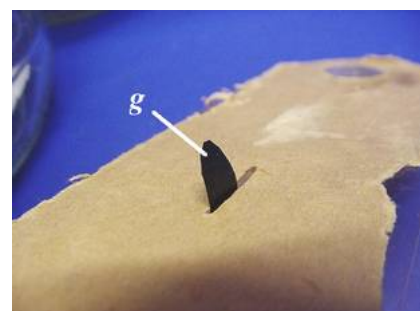
## Constructing the Neutral Support



The neutral support (e) is a strip of acrylic which supports the neutral connection (f) and provides an upper bearing for the main axle. Two legs pass through holes at the ends of the neutral support. There is a hole at the center for the main axle to pass through and two more holes for the neutral brushes. Begin by peeling the protective paper from one side of the neutral support and apply the self-adhesive foil (f) to that side. Remembering the principle of rounded conductors, trim the ends of the foil into semi-circles. The foil should cover the bearing hole at the center as well as the two brush holes.



With a razor blade or knife, cut the foil away from the bearing hole at the center. The foil should not contact the main axle as it spins.

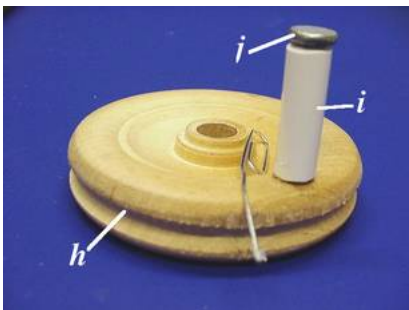


Cut four brushes (g), each 1 inch long and 1/4 inch wide from the square of brush material. This thin black plastic is electrically conductive. Make the ends of each brush round. Cut away the foil from each brush hole. Pass a brush through each brush hole and allow it to project about 1/2 inch on the non-foil side.

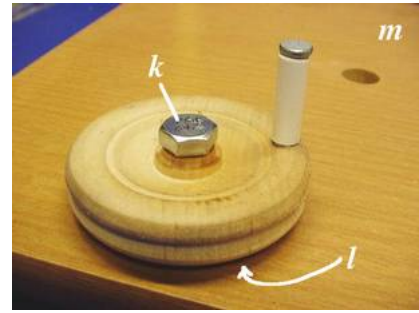


Tape the other end of each brush to the foil. I have used transparent tape here so you can see the brush, but you may use electrical tape.

## Constructing the Base



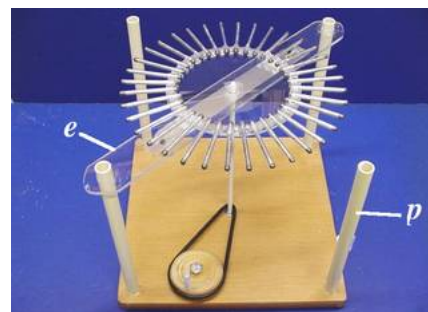
Pass the shaft of the handle (j) through the handle (i) and glue it into the hole in the pulley (h). Be careful not to get glue on the handle or it won't turn. I apply the glue to the hole with a paper clip and then push the shaft into the hole.



Pass the bolt (k) through the pulley and washer (l) into the threaded hole in the base (m). The washer goes between the pulley and the base. Tighten the bolt until the pulley is snug but turns freely.



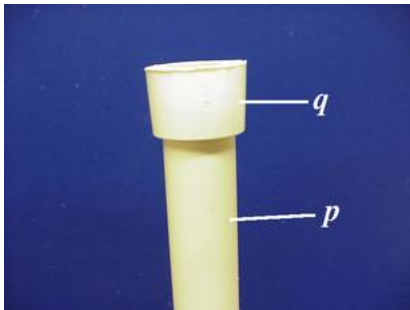
Place an end of the main axle (d) into the main bearing (n). Use a hammer to lightly force the axle into the bearing. The fit should be tight enough that no glue is needed. Place the bearing into the hole at the center of the base. Slip the belt (o) over the axle. When the Dirod is not in use, the belt should be left in this position so it doesn't stretch. When you want to run the Dirod, slip the belt over the pulley.



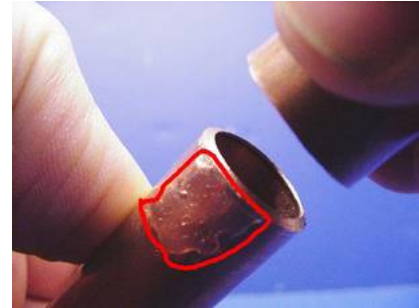
Then glue the legs (p) into the holes at the corners of the base. Slip the neutral support (e), *foil side down*, over two of the legs (p) as shown. The leg holes on the neutral support may be tight, so insert the legs gently to avoid cracking the neutral support. If the legs are too tight, you can

## Assembling the Corona Shield

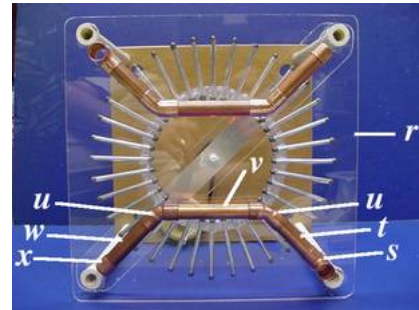
lightly sand them until they fit snugly. Place all four legs in the holes in the base, passing the main axle through the hole in the neutral support. Then force the disk, *rods on top*, onto the main axle. The axle should project above the disk about 3/8 inch, placing it just above the tops of the rods. Slip the belt around the pulley and turn it to check that the disk runs true. If not, make slight adjustments to the disk until it does. Adjust the neutral support so that the brushes contact each rod as the disk turns. When the disk runs true and each rod touches each neutral brush, glue the legs to the base, the neutral support to the legs, and the disk to the main axle.



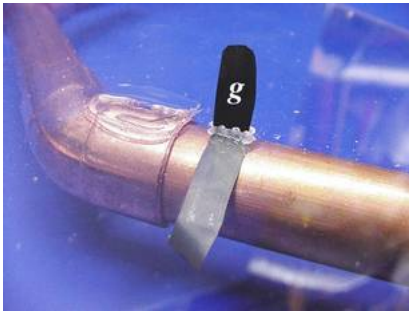
Place a socket (q) at the top of each leg. *Do not glue it.* The socket will be glued to the corona shield but not the leg. The friction fit it provides will securely attach the corona shield to the legs, but will allow the shield to be removed should the need arise. Place (don't glue) the corona shield (r) on top of the sockets and check that the main axle clears it. If not, either hammer the axle further into the bearing, or file the top of the axle until it does. At this point, the disk should be turning freely, running true, not hitting either the corona shield or the neutral support, and the neutral brushes should contact each rod as it passes. The main axle should not touch the corona shield. When all is running true, remove the corona shield, glue the neutral support to the legs and the disk to the main axle. *Let the glue dry overnight before proceeding.*



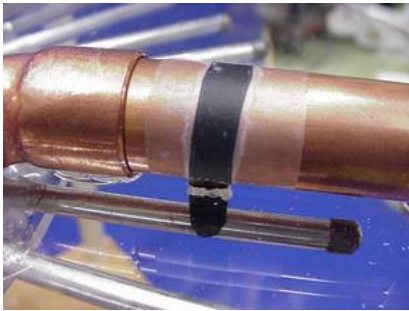
When attaching metal pipe to fittings, apply a thin layer of glue to one side of the pipe only. The other side should remain bare to provide electrical contact. A thin layer of glue may be applied to the outside once the fitting is in place. Soldering the fittings is neither necessary nor desirable.



There are two small brush holes and two large collector holes in the corona shield. Remove the protective paper from both sides of the shield and place it on the leg sockets, with the collector holes at the lower right and upper left corners of the figure (seen from above). Arrange the metal pipe and fittings as shown. Collector (t) goes directly over the brush hole. A tee (s) passes through the hole in the shield. The collector is connected to the inductor (w) via two 45 degree elbows (u) and a length of pipe (v). The end of the inductor is sealed against corona loss by an endcap. Study the figure carefully. It is imperative that (t) lies directly over the brush hole in the corona shield and (w) lies directly over the neutral brush. Both (t) and (w) should line up with the rods as they pass beneath. Only after you are confident that the shield, pipes, and fittings have been arranged correctly, glue the pipe to the fittings, the fittings to the shield, and the shield to the leg sockets. *Do not* glue the leg sockets to the legs as you will need to be able to remove the shield if the belt ever needs replacing.

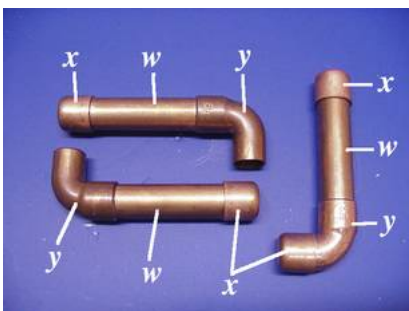


After the glue has set, remove the shield and flip it over. Pass a brush (g) through each of the brush holes as shown.

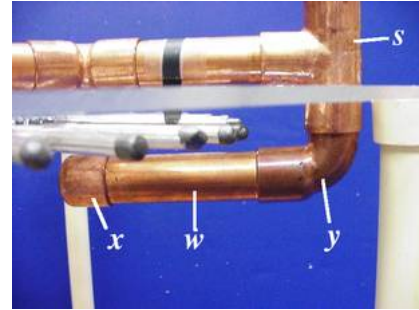


Tape each brush to a collector. I have used transparent tape so the brush can be seen, but you may use electrical tape. Replace the corona shield and adjust the leg sockets to ensure that the collector brushes make contact with each rod as the disk is turned. If the brushes are too short or too long, you may remove the tape and reposition them.

The rods should now make electrical contact with the collector via their brushes. Each rod should make electrical contact, via the neutral brushes, with the rod on the opposite side of the disk as it passes beneath the inductors. If this is the case, gently turn the pulley clockwise and make sure that this disk runs true, parallel to the neutral support and corona shield, and that the rods contact all four brushes. If everything is as it should be, you will be able to draw a spark if you place your hand between the opposite collectors.



Assemble the lower collectors and spark gap as shown. Note that only one of these assemblies, the spark gap, has an endcap at each end. When you understand the figure, you may glue the pieces together, allowing for electrical contact, as before.



Add the lower collector to the underside of the collector tee (s). Adjust it so that it is parallel to the upper collector and does not interfere with the rotation of the disk. This figure shows how the collector brush passes through the corona shield to make contact with the rods. When you understand how the lower collector should be positioned, glue it in place, allowing for electrical contact with the tee.



A 1 inch length of pipe (z) goes in the upper end of the tee. *Do not glue it in place.* You will need to remove it if you want to add accessories.



An endcap (x) goes on top of this pipe. Again, it should not be glued in place.

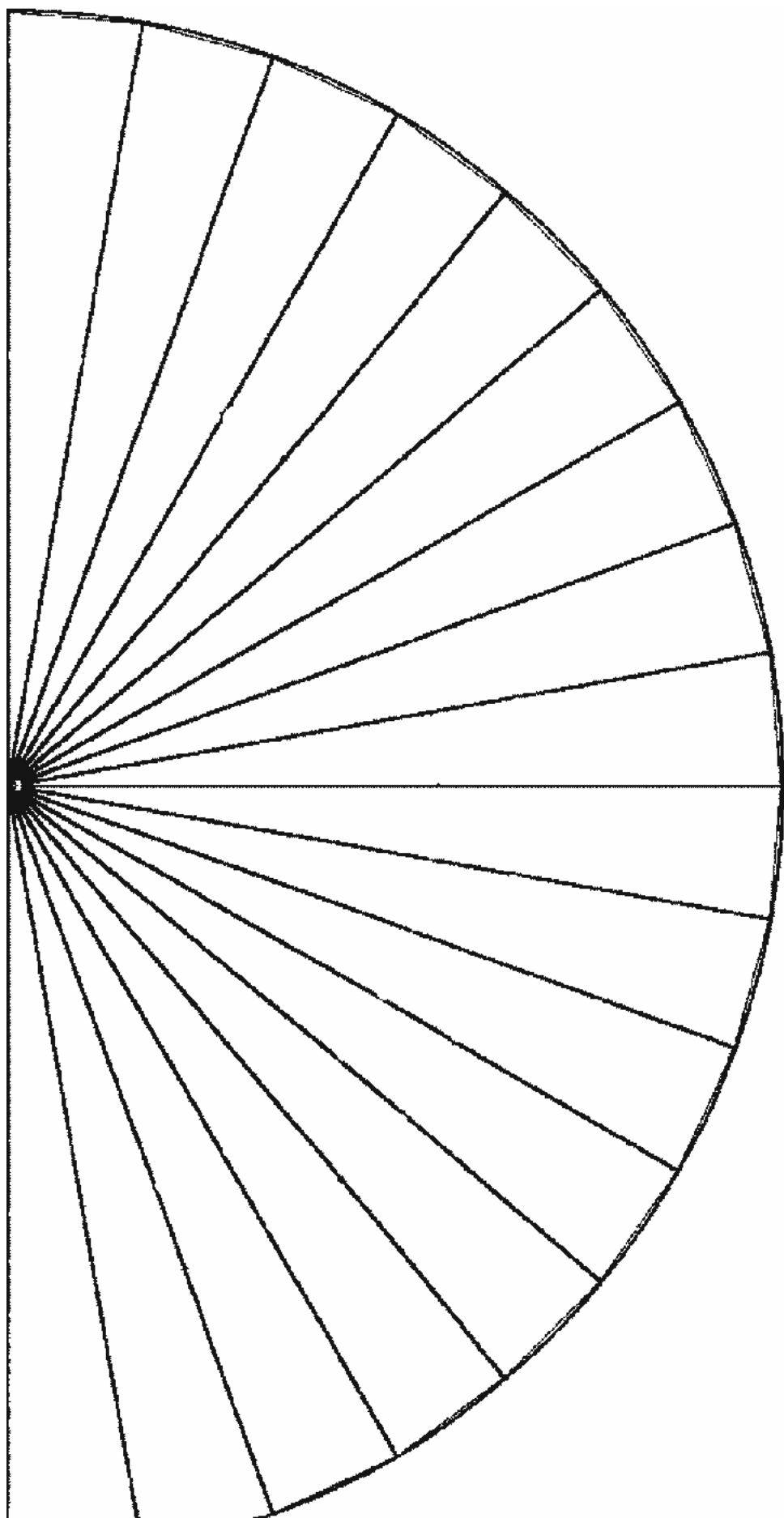


This completes the construction of the Dirod. The spark gap can be placed, *not glued*, on the corona shield as shown. When the pulley is turned clockwise, you should easily be able to draw an inch of spark. This corresponds to a potential of approximately 60 kV. If you fail to get anything, use a hair dryer to thoroughly dry the disk and corona shield and then try again. If you still get nothing, email me a couple of pictures of your Dirod and I will see whether I can spot the problem. Pay particular attention to your brushes.

The current, but not the voltage, is increased with increasing rotational speed. There is no need to go crazy with the pulley, however. At high rotational speeds, the upper bearing starts to wobble and the rods may fly off. This kind of speed is counterproductive anyway, because the brushes don't have time to rebound before the next rod comes around. Take it easy! A comfortable, controlled speed is all that is required. If the upper bearing is noisy, you can add *a single drop* of light machine oil, but take care that the oil doesn't drip down the main axle onto the belt.

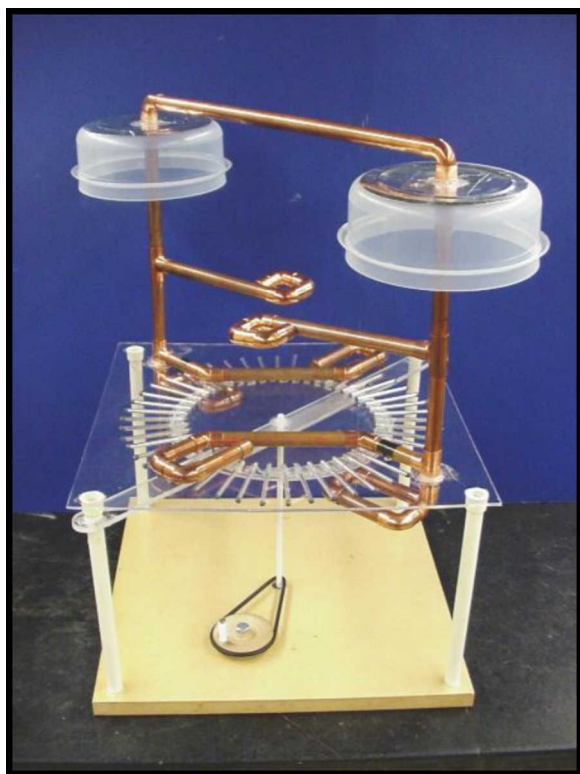
In the likelihood that your Dirod is producing sparks, take it into a pitch-black room and let your eyes adjust to the dark. Start running your Dirod without the spark gap in place. You will see the corona we have been speaking of as a faint purple glow interrupted by sparks. Anywhere you see such a glow, corona is leaking. If it is leaking from a sharp point, you can file it down and/or coat the point with epoxy. If, on the other hand, corona is crossing the disk from one collector to the other, you are producing the maximum potential possible with this size Dirod. Higher potentials will only be possible with a larger disk.

Template



# Radial Dirod #7

## Principles



Dirod #7 is essentially a scaled-up Dirod #6 with enhancements to the inductors and collectors to reduce corona loss. Please read the Dirod #6 instructions before assembling Dirod #7. Only the differences between #6 and #7 will be given here.

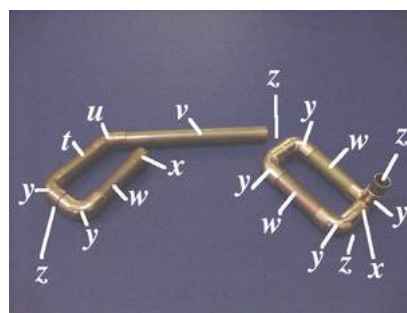
## Parts

Except for dimensions, most of #7's parts are identical to those of #6:

Part	Description	Number
a	rods	48
b	disk, 10" dia.	1
c	disk template	1
d	main axle, 9.5"	1
e	neutral support, 1.5"x22"	1
f	foil, 1"x13"	1
g	brush material	1
h	pulley	1
i	plastic handle, 1"	1
j	handle shaft, 1.625"	1
k	pulley shaft	1
l	washer	1
m	base, 15.5"x15.5"	1
n	main bearing	1
o	belt	1
p	CPVC leg, 10"	4
q	CPVC socket	4
r	corona shield, 15.5"x15.5"	1
s	copper tee	2
t	copper pipe, 2.5"	2
u	copper 45 degree elbow	4
v	copper pipe, 6"	2
w	copper pipe, 3"	8
x	copper endcap	6
y	copper 90 degree elbow	12
z	copper pipe, 1"	8

## Assembly

To build Dirod #7, follow the directions for Dirod #6 up to the section entitled "Assembling the Corona Shield." The only design difference between Dirod #6 and #7 is in the additional fittings used to reduce corona losses in the inductors and collectors. Assemble two sets of inductors and lower collectors as shown below:

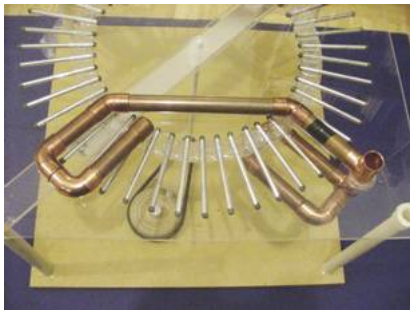


When you are confident that they have been assembled correctly, apply a little Goop or epoxy to each fitting, and then reassemble the inductors and lower collectors. Use only enough glue to hold the parts together will allowing the bare metal of the copper tubing to contact bare metal inside the fittings. If necessary, smooth the edges of the tubing so that they fit the fittings. Unlike the rods, however, the ends of the tubing are always inside fittings and so it is not necessary that they be smooth and round.

Each of the upper collectors is assembled from a tee (s), a tube (w), and a 45 degree elbow (u). The tee passes through a large hole in the corona shield. The collector brush passes through the small hole in the corona shield and is taped to the upper collector (w) with electrical or cellophane tape, just as it is in Dirod #6. The lower collector is then attached to the bottom of the tee, where it hangs down below the rods. With the corona shield in place, the disk should turn freely, the rods passing between the upper and lower collectors, and each rod should touch the collector brush as it passes.



The inductor can now be inserted into the collector's 45 degree elbow (u). The inductor should sit directly over the neutral brush.



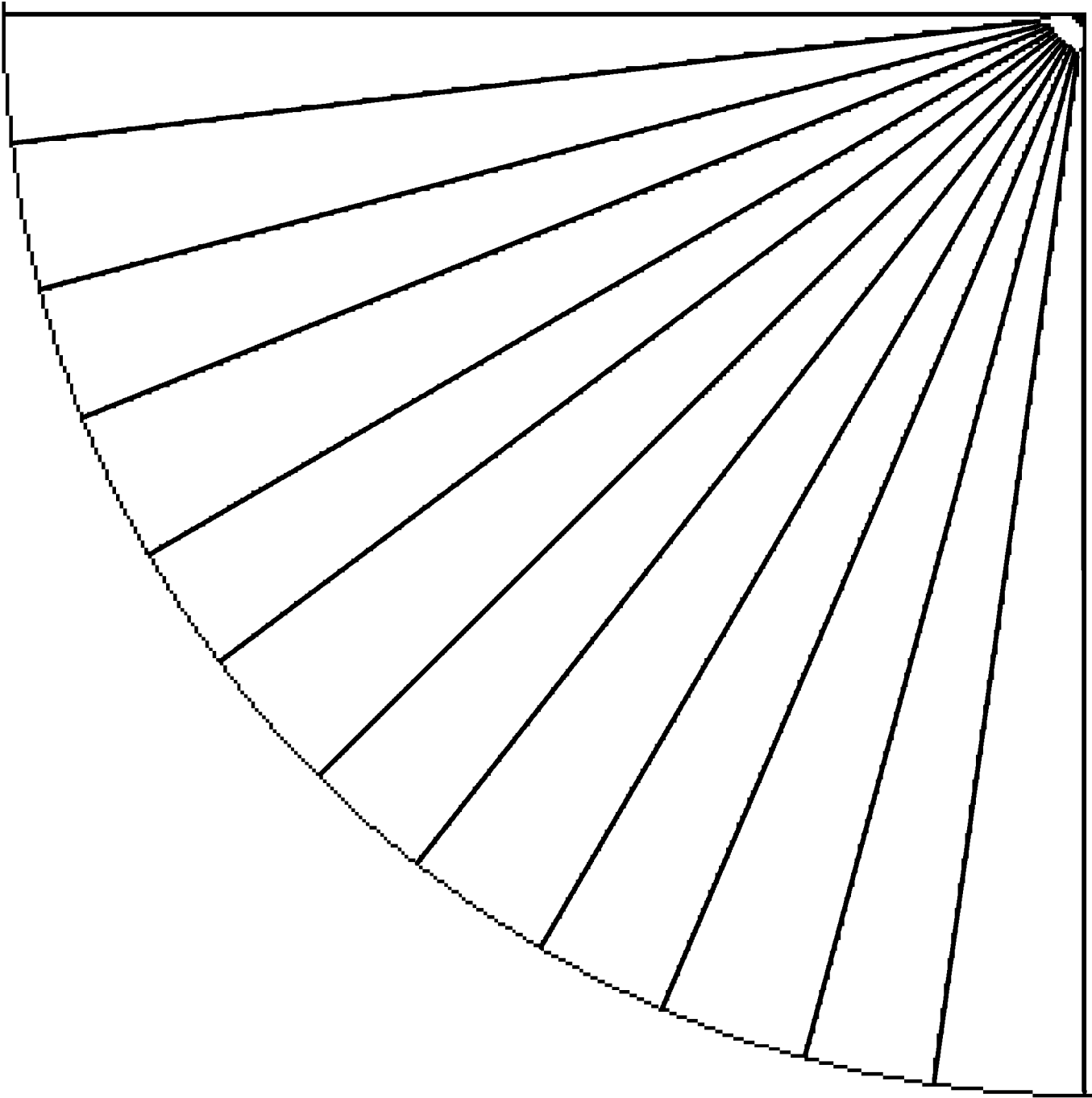
When both collectors and inductors have been assembled as shown, the corona shield can be Gooped to the leg sockets and the copper fittings can be tacked to the corona shield with spots of Goop. Slowly turning the disk by hand, confirm that each rod contacts a neutral brush as it passes beneath the inductor and a collector brush as it passes between the upper and lower collectors. When

you are satisfied that this is so, allow the Goop to dry overnight.

Just as with Dirod #6. A 1 inch length of tubing (z) and an endcap (x) are used to plug the top of the collector tee when accessories are not in use. They should not be glued, as they will need to be easily removed. You may wish to file the ends of the tube (z) so that it slides easily in and out of the tee.

Loop the belt over the pulley and spin the disk slowly clockwise. You should hear the crackle of static electricity. The small gap has not been included with Dirod #7 as you will certainly want to build a Rod Gap or a Ball Gap. With a pair of Rubbermaid Capacitors, #7 will give strong discharges the full 6 inches from collector to collector. A 2 inch ball gap gives discharges well over 2 inches across. Be sure to disconnect your belt when it is not in use so that it does not get kinked.

Template



# Radial Dirod #8

#8 differs significantly from that of the previous models and so it will be given in detail.

## Principles



Model #8 is an updated and improved version of Model #6. The principles of operation are identical to those described in [the Section called Principles in the chapter called Radial Dirod #6](#) and the reader is encouraged to read that section before proceeding. The disk diameter has been enlarged from 10 inches to 11.5 inches and the collectors have been moved farther apart, increasing the spark length and top voltage for Model 8. The aluminum rods have been replaced with foil strips and metallic beads, eliminating the tedious finishing of the rod ends. The beads are larger and smoother than the old rod ends and so they suffer less corona loss. The foil strips would suffer significant corona loss were it not for the beads. In addition to these improvements, the collector tees are now supported by the legs rather than by the corona shield, the upper bearing is now on the corona shield, and the neutral connection is through a foil strip underneath the base. Crowning all of these improvements, the corona shield is now quickly and easily removed, easing the replacement of brushes and belt. With a capacitor, Model #8 will produce hot 5-inch sparks across the corona shield and nearly 2-inch sparks with a ball gap. The construction of Model

## Parts

Part	Description	Number
a	base, 11.5"x11.5"	1
b	CPVC bearing support, 0.5"	1
c	main bearing	1
d	main axle, 10.75"x0.25"	1
e	corona shield, 11.5"x11.5"	1
f	CPVC leg, 11.5"	2
g	upper bearing	1
h	copper 90 degree elbow	10
i	copper tee	4
j	CPVC leg, 9.00"	2
k	copper pipe, 1.25"	2
l	copper pipe, 8.00"	2
m	copper pipe, 1.00"	8
n	copper endcap	6
o	disk, 11.5" dia.	1
p	foil tape, 10"x2"	1
q	metallized beads	72
r	pulley	1
s	big washer	3
t	pulley shaft	1
u	plastic handle, 1.25"	1
v	handle shaft, 2.00"	1
w	small washer	1
x	belt	1
y	small wheel	3
z	foil tape, 10"x0.25"	1
A	copper pipe, 10.25"	2
B	copper pipe, 1.50"	2
C	copper pipe, 1.75"	2
D	corona ring	2
E	brush material	1

## General Tips

Except for the copper tubing, the Dirod kit comes with all its parts pre-cut but you may want to smooth the cuts with a little fine sandpaper for cosmetic purposes. The copper tubing should be cut with a tubing cutter, available

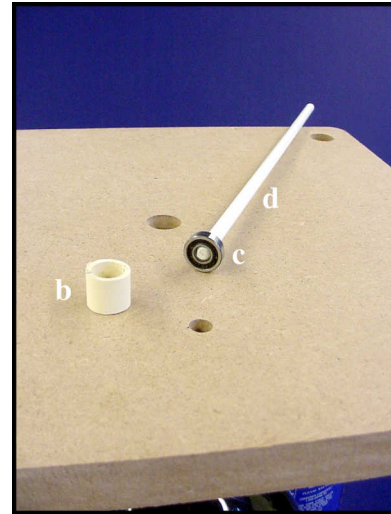
inexpensively wherever plumbing supplies are sold. The base can be painted with enamel or polyurethane. Stay away from black or metallic paints, however, as the base should be non-conductive. I give mine a couple of coats of water-based polyurethane, but you may leave the base unfinished if you wish. A little acetone will take the writing off of the PVC legs if you wish to do so.

You will also need a strong, flexible adhesive for bonding the various parts together. I have found no equal to “Plumber’s Goop”. Other “Goop” adhesives will also work. If you want to use other adhesives, it would be a good idea to try them out on scrap acrylic. The bond should be both strong and flexible. Clear epoxy will work in a pinch, but it is much more rigid than Goop. Please read the directions twice through and check your assembly against the figures before gluing anything.

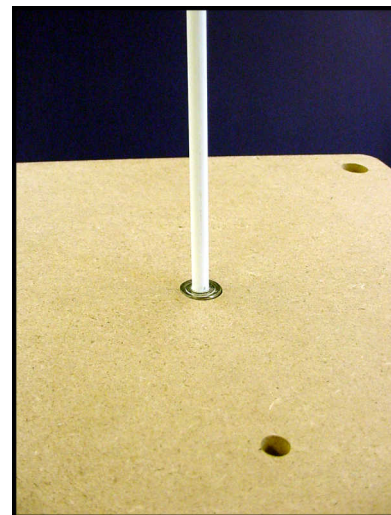
## Corona Shield Assembly



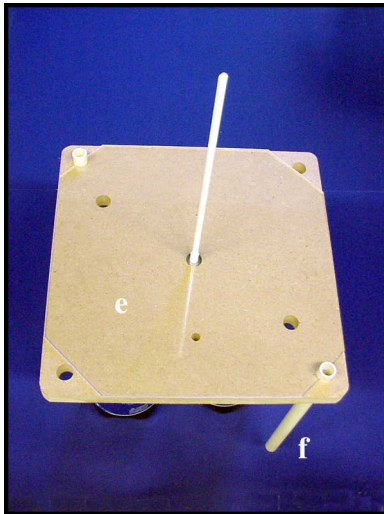
1. Because the legs will hang down below the base in the first phase of construction, you will need to elevate the base. I find that three 2-L soft-drink bottles are just the right size to support the base (a). The “front” of the generator has a small hole for the pulley. In addition to the holes at the corners and at the center, there are two 5/8-inch holes in the back-left and front-right corners.



2. The main bearing is supported by a short length of half-inch CPVC tubing (b). Main bearing (c) is force-fit onto one end of the main shaft (d).



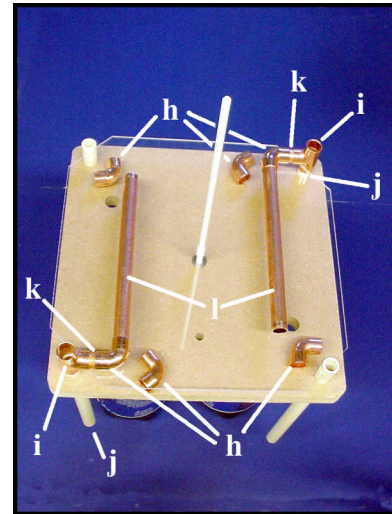
3. Apply some glue to bearing support (b) and insert it from *below* into the hole in the center of base (a). The goal here is to avoid getting any glue on the bearing itself. Insert the bearing into the hole and adjust the bearing support until the bearing sits flush with the top of the base.



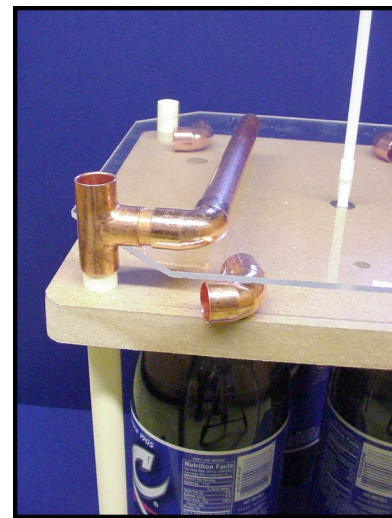
4. The corona shield (e) will eventually be supported by two legs (f), each of which have a slot near the top. Insert these slotted legs into the holes in the back-left and front-right corners of the base. Slide the main axle into the hole in the center of the corona shield and insert its corners into the leg slots. Note that the corners of the corona shield are not identical; those at the front-left and back-right corners clear the corner holes completely; those at the back-left and front-right fill the slots in the legs.



5. The upper bearing (g) consists of a short length of plastic tubing. Slide it down the main axle and insert it into the hole in the corona shield. You may glue it later, but for now let it be held to the shield by friction alone.



6. Lift the corona shield from the base, allowing the legs to slide upward in their holes, and insert four copper elbows (h) between the base and the shield. These provide *temporary* support for the shield while the collectors are assembled. Insert a tee (i) onto each of the remaining unslotted legs (j) and slide the legs into the front-left and back-right corners of the base. Assemble tube (k) (1.25-inch), elbow (h), and tube (l) (8-inch) to form the collectors as shown. Lever tube (l) to a vertical position, apply glue to the underside of tee (i) and elbow (h), and return it to the position shown.

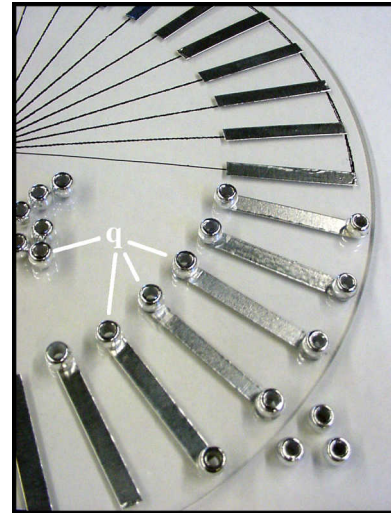


7. Remember, the four elbows underneath the corona shield are there only for support; do not glue them. Tubes (l) should be parallel to each other and to the sides of the corona shield. Allow the glue to set while you assemble the disk.

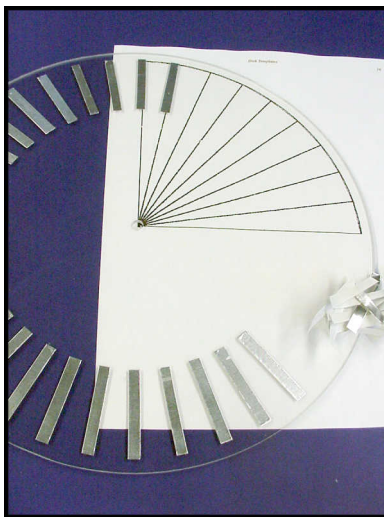
## Disk Assembly



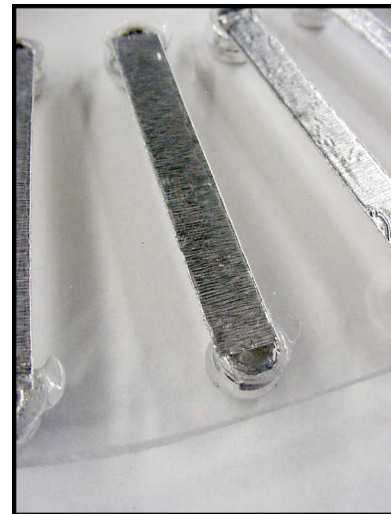
8. Peel the protective paper from the disk and place it over the disk template. Make sure that the hole in the disk is centered over the center of the template, as shown. Cut the adhesive foil tape into 36 strips (p), 2 inches long and 1/4 inch wide. Peel the protective paper from each foil strip and carefully stick it to the disk. Each strip should be centered on a radial line. Note that the foil strips *do not* go all the way to the edge of the disk.



10. Apply a little glue to each of the metallized beads (q) and set one on each end of each foil strip. Being round, these beads will minimize corona losses from the edges and corners of the foil strips.

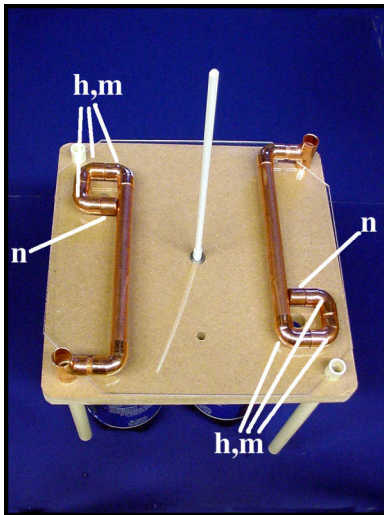


9. When you have applied about a quarter of the strips, rotate the disk and align the last few strips with the first few radial lines. Then continue adding strips until all of them have been applied. You should now have a disk with 36 equally-spaced foil strips.

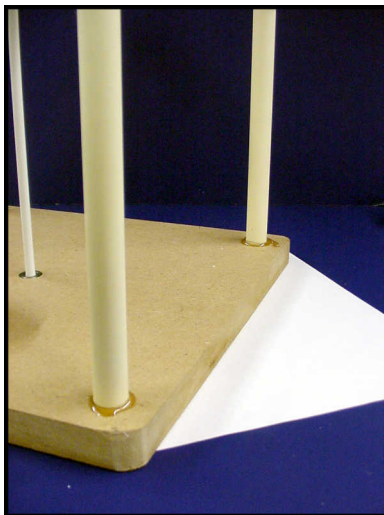


11. This figure shows the view from the other side of the disk. Each bead should be centered on the end of its foil strip. The corners of the strip *should not* protrude beyond the bead.

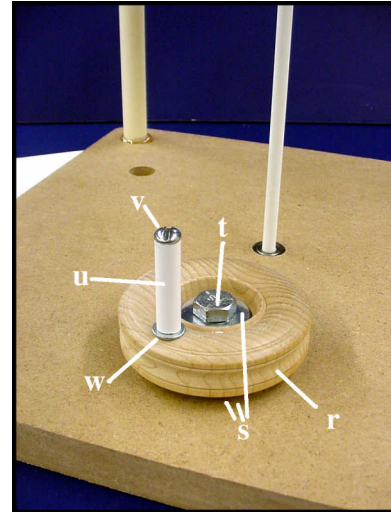
## Base Assembly



12. Once the glue on the collectors is strong enough to support them, remove the elbows (h) from beneath the corona shield. Use three elbows (h), three copper tubes (m)(1-inch) and an endcap (n) to assemble each of two inductors. The inductors should sit over the empty holes in the base. When you have verified the placement, lever each inductor to a vertical position, apply glue to the underside of the elbows, and return it to the position shown. Allow the glue to set as you attach the legs to the base.



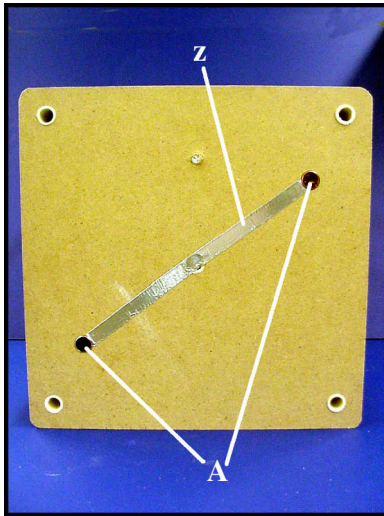
13. Remove the base from atop the soft-drink bottles and place it on your workbench. This will necessarily force the legs up through their holes. Remove the corona shield and glue the legs into their corresponding holes. A sheet of paper underneath the base will prevent you from gluing your Dirod to the workbench. Be sure that the slots in the longer legs face the center.



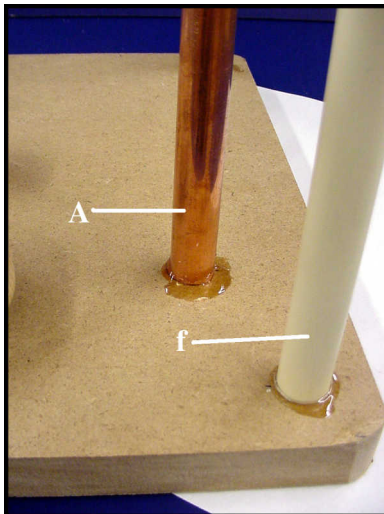
14. Assemble the pulley. Slip the handle shaft (v) through the handle (u) and small washer (w); then use a screwdriver to screw it into the pulley (r). Place two large washers (s) underneath the pulley, one more on top, and use a wrench to screw the pulley shaft (t) into the base. Both the handle shaft and the pulley shaft should be tight enough that things don't wobble, but not so tight as to bind either the handle or the pulley.



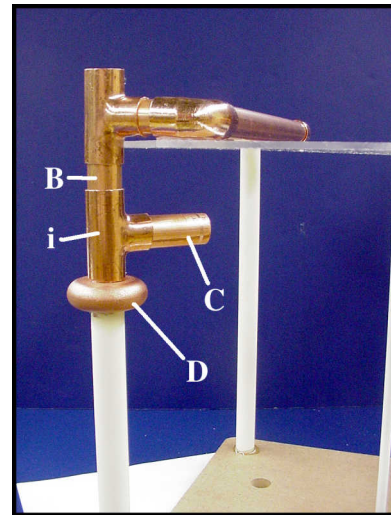
15. Force two small wooden wheels down the main shaft, almost to the main bearing. Separate the wheels slightly, apply glue between them, and force them back together. They should sit high enough above the main bearing that they do not touch the base. Slip the belt over the pulley and wheels to complete the drive section.



16. Flip the base over and apply a strip of foil tape between the two remaining empty holes. Push the neutral supports (A) through these holes from below. Each neutral support should make good contact with the foil strip.

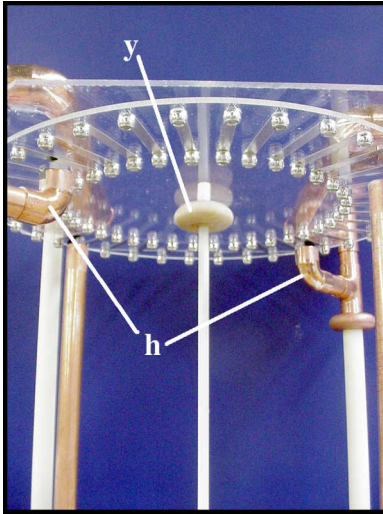


17. Turn the base right-side-up and glue the neutral supports into place. You can lift them up slightly, apply glue, and then push them back down into their holes so that glue penetrates the hole. Note that the neutral supports sit next to the longer, slotted legs (f).

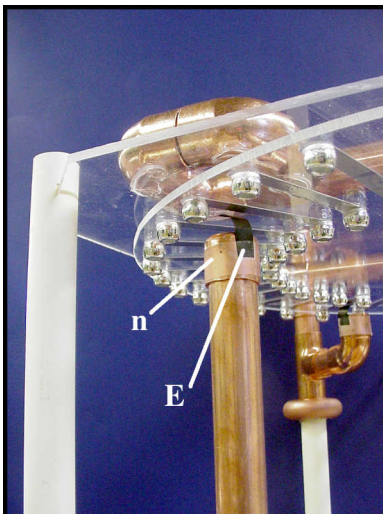


18. Slip a corona ring over each of the shorter, non-slotted legs. Add a tee (i), copper tube (B)(1.5-inch), and copper tube (C)(1.75-inch). Replace the corona shield assembly, placing two corners into the slots in slotted legs (f) and the two collector tees onto copper tube (B). Adjust tee (i) so that tube (C) points at the main axle. Use a ruler to measure the height of the corona shield above the base at each of the corners. If these heights are not equal, determine which of the tubes (B) might be too long or too short and cut another one. When all four corners of the corona shield are equidistant from the base, glue corona ring (D) to the leg and tube (C) to tee (i). *Do not glue tube (B) to anything.* When you want to remove the corona shield the tees must be able to slip free of tube (B). Check that tube (C) points at the main axle, that the corona shield is held firmly by the slots in legs (f), and that the corona shield sits level. Allow the glue to set before proceeding to the final assembly.

## Final Assembly

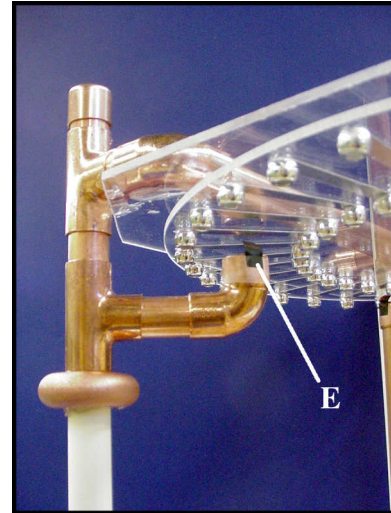


19. Pull back on legs (f) to release the corners of the corona shield and lift the shield to remove it. Slip a wooden wheel onto the main axle and then press the disk onto the axle *with the beads underneath the disk*. Add elbows (h) to tubes (C) and replace the corona shield. Adjust the disk so that it is midway between elbows (h) and the corona shield. Turn the pulley handle so that the disk turns and gently adjust it until it does not wobble. As you turn the pulley the disk should turn freely without touching either the elbows (h), the neutral supports, or the corona shield. When the disk runs true, slip the wooden wheel (y) down, apply some glue, and then push it back into place. Once again check to see that the disk runs true and allow the glue to set.



20. Remove the corona shield, add an endcap (n) to each neutral support. and tape a strip of brush material (0.75-

inch x 0.25-inch) to each endcap. Rotate the endcap so that as the disk runs clockwise, the brush is dragged over the endcap.

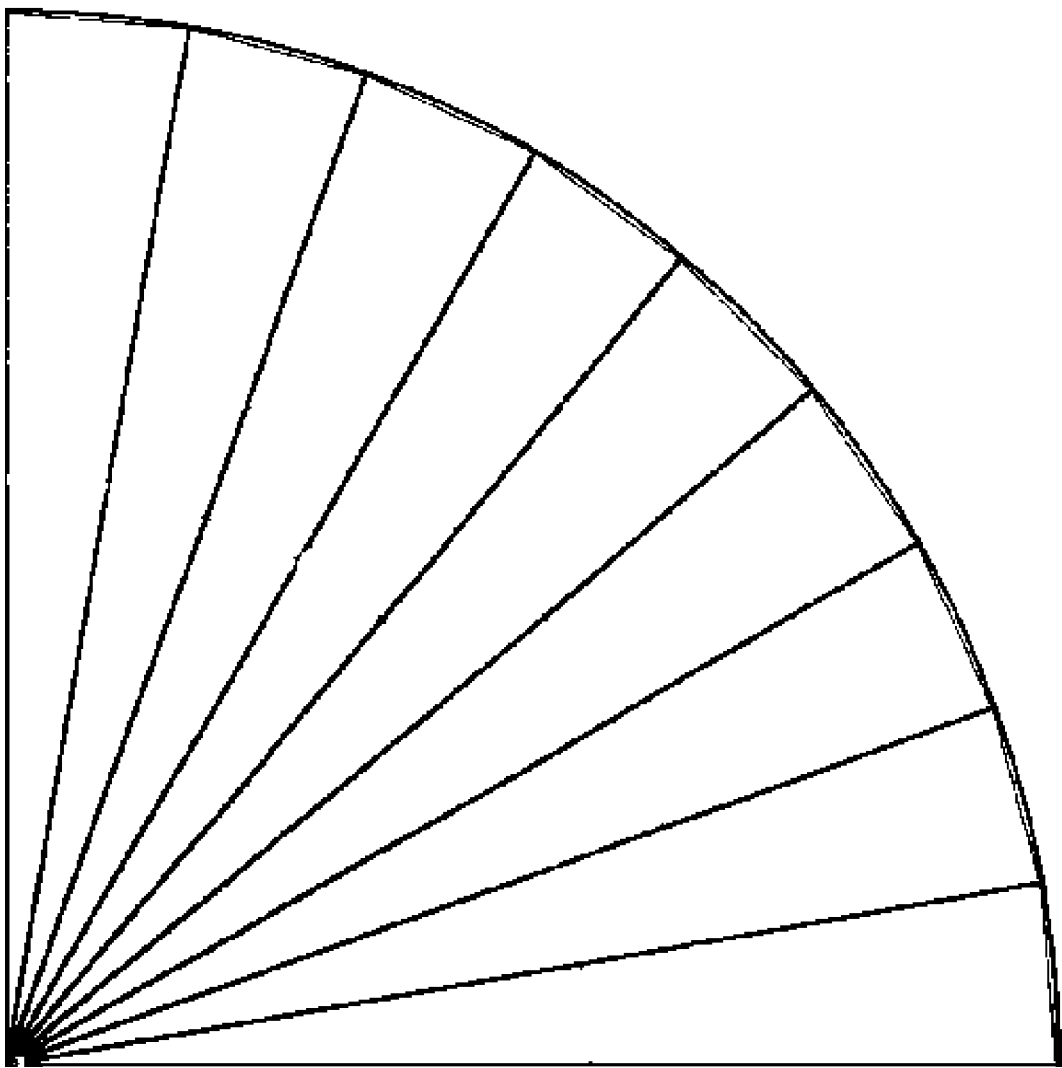


21. While the corona shield is off, tape a strip of brush material to each of the collector elbows so that as the disk turns clockwise, the brush is dragged over the mouth of the elbow.



22. Return the corona shield to the Dirod. Place a copper tube (n) and a copper pipe (m)(1-inch) into each of the collector tees. Turn the pulley handle clockwise and check to see that each brush contacts each foil strip as the disk turns. If any of the brushes are too short, adjust them or replace them. Turn the pulley and listen for the crackle of static. If it fails to start, take your Dirod into an air-conditioned room and run a hair dryer over it. Triple check that each brush contacts each foil strip as the disk turns.

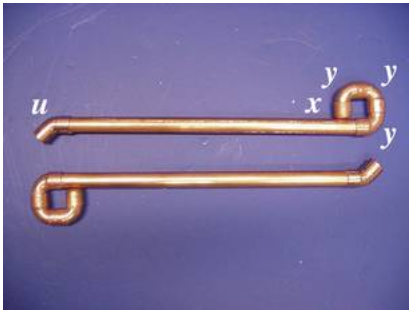
Template



# Accessories

## The Rod Gap

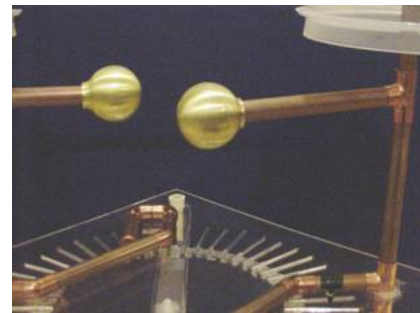
The little gap included with the #6 is all fine and good, but you will get bigger sparks with a rod gap. The parts are easy to come by at any hardware store. You need two 1 foot lengths of copper tubing, six street elbows, two end-caps, and two 45 degree elbows. Arrange them as shown in the figure and glue them together, allowing for electrical contact, as usual. You can save a couple of bucks by foregoing the street elbows. Just place the endcaps on the ends of the pipes, but corona leakage will rob you of about a quarter inch of spark.



To use the big gap, remove the caps from the collector tees and slip the 45 degree elbows over the 1 inch pipes (z). Adjust the distance between the rods to about 1 inch and run the Dirod. Little by little, nudge the gap wider and wider until no spark leaps. Then move it back in for the biggest spark possible.

## Ball Gap

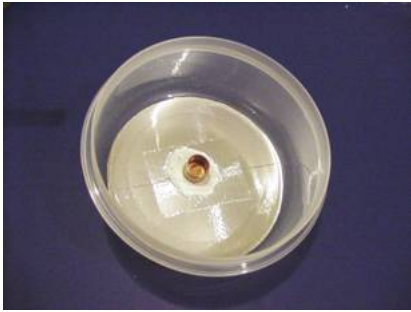
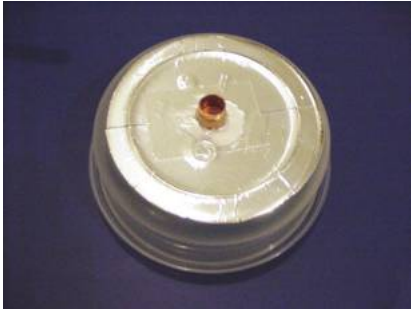
A nice ball gap can be constructed from round "dummy" doorknobs, i.e. those that don't include the latch. These are generally cheaper than "real" doorknobs. Just cut the knob off of its base with a Dremel tool or hacksaw and you have, in effect, a hollow metal sphere with an opening to the interior. Glue a copper endcap to the inside of the knob with conductive epoxy. Slip one end of a copper tube into the cap, the other end into a tee. Using two such knobs connected to opposite collectors, you have a nice gap that can be adjusted to any gap size.



## Capacitor

A capacitor is nothing more than two conductive surfaces separated by an insulator. A very nice, inexpensive capacitor can be constructed from Rubbermaid food storage boxes and aluminum HVAC tape. Using two 6 inch round containers, you can make a capacitor which will produce a 6 inch discharge (from collector to collector) from #7 and a 3.5 inch discharge from #6.

Begin by cutting four circles from the foil tape. My tape is 3 inches wide, so I tape two widths together for a 6 inch circle. Peel the backing off of the foil tape and attach a circle to the inside and outside bottoms of each container. The bottom of each container is now a foil sandwich with plastic in between. A copper endcap is then Gooped to the inside and outside centers of each container. Goop around the outside of each cap, leaving metal-to-metal contact between the cap and the foil.



The capacitor is completed by adding copper tubing to connect each of the collectors to the inside of a container. The tops of the containers are connected by a copper tube with either street elbows or regular elbows and 1 inch copper tubes to fit the endcaps. Nothing is glued together so that things can be taken apart and put back together in different arrangements. The capacitor is shown here with the ball gap, which gives 2.5 inch discharges with #7 and 1.5 inch discharges with #6.



Plans

