supporting evidence) that the visibility of the defocused image (often referred to as a "ghost" image) would be reduced. Of course, numerous previous patents had been awarded that already employed SA correction within the bifocal (see above). We have invented a novel strategy for employing controlled SA (or similar asphericity) to minimize the visibility of the out of focus "ghost" image generated by bifocal, trifocal or multifocal presbyopic correction (see detailed description below).

DISCLOSURE OF INVENTION

[0013] Generally described, embodiments of~~in one aspect~~ the present invention seek to provide~~s~~ lenses, design strategies, apparatuses, methods, and systems for eliminating or minimizing the visibility of ghost images present in presbyopic corrections through the zone-specific control of the sign of spherical aberration or other asphericity. Previous art has either *corrected* spherical aberration or indiscriminantly *induced* spherical aberration without regard to the relationship between lens power and sign of SA (see above). While such approaches can be variously successful in increasing the depth of field of the presbyopic or pseudophakic eye, they produce highly visible and visually unacceptable defocused ghost images. Such ghost images reduce the overall success of these presbyopic corrections. The current art is distinct from all previous art in that either it aims to specifically couple positive SA with the most positive powered (or least negative powered) regions of the bifocal and introduce negative SA into the individual optical zone with the least positive power (or most negative power), in order to maximize depth of field while minimizing the visibility of the ghost image. Said in another way, embodiments of the~~our~~ invention seek~~aims~~ to introduce positive SA into the near optic and negative SA into the distant optic of a bifocal, trifocal, or multifocal CL, IOL, or refractive surgery. It requires specifically that the distance correction and near correction contain opposite sign SA to each other: negative SA in the distance correction and positive in the near correction.

[0013a] According to a first aspect, there is provided a multifocal diffractive ophthalmic lens comprising a base optic adapted to change the power of user's eye, the base optic having an anterior surface and a posterior surface; and a diffractive element on at least one of the anterior surface and the posterior surface, the diffractive element providing at least one of a distance power and a near power, wherein the base optic is configured to produce a negative spherical aberration for the distance power and the diffractive element is configured to produce a positive spherical aberration for the near power.

[0013b] According to a second aspect, there is provided a multifocal diffractive ophthalmic lens comprising a lens optic portion adapted to change the power of user's eye, the base optic having an anterior surface and a posterior surface; and a diffractive portion on at least one of the anterior surface and the posterior surface, the diffractive element providing at least one of a distance power and a near power, wherein the base optic is configured to produce a spherical aberration for the distance power and the diffractive element is configured to produce a spherical aberration for the near power.

[0013c] According to a third aspect, there is provided a multifocal diffractive intraocular lens (IOL) for implantation in an eye of a patient, comprising a base lens portion adapted to change the power of user's eye, the base lens portion having a first surface and a second opposing surface; and a diffractive portion on at least one of the first and second surfaces of the base lens portion, the diffractive portion being configured to provide at least one of a distance power and a near power, wherein the base lens portion is configured to produce a spherical aberration for the distance power and the diffractive element is configured to produce a spherical aberration for the near power, and wherein the near power and the far power both simultaneously contribute to a retinal image.

~~CLAIMS:~~

1. A corrective optical lens adapted to change the power of a user's eye, comprising:
a near radially extending optical zone comprising sufficient optical power to focus objects relatively closer onto the retina, the near radially extending optical zone having a positive spherical aberration and having a first power adapted to increase as the radius of the first radially extending optical zone increases; and
a distant radially extending optical zone comprising sufficient optical power to focus objects relatively farther away onto the retina, the distant radially extending optical zone having a negative spherical aberration and having a second power different from the first power, the second power adapted to decrease as the radius of the second radially extending optical zone increases;
wherein the sizes and powers of the near and distance radially extending optical zones are adapted to attenuate visibility to the user of defocused light.

2. The corrective optical lens of claim 1, wherein the first power is adapted to increase in manner that generates a positive defocus in the near radially extending optical zone, and wherein the second power is adapted to decrease in manner that generates a negative defocus in the distant radially extending optical zone

3. The corrective optical lens of claim 1, wherein the spherical aberration of the near radially extending optical zone is in the range 0.1 microns to 0.4 microns for a 6mm diameter pupil.

4. The corrective optical lens of claim 1, wherein the corrective optical lens comprises a multifocal lens.

5. The corrective Optical lens of claim 1, wherein the corrective optical lens comprises a contact lens (CL).

~~6. The corrective optical lens of claim 1, wherein the corrective optical lens comprises an~~ intraocular lens (IOL).

7. The corrective optical lens of claim 1, wherein the corrective optical lens comprises a corneal onlay.

CLAIMS

1. A multifocal diffractive ophthalmic lens, comprising:

a base optic adapted to change the power of user's eye, the base optic having an anterior surface and a posterior surface; and

a diffractive element on at least one of the anterior surface and the posterior surface, the diffractive element providing at least one of a distance power and a near power, wherein the base optic is configured to produce a negative spherical aberration for the distance power and the diffractive element is configured to produce a positive spherical aberration for the near power.

2. The multifocal diffractive ophthalmic lens of claim 1, wherein the positive spherical aberration in the near power of the diffractive element is produced by varying at least one of the following characteristics of the diffractive element: surface shape, index of refraction, zone spacing, and zone profile.

3. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic is configured to produce the negative spherical aberration for the distance power via refractive optics.

4. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic is configured to produce the negative spherical aberration for the distance power via diffractive optics.

5. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic comprises a bifocal lens.

6. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic comprises a trifocal lens.

7. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic comprises a lens.

8. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic comprises a contact lens (CL).

9. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic comprises an intraocular lens (IOL).

10. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic comprises a corneal inlay.

11. The multifocal diffractive ophthalmic lens of claim 1, wherein the diffractive element comprises a first zone and a second zone, the first zone cooperatively arranged with the base optic to produce the negative spherical aberration for the distance power, and the second zone arranged to produce the positive spherical aberration for the near power.

12. The multifocal diffractive ophthalmic lens of claim 11, wherein the first optical zone is separated in a radial or axial direction from the second optical zone.

13. The multifocal diffractive ophthalmic lens of claim 1, wherein the diffractive elemnt producing the positive spherical aberration extends radially outward to a first diameter, the base optic producing the negative spherical aberration extending radially outward from the first diameter.

14. The multifocal diffractive ophthalmic lens of claim 1, wherein the base optic producing the negative spherical aberration extends radially outward to a first diameter, the diffractive element producing the positive spherical aberration extending radially outward from the first diameter.

15. A multifocal diffractive ophthalmic lens, comprising:

a lens optic portion adapted to change the power of user's eye, the base optic having an anterior surface and a posterior surface; and

a diffractive portion on at least one of the anterior surface and the posterior surface, the diffractive element providing at least one of a distance power and a near power, wherein the base optic is configured to produce a spherical aberration for the distance power and the diffractive element is configured to produce a spherical aberration for the near power.

16. The multifocal diffractive ophthalmic lens of claim 15, wherein the spherical aberration in the near power of the diffractive optic is produced by varying at least one of the following characteristics of the diffractive element: surface shape, index of refraction, zone spacing, and zone profile.

17. The multifocal diffractive ophthalmic lens of claim 15, wherein the base optic comprises an intraocular lens (IOL).

18. A multifocal diffractive intraocular lens (IOL) for implantation in an eye of a patient, comprising:

a base lens portion adapted to change the power of user's eye, the base lens portion having a first surface and a second opposing surface; and

a diffractive portion on at least one of the first and second surfaces of the base lens portion, the diffractive portion being configured to provide at least one of a distance power and a near power, wherein the base lens portion is configured to produce a spherical aberration for the distance power and the diffractive element is configured to produce a spherical aberration for the near power, and wherein the near power and the far power both simultaneously contribute to a retinal image.

19. The multifocal diffractive intraocular lens (IOL) of claim 18, wherein the positive spherical aberration in the near power of the diffractive element is produced by varying at least one of the following characteristics of the diffractive element: surface shape, index of refraction, zone spacing, and zone profile.