

# *the Bell Jar*

## Vacuum Technique and Related Topics for the Educator & Amateur Investigator

**Notes from the Vacuum Shack**

**No. 15 February 2021**

**In this issue:**

- Update on Chuck Sherwood's electron beam source and related efforts
- Construction of a surface micro-discharge (SMD) atmospheric pressure plasma source
- Electron Tube Store – materials and components supplier
- Articles of possible interest in *Vacuum Technology & Coating*

**Update on Chuck Sherwood's Electron Beam Source and Related Efforts**

In the December 2020 issue, Chuck Sherwood described his work on glass tube to metal fitting adapters and some early progress on his electron beam source. The electron source and window were left for later. The following pulls together some further updates. Chuck may be reached at [chuck1024@wowway.com](mailto:chuck1024@wowway.com)

A recent acquisition was a glass tee made from 1.5 inch borosilicate beaded process pipe. Below is a picture of the tee with a homemade KF40 adapter using Apiezon W wax as the seal per the notes in the December issue. He notes "here is a picture with wax in the joint. I tried to pour it but the wax was just too thick to pour even though the infrared thermometer showed a temp of 240 °F. I applied with a stick and heated it with a heat gun until it flowed down and then rotated the joint a little to work the wax into the joint. I used a lot of paper towels and solvent to clean the excess off." The photo below on the right shows a newer, shorter version of the wax sealed glass to KF adapter alongside the older version.



*the Bell Jar*, No. 15, February 2021

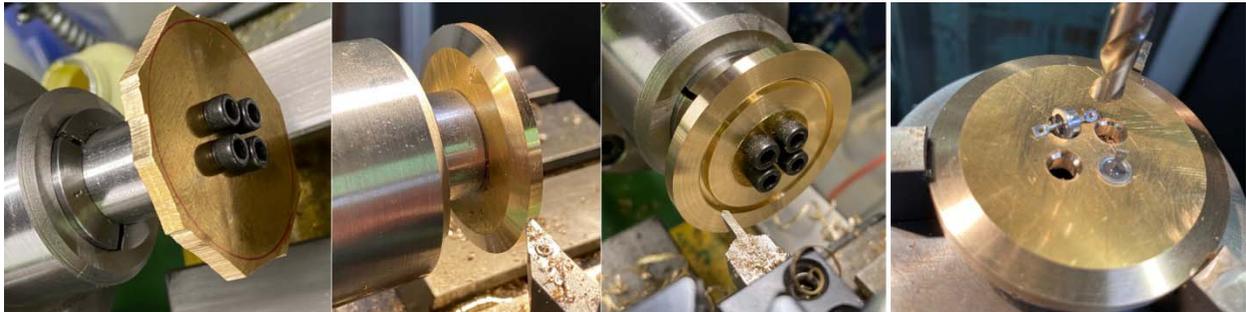


Turning to the electron source, Chuck had a KF40 base from a nude ion gauge. The photo to the left shows the base with a filament assembly that was extracted from a 3.6 volt screw base bulb. “I managed to extract [the filament] assemblies by crushing the base and glass envelope in a vise. The end result is a filament with a support bead.”

This filament can produce a 100 uA electron current when heated with about 2 volts. This allows the filament to run from batteries and biased at negative high voltage so that the anode can run at ground potential. Emission regulation can be as simple as a filament rheostat.

The next step was to replace the hard to get ion gauge base (or similar commercial feedthrough) with a simpler assembly. This approach used a homemade KF40 brass blank, drilled for solderable feedthroughs. Brass was chosen for its solderability and homebrew was necessitated by the discontinuance of brass vacuum components.

The raw stock was 3/16” thick brass. The photographs below show the general sequence. Knowing it was going to have 4 feedthroughs he drilled four holes to clear 10-32 screws and made a matching arbor to hold the plate during machining. The steps included turning to the correct KF40 diameter, cutting the clamping bevel and then cutting the groove for the center ring.



Removed from the lathe, the holes were enlarged to fit the feedthroughs and then counter sunk just a bit to make the feedthroughs flush. Chuck found some cheap feedthroughs on eBay, item number 263792708668. In the photograph above right, one feedthrough has been inserted into a hole and another is laying across the hole.

“I prefer 97% tin, 3% silver solder but it has a higher temperature and I didn't want to risk it. I did not know how much heat the feedthroughs would tolerate so I used 60/40 electronic solder and a large 80 watt iron. After getting the plate pretty hot, I could melt the solder near each feedthrough. It was not pretty but it holds well and I pumped it down into the "sixes" on the first try. In the future, I will try applying solder paste and then heat with an induction heater. It is

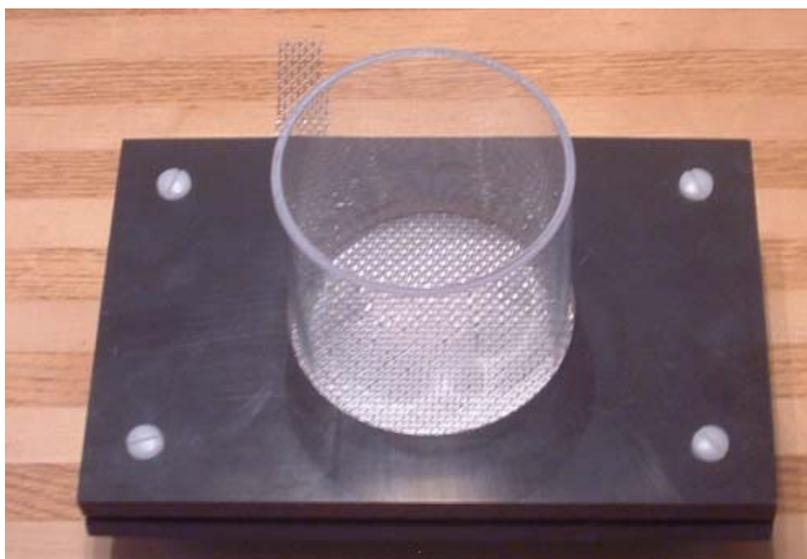
presently too cold to work in the garage where the induction heater is located.”

Below is photograph a two bulbs attached to feedthroughs and lit under vacuum. One of the bulbs still has the glass envelope and the other one has the envelope removed.



### **First Build of a Surface Micro-Discharge (SMD) Atmospheric Pressure Plasma Device**

Last month I presented an overview of the SMD configuration and a drawing of a version I was assembling. I completed it a few days ago and the design is as presented previously. The only difference is that I have used a slightly larger (3” diameter) powered electrode. Below is a photograph of the unit with the 4” diameter x 4” tall acrylic bell jar set in place. The ground connection to the mesh is via the tab to the rear left. The high voltage connection is underneath.



The photograph below is a side view showing the sandwich assembly. The self-stick bumpers are the thickness of the powered electrode. There are 16 of them and they serve to keep the powered disk electrode, Teflon dielectric and wire mesh flat when the 4 corner screws are tightened.



I hooked it up to the same 20 kHz power supply that I've been using for my atmospheric pressure plasma jet (APPJ) experiments and it worked but the discharge was only visible in a darkened room. I tried to take some photographs but the images were too dim to show much of anything. It does produce good quantities of ozone (based on odor) along with, I'm sure, the various other reactive oxygen and nitrogen species that are associated with an air atmosphere cold plasma. Touching the grid, of course, produces no sensation. I will be trying it out with a beefier supply as a next step.

### **Electron Tube Store**

A few years ago I was looking for some small diameter (1 mm) pure tungsten rod for a project. I happened on Electron Tube Store in Cap-aux-Meules, Québec, Canada (<https://electrontubestore.com/>). They have various wires including tungsten, thoriated tungsten and dumet plus plate, mesh and even mica tubing.

### **Articles of Possible Interest in *Vacuum Technology & Coating Magazine***

August 2012

#### ***The Vacuum Way Back Machine: A look at how it was in the early days***

Vacuum hardware from the first half of the 20<sup>th</sup> century.

July and August 2014

#### ***Differential Pumping in Vacuum Systems***

Part 1: Use of a guard vacuum

Part 2: Progressive vacuum and air-to-air systems

March 2015

#### ***Manometers and Boyle's Law***

Various forms of McLeod gauge and even a approach to extend the low end measuring range of modern gauges.

Articles may be accessed at <http://vtcmag.com/>. Scroll to the bottom of the page to the back issue selection box. Look for my columns and you can probably find other articles of interest in each issue.

## **End Notes**

My apologies to Mark Atherton. In compiling his power supply article that appeared last month I omitted the schematic. I have updated the January 2021 issue to include that rather important piece of information.

I'm working on the latest version of my saddle field atom/ion source. Actually, it's turning into a family with several KF50 housings, ancillary extraction electrodes and so forth. Not enough to report on this month but more will be coming over the next couple of issues..

Steve