SIGHT-CORRECTING OPTICAL COMPONENT SUCH AS AN INTRA-OCULAR IMPLANT OR CONTACT LENS

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention is generally concerned with optical components used to correct sight.

It is more particularly directed to intra-ocular implants although it is also applicable to contact lenses.

2. Description of the prior art

As is well known, an intra-ocular implant is designed to replace a defective crystalline lens.

An intra-ocular implant of this kind usually has no ability to accommodate.

This is the case, for example with the implant which is the subject of the U.S. Pat. No. 4,504,982.

In this American patent the central part of the front surface of the intra-ocular implant concerned forms an aspherical surface of revolution with a meridian section satisfying the equation:

$$X = \frac{1}{R}\left[\frac{Y^2}{1+\sqrt{1-(1+K)\,Y^2/R^2}}\right] + A2\,Y^4 + A3\,Y^6 + A4\,Y^8 + A5\,Y^{10}$$

in which R, K, A2, A3, A4 and A5 are numerical parameters. However, considered in its entirety this intra-ocular implant is of constant power, the numerical parameters in question simply being chosen so that most of its longitudinal spherical aberration is corrected.

Similarly, the intra-ocular implant which is the subject of the U.S. Pat. No. 4,769,033 has no ability to accommodate in that, being a bifocal lens, it makes no provision for intermediate vision between far vision and near vision.

The obvious disadvantage of intra-ocular implants of this kind with no ability to accommodate is that they are not inherently satisfactory for all kinds of vision and so require the occasional wearing of eyeglasses, especially in the case of a constant power intra-ocular implant.

An accommodating intra-ocular implant is described in the U.S. Pat. No. 4,710,193, however.

This intra-ocular implant is a diffractive device, however, and in practise causes non-negligible chromatic aberration.

An object of the present invention is an accommodating optical device, in particular in intraocular implant, which is advantageously free of this disadvantage.

Until now intra-ocular implant design calculations have essentially been based on the single power that the implant is required to have, with the implant isolated in air, and without reference to the longitudinal spherical aberration to which the implant gives rise in the eye. The invention departs from this conventional thinking by regarding an intra-ocular implant of this kind, once fitted, as forming one component of an optical system whose other components are part of the eye concerned and by conferring upon the intra-ocular implant the surface shapes required to produce a given longitudinal spherical aberration within this optical system, as estimated by calculation.

The problem arises that the component parts of an eye and therefore their characteristics vary from one person to another.

The invention also proposes to use a particular eye model as a reference standard.

This is preferably the eye model described by R. NAVARRO et al in an article entitled "Accommodation-dependent model of the human eye with aspherics" in J. Opt. Soc. Am. A, vol. 2, No. 8, Aug. 1985 which is incorporated in the application by reference.

A different eye model could equally well be chosen instead of this one, however.

SUMMARY OF THE INVENTION

The present invention consists in a sight-correcting optical component having front and rear surfaces at least one of which has a central part in the form of an aspherical surface of revolution with a meridian section satisfying the equation

$$X = \frac{1}{R_1}\left[\frac{Y^2}{1+\sqrt{1-(1+K)\,Y^2/R_1^2}}\right] + A2\,Y^4 + A3\,Y^6 + A4\,Y^8 + A5\,Y^{10}$$

in which R1, K, A2, A3, A4 and A5 are numerical parameters chosen so that for the optical system comprising the optical component and a specified eye model, minus the crystalline lens if the optical component is an intra-ocular implant, they yield for an object proximity P defined by the equation

$$P = N' \cdot \frac{dx'}{f2}$$

in which N' is the refractive index of the image medium, dx' is the longitudinal spherical aberration in the image space and f' is the focal length of said eye model a representative curve which:

for high values of the distance from the axis comprises a substantially straight first section with a slope less than or equal to zero and entirely located between a vertical line passing through a defined reference origin and an oblique line passing through points with coordinates (−1, 1.5) and (−1.5, 2.75) relative to the reference origin;

for low values of the distance from the axis comprises a second section intersecting the diopter axis vertically between points with horizontal coordinates (−2.5) and (−4) relative to said reference origin, and

for intermediate values of the distance from the axis comprises a median section merging monotonically and continuously with the first and second sections.

The optical system comprising the optical component in accordance with the invention and the eye to which it is applied has caustic characteristics at two points representing correct conditions of vision for far vision and for near vision, with a possibility of intermediate vision between the latter, for optimum user comfort.

Especially in the case of an intra-ocular implant substituted for a defective crystalline lens, the invention achieves true restoration of the ability to accommodate lost by the eye, while keeping longitudinal spherical aberration within limits that are naturally acceptable.

In a first embodiment the longitudinal spherical aberration for far vision is that of eye itself.

In a second embodiment it is properly corrected.