

TELEDIOPTRIC LENS SYSTEM

BACKGROUND OF THE INVENTION

1. Technical Field

This invention relates generally to corrective lenses, and more particularly to an ocular telescopic lens system with a novel spectacle arrangement and improved intraocular lens for low-vision conditions such as macular degeneration.

2. Background Information

Macular degeneration affects the central retinal area known as the macula, and it can lead to a gradual or sudden loss of vision to the level of 20/200 or less. It may affect only about one-quarter to four square millimeters of the central retinal area, thereby leaving 95-99% of the retina unaffected. Thus, vision for reading and watching television can be lost while peripheral vision remains intact.

Telescopic systems that increase the retinal image size of a given object have been used in the past to compensate for this loss of vision. In addition, intraocular lenses having both converging and diverging portions have been used as part of the telescopic system, the diverging portion providing a telescopic effect over a restricted field of fixation when used with a converging spectacle lens, and the converging portion providing unrestricted peripheral vision when used without the spectacle lens. However, there are certain aspects of these lens arrangements that need improvement.

For example, the converging spectacle lens may have a power in the range of approximately +8 to +35 diopter or more, perhaps typically greater than +20 diopter, and a lens of this power may exhibit peripheral distortion that reduces the field of fixation, i.e. the amount the viewing axis of the eye can deviate from the optical axis of the spectacle lens. In addition, far and near vision adjustment by movement of the spectacle lens relative to the eye varies the vertex distance so that astigmatic correction, which is typically placed on the back surface of the lens, may be affected. Inasmuch as very steep surfaces have to be used, even small surface decentration can cause large amounts of aberration. Furthermore, a high power spectacle lens may be somewhat thick and heavy, and fabrication relatively expensive in view of such concerns as the more critical dimensions of the lens surface.

Consequently, it is desirable to have a new and improved spectacle lens arrangement for a teledioptric system that overcomes these concerns—one providing sufficient lens power and greater field of fixation that can be adjusted without varying the vertex distance and which utilizes a less heavy and less expensively fabricated lens.

Another aspect of existing telescopic systems that needs improvement, concerns the intraocular lens. An example of a lens having both converging and diverging portions is described in U.S. Pat. No. 4,666,446 to Koziol et al. The intraocular lens illustrated in that patent includes a forward lens surface having a converging or convex forward portion and a diverging or concave forward portion, as well as a rearward surface that includes converging and diverging rearward portions. The converging forward portion and the converging rearward portion combine to form a converging or positive lens, while the diverging forward por-

tion and the diverging rearward portion combine to form a diverging or negative lens.

However, this arrangement could be improved to increase the field of view through the converging lens for off-axis images and to avoid discontinuities in the lens surface. Consequently, it is desirable to have an improved intraocular lens with these attributes.

SUMMARY OF THE INVENTION

This invention solves the problems outlined above with an intraocular lens and a spectacle arrangement that combine in a new and improved ocular telescopic lens system.

Briefly, the above and further objects of the present invention are realized by providing an ocular telescopic system that includes a bi-element spectacle lens arrangement. This results in less off-axis distortion with lenses that are less heavy and easier to fabricate, and power adjustment can proceed without varying the vertex distance. A novel intraocular lens is also provided that has a diverging portion on only one lens surface to thereby improve optical and physiological properties.

Generally, an ocular telescopic lens system constructed according to the invention includes an intraocular lens and a spectacle lens arrangement. According to a major aspect of the invention, the intraocular lens has a converging lens portion as well as a diverging lens portion that combines with multiple-element spectacles having anterior and posterior lenses arranged to converge light toward the diverging lens portion of the intraocular lens.

According to another aspect of the invention, there is provided multiple-element spectacles that include a lens system having at least an anterior lens and a posterior lens, and mounting components for mounting the anterior and posterior lenses on a spectacle frame so that light passes first through the anterior lens and then through the posterior lens in traveling to the eye. The anterior and posterior lenses may combine to serve as an objective lens and provide at least +8 diopter power.

According to yet another aspect of the invention, there is provided mounting components for adjusting a distance by which the anterior lens and the posterior lens are separated in order to cause a spectacle power change. These may enable adjustment of the anterior lens while the posterior lens remains generally fixed in position relative to a spectacle frame on which the lenses are mounted. Thus, adjusting the distance by which the anterior lens and posterior lens are separated does not vary the vertex distance by which the posterior lens is separated from the cornea of a user. In other words, a toric surface correcting for astigmatism is placed on the back surface of the posterior lens, and since the vertex distance remains constant, this correction remains unchanged.

Still another aspect of the invention provides an intraocular lens having an optic with a generally continuous rearward surface that combines with a first portion of the forward surface as the converging lens portion and with a second portion of the forward surface as the diverging lens portion. Of course, the intraocular lens can be with or without the multiple-element spectacles of this invention, as can the spectacles be used with or without the inventive intraocular lens.

A method of treating low vision according to the invention includes the steps of implanting in a patient an intraocular lens having a converging lens portion and a diverging lens portion, and then applying multiple-ele-