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(54) **EYEGGLASS MANUFACTURING METHOD USING VARIABLE INDEX LAYER AND A LENS**

VERFAHREN ZUR HERSTELLUNG VON LINSEN MIT EINEM SCHICHT MIT VARIABLEN
BRECHUNGSINDEX UND EINER LINSE

PROCEDE DE FABRICATION DE LUNETTES A L'AIDE D'UNE COUCHE A INDICE VARIABLE ET
UNE LENTILLE

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- **PATENT ABSTRACTS OF JAPAN** vol. 007, no. 054 (P-180), 4 March 1983 (1983-03-04) & JP 57 201216 A (SUWA SEIKOSHA KK), 9 December 1982 (1982-12-09)
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Description

FIELD OF THE INVENTION

[0001] The present invention relates, generally to an eyeglass manufacturing method using a layer with a variable Index of refraction. More specifically, the present invention pertains to patient-specific spectacle lenses manufactured with an variable Index aberrator in order to more accurately correct lower order aberrations and additionally correct higher order aberrations. The present invention also provides a means for correcting vision problems caused by retinal dysfunction.

BACKGROUND OF THE INVENTION

[0002] Present manufacturing techniques for eyeglass lenses are capable of producing lenses that correct only the lower order (sphere and cylinder) aberrations. Customarily, lens blanks are available in discrete steps of refractive power of 0.25 diopters. In most cases, these steps are too large to create optimum vision for a patient's eye.

[0003] Conventional lenses may also be formed by laminating two lenses or lens blanks to form a composite lens, as described in US 4,969,729 A and US 4,883,548 A. US 4,969,729 A discloses a composite plastic lens, which is composed of an anterior plastic lens and a posterior plastic lens, each lens having a corrective feature. The lenses are bonded together using an adhesive layer that has an Index of refraction equal to the index of refraction of the anterior and posterior lenses when cured. US 4,883,548 A discloses a process of creating a laminated ophthalmic lens, which is composed of a first and second lens element. The first and second lens elements each have specific lens optical values and are kept in stock for assembly into a composite ophthalmic lens. After a first and second lens element are selected, surfaces of both lens elements are coated with an adhesive and the surfaces are laminated, forming a single lens. However, like single lenses, composite lenses correct only for lower order aberrations and the constituent lens elements of composite lenses are customarily available only in discrete steps.

[0004] Current manufacturing techniques do not effectively treat vision problems resulting from retinal dysfunction. For example, in macular degeneration, patients suffer from vision loss in selective areas of the fundus, typically close to the center of vision. Laser treatment of the affected areas further destroys retinal tissue, causing blindness at the treated areas. Clinical studies have shown that the human eye and brain are capable of switching to other areas of the retina to substitute the damaged area with an undamaged area. In other words, damaged areas in the retina are essentially bypassed by the brain. Ultimately, vision loss will occur as a portion of an image falls on the damaged retina. Consequently, there is a need to manufacture an eyepiece such that the

Image may be "warped" around the dysfunctional tissue in order to allow the entire image to focus on the remaining healthy tissue. US-A-5,777,719 discusses resolution of retinal images.

[0005] In light of the aforementioned problems, the need for an optical element which generates a unique wavefront phase profile becomes apparent. Traditional manufacturing methods create such profiles through grinding and polishing. Such a method of manufacture is very costly due to the amount of time and expertise required.

SUMMARY OF THE PRESENT INVENTION

[0006] The present invention utilizes the technology developed by the wavefront aberrator in which a layer of variable index material, such as curable epoxy, can be sandwiched between two plane or curved glass or plastic plates. This sandwich is then exposed to the curing radiation (i. e., UV light) that is modulated spatially or temporally in order to create spatially resolved variations of refractive indices. This will allow the manufacturing of a lens that is capable of introducing or compensating for low and high order aberrations. The invention provides an eyeglass lens and a method for making a lens according to claims 1 and 4.

[0007] In the simplest form, two lens blanks are sandwiched together with a layer of epoxy such that the lenses used in conjunction approximately correct the patient's refractive spherical and cylindrical correction to within 0.25 diopters. Subsequently, the epoxy aberrator would be exposed to curing radiation in a pre-programmed way in order to fine-tune the refractive properties of the spectacle lens to the exact spherical and cylindrical prescription of the patient's eye.

[0008] Another application of the present invention is to manufacture multi-focal or progressive addition lenses constructed with a layer of variable index material sandwiched in between the two lens blanks. The drawback of progressive addition lenses today is that, like regular spectacle lenses, a true customization for a patient's eye cannot be achieved due to the current manufacturing techniques. Using the two lenses and epoxy, a customized progressive addition lens or reading lens can be manufactured by appropriately programming the curing of the epoxy aberrator.

[0009] The present invention provides an opportunity to manufacture lenses that give patients "supervision." In order to achieve supervision, higher order aberrations of the patient's eye need to be corrected. Since these higher order aberrations, unlike the spherical and cylindrical refractive error, are highly asymmetrical, centering of the eye's optical axis with the zone of higher order correction ("supervision zone") is important. To minimize this effect, one could devise a spectacle lens that incorporates a supervision zone only along the central optical axis, allowing the patient to achieve supervision for one or more discrete gazing angles. The remainder of the

lens would then be cured to correct only the lower order aberrations. An optional transition zone could be created between the supervision zone and the normal vision zone allowing for a gradual reduction of higher order aberrations. Again, all of this would be achieved by spatially resolved programming of the epoxy aberrator's curing.

[0010] In order to cover a larger field of view with supervision, a multitude of supervision "islands" might be created. The supervision islands then are connected by transition zones that are programmed to gradually change the higher order aberrations in order to create smooth transitions.

[0011] In bifocal lenses, refractive power in discrete steps of 1 diopter is added in the lower area of the lens to aid the spectacle wearer in near distance viewing, i.e. reading. For cosmetic reasons, the visible dividing line between the distance viewing area and the reading area is disliked by many presbyopic patients. With the event of the progressive addition lens, the sharp dividing line between the distance area and the reading area has been eliminated by introducing a continuous varifocal corridor of vision with a refractive power slowly changing from the distance viewing prescription to the reading prescription.

[0012] However, due to manufacturing limitations several disadvantages exist with the progressive addition lens. First, vision through areas outside the corridor is noticeably distorted, making the progressive addition lens unsuitable for many patients. Second, while the patient's individual prescription is applied to the distance viewing area, the added refractive power for the reading area is only offered in discrete steps of 1 diopter. Third, the distance between the centers of the distance viewing and reading viewing areas is fixed by the lens design and cannot be changed to accommodate for an individual's preference or application. Furthermore, the corridor design is fixed for any particular brand of lens and cannot be changed according to the patient's actual viewing preferences or spectacle frame selected.

[0013] Therefore, when prescribing a progressive addition lens, the eye care professional has to choose from an assortment of designs and manufacturers of the lens which matches the requirements of the patient most closely. The present invention allows one to manufacture a lens that is entirely customized and optimized to the patient's individual requirements.

[0014] Lastly, the present invention may be used to "warp" the retinal image so that damaged portions of the retina will be bypassed by the image. In order to do this, the visual field of the patient needs to be mapped with a perimeter or micro-perimeter. From this map of healthy retina, spectacle lenses could be manufactured using the epoxy aberrator.

DESCRIPTION OF THE DRAWINGS

[0015] The novel features of this invention, as well as the invention itself, both as to its structure and its operation, will be best understood from the accompanying

drawings, taken in conjunction with the accompanying description, in which like reference characters refer to similar parts, and in which:

Figure 1 is a perspective view of an eyeglass that incorporates a supervision zone for long distance applications;

Figure 2 shows a cross sectional view of Figure 1; Figure 3 shows a top view of a progressive addition lens, which includes a supervision zone and reading zone;

Figure 4 shows a top view of a reading or special application lens;

Figure 5A shows a top view of a lens including a multitude of supervision islands, which cover a larger view with supervision;

Figure 5B shows a top view of a multi-focal lens including a multitude of reading islands, allowing for far vision correction and simultaneous reading correction;

Figure 6 shows a text object imaged onto a damaged retina;

Figure 7 shows the image of the same object as Figure 6 from the patient's perspective;

Figure 8 shows the patient's view of the image after the brain shuts down the damaged retina;

Figure 9 shows an image focused on a damaged retina, with a corrective lens in place;

Figure 10 shows the image as the patient initially sees it;

Figure 11 shows the image as the patient sees it after the brain shuts down the damaged retina; and Figure 12 shows a sequence of manufacture for the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0016] Referring initially to Figure 1, a lens assembly that incorporates a supervision zone is shown and generally designated 100. Figure 1 shows that the lens assembly 100 includes an upper lens 102, a variable index layer 103, and a lower lens 104. In a preferred embodiment, the variable index layer is made of ultra-violet curing epoxy which exhibits an index of refraction that can be changed by exposure to ultraviolet radiation. However, it is to be appreciated that other materials which exhibit similar characteristics, namely a variable index of refraction, may be incorporated into the present invention.

[0017] The variable index layer 103 makes up the normal vision zone 106, the transition zone 110, and the supervision zone 108, where the epoxy at each zone is cured to a specific index of refraction. The normal vision zone 106 corrects the lower order spherical and cylindrical aberrations of the patient's eye. The transition zone 110 allows for a gradual reduction of higher order aberrations. The supervision zone 108 lies along the patient's optical axis (not shown) and corrects the higher order

aberrations allowing the patient to achieve supervision for one or more discrete gazing angles. The shape of the lens 100 is meant to be exemplary of the shape of a typical eyeglass lens, and any shape, including highly curved lenses, may be used while not departing from the present invention..

[0018] Referring now to Figure 2, a cross section of lens 100 is represented such that upper lens 102 has a thickness 112, epoxy layer 103 has a thickness 116, and the lower lens 104 has a thickness 114. The epoxy layer 103 is sandwiched between the upper lens 102 and the lower lens 104 and is held in place by a stopper 118.

DESCRIPTION OF ALTERNATIVE EMBODIMENTS

[0019] Referring now to Figure 3, an alternative embodiment of the present invention is illustrated as a progressive addition lens and generally designated 200. Figure 3 shows a top view of a transition lens 200 in which there is a supervision zone 202, a transition zone 204, and a short distance viewing zone 206. The normal vision zone 208 of the progressive addition lens 200 is corrected for the lower aberrations. Again, the creation of the various vision zones is by means of selectively curing the epoxy aberrator sandwiched between two glass (or plastic) blanks, not through the traditional means of grinding or molding these features into a blank. The transition lens 200 has a similar cross section to that depicted in Figure 2.

[0020] Referring now to Figure 4, another alternative embodiment of the present invention is illustrated as a reading lens and generally designated 300. Figure 4 shows a top view of a reading lens 300 in which there is a supervision zone 302, a transition zone 304, and a normal vision zone 306.. The reading lens 300 has a similar cross section to that depicted in Figure 2. The supervision zone 302 may be used for, but not limited to, high-resolution applications such as reading, precision close up work, etc.

[0021] Referring now to Figure 5A, an alternative embodiment of the present invention is illustrated as a supervision lens that covers a larger field of view and is generally designated 400. Figure 5A shows a top view of a supervision lens 400 in which there is a plurality of supervision islands 402, and a transition zone 404. The plurality of supervision islands 402 create a larger field of view for the patient, while the transition zone 404 is manufactured to gradually change the higher order aberrations in order to create smooth transitions.

[0022] Referring now to Figure 5B, another alternative embodiment of the present invention is illustrated as a multi-focal lens that allows for simultaneous correction for far vision and reading vision and is generally designated 450. Figure 5B shows a top view of a multi-focal lens 450 in which there is a plurality of optical islands 452, each representing the patient's reading prescription while the background zone 454 represents the patient's far vision prescription, or vice versa. Ideally, the diameter

of the optical islands is on the order of 100 microns so that a maximum number of optical islands falls within the typical pupil size of 2 to 6 mm diameter.

[0023] One special application of this invention is the use for correcting vision problems caused by retinal dysfunction, e.g., by eye diseases like glaucoma or macular degeneration. Figure 6 shows an eye generally designated 500, in which an image 502 is imaged by the eye's cornea and lens 504 onto the inner surface of the eye 500 where there is damaged retinal tissue 506. The patient initially sees only a portion of the image and an obstruction, as shown in Figure 7. Eventually the brain shuts off the damaged portion of the retina and the patient's view no longer includes the obstruction, such a view is represented in Figure 8. Although the patient no longer sees an obstruction, a portion of the image remains unseen. The present invention is capable of correcting this phenomenon as illustrated in Figures 9-11. Figure 9 again shows an eye generally designated 600, in which an object 602 is imaged through the eye's cornea and lens 604 onto the inner surface of the eye 600 where there is damaged retinal tissue 606. However, a lens 608 manufactured using the epoxy wavefront aberrator is placed in front of the eye 600. The retinal image 609 of the object 602 is warped around damaged retinal tissue 606 such that none of the image 602 is lost. Figure 10 shows the image the patient sees. As previously mentioned, over time the brain will terminate the signals generated by the damaged retinal tissue 606 and the patient will see the entire image 602 as shown in Figure 11..

[0024] Figure 12 shows a flow chart in which the manufacturing steps of the present invention are disclosed and generally designated 700. First the patient's eye must be imaged in order to determine the wavefront prescription. Second, both the upper and lower lenses must be selected. This selection corrects both the patient's spherical and cylindrical aberrations to within 0.25 diopters. Next, one side of the first lens is coated with epoxy. The second lens is then placed on the epoxy coated surface of the first lens, such that the epoxy is sandwiched between the two lenses. Finally the epoxy is cured to match the wavefront prescription.

[0025] While the different embodiments of the present invention as herein shown and disclosed in detail is fully capable of obtaining the objects and providing the advantages herein before stated, it is to be understood that it is merely illustrative of a preferred embodiment and an alternative embodiment of the invention and that no limitations are intended to the details of construction or design herein shown other than as described in the appended claims. The appended claims contain reference signs for certain claim elements for the sole purpose of making the claims easier to understand. Such reference signs are not intended to limit the extent of the matter protected by the claims in any way.

Claims

1. A method for making a lens (100, 200, 300, 400, 450, 608), comprising:

imaging a patient's eye (500, 600) to determine a wavefront prescription; selecting a first lens and a second lens (102, 104); coating said first lens with a material (103) having an index of refraction that can be changed by exposure to ultraviolet radiation; placing said second lens (104) on said material (103) such that said material is sandwiched between first lens (102) and said second lens (104); and curing said material (103) on said first lens (102) in accordance with said wavefront prescription.
2. The method of claim 1 in which said material (103) is an epoxy.
3. The method of claim 1 in which said material (103) is an ultraviolet curing epoxy.
4. An eyeglass lens (100, 200, 300, 400, 450, 608) comprising:

a first layer comprising a lens (102) or lens blank having a constant index of refraction; and at least one second layer (103) comprising a material having a varying index of refraction, the second layer (103) having a substantially constant thickness.
5. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 4 comprising a third layer, the third layer comprising a second lens (104) or lens blank, the second layer (103) being sandwiched between the first layer (102) and the third layer (104).
6. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 5, further comprising a stopper (118) sandwiched between the first layer (102) and the third layer (104).
7. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 4 configured to correct at least one higher order aberration along an optical axis of a patient for first discrete viewing angle.
8. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 7 configured to correct the higher order aberration along the optical axis of the patient for a second discrete viewing angle.
9. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 8 configured to correct at least one lower order aberration along the optical axis of the patient for the first discrete viewing angle, the second discrete viewing angle, or both.
10. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 7 configured to correct at least one lower order aberration along the optical axis of the patient for the first discrete viewing angle.
11. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 4 in which the first layer (102) is configured to correct at least one lower order aberration along an optical axis of a patient, and in which the second layer (103) comprises a plurality of zones (108, 110, 404), each of the zones being configured such that the varying index of refraction within each of the zones corrects for a higher order aberration of the patient.
12. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 4 configured to create aberrations that warp a patient's retinal image (609) around dysfunctional retinal tissue.
13. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 4 configured to correct for both far vision and reading vision.
14. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 13 in which the first layer is a single vision lens (102) configured to correct for far vision, and the varying index of refraction in the second layer (103) is configured to correct for the reading vision.
15. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 4 in which the first layer (102) is configured to correct a patient's vision at one distance, and in which the second layer (103) comprises a plurality of zones (452, 454, 202, 204, 206, 208, 302, 304, 306, 402, 404), each of the zones being configured such that the varying index of refraction within each of the zones corrects for the patient's vision at a second distance.
16. The eyeglass lens (100, 200, 300, 400, 450, 608) of claim 4 in which the second layer (103) has been cured to match wavefront prescription of a patient.
17. The lens (100, 200, 300, 400, 450, 608) of claim 6, wherein the index of refraction of the material (103) of the second layer can be varied by selective exposure to radiation.
18. The lens (100, 200, 300, 400, 450, 608) of any of claims 4 to 17 in which the material (103) is epoxy.
19. The lens (100, 200, 300, 400, 450, 608) of claim 18 in which the material is an ultraviolet curing epoxy.

20. The method of any of claims 1 to 3, further comprising:

determining if the patient's eye (500, 600) includes dysfunctional retinal tissue such that a portion (506, 606) of an image (609) projected onto a retina by the eye (500, 600) of said patient is unseen by said patient, wherein said lens (100, 200, 300, 400, 450, 608) comprises a wavefront aberrator that warps said image (609) around said dysfunctional retinal tissue (506, 606) such that said portion of an image is seen by said patient.

21. The method of any of claims 1 to 3 or 20, wherein said lens (100, 200, 300, 400, 450, 608) is the lens (100, 200, 300, 400, 450, 608) of any of claims 4 to 19.

Patentansprüche

1. Verfahren zur Herstellung einer Linse (100, 200, 300, 400, 450, 608) enthaltend:

Abbilden eines Auges eines Patienten (500, 600) zur Bestimmung einer Wellenfront-Korrektur;

Auswahl einer ersten Linse und einer zweiten Linse (102, 104); Beschichten der ersten Linse mit einem Material (103), welches einen Brechungsindex aufweist, der durch ultraviolette Bestrahlung verändert werden kann;

Platzieren der zweiten Linse (104) auf dem Material (103), so dass das Material zwischen die erste Linse (102) und die zweite Linse (104) geschichtet ist, und

Aushärten des Materials (103) auf der ersten Linse (102) in Übereinstimmung mit der Korrektur.

2. Verfahren nach Anspruch 1, bei dem das Material (103) ein Epoxidharz ist.

3. Verfahren nach Anspruch 1, bei dem das Material (103) ein UV-härtbares Epoxidharz ist.

4. Brillenglas (100, 200, 300, 400, 450, 608) enthaltend:

eine erste Schicht enthaltend eine Linse (102) oder Linsenrohling mit einem konstanten Brechungsindex; und
wenigstens einer zweiten Schicht (103) enthaltend ein Material mit einem variierenden Brechungsindex, wobei die zweite Schicht (103) eine im wesentlichen konstante Dicke aufweist.

5. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 4, enthaltend eine dritte Schicht, wobei die dritte Schicht eine zweite Linse (104) oder Linsenrohling umfaßt, wobei die zweite Schicht (103) zwischen die erste Schicht (102) und die dritte Schicht (104) geschichtet ist.

6. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 5, ferner enthaltend einen Halter (118) welcher zwischen die erste Schicht (102) und die dritte Schicht (104) geschichtet ist.

7. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 4, ausgebildet zur Korrektur wenigstens eines Abbildungsfehlers höherer Ordnung entlang der optischen Achse des Patienten für einen ersten diskreten Betrachtungswinkel.

8. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 7, ausgebildet zur Korrektur des Abbildungsfehlers höherer Ordnung entlang der optischen Achse des Patienten für einen zweiten diskreten Betrachtungswinkel.

9. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 8, ausgebildet zur Korrektur wenigstens eines Abbildungsfehlers niedriger Ordnung entlang der optischen Achse des Patienten für den ersten diskreten Betrachtungsfehler, den zweiten diskreten Betrachtungswinkel, oder beiden.

10. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 7, ausgebildet zur Korrektur wenigstens eines Abbildungsfehlers niedriger Ordnung entlang der optischen Achse des Patienten für den ersten diskreten Betrachtungswinkel.

11. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 4, bei dem die erste Schicht (102) ausgebildet ist zur Korrektur wenigstens eines Abbildungsfehlers niedriger Ordnung entlang einer optischen Achse eines Patienten, und bei dem die zweite Schicht (103) eine Vielzahl von Zonen (108, 110, 404) umfasst, die jeweils so ausgebildet sind, dass der variierende Brechungsindex innerhalb jeder Zone einen Abbildungsfehler höherer Ordnung des Patienten korrigiert.

12. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 4, ausgebildet zur Erzeugung von Abbildungsfehlern, die das Bild auf der Netzhaut (609) um dysfunktionales Netzhautgewebe herum krümmen.

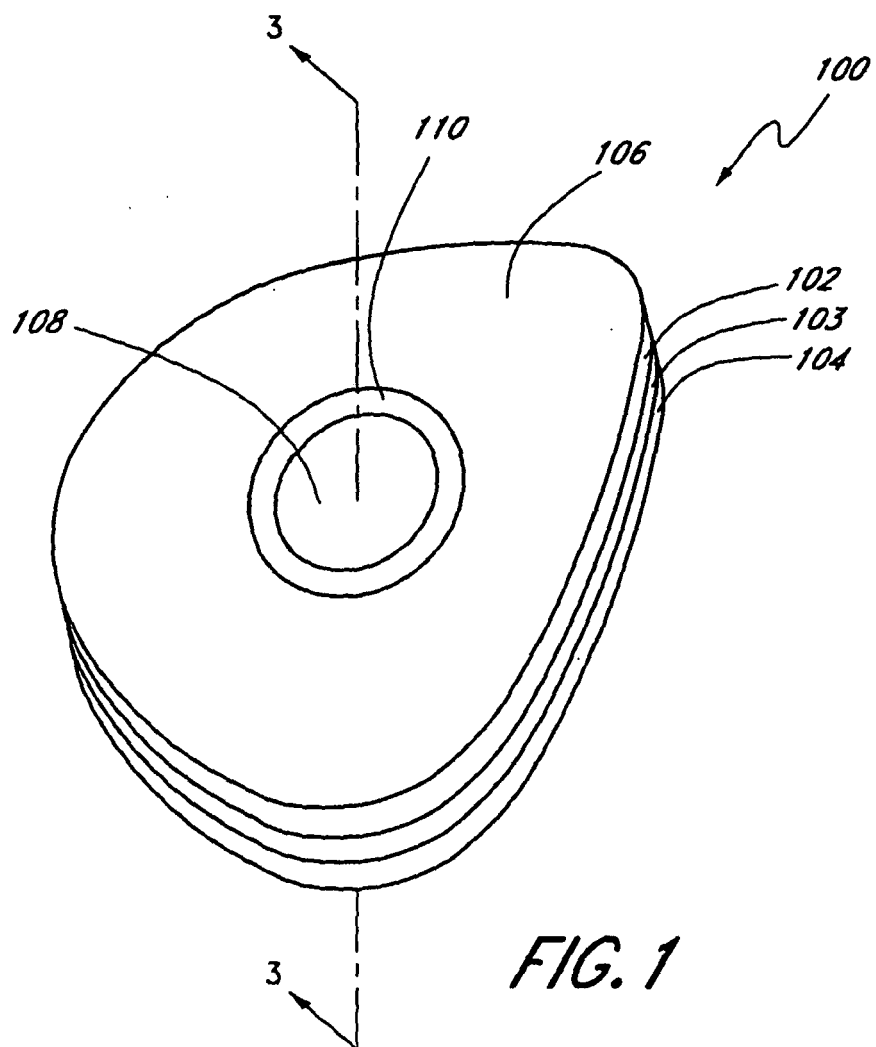
13. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 4, ausgebildet sowohl zur Korrektur von Fernsicht als auch Nahsicht.

14. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 13, bei dem die erste Schicht (102) aus einer einfach wirkenden Linse besteht, die zur Korrektur der Fernsicht ausgebildet ist und der variierende Brechungsindex in der zweiten Schicht (103) angepaßt ist zur Korrektur der Nahsicht. 5
15. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 4, bei dem die erste Schicht (102) angepaßt ist zur Korrektur der Sehkraft des Patienten für eine Entfernung und die zweite Schicht (103) eine Vielzahl von Zonen (452, 454, 202, 204, 206, 208, 302, 304, 306, 402, 404) enthält, wobei jede Zone so ausgebildet ist, dass der variierende Brechungsindex innerhalb jeder Zone die Sehkraft des Patienten für eine zweite Entfernung korrigiert. 10
16. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 4, bei dem die zweite Schicht (103) so ausgehärtet wurde, dass sie der Wellenfront-Korrektur eines Patienten entspricht. 15
17. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 6, bei dem der Brechungsindex des Materials (103) der zweiten Schicht durch selektives Aussetzen einer Strahlung verändert werden kann. 20
18. Brillenglas (100, 200, 300, 400, 450, 608) nach einem der Ansprüche 4 bis 17, bei dem das Material (103) Epoxydharz ist. 25
19. Brillenglas (100, 200, 300, 400, 450, 608) nach Anspruch 18 bei dem das Material ein UV-härtendes Epoxydharz ist. 30
20. Verfahren nach einem der Ansprüche 1 bis 3, ferner enthaltend: 35
- Bestimmen ob das Auge des Patienten (500, 600) dysfunktionales Netzhautgewebe aufweist, so dass ein Teil (506, 606) eines Bildes (609), dass vom Auge (500, 600) des Patienten auf die Netzhaut abgebildet wird, vom Patienten nicht gesehen wird; 40
- wobei das Brillenglas (100, 200, 300, 400 450, 608) einen Abbildungsfehler erzeugt, der das Bild (609) um das dysfunktionale Netzhautgewebe herum krümmt, so dass der Teil eines Bildes von dem Patienten gesehen wird. 45
21. Verfahren nach einem der Ansprüche 1 bis 3 oder 20, bei dem das Brillenglas (100, 200, 300, 400, 450, 608) ein Brillenglas (100, 200, 300, 400, 450, 608) nach einem der Ansprüche 4 bis 19 ist. 50

Revendications

1. Procédé pour fabriquer une lentille (100, 200, 300, 400, 450, 608) comprenant:
 - la formation d'une image de l'oeil (500, 600) d'un patient pour déterminer une prescription du front d'onde,
 - le choix d'une première lentille et d'une deuxième lentille (102, 104),
 - le revêtement de ladite première lentille avec un matériau (103) ayant un indice de réfraction qui peut être changé par exposition aux rayons ultraviolets,
 - le placement de ladite deuxième lentille (104) sur ledit matériau (103) de telle manière que ledit matériau soit pris en sandwich entre la première lentille (102) et ladite deuxième lentille (104) ; et
 - le durcissement dudit matériau (103) sur ladite première lentille (102) conformément à ladite prescription du front d'onde.
2. Procédé selon la revendication 1, dans lequel ledit matériau (103) est un époxy.
3. Procédé selon la revendication 1, dans lequel ledit matériau (103) est un époxy durcissant aux ultraviolets.
4. Lentille (100, 200, 300, 400, 450, 608) de lunettes comprenant :
 - une première couche comprenant une lentille (102) ou une ébauche de lentille ayant un indice de réfraction constant, et
 - au moins une deuxième couche (103) comprenant un matériau ayant un indice de réfraction variable, la deuxième couche (103) ayant une épaisseur sensiblement constante.
5. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 4, comprenant une troisième couche, la troisième couche comprenant une deuxième lentille (104) ou une ébauche de lentille, la deuxième couche (103) étant prise en sandwich entre la première couche (102) et la troisième couche (104).
6. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 5, comprenant en outre un arrêt (118) pris en sandwich entre la première couche (102) et la troisième couche (104).
7. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 4, configurée pour corriger au moins une aberration d'ordre supérieur le long d'un axe optique d'un patient pour un premier angle de vision discret.

8. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 7, configurée pour corriger l'aberration d'ordre supérieur le long de l'axe optique du patient pour un deuxième angle de vision discret.
9. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 8, configurée pour corriger au moins une aberration d'ordre inférieur le long de l'axe optique du patient pour le premier angle de vision discret, le deuxième angle de vision discret, ou les deux.
10. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 7, configurée pour corriger au moins une aberration d'ordre inférieur le long de l'axe optique du patient pour le premier angle de vision discret,
11. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 4, dans laquelle la première couche (102) est configurée pour corriger au moins une aberration d'ordre inférieur le long d'un axe optique d'un patient, et dans laquelle la deuxième couche (103) comprend une pluralité de zones (108, 110, 404), chacune des zones étant configurée de telle manière que l'indice de réfraction variable dans chacune des zones corrige une aberration d'ordre supérieur du patient.
12. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 4, configurée pour créer des aberrations qui distordent l'image rétinienne (609) d'un patient autour du tissu rétinien dysfonctionnel.
13. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 4, configurée pour corriger tant la vision de loin que la vision de lecture.
14. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 13, dans laquelle la première couche est une lentille unifocale (102) configurée pour corriger la vision de loin, et l'indice de réfraction variable dans la deuxième couche (103) est configuré pour corriger la vision de lecture.
15. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 4, dans laquelle la première couche (102) est configurée pour corriger la vision d'un patient à une distance, et dans laquelle la deuxième couche (103) comprend une pluralité de zones (452, 454, 202, 204, 206, 208, 302, 304, 306, 402, 404), chacune des zones étant configurée de telle manière que l'indice de réfraction variable dans chacune des zones corrige la vision du patient à une deuxième distance.
16. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 4, dans laquelle la deuxième couche (103) a été durcie pour correspondre à la prescription de front d'onde d'un patient.
17. Lentille (100, 200, 300, 400, 450, 608) selon la revendication 6, dans laquelle l'indice de réfraction du matériau (103) de la deuxième couche peut être varié par exposition sélective à une irradiation.
18. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon une quelconque des revendications 4 à 17, dans laquelle le matériau (103) est de l'époxy.
19. Lentille (100, 200, 300, 400, 450, 608) de lunettes selon la revendication 18, dans laquelle le matériau est un époxy durcissant aux ultraviolets.
20. Procédé selon une quelconque des revendications 1 à 3, consistant en outre :
- à déterminer si l'oeil du patient (500, 600) comprend du tissu rétinien dysfonctionnel de sorte qu'une partie (506, 606) d'une image (609) projetée sur une rétine par l'oeil (500, 600) dudit patient n'est pas vue par ledit patient, dans lequel ladite lentille (100, 200, 300, 400, 450, 608) comprend un abrateur de front d'onde qui distord ladite image (609) autour dudit tissu rétinien dysfonctionnel (506, 606) de telle sorte que ladite partie d'image est vue par ledit patient.
21. Procédé selon une quelconque des revendications 1 à 3 ou 20, dans lequel ladite lentille (100, 200, 300, 400, 450, 608) est la lentille (100, 200, 300, 400, 450, 608) de l'une quelconque des revendications 4 à 19.



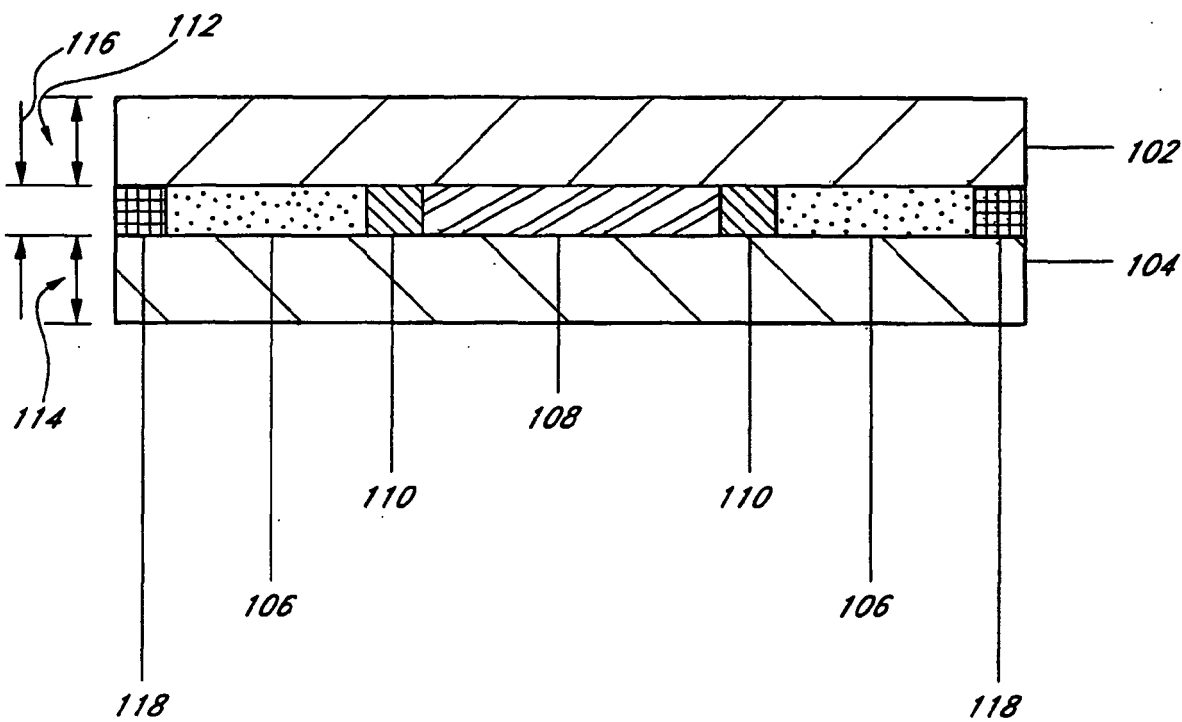


FIG.2

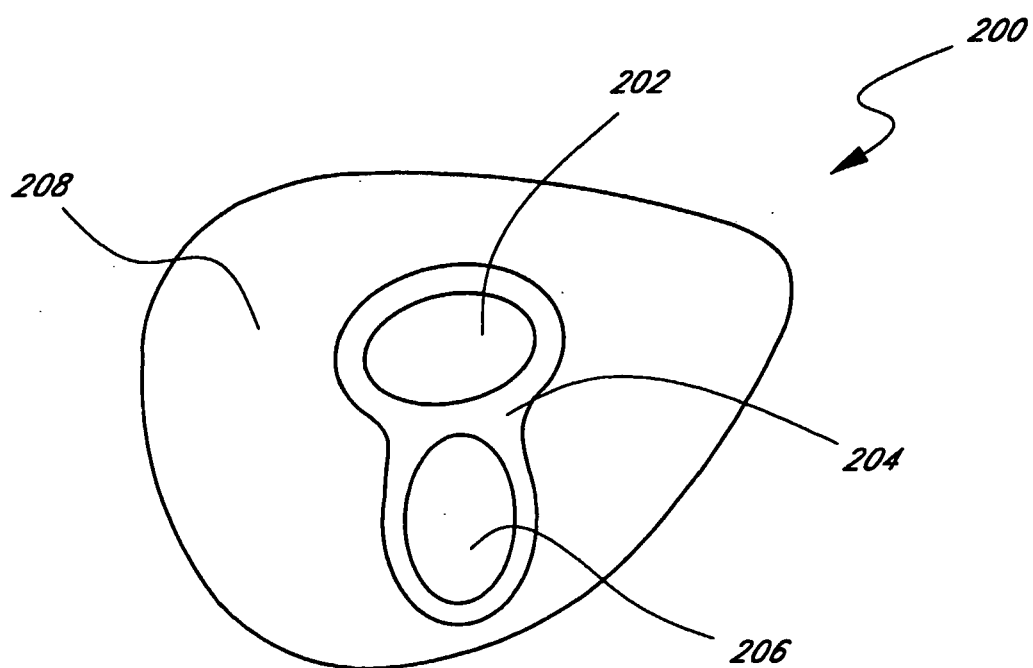


FIG. 3

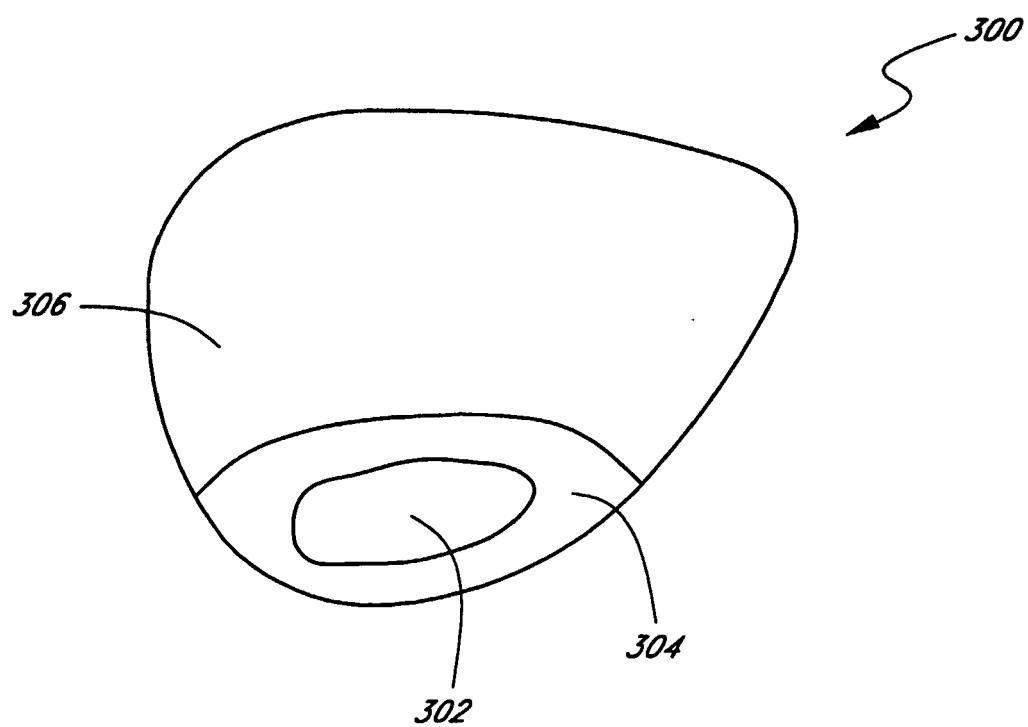


FIG. 4

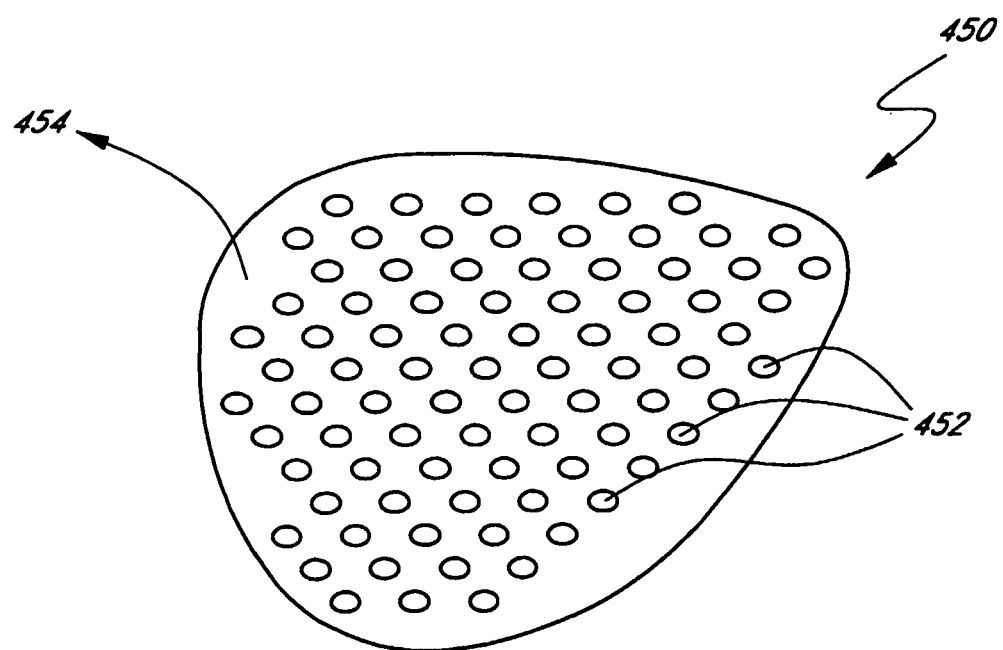
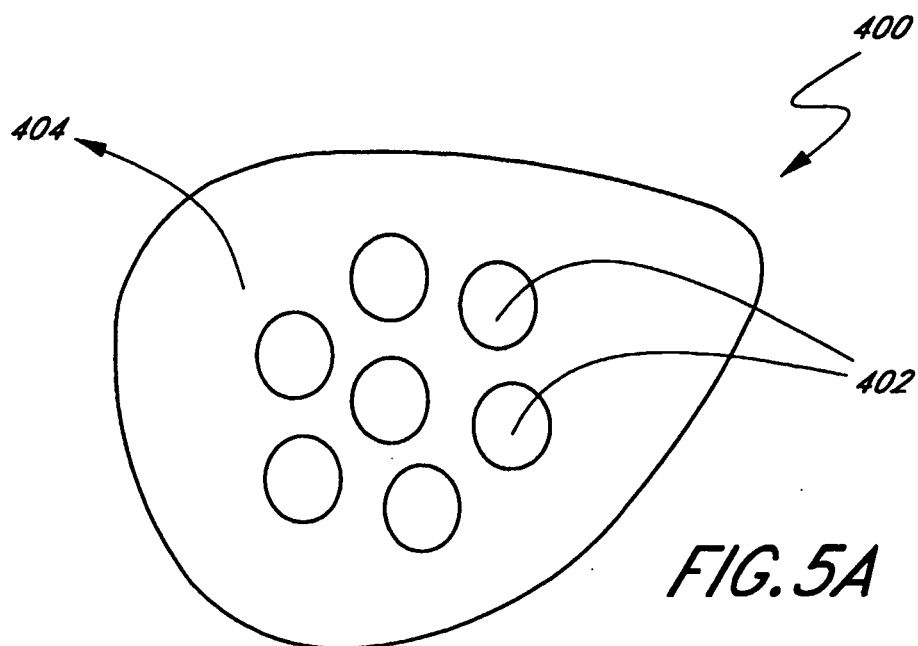


FIG. 5B

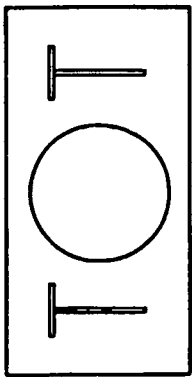


FIG. 7

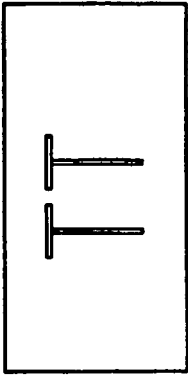


FIG. 8

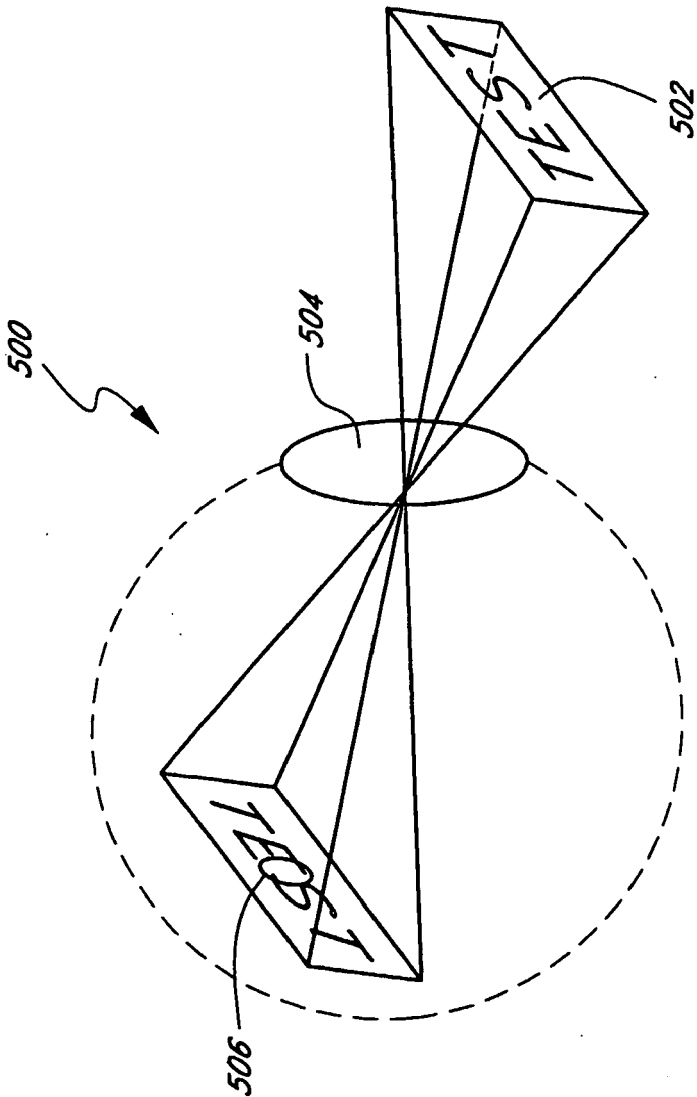


FIG. 6

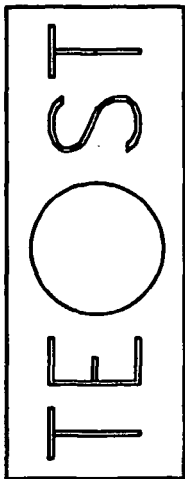


FIG. 10

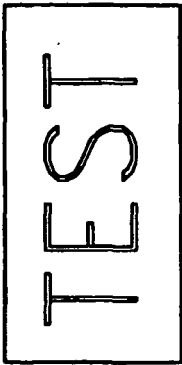


FIG. 11

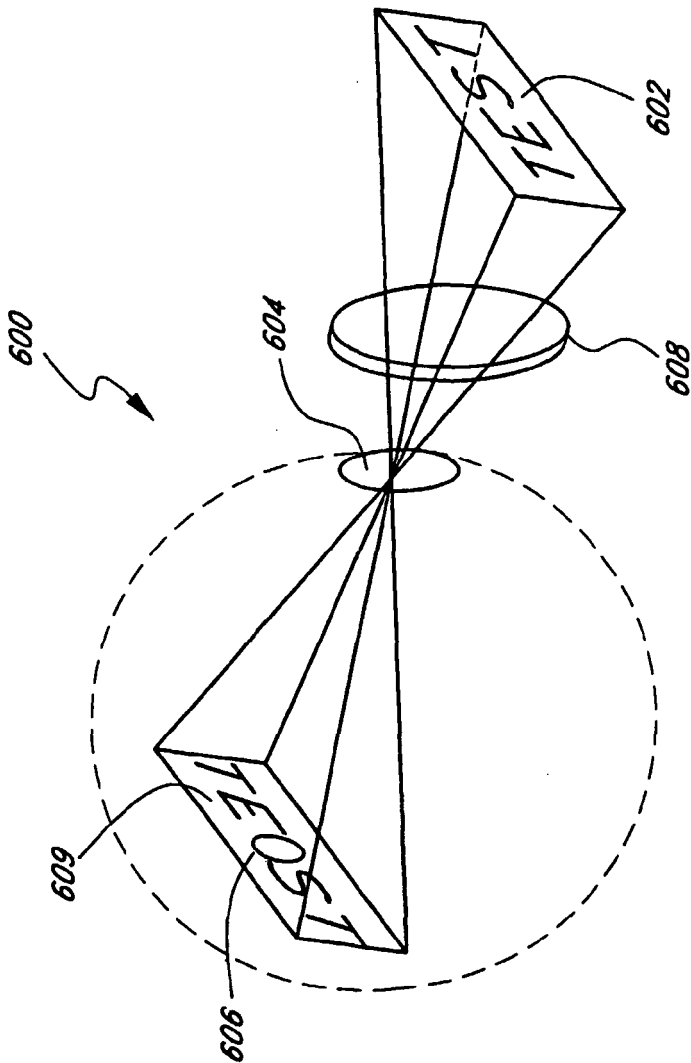


FIG. 9

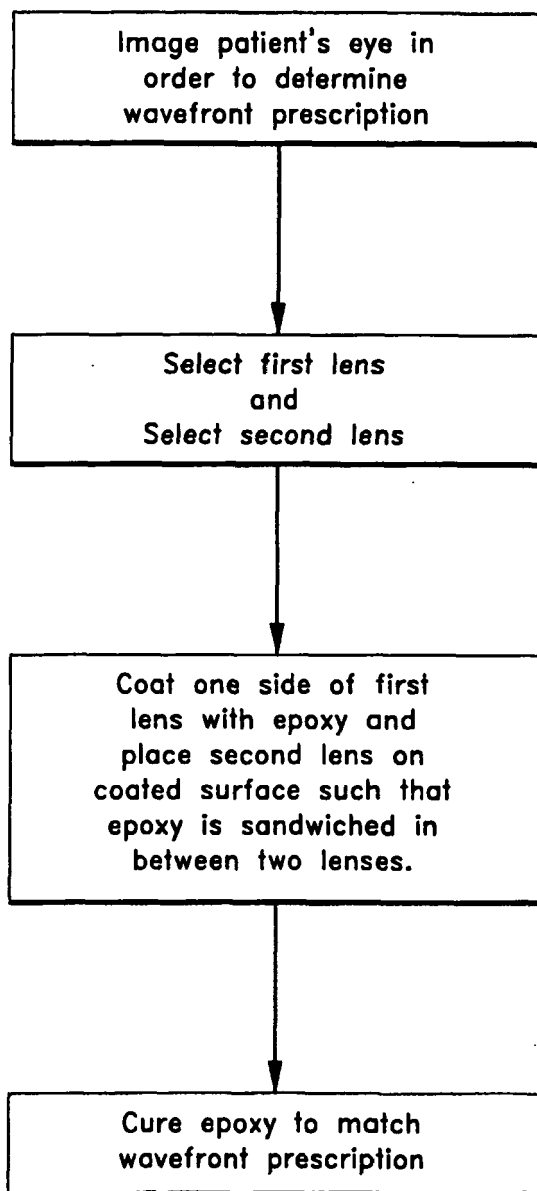


FIG. 12

REFERENCES CITED IN THE DESCRIPTION

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