FOCUSSABLE INTRAOCULAR LENS

BRIEF DESCRIPTION

This invention relates to a novel intraocular lens that is capable of providing accommodation responsively to contraction and relaxation of the ciliary body.

In the normal eye the crystalline lens is self-biased toward a spherical shape, that is, toward maximum refraction, and for distance viewing it is radially tensioned, and thereby flattened, by relaxation of the ciliary body.

The lens of the present invention operates on a basically different principle, one generally similar to the usual focussing arrangement in photographic cameras. It achieves accommodation by adjustment of its focal distance, the spacing between the lens and the fovea. The lens in spring biased toward its distance focus position, where it remains so long as the ciliary body remains relaxed. When the ciliary body contracts it compresses the spring bias, moving the lens away from the fovea to provide accommodation for near viewing.

The bias may be supplied by radially extending struts molded integrally with the lens, which struts extend slightly rearwardly from the lens to engage, or, rather, to be engaged by the ciliary body. When the ciliary body contracts it thus drives the outer ends of the struts radially inwardly causing their inner ends to move forwardly, carrying the lens forwardly and thereby increasing its focal distance.

Alternative forms of the invention may include miniature lens systems of two or more lens elements in accordance with the designer's choice. In the usual case only one of the elements of a system is arranged for movement responsively to the ciliary body, while the other, or others, of the individual elements remain in fixed position.

The lens of the invention is preferably placed in the natural capsule that previously held the crystalline lens, and the zonules are left in place, unless they are somehow damaged, in which case they may be replaced by an air filled flexible toroid. The capsule serves to hold the lens, and especially the struts, in proper position for engagement by the ciliary body. As in the usual modern practice only a portion of the front wall of the capsule is removed, and a small window is cut in its rear wall. The struts extend to the perimeter of the capsule, and the entire structure is retained by the capsule.

DETAILED DESCRIPTION

Representative embodiments of the invention will be described in detail in conjunction with the accompanying drawing, wherein:

FIG. 1 is a cross sectional view of an intraocular lens in accordance with a first embodiment of the invention;

FIG. 2 is a front elevational view of the lens shown in FIG. 1;

FIG. 3 is a fragmentary sectional view of an eye in which the lens shown in FIGS. 1 and 2 has been implanted;

FIG. 4 is a fragmentary sectional view of an eye in which a lens according to a modified form of the invention has been implanted; and

FIG. 5 is a fragmentary sectional view of an eye in which the zonules have been replaced by an air filled torus.

Referring now to FIGS. 1, 2, and 3, the lens according to the first embodiment of the invention comprises a central refractive element **10** about six to eight millimeters in diameter and having a refractive power selected by the surgeon to provide normal distance vision when it is implanted in the capsule **12** and the ciliary body **14** is relaxed. Radially extending struts **16** are molded integrally with the refractive element **10** and are terminated at their outer ends by any desired blunt abutment means such as the arcuate rim portions **18** illustrated. The struts are just long enough so that the terminations **18** are in light pressure contact with the perimeter of the capsule **12** when the lens is implanted in the eye **20**. The struts lie at an angle to the central plane of the refractive element **10** so that the terminations **18** lie slightly closer to the fovea when the lens is implanted than does the refractive element **10**.

When the ciliary body **14** contracts, as it normally does when the eye tries to focus on a nearby object, it drives the outer ends of the struts **16** radially inwardly, thereby forcing the lens **10** forwardly, away from the fovea, and, as the ciliary body relaxes the struts act as springs to retract the refractive element **10** back to its original position for distance focus.

It is preferred to make the refractive element **10** as small as is practicable, that is, as small as is needed to admit enough light for practical vision. This is to minimize resistance to motion of the refractive element by the aqueous humour, or by the saline solution that may replace it. It is presently thought that about six millimeters diameter is close to the optimum size.

An intraocular system comprising two lens elements **30** and **32**, respectively, according to the invention is illustrated in FIG. **4**. It comprises a posterior lens element **30** of significantly smaller diameter than the capsule **12**. It is positioned centrally within the capsule **12** in contact with the posterior wall thereof. It remains in position because of the smallness of forces available to dislodge it as compared to its natural adherence to the capsule wall.

The second element **32** lies in the anterior chamber of the eye, and is generally similar to the lens **10** shown in FIGS. **1**, **2**, and **3**, being supported on struts **34** that extend rearwardly and radially outwardly through the fornix in the anterior wall of the capsule **12** into engagement with the perimeter of the capsule. The powers of the lenses **30** and **32**, and the initial spacing between them are selected by the optical designer to provide the desired focussing action in response to motion of the movable lens **32**. A large variety of choices are available.

As shown in FIG. **5**, the zonules **40** (FIGS. **3** and **4**, and not shown in FIG. **5**) may be removed and replaced by an air filled torus **42** that acts as a cushion between the lens **10** and the ciliary body **14**, and also serves to keep the lens **10** in proper position relative to the ciliary body. The torus **42** may be made of any flexible and impervious sheet material that is compatible with body tissues and fluids.

What is claimed is:

1. An intraocular lens capable of providing accommodation comprising a lens element, and spring biasing means operative between said lens element and the ciliary body when the lens element is implanted for alternately moving the lens element bodily all parts in the same direction toward a first position relative to the fovea when the ciliary body is relaxed and bodily all parts in the same direction toward a second position