THE SINGLE-BEAM WAY TO CONCAVE GRATINGS

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An interference technique using a single laser beam, developed at the National Physical Laboratory in England, creates a major advance in concave diffraction gratings.

The optical components in a spectrometer perform two functions. They form an image of the slit through which the light enters the instrument, and they disperse the light into a spectrum so that images of different wavelengths are formed at different positions in the focal plane. In most instruments the image formation is achieved by lenses or mirrors that act as collimator and camera, and the dispersion is achieved separately by either a prism or a grating. Yet it has been known since 1882 that it is possible to combine the two functions in a single component by ruling a diffraction grating directly onto the surface of a concave mirror.

There are two distinctly different advantages to be gained from the use of concave gratings:

1. The instrument consists of far fewer components than one with separate collimator, disperser and focusing elements. It should therefore in principle be less expensive to manufacture and assemble.

2. By avoiding the use of several optical components we avoid the optical losses associated with these components. For visible and infrared radiation these losses are not great, but in the ultraviolet, where the reflectance of metal mirrors may be as low as 10 percent, the use of a concave grating could increase the throughput of an instrument by a large factor.

When contemplating the use of a concave grating it is important to appreciate for what reason you are doing so, because the design philosophies behind ruled vs. interference are quite different. If your objective is to minimize the cost of manufacture, then you require a simple *mechanical* construction. This can be achieved, but usually at the cost of some degradation of optical performance. If you are looking for diffraction-limited optical performance, then you must take great care in setting up the instrument anyway, and a given specification usually can be achieved most easily using separate focusing optics. This does not, of course, apply to the ultraviolet. But here one has to accept a more com-

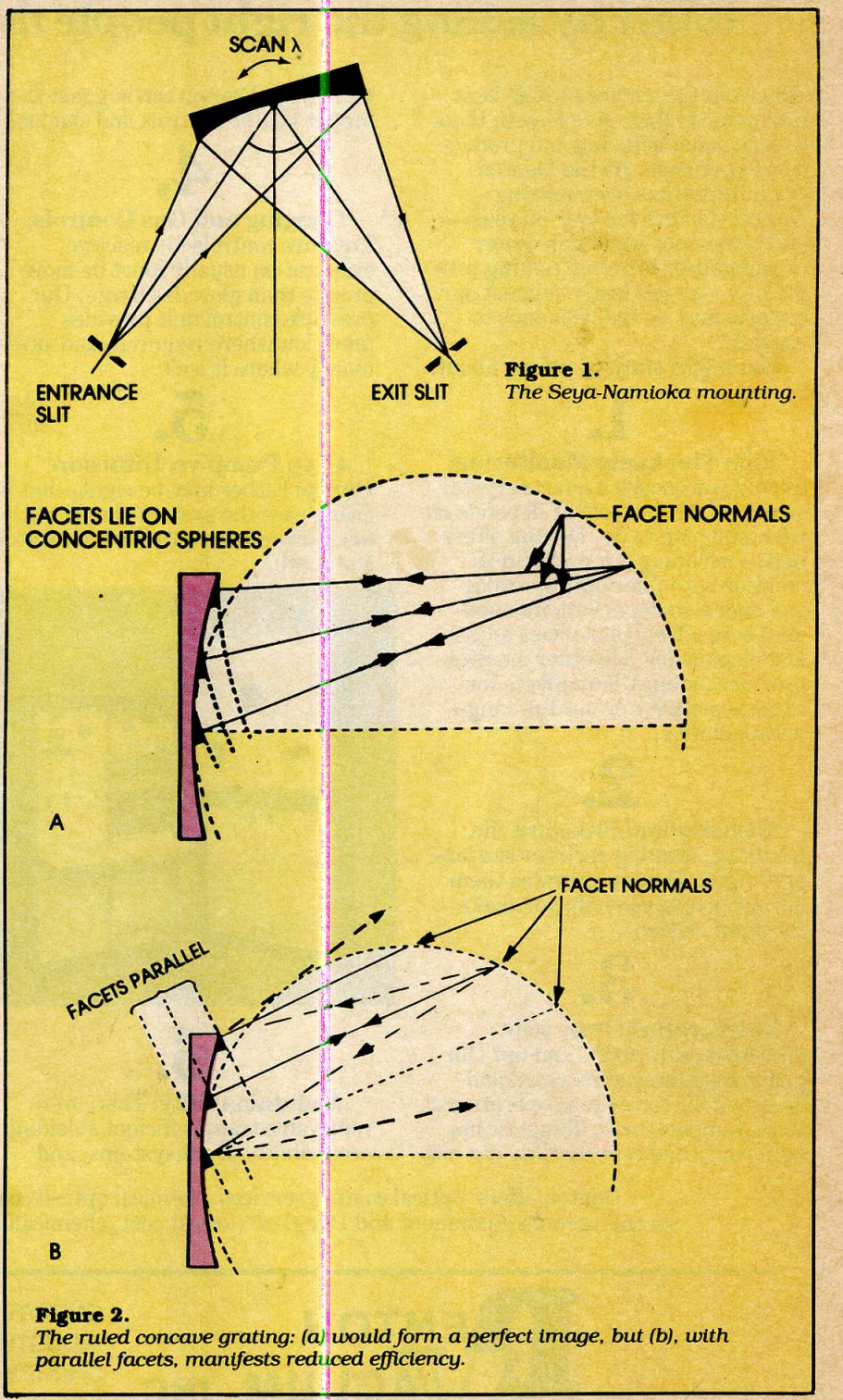

Figure 1.
The Seya-Namioka mounting.

Figure 2.
The ruled concave grating: (a) would form a perfect image, but (b), with parallel facets, manifests reduced efficiency.