

## POSTERIOR CHAMBER INTRA-OCULAR TRANSPLANT DEVICE

### BACKGROUND AND SUMMARY OF THE INVENTION

The invention relates to an intra-ocular implantable device and to a method of surgically implanting such device in the posterior chamber of a human eye.

Surgical removal of opaque lenses from the eyes of cataract patients is one of the most common surgical procedures. After such surgery, contact lenses or spectacles are usually prescribed to provide at least limited vision for the patient. While spectacle lenses and contact lenses have a number of optical drawbacks, the ready ability to remove or replace them if defective makes them safe and attractive appliances.

For some patients, however, spectacles and contact lenses are not workable. Many older patients are unable to insert and remove the contact lenses or even handle the thick spectacles. The same is true with very young patients. Fortunately for such patients a surgical alternative is available—implantation of a prosthetic or artificial lens into the interior of the eye to replace the opaque natural lens which has been surgically removed. While this type of surgery for all cataract patients may not be appropriate now, improvements in lenses and techniques, such as the present invention, may make such surgery universal for cataract patients in the future. This operation is called lens implant insertion and well over 100,000 such operations have taken place to date in the United States.

For first intra-ocular lens of modern times was implanted by Ridley in 1949 into the posterior chamber of an eye. Because of difficulties encountered with fixation in the posterior chamber, most implantations thereafter were in the anterior chamber or involved clipping in some fashion to the iris. *Pseudophakos*, by Jaffe, Galin, Hirschman, and Clayman (the latter, the present inventor) (C. V. Mosby Company 1978), summarizes the developments in the field and also describes many of the different types of devices which have been implanted in the past.

Although contrary to early efforts, placement of a device in the posterior chamber has a number of substantial advantages. Accordingly, in recent years several devices have been proposed and developed for placement in that chamber. The Shearing intra-ocular lens, which is described in U.S. Pat. No. 4,159,546, uses a pair of spring-like loops on either side of the lens (optic) which are positioned in the area between the iris and the ciliary body known as the ciliary sulcus. The Shearing lens is plano-convex with the plane surface designed to contact the posterior capsule or surface of the natural lens, which membrane is normally left intact but often perforated (discised), during extracapsular cataract extraction (ECCE). The optic portion of the Shearing lens is circular. The Shearing lens is similar in construction to an earlier device of Barraquer, but which was designed for placement in the anterior chamber. The patents to Poler U.S. Pat. No. 4,073,014 and 4,080,709 are other examples of posterior chamber devices.

The present invention relates to a unique implantable intra-ocular device having a number of substantial advantages over prior art devices, including the device of Shearing. As in Shearing, in the present invention two haptic loops are attached to a lens, opposite each other.

As in Shearing, at least one of the haptic loops is compressible, and preferably both can be compressed. Though the lens is designed for fixation in the ciliary sulcus, the unique compressibility of the haptic loops achieved by using dissimilar thicknesses in the upper and lower loops make the present invention also suitable for insertion in the capsular "bag", (this is the remnant of the capsule of the natural lens, after extracapsular cataract extraction). However, in contrast to Shearing the lower loop has a stiffness greater than that of the upper loop. The experience has been that when an implantable device displaces from its desired position, it tends to move downward, or if the pupil is assymmetric the latter tends to peak upwards. Providing the lower haptic loop with a greater stiffness ensures that the device will remain in a proper position, and the optic will occupy all or most of the pupillary aperture.

The lens of the present invention has a vertical dimension greater than its horizontal dimension. Since decentering as noted above tends to be movement in the vertical direction, making that dimension greater also helps ensure that the lens will be maintained in a position to satisfactorily carry out its function.

Implantation can either take place at the time the cataract is removed, i.e., primary implantation, or during a second operation subsequent thereto, i.e., secondary implantation. As noted above, during ECCE the posterior capsule or surface of the natural lens is usually left intact, but is often perforated to guard against the possibility that it will later become opaque. If that occurs the perforation will allow a distinct image to impinge on the retina to provide satisfactory vision. This step of perforation is called discission. During primary implantation the normal procedure is to carry out discission after the implanted lens has been put in place. After the nucleus and cortex of the natural lens has been removed, the pressure of the vitreous fluid behind the natural lens capsule often pushes that posterior surface forward. In the Shearing lens, the membrane presses directly against the plane rear surface of the lens, which can make discission a difficult operation without decentering the lens and/or getting vitreous fluid into the anterior chamber.

This problem however is much reduced by the present invention in which the rear surface of the lens is convex, providing sufficient room to carry out discission without difficulty. In addition, the optical characteristics of the lens of the present invention are believed to be improved by making the rear surface convex and the front surface plano.

According to another aspect of the present invention, the front surface of the lens is provided with at least one, and preferably upper and lower, angulated bores which extend into the lens at an angle to the vertical of, for example, 15° to 20°. In the past it has been conventional to insert the device into the eye using forceps. However, opening forceps in the limited space within the anterior chamber can be disadvantageous to the corneal endothelium. By providing angulated bores, the implant can be fixated at either the upper or lower angulated bore with either a fine spatula or forceps and maneuvered interiorly into position.

According to another aspect of the invention, the lens is provided with straight line portions in the lateral edges of the optic. These straight edges not only minimize the incision required to insert the implant but also guide the lens into position as it is inserted. Lenses hav-