17 KV 45MA Solid State Jacobs Ladder

Kit Instructions

by

Physics Playground

www.physicsplayground.com

WARNING: Jacobs Ladders are high voltage devices that may be lethal if touched and produce very high levels of ozone and nitrogen oxides which are both toxic gases. These kits are built and operated at your own risk and should only be assembled and used by those who are familiar with constructing and operating high voltage equipment. Once again, use at your own risk.

Jacob's Ladder Introduction:

Thanks you and welcome to what might be your first Jacobs Ladder and from my experience, this package contains the best combination for building a compact high output Jacobs Ladder by utilizing solid state electronics along with a very simplistic flow design that will insure consistent convection currents plus reduce the buildup of ozone and nitrogen oxides that commonly taint the arcing rod tube.

The operation of a Jacob's ladder is rather simplistic in its nature such that it takes two conductive rods and runs a high voltage across them to achieve an arc at the location of the least electrical resistance, which is at the bottom where the rods are the closest. The rising of the arcs is created by the high temperature arcs that induce a hot rising convection current, causing the arc to rise along with it. For the ladder to work efficiently, the arc must be strong enough to produce significantly hot

convection currents. While most ladders operate at 10KV, this unit will run at 17 kV and pushes 30% more current then the traditional NST driven systems. You will find this combination to produce very bright fast rising arcs, however at the same time the high power output will also produce very high levels of ozone and nitrogen oxides which cause an orange tint build within the tube plus are highly toxic materials, so always use these in well ventilated areas under constant supervisions or at best, only use the ladder outdoors.

To prevent the buildup of these toxic gases within the tube, you will see that a fan has been designed into the system that blows air through a 1/8 hole directly below the bottom of the arcing rods. This hole ultimately serves two purposes, the first being to flush out the toxic gases and secondly it will aid to the rising convection currents, meaning that the arcs will never get stuck.

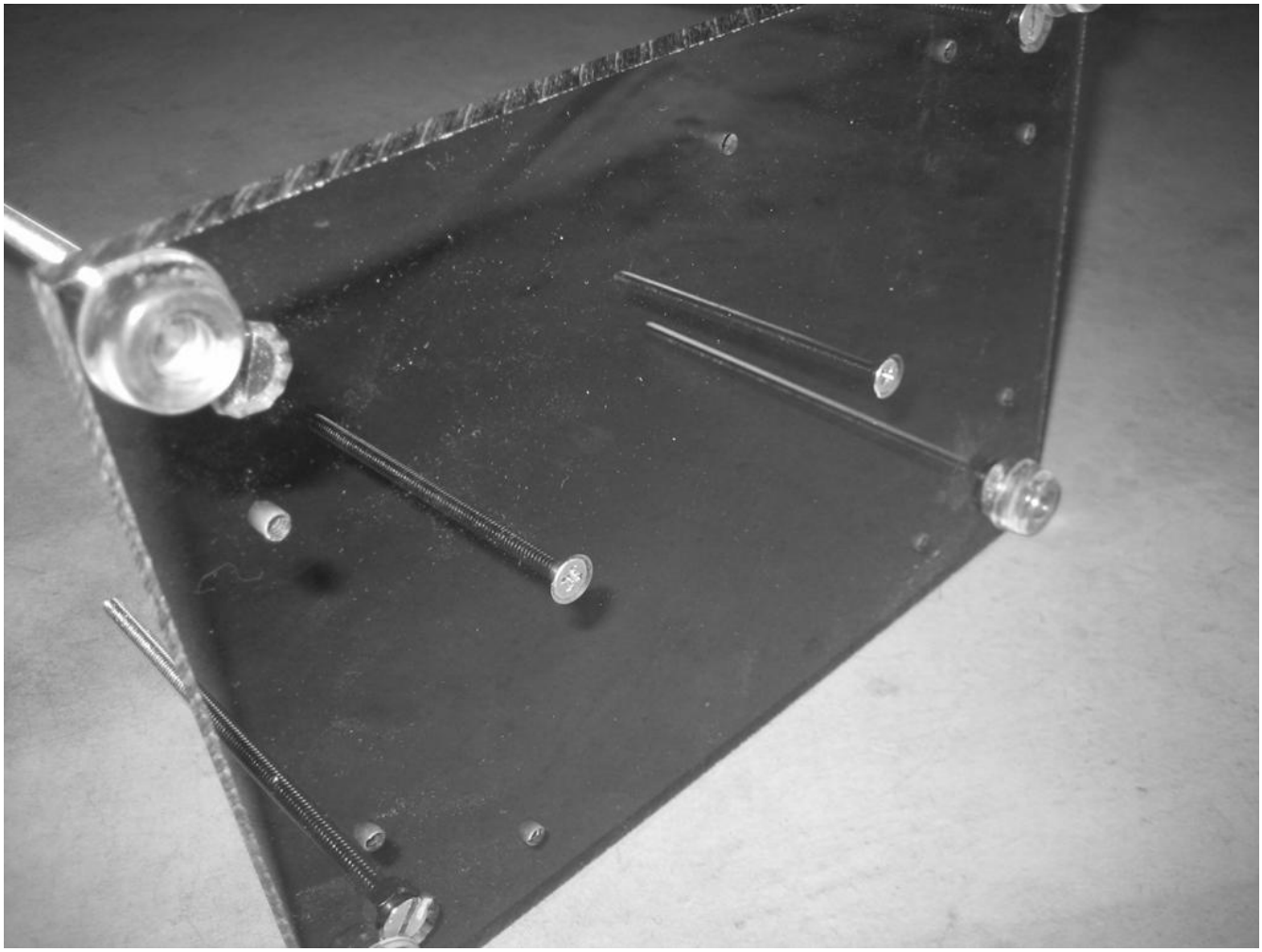
With these concepts in mind, let's get ready to build the Jacobs Ladder. To complete this ladder, you will need the tools and materials listed below and the overall build process should only take about 1 hour to complete at a moderate pace. Take your time and carefully read through the instructions. Should there be any questions along the way please do not hesitate to contact me, Frederick Graff the owner of Physics Playground at frederickgraff@hotmail.com or (209) 914-2619.

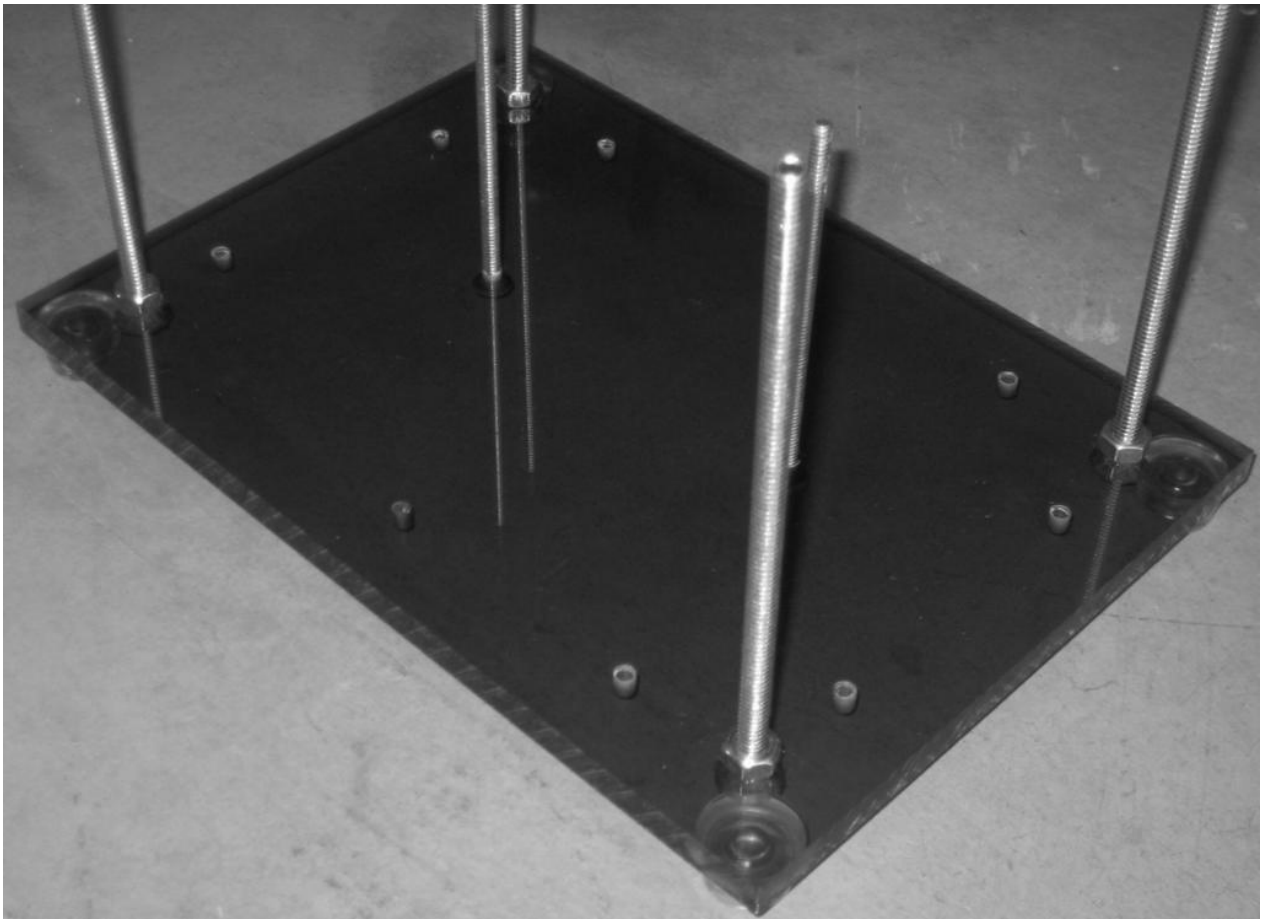
Tool and Supplies Needed

- Screw Driver (standard and Phillips)
- Flat Jaw Pliers
- Small Vice Press
- Box Knife
- Electrical Tape
- Drill with 1/8 and 3/16 bit

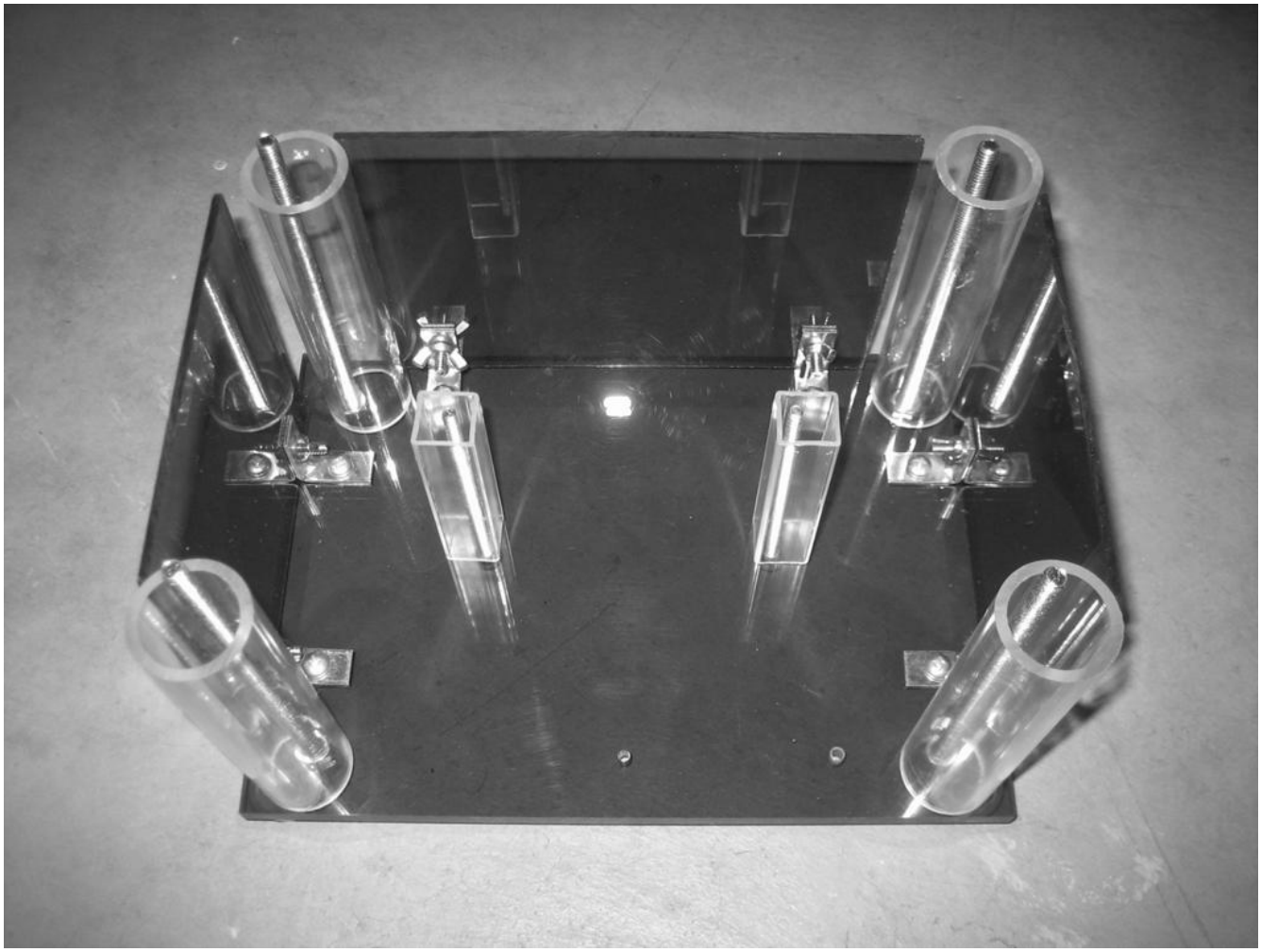
Base Construction Procedure:

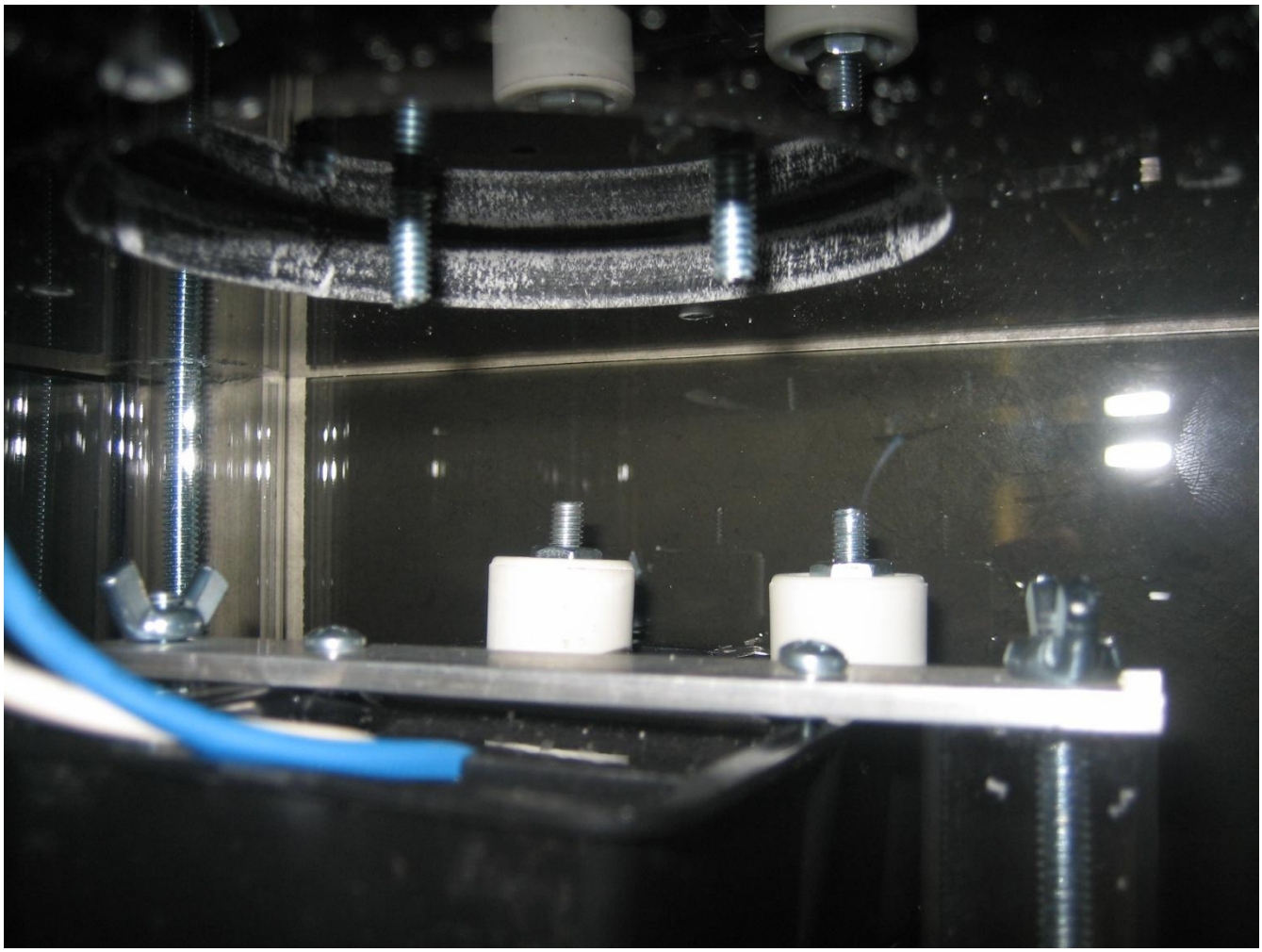
1) Place the four large ¼-20 x 6 inch bolts through the corner locations and then fasten them with the ¼-20 bolts.
2) Screw in the two 10-24 x 4 inch machine screws through the center locations.
3) Attach the rubber feet at each location. These will have a self adhesive on the bottom.





4) Connect the 6 L-Brackets the side locations and fasten the with the smaller 10-24 x 3/8 machine screws.
5) Connect the acrylic sides at the L-Bracket location using the 10-24 x 5/8 machine screws along with the 10-24 wing nuts.
6) Place in the appropriate acrylic tubes at the following locations as seen in the next illustration.
7) Attach the transformer mounting bracket and connect it with the 10-24 wing nuts.
8) Attach the transformer with the smaller screws that will be located with the rod braces in a smaller bag. These screws look like small wood screws. Because the transformer is very light, only slightly snug the screws that hold the transformer to the aluminum mount.

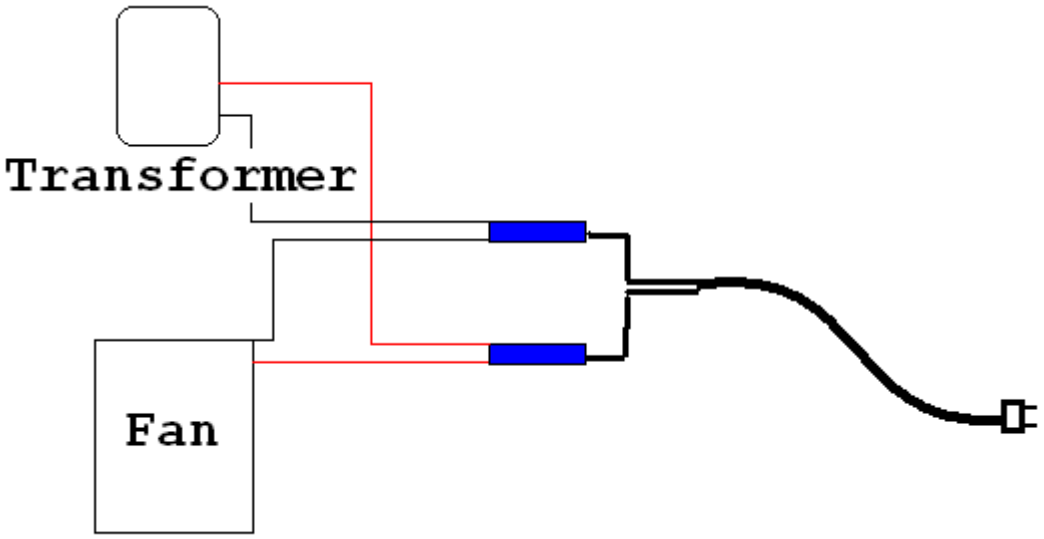




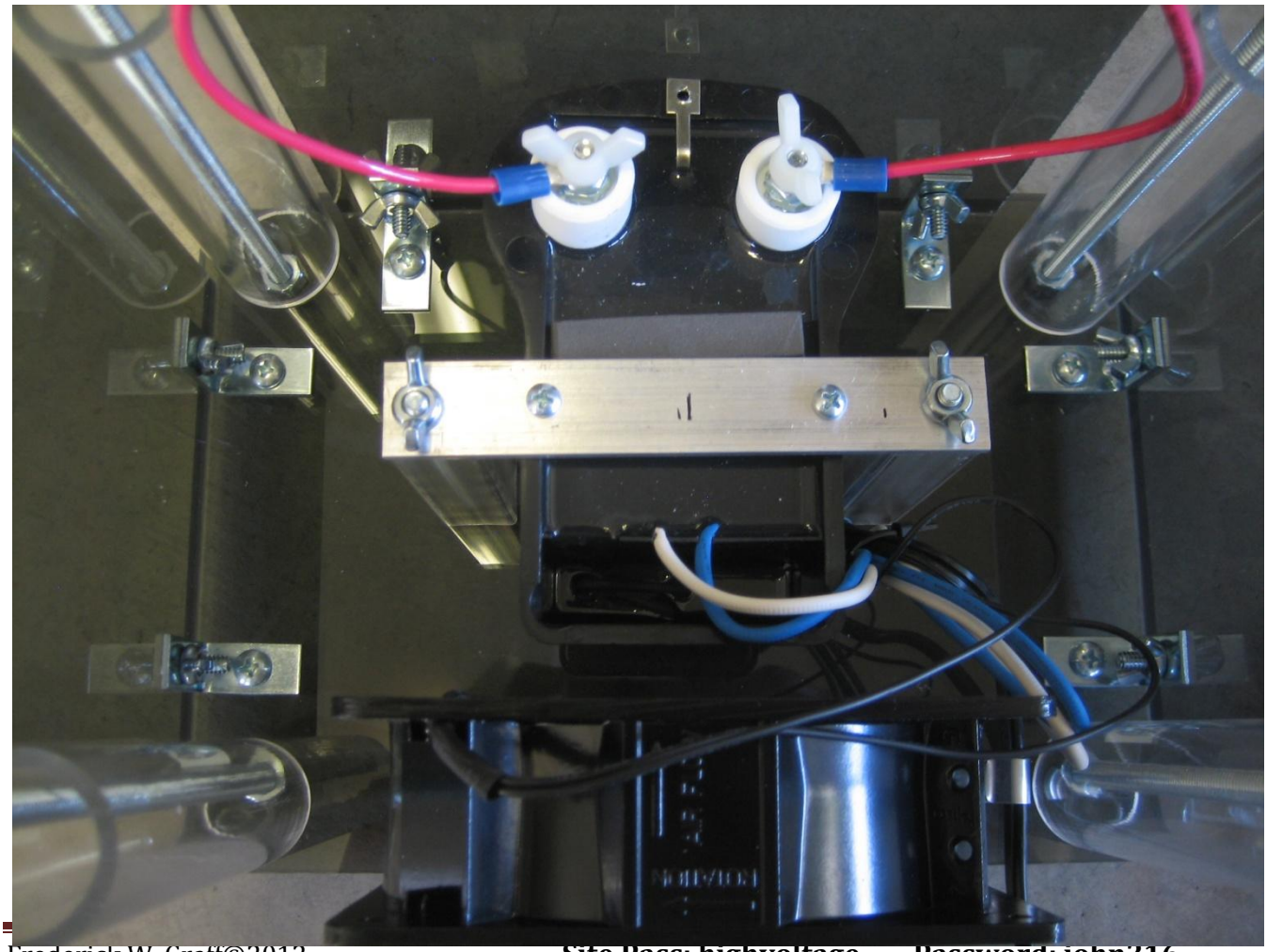
Wiring the circuit:

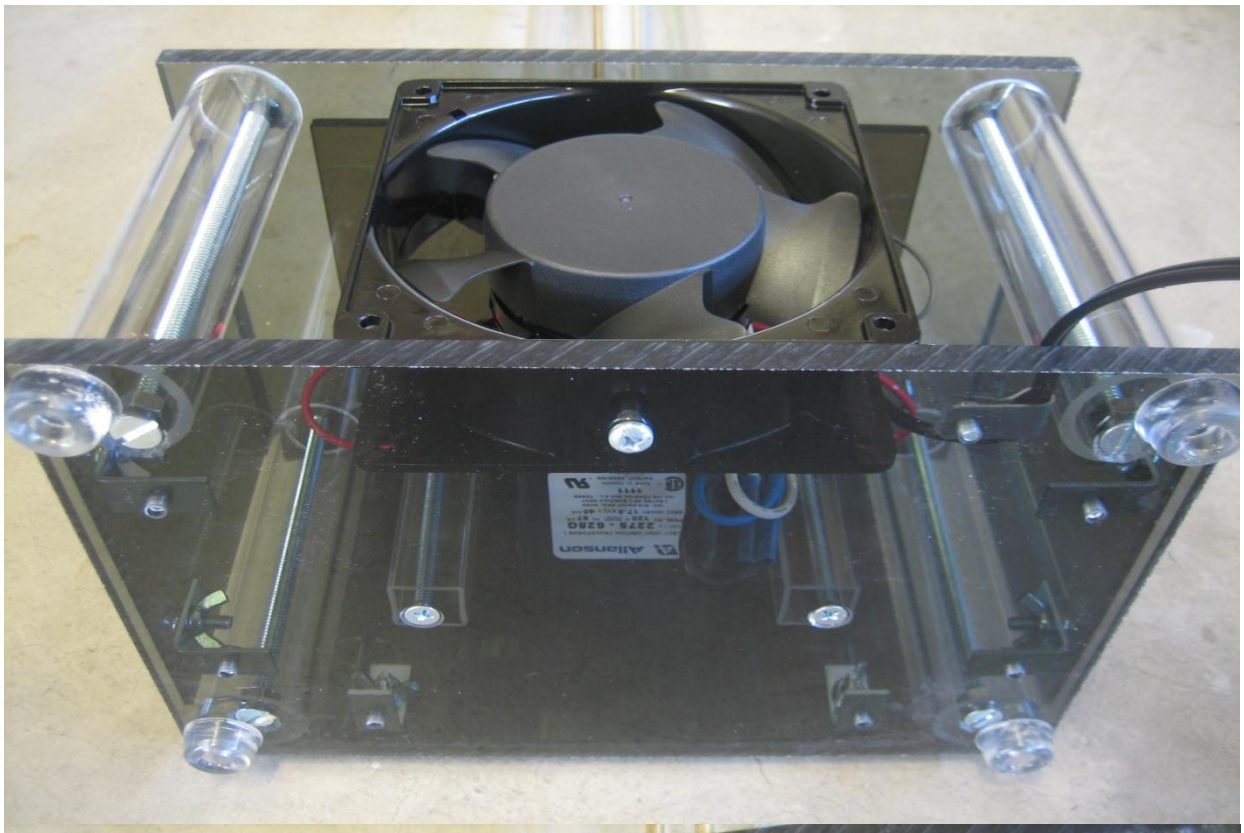
1) The fan and the transformer are wired in parallel with each other and will turn on simultaneously.
2) Connect one of the wires from the transformer to one of the wires from the fan and crimp both of them together on the same side using the blue wire connector. Do the same with the wires with another blue crimp terminal. Next, connect the other end of the crimp terminals to the power cord. Make sure that there is no wire exposed in the design.

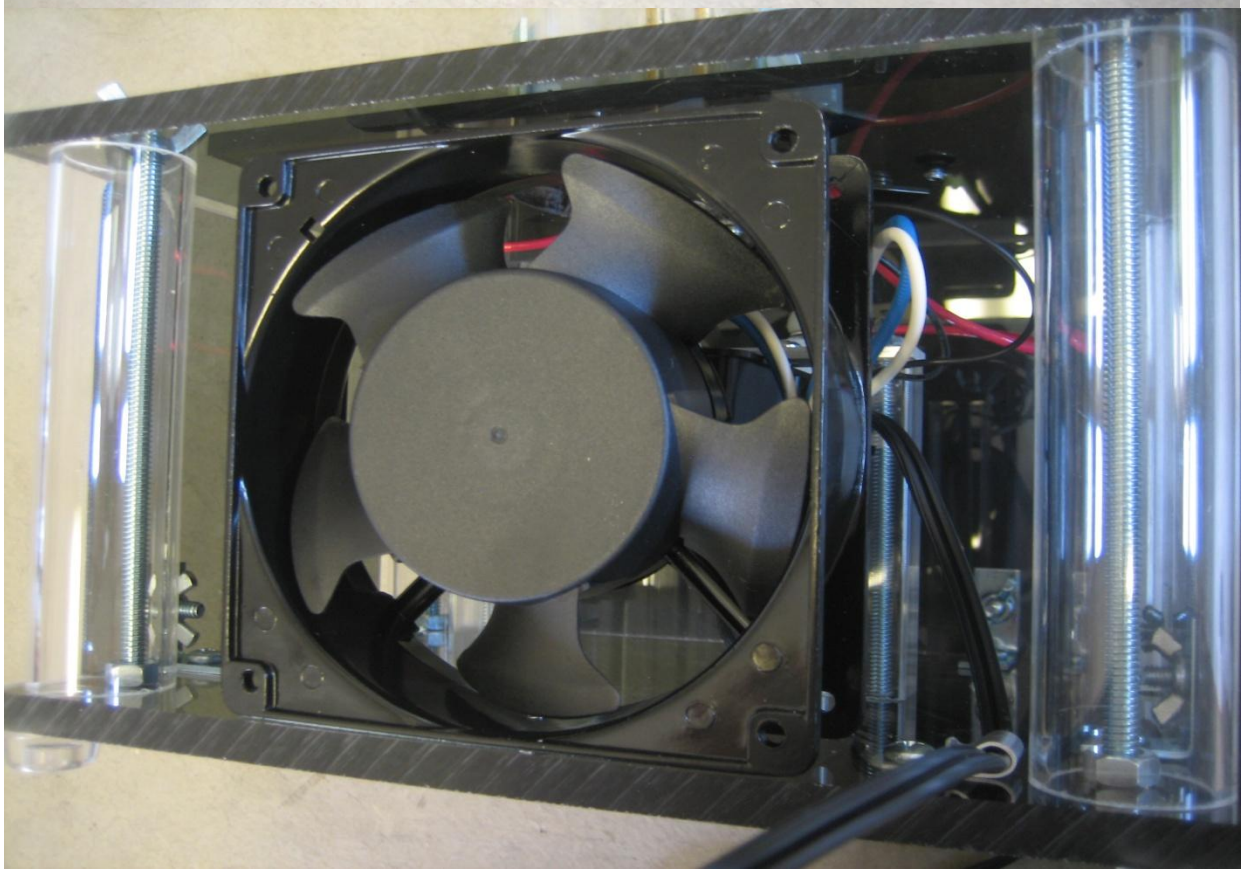
Jacob's Ladder Schematic Diagram



3) Fasten the fan using the 10-24 x ½ machine screw by inserting it from the bottom of the base. Only snug the screw. You may need to use a few small washers so that the screw does not interfere with the fan blade.
4) Next, attach the small aluminum wire brace to hold the power cord and situate the wires so that they are not touching the transformer aluminum support brace and nor motor fan. Four black zip ties have been included. If needed, use one of these to brace the wires, just know that they must be kept distant from the output wires from the transformer and its support because they will short out.

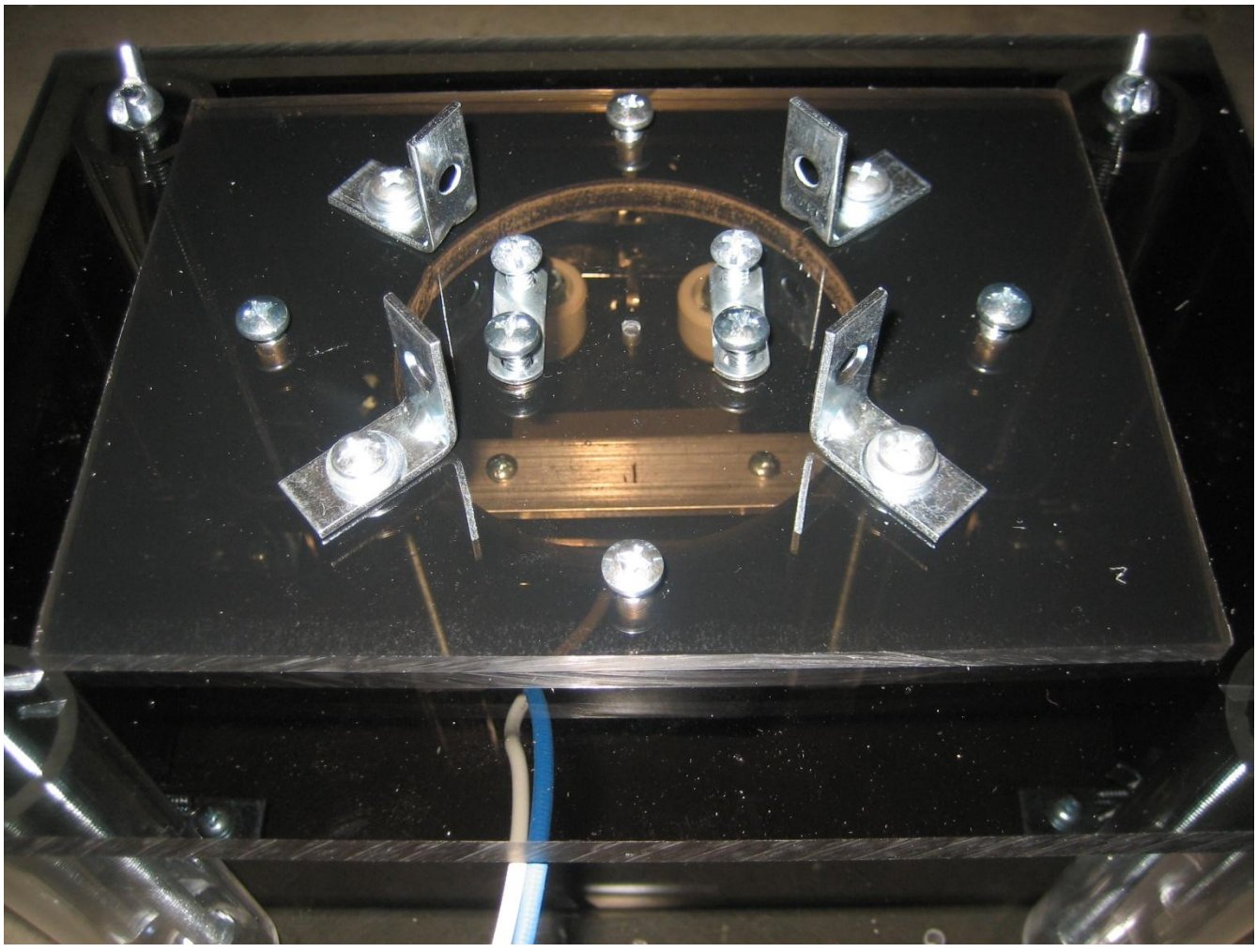




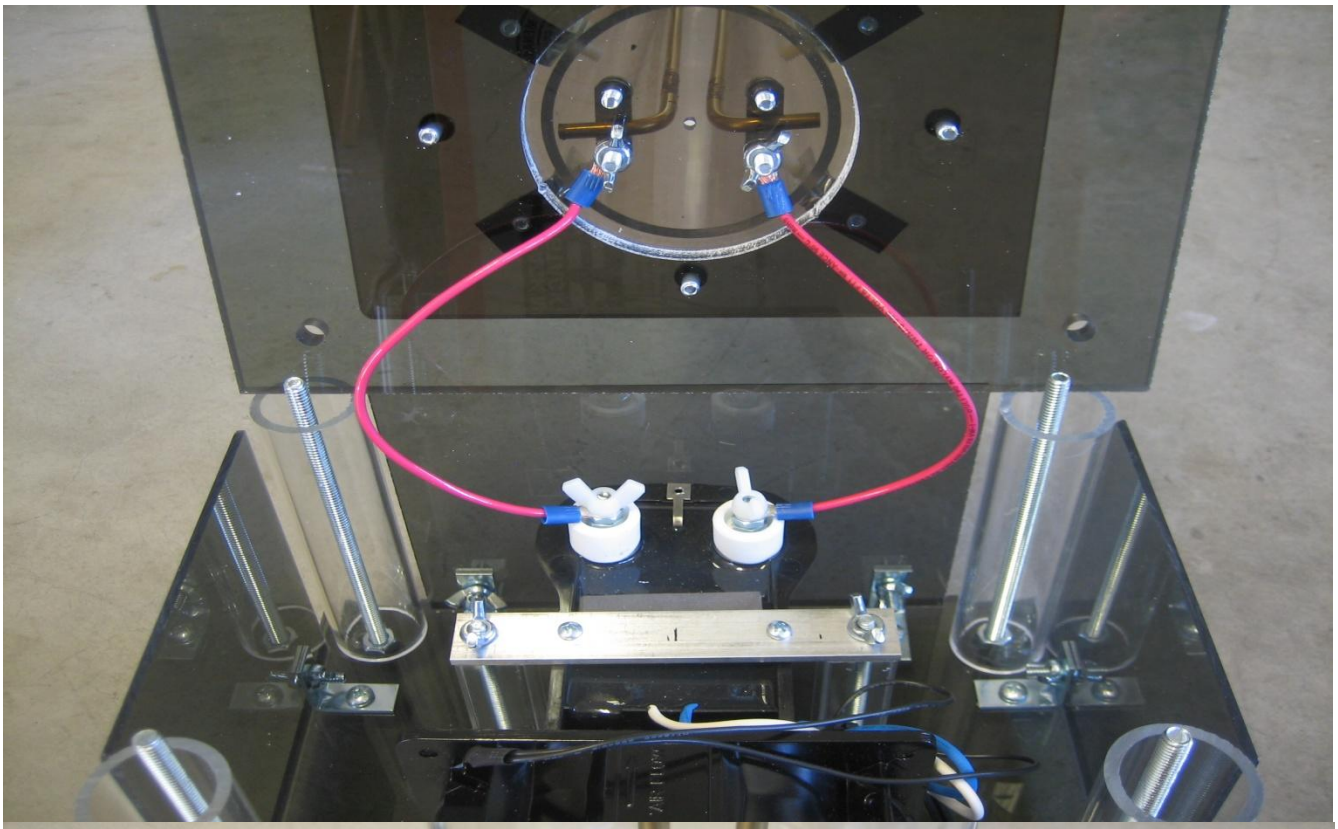


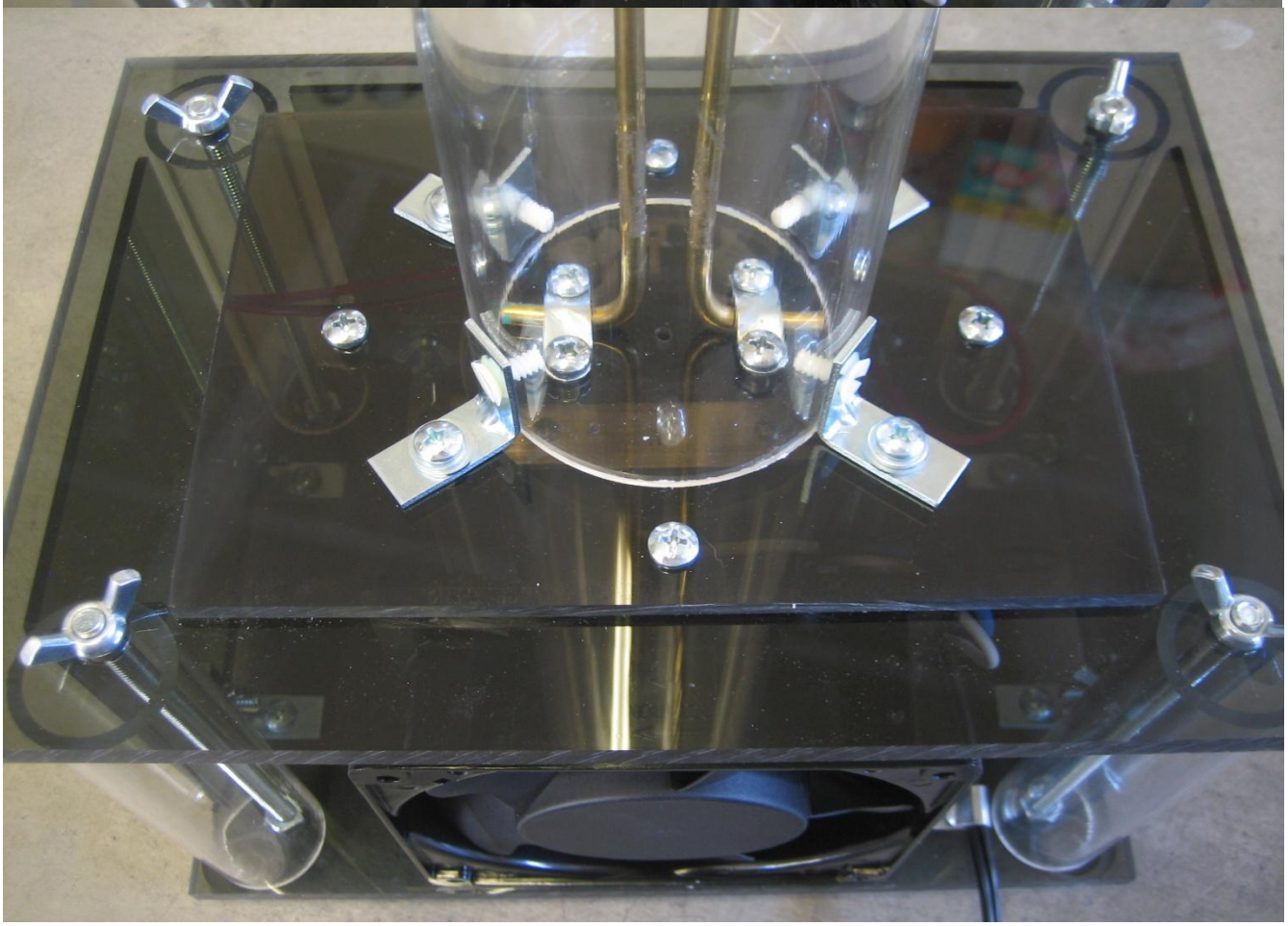
Arcing Rods and Tubing:

1) Connect the bottom of the tubing base to the top plate of the Jacob's Ladder Base. The acrylic will be fastened by using 10-24 x 5/8 machine screws.
2) Fasten on the 1 inch L-brackets using the 10-24 x 3/8 machine screws along with a few washers to space the screws. Next, attach the arcing rod support braces with two different machine screws. The side closest to the transformer output leads needs the larger 10-24 x 1 inch machine screws because these will be the screws the high voltage wires connect to.



3) Prepare the 36 x 3/16 brass arching rods by bending them both at ¾ at each end using a vice press.
4) Using flat jaw priers, curl the other end of each rod. This does take a bit of effort.
5) VERY IMPORTANT!!! Fasten each of the rods at the base so that the rods are a **3/8 of an inch** apart and no more. **If the bottom gap is too far apart it will initially overload the transformer and possibly destroy the circuit of the transformer.**
6) Manually adjust the angle of the rods so that they gradually draw apart toward the top. **It is better that the rods slightly bow out than in**.
7) Attach the bottom of the tube to the L-brackets with the 10-24 nylon screws.
8) At each end of the red wires, connect the blue ring connectors. Attach one end to the transformer using the nylon screws and the other end with the metal 10-24 wing nuts. Make sure that these wires bow away from each other when connected so that they cannot touch. Also, make sure that the wires do not touch the aluminum transformer brace.





9) Screw on the top plate with the larger wing nuts and prepare for an initial test.

<u>WARNING:</u> While testing, never make modifications while the system is plugged in!!!

- ✓ Check that the main power lines are not touching the aluminum transformer support system or fan blades. Use black zip ties or electrical tape if needed to separate and protect wires.
- ✓ Check that the high voltage red wires are not touching each other or the aluminum support system.
- ✓ Make sure all screws are fastened.
- ✓ Check that the top of the rods are far apart however not yet fastened because you may need to make adjustments.
- ✓ Check that the bottoms of the rods are not more that 1/4 to 3/8 of an inch apart.

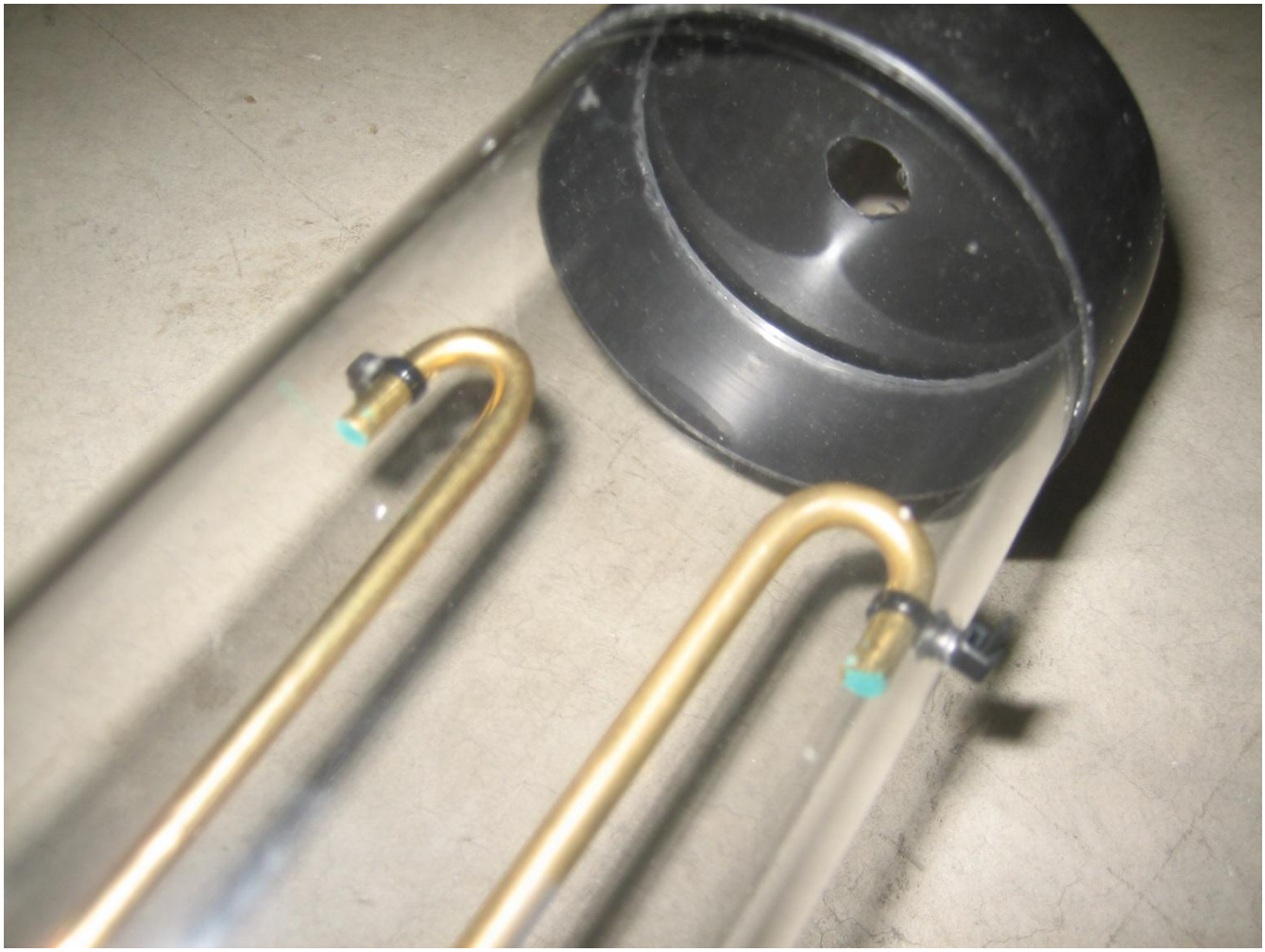
10) The entire system should be thoroughly connected. With your left hand behind your back for safety and you are not touching any part of the ladder except the power supply, turn on the system for no more that 45 seconds. The fan should start up and the arc should start to run up the column.

11) **Unplug the system before you take the next steps!!!**

12) Trouble shooting: (Must have power off while trouble shooting)

- ❖ If the arc is stuck at the bottom slightly widen the bottom of the rods.
- ❖ If the rods are bowed inward the arc may not climb to the top.

13) Once the system is running properly, you will need to find the top hole locations to run the black zip ties through to secure the top of the brass rods. Eye the locations and then place a mark to drill the holes through the acrylic.
14) First drill using a 1/8 drill bit and then use a large 3/16 bit. Run the drill bits in reverse otherwise the acrylic will crack unless you have special acrylic drill bits.
15) Connect the top black end cap to the tubing and use a box knife to cut out a small 1/n hole to allow the gases to escape.



Jacobs Ladder Operation and Safety:

1) Only use the Jacob's Ladder in well ventilated areas.
2) Never leave unattended.
3) Never touch the ladder while in operation and always keep it in safe location away from reach.
4) Never stick body parts or foreign object in the unit while running
5) Do not operate if under the influence of medication or drugs.
6) The transformers are designed to have a constant duty cycle so there are no time limits on the run time.

WARNING: Use at your own risk.

Solid State Jacob's Ladder Part Check List:

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Instructions are accessed from the website under Jacob's Ladder Kit Instructions

Base and Structure Components:_____

1) ____Top and Bottom Acrylic

2) ____3 side panels

3) ____ Tubing Base

4) ____ Acrylic Tube

5) ____ 4 Rubber Feet

6) ____ (2) Acrylic Transformer Supports

7) ____ Aluminum Transformer Support

Electrical_____

1) ____ 17.5 KV Solid State Transformer

2) ____ 120 x 120 x 38 AC Cooling Fan Tapped 10-24

3) ____ Extension Cord

4) ____ 2 Wire Braces

5) ____ 2 Wire Connectors

6) ____ 4 Ring Terminal Connectors

7) ____ Aluminum Wire Brace

8) ____ 3/16 x 36 Brass Electrodes

9) ____ 5 Black Zip Ties

10) ____ Tubing Cover

11) ____ Two Sections of 16 Gauge Wire

12) ____ Danger HV Sticker

13) ____ (2) Brass Electrode Brace

Hardware:_____

1) ____ (4) 1/4 x 20 x 6 Bolts

2) ____ (4) 1/4x20 Bolts

3) ____ (4) 1/4 x 20 W-nuts

4) ____ (10) L-Brackets

5) ____ (2) 10-24 x 4 Bolts

6) ____ (11) 10-24 x 3/8 Screws

7) ____ (12) 10-24 x 5/8 Screws

8) ____ (10) 10-24 W-nuts

9) ____ (2) 10-24 x 1 Screws

10) ____ (2) 10-32 Nylon Wing Nut

11) ____ (2) Transformer Screws

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