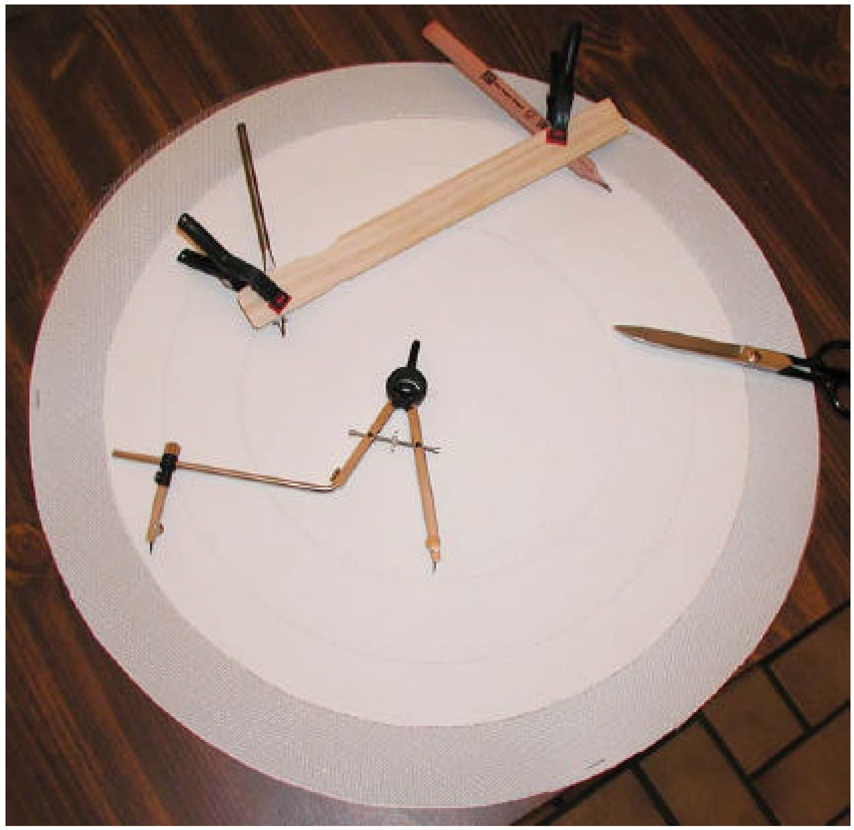
# MAKING AN APODIZING SCREEN

by Harold R. Suiter

Making a screen is not difficult as long as you order things correctly. This description will assume you want to make one for a very large instrument — a big Dobson-mounted reflector for example. Apodizers for smaller instruments are so easy that instructions are almost superfluous. The only thing to remember in the case of small apodizers that it is better to make an apodizer with two layers than to have the third layer be only a fringe around the outside. At some point the number of periods in this outer layer is so small that it does not resemble a diffraction grating. In any case, the denser screens of coated fiber often are better as dual screens rather than triple ones. It also assumes that you have a valid design for accurately measured material, as given in the main article. Most people who have made apodizing screens have just imitated other screens they heard about. That does **NOT** work.



*For big instruments you sometimes need to construct your own compass, as was done here using a paint stirrer, a carpenter's pencil, a wood drill, and clamps.*

First of all, measure the inside diameter of your tube. If you have a 20-inch mirror, tube diameters should be 21 to 22 inches. That should be the outside diameter of your apodizer as well. Even though portions of the screening material will be out of the optical path, it is useful to extend the screen out this far to provide attachment points between the screens.

Second, acquire at least 4 blank poster cards bigger than the inside diameter of the tube. The easiest to find will be equal to 22 inches in one direction, so a 20-inch is about the largest telescope that is convenient to apodize. If you have a telescope bigger than this, you will have to be creative to find backing cards. Also, you may have to come up with a more robust way of holding them than setting them against the spider since they will be so large they will tend to flop through the spider.

Draw a bold circle at the radius of the inside of the tube and each of the radii $r$ calculated for the screen on three of the poster boards. Also draw a ring at least as big as the mirror and preferably a little bigger just inside the outer ring. For the 20-inch mirror in the picture these rings had radii 10.5 inches, 10 inches, and each of the listed values for the 0.175 obstruction calculated from the table (the diagonal has a minor axis of 3.5 inches), namely 4.95, 7.05, and 8.5 inches. Lastly draw the outer radius and *all three radii* on a single poster board that is set aside.

Attach a piece of screen on each of the single-radius cardboard pieces. Use staples outside the optical path, but inside the large circle. Cut the outside with scissors and the inside with a chisel. The reason that you cannot use scissors on the inside is because scissors tend to maul the edge of the aluminum screen, especially when making a concave cut. On the outside this makes no difference and the curvature is lower. It is easier to use scissors for both cuts on coated fiber screens.

After each of the annuli are cut out, separate them by removing staples from their cut backings. Attach them to the fourth backing with all radii drawn-in from the outside in. Here, I put the 8.5-inch inside radius first, followed by the 7.05 inch radius. The reason you go in from the outside is that you don't want to hide the alignment marks prematurely. Carefully center the *inner* rings, and rotate the last two at roughly 30 and 60 degrees to the first (precision is not important). Attach them as before with a staple at the edge. Attach the last screen in at least three places but do not staple all the way through the backing cards. Peel the edge of the screens up and staple through all three layers without including the backing card. Then, when you remove the staples that extend through the card, you will not remove these.

Detach the three aligned and loosely attached screen layers from the last backing card. Because the screen has some residual curvature, it will not want to lie flat (the aluminum screens are worse about this than the coated fiber screens). You can diminish deformation if you press the screens flat and put more staples near the edge.

Recover two of the original templates. Cut out the thin annulus just inside the outer diameter. In my case, this was a shallow floppy ring between 10 and 10.5 inch radius. As I mentioned before, it would have been good if I had been able to increase the radius of the inner dimension 1/8 inch to allow about a 1/4-inch region of 100-percent illumination, but this would have made the ring too thin. Place these rings on either side of the edges and staple into place. Finally, cover the outside with tape to prevent injury from the tiny aluminum projections. Use these covering rings even if you are using the less dangerous coated fiber, because the floppier fiber screens need more mechanical support.

*The picture shows how the screen is used at the upper end of the telescope. I like these "minimalist" screens because they don't involve enough hardware to seriously unbalance the telescope.*

THE APODIZER IN USE

The usual application of an apodizer is high-power planetary or perhaps double-star observation. If you are using a lower power than 20 or 30 per inch, you are not using the apodizer in any fashion that it can apply to, other than perhaps an image darkener. If you are using it on an object bigger than the hole inside the spectra, you are wasting your time.

I like the non-weighty screens of the last figure because they don't interfere with the balance of the telescope.