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(54) Title: CONTACT LENS COMPRISING A LENTICULAR IN A SUPERIOR PORTION OF THE CONTACT LENS

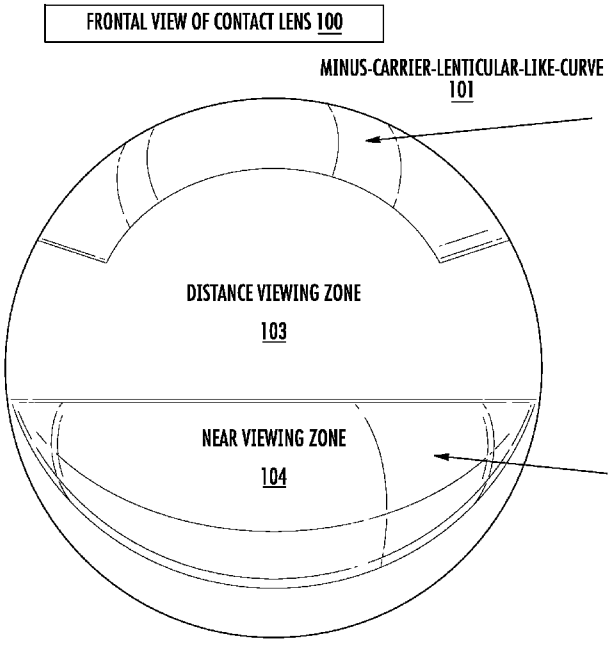


FIG. 1A

(57) Abstract: Disclosed herein is a contact lens comprising a lenticular in a superior portion of the contact lens wherein the contact lens attaches to an upper eyelid of a wearer by the lenticular interacting with an upper tarsal plate of the upper eyelid of a wearer, said interaction allows the contact lens to translate upwards in downgaze and maintain rotational stability. In one aspect, the lenticular has a top surface, said top surface having a shape selected from the group consisting of flat, flat with rounded corners, concave, convex or tapered having a thicker portion closer to an edge of the contact lens, or combinations thereof. In another aspect, the lenticular is comprised of a plurality of lenticular sections. In yet another aspect, the lenticular is anatomically-shaped.

[Continued on next page]

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CONTACT LENS COMPRISING A LENTICULAR IN A SUPERIOR PORTION OF THE CONTACT LENS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and benefit of U.S. patent application serial no. 15/274,159 filed September 23, 2016, which claims benefit of U.S. Provisional Application No. 62/222,376, filed September 23, 2015, both of which are hereby incorporated herein by reference in their entirety.

BACKGROUND

[0002] The current state-of-the art in rotational stabilization includes back surface toricity (effective for rigid gas-permeable contact lenses), base-down and peri-ballast prism, or Dynamic Stabilization which is a modification of base-down prism. There are patients for whom one or none of the existing designs are sufficient to provide rotational stabilization for a contact lens.

[0003] Traditionally, rigid gas permeable (RGP) contact lenses are fitted with a "lid attachment" fit by either using the naturally thicker edge of a minus-shaped RGP contact lens or by adding minus-carrier lenticular (a thicker edge) to a plus-shaped RGP contact lens. The shape that is used in conventional RGP lenses was probably largely a function of what could be manufactured when lid attachment was first described in the 1970s. With these conventional lens, the thicker edge would be found 360° around the lens periphery. However, the lens does not necessarily need to be that shape in order to achieve lid attachment, and other shapes and designs may provide a better fit that allows the contact lens to translate upwards in downgaze. Translation of the lens in downgaze would allow the use of a true bifocal, distance power in the upper, middle portion of the lens, and near power in the lower portion of the lens. In addition, the lid attachment fit provides rotational stabilization for toric lenses and other applications.

[0004] Therefore, what is desired are contact lenses that overcome challenges in the art, some of which are described above.

SUMMARY

[0005] Disclosed and described herein is a soft contact lens with a lid-attachment fit. The portion that is used for lid attachment (i.e., the lenticular) is placed only at the top (superior) aspect of the contact lens. With modern manufacturing capabilities, any number of shapes can be implemented to achieve the lid attachment fit.

[0006] The present disclosure relates to translating bifocal, trifocal, or multifocal contact lenses that work when the cornea is spherical or toric. For rotational stabilization, the contact lenses disclosed herein have an advantage over base-down prism, peri-ballasting, and Dynamic Stabilization in that it uses the interaction between the lenticular aspect described below and the upper eyelid tarsal plate to stabilize the contact lens and may also use the interaction between the base of the prism and the lower eyelid. Interactions between the lens and one or both eyelids provides better stabilization in the lens design disclosed herein. This same contact lens design will also allow for the contact lens to have a translational movement when the patient looks from straight ahead gaze into downgaze. Instead of pushing the base of the prism in the contact lens upwards with the lower eyelid, as much of the prior art attempts to do, this design pulls the contact lens upwards with the superior lenticular aspect. This is because the lenticular aspect allows the contact lens to use a "lid-attached" fit, wherein the lens stays with the upper lid as the patient looks downwards.

[0007] The description below sets forth details of one or more embodiments of the present disclosure. Other features, objects, and advantages will be apparent from the description and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The accompanying figures, which are incorporated in and constitute a part of this specification, illustrate several aspects described below.

[0009] FIGS. 1A and 1B are schematic diagrams providing frontal (FIG. 1A) and a profile view (FIG. 1B) of a bifocal contact lens according to lens designs disclosed herein. FIGS. 1A and 1B show a lenticular 101 comprising a minus-carrier lenticular-like curve located on or proximate the superior edge of the contact lens 100.

[0010] FIGS. 1C and 1D are schematic diagrams providing frontal (FIG. 1C) and a profile view (FIG. 1D) of an alternate bifocal contact lens according to lens designs disclosed herein. FIGS. 1C and 1D show a lenticular 101 comprising a minus-carrier lenticular-like curve located further toward the center of the contact lens away from the superior edge of the contact lens 100.

[0011] FIGS. 2A (front view) and 2B (profile view) are schematic diagrams of a contact lens showing a “push” and “pull” mechanism associated with a superior lenticular and an inferior prism segment.

[0012] FIGS. 3A-3F are profile schematic images of exemplary contact lens having various shaped lenticulars in a superior portion of the contact lens.

[0013] FIG. 4A is a profile schematic image of exemplary contact lens having an exemplary anatomically-shaped lenticular in a superior portion of the contact lens

[0014] FIG. 4B is a front view of the anatomically-shaped lenticular of FIG. 4A showing width (w) and height (h) dimensions.

[0015] FIG. 4C is a front view of a contact lens having an anatomically-shaped lenticular in a superior portion of the contact lens.

[0016] FIGS. 5A and 5B are profile images of eyes that illustrate the lid attachment fit of contact lens having a lenticular in the superior portion of the lens as compared with a contact lens that does not have a lenticular.

[0017] FIGS 6A-6J illustrate front views of contact lens having non-limiting examples of lenticulars as disclosed and described herein.

DETAILED DESCRIPTION

[0018] The present disclosure now will be described more fully hereinafter with reference to specific exemplary embodiments. Indeed, the present disclosure can be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

[0019] Disclosed herein is a contact lens comprising lenticular over an upper (superior) portion of the lens. For example, the lenticular may comprise a rounded, minus-carrier, lenticular-like curve over a central, upper portion of the lens, though other lenticular shapes, designs and locations are contemplated.

[0020] The various embodiments of a contact lens disclosed herein comprises a superior-located lenticular design that creates: (1) rotational stability of the contact lens in all gazes, (2) upwards translation, or movement, of the contact lens when the eye is in downward gaze, and (3) a general, centered placement of the contact lens over the cornea and the pupil as needed as the person's gaze changes. By "upwards translation of the contact lens when the eye is in downward gaze" means that the contact lens is held in an upwards position when the patient looks down. The embodiments disclosed and described herein include one or more lenticulars located in a superior portion of the contact lens where the lenticular has any shape that would allow any contact lens (soft, rigid gas permeable, hybrid, etc.) to attach itself to the inside of the upper lid.

[0021] Referring to FIGS. 1A and 1B, a schematic diagram of frontal (FIG. 1A) and profile view (FIG. 1B) of a bifocal contact lens 100 according to lens designs disclosed herein is illustrated. The lens is bifocal in that is has a distance viewing zone 103 and a near viewing zone 104. One of the features of the contact lens shown in FIGS 1A and 1B is the placement of a lenticular 101

over the upper, central portion of the contact lens. As described herein, the upper portion of the contact lens 100 is referred to as the superior portion and the lower portion of the contact lens 100 is referred to as the inferior portion. Generally the lenticular 101 is located completely in the superior portion of the contact lens 100 above a horizontal midline that passes through the center of the contact lens 100; however, the ends of one or more of the lenticulars may extend into the inferior portion of the contact lens that lies below the horizontal midline. In the embodiment shown in FIGS 1A and 1B, the lenticular 101 comprises a rounded, minus-carrier-lenticular-like-curve that extends in an arc around a portion of the upper edge of the contact lens 100, though other shapes, sizes and designs of lenticulars 101 are contemplated within the scope of embodiments of this invention and disclosed herein. Another feature of the design shown in FIGS. 1A and 1B is the possible use of prism 102 or a ballast in the lower portion of the contact lens 100. The combined features of the contact lens 100 disclosed herein provide rotational stabilization, translation, and/or centration. The contact lens disclosed herein can be a rigid gas permeable or soft contact lens design, or a hybrid design, such that the contact lens has a rigid center with soft surround. The lens can be made of a material that can sense light activity or molecules in the ocular environment and that contains elements that modulate light or the surrounding ocular environment, i.e., liquid crystal displays, filters, photochromatic materials, compartments containing other materials, or sensors. Though shown in FIGS. 1A and 1B as bifocal lens, it is to be appreciated that the contact lens 100 described herein can be of any vision including single-vision, bifocal, multifocal, and/or toric.

[0022] In FIGS. 1A, 1B, 1C and 1D, the lenticular 101 can be seen at the top of the contact lens 100. The lenticular 101 (in this example a minus-carrier-lenticular-like-curve) can be placed at the upper edge of the contact lens 100, as seen in FIG. 1B, or can be located some distance from the edge of the contact 100, as can be seen in FIG. 1D. For example, the lenticular 101 can be located in the central, upper portion of the contact lens 100. The lenticular 101 can be .1, .2, .3, .4, .5, .6, .7, .8, .9, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, or 5.0 millimeters, or more, less, or any amount in-between, away from the outer edge of the contact lens 100. A prism 102 or ballast can be located in the lower half of the contact lens 100. The use of prisms is discussed in more detail herein.

[0023] The current state-of-the-art in translating contact lenses is a rigid gas permeable contact lens. There are currently no successful soft contact lenses that achieve translating vision. All of the prior art in translating soft contact lenses moves in the opposite direction of this design, i.e., all other designs attempt to thin the upper portion of the contact lens as much as possible, rather than making it thicker and attached to the upper lid. The contact lens disclosed herein provides a translating contact lens, including a soft contact lens, which is more comfortable and requires less

adaptation time than a rigid gas permeable lens. Generally speaking, patients are more willing and able to wear a soft contact lens than a rigid gas permeable contact lens, and a soft contact lens requires less expertise to fit. The current state-of-the-art in bifocal or multifocal soft contact lenses is simultaneous vision. In these lenses, both the rays focusing the distance vision and the rays focusing the near vision are within the pupil at the same time. Thus, the patient must be able to ignore the rays that are not in focus. This leads to some degradation of vision. The translating soft contact lens disclosed herein allow only light from one distance to be in focus at a time, providing clearer vision at each distance.

[0024] The other current state-of-the-art option for fitting presbyopic patients in soft contact lenses is called monovision. In this case, one eye is powered for distance vision (usually the dominant eye) and one eye is powered for near vision (usually the non-dominant eye). Some patients are unable to adapt to this type of lens, again, especially when the patient requires a greater reading add power. The difference between the two eyes becomes too uncomfortable. Also, it is well established that monovision correction in contact lenses or laser vision correction leads to a loss of depth perception. The translating soft contact lens disclosed herein allows for the use of higher reading add powers without degradation of the quality of distance vision. Because both eyes are fully and equally corrected at distance and near in the disclosed design, there is no induced loss of depth perception. The translating soft contact lens disclosed herein can also have an optical segment that provides a gradient of power change between the distance and near segments.

[0025] The contact lens disclosed herein are designed to suit many practical purposes. For example, in both rigid and soft contact lenses, the lens designs disclosed herein provide rotational stabilization in all gazes for toric contact lens designs, contact lenses designed to correct for various types of ocular aberration beyond a spherical correction, for electronically-generated and/or virtual optically displayed images, and/or bifocal or multifocal contact lenses. Additionally, the lens designs disclosed herein create upwards translation of a bifocal/multifocal contact lens in downward gaze. Furthermore, the lens designs disclosed herein achieve a "lid attached" fit similar to rigid gas permeable contact lens, *i.e.,* keep the contact lens attached under the upper lid before, during, and after a blink.

[0026] In one embodiment, the upper portion of the contact lens interacts with an upper eyelid of the wearer. The upper portion of the contact lens that interacts with the upper lid can comprise 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, or 75% of the area between the upper edge of the contact lens and the geometric center of the contact lens. For example, the area of the upper portion of the contact lens (meaning the “top half” of the contact lens, or the area between the upper edge

and geometric center of the contact lens) that interacts with the upper lid can comprise 10 to 50% of the upper area of the lens.

[0027] Conventionally, a minus carrier lenticular can be used in rigid gas permeable contact lenses in order to create a lid attached fit in a plus-shaped contact lens. In the contact lens design disclosed herein, a lenticular 101 is placed in the central, upper portion of the lens only, rather than over a larger portion of the lens circumference. Some embodiments of the lens designs disclosed herein have a smaller area where a relatively thick edge is present to interact with the upper eyelid margin, and the minimal presence of the lenticular improves comfort over a more traditional minus carrier lenticular that would ordinarily be placed over the entire lens circumference. There is enough surface area and thickness of the lenticular present in the contact lens disclosed herein; however, to interact with the upper tarsal plate to assist with centration and rotational stability.

[0028] As shown in FIGS. 2A and 2B, and referred to herein as a "push" and a "pull" mechanism, in addition to the upper eyelid interacting with the lenticular, the upper eyelid can also interact with an optional prism in the lower portion of the contact lens according to the lens designs disclosed herein. The edge of the upper eyelid squeezes the thicker, base of the prism of the contact downwards with each blink. The base of the prism also interacts with the lower eyelid with each blink; therefore, the base of the prism is placed above the lower contact lens margin, high enough to remain above the lower eyelid when the eye is open. Just as multiple base curve options are available for fitting different corneal curvatures, multiple heights of the prism base are optionally used to account for differences in aperture size and position of the eyelids. In addition, multiple overall diameters of the contact lens can also be used. In other words, the prism portion can provide a change in power from the central optic zone of the contact lens. The base of the prism may not slide more than 1, 1.5, 2, 2.5, or 3 millimeters (mm) behind the lower lid, when in the patient is looking straight ahead and/or downwards when the eye is open and during the blink.

[0029] As disclosed above, the contact lens comprises a relatively thick area compared to the remaining portion of the contact lens. This area of thickness can be 1.5, 2, 3, 4, 5, 6, 7, 8, 9, or 10 times thicker than the remaining "non-thick" portion of the contact lens. For example, the relatively thick area can comprise a thickest portion, which is 2 to 10 times thicker than the remaining center portion of the contact lens.

[0030] The embodiments of contact lens disclosed herein can be used in the correction of ametropia (myopia, hyperopia, astigmatism, and/or higher order aberrations) in patients with or without presbyopia, i.e., a reading add that moves upwards through translation, in patients with other accommodative disorders, and/or patients with a binocular vision disorder can also be

provided in the lens designs disclosed herein. Presbyopia affects approximately 100% of the population who live long enough (-45 years of age) to develop the condition. The embodiments of contact lens disclosed herein can also treat other accommodative disorders, or binocular vision disorder. In some instances, embodiments of the contact lens disclosed herein can be used to display an electronically-generated and/or other virtual optically-displayed image.

[0031] Conventional contact lenses provide very limited options in terms of design parameters such as diameter and curvature. The disclosed contact lenses achieve translation in a soft contact lens. Soft contact lenses are typically only feasible to manufacture in two base curve options, and very few are offered in multiple diameters. These multiple options in these two parameters in addition to the ability to vary the prism height, size, amount, or axis are optionally considered in the lens designs disclosed herein. Back or front surface toricity takes advantage of a toric, rather than spherical, corneal shape that occurs in some patients with astigmatism. The lenses disclosed herein still work when the cornea is spherical (not toric). The described lenses also have an advantage over base-down prism, peri-ballasting, and Dynamic Stabilization in that it optionally uses a lenticular aspect described above to use the upper eyelid tarsal plate to stabilize the contact lens in addition to the prismatic interaction of the lower lid (in lenses having an inferior prism or ballast). Interactions with both lids can provide better stabilization.

[0032] FIGS. 3A-3F are profile schematic images of exemplary contact lens having various shaped lenticulars in a superior portion of the contact lens. Each of the lenticulars 301 have a shaped top surface 302. In FIG. 3A, the lenticular 301 comprises a rounded, minus-carrier, curve 302 over a central, upper portion of the lens. As described herein, the lenticular may be on or proximate to the edge of the contact lens 100, or set back further away from the edge of the lens 100. Further, the lens 100 may include a single lenticular 301, or it can be a plurality of lenticulars having various shapes, sizes and designs. FIGS. 3B-3F illustrate non-limiting examples of profiles of various other lenticulars including a flat-topped 302 lenticular 301 (FIG. 3B), a lenticular 301 having a flat top with rounded edges 302 (i.e., a “bump”) (FIG. 3C), a lenticular 301 having a concave top 302 (FIG. 3D), a lenticular 301 having a convex top 302 (FIG. 3E), and a lenticular 301 having a tapered top 302 shape that is thicker closer to the edge of the contact lens and which gradually thins toward the center of the contact lens (FIG. 3F). It is to be appreciated that the lenticulars 301 shown in FIGS. 3A-3F are intended to be non-limiting and are for exemplary purposes only. It is contemplated that the lenticulars of this invention are not limited by shape, size, number, position, or location (so long as they are substantially located within the superior portion of the contact lens).

[0033] FIG. 4A is a profile schematic image of exemplary contact lens having an exemplary anatomically-shaped lenticular in a superior portion of the contact lens. In this embodiment, the lenticular is shaped specifically to fit into a conjunctival sac and attach to the upper eyelid of the wearer. For example, the lenticular of FIG. 4A is designed to fit within Kessing's Space of the wearer's upper eyelid (see, Kessing, Svend V., "A New Division of the Conjunctiva on the Basis of X-Ray Examination," Acta Ophthalmologica Vol. 45, 1967, which is fully incorporated by reference.) FIG. 4B is a front view of the anatomically-shaped lenticular 401 of FIG. 4A showing width (w) and height (h) dimensions. In one of the embodiments, the anatomically-shaped lenticular 401 shown in FIGS. 4A and 4B is shaped and sized in accordance with the conjunctival inserts disclosed and described in U. S. Patent 6,217,896, which is fully incorporated by reference.

[0034] Although volumetric and linear dimensions vary between individuals, human inferior conjunctival sacs have certain generally common features: a crescent shape horizontally; a thick inferior horizontal ridge and a wedge-like shape sagittally). In order to maximally utilize the actual volume and shape that could be contained in human conjunctival sacs, the anatomically-shaped lenticular 401 can be of a crescent shape in the horizontal plane, with the central back curvature conforming to the bulbar surface (radius of back curvature approximately 14 mm, range 12-18 mm). Most of the volume of the device is contained in the inferior 50% of the shape, within a horizontal ridge situated approximately ⅔ of the way from the top of the lenticular 401 and ⅓ of the way from the bottom of the lenticular 401. The maximum thickness of this ridge, being of a crescent shape in the horizontal plane, is a dimension noted in the table (Table I), below. The front surface of the lenticular 401 is more curved than the back in order to attain the crescent shape. The lenticular 401 tapers superiorly above the ridge, so as to situate between the tarsal plate and the globe, so that the anatomically-shaped lenticular 401 thins to an acute angle at its superior edge. Therefore, in the sagittal plane the lenticular 401 appears wedge-like above the ridge, such that pressure of the inferior margin of the upper eyelid will induce a "minus-carrier" effect and help to contain the lenticular 401 inside inferior cul-de sac. From the middle of the thicker volume in the ridge, the lenticular 401 tapers to blunt points nasally and temporally, such that the lenticular 401 is anchored within the tissue more tightly bound at the canthi. The horizontal length of the lenticular 401 is a dimension, covered in Table I, which is measured along the back surface of the lenticular 401 from left to right behind the ridge. At the bottom, the lenticular is rounded from left to right (radius of curvature approximately 22 mm, range 20-25 mm) and from front to back (radius of curvature approximately 0.75 mm, range 0.5-1.0 mm in the middle) with the most inferior portion of the lenticular 401 at the horizontal middle.

[0035] Below, Table I provides exemplary dimensions for three sizes of an anatomically-shaped lenticular 401 (refer to FIGS. 4A and 4B).

DIMENSIONS OF THREE DESIGNS OF AN ANATOMICALLY-SHAPED LENTICULAR			
	Three Designs by Size		
DIMENSIONS	**LARGE**	**MEDIUM**	**SMALL**
Volume (µl)	160	110	60
Max. Horizontal Width (W) (mm)	26.75	23.5	20.25
Max Vertical Height (H) (mm)	9.0	7.9	6.8
Max. Thickness (T) (mm)	2.6	1.7	0.8

Table I

[0036] From the thickest sagittal plane at its horizontal midpoint, the anatomically-shaped lenticular 401 to the right has a shape of equal, but opposite, conformation to that existing on the left. This is so that the anatomically-shaped lenticular 401 will be wearable in the cul-de-sac of either eye, the left/right shape difference between conjunctival sacs of the two eyes having been shown to be minimal. The vertical height of the insert (or thickness, T) (see FIG. 4A), another dimension noted in Table I, is maximum at the center of the insert and decreases left and right to the blunt lateral extremities. This is because the anatomically-shaped lenticular 401 is somewhat meniscus-shaped in the facial plane, being more convex at its inferior edge and relatively flat horizontally at the superior edge. FIG. 4C is a front view of a contact lens 100 having an anatomically-shaped lenticular 401 in a superior portion of the contact lens.

[0037] Additional non-limiting examples of anatomically-shaped lenticulars includes lenticulars having shapes that include round/oval, ellipse, triangular, heart shaped, square, pentagonal, diamond, pear shaped, rectangular, combinations thereof, and the like such that the lenticular is shaped to fit into a conjunctival sac and attach to the upper eyelid of the wearer.

[0038] FIGS. 5A and 5B are profile images of eyes that illustrate the lid attachment fit of contact lens 100 having a lenticular 501 in the superior portion of the lens as compared with a contact lens

that does not have a lenticular. In various embodiments, the lenticular 501 may be anatomically-shaped to attach to the upper eyelid by fitting within a conjunctival sac.

[0039] FIGS 6A-6J illustrate front views of contact lens having non-limiting examples of lenticulars in the superior portion of the contact lens as disclosed and described herein. It is to be appreciated that the lenticular regions of the embodiments shown in FIGS. 6A-6J have at least a portion of the lenticular where the thickness of the lenticular is greater than the thickness of the lens at its center portion. In FIG. 6A, the lenticular 601 has a semicircular shape. In FIG. 6B, the lenticular 601 has an arc shape. It is to be appreciated that the arc length can be shorter or longer that the length shown in FIG. 6B. In FIGS. 6C and 6D, the lenticular 601 is comprised of a plurality of lenticular sections 602. For example, the lenticular 60 1of FIG. 6C is comprised of a plurality of semispherical sections on the superior portion of the contact lens and the lenticular 601 of FIG. 6D is comprised of a plurality of arc sections. It is to be appreciated that the multi-section lenticulars of FIGS. 6C and 6D are exemplary and that other numbers of sections, shapes and sizes of lenticulars are contemplated within the scope of embodiments of the invention. FIGS. 6E-6J illustrate non-limiting examples of other shapes, sizes, positions and locations of lenticulars 601 that are contemplated within the scope of embodiments of the invention. Each of the embodiments shown herein may have, or may not have, prisms and/or ballasts in the inferior portion of the contact lens 100.

[0040] Also disclosed herein are methods of making the contact lenses disclosed herein. For example, disclosed is a method of making a contact lens, the method comprising manufacturing a contact lens comprising forming a lenticular in the superior portion of the lens. The contact lens can further comprise a base down prism or a ballast in the inferior portion of the lens. In one example, the base down prism or ballast is added to the lens in a second step of a manufacturing process.

[0041] Also disclosed is a method of treating an individual in need of vision correction, the method comprising dispensing the contact lens disclosed herein to the individual, thereby treating the individual in need of vision correction. In one example, the individual has been diagnosed with ametropia (e.g., astigmatism, myopia, hyperopia). In another example, the individual has been diagnosed with presbyopia, another accommodative disorder, and/or a binocular vision disorder. For example, one or more surfaces of embodiment of the contact lens described herein can be made toric (to treat astigmatism), and/or a flatter or a steeper front surface can be formed in the embodiments of contact lens described herein (to correct either myopia or hyperopia), and/or a bifocal/trifocal/multifocal change in power can be formed in the bottom (inferior portion) of the

lens to treat presbyopia. Additional medical use of embodiments of the contact lens described herein include treatment of Keratoconus.

[0042] Furthermore, embodiments of the disclosed contact lens can be used for cosmetic purposes such as changing/enhancing eye color and/or eye appearance.

[0043] As used in the specification, and in the appended claims, the singular forms “a,” “an,” “the,” include plural referents unless the context clearly dictates otherwise.

[0044] The compositions and methods of the appended claims are not limited in scope by the specific compositions and methods described herein, which are intended as illustrations of a few aspects of the claims and any compositions and methods that are functionally equivalent are intended to fall within the scope of the claims. Various modifications of the compositions and methods in addition to those shown and described herein are intended to fall within the scope of the appended claims. Further, while only certain representative compositions and method steps disclosed herein are specifically described, other combinations of the compositions and method steps also are intended to fall within the scope of the appended claims, even if not specifically recited. Thus, a combination of steps, elements, components, or constituents may be explicitly mentioned herein or less, however, other combinations of steps, elements, components, and constituents are included, even though not explicitly stated. The term “comprising” and variations thereof as used herein is used synonymously with the term “including” and variations thereof and are open, non-limiting terms. Although the terms “comprising” and “including” have been used herein to describe various embodiments, the terms “consisting essentially of” and “consisting of” can be used in place of “comprising” and “including” to provide for more specific embodiments of the invention and are also disclosed. Other than in the examples, or where otherwise noted, all numbers expressing quantities of ingredients, reaction conditions, and so forth used in the specification and claims are to be understood at the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, to be construed in light of the number of significant digits and ordinary rounding approaches.

CLAIMS

What is claimed is:

1. A contact lens comprising:

   a superior portion of the contact lens;

   an inferior portion of the contact lens;

   a lens portion; and

   a lenticular located in the superior portion of the contact lens, wherein the contact lens attaches to an upper eyelid of a wearer by the lenticular interacting with an upper tarsal plate of the upper eyelid of a wearer, said interaction allows the contact lens to translate upwards in downgaze, and

   wherein the lenticular has a top surface, said top surface having a shape selected from the group consisting of flat, flat with rounded corners, concave, convex or tapered having a thicker portion closer to an edge of the contact lens, or combinations thereof.

2. The contact lens of claim 1, wherein the lens is a soft contact lens.

3. The contact lens of claim 1, wherein the lens is a rigid gas permeable contact lens.

4. The contact lens of claim 1, wherein the lens is a hybrid contact lens.

5. The contact lens of any of claims 1-4, wherein the lens is comprised of a material that can sense light activity or molecules in the ocular environment and that contains elements that modulate light or the surrounding ocular environment.

6. The contact lens of any of claims 1-5, wherein the lenticular interacting with the upper tarsal plate of the upper eyelid of a wearer comprises the lenticular interacting with the upper tarsal plate of the upper eyelid of a wearer to provide centration and rotational stability.

7. The contact lens of claim 6, wherein the lenticular comprises between 10% and 50% of an area between an upper edge of the contact lens and a geometric center of the contact lens.

8. The contact lens of any of claims 1-7, wherein the lenticular comprises a relatively thick edge of the contact lens in the superior portion of the contact lens that interacts with a margin of the upper eyelid.

9. The contact lens of claim 8, wherein the relatively thick area comprises a thickest portion that is 2 to 10 times thicker than any remaining portion of the contact lens.

10. The contact lens of any of claims 1-9, wherein the contact lens comprises a base down prism located at least partially in the inferior portion of the contact lens.

11. The contact lens of claim 10, wherein the base down prism comprises a thicker base of the inferior portion of the contact lens.

12. The contact lens of claim 11, wherein the prism portion provides a change in power from a central optic zone of the contact lens.

13. The contact lens of claim 11, wherein an edge of the upper eyelid squeezes the thicker base of the base down prism downwards with each blink.

14. The contact lens of claim 13, wherein the thicker base of the base down prism also interacts with a lower eyelid with each blink, so that the thicker base of the base down prism remains above a margin of the lower eyelid.

15. The contact lens of claim 14, wherein the thicker base of the base down prism does not slide more than 2mm behind the lower eyelid, when in the patient is looking straight ahead and/or downwards when the eye is open and during a blink.

16. The contact lens of any of claims 1-15, wherein the contact lens is used to treat ametropia.

17. The contact lens of any of claims 1-15, wherein the contact lens is used to treat presbyopia, other accommodative disorders, or a binocular vision disorder.

18. The contact lens of any of claims 1-17, wherein the contact lens is used to display an electronically-generated and/or other virtual optically-displayed image.

19. The contact lens of any of claims 1-18, wherein the lenticular is .1, .2, .3, .4, .5, .6, .7, .8, .9, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, or 5.0 millimeters away from an outer edge of the superior portion of the contact lens.

20. The contact lens of any of claims 1-19, wherein the lenticular is comprised of a plurality of lenticular sections located in the superior portion of the contact lens.

21. The contact lens of any of claims 1-20, wherein the lenticular is anatomically-shaped.

22. The contact lens of claim 21, wherein the anatomical shape of the lenticular is designed to fit within Kessing's Space of the wearer's upper eyelid.

23. A contact lens comprising:

a superior portion of the contact lens;

an inferior portion of the contact lens;

a lens portion; and

a lenticular located in the superior portion of the contact lens, wherein the contact lens attaches to an upper eyelid of a wearer by the lenticular interacting with an upper tarsal plate of the upper eyelid of a wearer, said interaction allows the contact lens to translate upwards in downgaze, and

wherein the lenticular is comprised of a plurality of lenticular sections.

24. The contact lens of claim 23, wherein the lens is a soft contact lens.

25. The contact lens of claim 23, wherein the lens is a rigid gas permeable contact lens.

26. The contact lens of claim 23, wherein the lens is a hybrid contact.

27. The contact lens of any of claims 23-26, wherein the lens is comprised of a material that can sense light activity or molecules in the ocular environment and that contains elements that modulate light or the surrounding ocular environment.

28. The contact lens of any of claims 23-27, wherein the lenticular interacting with the upper tarsal plate of the upper eyelid of a wearer comprises the lenticular interacting with the upper tarsal plate of the upper eyelid of a wearer to provide centration and rotational stability.

29. The contact lens of claim 28, wherein the lenticular comprises between 10% and 50% of an area between an upper edge of the contact lens and a geometric center of the contact lens.

30. The contact lens of any of claims 23-29, wherein the lenticular comprises a relatively thick edge of the contact lens in the superior portion of the contact lens that interacts with a margin of the upper eyelid.

31. The contact lens of claim 30, wherein the relatively thick area comprises a thickest portion that is 2 to 10 times thicker than any remaining portion of the contact lens.

32. The contact lens of any of claims 23-31, wherein the contact lens comprises a base down prism located at least partially in the inferior portion of the contact lens.

33. The contact lens of claim 32, wherein the base down prism comprises a thicker base of the inferior portion of the contact lens.

34. The contact lens of claim 33, wherein the prism portion provides a change in power from a central optic zone of the contact lens.

35. The contact lens of claim 33, wherein an edge of the upper eyelid squeezes the thicker base of the base down prism downwards with each blink.

36. The contact lens of claim 35, wherein the thicker base of the base down prism also interacts with a lower eyelid with each blink, so that the thicker base of the base down prism remains above a margin of the lower eyelid.

37. The contact lens of claim 35, wherein the thicker base of the base down prism does not slide more than 2mm behind the lower eyelid, when in the patient is looking straight ahead and/or downwards when the eye is open and during a blink.

38. The contact lens of any of claims 23-37, wherein the contact lens is used to treat ametropia.

39. The contact lens of any of claims 23-37, wherein the contact lens is used to treat presbyopia, other accommodative disorders, or a binocular vision disorder.

40. The contact lens of any of claims 23-39, wherein the contact lens is used to display an electronically-generated and/or other virtual optically-displayed image.

41. The contact lens of any of claims 23-40, wherein at least one of the plurality of lenticular sections of the lenticular is .1, .2, .3, .4, .5, .6, .7, .8, .9, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, or 5.0 millimeters away from an outer edge of the superior portion of the contact lens.

42. The contact lens of any of claims 23-41, wherein at least one of the plurality of lenticular sections of the lenticular is anatomically-shaped.

43. The contact lens of claim 42, wherein the anatomical shape of the at least one lenticular section is designed to fit within Kessing's Space of the wearer's upper eyelid.

44. The contact lens of any of claims 23-43, wherein each lenticular section has a shape selected from the group consisting of arced, curved, round, circular, hemispherical, square, rectangular, triangular, oval, multi-sided, and combinations thereof.

45. The contact lens of any of claims 23-44, wherein each lenticular section has a top surface, said top surface having a shape selected from the group consisting of curved, round, spherical, flat, flat with rounded corners, concave, convex or tapered having a thicker portion closer to an edge of the contact lens, or combinations thereof.

46. A contact lens comprising:

a superior portion of the contact lens;

an inferior portion of the contact lens;

a lens portion; and

a lenticular located in the superior portion of the contact lens, wherein the contact lens attaches to an upper eyelid of a wearer by the lenticular interacting with an upper tarsal plate of the upper eyelid of a wearer, said interaction allows the contact lens to translate upwards in downgaze, and

wherein the lenticular has an anatomical shape.

47. The contact lens of claim 46, wherein the lens is a soft contact lens.

48. The contact lens of claim 46, wherein the lens is a rigid gas permeable contact lens.

49. The contact lens of claim 46, wherein the lens is a hybrid contact.

50. The contact lens of any of claims 46-49, wherein the lens is comprised of a material that can sense light activity or molecules in the ocular environment and that contains elements that modulate light or the surrounding ocular environment.

51. The contact lens of any of claims 46-49, wherein the lenticular interacting with the upper tarsal plate of the upper eyelid of a wearer comprises the lenticular interacting with the upper tarsal plate of the upper eyelid of a wearer to provide centration and rotational stability.

52. The contact lens of claim 51, wherein the lenticular comprises between 10% and 50% of an area between an upper edge of the contact lens and a geometric center of the contact lens.

53. The contact lens of any of claims 46-52, wherein the lenticular comprises a relatively thick edge of the contact lens in the superior portion of the contact lens that interacts with a margin of the upper eyelid.

54. The contact lens of claim 53, wherein the relatively thick area comprises a thickest portion that is 2 to 10 times thicker than any remaining portion of the contact lens.

55. The contact lens of any of claims 46-54, wherein the contact lens comprises a base down prism located at least partially in the inferior portion of the contact lens.

56. The contact lens of claim 55, wherein the base down prism comprises a thicker base of the inferior portion of the contact lens.

57. The contact lens of claim 56, wherein the prism portion provides a change in power from a central optic zone of the contact lens.

58. The contact lens of claim 56, wherein an edge of the upper eyelid squeezes the thicker base of the base down prism downwards with each blink.

59. The contact lens of claim 58, wherein the thicker base of the base down prism also interacts with a lower eyelid with each blink, so that the thicker base of the base down prism remains above a margin of the lower eyelid.

60. The contact lens of claim 59, wherein the thicker base of the bae down prism does not slide more than 2mm behind the lower eyelid, when in the patient is looking straight ahead and/or downwards when the eye is open and during a blink.

61. The contact lens of any of claims 46-60, wherein the contact lens is used to treat ametropia.

62. The contact lens of any of claims 46-60, wherein the contact lens is used to treat presbyopia, other accommodative disorders, or a binocular vision disorder.

63. The contact lens of any of claims 46-62, wherein the contact lens is used to display an electronically-generated and/or other virtual optically-displayed image.

64. The contact lens of any of claims 46-63, wherein the lenticular is .1, .2, .3, .4, .5, .6, .7, .8, .9, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, or 5.0 millimeters away from an outer edge of the superior portion of the contact lens.

65. The contact lens of any of claims 46-64, wherein the lenticular is comprised of a plurality of lenticular sections located in the superior portion of the contact lens.

66. The contact lens of any of claims 46-65, wherein the anatomical shape of the lenticular is designed to fit within Kessing's Space of the wearer's upper eyelid.

67. A method of making a contact lens, the method comprising manufacturing a contact lens comprising a lenticular in a superior portion of the contact lens, wherein the lenticular has a top surface, said top surface having a shape selected from the group consisting of flat, flat with rounded corners, concave, convex or tapered having a thicker portion closer to an edge of the contact lens.

68. The method of claim 67, wherein the method further comprises forming a base down prism in an inferior portion of the contact lens.

69. The method of claim 68, wherein the base down prism is added to the lens in a second step of a manufacturing process.

70. A method of making a contact lens, the method comprising manufacturing a contact lens comprising a lenticular in a superior portion of the contact lens, wherein the lenticular is comprised of a plurality of lenticular sections.

71. The method of claim 70, wherein the method further comprises forming a base down prism in an inferior portion of the contact lens.

72. The method of claim 71, wherein the base down prism is added to the lens in a second step of a manufacturing process.

73. A method of making a contact lens, the method comprising manufacturing a contact lens comprising a lenticular in a superior portion of the contact lens, wherein the lenticular is anatomically-shaped.

74. The method of claim 73, wherein the method further comprises forming a base down prism in an inferior portion of the contact lens.

75. The method of claim 74, wherein the base down prism is added to the lens in a second step of a manufacturing process.

76. A method of treating an individual in need of vision correction, the method comprising dispensing the contact lens of any of claims 1-66 to the individual, thereby treating the individual in need of vision correction.

77. The method of claim 76, wherein the individual has been diagnosed with ametropia.

78. The method of claim 76, wherein the individual has been diagnosed with presbyopia, another accommodative disorder, and/or a binocular vision disorder.

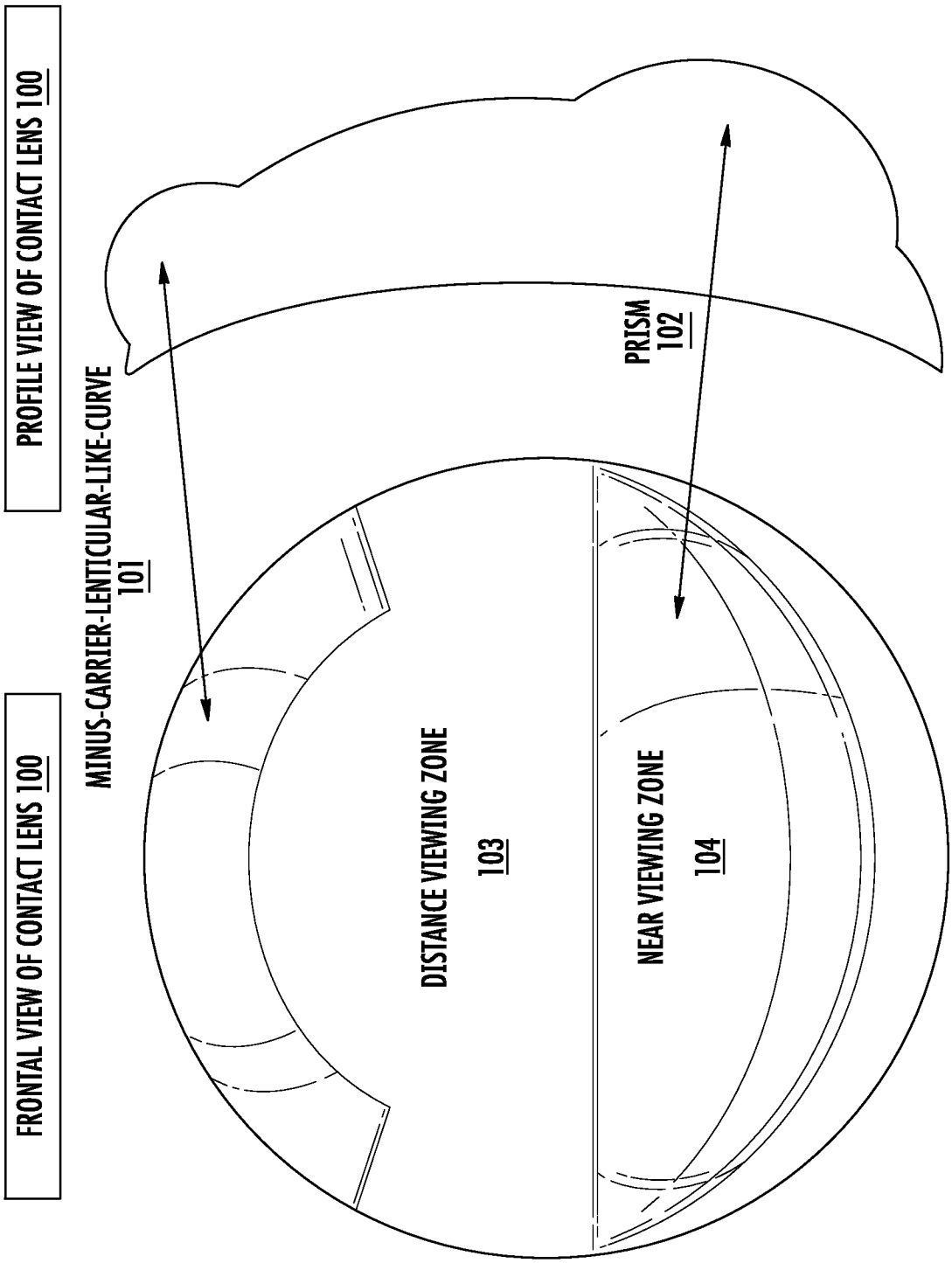

FRONTAL VIEW OF CONTACT LENS 100
DISTANCE VIEWING ZONE
103
NEAR VIEWING ZONE
104

FIG. 1A

PROFILE VIEW OF CONTACT LENS 100
MINUS-CARRIER-LENTICULAR-LIKE-CURVE
101
PRISM
102

FIG. 1B

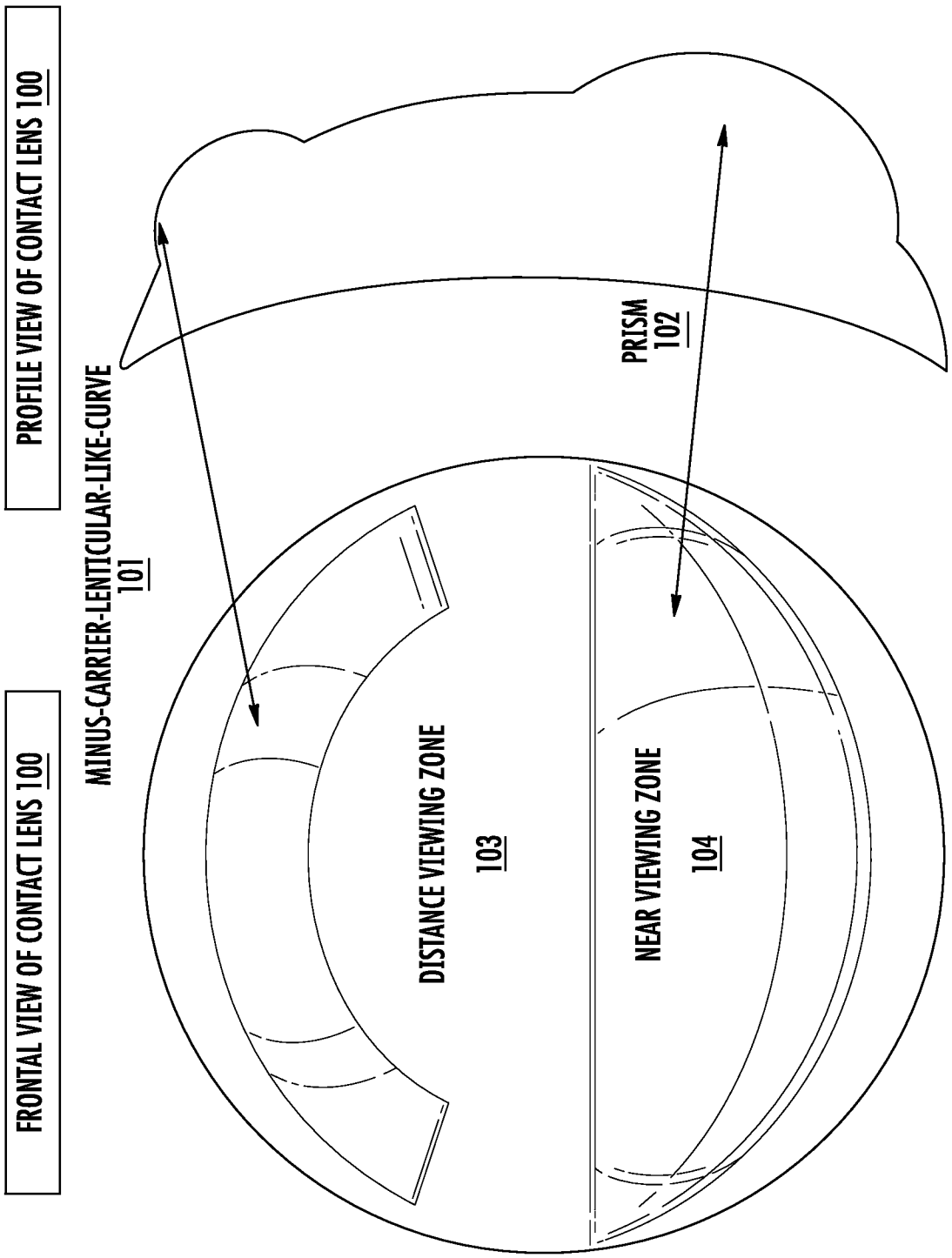

PROFILE VIEW OF CONTACT LENS 100
MINUS-CARRIER-LENTICULAR-LIKE-CURVE 101
PRISM 102
FRONTAL VIEW OF CONTACT LENS 100
DISTANCE VIEWING ZONE 103
NEAR VIEWING ZONE 104

FIG. 1D

FIG. 1C

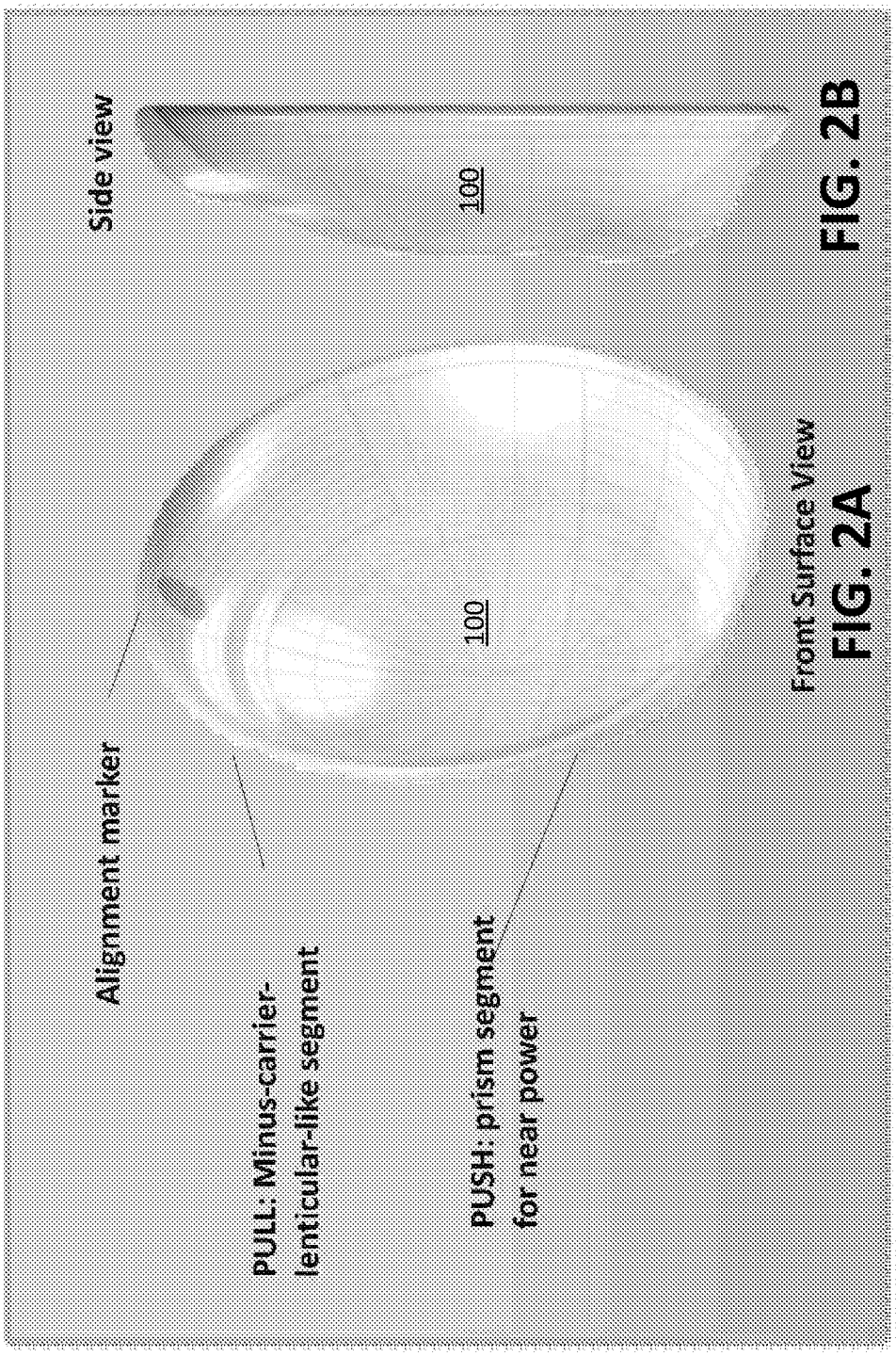

Alignment marker
PULL: Minus-carrier-lenticular-like segment
PUSH: prism segment for near power
100
Front Surface View
100
Side view

FIG. 2A

FIG. 2B

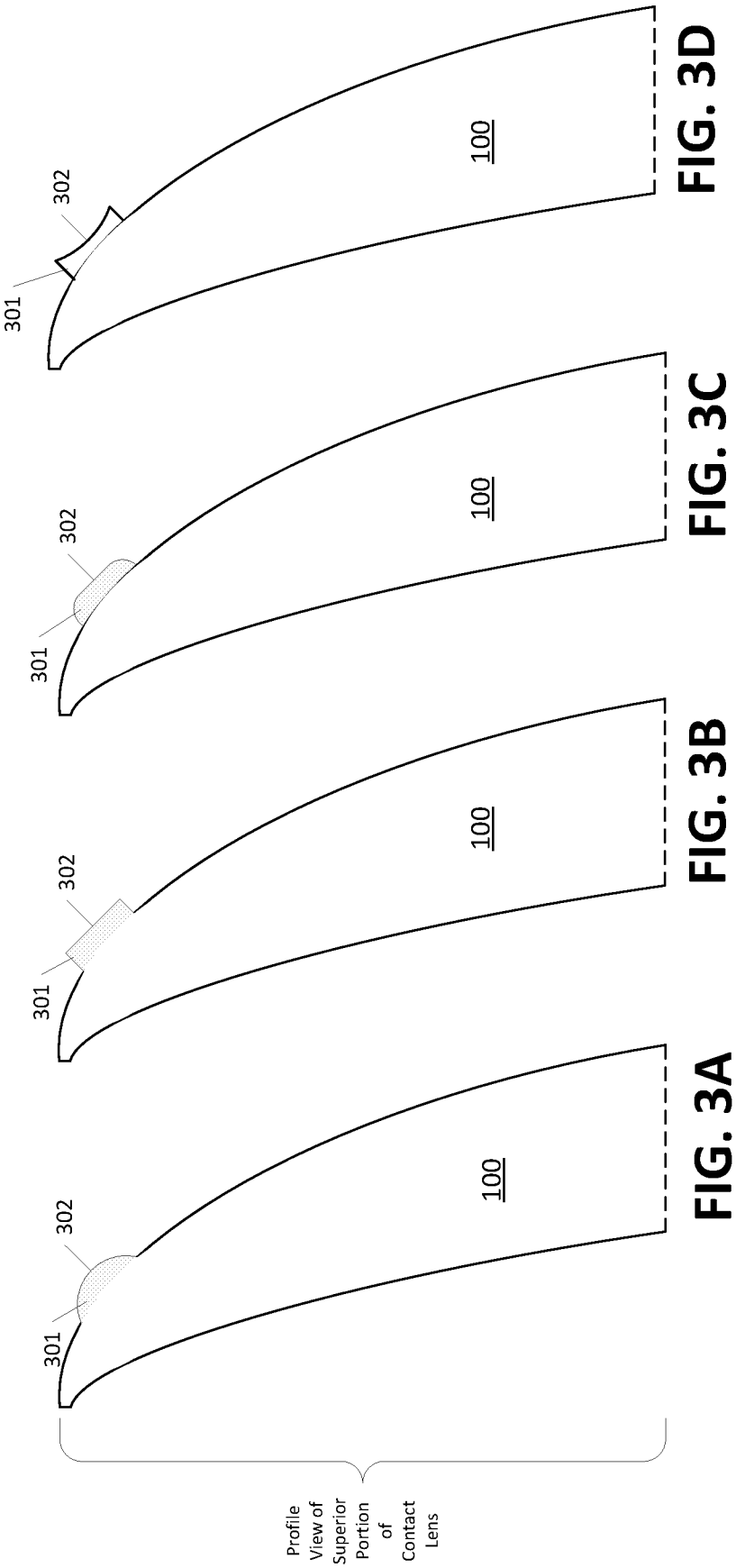


FIG. 3A

FIG. 3B

FIG. 3C

FIG. 3D

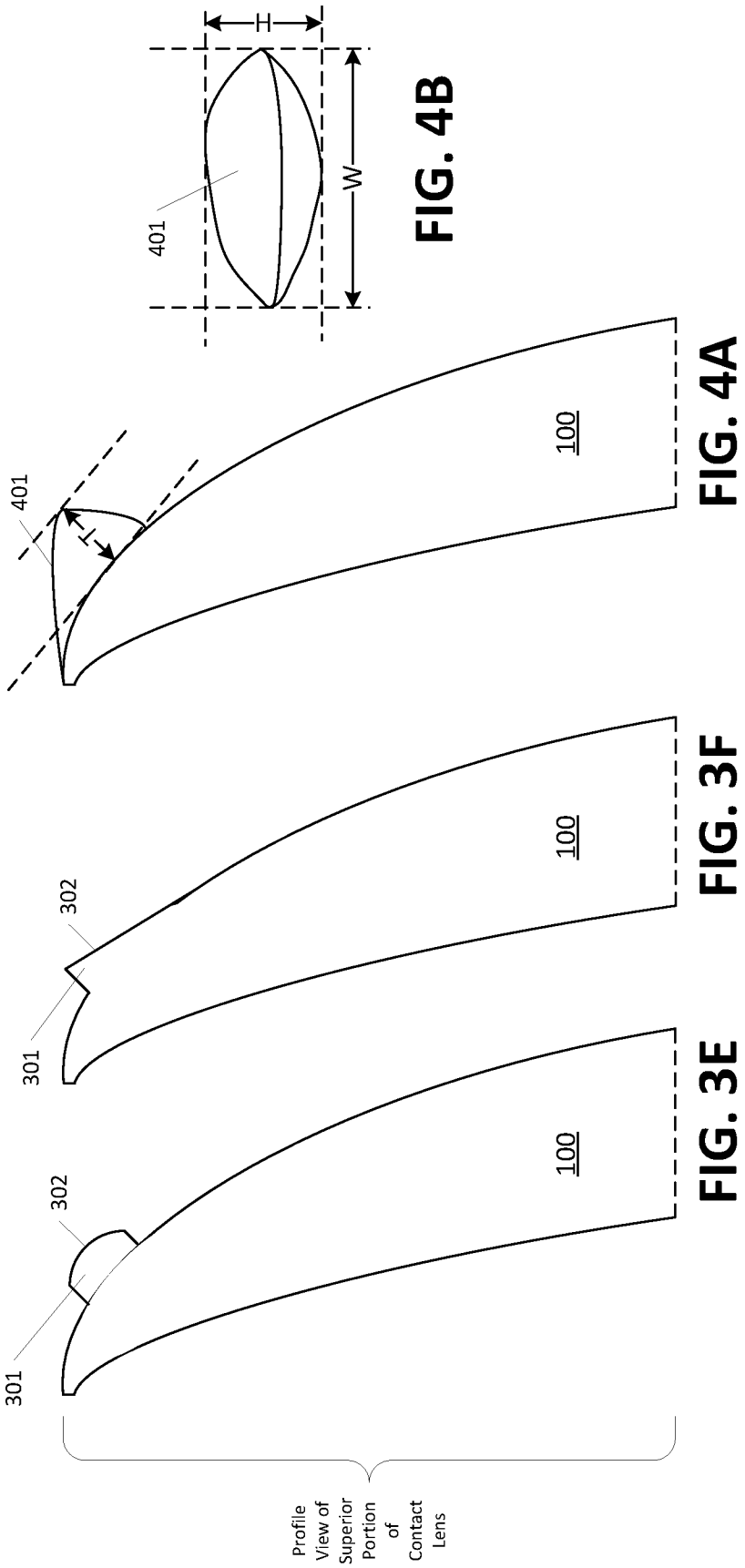


FIG. 4B

FIG. 4A

FIG. 3F

FIG. 3E

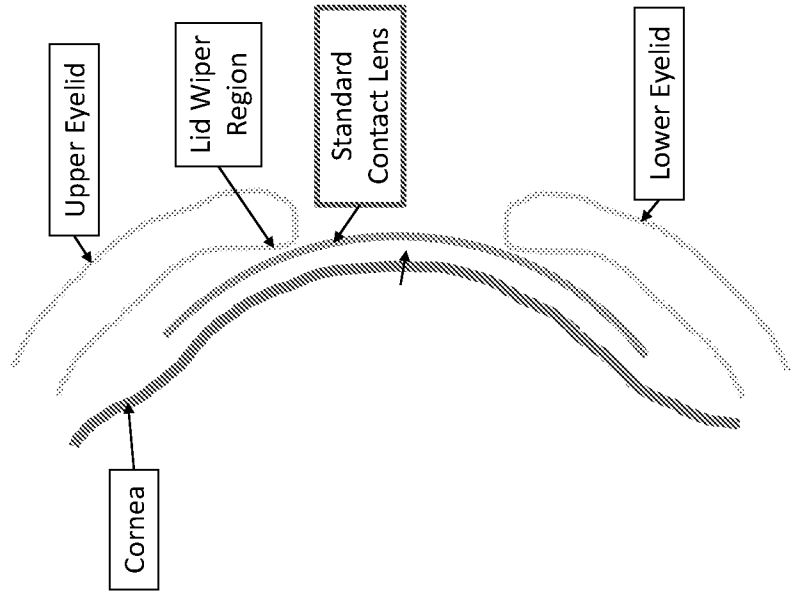


FIG. 5B

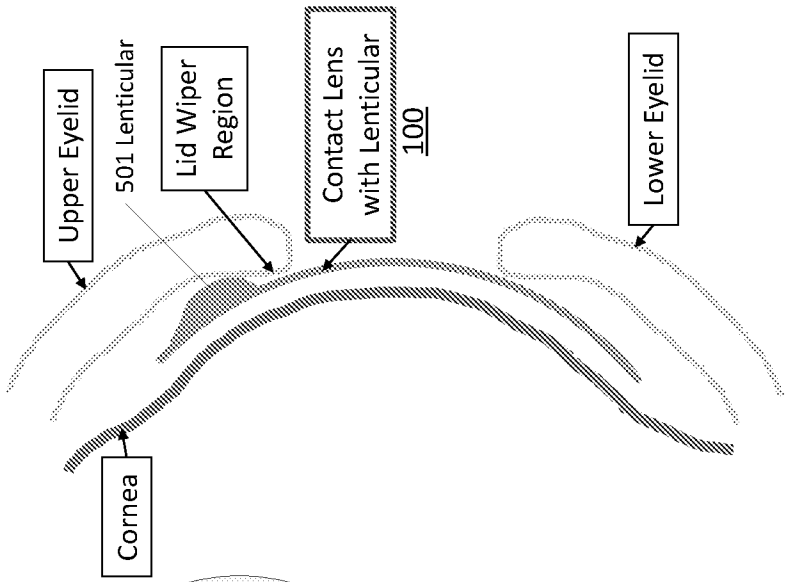


FIG. 5A

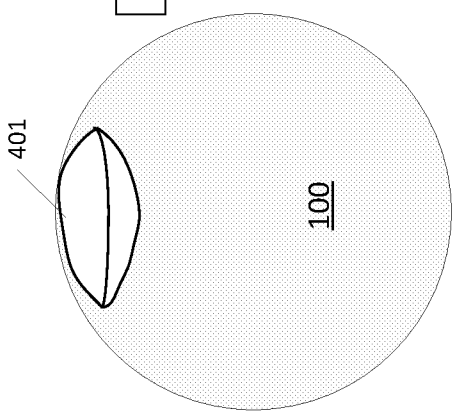


FIG. 4C

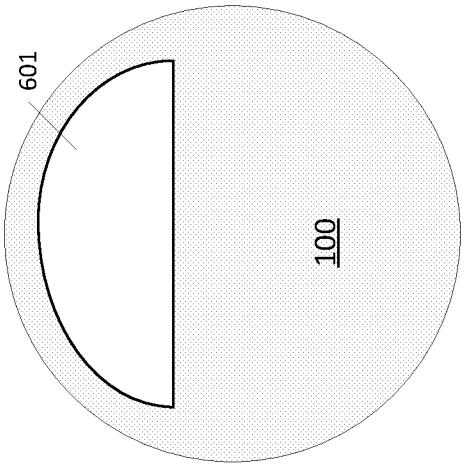


FIG. 6A

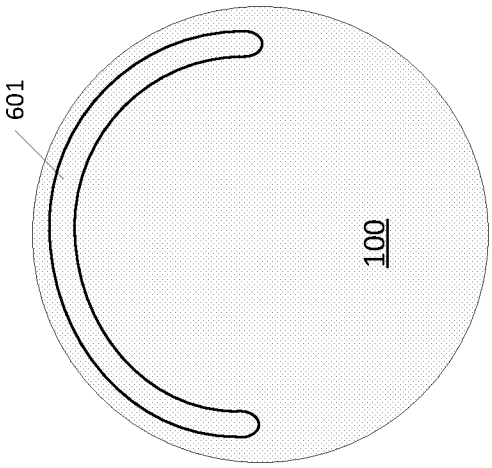


FIG. 6B

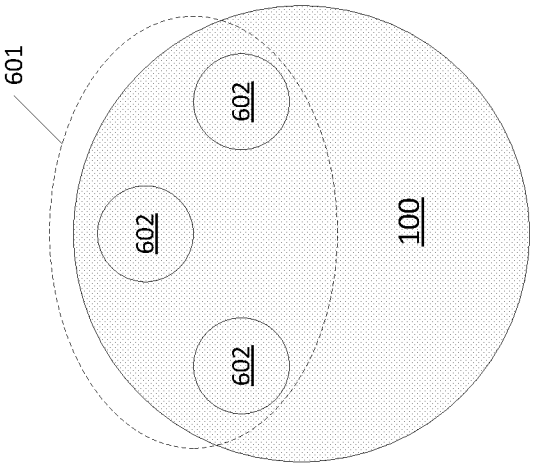


FIG. 6C

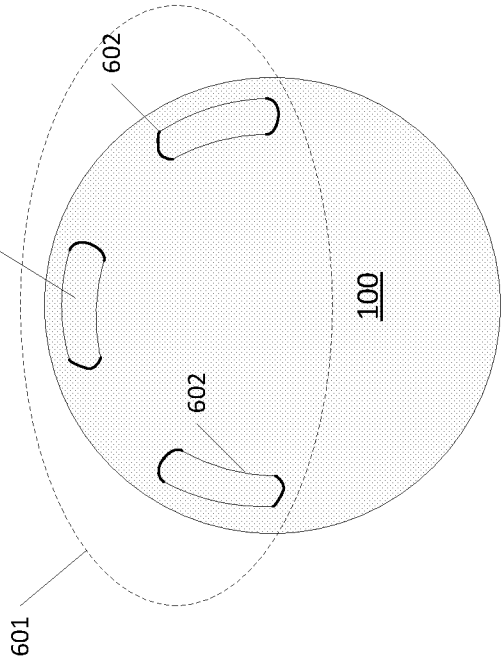


FIG. 6D

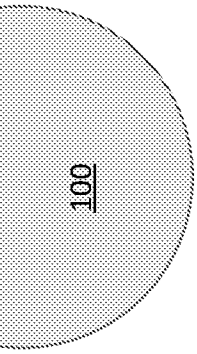


FIG. 6H

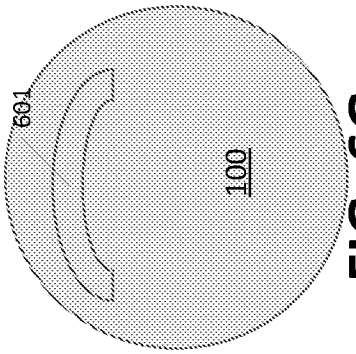


FIG. 6G

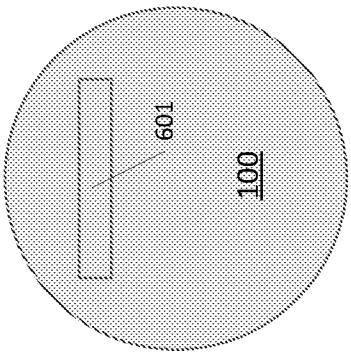


FIG. 6J

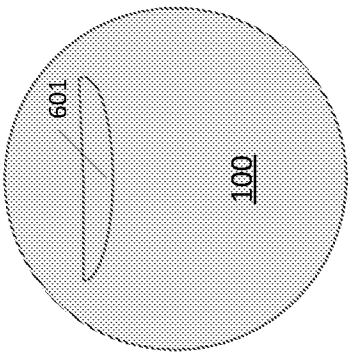


FIG. 6F

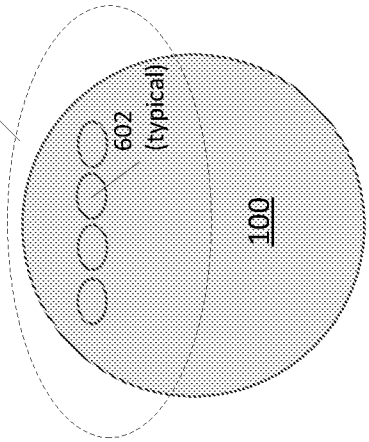


FIG. 6I

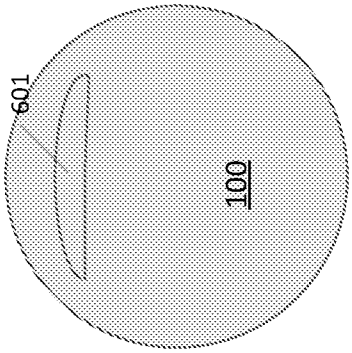


FIG. 6E

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 17/48617

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G02C 7/04 (2017.01)
CPC - G02C 7/048, G02C 7/04, G02C 7/043, G02C 7/049

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)
See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y -- A	US 5,764,339 A (HORTON); 9 June 1998 (09.06.1998); entire document, especially Fig. 1, 2a; col. 2, ln 25-36; col. 2, ln 65- col. 3, ln 10; col. 3, ln 55-59.	67, 70, 73 --- 68, 71, 74 --- 1-5, 23-27, 46-52, 69, 72, 75
Y -- A	US 6,109,749 A (BERNSTEIN); 29 August 2000 (29.08.2000); entire document, especially Fig. 1; Abstract.	68, 71, 74 --- 69, 72, 75
A	US 2014/0063445 A1 (CALDARISE et al.); 6 March 2014 (06.03.2014); entire document, especially para. [0046].	1-5, 23-27, 46-52
A	US 5,125,728 A (NEWMAN et al.); 30 June 1992 (03.06.1992); entire document, especially Fig. 7; col. 2, ln 23-46.	1-5, 23-27, 46-52
A	US 2005/0068489 A1 (HALL et al.); 31 March 2005 (31.03.2005); entire document.	1-5, 23-27, 46-52, 69, 72, 75

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* 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	Date of mailing of the international search report
5 October 2017	08 NOV 2017
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. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 17/48617

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 6-22, 28-45, 53-66, 76-78
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.