Then knowing the size of the component to be made, the optical technician will cut a workable portion from a larger block of the chosen material.

The approximate shape of the component is then generated with diamond tools on a machine resembling a drill press. For example, in the case of a concave lens a hollow is carved from the centre of the material, while for a convex lens the edges of the lens are pared down. At this stage, the "blank", or lens of approximate shape, is a translucent component with frosted surfaces.

Next, a grinding operation works the lens surface to a smoother texture.

The blank is first "waxed" onto a metal holder and the assembly is mounted in a grinding apparatus. A metal grinding tool of complementary shape to the lens surface is then chosen. For example, a concave lens of certain radius of curvature will require a convex tool of identical curvature.

An abrasive such as emery, which is fed periodically between the two surfaces, breaks down into progressively finer particles as the grinding proceeds and the lens surface becomes smoother.

Here, the surface of a large optical flat (bottom) is ground by the small flat-faced tool riding over it. The glass blank (or unfinished optical component) revolves rapidly on a turntable while the tool oscillates back and forth over its surface. This continually varying motion assures uniform grinding. An abrasive material, such as emery, is brushed regularly onto the blank's surface during the course of this operation.

La face supérieure d'un grand disque de verre de qualité optique est meulée à l'aide d'un petit outil à tête plate. L'ébauche tourne rapidement sous l'outil dont le mouvement de va et vient permet d'obtenir un meulage uniforme. Une poudre abrasive, comme l'émeri, est déposée à intervalles réguliers sur la surface de la pièce pendant l'opération.

During this stage, the lens blank is tested by mechanical means until it is found to have the correct radius of curvature. However, since there are limits to the accuracy of mechanical testing, the final criterion of lens quality is established during the polishing operation.

Although the mechanical principles of lens polishing are similar to grinding, the surface materials used on the polishing tools are quite different.

After grinding, the glass surface is composed of thousands of microscopic points. The heat of friction from polishing melts these tiny peaks, enabling the material to flow into the valleys between them and form a smooth, continuous surface. This smoothing action is possible since glass, unlike crystals, is in reality a supercooled fluid with a definite flow rate. At normal temperatures, glass remains rigid and solid. However, raising its surface temperature by polishing elevates the flow rate enough to fill the minute surface voids.

As in grinding, a metal tool complementary to the size and shape of the lens is chosen and a layer of the appropriate resin is applied to it. While still warm, the resin is molded to its proper surface shape by another iron tool which matches the lens contour. The polishing tool is then warmed with a heat lamp and revolved with the lens blank in position until the two surfaces are matched very closely.

At this point, polishing compound is inserted between the surfaces and the actual polishing operation begins.

"The tool's resin surface is dynamic and flows continually," explains Mr. Cairns. "It is almost alive. For that reason, highly accurate polishing is possible."

The object then becomes both to obtain the correct lens shape with the tool, and to polish the lens surface uniformly. The skilful optical technician must optimize both conditions at the same time to produce a correct and polished surface. In doing so, numerous variables must be juggled, such as the ambient room temperature, humidity, polishing material hardness, the nature of polishing compound, speed of rotation, stroke and pressure applied. And like an artful juggler, the optical technician may let none of the balls drop.

During this procedure, all components are tested for accuracy and quality by an optical method called interferometry which is considerably more accurate than the mechanical testing at the grinding stage. By this method, the shape of the new component is compared with a known standard surface through analysis of a pattern of interference fringes. By analyzing this fringe pattern, the optical technician can determine the quality of the final component.

The separation between fringes, expressed in wavelengths, is constant for a particular monochromatic source (which produces a single wavelength of light). Although they appear as straight lines, each individual fringe (when viewed closely) is irregular and represents a profile of the difference between the standard and the component being tested.

As the component is polished nearer completion, the fringes become broader and straighter, and the measured deviation grows smaller. The error in any surface, whether flat, concave or convex can be determined in the same manner, by comparing the amount of deviation from straightness in a single fringe with the spacing between adjacent fringes.

At this stage, the optical technician begins to work by hand, alternately gauging then changing the surface shape by polishing. After slow, cautious progress the desired surface is finally attained.

Once its quality is verified, the new component becomes ready for use; the optical technician's custom-made contribution to the world of research. ☐ **W.J. Cherwinski**