ACCOMMODATING INTRAOCULAR LENS

BACKGROUND OF THE INVENTION

The present invention relates generally to surgical implant devices and more particularly to intraocular lenses.

As persons age, their eyes typically loose the ability to change focus quickly and to clearly focus on close, distant and intermediately-positioned objects. Because of this loss of accommodation in the human eye, persons reaching their early forties often find it necessary to wear reading glasses to clearly focus on closely-positioned objects.

An even more pronounced loss of accommodation typically occurs when the crystalline lens is replaced by a conventional intraocular lens. Such replacement is performed, as is well known, in response to the formation of cataracts in the crystalline lens or when the crystalline lens is damaged by disease or injury. It has been recognized that with time the ciliary muscle of the eye develops the ability to move the intraocular lens back and forth along its center axis, thereby changing the focal point of the light rays passing through the intraocular lens and reaching the retina. Less than one diopter of power change is believed to occur pursuant to this movement. This minimal accommodation is insufficient to permit an individual to focus on close and distant objects, since 3 to 6 diopters of power change is typically required to achieve this range of change in focus.

In an attempt to overcome loss of accommodation in the eye, bifocal intraocular lenses have been developed. These lenses include a relatively thick center section comprising a minor portion of the entire diameter of the lens and a relatively thin peripheral section surrounding the center portion and having a thickness substantially equal to that of conventional intraocular lenses. The thicker center section has a focal power that is selected to permit the eye to focus on close objects and the thin peripheral section has a focal power that is selected to permit the eye to focus on distant objects.

When an eye containing such a bifocal intraocular lens is focused on a close object, the iris of the eye closes down. As a result, only the light rays passing through the thick center section of the lens reach the retina, whereby the closely-positioned object appears in focus. On the other hand, when the eye is focused on distant objects, the majority of light rays passing through the bifocal intraocular lens pass through the peripheral section thereof (because the peripheral section comprises the majority of the bifocal intraocular lens), whereby the distant objects appear in focus. Because only a small percentage of the light rays traveling through the bifocal lens in an eye focused on a distant object pass through the thick center section, the mind is able to ignore these rays with the result that these differently-focused light rays are not visible.

Although the bifocal intraocular lens has improved accommodation capabilities as compared to a conventional intraocular lens, the former does not provide the type and degree of accommodation provided by the crystalline lens of a young person's eye. Specifically, the bifocal intraocular lens refracts incoming light rays such that viewed objects are in focus at substantially only two focal lengths, typically close and distant. By way of contrast, a young person's eye varies the focus in analog fashion between close and distant objects so that objects at all focal lengths (assuming the person has **20/20** vision) are in focus. Hence, it is a significant drawback of the bifocal intraocular lens that it cannot provide the continuum of focal powers required to permit clear focusing on close, distant and intermediately-positioned objects.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an intraocular lens which will provide the human eye in which is it implanted with an accommodation capability substantially equal to that of a typical young person's eye.

Another object of the present invention is to provide an intraocular lens which will permit the human eye in which it is implanted to change focus automatically in analog fashion so as to permit the eye to clearly focus on objects positioned at close, intermediate and distant locations.

Yet another object of the present invention is to provide an accommodating intraocular lens which is easily implantable, readily accepted by the human eye and will function satisfactorily for an extended period of time.

These and other objects are achieved by an adjustable-power intraocular lens comprising a lens assembly and an adjustment mechanism or haptics coupled between the lens assembly and the ciliary muscle of the eye. In a first embodiment of the present invention the lens assembly comprises a single progressive power lens. In this embodiment, the haptics are adapted to move the lens normally to the center axis thereof so as to progressively change the focal power of the lens. In a second embodiment of the present invention the lens assembly comprises a pair of compound lens positioned so that their center axes are coaxial. In this second embodiment the haptics are adapted to move the lenses toward and away from one another along the center axes thereof so as to change the focal power of the lens assembly. In a third embodiment of the present invention, a pair of progressive lenses are positioned so that their center axes are coaxial or extend in parallel, with the higher power side of one of the progressive lenses being diametrically opposed to the higher power side of the other. In this third embodiment, the haptics are adapted to move both of the lenses normally to their center axes so as to progressively change the focal power of the lens assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention are set forth in the following specific description of a preferred embodiment of the invention and the accompanying drawings wherein:

FIG. **1** is a front elevation view of the first embodiment of the present invention, including a schematic representation of the ciliary muscle in which the first embodiment is disposed;

FIG. **2** is a side elevation view of the embodiment illustrated in FIG. **1**;

FIG. **3** is a front elevation view of the second embodiment of the present invention, including a schematic representation of the ciliary muscle in which the second embodiment is disposed;

FIG. **4** is a side elevation view of the embodiment illustrated in FIG. **3**;