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CORNEAL CONTACT LENS HAVING INNER ELLIPSOIDAL SURFACE

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This invention concerns an improved concavo-convex contact lens of the type which is designed to rest upon the cornea or over the colored portion of the eye and not extend into the scleral or white portion.

The present day art of fitting corneal contact lenses, generally stated, consists in selecting a lens made up of an inner spherical surface (or toric surface) to best fit the corneal curves of the eye at the apex of the cornea and then examining this fit with fluorescein solution between the lens and the eye. It is almost invariably found by this procedure that if the lens clears the apex of the cornea it impinges tightly on the peripheral areas. By a series of auxiliary bevels or secondary surfaces these areas are ground away in an attempt to obtain the best approximate fit of the cornea. Thus in an average corneal type contact lens of 10 mm. diameter the inner 6 to 7 mm. is usually left untouched, and is the radius closely approximating the keratometer value of the corneal radius, and the remaining 1.5 to 2 mm. circular annulus is ground to one or more longer radii.

To be more specific, according to conventional practice, in order to make the inner surface of the lens compatible to the cornea, the lens is first reduced in diameter to as small a size as possible for the purpose of using the central "optic zone" of about 6 to 7 mm. in diameter as a bearing surface for the lens. However, a lens as small as 6 to 7 mm. in diameter does not work well in the eye because of two problems that arise. (1) Such a small lens nearly always causes lid irritation in blinking due to the fact that the margin of the lids contains the greatest concentration of nerve endings and, (2) such lenses slip readily due to lid action and will either be displaced off the cornea or fall out of the eye. Still further, such lenses are not satisfactory because of the tight fit at the peripheral areas.

In an attempt to solve the foregoing problems, it has been suggested in Butterfield U.S. Patent 2,544,246, granted March 6, 1951, that the corneal lens have an inner spherical central area and an outer marginal portion formed by a series of separate and discrete steps to introduce a "parabolic" fit. The result of this suggestion is to produce a surface of uncertain rate of change of curvature when these "steps" are "blended."

Touhy Patent 2,510,438, granted June 6, 1950, discloses a corneal contact lens having a radius of curvature on its concave side slightly greater than the radius of curvature of the cornea with an increasing clearance at the marginal areas of the lens. Such a lens does not provide an adequate means of even closely conforming to the shape of the cornea because there can be no spherical surface constructed "slightly greater than the radius of curvature of the cornea to which it is applied" that will do anything but set up a gradient of pressure on the cornea with a maximum pressure at the apex and a minimum towards the edge.

The usual procedure in the art of fitting corneal contact lens is to use a lens of an average of 9.5 mm. diameter—the lenses usually vary from 9.0 to 10.5 mm. in diameter. However, as the lens diameter increases, the auxiliary secondary curves beyond the optic zone become wider and wider so that most lenses end up with the optic zone no larger than 6 to 7 mm. and the remainder of the lens surface of such longer spherical radius (of 1 to 2 mm. longer than the optic zone radius) that this area no longer serves as a bearing surface, but as a stand-off shield to bring the edge far enough under the lids in an attempt to avoid lid irritation.

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The shape of the cornea of the eye is, in fact, that of an ellipsoid. It is for this reason that the central problem of fitting a corneal contact lens more accurately to the human eye has not been solved by the present day spherical, toric, or parabolic lenses. From my study of the measurements of hundreds of eyes and the making of contact lenses to fit these measurements and the testing of such lenses by actual wearers, I have found that, (a) an ellipsoid represents a better approximation of the form of the surface of the cornea of the human eye, and (b) contact lenses with inner elliptical surfaces represent a marked improvement in the comfort and wearing time by the patient. These highly desirable results may be explained as follows: (1) The elliptical form of surface of the corneal contact lens distributes the pressure of the lens on the cornea more evenly over the surface of the cornea. (2) Larger diameter lenses that avoid lid irritation may now be used than is at present possible because the ellipsoidal surface is a bearing surface and so reduces the total pressure per unit area. (3) The inner ellipsoidal bearing surface results in more accurate centering of the lens around the optic axis of the eye and so avoids astigmatism and provides better visual results (4) The inner ellipsoidal surface results in less slipping of the lens with blinking or eye movements and so reduces friction due to lens movement, and (5) The inner ellipsoidal surface results in less lens rotation and so produces better stationary alignment for cases requiring bifocals and astigmatic correction for residual astigmatism.

In the drawings:

FIGURE 1 illustrates the trouble experienced in the use of conventional lenses;

FIGURE 2 shows the general form of an ellipse, the left portion of which conforms to the shape of the cornea, and is given to aid in the explanation of the invention;

FIGURE 3 is helpful in an understanding of certain measurements related to the right eye and which are referred to hereinafter;

FIGURE 4 illustrates how different ellipsoidal inner surfaces can be generated to form the inner surface of the contact lens of the invention;

FIGURES 5 and 6 show different embodiments of corneal contact lens of the invention;

FIGURES 7 and 8 illustrate how gauges or templates and dies can be made for use in the manufacture of lenses of the invention;

FIGURE 9 shows the equipment for making the lens of the invention;

FIGURE 10 shows how the inner surface of a spherical lens can be ground to form an ellipsoidal peripheral surface in accordance with another embodiment of the invention; and

FIGURES 11 and 12 are charts helpful in making two different series of ellipsoidal test lenses to enable the practitioner to quickly check the fit on a patient.

A better appreciation of the results achieved by the corneal contact lens of the invention may be had by examining the radii that are usually employed in the