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(54) Title: ILLUMINATION DEVICE

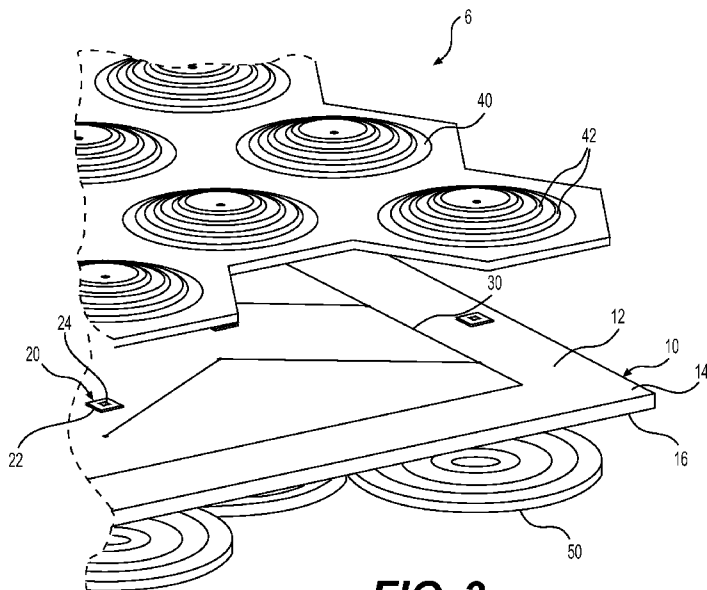


FIG. 3

(57) Abstract: Device for providing comprising: A panel having rigid layer (12) having a patterned electrical circuit (30) thereon. An array of illuminating units, each unit being formed by at least one rigid element and a portion of the rigid layer; and including: a rigid optical dispersing element (50), a light source (20) sandwiched within the panel for generating light from electrical energy, and an electrical conductor. The electrical conductor being the primary heat sink for the light source, the light source being primarily cooled via conduction. The electrical conductor and the optical dispersing element being dimensioned and arranged within the unit such that the electrical conductor does not materially impede transmission of light generated by the light source to the outside of the device. The electrical conductor transmitting electrical and thermal energy received from the light source away from the unit.

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AMENDED CLAIMS

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CLAIMS

1. A device for providing illumination comprising:
 - a panel having at least one rigid layer, the at least one rigid layer having at least one patterned electrical circuit thereon;
 - 5 an array of illuminating units, each unit being formed by at least one rigid element and a portion of the at least one rigid layer, each unit including:
 - a series of rigid concentric annular optical dispersing elements secured to the at least one rigid layer for dispersing light outside the unit,
 - a light source secured to the at least one rigid layer and sandwiched within the panel for converting electrical energy into light, and
 - 10 an electrical conductor in electrical communication with the light source to transmit electrical energy thereto, the electrical conductor being in thermal communication with the light source to receive thermal energy therefrom, the electrical conductor being the primary heat sink for the light source, the light source being primarily cooled via conduction;
 - 15 the electrical conductor and the optical dispersing elements of each unit being dimensioned and arranged within the unit such that the electrical conductor does not materially impede transmission of light generated by the light source within the unit to outside the unit;
 - 20 the electrical conductor being at least electrically and thermally interconnected with the patterned circuit to transmit electrical energy to the light source and to receive thermal energy from the light source for transmission away from the unit.
2. The device of claim 1, wherein the light source is sandwiched between the at least one rigid layer and at least one of the rigid optical dispersing elements.
- 25 3. *(Cancelled)*
4. *(Cancelled)*
5. The device of claim 1, wherein the rigid optical dispersing elements of multiple units are all part of a single rigid layer distinct from the at least one rigid layer having the at least one patterned electrical circuit thereon.

6. The device of claim 1, wherein the electrical conductor and the optical dispersing elements of each unit are dimensioned and arranged within the unit such that the electrical conductor impedes transmission of no more than 20% of the light generated by the light source within the unit to outside the unit.
- 5 7. The device of claim 1, wherein
each unit of the array further includes a rigid optical redirecting element secured to the at least one rigid layer for redirecting light within the unit to the optical dispersing elements; and
the electrical conductor, the optical dispersing elements, and the optical redirecting
10 conductor does not materially impede transmission of light generated by the light source within the unit to outside the unit.
8. The device of claim 7, wherein the light source is sandwiched between the at least one rigid layer and one of the rigid optical dispersing elements.
9. The device of claim 7, wherein the light source is sandwiched between the at least one
15 rigid layer and the rigid optical redirecting element.
10. The device of claim 7, wherein the optical redirecting element of each unit is a series of optical redirecting elements.
11. *(Cancelled)*
12. The device of claim 10, wherein the optical redirecting element of each unit is a series of
20 concentric annular optical redirecting elements.
13. The device of claim 7, wherein
the rigid optical dispersing elements of multiple units are all part of a first single rigid layer distinct from the at least one rigid layer having the at least one patterned electrical circuit thereon; and
25 the rigid optical redirecting elements of multiple units are all part of a second single rigid layer distinct from the at least one rigid layer having the at least one patterned electrical circuit thereon and the first single rigid layer.
14. The device of claim 7, wherein the rigid optical redirecting element redirects light from a light guide for transmission to the rigid optical dispersing elements.

15. The device of claim 14, wherein the light guide has a secondary optical element for redirecting light within the light guide.
16. The device of claim 7, wherein the electrical conductor, the optical dispersing elements, and the optical redirecting element of each unit are dimensioned and arranged within the unit
5 such that the electrical conductor impedes transmission of not more than 20% of light generated by the light source within the unit to outside the unit.
17. The device of claim 1, wherein the light source is at least partially encased in a thermal insulator.
18. A device for providing illumination comprising:
10 a panel having a plurality of rigid layers bonded together;
an array of illuminating units formed by the plurality of layers of the panel, each one of the array of illuminating units including:
- 15 a series of concentric annular optical dispersing elements associated with a first surface of one of the layers of the plurality of layers for dispersing light outside the unit;
 - a series of optical redirecting elements associated with a second surface of one of the layers of the plurality of layers for redirecting light within the unit to the optical dispersing elements;
 - 20 a light source sandwiched between two of the layers of the plurality of layers for converting electrical energy into light;
- one of the layers of the plurality of layers having an electrical conductor in electrical communication with the light source to transmit electrical energy thereto, the electrical conductor being in thermal communication with the light source to receive thermal energy therefrom, the electrical conductor being the primary heat
25 sink for the light source, the light source being primarily cooled via conduction;
- the electrical conductor, the series of optical dispersing elements and the series of optical redirecting elements of being dimensioned and arranged within the unit such that the electrical conductor does not materially impede transmission of light generated by the light source within the unit to outside the unit;
- 30 one of the layers of the plurality of layers having a patterned circuit electrically and thermally interconnected with light source of at least some of the units to

transmit electrical energy thereto and to receive thermal energy therefrom for transmission away from the units.

19. The device of claim 18, wherein
the series of optical dispersing elements are formed on the first surface; and
5 the series of optical redirecting elements are formed on the second surface.
20. The device of claim 18, wherein the electrical conductor, the optical dispersing elements, and the optical redirecting elements of each unit are dimensioned and arranged within the unit such that the electrical conductor impedes transmission of not more than 20% of the light generated by the light source within the unit to outside the unit.
- 10 21. An illumination panel comprising:
- a receiver substrate assembly including:
 - a rigid sheet of light transmissive material having a first surface, a second surface opposite the first surface, and a conductor pattern attached to the first surface; and
 - 15 ○ at least one receiver assembly affixed to the rigid sheet, each receiver assembly including a light source in electrical communication with the conductor pattern;
 - at least one light-guide optic attached to and supported by the receiver substrate assembly, each light-guide optic in optical communication with the
20 light source of an associated one of the at least one receiver assembly for guiding light for output via the rigid sheet.
22. The illumination panel of claim 21 wherein the at least one light-guide optic is attached to and supported by the first surface of the receiver substrate assembly.
23. The illumination panel of claim 22 further comprising at least one focusing optic
25 attached to and support by the second surface of the receiver substrate assembly, each focusing optic associated with and in optical communication with one of the at least one light-guide optic, each focusing optic comprising at least one focusing element for cooperative operation with the light-guide optic.

24. The illumination panel of any one of claims 21-23 wherein each light-guide optic comprises at least one reflective surface for guiding light received from the light source out through the receiver substrate assembly.
25. The illumination panel of claim 23 or 24 wherein the at least one focusing element
5 includes a lens.
26. The illumination panel of any one of claims 21-25 wherein the conductor pattern includes two or more bus bars.
27. The illumination panel of any one of claims 21-26 wherein the light transmissive material of the rigid sheet is a thermally insulating material.
- 10 28. The illumination panel of any one of claims 21-27 wherein the light transmissive material of the rigid sheet is glass.
29. The illumination panel of any one of claims 21-28 wherein the first and second surfaces of the rigid sheet are flat and parallel to each other.
30. The illumination panel of any one of claims 21-29 wherein the light-guide optic is
15 made of a different material than the rigid sheet.
31. The illumination panel of any one of claims 21-30 wherein the light-guide optic is made of poly(methyl) methacrylate.
32. The illumination panel of any one of claims 23-31 wherein the focusing optic is made of a different material than the rigid sheet.
- 20 33. The illumination panel of any one of claims 23-32 wherein the focusing optic is made of poly(methyl) methacrylate.
34. The illumination panel of any one of claims 23-33 wherein at least one of the at least one light-guide optic and the at least one focusing optic is 3D printed onto the rigid sheet.
35. The illumination panel of any one of claims 21-34 wherein the conductor pattern
25 comprises at least two bus bars and a plurality of interconnection traces for electrical connection of the at least one receiver assembly to the bus bars.

36. The illumination panel of any one of claims 23-35 wherein the conductor pattern comprises a heat spreader portion.
37. The illumination panel of claim 26 wherein the heat spreader portions comprises a positive half and a negative half, each half comprising a plurality of arms in the shape of circular arcs and a terminus interconnected by an interconnection trace.
38. The illumination panel of any one of claims 2-37 wherein the conductor pattern is metalized onto the first surface.
39. The illumination panel of any one of claims 21-38 wherein the conductor pattern is formed from a sheet of conductive material.
40. The illumination panel of claim 36 wherein the conductor pattern is disposed between the rigid sheet and one of the light guide optic and the focusing optic, and the heat spreader portion is shaped and positioned so as to avoid blocking light transmitted from the reflecting surfaces of the light guide optic to the focusing optic.
41. An illumination panel comprising:
- at least one sheet of glass having a top face and a bottom face; and
 - a plurality of optical units connected to the at least one sheet of glass, each optical unit including:
 - a first optical element attached to the top face of the at least one sheet of glass,
 - a second optical element attached to the bottom face of the at least one sheet of glass,
 - a light source, and
 - electrical connectors connected to the light source,the light source and the electrical connectors being sandwiched between other elements of the optical unit.

42. An illumination providing optical unit comprising:
- a transparent substrate having a top face and a bottom face;
 - a light source facing away from the bottom face of the transparent substrate;
 - a first optical element attached to the top face of the transparent substrate, the first
- 5 optical element having a plurality of lenses;
- a second optical element attached to the bottom face of the transparent substrate, the second optical element including a plurality of first reflectors;
 - a second reflector facing towards the bottom face of the transparent substrate, the light
- 10 source being behind a focus of the second reflector, the second reflector reflecting light received from the light source towards the plurality of first reflectors, the plurality of first reflectors reflecting light towards the plurality of lenses for dispersal.

STATEMENT UNDER PCT ARTICLE 19(1)

By the present amendment, claims 1, 2, 6, 7, 8, 12, 14, 16 and 18 have been amended; claims 3, 4 and 11 have been cancelled; and no claims have been added.

Specifically, claims 1 and 18 have been amended by incorporating therein the limitations of claims 3 and 4. As a consequence claims 3 and 4 have been cancelled. In view of these amendments, claim 11 has been cancelled as being redundant, claim 12 has been amended to remove some redundancy, and claims 2, 6, 7, 8, 14 and 16 have been amended to change the singular expression “element” to the plural expression “elements”.

A marked-up copy showing the amendments is submitted herewith.