ASPHERIC OPHTHALMIC ACCOMMODATING LENS DESIGN FOR INTRAOCULAR LENS AND CONTACT LENS

TECHNICAL FIELD

The present invention relates to an aspheric ophthalmic lens configuration and specifically to an improved aspheric intraocular or contact lens designed to provide correction of the refractive error of the eye while simultaneously providing an accommodative effect simulating that of the phakic non-presbyopic eye, resulting in clear central vision for the aphakic or presbyopic patient over a full range of distances, regardless of the size of the pupillary aperture. The ophthalmic lens design is characterized as having at least one surface rotationally non-symmetrical about the optical axis of the lens, with defined angular zones of distinct or varying curvature responsible for near, intermediate, or distance vision or combinations thereof.

BACKGROUND OF THE INVENTION

Substantially parallel light rays proceeding from an object viewed at a distance and entering the emmetropic or optically normal eye are brought to focus on the retina. When the object viewed is six meters or more from the eye, the ciliary muscle is relaxed and light rays entering the eye from distant objects are focused on the retina. When such relaxation is maintained, diverging light rays from objects closer to the observer would establish their focus behind the retina. Light rays proceeding from objects closer than six meters are brought to focus on the retina as a result of an increase in the curvature or refractive power of the crystalline lens in the human eye. This physiologic process by which the form and density of the crystalline lens is changed is called accommodation, and ideally results in clear central vision over a full range of distances. The failing or absence of accommodation resulting in presbyopia and the lack of accommodation in an aphakic eye may be addressed in the design of the contact lens or intraocular lens which corrects the refractive error and in some manner and to some degree the accommodative insufficiency or absence of accommodation in the presbyopic or aphakic patient. Numerous contact lens and intraocular lens designs have been proposed to provide an accommodative effect similar in various respects to that of physiologic accommodation.

In U.S. Pat. No. 4,580,882, a continuously variable contact lens is described incorporating a concave aspheric surface of revolution and which has continuously varying refractive power extending from the center region of the lens peripheralward. In this lens design, the refractive power to achieve the desired distance vision correction is located in the center region of the lens with the power increasing peripheralward, up to 9.7 mm in diameter, to the desired near vision power. A problem exists in that such a lens design assumes a maximum pupillary aperture to achieve the desired refractive power for both distance and near vision requirements. It should be evident that such an assumption is not valid under many circumstances and the benefits of such a lens design will degrade accordingly, dependent upon actual conditions encountered by the patient.

In U.S. Pat. No. 4,418,991, a presbyopic contact lens is described as having a spherical anterior surface and a posterior surface of revolution with an annular fitting region as well as an optical region having a central portion providing the distance correction, with a paracentral portion providing a gradient of diopter adds for close and intermediate viewing. In the paracentral portion, the increasing radii of curvature away from the center results in a gradient of diopter add achieved by a continuous flattening of the paracentral area away from the center to between 4 mm and 5½ mm. As stated in this patent, the pupil of the eye has a diameter of about 4 mm to 5 mm in an indoor situation, but may be significantly smaller in conditions where there is a greater amount of light. In normal daylight conditions, the iris aperture may be reduced to from about 2 mm to 3 mm. Again, it should be evident that although the optical area of the lens in this prior invention is designed in an attempt to provide multifocal capabilities, limitations exist with respect to the pupillary aperture which will physically vary depending upon the conditions the wearer encounters, thereby effecting the focusing qualities of the lens.

Similarly, intraocular lenses are implanted in the eye as a replacement of the absent human crystalline lens. In U.S. Pat. No. 4,710,193, an aspheric posterior chamber intraocular lens is described which has at least one convex aspheric surface of revolution designed to provide continuously and regularly increasing refractive power from its apex peripheralward in its optically active area. This invention is stated to correct the axial refractive error of the aphakic eye and to produce clear central vision over a continuous range of distances from near to far. Similar problems exist with regard to the desired refractive correction characteristics of this intraocular lens design with respect to changes in the size of pupillary aperture.

SUMMARY OF THE INVENTION

Based upon the foregoing, there is found to be a need to provide a multifocal lens configuration which provides an accommodative effect simulating that of the non-presbyopic phakic eye, thereby resulting in clear central vision over a continuous range of distances ranging from far to near. This optical effect should be achieved over the described full range of distances, regardless of the size of the pupillary aperture. It is therefore a main object of the present invention to provide a multifocal lens configuration which will provide the aphakic or presbyopic patient clear central vision over a continuous range of distances from far to near, regardless of the size of the pupillary aperture.

Another object of the invention is to provide a multifocal lens configuration wherein one or both surfaces of the lens is defined by semi-meridian sections which are aspheric or transitional in curvature acting to significantly reduce astigmatism, chromatic and especially spherical aberrations.

It is another object of the invention to provide a multifocal lens configuration for use as a contact lens, wherein one or both surfaces of the lens incorporates the novel surface design of the invention.

It is another object of the invention to provide a multifocal lens configuration for use in an intraocular lens, wherein one or both surfaces of the lens incorporates the novel surface design of the invention.

Another object of the invention is to provide the multifocal lens configuration having one or both surfaces thereon including variable power which is defined in angular rather than annular zones to give clear vision