



(43) International Publication Date
25 June 2015 (25.06.2015)

(51) International Patent Classification:
A61F 2/16 (2006.01)

(21) International Application Number:
PCT/US2014/062810

(22) International Filing Date:
29 October 2014 (29.10.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/918,942 20 December 2013 (20.12.2013) US

(71) Applicant (for all designated States except US): NO-VARTIS AG [CH/CH]; Lichtstrasse 35, CH-4056 Basel (CH).

(72) Inventors; and

(71) Applicants (for US only): DEVITA-GERARDI, Lauren [US/US]; 1327 Brown St., Unit 302, Des Plaines, IL 60016 (US). LEWELLEN, Kevin M. [US/US]; c/o Alcon Research, Ltd., 6201 South Freeway, Fort Worth, TX 76134 (US).

(74) Agents: PREJEAN, Jonathan E. et al.; Alcon Research, Ltd., 6201 South Freeway, Fort Worth, TX 76134 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: ACCOMMODATING INTRAOCULAR LENS

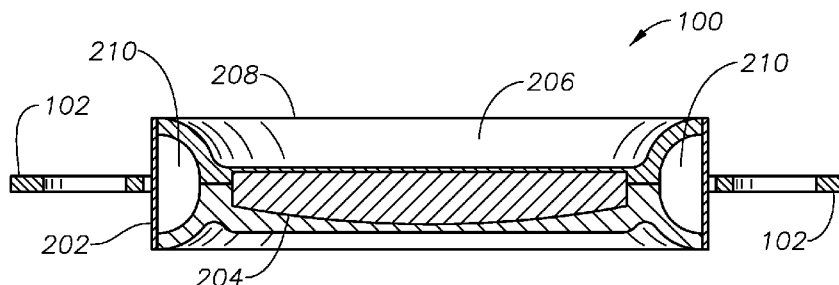


FIG. 2

(57) Abstract: An accommodating intraocular lens includes an optic and four haptics. The optic includes an outer wall, a solid posterior optic, an anterior fluid chamber, an anterior membrane and a fluid reservoir within the outer wall surrounding the anterior fluid chamber and the solid posterior optics. The four haptics are attached to the outer wall at four attachment points. Each of the four haptics includes an arc member extending between successive attachment points and contacting the outer wall only at the attachment points. Each of the arc members is configured to compress laterally under accommodative forces.

ACCOMMODATING INTRAOCULAR LENS

TECHNICAL FIELD

5 This invention relates generally to the field of accommodating intraocular lenses and, more particularly, to a haptic design for a curvature changing accommodating intraocular lens.

BACKGROUND OF THE INVENTION

10 The human eye in its simplest terms functions to provide vision by transmitting light through a clear outer portion called the cornea, and focusing the image by way of a crystalline lens onto a retina. The quality of the focused image depends on many factors including the size and shape of the eye, and the transparency of the cornea and the lens.

15 When age or disease causes the lens to become less transparent, vision deteriorates because of the diminished light which can be transmitted to the retina. This deficiency in the lens of the eye is medically known as a cataract. An accepted treatment for this condition is surgical removal of the lens and replacement of the lens function by an artificial intraocular lens (IOL).

20 In the United States, the majority of cataractous lenses are removed by a surgical technique called phacoemulsification. During this procedure, an opening is made in the anterior capsule and a thin phacoemulsification cutting tip is inserted into the diseased lens and ultrasonically vibrated. The vibrating cutting tip liquefies or emulsifies the lens so that the lens may be aspirated out of the eye. The diseased lens, once removed, is replaced by an IOL.

25 In the natural lens, distance and near vision is provided by a mechanism known as accommodation. The natural lens is contained within the capsular bag and is soft early in life. The bag is suspended from the ciliary muscle by the zonules. Relaxation of the ciliary muscle tightens the zonules, and stretches the

capsular bag. As a result, the natural lens tends to flatten. Tightening of the ciliary muscle relaxes the tension on the zonules, allowing the capsular bag and the natural lens to assume a more rounded shape. In this way, the natural lens can focus alternatively on near and far objects.

5 As the lens ages, it becomes harder and is less able to change its shape in reaction to the tightening of the ciliary muscle. Furthermore, the ciliary muscle loses flexibility and range of motion. This makes it harder for the lens to focus on near objects, a medical condition known as presbyopia. Presbyopia affects nearly all adults upon reaching the age of 45 to 50. Various accommodative
10 intraocular lenses (IOLs) have been proposed. However, due to limited residual accommodative forces, the mechanical design required to effectively translate accommodative force into changes in optical power has proved challenging.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 illustrates an accommodating intraocular lens according to an
15 embodiment of the invention; and

FIGURE 2 illustrates a cross-sectional side view of the lens of FIGURE 1.

SUMMARY OF THE INVENTION

Various embodiments of the present invention provide sensors for assessing residual accommodative function. In a particular embodiment, An
20 accommodating intraocular lens includes an optic and four haptics. the optic includes an outer wall, a solid posterior optic, an anterior fluid chamber, an anterior membrane and a fluid reservoir within the outer wall surrounding the anterior fluid chamber and the solid posterior optics. The four haptics are attached to the outer wall at four attachment points. Each of the four haptics
25 includes an arc member extending between successive attachment points and contacting the outer wall only at the attachment points. Each of the arc members

is configured to compress laterally under accommodative forces. The embodiments discussed below are exemplary, and various changes can be made to these illustrative embodiments without deviating from the scope of the invention. For example, the features of one embodiment can be combined with those of another embodiment.

DETAILED DESCRIPTION

As shown in FIGURE 1, an accommodating intraocular lens 100 includes four haptics 102 producing uniform lateral translation around an optic 104. The haptics 102 are connected to an outer wall 202 of the optic 104 at four attachment points 106 with arc members 108 extending between the attachment points 106 to produce lateral force at each attachment point 106. The arc members 108 allow flexion in the haptics so that the lateral accommodative force is translated gradually and uniformly into force on the optics. In order to further increase the uniformity of the contact at the attachment points 106, the optics 104 has octagonal sides with four of the octagonal sides forming flat planes at the attachment points 106.

FIGURE 2 illustrates a cross-section of the lens 100, which illustrates the force-transfer mechanism for converting the lateral force into a change in optical power. The outer wall 202 of the optic 104 is attached to a solid posterior optic 204 and an anterior fluid chamber 206 covered by a membrane 208. The posterior optic 204 is plano-convex, so that when the membrane 208 of the anterior plane bulges outwardly, the optical power of the lens 100 is increased. A fluid reservoir 210 within the outer wall 202 surrounds the solid posterior optic 204 and the anterior fluid chamber 206. The fluid reservoir 206 can deform the anterior fluid chamber by pressure transfer in the depicted embodiment or, in alternative embodiments, by transferring fluid to the anterior chamber 206 via channels, such as holes or slots (not shown). As the outer side 202 is laterally compressed by the haptics 102, the fluid in the anterior chamber 206 causes the

membrane 208 to bulge outwardly. This in turn produces an increase in optical power.

Those having ordinary skill in the art will appreciate that various changes can be made to the above embodiments without departing from the scope of the
5 invention.

What is claimed is:

1. An accommodating intraocular lens, comprising:

an optic comprising an outer wall, a solid posterior optic, an anterior fluid chamber, an anterior membrane and a fluid reservoir within the outer wall
5 surrounding the anterior fluid chamber and the solid posterior optics; and

four haptics attached to the outer wall at four attachment points, each of the four haptics comprising an arc member extending between successive attachment points and contacting the outer wall only at the attachment points, each arc member configured to compress laterally under accommodative forces.

10

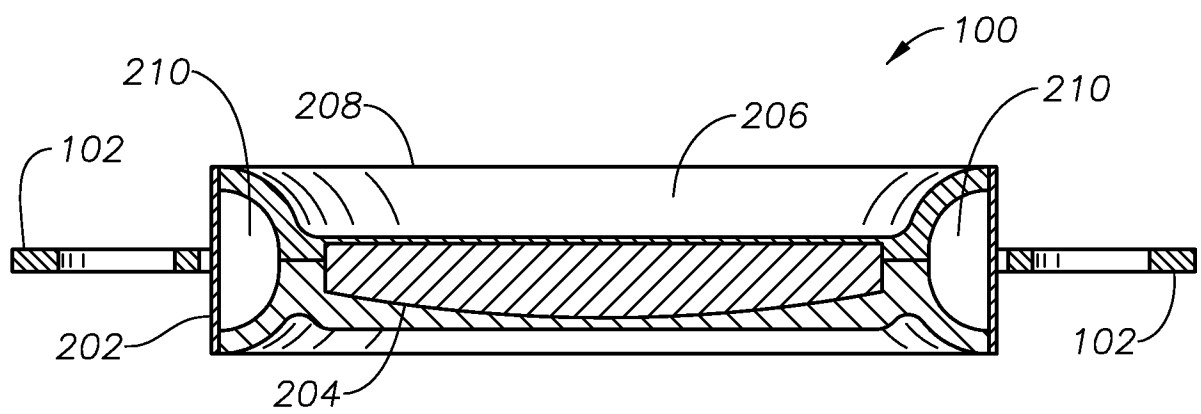
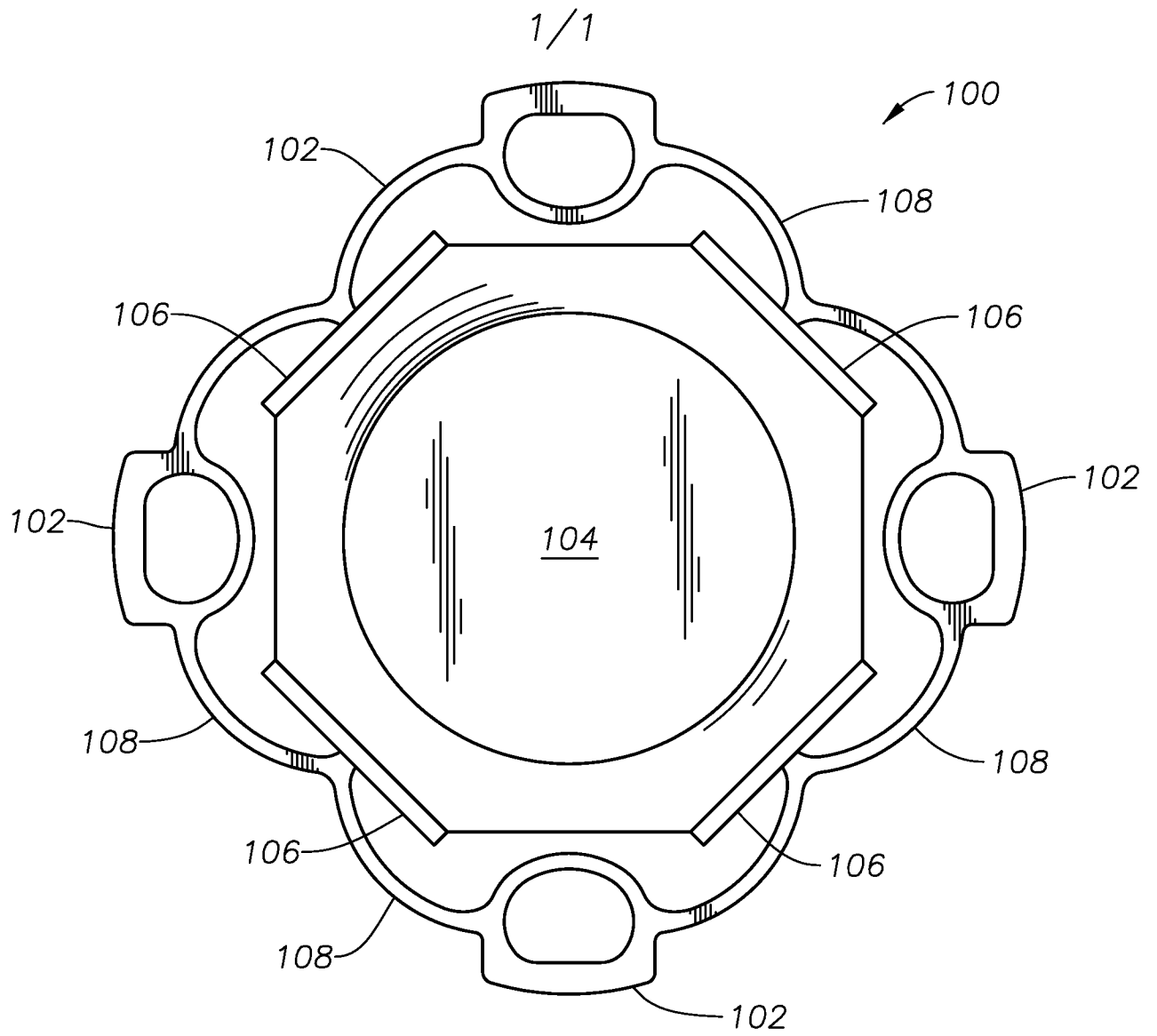
2. The lens of Claim 1, wherein the outer wall of the optic is octagonal and each of the attachment points comprises a side of the octagonal outer wall.

3. The lens of Claim 1, wherein the solid posterior optic is plano-convex.

15

4. The lens of Claim 1, wherein the fluid reservoir and the anterior fluid chamber are connected by at least one fluid channel.

20



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/62810

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61F 2/16 (2015.01)

CPC - A61F 2002/1681

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) : A61F 2/16 (2015.01)

CPC : A61F 2002/1681

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8) : A61F 2/00, 2/02, 2/14 (2015.01) USPC : 623/4.1, 6.11, 6.13, 6.22, 6.37, 6.38, 6.43

CPC: A61F 2/00, 2/02, 2/14, 2/16, 2/1613, 2/1624, 2/1635

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Patbase, Google Patent, Google Scholar: intraocular, intra, ocular, iol, fluid, liquid, chamber, reservoir, bladder, membrane, film, planoconvex, plano, convex, deform, stretch, inflate, expand, ring, perimeter, periphery, change, modify, alter, focus, power, curvature, volume, fixed, solid, lens, polygon, octagon, optic, four, quad, 4, haptic, arc

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2010/0324672 A1 (ESCH et al) 23 December 2010 (23.12.2010) see especially para [0055], [0057], [0058], [0060], [0062], fig 5A-D	1-2, 4 ----- 3
Y	US 2010/0324671 A1 (SHADDUCK) 23 December 2010 (23.12.2010) see especially para [0030]-[0032], [0034]-[0037], fig 1-2	3
A, P	US 2014/0180405 A1 (WEINSCHENK III et al) 26 June 2014 (26.06.2014) see whole document	1-4
A	US 2011/0118834 A1 (LO et al) 19 May 2011 (19.05.2011) see whole document	1-4
A	US 2010/0094412 A1 (WENSRICH) 15 April 2010 (15.04.2010) see whole document	1-4
A	US 2007/0203578 A1 (SCHOLL et al) 30 August 2007 (30.08.2007) see whole document	1-4
A	US 4,932,966 A (CHRISTIE et al) 12 June 1990 (12.06.1990) see whole document	1-4

☐ Further documents are listed in the continuation of Box C:

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

09 January 2015 (09.01.2015)

Date of mailing of the international search report

23 JAN 2015

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774