# A Primer on Using Ace Threds®

**Adding feedthroughs to glassware**

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## I. INTRODUCTION

I have frequently mentioned Ace Glass Corporation's [http://www.aceglass.com] line of proprietary Ace Thred® connectors. Ace patented the configuration in 1972 [1] as a gas tight, low stress connector. Ace makes the claim that this is "the most important glass connection since the spherical joint." That may or may not be so, but I have found these connectors to be wonderful for vacuum chambers that are designed for service in the ranges down to high vacuum.

The principle of the Ace Thred is shown in Figure 1 below. The thred itself is a precision molded connector of borosilicate glass. The glassblower attaches this connector to the apparatus at the desired locations. The other parts of the thred consist of a nylon bushing and a fluorocarbon o-ring. When assembled around an appropriately sized rod (usually aluminum if the rod is serving as an electrical feedthrough), the tightening of the bushing compresses the o-ring between the glass connector and the rod. The bushing is not exposed to vacuum thus making the seal compatible with medium and high vacuum systems.

## II. SPECIFICATIONS

The table below shows Ace Glass' published data for the various sizes of Ace Thred bushings. My favorite sizes are numbers 7, 11 and 25. These take rods or tubes in diameters of 1/4, 3/8 and 1 inch respectively.

In my experience the vacuum ratings are on the conservative side. I have used sizes to #25 in applications well below $10^{-4}$ Torr.

| Thred Size | Rod OD (mm) | Vacuum (Torr) |
|---|---|---|
| #7 | 6-7 | $<10^{-5}$ |
| #11 | 9-10.5 | $<10^{-5}$ |
| #15 | 12.5-14 | $<10^{-5}$ |
| #18 | 16-17 | $<10^{-4}$ |
| #25 | 24-25 | $<10^{-4}$ |
| #36 | 34-35 | Not Rated |
| #50 | 47-48 | Not Rated |
| #80 | 80 | Not Rated |

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Materials selections for the bushings are nylon and teflon. Since the bushing itself is not exposed to vacuum, nylon may be used for all applications except where better temperature performance is required. Plugs

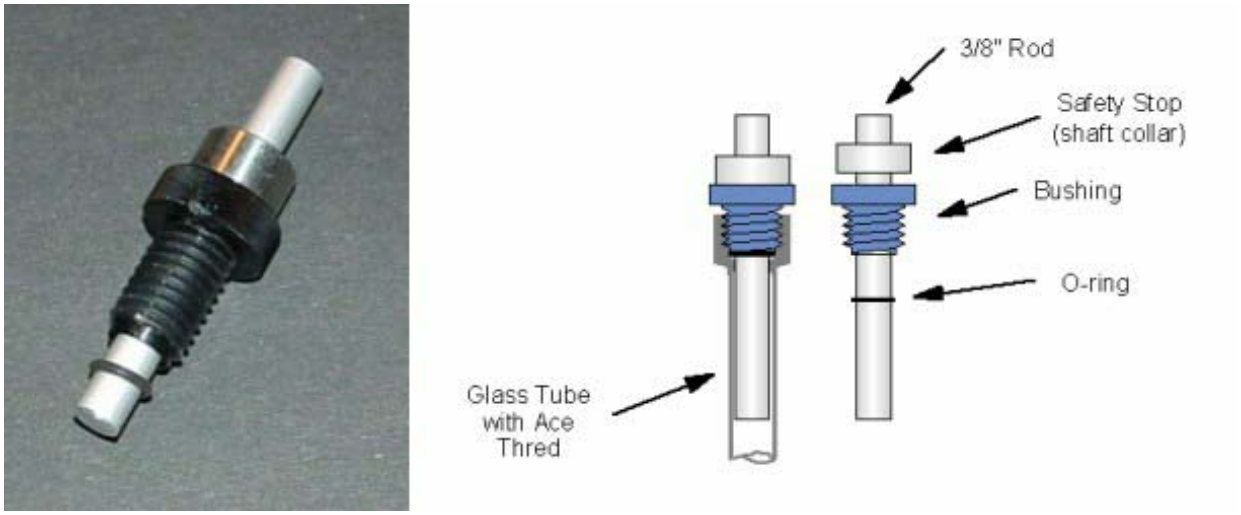


**Figure 1** - **#11 Ace Thred with 3/8 inch Diameter Aluminum Feedthrough**

(discussed later) are different in that the nose of the plug is exposed to vacuum.

## III. SAFETY

In the case of straight rod sections that are inserted into Ace Threds it is essential that some kind of stop be added so that there is no chance of the rod being drawn though the fitting by the differential pressure created by the vacuum in the apparatus. This can be done by machining a step into the rod or, as shown in Figure 1, affixing a shaft collar or other device. Shaft collars are convenient since they can be easily repositioned.

I have seen a 3/8" rod get propelled axially through a piece of glassware when the Ace Thred bushing was loosened just a little bit. The result, fortunately was minor damage but the velocity of the rod was high enough to puncture the screened center rings at the pump out port. Needless to say, if the rod were aimed at an adjacent glass wall, it would shatter the apparatus.

As a final note, as with all glass vacuum (or pressure) apparatus, use protective eyewear at all times.

## IV. AN EXAMPLE

When I was a teenager I constructed (well, partially constructed - I ran into problems with the van de Graaff generator) a simple potential drop particle accelerator following Frank Lee's design that was described in a 1959 Scientific American *Amateur Scientist* column [2]. A later column [3] described a design for a similar apparatus by Larry Cress. Figure 2 shows a rendering of the upper part of Cress' accelerator tube.

Cress' tube consisted of several pieces of 1-1/4 inch diameter pyrex tubes, each about 3 inches in length. The simple ion source, driven by a spark coil, was mounted on a disk of lucite. The acceleration electrodes were disks of brass with ¾ inch copper tubes soldered to holes in the disks. All of the components were joined with vacuum sealing wax (Apiezon W).

My take on an implementation with Ace Threds is shown in the right hand side of Figure 2. Please note that I have never built this specific tube but I have done equivalent structures many times.

The ion source is at the top of a tube that incorporates a ring seal and is topped with an 11mm Ace Thred. A sleeve with a threaded hole in the side slips over the inner 5/8" outside diameter tube. A 7mm Ace Thred is to the side and the 1/4" diameter rod has a threaded piece that screws into the sleeve.

The acceleration electrodes are rings that are fitted to the glass tubing. Within the rings (or machined as part of the rings) are tubes, much like the copper tubes in Cress' design. As with the ion source electrode sleeve, a 7mm Ace Thred is associated with each electrode.

The target is held in a side arm that is terminated in a 25mm Ace Thred. This permits easy insertion of the targets.

Finally, the bottom of the tube is a straight section that mates with a compression adapter.

## V. A MULTI-PURPOSE DISCHARGE TUBE

A "real" design is shown in Figure 3. This tube may be used as an x-ray source, electron accelerator or simple ion accelerator. A Langmuir probe may also be inserted into the tube.

At the top of the tube is a #11 Ace Thred. The top section of glass is sized at 1 inch inside diameter so that 1 inch rod and tube stock can be used for electrodes. A #7 feedthrough is provided just below this section. This may be used for a number of purposes such as for a bias or extraction electrode. This is also where a Langmuir probe would be inserted.

The bottom side feedthrough is a #25 Ace Thred. This can be used for targets, to hold a phosphor screen,

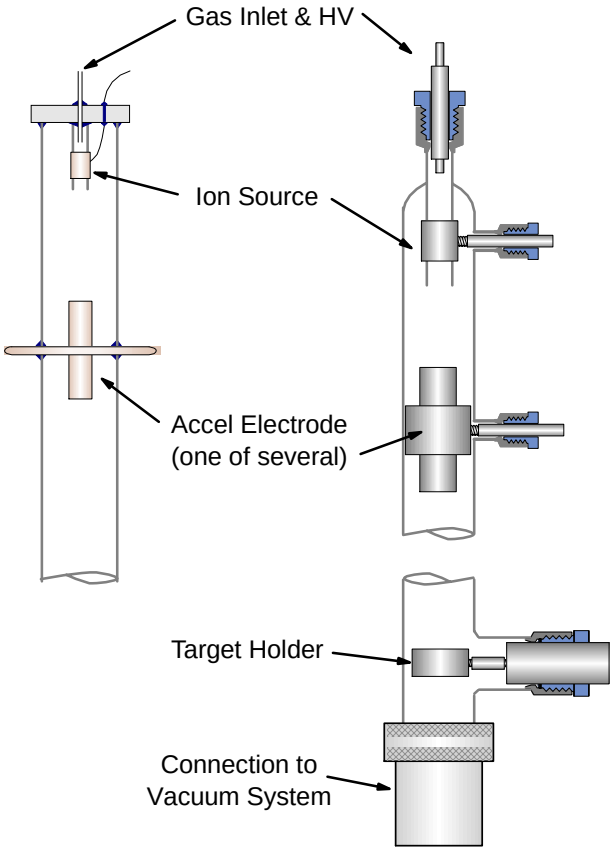


**Figure 2 - Accelerator Columns**

or as a sample holder if items are inserted for ion or electron irradiation.

At the lower end is a straight section of 1-3/8 inch diameter, sized to fit a standard compression fitting.

Figure 3 shows the tube in a simple cold cathode x-ray tube configuration. The cathode is an aluminum "dish" 1 inch in diameter. The target holder is made from 1 inch rod stock with one end milled half way through. Two 8-32 holes are drilled and tapped in the flat section, about 1 inch apart. The target is made from sheet tungsten (salvaged from an evaporation boat) that is fastened by clamping the sheet under the heads of the two screws. Figure 4 is a photo of the same tube in the cold cathode x-ray configuration.

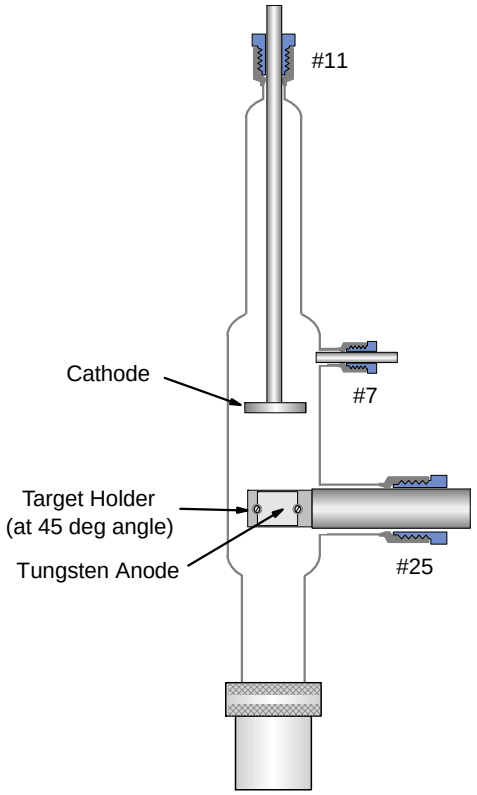


**Figure 3 - Multi-Purpose Discharge Tube**

## VI. PLUGS & ELECTRICAL FEEDTHROUGHS

Another useful piece of Ace Thred hardware is the face seal plug. As shown in Figure 5 these are simply solid bushings that have an o-ring groove near the tip. (There are also plugs that seal just under the head of the plug but these expose the entire length of thread to vacuum and, in my experience, are not as reliable under vacuum.)

**Figure 4 - Tube Configured for X-Ray Production**

Plugs can be used to make electrical feedthroughs and are especially valuable when several connections are to be made and where the plug might serve as the support for a subassembly that will be in the vacuum chamber.

Materials selection is important in the case of plugs as the plug material is exposed to vacuum. I've used nylon plugs in the #36 size down to 1 micron and teflon #50 well below that.

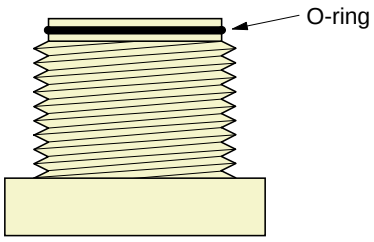


**Figure 5 - Ace Thred Face Seal Plug**

My method for making a feedthrough is shown in Figure 6. This is a 2 electrode feedthrough that I made for a miniature evaporation chamber that's being used at a technical college. In this case I used a 36mm plug made of nylon.

I used 5/16 inch diameter aluminum rod with 8-32 hardware. I drilled the plug part way through the same diameter as the rod and then continued each hole to clear a length of 8-32 brass threaded rod. The seal is made by placing a small o-ring on the threaded rod

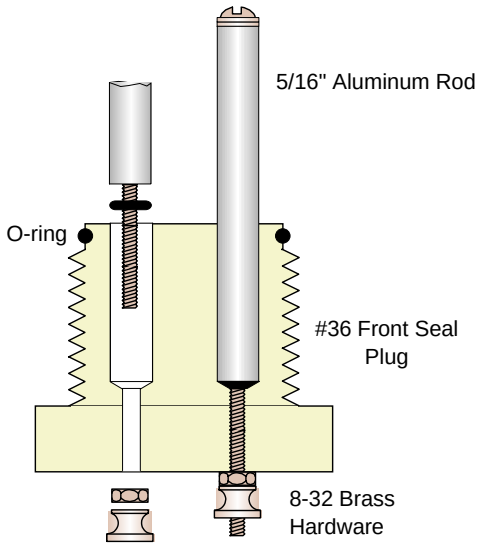


**Figure 6 - Feedthrough**

where it will be compressed at the bottom of the aluminum rod when the hardware is tightened. A suitable o-ring for this application would be 5/32" inside diameter x 9/32" outside diameter (1/16" cross section). Needless to say, the bottom of the aluminum should be machined to a smooth finish.

The smallest rod that I have used is 1/4" diameter with #6-32 hardware. A suitable o-ring would be 1/8" inside diameter x 1/4" outside diameter (1/16 cross section).

Figure 7 shows an RF feedthrough built for a small RF sputtering chamber. The connector is an HN bulkhead mount type . The wire that is shown is the ground connection that goes from the connector housing to the substrate holder.

## CITED REFERENCES

[1] Charles M. DeWoody, *Flexible Pressure-Type Joint for Rigid Tubing*, US Patent 3.695,642, October 3, 1972.
[2] C. L. Stong, *How to Make an Electrostatic Machine to Accelerate Both Electrons and Protons*, Scientific American, June, 1959.
[3] C.L. Stong, *How to Build a Machine to Produce Low Energy Protons and Deuterons*, Scientific American, August, 1971.

**Figure 7- RF Feedthrough**