CLAIMS

1. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert.

2. The energized ophthalmic lens device of Claim 1 wherein the ophthalmic lens device comprises a contact lens.

3. The energized ophthalmic lens device of Claim 2, further comprising:
a first layer of electrode material proximate to the back surface of the front curve piece; and
a second layer of electrode material proximate to the front surface of the back curve piece.

4. The energized ophthalmic lens device of Claim 3, further comprising a first layer of dielectric material proximate to the layer of liquid crystal material wherein the first layer of dielectric material varies in thickness across a region within the optical zone resulting in a varying electric field across the layer of liquid crystal material when an electric potential is applied across the first layer of electrode material and the second layer of electrode material.

5. The energized ophthalmic lens device of Claim 3 wherein the layer of liquid crystal material varies its index of refraction affecting a ray of light traversing the layer of liquid crystal material when an electric potential is applied across the first layer of electrode material and the second layer of electrode material.

6. The energized ophthalmic lens device of Claim 5 wherein the variable optic insert alters a focal characteristic of the lens.

7. The energized ophthalmic lens device of Claim 6 further comprises a processor.

8. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone, and comprising an insert front curve piece, an intermediate curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the intermediate curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

at least a first and second layer of liquid crystal material operatively associated with the variable optic insert.

9. The energized ophthalmic lens device of Claim 8 wherein the ophthalmic lens device comprises a contact lens.

10. The energized ophthalmic lens device of Claim 9 further comprising:
a first layer of electrode material proximate to the back surface of the front curve piece;

a second layer of electrode material proximate to the front surface of the intermediate curve piece; and

wherein the first layer of liquid crystal material is between the first layer of electrode material and the second layer of electrode material.

11. The energized ophthalmic lens device of Claim 10 further comprising a first layer of dielectric material proximate to the first layer of liquid crystal material wherein the first layer of dielectric material varies in thickness across a region within the optical zone resulting in a varying electric field across the layer of liquid crystal material when an electric potential is applied across the first layer of electrode material and the second layer of electrode material.

12. The energized ophthalmic lens device of Claim 10 wherein the layer of first liquid crystal material varies its index of refraction affecting a ray of light traversing the first layer of liquid crystal material when an electric potential is applied across the first layer of electrode material and the second layer of electrode material.

13. The energized ophthalmic lens device of Claim 10 wherein the variable optic insert alters a focal characteristic of the lens.

14. The energized ophthalmic lens device of Claim 8 wherein the intermediate curve piece is a combination of two curved pieces which have been joined together.

15. The energized ophthalmic lens device of claim 10 further comprises an electrical circuit, wherein the electrical circuit controls the flow of electrical energy from the energy source to the first and second electrode layers.

16. The energized ophthalmic lens device of claim 15 wherein the electrical circuit comprises a processor.

17. The energized ophthalmic lens device of claim 16 wherein the first liquid crystal layer is between and proximate to a first alignment layer and a second alignment layer , wherein the first and second alignment layers are collectively between the first layer of electrode material and the second layer of electrode material, and wherein the first layer of electrode material and the second layer of electrode material are in electrical communication with the electrical circuit.

18. The energized ophthalmic lens device of claim 17 further comprising:

a third alignment layer and a forth alignment layer, wherein the second liquid crystal layer is between and proximate to the third alignment layer and the forth alignment layer;

a third layer of electrode material and a forth layer of electrode material, wherein the second liquid crystal layer, the third alignment layer and the forth alignment layer are collectively between the third layer of electrode material; and

wherein the third layer of electrode material and the forth layer of electrode material are in electrical communication with the electrical circuit.

19. The energized ophthalmic lens device of claim 18 wherein the first alignment layer and the second alignment layer align the first liquid crystal layer predominantly along a first linear axis; and the third alignment Lauer and the forth alignment layer align the second liquid crystal layer predominantly along a second linear axis.

20. The energized ophthalmic lens device of Claim 19 wherein the first linear axis is approximately perpendicular to the second linear axis.

21. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material comprises nano-sized polymer dispersed liquid crystal regions.

22. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert- in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material comprises polymer dispersed liquid crystal regions.

23. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back

curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone; ;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material comprises layers with varied anchoring strength.

24. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone; ;

an energy source embedded in the variable optic insert- in at least a region comprising the non-optical zone, and

the variable optic insert comprising a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material is oriented by organized alignment layers wherein polarized light in a defined pattern controls the organization of the alignment layers.

25. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material is oriented by organized alignment layers and aligns the liquid crystal material into gradient indexed orienations that interact with incident light to provide a parabolic phase delay to radius relationship.

26. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert- in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material comprises cycloidal wave plate patterned liquid crystal layers

27. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material comprises shaped dielectric layers with polymer dispersed liquid crystal layers.

28. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the layer comprises polymer dispersed liquid crystal layers with varied density of liquid crystal containing voids in the polymer layer.

29. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the layer comprises polymer dispersed liquid crystal layers with varied density of liquid crystal containing voids in the polymer layer.

30. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece, wherein a back surface of the front curve piece and a front surface of the back

curve piece have differing surface topology at least in the portion within the optical zone, the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone;

a single layer of aligned liquid crystal material operatively associated with the variable optic insert, wherein the single layer of aligned liquid crystal material interacts strongly with a first polarization orientation of incident light and not with a second polarization orientation of incident light, wherein the first polarization orientation of incident light is orthogonal to the second polarization orientation of incident light; and wherein the differential interaction of the single layer with the first polarization orientation of incident light forms a first focal characteristic different from a second focal characteristic determined by interaction of the single layer with the second polarization orientation of incident light.

31. A method of forming an ophthalmic device, the method comprising:
forming an ophthalmic insert piece, wherein the insert piece assumes a non-planar shape;
coating a surface region of the ophthalmic insert piece with an alignment material;
orienting the molecules of the alignment material by irradiating them with electromagnetic radiation.

32. The method of claim 31, wherein the alignment material comprises one or more of an azobenzene compound.

33. The method of claim 31, wherein the orienting is performed by control of the polarization of the irradiating light.

34. The method of claim 32, wherein the one or more of an azobenzene compound is oriented into either of a cis or a trans configuration.

CLAIMS

1. An energized ophthalmic contact lens comprising:

a variable optic insert comprising at least a portion within the optical zone, and comprising an insert front curve piece, an intermediate curve piece and an insert back curve piece;

the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone;

at least a first and second layer of liquid crystal material operatively associated with the variable optic insert;

a first layer of electrode material proximate to the back surface of the front curve piece;

a second layer of electrode material proximate to the front surface of the intermediate curve piece; and

wherein the first layer of liquid crystal material is between the first layer of electrode material and the second layer of electrode material;

an electrical circuit, wherein the electrical circuit controls the flow of electrical energy from the energy source to the first and second electrode layers wherein the electrical circuit comprises a processor; and

wherein the first liquid crystal layer is between and proximate to a first alignment layer and a second alignment layer, and the first and second alignment layers are collectively between the first layer of electrode material and the second layer of electrode material, and wherein the first layer of electrode material and the second layer of electrode material are in electrical communication with the electrical circuit;

a third alignment layer and a fourth alignment layer, wherein the second liquid crystal layer is between and proximate to the third alignment layer and the fourth alignment layer;

a third layer of electrode material and a fourth layer of electrode material, wherein the second liquid crystal layer, the third alignment layer and the fourth alignment layer are collectively between the third layer of electrode material; and

wherein the third layer of electrode material and the fourth layer of electrode material are in electrical communication with the electrical circuit.

2. The lens of Claim 1, further comprising a first layer of dielectric material proximate to the first layer of liquid crystal material wherein the first layer of dielectric material varies in thickness across a region within the optical zone resulting in a varying electric field across the layer of liquid crystal material when an electric potential is applied across the first layer of electrode material and the second layer of electrode material.

3. The lens of Claim 1, wherein the layer of first liquid crystal material varies its index of refraction affecting a ray of light traversing the first layer of liquid crystal material when an electric potential is applied across the first layer of electrode material and the second layer of electrode material.

4. The lens of Claim 1, wherein the variable optic insert alters a focal characteristic of the lens.

5. The lens of Claim 1, wherein the intermediate curve piece is a combination of two curved pieces which have been joined together.

6. The lens of Claim 1, wherein the first alignment layer and the second alignment layer align the first liquid crystal layer predominantly along a first linear axis; and the third alignment layer and the fourth alignment layer align the second liquid crystal layer predominantly along a second linear axis.

7. The lens of Claim 6, wherein the first linear axis is approximately perpendicular to the second linear axis.

8. An energized ophthalmic lens device comprising:
a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece;
the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material is oriented by organized alignment layers and aligns the liquid crystal material into gradient indexed orientations that interact with incident light to provide a parabolic phase delay to radius relationship.

9. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece;

the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert- in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the liquid crystal material comprises cycloidal wave plate patterned liquid crystal layers.

10. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece;

the variable optic insert further comprising a non-optical zone;

an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone; and

a layer of liquid crystal material operatively associated with the variable optic insert, wherein the layer comprises polymer dispersed liquid crystal layers with varied density of liquid crystal containing voids in the polymer layer.

11. An energized ophthalmic lens device comprising:

a variable optic insert comprising at least a portion within the optical zone and comprising an insert front curve piece and an insert back curve piece;

the variable optic insert further comprising a non-optical zone;
an energy source embedded in the variable optic insert in at least a region comprising the non-optical zone;
a single layer of aligned liquid crystal material operatively associated with the variable optic insert, wherein the single layer of aligned liquid crystal material interacts strongly with a first polarization orientation of incident light and not with a second polarization orientation of incident light, wherein the first polarization orientation of incident light is orthogonal to the second polarization orientation of incident light; and wherein the differential interaction of the single layer with the first polarization orientation of incident light forms a first focal characteristic different from a second focal characteristic determined by interaction of the single layer with the second polarization orientation of incident light.

12. A method of forming the contact lens of any one of the preceding claims, comprising: forming an ophthalmic insert piece, wherein the insert piece assumes a non- planar shape; coating a surface region of the ophthalmic insert piece with an alignment material; and orienting the molecules of the alignment material by irradiating them with electromagnetic radiation.

13. The method of Claim 12, wherein the alignment material comprises one or more of an azobenzene compound.

14. The method of Claim 12, wherein the orienting is performed by control of the polarization of the irradiating light.

15. The method of Claim 13, wherein the one or more of an azobenzene compound is oriented into either of a cis or a trans configuration.