INTRAOCULAR-EXTERNAL LENS COMBINATION SYSTEM AND METHOD OF USING SAME

This is a continuation of application Ser. No. 289,459, filed Dec. 22, 1988, now abandoned, which is a continuation of U.S. Ser. No. 218,820, filed July 12, 1988, now abandoned, which is a continuation of U.S. Ser. No. 109,165, filed Oct. 16, 1987, now abandoned, which is in in turn a continuation of U.S. Ser. No. 316,920, filed Oct. 30, 1981, now U.S. Pat. No. 4,710,197, issued Dec. 10, 1987.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an intraocular lens for use in combination with an external lens system to form an image on the retina.

2. General State of the Art

One of the leading causes of blindness in America is macular degeneration. In this condition, the central retina, which perceives fine detail, is deficient. In the less severe cases of this disease, patients can often be helped by simple magnifiers or by various telescopes, both of which serve to enlarge the image formed on the retina.

Magnifiers are used for reading or other tasks involving near vision. A variety of magnifiers are available and are generally useful for their intended purpose. However, such magnifiers are bulky and inconvenient and are of no help in other tasks such as walking about. Such magnifiers are likewise tiring to the user, thus detracting from their usefulness.

For improved distant vision, a telescope is required. In order to be suitable for low vision patients, telescopes must be compact, light weight, and reasonably inexpensive. These requirements together with basic optical limitations generally result in a device which magnifies but with an enormous loss of visual field. For the low vision patient, with his natural lens, telescopes of 2.2×, 2.5×, or 3× are often prescribed for use outdoors, or for other distance viewing. The field loss is so great that most patients with macular degeneration do not find telescopes of much practical value. Such telescopes are, therefore, often of limited practical use because of their narrow field, poor cosmetic appearance and difficulty in fitting to the patients face. As a result, they are used relatively infrequently by patients.

When patients have cataracts in addition to macular degeneration, the prognosis is even worse. Removal of the cataract, followed by vision correction with spectacles or contact lenses, renders the field of vision smaller without significantly improving magnification.

The aphakic patient with a normal retina faces a formidable optical problem. Spectacle lenses of +11 to +16 diopters are needed to provide the required additional focusing power. The lenses are thick and must be precisely fitted to the patient's face. Furthermore, the field of view is restricted by the size and the refracting effect of the lenses. Alternatively, contact lenses of similar power may be worn. However, a substantial number of patients, particularly older patients with limited finger dexterity, cannot wear contact lenses.

If the aphakic patient further has macular degeneration, the conventional telescopic low-vision aids mounted on the spectacle frame will be a problem. The telescope adds weight, and projects beyond the already large spectacle lenses. The telescope further limits the field of vision. The field problem is aggravated by the fact that the presence of the spectacle lens moves the telescope yet further from the eye than the optimum position.

Some aphakic low-vision patients can use a 6× or 8× hand-held telescope. The 6× has a field of view of 11°, while the 8× has a field of 8°. Yet, this solution is not viable for the many patients who do not have the steadiness of hand to use such hand-held telescopes.

As a result of the above optical problems and the already reduced visual acuity, low-vision patients who develop cataracts are often not operated on.

Conversely, in other instances demagnification of the optical image is desirable. Thus, patients with retinitus pigmentosa (RP) and some patients with advanced glaucoma suffer a loss of peripheral vision. In order to function normally, e.g., to cross the street, they may benefit from a visual aid that demagnifies the retinal image, thus putting more of the visual field onto the central portion of the retina that is still functional.

The principle of the invention and the various embodiments disclosed herein overcome the above deficiencies while achieving the objectives set forth.

A search of the prior art has uncovered the following materials:

TROUTMAN, in an article entitled "Artiphakia and Aniseikonia", which appeared in the *American Journal of Ophthalmology*, pages 602–639, October, 1963, discusses the state of the art in artificial intraocular lenses. On page 614, the article states: "There is no reference in the literature on intra-ocular lenses as to the telescopic magnification which can be attained with the combination of an intraocular lens and a spectacle lens."

LEVY, Jr. et al., U.S. Pat. No. 4,074,368, disclose an intraocular lens that is based on the principle of a Galilean telescope wherein both the negative element **18** and the positive element **14** are fastened together, and both placed within the eye. Positive element **14** is an air lens formed by bubble **15**, and negative element **18** is an air lens formed by bubbles **20** and **22**. The patent suggests implantation of this intraocular lens system for relief of conditions such as macular degeneration and diabetic retinopathy.

LIEB, U.S. Pat. No. 2,834,023, discloses anterior chamber lenses for refractive correction of aphakia, high ametropia, and anisometropia, and bilateral and unilateral cataracts. Of particular interest are FIGS. **6–9**, wherein lens **20** is of the diverging type.

FILDERMAN, U.S. Pat. No. 3,027,803, discloses a spectacle lens-contact lens system which forms a modified Galilean telescope. Contact lens **10** serves as the negative lens in the telescope lens system, and central segment L2 of spectacle lens L1 serves as the positive objective lens of the telescopic lens system. Furthermore, the patent discloses how a 2× magnification system can be developed by using a negative lens of −50 diopters and a positive lens of +25 diopters.

DITTMER, U.S. Pat. No. 2,164,801, discloses a corrective lens system wherein an alternate embodiment provides a telescopic lens system, as illustrated in FIG. **5**. The telescopic lens system comprises negative contact lens **23** which is worn on eye **10**, and positive spectacle lens **24** which is mounted in front of eye **10**.

SPERO, U.S. Pat. No. 2,078,590, discloses telescopic spectacles wherein positive lens **15** is secured to glass carrier member **16**, and negative lens **17** is secured to