CYLINDRICALLY SEGMENTED ZONE OF FOCUS ARTIFICIAL LENS

CROSS-REFERENCES TO CO-PENDING APPLICATIONS

This application is related to application Ser. No. 07/088,428, filed Aug. 24, 1987, "Laminated Zone of Focus Artificial Lens"; application Ser. No. 07/088,249, filed Aug. 24, 1987, "Radially Segmented Zone of Focus Artificial Lens"; and application Ser. No. 07/088,412, filed Aug. 24, 1987, "Multiple Element Zone of Focus Artificial Lens".

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to an implantable intraocular lens, and more particularly, pertains to a lens containing annular lens elements. The present invention relates to lenses which have discrete areas which serve to bring impinging rays to a focus in an specific area of the focal plane. Such lenses are called zone of focus lenses and are particularly useful for implantation into the eye as a substitute for the natural lens since, in combination with the brain, they effectively replicate the ability of the natural lens to bring objects at varying distances to a sharp focus.

The invention relates specifically to a zone of focus lens in which the lens is divided into annular lens elements. Each lens element serves to bring the impinging rays from an object at a predetermined distance to a focus on a particular region of the retina. By selecting various powers for the elements, it is possible to have an object at a given distance brought to an acceptable focus by at least one of such elements. In this manner, an in-focus image (sharp image) is created on a particular portion of the retina serviced by that element. It has been found that the processing of the image by the brain results in the selective consideration of the sharpest image and the virtual discard of the other out of focus images created by other elements.

2. Description of the Prior Art

Prior art includes limited attempts to produce a lens having areas of varying powers have been made. There have been many attempts to produce implantable lenses which serve for both close and far seeing, similar to the bifocal spectacles. In general, such lenses have been produced with two regions having different powers. The light which impinges on the retina passes through one region to the exclusion of the other. In such a system, only one region of the lens is used at a time and there is no accommodation by the brain to reject an out of focus image. Great care and accuracy must be used in the pre-operative measurements since both the near and far powers must be accurately determined. Since the near and far powers are not specifically interrelated, the inventory requirements are compounded since a variety of near powers must be available for every far power.

The present invention overcomes the disadvantages of prior art references by providing a lens which includes an annularly segmented lens where each segment is of a different power.

SUMMARY OF THE INVENTION

The lens is a composite of a cylindrical and annular optical lens elements, each of which has a distinct power and focal length. Each element brings the impinging rays to bear on a predetermined portion of the retina, which may be either unique to that element or shared with other elements of like power. The elements are selected to have a sufficient range of powers to accommodate the projected use. That is, the value of the power and the number of elements will be determined by the projected use. Most uses can be accommodated with a lens having two or three powers to accommodate objects at near, far and intermediate distances. These powers can be distributed among a like number of lens elements or a number of elements which is two, three or even more times the number of powers. The distribution of powers among the elements need not be done equally. For example, if most of the sight is required at close distances, the number of elements for this distance can be increased and the number of elements for far vision correspondingly decreased. Alternatively, the various elements may have different areas.

Accommodation of the brain to such an arrangement may be enhanced by adding a distinctive color to the elements of like power. This approach may be utilized where loss or impairment of color vision is of little consequence.

Elements of differing powers can be provided by grinding or otherwise forming a uniform lens surface over a composite structure of elements having differing indices of refraction.

In the alternative, the lens elements can be fabricated of like material and the differing powers obtained by grinding, molding or otherwise shaping the surface of the individual elements to provide individual curvatures.

Lens is a generic term for intraocular lens, intracorneal lens, or contact lens.

It is a principal object hereof to provide an intraocular lens including a cylindrically segmented zone of focus artificial lens optic.

It is another object of the invention to provide a minimum cost zone of focus lens which does not require either an extensive inventory of various powers and combination of powers or extensive pre-operative measurement prior to implantation into the eye as a replacement for a defective lens.

Still another object of this invention is to provide a very low cost approach to the replacement of a defective lens by providing a very nearly universal lens which provides vision adequate to allow a normal life style.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects of the present invention and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIG. 1 illustrates a top view of a cylindrically segmented zone of focus lens according to the invention;

FIG. 2 illustrates a cross-sectional view taken along line 2—2 of FIG. 1;

FIGS. 3A and 3B illustrate a schematic isometric view of an optical system in which the zone of focus lens develops individual images for each lens element;

FIG. 4 illustrates a cross-sectional view of FIG. 1;

FIG. 5 illustrates a cross-sectional view taken along line 5—5 of FIG. 1;