rotatable circular disc, of the same diameter as the cam follower CF', is supported by bearings within bracket sleeve 74 rigidly attached to linkage 61 such that its abrading edge lies in the generating plane through G'B'. Said abrading tool is perpendicular to, and coaxial with, said cam follower axis and is made to rotate rapidly on its shaft 75 about said axis by belt 76 and shaft 77 supported by bracket 78 and driven by motor M' supported on shelf 60.

In the generation of the variable surface of the lens of this invention, where the portion above the great arc is spherical, the circular cam plane is first set at the zero position in which it is parallel to the generating plane, seen in full lines in FIG. 17. The radius of curvature of the cam circle, r, is equal to r(axial). The work holder attached rigidly to arm D' which extends from evolute cam R', has affixed to it by means of pitch or other adhesive or mechanical means, the workpiece WP' which consists of a lens blank 70 mm in diameter with the upper or exposed surface curved approximately like the desired finished variable surface. The position of the work holder WH' and workpiece WP' is such that the lens blank surface is bisected by the central plane. The work holder is attached to arm D' by suitable means adjustable like slide HS while arm D' is attached to evolute cam R' adjustable like slide VS in such position that during the process of generating the variable surface, the axial point will be at the geometrical center of the generated workpiece, i.e., the normal to the principal curve which is tangent to the evolute at point G' will coincide with the minor axis of the elliptical arc portion of the principal curve below the great arc.

Starting with the cam plane at the zero position and the evolute cam R' pivoted about a horizontal line through point G' in the generating plane and such that the edge of the workpiece farthest from the circular cam plane is just at the generating plane, the cam follower CF' is made to roll back and forth along the circular cam C while the generating tool GT' is rotating rapidly. At the end of each oscillation of the cam follower, evolute cam R' is rotated by wheel 21' a predetermined amount about said horizontal line through point G' as previously described in the first embodiment, thereby advancing the surface of the workpiece through the generating plane. Such oscillations and angular cam rotations are repeated until that portion of the variable surface above the great arc is generated as a spherical portion. Thereafter at the end of each succeeding oscillation of the cam follower, the circular cam plane is rotated by wheel 80, worm 81, worm wheel 82 and shaft 85 a predetermined angular increment ϕ calculated by means of equation (32), read at pointer 83 on indicia 84, while evolute cam R' is also rotated a predetermined amount, and continues to advance the workpiece through the principal plane as it rolls without sliding up cam plate surface Q', until the second portion of the variable surface below the great arc is generated. Oscillation of shelf 60, frame 61, the cam follower CF' and the generating tool GT' may be made manually using handle 69a. It is understood that this oscillation could be caused by a motor, if desired.

Other than the changes above described, lenses are formed by the second embodiment the same as in the first embodiment.

At the completion of the generation of the variable surface of the lens of this invention, marks left by the circular abrading tool consisting of the fine pits and scratches along transverse circular and elliptical arcs, must be removed by fine grinding and polishing as in the case of the first embodiment.

Comparing FIG. 20 with FIG. 18, there is shown an alternate way of preventing slippage as the evolute cam face EC or EC' rolls on the coacting vertical cam plate face Q or Q'. In FIG. 20, the vertical face Q' is provided with a rack 90 and the evolute cam face EC' is provided with coacting gear teeth 91. Note that no guiding cam surface such as that shown at SC and SC' is necessary with this construction and the point G'' coincides with the position G and G' previously described. This construction for preventing slippage between the evolute cam and its coacting vertical cam plate may be used in either the first or second embodiment of this invention.

In the description of both the first and second embodiments of the apparatus and method of this invention, I have shown the coaxial cam follower and generating tool as oscillatory across the cam and workpiece and a fixed center plane. It should be understood that such motions are relative and that identical effects can be achieved and are included within the scope of this invention with the apparatus constructed such that the workpiece, cam and center plane oscillate together in a direction horizontal and perpendicular to said center plane while the coaxial cam follower and tool are held fixed except for substantially vertical oscillation.

Although this specification has been directed primarily at ophthalmic lenses to be used in spectacles, it is also intended to be used for corneal contact lenses which differ from the spectacle lens only in magnitude but not in optical principles.

Where there is mentioned herein a curvature at a "point", it should be understood as referring to the curvature of an infinitesmally small line or surface at such point.

The term "cut" as used herein in the specification and claims means "abrade" also.

What is claimed is:

1. A multifocal ophthalmic lens of homogeneous transparent optical material, useful for the correction of the refractive error and the accommodative insufficiency or absence of accommodation in presbyopia and aphakia, having a geometrically and optically continuous variable convex front surface at least a portion of which changes continuously and regularly in refractive power, and a coacting coincoid conicold surface of eccentricity zero or greater or toric back surface, said variable front surface characterized by having a single pair orthogonal principal planes each of said planes of said pairs intersecting said variable convex front surface normally at all points, the first of said principal planes, generally horizontal in use, intersecting said front surface normally in a conic great arc of eccentricity zero or greater, the derivative of curvature of said variable front surface vanishing at said great arc at least in sections by all planes orthogonal to it, said arc providing a unique tangential junction between an upper and a lower portion of said variable front surface, there being geometrical and optical continuity and a continuous and regular change in curvature and refractive power in crossing said conic great arc, without localized distortion in the field of vision through said lens, the second of said principal planes being a generally vertical plane of symmetry of said variable front surface, intersecting orthogonally said great arc and said first principal plane and forming the axis of said vari-