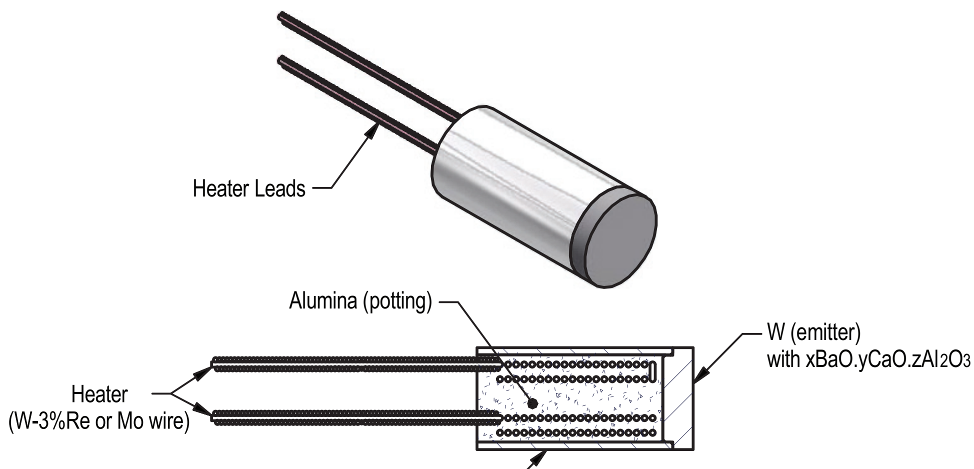
Mounting Configurations

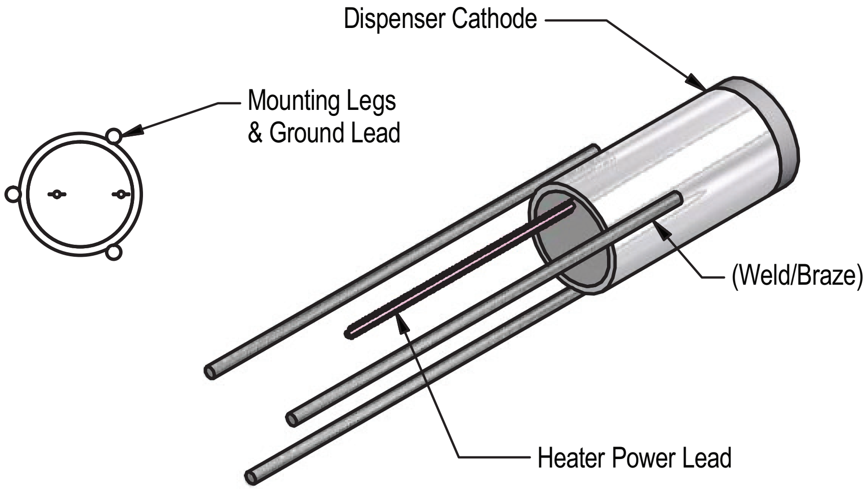
Spectra-Mat, a world leader in dispenser cathode manufacture and technology since 1963, is frequently asked for assistance in designing an appropriate cathode mounting structure. This bulletin describes some mounting structures for consideration.

A basic dispenser cathode is shown in figure 1, along with a cross section and reference materials. The cathode has no specific mounting structure but can be held by the leads themselves without fear of damage during operation.



Dispensor Cathode - Fig. 1

The caveat with using the heater leads as a mount is the lack of precision in position. The leads are wire and will flex and move slightly during operation, either from thermal changes associated with the heater, or through vibrations external to the vacuum device. There are devices relatively immune to problems from small movements of the cathode – HeNe lasers and some x-ray tubes, for example – where this simple mount is appropriate.



Tripod Wire Mount - Fig. 2

One can also mount the basic cathode of figure 1 by directly spot welding or brazing to the body. This does create a large thermal (conduction) path, and is not very efficient in terms of power.

Other devices might require much better position and beam accuracy. Adding a few wires solidly brazed against the molybdenum body provides greater solidity to the next component (see figure 2). Precise positioning can be achieved when building the gun structure. Legs can be inserted into stainless steel or other weldable material and welded or brazed into final position.

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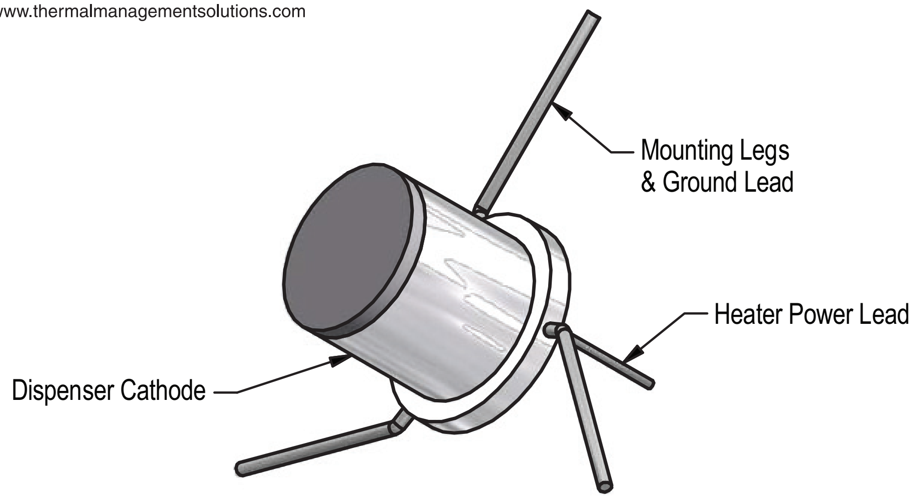


Tripod Wire Mount (Rotating Expansion) - Fig. 3

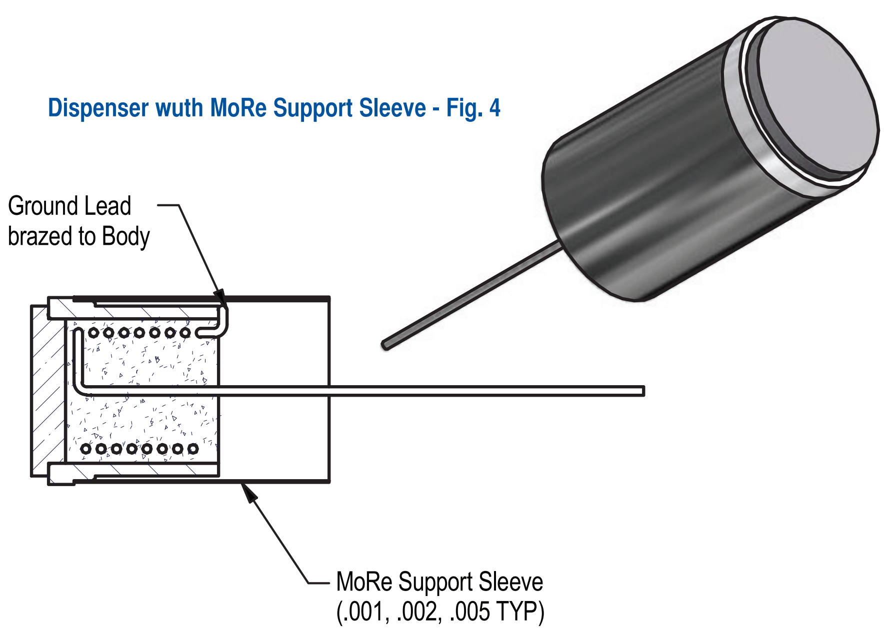
We gain thermal isolation by increasing the conduction path as compared to attaching to the body directly. One has to figure in an estimate of the thermal expansion of the legs in the "hot" state, as the three legs along the axis of the cathode insures thermal positioning remains parallel to the cathode axis.

We can add a cylindrical sleeve component to the molybdenum-rhenium (MoRe) body. The cylindrical sleeve is much stiffer and radial position is maintained. MoRe, unlike pure molybdenum, can readily be spot welded; creating a weld joint to the next higher assembly is relatively straightforward and acceptable practice with no fear of problematic welds.

The expansion of this unit is linear along the center axis of the cathode. Radially it is very robust, without much movement. With a small bit of calculation one can make a reasonable first estimate as the "hot" position. SMI would assume the mating part remains at ~ 400°C, the cathode at 1000°, and the expansion approximately equal to the length of the sleeve times the expansion rate of MoRe (~.0035 in/in sleeve length). More precise values might be necessary in the gun structure and require knowledge of the mating materials.

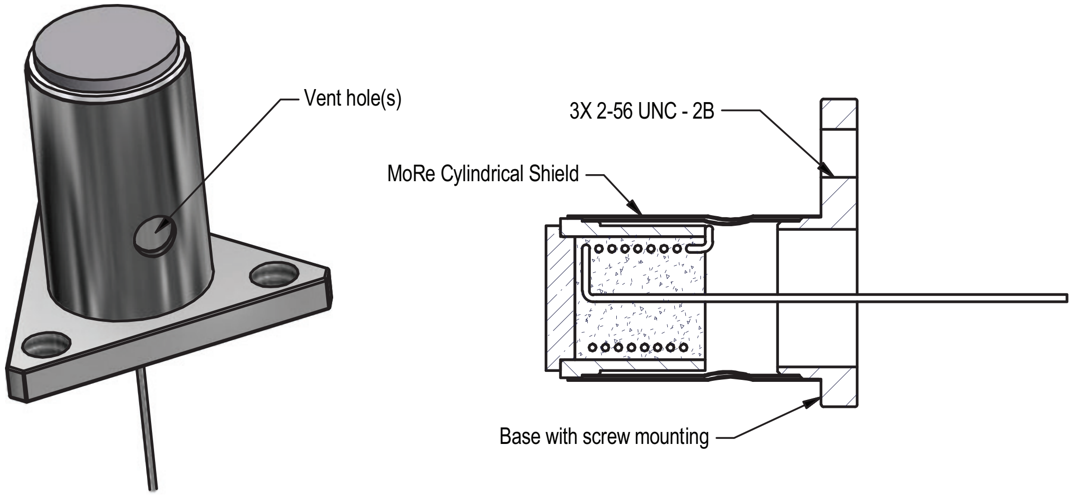
Two additional structures are frequently employed during gun design. First, a molybdenum, stainless steel (304L or 316L) or Kovar® or other metal base may be attached – usually brazed -- to the molybdenum support sleeve. A base with threaded holes, as shown in figure 5, provides an easily attached to mounting surface, and if requested, a datum upon which to include a cylindrical shield (or multiple cylindrical shields). A Kovar or Monel® base is attached to a supporting structure via welds. Kovar™ was designed specifically as a thermal match for borosilicate glass and can be attached directly to a glass vacuum envelope.

Dispenser wuth MoRe Support Sleeve - Fig. 4



1 Kovar is a registered trademark of Carpenter Technology Corporation. Monel is a registered trademark of Special Metals Corporation.

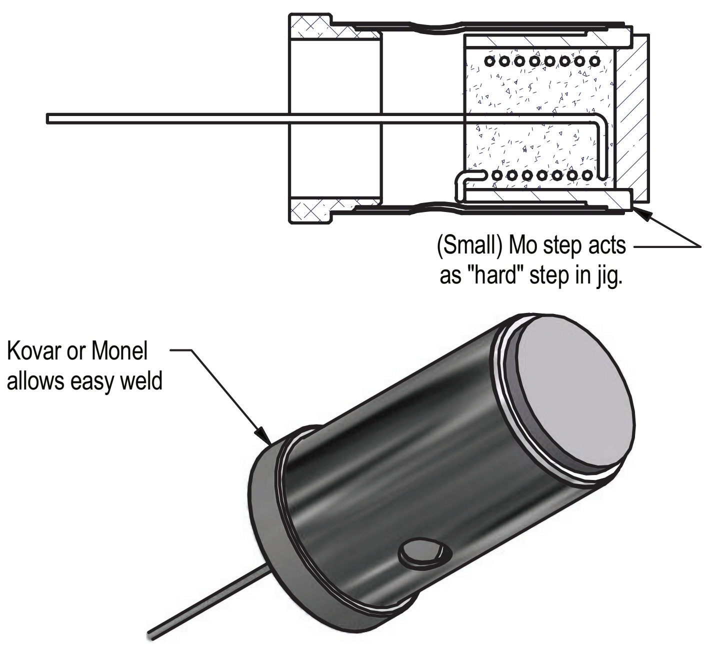
A stepped base may also be created, without the screw holes, and may be clamped between mating parts or welded securely, as shown in figure 6.



Cathode with Base and Cylindical Shield - Fig. 5

A base screwed to a plate (with vented screws) may provide superior positioning in many applications. Alternatively, jigging the part against the molybdenum body (see section of figure 6) allows the base to float and more precisely positions the emitter. SMI can very accurately position the emitter to the molybdenum surface. By including a final machine operation, the concentricity between the base and emitter can be held to that of a typical lathe, <.0005”.

Both figures 5 and 6 expand along the linear axis, but can be exceptionally well positioned radially. Both show heat shields and are more power efficient than the more basic configurations. Both of them are also significantly more complex than that of figure 1. The trade is ease of assembly into the gun.



Cathode with Base (weld or clamp) - Fig. 6

One final configuration, a re-entrant design, can be accurately designed to remove the thermal expansion along the linear axis and maintain exceptional concentricity. A re-entrant design has two sleeves expanding in opposite directions, as shown in figure 7. This can be designed with single or multiple heat shields, as well. Figure 7 shows a single cylindrical heat shield and through holes for screw attachment to a mating flange. The mating surface is usually near the cathode surface, and the cathode and flange surfaces are machined as matching datums. Either the top or bottom of the flange mount may be defined as the mounting surface by identifying it as the reference datum to the cathode. In practice, this is a very effective approach to eliminating the thermal expansion differences. It also provides excellent positioning from the cathode surface to the mating surfaces. Again, the cathode becomes more complex.

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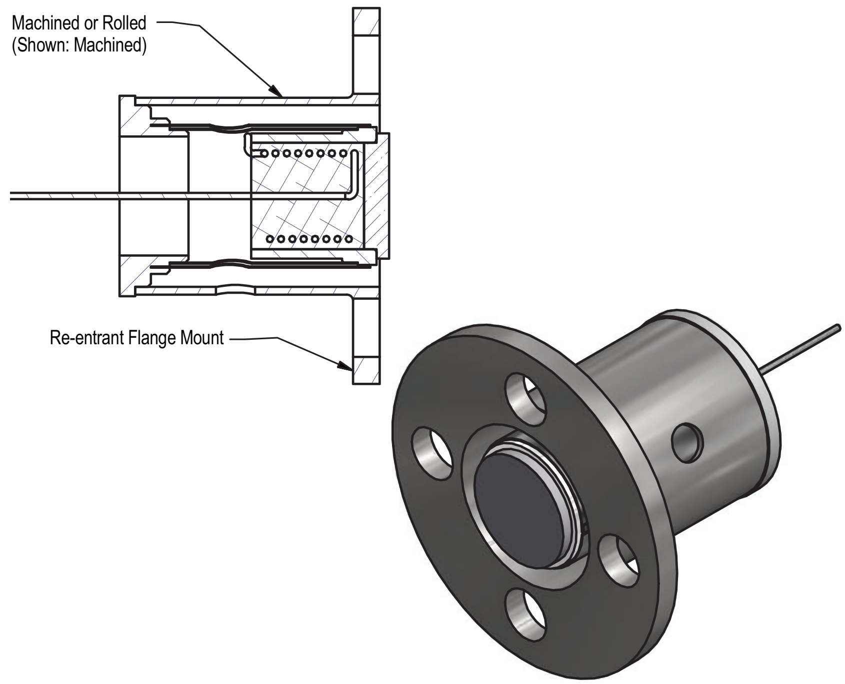
The configurations all show a planar cathode. Spectra-Mat routinely manufactures parts with spherical radii for Pierce gun geometry or elliptical surfaces for sheet beam devices, as well as rectangular or any other myriad cathode geometries for specialty electron demands. The seven configuration shown are not inclusive of all the variations SMI manurfactures but are representative of a few of the more common configurations available.



Cathode with Re-entrant Sleeves and Flange - Fig. 7

Table 1 lists advantages of the seven configurations shown:

Design	Controls Radial move't	Controls Linear move't	Ease of Assembly*	Ease of Mounting*	Cathode Position Precision	Power Efficiency
Basic	No	No	1	1	OK	Poor
Tripod Mount	Yes	No	1	2	Better	Better
Rotationally fixed tripod	Yes	OK	2	2	Better	Better
Support Sleeve	Yes	Good	2	3	Good	Good
Screw Mount Base	Yes	Good	3	2	Good	Good
Weld Base	Yes	Good	3	4	Excellent	Good
Reentrant	Yes	Excellent	4	2	Excellent	Excellent

** Relative values: 1 = simple, 4 = complex. For Manufacturability, items at 3, or 4 can provide superior datum to datum accuracy with a final machine operation. Ratings are subjective; customer jigging and equipment may determine one mounting preferable to others.*

Spectra-Mat technical staff can provide assistance at any time during the design phase of your electron device. Contact us at: smi_engineering@saes-group.com