ASPHERIC MULTIFOCAL CONTACT LENS HAVING CONCENTRIC FRONT SURFACE

FIELD OF THE INVENTION

The present invention generally relates to concentric multifocal contact lenses. The subject lens utilizes a combination of aspherical curves on the back side of the lens with spherical curves on the front surface of the lens to provide better fit and centering while offering greater power correction.

BACKGROUND

Multifocal contact lenses are well known and include a variety of designs for providing multiple focal points. One popular design provides concentric rings or zones on either the front or back surface of the lens. Examples of such lenses are provided in U.S. Pat. Nos. 5,507,979; 5,349,395; 5,270,744; 5,181,053; 5,125,729; 4,890,913; 4,861,152; 4,838,674 and UK Patent Application 2,059,102, all of which are incorporated herein by reference. These type of lenses are sometimes referred to as a "simultaneous" multifocal lense and may have either a circular near zone surrounded by an annular distance zone (center-near) or the reverse (center-far).

Aspherical concentric multifocal lenses have an increasingly flatter curve from the center to the edge of the lens. This aspherical curve may appear on either the back or front side of the lens, although it typically appears on the back side. The flattening of the back surface on these lenses within the optical zone (region) produces the multifocal power in conjunction with the refractive index difference between the tear film and the lens material. An example of such a lens is provided in U.S. Pat. No. 5,436,678 to Carroll which is incorporated herein by reference. This reference discloses a lens having a multi-aspherical back surface having a concentrically arranged central zone, a marginal zone and a peripheral zone wherein each of the zones is constituted by portions of aspherical second-order surfaces of revolution. This lens reduces the need for steep fitting and offers many other advantages including good centering. One drawback to this design, however, is that it can be difficult to provide sufficient power correction toward the periphery of the lens without compromising fit.

The use of multiple surfaces on either or both the front and back sides of lenses is known. For example, lens designs are known which provide multiple spherical surfaces on the front side of the lens. Unfortunately, such designs are very limited as it is difficult to provide sufficient power correction without "vision jumps" between spherical surfaces. Other lens designs have included the use of aspherical curves on both the front and back sides of a lens. This practice has also been limited as the use of aspherical curves on both the front and back sides of a lens tends to reduce vision acuity beyond an acceptable range.

Thus, it is desired to provide a multifocal lens having the centering and fit characteristics of the lens described in U.S. Pat. No. 5,436,678, while also providing increased power correction, particularly toward the periphery of the lens.

SUMMARY OF THE INVENTION

The present invention is multifocal contact lens which provides excellent fit and centering characteristics while also providing increased power correction by utilizing multiple surfaces on both the front and back sides of the contact lens. The subject multifocal contact lens has an edge, a front and back side and a series of concentrically arranged zones comprising central zone, a marginal zone and a peripheral zone. Each of the zones on the back side of the lens is defined by a second-order surface of revolution other than spherical, and the front side comprises multiple spherical surfaces for providing increasing power correction from the central zone toward the peripheral zone.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is an enlarged cross-sectional view showing the fit between a cornea and a contact lens of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed toward contact lenses and includes: introcular lenses, scleral lenses, and corneal lenses. Such lenses may include hard, rigid gas permeable, and soft lenses, although a preferred embodiment of the invention relates to rigid gas permeable (RGP) lenses including those produced from fluoro silicone acrylate materials.

The contact lenses of the present invention may be made using a variety of well known methods including various molding and lathe cutting techniques. In a preferred embodiment, lenses are cut from contact lens blanks, or "buttons" (such as Boston ES™ from Polymer Technology), using a CNC lathe system. Such lathe systems include a data processing system capable of calculating curves corresponding to a desired lens surface, typically based upon inputted lens design parameters. A description of such a system is provided in U.S. Pat. No. 5,452,031 to Ducharme, which is incorporated herein by reference. With such systems, an operator typically inputs lens design parameters into the system by way of an input means (e.g. such as a keyboard, disk, modem, or other similar means used to download information to a processing unit). Using the inputted lens design parameters, a central processing unit (or similar means) calculates a lens surface using a set of pre-programmed algorithms. Once the shape of the lens is defined, a corresponding surface is cut into the button by way of a computer driven lathe.

With using the various aspherical surfaces described above with respect to the back side of the lens, it has been found that some applications require additional power correction which can not be obtained without compromising fit. This problem has been solved by the use of multiple spherical surfaces on the front side of the lens in combination with the aforementioned aspherical back side surface. Although the use of multiple spherical surfaces has been disfavored due to the significant "vision jumps" noticeable between such surfaces, these "vision jumps" are minimized in the present invention by combining the spherical surfaces on the front side of the lens with a back surface including aspherical surfaces. Because power correction is generated at both the front and back sides of the lens, the surfaces provided on each side of the lens need not be as extreme as if only one surface was used for providing power correction. Consequently, fewer spherical surfaces are required on the front surface of the lens, thus reducing noticeable jumps in vision ("vision jumps"). Furthermore, as less power correction is required on the back side of the lens, more consideration can be given to fit and centering characteristics.

Referring to FIG. **1**, there is provided a cross sectional view of a cornea **(2)** with its surface **(4)** adjacent to the back surface of the subject lens **(6)**. The lens **(6)** has an edge **(7)**, a front side **(8)**, a back side **(9)** and three concentric zones