

CLAIMS

WHAT IS CLAIMED IS:

1. An apparatus to treat an astigmatism of an eye with retinal stimulation of the eye, the apparatus comprising:
a light source configured to provide a stimulus to a retina of the eye, wherein the stimulus is configured to be aligned with respect to an astigmatic axis of the eye to treat the astigmatism of the eye.
2. The apparatus of claim 1, wherein the stimulus comprises a first light stimulus on a first side of the astigmatic axis and a second light stimulus on a second side of the astigmatic axis.
3. The apparatus of claim 2, wherein the first stimulus comprises a first intensity and a first duration at a first distance from the astigmatic axis and the second stimulus on the second side comprises a second intensity and a second duration at a second distance from the astigmatic axis and wherein one or more of the second intensity or the second duration is different from one or more of the first intensity or the first direction to compensate for the first difference being different from the second distance.
4. The apparatus of claim 2, wherein the eye comprises a second astigmatic axis, and wherein the first light stimulus and the second light stimulus are arranged to illuminate the retina along the second astigmatic axis to decrease astigmatism along the first axis.
5. The apparatus of claim 1, wherein the light source is configured to illuminate the retina with a first light stimulus on a first side of the astigmatic axis and a second light stimulus on a second side of the astigmatic axis.
6. The apparatus of claim 5, wherein the light source is configured to inhibit illumination of a macula with the first stimulus and the second stimulus.
7. The apparatus of claim 1, wherein the light source is arranged to provide light to a first region of peripheral retina outside a macula and a second region of peripheral retina outside the macula, the second region opposite the first region with the macula of the retina located between the first region and the second region.
8. The apparatus of claim 7, wherein the retina comprises a third region between the first region and the second region on a first side of the macula and a fourth region between the first region and the second region on a second side of the macula and wherein the light source is configured to provide greater amounts of light to the first region and the second region than to the third region and the fourth region.

9. The apparatus of claim 8, wherein each of the four regions comprises a quadrant of the retina, the first region corresponding to a first quadrant, the second region corresponding to a second quadrant, the third region corresponding to a third quadrant, the fourth region corresponding to a fourth quadrant.

10. The apparatus of claim 1, further comprising:
a lens comprising an optical zone for the eye to view an object; and
a plurality of optics arranged around the optical zone to project a plurality of images anterior to the retina of the eye at a plurality of locations outside one or more of a fovea or a macula of the eye, the plurality of optics arranged with respect to an astigmatic meridian of the eye.

11. The apparatus of claim 10, further comprising a processor coupled to the plurality of optics, the processor configured with instructions to project light to the plurality of locations.

12. The apparatus of claim 11, wherein the plurality of optics is arranged to treat astigmatism with a first plurality of optics and to treat myopia and astigmatism with a second plurality of optics and the first plurality of optics and wherein the processor is configured with instructions to illuminate the first plurality of optics to treat the astigmatism and to illuminate the first plurality of optics and second plurality of optics to treat the myopia.

13. The apparatus of claim 12, wherein the first plurality of optics is configured to deliver an amount of light to treat the astigmatism corresponding to a steep meridian of a cornea and wherein the second plurality of optics is configured to treat myopia corresponding to a flatter meridian of the cornea located 90 degrees from the steep meridian of the cornea.

14. The apparatus of claim 13, wherein the first plurality of optics is configured to pass through a steeper region of the cornea than the second plurality of optics.

15. The apparatus of claim 13, wherein the first plurality of optics is configured to pass through a flatter region of the cornea than the second plurality of optics.

16. The apparatus of claim 14, wherein each the first plurality of optics and the second plurality of optics is configured to transmit light across an optical axis of the lens to project an image anterior to the retina on an opposite side of the optical axis.

17. The apparatus of claim 12, wherein the processor is configured to treat the myopia and astigmatism sequentially.

18. The apparatus of claim 12, wherein the processor is configured with instructions to selectively illuminate each of the first plurality of optics and the second plurality of optics.

19. The apparatus of claim 12, wherein the processor is programmable with instructions to selectively illuminate the second plurality of optics in relation to an astigmatic meridian on the eye and wherein the lens is stabilized when placed in front of the eye.

20. The apparatus of claim 10, wherein the astigmatic meridian corresponds to a meridian of a cornea having a curvature steeper than a curvature of a flatter meridian of the cornea, and wherein the plurality of optics is configured to decrease scleral growth at locations of the sclera corresponding to the steeper meridians to decrease the astigmatism of the eye.

21. The apparatus of claim 20, wherein a steep meridian of the cornea corresponds to a line along the retina and wherein the line extends through the plurality of locations.

22. The apparatus of claim 21, wherein the plurality of optics is configured to decrease growth of the sclera at locations corresponding to the steep meridian in relation to growth of the sclera at locations away from the locations corresponding to the steep meridian.

23. The apparatus of claim 20, wherein the flatter meridian of the cornea corresponds to a line along the retina and wherein the line extends through the plurality of locations.

24. The apparatus of claim 23, wherein the plurality of optics is configured to decrease growth of the sclera at locations corresponding to the flatter meridian in relation to growth of the sclera at locations away from the locations corresponding to the flatter meridian.

25. The apparatus of claim 10, wherein the astigmatic meridian corresponds to a meridian of a cornea having a curvature steeper than a curvature of a flatter meridian of the cornea, and wherein the plurality of optics is configured to decrease scleral growth at locations of the sclera corresponding to the flatter meridians to decrease the astigmatism of the eye.

26. The apparatus of claim 10, wherein the plurality of optics is configured to promote a change in one or more of an axial length or a choroidal thickness of the eye to treat the astigmatism.

27. The apparatus of claim 10, wherein the plurality of optics is configured to transmit light across an optical axis of the lens to project an image anterior to the retina on an opposite side of the optical axis.

28. The apparatus of claim 10, wherein the astigmatic meridian of the eye comprises a steep meridian of a cornea of the eye and wherein the plurality of locations of the retina corresponds to the steep meridian.

29. The apparatus of claim 28, wherein an optical axis of the lens extends from the object through the optical zone to a fovea of the eye and wherein light from the plurality of optics traverses the optical axis and extends to the plurality of locations.

30. The apparatus of claim 29, wherein light from each of the plurality of optics extends to a corresponding location on the retina and traverses the optical axis.

31. The apparatus of claim 10, wherein the lens comprises stabilization to orient the lens in an inferior superior direction along the eye, and wherein the plurality of optics is arranged to direct the light with respect to the astigmatic meridian with the lens stabilized on the eye in the inferior superior direction.

32. The apparatus of claim 31, wherein the lens comprises a contact lens and wherein the contact lens comprises contact lens stabilization.

33. The apparatus of claim 31, wherein the lens comprises a spectacle lens and wherein the spectacle lens is supported with an eyeglass frame.

34. The apparatus of claim 10, wherein each of the plurality of optics is configured to project an image at a location anterior or posterior to a corresponding retinal location to treat the astigmatism.

35. The apparatus of claim 10, wherein each of the plurality of optics is configured to project an image anterior to the retina at a corresponding retinal location.

36. The apparatus of claim 35, wherein the lens comprises a spectacle lens and wherein the plurality of optics has been adjusted to reduce an effect of astigmatism on a location of image formation anterior to the retina.

37. The apparatus of claim 10, wherein the lens comprises a spectacle lens and wherein an eye position sensor is configured to adjust the plurality of optics reduce movement of the plurality of locations on the retina in response to eye movement.

38. The apparatus of claim 10, wherein the lens comprises one or more of a plano lens, a spherical correction lens, an astigmatic correction lens, or prism correction lens.

39. A method of treating an eye, the method comprising:
providing a stimulus to a retina of the eye, wherein the stimulus is aligned with respect to an astigmatic axis of the eye to treat an astigmatism of the eye.

40. The method of claim 39, wherein the stimulus comprises a first light stimulus on a first side of the astigmatic axis and a second light stimulus on a second side of the astigmatic axis.

41. The method of claim 40, wherein the first stimulus comprises a first intensity and a first duration at a first distance from the astigmatic axis and the second stimulus on the second side comprises a second intensity and a second duration at a second distance from the astigmatic axis and wherein one or more of the second intensity or the second duration is different from one or more of the first intensity or the first direction to compensate for the first difference being different from the second distance.

42. The method of claim 40, wherein the eye comprises a second astigmatic axis, and wherein the first light stimulus and the second light stimulus are arranged along the second astigmatic axis to decrease astigmatism along the first axis.

43. The method of claim 39, wherein the stimulus is configured to inhibit illumination of a macula with the first stimulus and the second stimulus.

44. The method of claim 39, wherein the stimulus is arranged to provide light to a first region of peripheral retina outside a macula and a second region of peripheral retina outside the macula, the second region opposite the first region with the macula of the retina located between the first region and the second region.

45. The method of claim 44, wherein the retina comprises a third region between the first region and the second region on a first side of the macula and a fourth region between the first region and the second region on a second side of the macula and wherein the stimulus provides greater amounts of light to the first region and the second region than to the third region and the fourth region.

46. The method of claim 45, wherein each of the four regions comprises a quadrant of the retina, the first region corresponding to a first quadrant, the second region corresponding to a second quadrant, the third region corresponding to a third quadrant, the fourth region corresponding to a fourth quadrant.

47. The method or apparatus of any one of the preceding claims wherein the astigmatic axis corresponds to a cylinder axis with plus cylinder notation.

48. The method or apparatus of any one of the preceding claims wherein the astigmatic axis corresponds to a cylinder axis with minus cylinder notation.