

LAMINATED ZONE OF FOCUS ARTIFICIAL HYDROGEL LENS

CROSS REFERENCE TO CO-PENDING APPLICATIONS

This Application is a Continuation-in-Part of Application Ser. No. 07/088,428, filed Aug. 24, 1987, entitled "Laminated Zone of Focus Artificial Lens", now U.S. Pat. No. 4,798,609; which is related in part to Application Ser. No. 07/258,019, filed Oct. 17, 1988, entitled "Multiple Element Zone of Focus Artificial Hydrogel Lens", which is a Continuation-in-Part of Application Ser. No. 07/088,412, filed Aug. 24, 1987, entitled "Multiple Element Zone of Focus Artificial Lens", now U.S. Pat. No. 4,778,462; Application Ser. No. 07/258,027, filed Oct. 17, 1988, entitled "Cylindrically Segmented Zone of Focus Artificial Hydrogel Lens", which is a Continuation-in-Part of Application Ser. No. 07/088,413, filed Aug. 24, 1987, entitled "Cylindrically Segmented Zone of Focus Artificial Lens", now U.S. Pat. No. 4,795,462; and Application Ser. No. 07/258,029, filed Oct. 17, 1988, entitled "Radially Segmented Zone of Focus Artificial Hydrogel Lens", which is a Continuation-in-Part of Application Ser. No. 07/088,249, filed Aug. 24, 1987, entitled "Radially Segmented Zone of Focus Artificial Lens", now U.S. Pat. No. 4,798,609.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to an implantable intraocular lens and, more particularly, pertains to a hydrogel lens containing laminated zone of focus lens elements.

This lens relates to hydrogel lenses which have discrete areas which serve to bring impinging rays to a focus in a 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 hydrogel lens is a laminated structure comprising a number of laminated planar or curved hydrogel elements. The incident rays are brought to a focus on a portion of the retina and are dependent on the number of lens elements traversed by the ray. The lens area common to each combination of laminated lens elements serves to bring the rays from a given object passing through the area to a focus on a predetermined region of the retina. By selecting various powers for the hydrogel lens element laminate areas, it is possible to have an object at a given distance brought to an acceptable focus by at least one of the lens element laminated areas. In this manner, an in-focus image or sharp image is created on a particular portion of the retina serviced by that area. 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 the areas.

2. Description of the Prior Art

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 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 of the brain to reject an out-of-focus image. Great care and accuracy must be used in the preoperative 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.

Further, the rigid materials used for lenses have required relatively large incisions for implantation, but the post-operative recovery period is shorter when a small incision is made.

The present invention overcomes the disadvantages of the prior art by providing a hydrogel lens which includes two or more laminated lens elements where each hydrogel lens element is of a different power.

SUMMARY OF THE INVENTION

The lens is a composite of laminate hydrogel lens elements. The lens area common to a given combination of lens elements has a given focal length and brings the impinging rays to bear on a predetermined, unique, portion of the retina. The common areas 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 areas 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. The distribution of powers among the areas need not be done equally. For example, if most of the sight is required at close distances, the area for this distance can be increased and the area for far vision correspondingly decreased.

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

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

Lens is a generic term for intraocular lens, intracorneal lens, or contact lens. Lenses also include any optical lens such as cameras, television, telescopes, projectors, optical instruments, glasses, etc.

It is a principal object hereof to provide a laminated zone of focus hydrogel lens.

It is therefore an object of this invention to provide a very low cost zone of focus hydrogel lens which will make the replacement of a defective natural lens available to many who cannot now afford the operation.

It is another object of the invention to provide a minimum cost zone of focus hydrogel lens which does not require either an extensive inventory of various powers and combination of powers or extensive preoperative 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 hydrogel lens which provides vision adequate to allow a normal life style.