



(51) International Patent Classification:

F21V 33/00 (2006.01) *G02B 27/09* (2006.01)
F21K 99/00 (2010.01) *F21Y 103/00* (2006.01)
F21S 8/00 (2006.01) *F21W 131/305* (2006.01)
G02B 3/00 (2006.01)

(21) International Application Number:

PCT/US2010/060156

(22) International Filing Date:

13 December 2010 (13.12.2010)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12/636,524 11 December 2009 (11.12.2009) US
61/314,665 17 March 2010 (17.03.2010) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

[Continued on next page]

(54) Title: RETROFIT-STYLE LAMP AND FIXTURE, EACH INCLUDING A ONE-DIMENSIONAL LINEAR BATWING LENS

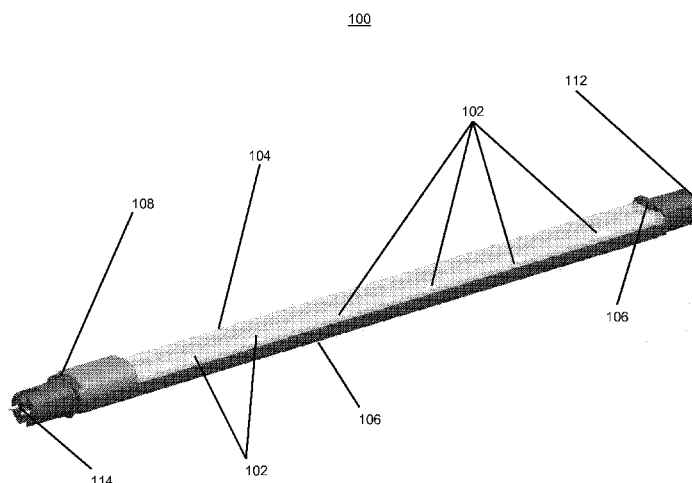


FIG. 1

(57) Abstract: A retrofit-style lamp is disclosed. The retrofit-style lamp includes a plurality of light sources, and a one-dimensional (1D) linear batwing lens. The 1D linear batwing lens beam shapes light emitted by at least two light sources of the plurality of light sources. The retrofit-style lamp also includes a housing including the plurality of light sources, and attached to the 1D linear batwing lens. The combination of housing and lens is then itself fitted with endcaps, including electrical connectors, for placement within a fixture, such as within an existing conventional fluorescent tube fixture located within a storage structure, for example a refrigeration case. Alternatively, the plurality of light sources, the 1D linear batwing lens, and the housing may be formed, along with a power supply, as a standalone retrofit fixture for use in enclosed storage structures, where the retrofit fixture replaces a conventional fluorescent fixture.



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- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))* — *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Published:

- *with international search report (Art. 21(3))*

RETROFIT-STYLE LAMP AND FIXTURE, EACH INCLUDING A ONE-DIMENSIONAL LINEAR BATWING LENS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority of U.S. Patent Application Serial No. 12/636,524, filed December 11, 2009, and U.S. Provisional Patent Application Serial No. 61/314,665, filed March 17, 2010, the entire contents of both of which are hereby incorporated by reference.

TECHNICAL FIELD

[0002] The present invention relates to lamps, and more specifically, to retrofit-style lamps incorporating a lens.

BACKGROUND OF THE INVENTION

[0003] Enclosed storage structures, such as refrigeration cases, have long had light sources and light fixtures disposed within to provide light to anyone accessing an item or items stored within the structure. Typically, such a fixture uses one or more fluorescent bulbs, usually in the shape of a tube, to disperse light within the enclosed space defined by the storage structure. Such fixtures may be located along the front corners of a vertically-elongated storage structure, such as on either side of a door that opens to the left or right, or may be located along a top corner or a front edge, when the storage structure is horizontally-elongated. When a fluorescent tube breaks or otherwise ceases to function for any reason, the non-functioning tube is removed, and a new one is put into the fixture.

[0004] While fluorescent tubes are reasonably low in cost, and maintenance of fixtures including fluorescent tubes is reasonably easy and also low cost, a typical fluorescent-based bulb is not as energy-efficient or as long-lasting as a typical light emitting diode (LED) light source. Thus, lamps and fixtures that employ LEDs instead of fluorescent tubes are becoming increasingly popular.

SUMMARY OF THE INVENTION

[0005] Conventional techniques for providing light within an enclosed storage structure, such as a refrigeration case, using an LED-based light source suffer from a variety of faults. A conventional LED-based fixture typically requires a 1:1 ratio between the LED sources and the optics used, and thus the optics is typically injection molded. That is, each LED chip has its own optic (i.e., lens). This is due, in part, to attempting to compensate for the less-than uniform distribution of light a conventional LED-based fixture provides, compared to a conventional fluorescent-based fixture. For a typical fixture measuring four feet in length, there may be ten or twelve lenses present. In some configurations, should a lens break or otherwise need to be replaced, it is not possible to simply replace the single lens, but rather the entire fixture must be replaced. The same is true for the LED chips in some configurations (i.e., if one chip breaks or otherwise needs to be replaced, the entire fixture must be replaced, not just the one chip, or an array of chips). This makes a conventional LED-based light source more expensive to maintain over time than conventional fluorescent light sources, despite the cost savings of using more energy efficient LEDs in place of conventional fluorescent light sources.

[0006] Further, the 1:1 ratio between the LEDs/LED chips and the optics means that a retrofit-style option replacement of a conventional light source is impossible. (A retrofit-style option is one where a conventional light source in an existing fixture is replaced by an LED-based light source and appropriate changes are further made to the ballast and/or the power supply of the existing fixture, so as to allow the fixture to properly power and operate the LEDs. Thus, a retrofit-style replacement may result in the replacement of not only the light source, but also the existing ballast and/or power supply of the existing fixture. In contrast, a true retrofit option would replace the conventional light source in an existing fixture with an LED-based light source, but would not require any changes to the already-existing ballast and/or power supply.) That is, the 1:1 ratio makes it impossible to add an LED-based light source and its related optics to an already-existing fixture, where they would replace the conventional fluorescent tube (leaving aside the issue of whether the current ballast and/or power supply used by the already-existing fixture would be capable of supporting the LEDs). The entire fixture must be removed and replaced, adding to installation costs in comparison to a retrofit-style solution. Further, conventional LED-based fixtures for refrigeration cases and similar structures are typically larger and bulkier in terms of space occupied than conventional fluorescent fixtures for the same structures. In some

structures, the conventional LED-based fixture will not fit into the structure properly. In other structures, even if the conventional LED-based fixture does fit, it takes up more space than a conventional fluorescent fixture, leaving less space for products within the case or structure.

[0007] Embodiments of the present invention provide a retrofit-style solution for use with fixtures already located within enclosed storage structures, such as but not limited to refrigeration cases and other similar structures. The retrofit-style solution lamp described herein may use LED-based light sources, making it more energy-efficient and having a longer life than conventional light sources, such as conventional fluorescent tube lamps, and has its own incorporated optic that produces a dispersion of light that better illuminates an enclosed storage structure, such as a refrigeration case. When configured as a retrofit-style lamp, the solution replaces a conventional fluorescent tube lamp, providing the energy-efficiency and long life benefits of LED-based light sources. When configured as a fixture, the solution replaces existing conventional fluorescent fixtures as well as existing conventional LED-based fixtures with a fixture that provides energy efficiency, longer life, and a better dispersion of light, as well as being easier and less expensive to maintain and repair.

[0008] In an embodiment, there is provided a retrofit-style lamp. The retrofit-style lamp includes a plurality of light sources and a one-dimensional linear batwing lens. The one-dimensional linear batwing lens beam shapes light emitted by at least two light sources of the plurality of light sources.

[0009] In a related embodiment, the at least two light sources of the plurality of light sources may be located in a region beneath a central portion of the one-dimensional linear batwing lens. In another related embodiment, the plurality of light sources may include a plurality of light-emitting diodes. In still another related embodiment, the one-dimensional linear batwing lens may be scalable in relation to a number of light sources comprising the plurality of light sources.

[0010] In yet another related embodiment, the one-dimensional linear batwing lens may be extrudable. In a further related embodiment, the extrudable one-dimensional linear batwing lens may be co-extrudable. In a further related embodiment, the co-extrudable one-dimensional linear batwing lens may be comprised of a first portion and a second portion, wherein the first portion may be comprised of a first material, and wherein the second portion may be comprised of a second material. In another further related embodiment, the co-extrudable one-dimensional linear batwing lens may be comprised of a first portion and a second portion, wherein the first portion and the second portion may be comprised of a

material, and wherein the first portion may include a first filter and the second portion may include a second filter.

[0011] In yet still another related embodiment, the one-dimensional linear batwing lens may include an upper portion and a lower portion, wherein the upper portion may be located farther from the plurality of light sources than the lower portion, and wherein the upper portion may be divided into a first non-planar section and a second non-planar section. In a further related embodiment, the first non-planar section and the second non-planar section may be similarly shaped. In another further related embodiment, the first non-planar section and the second non-planar section may be of different shapes.

[0012] In still another related embodiment, the one-dimensional linear batwing lens may include an upper portion and a lower portion, wherein the upper portion may be located farther from the plurality of light sources than the lower portion, and wherein the upper portion may include a dip. In a further related embodiment, the dip may be characterized by an angle.

[0013] In yet another related embodiment, the retrofit-style lamp may further include a housing, wherein the plurality of light sources is arranged within a space defined in part by the housing. In a further related embodiment, the one-dimensional linear batwing lens may be coupled to the housing. In another further related embodiment, the retrofit-style lamp may further include a pair of electrical connectors, wherein a first of the pair of electrical connectors may be attached to a first end of the housing, and wherein a second of the pair of electrical connectors may be attached to a second end of the housing. In a further related embodiment, the one-dimensional linear batwing lens may be coupled to the housing, forming a lens-housing combination, and the pair of electrical connectors may be attached to the lens-housing combination. In a further related embodiment, the retrofit-style lamp may further include an endcap, wherein the endcap is connectable between one of the pair of electrical connectors and the lens-housing combination.

[0014] In another embodiment, there is provided an enclosed storage structure lighting fixture. The enclosed storage structure light fixture includes a housing; a power supply, wherein the power supply is connectable to the housing; a plurality of light sources located in a region defined by the housing, wherein the plurality of light sources receive power from the power supply; and a one-dimensional linear batwing lens, coupled to the housing, wherein the one-dimensional linear batwing lens beam shapes light emitted by at least two light sources of the plurality of light sources. In a related embodiment, the one-dimensional linear batwing lens may provide a substantially uniform distribution of light within a space defined

in part by an enclosed storage structure, by beam shaping light emitted by the plurality of light sources.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The foregoing and other objects, features and advantages disclosed herein will be apparent from the following description of particular embodiments disclosed herein, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles disclosed herein.

[0016] FIG. 1 shows a retrofit-style lamp including a one-dimensional linear batwing lens according to embodiments disclosed herein.

[0017] FIG. 2 illustrates a sectional cross-view of a housing including attached light sources and an attached one-dimensional linear batwing lens.

[0018] FIG. 3 shows a profile view of an open-ended light fixture having a housing including attached light sources and an attached one-dimensional linear batwing lens, wherein the light sources are not powered and the interior of the housing is visible through the lens.

[0019] FIG. 4 shows a profile view of a section of a light fixture having a housing including attached light sources and an attached one-dimensional linear batwing lens, wherein the light sources are powered and the interior of the housing is not visible through the lens.

[0020] FIG. 5 shows a cross-section view of an alternative one-dimensional linear batwing lens, according to embodiments described herein.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Embodiments described herein show a novel retrofit-style lamp suitable for use in storage units such as refrigeration cases. The retrofit-style lamp incorporates its own lens instead of relying on a lens attached to the fixture in which the lamp is placed. The lens is a one-dimensional linear batwing lens, which produces a batwing type of beam pattern by beam shaping light from a plurality of light sources, which may include LED-based light sources. The lens is extruded and is able to be used with any number of light sources. The lamp also includes a housing to which the light sources and the lens are attached, with endcaps including electrical pin connectors affixed to each end of the housing. The endcaps, through the electrical pin connectors, allow the light sources to receive power and produce light, which the incorporated one-dimensional linear batwing lens spreads in a substantially

uniform pattern through the storage unit. Thus, the endcaps allow the lamp to be placed in any type of fixture that accepts fluorescent lamp tubes. The retrofit-style lamp may also be modified by removing the endcaps and adding covers with appropriate electrical connectors so as to be used as a fixture, directly attached to a storage unit in replacement of a conventional fluorescent lamp fixture.

[0022] FIG. 1 shows a retrofit-style lamp 100 (including and corresponding to a cross-sectional view 200 in FIG. 2 and a profile sectional view 300 in FIG. 3) including a plurality of light sources 102, a one-dimensional linear batwing lens 104, a housing 106, a pair of endcaps 108 and 110, and a pair of electrical connectors 112 and 114. Thus, the one-dimensional linear batwing lens 104 is incorporated into the retrofit-style lamp 100, such that the fixture (not shown) into which the retrofit-style lamp 100 is placed does not need to have an optic or optics (i.e., lens/lenses) of its own. The retrofit-style lamp 100 is suitable for placement in any type of fixture, such as but not limited to a conventional fluorescent tube lamp fixture (not shown). The one-dimensional linear batwing lens 104 is coupled to the housing 106, as seen most easily in FIG. 2, to form an outer body of the retrofit-style lamp 100. The one-dimensional linear batwing lens 104 may be coupled to the housing 106 in any known way. For example, in some embodiments, the one-dimensional linear batwing lens 104 and the housing 106 are each shaped so as to form an interlocking connection. An example of such an interlocking connection is shown in FIG. 2, where the one-dimensional linear batwing lens 104 and the housing 106 each include a tab 220_N attached to a post 222_N , such that the tabs 220_3 and 220_4 on the one-dimensional linear batwing lens 104 may be slid into the two cavities created by the tabs 220_1 and 220_2 and the posts 222_1 and 222_2 of the housing 106, keeping the one-dimensional linear batwing lens 104 and the housing 106 connected. Note that the tabs 220_N and the posts 222_N , in some embodiments, are created from the same material as the housing 106 and/or the one-dimensional linear batwing lens 104 and are a solid part of the housing 106 and/or the one-dimensional linear batwing lens 104, such that the tabs 220_N and the posts 222_N are created when the housing 106 and/or the one-dimensional linear batwing lens 104 is created (i.e., shaped). Alternatively, in some embodiments, the tabs 220_N and the posts 222_N are separate from the housing 106 and/or the one-dimensional linear batwing lens 104 and must be connected or otherwise attached thereto (e.g., by use of an epoxy or other adhesive material, or through use of a mechanical connection). Alternatively, in some embodiments, the posts 222_N are a solid part of the housing 106 and/or the one-dimensional linear batwing lens 104, as described above, and the tabs 220_N are separate and must be connected or otherwise attached to the corresponding

posts 222_N (e.g., by use of an epoxy or other adhesive material, or through use of a mechanical connection). Further, in some embodiments, the connection of the housing 106 and the one-dimensional linear batwing lens 104 is outside of the active optical field of the one-dimensional linear batwing lens 104, so that the housing 106 retains and supports the one-dimensional linear batwing lens 104 without disturbing the beam pattern created by the beam shaping of the one-dimensional linear batwing lens 104, acting on light from the plurality of light sources 102. Thus, it is possible to exchange a different lens (including a different one-dimensional linear batwing lens) for the one-dimensional linear batwing lens 104 that is originally part of the retrofit-style lamp 100, should (for example) the original one-dimensional linear batwing lens 104 break or otherwise need to be replaced, or should a different optic be necessary and/or desired for the retrofit-style lamp 100.

[0023] The housing 106 may be made of any material that serves a thermal management function. Thus, in some embodiments, the housing 106 serves as a heat sink for any heat created by the retrofit-style lamp 100 and/or any of its components, such as heat created by, for example, the plurality of light sources 102). The housing 106 is also extrudable (i.e., may be formed having a desired cross-section by being forced through a die). In some embodiments, the housing 106 is made of aluminum. In other embodiments, the housing 106 may be made of, for example but not limited to, sheet metal, a plastic material, and the like. The housing 106 may be of any shape that allows the retrofit-style lamp 100 to fit into a lighting fixture. The housing 106, as described above, must be able to be connected to the one-dimensional linear batwing lens 104, using, for example, any of the connection mechanisms described above. In some embodiments, the housing 106 has a low profile, which allows the retrofit-style lamp 100 to be placed into, for example, conventional fluorescent tube fixtures. In some embodiments, upper walls 240 of the housing 106 (seen most easily in FIG. 2) provide a precise mechanical cutoff at edges 242 of the housing 106 to eliminate reverse glare from the plurality of light sources 102.

[0024] The pair of electrical connectors 112 and 114 are located, respectively, on either end of the retrofit-style lamp 100. The first of the pair of electrical connectors 112 is attached to a first end 182 of the housing 106, and the second of the pair of electrical connectors 114 is attached to a second end 184 of the retrofit-style lamp 100. The pair of electrical connectors 112 and 114 may be any known type of electrical connector, such as but not limited to a pair of two-pin connector as is typically used on conventional fluorescent lamp tubes. The pair of electrical connectors 112 and 114 provide the retrofit-style lamp 100 with power received from the fixture (not shown) into which the retrofit-style lamp 100 is placed. The power

received by the pair of electrical connectors 112 and 114 is sent to the plurality of light sources 102 through any power-conducting material, such as but not limited to wire, or pin connectors located on a printed circuit board (PCB) that includes any number of the plurality of light sources 102. The pair of electrical connectors 112 and 114, in some embodiments, are connected to the joined one-dimensional linear batwing lens 104 and housing 106 (which may be considered to be a lens-housing combination). In some embodiments, the pair of electrical connectors 112 and 114 are directly connected to the lens-housing combination. Alternatively, as is shown in FIG. 1, the pair of endcaps 108 and 110 is interposed between the lens-housing combination and the pair of electrical connectors 112 and 114. That is, either of the pair of endcaps 108 and 110 is connectable between one of the pair of electrical connectors 112 and 114, and the lens-housing combination. For example, as shown in FIG. 1, a first of the pair of endcaps 108 is connected between the first of the pair of electrical connectors 112 and the interconnected one-dimensional linear batwing lens 104 and the housing 106, and the second of the pair of endcaps 110 is connected between the second of the pair of electrical connectors 114 and the interconnected one-dimensional linear batwing lens 104 and the housing 106. Thus, any electrical connection between either or both of the pair of electrical connectors 112 and 114 and the plurality of light sources 102 must be maintained (i.e., not interrupted, severed, or otherwise blocked by) the pair of endcaps 108 and 110. In some embodiments, the pair of endcaps 108 and 110, with the exception of an electrical connection to the pair of electrical connectors 112 and 114, seal off the interior of the interconnected one-dimensional linear batwing lens 104 and the housing 106 (i.e., the lens-housing combination). The pair of endcaps 108 and 110 may be made of any material that is able to withstand any heat generated by the retrofit-style lamp 100 without becoming deformed, and without either of the pair of endcaps 108 and 110 becoming disengaged or otherwise disconnected from the other components of the retrofit-style lamp 100. In some embodiments, an endcap and an electrical connector may be a single component, while alternatively, in other embodiments, an endcap and an electrical connector may be discrete components that must be connected in some manner. Both the pair of endcaps 108 and 110 and the pair of electrical connectors 112 and 114 may be joined to other components of the retrofit-style lamp 100 using any available connection mechanisms and/or materials (for example, but not limited to, mechanical connections, adhesive-based connections, combinations thereof, and so on). In some embodiments, one or both of the pair of endcaps 108 and 110 may be shaped or otherwise formed so that, when the retrofit-style lamp 100 is placed into a fixture, proper engagement of the retrofit-style lamp 100 with the fixture results

in the endcap/endcaps “locking” the retrofit-style lamp 100 into place, or otherwise indicating that the retrofit-style lamp 100 has been properly installed into the fixture. In some embodiments, this functionality is found on one or both of the pair of electrical connectors 112 and 114. Alternatively, in some embodiments where the pair of endcaps 108 and 110 and the pair of electrical connectors 112 and 114 are formed into a pair of single pieces (i.e., an endcap-electrical connector combination), the “locking” and/or indicator functionality described above is found in one or both of the endcap-electrical connector combinations.

[0025] As seen in FIGS. 2 and 3, the plurality of light sources 102 is arranged within a space 150 defined in part by the housing 106. The space 150 may also be defined in part by the one-dimensional linear batwing lens 104, as well as, or alternatively by, the connection mechanism between the housing 106 and the one-dimensional linear batwing lens 104. The plurality of light sources 102 may be any type of light source capable of producing light that may be beam shaped by the one-dimensional linear batwing lens 104. In some embodiments, the plurality of light sources 102 are a plurality of light-emitting diode(LED)-based light sources, such as but not limited to a plurality of light-emitting diodes (LEDs), a plurality of organic light-emitting diodes (OLEDs), combinations thereof, and the like. In some embodiments, the retrofit-style lamp 100 uses Golden Dragon® LEDs made by OSRAM Opto Semiconductors of Regensburg, Germany, and Sunnyvale, California, USA. A single LED 102₁ is shown in FIG. 2. The plurality of LED-based light sources may be arranged, as is well-known in the art, on one or more printed circuit boards (PCBs) that extend from one part of the retrofit-style lamp 100 to another. Where two or more PCBs are used in the retrofit-style lamp 100, the PCBs are electrically connected to each other to allow all of the LED-based light sources on all the PCBs to be powered from the same source (e.g., the fixture into which the retrofit-style lamp 100 is attached). Any PCBs used are sized to fit within the retrofit-style lamp 100, which in some embodiments is approximately 1.5 inches wide at its widest point. The one-dimensional linear batwing lens 104 beam shapes light emitted by at least two light sources of the plurality of light sources. The dispersion of light created (i.e., beam shaped) by the one-dimensional linear batwing lens 104 is a batwing dispersion, regardless of the number of the light sources, or type of light sources, used. Thus, it possible to use any number of light sources, including any number of LEDs, with the one-dimensional linear batwing lens 104; for example, see FIG. 3. The one-dimensional linear batwing lens 104 therefore may be said to be scalable, such that no change is required to the lens to produce a batwing dispersion even if the number of light sources used in the retrofit-style lamp 100 changes.

[0026] As shown most clearly in FIG. 2, which is a cross-section of the retrofit-style lamp 100 shown in FIG. 1, and FIG. 3, which is a profile view of a section of the retrofit-style lamp 100 shown in FIG. 1, the plurality of light sources 102 are located in a region 202 beneath a central portion 204 of the one-dimensional linear batwing lens 104. Referring just to FIG. 2 now, in some embodiments, the distance between the top of a light source 102₁ (e.g., a single LED or a chip of LEDs) located in the region 202, measured from the center 206 of the light source 102₁, and the bottom edge of the one-dimensional linear batwing lens 104 (i.e., the part of the one-dimensional linear batwing lens 104 that is facing towards the plurality of light sources), measured from the center 208 of a bottom edge 290 of the one-dimensional linear batwing lens 104, is 3.2 millimeters.

[0027] As used throughout, the term retrofit-style lamp is one where a conventional light source in an existing fixture is replaced by an LED-based light source and appropriate changes may be further required to at least one of the ballast and/or the power supply of the existing fixture, so as to allow the fixture to properly power and operate the LEDs. Thus, a retrofit-style lamp replaces the conventional light source, and in some embodiments, may require the existing ballast and/or power supply of the existing fixture to also be replaced. In contrast, a retrofit lamp would replace the conventional light source in an existing fixture with an LED-based light source, but would not require any changes to the already-existing ballast and/or power supply of the conventional fixture.

[0028] A one-dimensional linear batwing lens, such as the one-dimensional linear batwing lens 104 shown in FIGs. 1-3, will now be described in more detail. A one-dimensional linear batwing lens is a batwing style lens that is extended in one dimension in a linear direction so as to be used with more than a single light source and to produce, through beam shaping, a substantially batwing and/or batwing-type distribution from how many ever light sources are used. The distribution produced by a one-dimensional linear batwing lens is a substantially batwing distribution that is substantially uniform within a defined space, such as but not limited to the interior of a refrigeration case (not accounting for the reflective and/or blocking effects of anything contained within the defined space). The substantial uniformity of the distribution is such that the light, as beam shaped by the one-dimensional linear batwing lens, fills up a defined space. The one-dimensional linear batwing lens 104 is extrudable, which results in less expensive tooling costs when the lens is formed. The one-dimensional linear batwing lens 104 may be made of, for example but not limited to, any transparent polymer that is extrudable, may be connected to a housing without affecting the batwing dispersion of light produced, and is resistant to the heat produced by the plurality of light sources. In some

embodiments, the one-dimensional linear batwing lens 104 is made from an acrylic, a polycarbonate (i.e., plastic), or glass, or some combination thereof.

[0029] In some embodiments, the extrudable one-dimensional linear batwing lens 104 is co-extrudable, that is, one portion of the lens is made from a first material and the other portion of the lens is made from a second material. Thus, for example, the one-dimensional linear batwing lens 104 may be made of both an acrylic and a polycarbonate. In such embodiments, the co-extrudable one-dimensional linear batwing lens may be comprised of a first portion and a second portion. The first portion is comprised of a first material and the second portion is comprised of a second material. The one-dimensional linear batwing lens 104 may be divided into two portions by a straight plane that intersects (i.e., crosses) the entirety of the one-dimensional linear batwing lens 104 in any direction. The one-dimensional linear batwing lens 104 may, alternatively, be divided into two portions by a curved surface that intersects (i.e., crosses) the entirety of the one-dimensional linear batwing lens 104 in any direction. Thus, in some embodiments, the division of the one-dimensional linear batwing lens 104 may be into equal portions (e.g., two halves, each of the same size) or into two unequal portions. In some embodiments, the one-dimensional linear batwing lens 104 may be formed of more than two materials, and thus may be divided into more than two portions, where each portion is made of a different material. Further, in some embodiments, the one-dimensional linear batwing lens 104 may be made of two materials, but may include more than two portions. Thus, instead of being divided by, for example, a single intersecting plane, the one-dimensional linear batwing lens 104 in such embodiments may be divided by a plurality of intersecting planes, where each plane crosses two distinct outer boundaries of the one-dimensional linear batwing lens 104. Of course, any type of dividing shape may be used. For example, if looking at the cross-section shown in FIG. 2, there may be a first plane (not shown) that intersects the one-dimensional linear batwing lens 104 in a vertical direction (i.e., from top to bottom, or vice versa), and there may be a second plane that intersects the one-dimensional linear batwing lens 104 in a horizontal direction (i.e., from left to right, or vice versa). This would create four distinct portions of the one-dimensional linear batwing lens 104, and each portion may be made from a different material, or one portion may be made of a first material and the remaining portions from a second material, or two portions may be made of a first material and the remaining portions from a second material, and so on.

[0030] In some embodiments, the one-dimensional linear batwing lens 104 may be made of a material (e.g., acrylic), but may still be divided into portions (two or more). In such embodiments, each portion of the one-dimensional linear batwing lens 104 will be made of

the material, but a first portion may include a first filter, a second portion may include a second filter, and so on. As described above with regards to how different materials may be used for the one-dimensional linear batwing lens 104, similarly, different filters may be applied to different portions of the one-dimensional linear batwing lens 104 in any combination. A filter may include, but is not limited to, different colors, different textures, different diffusion levels, and so on.

[0031] As described above, the one-dimensional linear batwing lens 104 may be divided into different portions, for example, into two different portions by a horizontal plane that divides the one-dimensional linear batwing lens 104 into an upper portion 170 and a lower portion 172 (shown in FIG. 2), where the upper portion 170 is located farther from the plurality of light sources 102 than the lower portion 172. The upper portion 170 may then be divided into a first non-planar section and a second non-planar section, for example by a vertical plane that bisects the upper portion 170 (not shown). Thus, the one-dimensional linear batwing lens 104 may be said to be bi-modal. The upper portion 170, as shown in FIG. 2, may include a dip 174 that is created by the shape of the outermost edge of the upper portion 170 (i.e., the edge of the one-dimensional linear batwing lens 104 that is farthest from the plurality of light sources 102 and may be touched by a person holding the retrofit-style lamp 100). The dip 174 may be characterized by an angle. For example, the angle of the dip 174 may be between 0° and 180° not inclusive of the end points. In some embodiments, the first non-planar section and the second non-planar section may be similarly shaped, as is shown in FIG. 2. In some embodiments, the first non-planar section and the second non-planar section are of different shapes (not shown). For example, the first non-planar section may have a top surface that is shaped like a parabola, and the second non-planar section may have a top surface that is shaped like a half-circle, so long as the shape produces the desired batwing-like dispersion. Thus, the upper portion 170 may, at its outermost edge, have any shape that produces the desired batwing-like dispersion. The lower portion 172 may similarly be of any non-linear shape that results in two cylindrical arcs that are not tangent at the joint (i.e., not a continuous cylindrical arc). The outermost edge of the lower portion 172 (i.e., the edge closest to the plurality of light sources 102) may thus be of any non-linear shape, as long as it corresponds to the shapes of the upper portion 170 of the lens, because the upper portion 170 and the lower portion 172 work together to produce the desired batwing dispersion. Of course, changing the shape of the one-dimensional linear batwing lens 104 may result in changes to the width and/or the thickness of the one-dimensional linear batwing lens 104.

[0032] In an example embodiment, the one-dimensional linear batwing lens 104 measures 1.386 inches at its widest point (i.e., in a horizontal direction), and measures 0.536 inches at its tallest point (i.e., in a vertical direction), 0.358 inches without including the height of the post 222₃ or 222₄. The radius of curvature at the dip 174 is R.047, while the radius of curvature at a first curved edge 280 and a second curved edge 282 of the upper portion 170 is R.656, as well as the radius of curvature at a side edge 284. In embodiments where the upper portion 170 is equal on both sides of the dip 174, the same radii of curvature are found on both sides of the upper portion 170. The space between the upper portion 170 at the dip 174 and the center 208 of the bottom edge 290 of the one-dimensional linear batwing lens 104 is 0.100 inches. The radius of curvature of the bottom edge 290 on either side of the center 208 is R.698. In embodiments where the one dimensional linear batwing lens 104 includes posts 222 to connect to the housing 106, the distance between a side edge 292 of the post 222₃ and a side edge 294 of the post 222₄ is 1.310 inches plus or minus 0.020 inches.

[0033] In some embodiments, the retrofit-style lamp 100 may include only a single endcap and a single electrical connector at one end, with the other end including only a closure that seals off the interior of the retrofit-style lamp 100. Further, in some embodiments, a number of lens-housing combinations, each including a distinct plurality of light sources and a distinct one-dimensional linear batwing lens, may be placed side-by-side, or otherwise combined together, and then joined to the same endcap/pair of endcaps, and/or the same electrical connector/pair of electrical connectors, to form a retrofit-style lamp. Thus, in some embodiments, the retrofit-style lamp may have a generally linear shape, as the retrofit-style lamp 100 shown in FIG. 1, while in other embodiments, the retrofit-style lamp may have a non-linear shape (for example, but not limited to, an “X” shape, a “+” shape, an “*” shape, a “” shape, and so on). In such embodiments, each distinct arm/leg/side of the shape includes at least one one-dimensional linear batwing lens, such that if the arm/leg/side were separated from the rest and provided power, a batwing dispersion would be produced by at least two source of light associated with the lens.

[0034] In some embodiments, instead of being configured as a lamp, such as the retrofit-style lamp 100 shown in FIG. 1, the pair of electrical connectors 112 and 114 and the endcaps 108 and 110 may be removed from the retrofit-style lamp 100 to create a fixture 400, a portion of which is shown in FIG. 4. The fixture 400 thus includes a plurality of light sources 402 (only one of which is shown in FIG. 4), a one-dimensional linear batwing lens 404, a housing 406, and a power supply (not shown). The power supply is connectable to the housing 406, and provides power to the fixture 400, and more specifically, to the plurality of light sources 402.

The plurality of light sources 402 is located in a region defined, at least in part, by the housing 406, and the plurality of light sources 402 receive power from the power supply. The one-dimensional linear batwing lens 404 is coupled to the housing 406, and beam shapes light emitted by at least two light sources of the plurality of light sources 402. The plurality of light sources 402, the one-dimensional linear batwing lens 404, and the housing 406 each share the same properties and/or configurations (and/or potential properties and/or configurations) as those of the corresponding components (i.e., the plurality of light sources 102, the one-dimensional linear batwing lens 104, and the housing 106) for the retrofit-style lamp 100 shown in FIG. 1. The one-dimensional linear batwing lens 404 of the fixture 400 provides a substantially uniform distribution of light within a space defined in part by an enclosed storage structure (not shown), such as but not limited to a refrigeration case, by beam shaping light emitted by the plurality of light sources 402. Though the portion of the fixture 400 shown in FIG. 4 is open, such that it is possible to see inside the fixture 400, the fixture 400 is fitted with housing closures (not shown in FIG. 4) that seal the interior of the fixture 400. Of course, such housing closures allow for power to be provided from the power supply to the plurality of light sources 402 located in the interior of the fixture 400, for example through the use of one or more wires, or any other suitable electrical transmitters.

[0035] FIG. 5 shows an alternative one-dimensional linear batwing lens 500. The alternative one-dimensional linear batwing lens 500 looks very similar to, and in some embodiments, is the same as, the one-dimensional linear batwing lens 104 shown in FIGs. 1-4, with one change: the alternative one-dimensional linear batwing lens 500 adds two additional spherical surfaces 502, 504, for a total of five spherical surfaces. The two additional spherical surfaces 502, 504 are located on a bottom portion 506 of the alternative one-dimensional linear batwing lens 500. That is, the two additional spherical surfaces 502, 504 face a light source, such as the LED 508 shown in FIG. 5. This improves design flexibility over the one dimensional linear batwing lens 104. By changing one or both of the two additional spherical surfaces 502, 504, changes in the beam distribution pattern may be achieved. That is, by increasing the size of one of the two additional spherical surfaces 502, 504, the size of a corresponding part of the beam distribution pattern is also increased, and vice versa. The effect of such a change in one of the two additional spherical surfaces 502, 504, in some embodiments, is not entirely independent from the other additional spherical surface, but in some embodiments, may be.

[0036] As is well known in the art, the beam angle of the light emitted from a light source, such as the LED 508, impacts the beam distribution pattern. For embodiments described

herein, with a desired or targeted distribution of 75° , the beam angle of the light source may be at least 80° but is preferably 120° or greater, including 150° .

[0037] Alternatively, in some embodiments, one or more or any combination thereof of the two additional spherical surfaces 502, 504 may be aspherical, that is, not equi-radial (i.e. incapable of forming a circle). Further, in embodiments having five spherical surfaces, any or all or some combination thereof of the spherical surfaces may be aspherical. As with the one-dimensional linear batwing lens 104, embodiments of the alternative one-dimensional linear batwing lens 500 may be created by extrusion (and in some embodiments, by co-extrusion), or may also be injection molded, or otherwise created in any other way as described herein.

[0038] Further, in some embodiments, the alternative one-dimensional linear batwing lens 500 may be rotated about a axis that runs through the center of the alternative one-dimensional linear batwing lens 500 and/or through a light source providing light through the alternative one-dimensional linear batwing lens 500, such as a z-axis 510 as shown in FIG. 5. Such a rotation results in the creation of a two-dimensional batwing lens having five spherical surfaces. A two-dimensional batwing lens having five spherical surfaces may be extruded or may be injection molded and includes the same properties described herein for a one-dimensional linear batwing lens 104 and/or the alternative one-dimensional linear batwing lens 500. In some embodiments, such a two-dimensional batwing lens having five spherical surfaces may act on a single light source (i.e., a single LED chip and/or package, which may itself contain one or more than one LEDs) or on multiple light sources (i.e., more than one LED chip and/or package).

[0039] Unless otherwise stated, use of the words "substantial" and "substantially" may be construed to include a precise relationship, condition, arrangement, orientation, and/or other characteristic, and deviations thereof as understood by one of ordinary skill in the art, to the extent that such deviations do not materially affect the disclosed methods and systems.

[0040] Throughout the entirety of the present disclosure, use of the articles "a" or "an" to modify a noun may be understood to be used for convenience and to include one, or more than one, of the modified noun, unless otherwise specifically stated.

[0041] Elements, components, modules, and/or parts thereof that are described and/or otherwise portrayed through the figures to communicate with, be associated with, and/or be based on, something else, may be understood to so communicate, be associated with, and or be based on in a direct and/or indirect manner, unless otherwise stipulated herein.

[0042] Although the methods and systems have been described relative to a specific embodiment thereof, they are not so limited. Obviously many modifications and variations may become apparent in light of the above teachings. Many additional changes in the details, materials, and arrangement of parts, herein described and illustrated, may be made by those skilled in the art.

What is claimed is:

1. A retrofit-style lamp comprising:
 - a plurality of light sources; and
 - a one-dimensional linear batwing lens, wherein the one-dimensional linear batwing lens beam shapes light emitted by at least two light sources of the plurality of light sources.
2. The retrofit-style lamp of claim 1 wherein the at least two light sources of the plurality of light sources are located in a region beneath a central portion of the one-dimensional linear batwing lens.
3. The retrofit-style lamp of claim 1 wherein the plurality of light sources comprises a plurality of light-emitting diodes.
4. The retrofit-style lamp of claim 1 wherein the one-dimensional linear batwing lens is extrudable.
5. The retrofit-style lamp of claim 4 wherein the extrudable one-dimensional linear batwing lens is co-extrudable.
6. The retrofit-style lamp of claim 5 wherein the co-extrudable one-dimensional linear batwing lens is comprised of a first portion and a second portion, wherein the first portion is comprised of a first material, and wherein the second portion is comprised of a second material.
7. The retrofit-style lamp of claim 5 wherein the co-extrudable one-dimensional linear batwing lens is comprised of a first portion and a second portion, wherein the first portion and the second portion are comprised of a material, and wherein the first portion includes a first filter and the second portion includes a second filter.
8. The retrofit-style lamp of claim 1 wherein the one-dimensional linear batwing lens is scalable in relation to a number of light sources comprising the plurality of light sources.

9. The retrofit-style lamp of claim 1 wherein the one-dimensional linear batwing lens includes an upper portion and a lower portion, wherein the upper portion is located farther from the plurality of light sources than the lower portion, and wherein the upper portion is divided into a first non-planar section and a second non-planar section.
10. The retrofit-style lamp of claim 9 wherein the first non-planar section and the second non-planar section are similarly shaped.
11. The retrofit-style lamp of claim 9 wherein the first non-planar section and the second non-planar section are of different shapes.
12. The retrofit-style lamp of claim 1 wherein the one-dimensional linear batwing lens includes an upper portion and a lower portion, wherein the upper portion is located farther from the plurality of light sources than the lower portion, and wherein the upper portion includes a dip.
13. The retrofit-style lamp of claim 12 wherein the dip is characterized by an angle.
14. The retrofit-style lamp of claim 1 further comprising a housing, wherein the plurality of light sources is arranged within a space defined in part by the housing.
15. The retrofit-style lamp of claim 14 wherein the one-dimensional linear batwing lens is coupled to the housing.
16. The retrofit-style lamp of claim 14 further comprising a pair of electrical connectors, wherein a first of the pair of electrical connectors is attached to a first end of the housing, and wherein a second of the pair of electrical connectors is attached to a second end of the housing.
17. The retrofit-style lamp of claim 16 wherein the one-dimensional linear batwing lens is coupled to the housing, forming a lens-housing combination, and wherein the pair of electrical connectors is attached to the lens-housing combination.

18. The retrofit-style lamp of claim 17 further comprising an endcap, wherein the endcap is connectable between one of the pair of electrical connectors and the lens-housing combination.

19. An enclosed storage structure lighting fixture comprising:

- a housing;
- a power supply, wherein the power supply is connectable to the housing;
- a plurality of light sources located in a region defined by the housing, wherein the plurality of light sources receive power from the power supply; and
- a one-dimensional linear batwing lens, coupled to the housing, wherein the one-dimensional linear batwing lens beam shapes light emitted by at least two light sources of the plurality of light sources.

20. The enclosed storage structure lighting fixture of claim 19 wherein the one-dimensional linear batwing lens provides a substantially uniform distribution of light within a space defined in part by an enclosed storage structure, by beam shaping light emitted by the plurality of light sources.

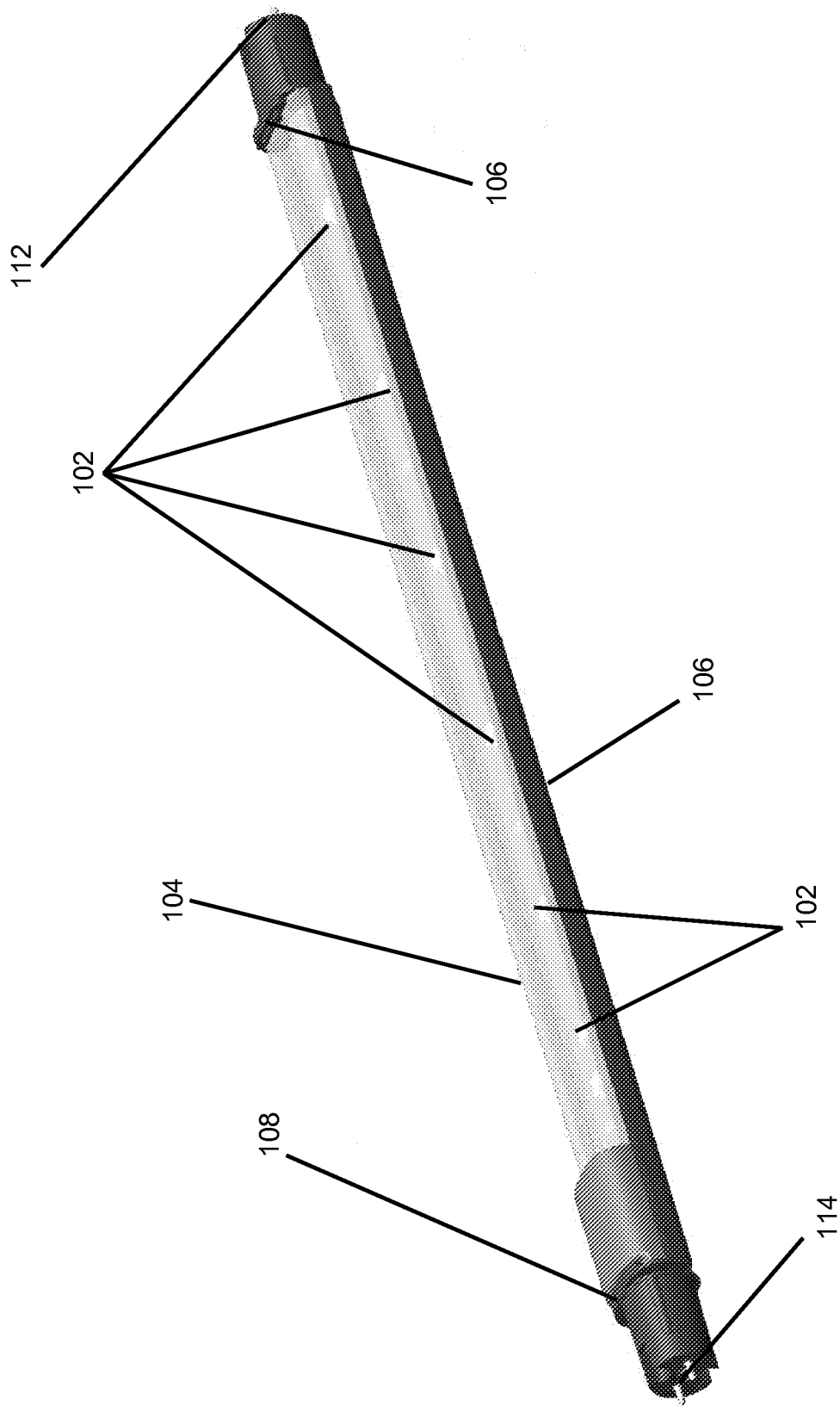


FIG. 1

200

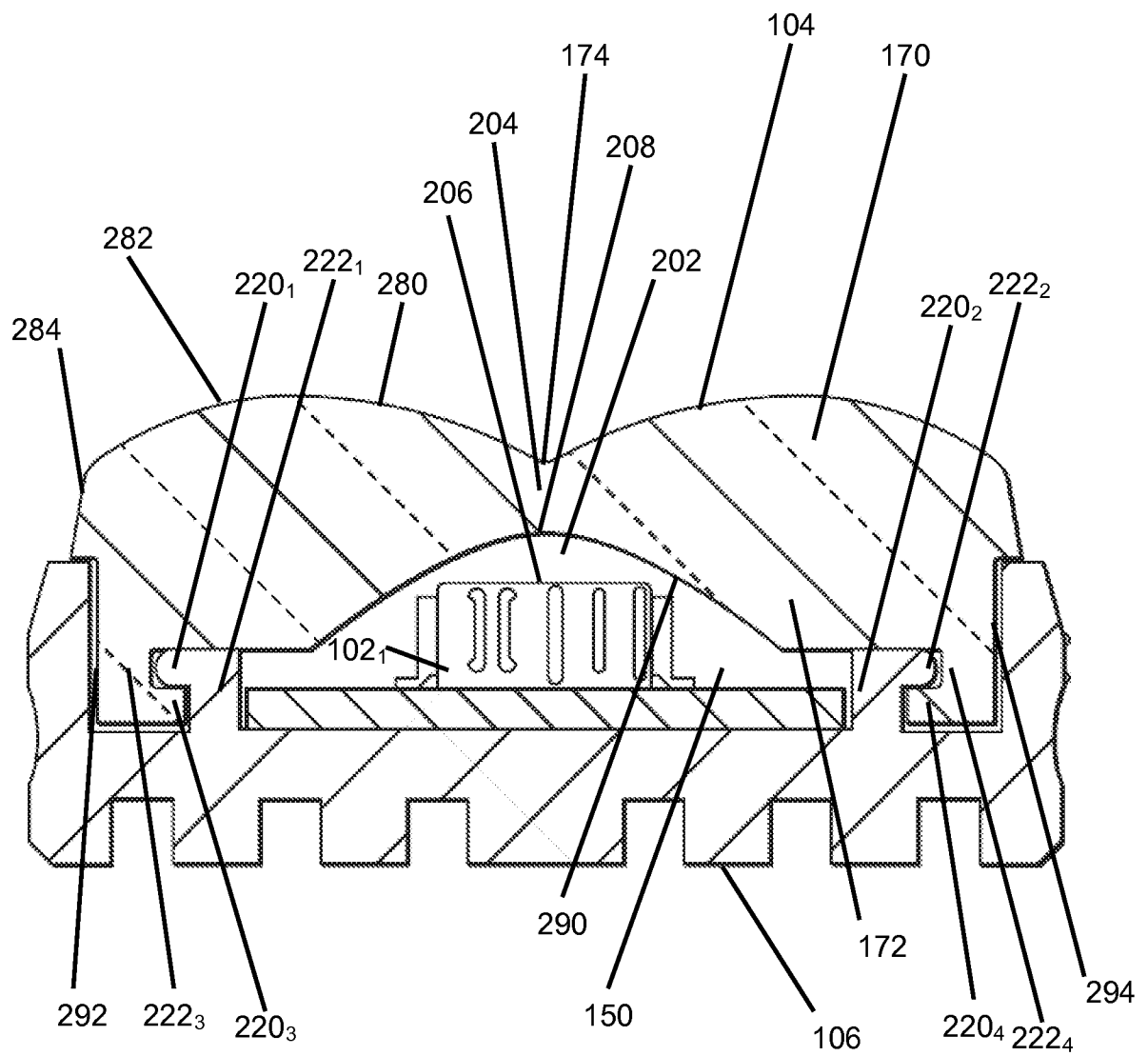


FIG. 2

300

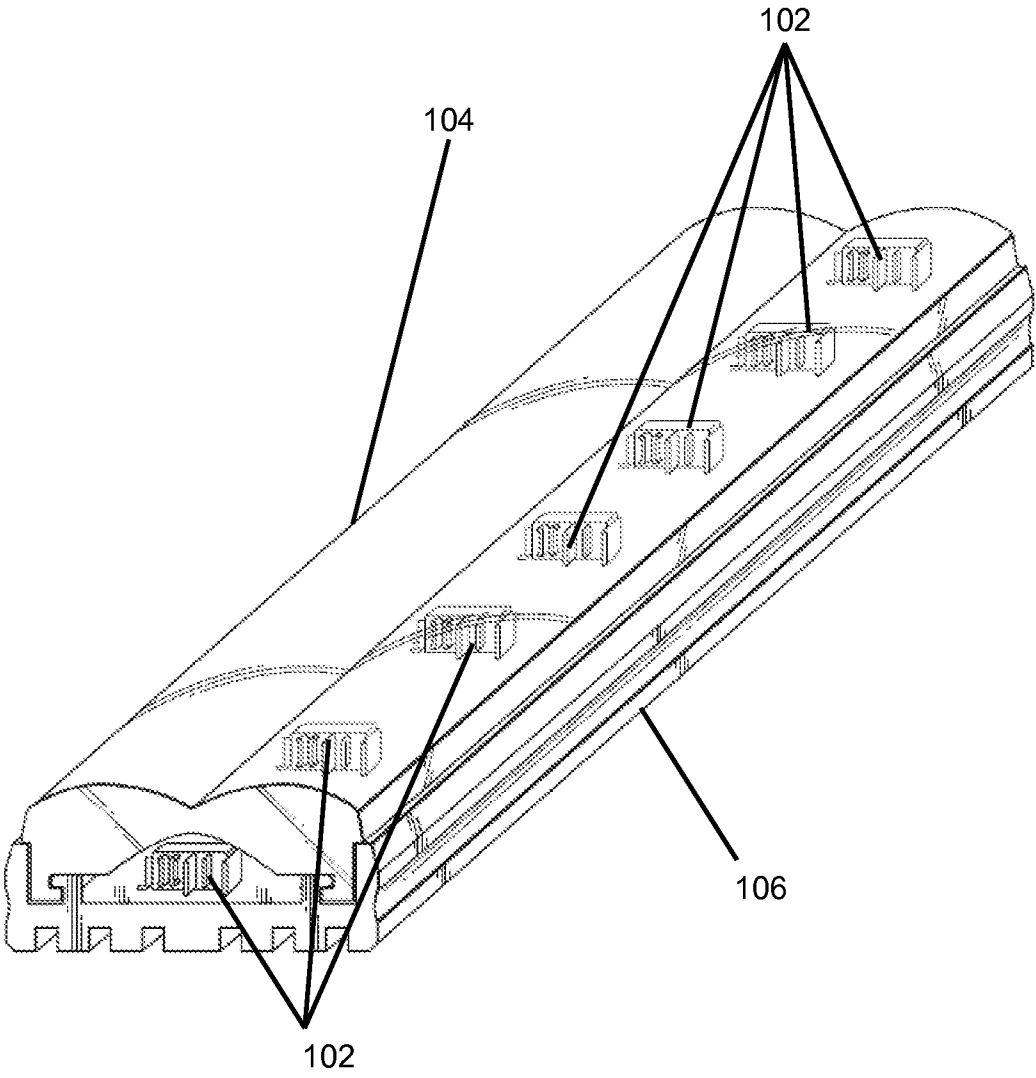


FIG. 3

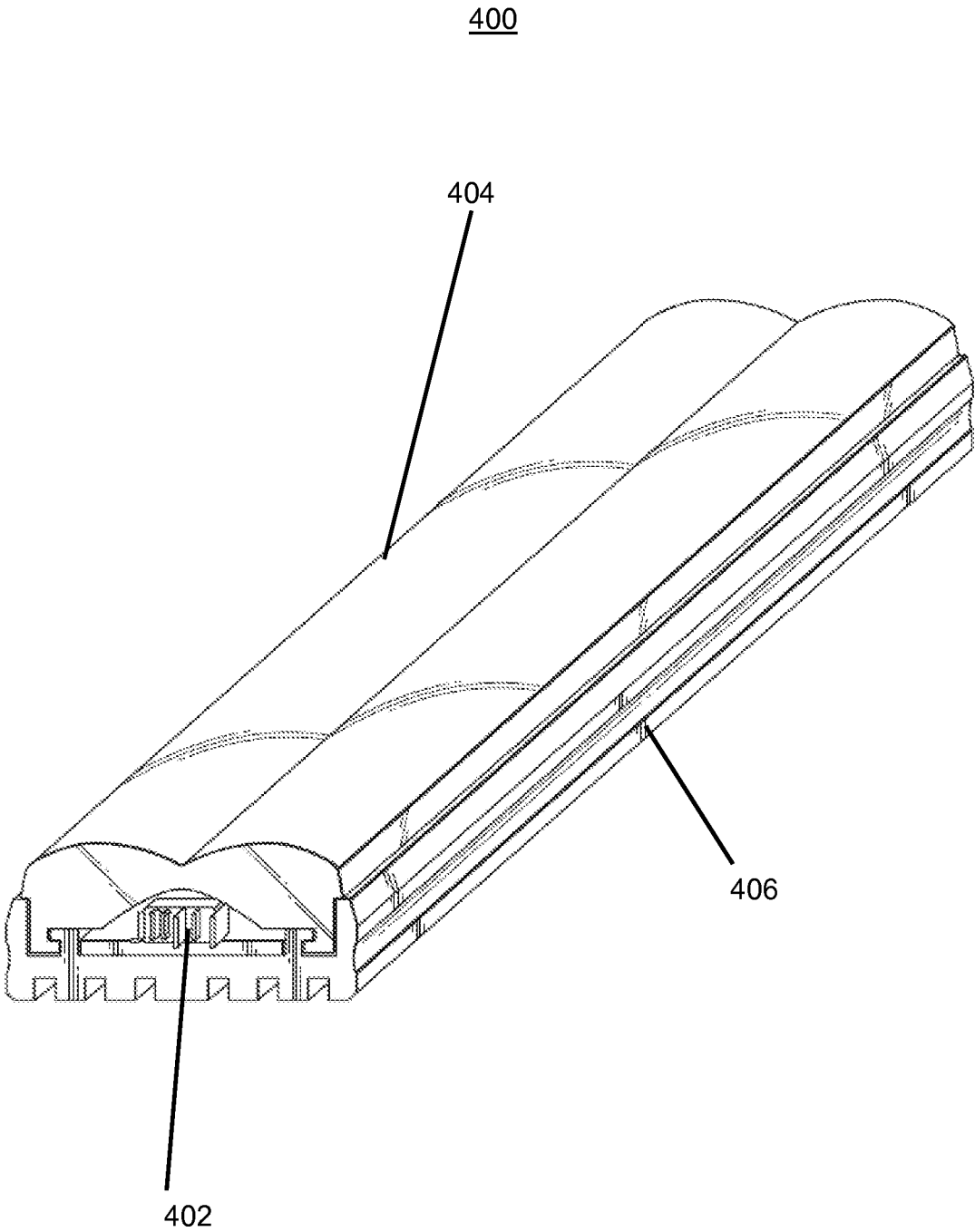


FIG. 4

500

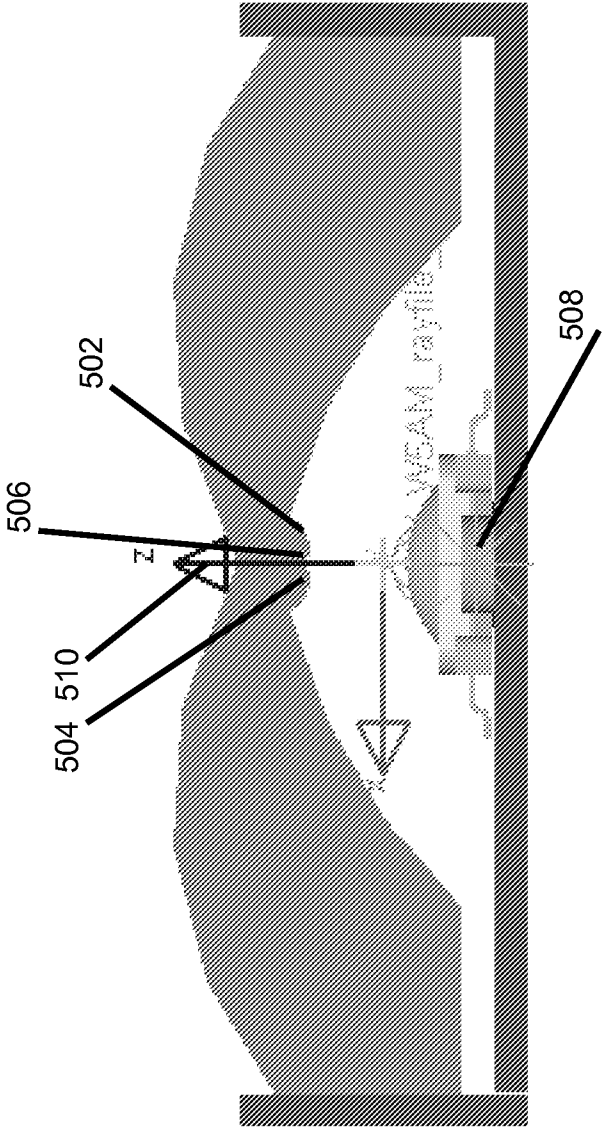


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/060156

A. CLASSIFICATION OF SUBJECT MATTER INV. F21V33/00 F21K99/00 F21S8/00 G02B3/00 G02B27/09 ADD. F21Y103/00 F21W131/305		
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) F21K F21S F21V G02B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/232961 A1 (PFUND DAVID [US]) 19 October 2006 (2006-10-19) paragraph [0066] - paragraph [0069]; figures 21-23 -----	1-13, 15-20
X	US 4 414 609 A (SHEMITZ SYLVAN R [US]) 8 November 1983 (1983-11-08) column 3, line 60 - column 4, line 47; figures 2,3 -----	1,2,14, 15,19,20
A	WO 2009/052172 A2 (HUSSMANN CORP [US]; ANDERSON TIMOTHY DARRELL [US]) 23 April 2009 (2009-04-23) paragraph [0022] - paragraph [0026]; figures 1-3,7 -----	1-20
☐ 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 document 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 22 March 2011		Date of mailing of the international search report 08/04/2011
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Schmid, Klaus

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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