For larger lenses it is usual to collapse the lens back to zero thickness at a number of points, forming the Fresnel lens of Figure 11.29. Because of the need for very high optical quality surfaces on the curved facets, it has proved difficult to manufacture such lenses with high transmission [53] because the mold tool is manufactured using diamond point turning. This leaves microscopic grooves, which are difficult to polish out because of the presence of the vertical region between facets.[14] If the facets are made small compared to the size of the cell, then flat facets can be used with little loss of concentration. In this case, the mold can be manufactured using a flat diamond turning tool, which gives very good optical surfaces.

Fresnel lenses do not transmit all the light they intercept to the focus. Losses come from several sources. First, Fresnel reflection from the optical interfaces causes about 8% loss (more for a short focal length lens because of the steep angle of the exit ray to the facet surface). This can potentially be reduced by the use of antireflection coatings. Second, the vertical regions between facets cannot be completely vertical or the lens cannot be removed from the mold. The angle of this portion is called the draft angle, and is in the neighborhood of 2°. Light striking this wall is deflected out of the focus. Finally, the tips and valleys have nonzero radius. Clearly, the smaller the facets, the more important

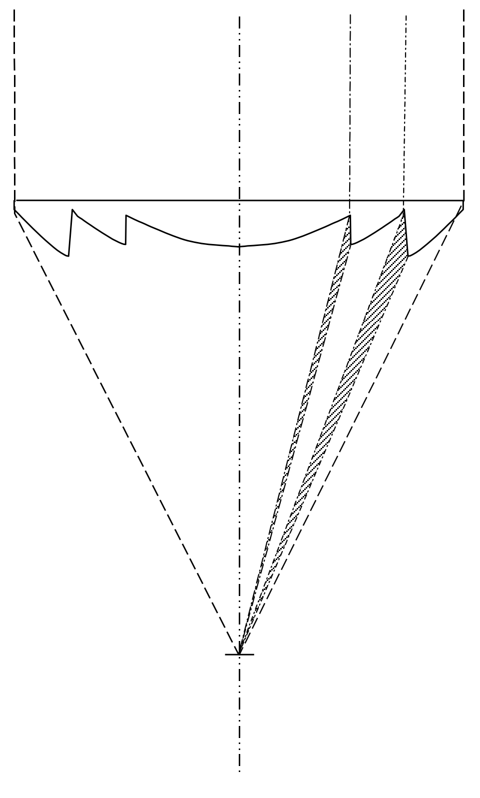

Figure 11.29 Cross section of a Fresnel lens

[14] This work was performed in the 1980s. It is very likely that the modern tool making machines can produce a very high-quality mold.