



- (51) **International Patent Classification:**
F21V 23/00 (2015.01) *F21Y 105/10* (2016.01)
- (21) **International Application Number:**
PCT/US2017/062517
- (22) **International Filing Date:**
20 November 2017 (20.11.2017)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
62/425,137 22 November 2016 (22.11.2016) US
- (71) **Applicant:** HUBBELL INCORPORATED [US/US]; 40 Waterview Drive, Shelton, Connecticut 06484-1000 (US).
- (72) **Inventors:** MORALES, Luis; 40 Waterview Drive, Shelton, Connecticut 06484 (US). WEEKS, JR., Thomas Warren; 40 Waterview Drive, Shelton, Connecticut 06484 (US).
- (74) **Agent:** WORKMAN, J., Parks; DORITY & MAN-NING, P.A., P O Box 1449, Greenville, South Carolina 29602-1449 (US).
- (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, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, 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.

(54) **Title:** LED CIRCUIT BOARD LAYOUT FOR LOW PROFILE LIGHTING FIXTURE

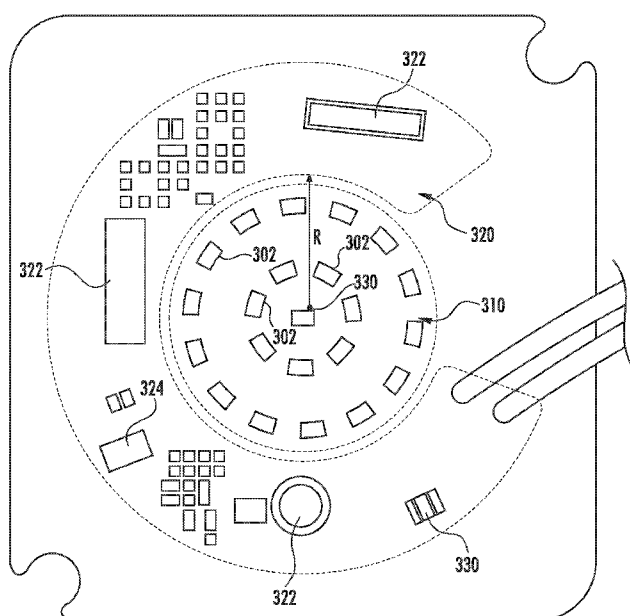


FIG. 6

(57) **Abstract:** Light emitting device (LED) circuit board layouts for low profile lighting fixtures are provided. In some embodiments, the lighting fixture can include a fixture housing. The lighting fixture can include one or more LED devices disposed on a circuit board. The lighting fixture can include one or more electronic components associated with at least one of a driver circuit or a filter circuit (e.g., as part of a flicker reducing circuit) disposed on the circuit board. The one or more LED devices are disposed on a first portion of the circuit board and the electronic components are disposed on a second portion of the circuit board. The second portion of the circuit board can be spaced radially apart from a center point of the circuit board relative to the first portion.



(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, 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, KM, ML, MR, NE, SN, TD, TG).

Published:

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

LED CIRCUIT BOARD LAYOUT FOR LOW PROFILE LIGHTING FIXTURE

PRIORITY CLAIM

[0001] The present application claims the benefit of priority of U.S. Provisional Patent Application No. 62/425,137, entitled “LED Circuit Board Layout for Low Profile Lighting Fixture,” filed November 22, 2016, which is incorporated herein by reference for all purposes.

FIELD

[0002] The present subject matter relates generally to lighting fixtures.

BACKGROUND

[0003] Lighting fixtures can be used for providing lighting for a space, such as a building or room. Light emitting diode (LED) devices and other solid state devices are becoming increasingly used in many lighting applications and have been integrated into a variety of lighting fixtures. Use of LED light sources in lighting fixtures can provide increased efficiency, life and durability, can produce less heat, and can provide other advantages relative to traditional incandescent and fluorescent lighting systems. Moreover, the efficiency of LED light sources has increased such that higher power can be provided at lower cost to the consumer.

[0004] The use of LED light sources has allowed for the provision of “low profile” light sources. These low profile light sources can be surface mounted to a ceiling or other surface adjacent to a junction box or can housing of a can lighting fixture. The shallow depth of the low profile lighting fixtures can reduce the intrusion of the lighting fixture from the surface into the space. To accommodate their shallow depth, low profile lighting fixtures often include a single circuit board that includes both the LED devices as well as other electronic components for driver circuits used to power the LED devices.

BRIEF DESCRIPTION

[0005] Aspects and advantages of embodiments of the present disclosure will be set forth in part in the following description, or may be learned from the description, or may be learned through practice of the embodiments.

[0006] One example aspect of the present disclosure is directed to a lighting fixture. The lighting fixture can include a fixture housing. The fixture housing can be associated with a depth dimension and a length dimension. A ratio of the depth dimension to the length dimension can be, for instance, about 0.25 or less. The lighting fixture can further include one or more LED devices disposed on a circuit board. The lighting fixture can include one or more electronic components associated with a filter circuit disposed on the circuit board. The one or more LED devices are disposed on a first portion of the circuit board and the one more electronic devices are disposed on a second portion of the circuit board. The second portion of the circuit board can be spaced radially apart from a center point of the circuit board relative to the first portion.

[0007] Another example aspect of the present disclosure is directed to a surface mount, low profile lighting fixture. The lighting fixture includes a fixture housing configured to be surface mounted to a surface. The fixture housing can be associated with a depth dimension and a length dimension. A ratio of the depth dimension to the length dimension can be, for instance, about 0.25 or less. The lighting fixture can further includes a driver circuit. The lighting fixture can further include a flicker reducing circuit. The lighting fixture can further include one or more LED devices. The driver circuit, flicker reducing circuit, and the one or more LED devices can be disposed on the same circuit board. The one or more LED devices can disposed on a center portion of the circuit board. One or more electronic components associated with the driver circuit and the flicker reducing circuit can be disposed on a peripheral portion of the circuit board. The second portion can be located on the circuit board relative to the first portion of the circuit board such that the one or more electronic components associated with the driver circuit and the flicker reducing circuit do not interfere with light emitted from the one or more LED devices disposed on the first portion.

[0008] Other example aspects of the present disclosure are directed to systems, methods, devices, circuits and apparatus associated with low profile lighting fixtures.

[0009] These and other features, aspects and advantages of various embodiments will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and

constitute a part of this specification, illustrate embodiments of the present disclosure and, together with the description, serve to explain the related principles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Detailed discussion of embodiments directed to one of ordinary skill in the art are set forth in the specification, which makes reference to the appended figures, in which:

[0011] FIG. 1 depicts a side view of an example lighting fixture according to example embodiments of the present disclosure;

[0012] FIG. 2 depicts a bottom view of an example lighting fixture according to example embodiments of the present disclosure;

[0013] FIG. 3 depicts a perspective view of a top portion of an example lighting fixture according to example embodiments of the present disclosure;

[0014] FIG. 5 depicts a top view of a top portion of an example lighting fixture according to example embodiments of the present disclosure;

[0015] FIG. 6 depicts an exploded view of example lighting fixture according to example embodiments of the present disclosure; and

[0016] FIG. 7 depicts an example circuit board layout for LED circuit board to be used in an example lighting fixture according to example embodiments of the present disclosure.

DETAILED DESCRIPTION

[0017] Reference now will be made in detail to embodiments, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the embodiments, not limitation of the present disclosure. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made to the embodiments without departing from the scope or spirit of the present disclosure. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that aspects of the present disclosure cover such modifications and variations.

[0018] Example aspects of the present disclosure are directed low profile lighting fixtures having one or more light emitting diode (LED) devices. An example low profile lighting fixture can be configured to be surface mounted to a surface (e.g., a ceiling or a wall) in a manner that covers a junction box or a recessed can housing. The low profile lighting fixture can have a circuit board having the one or more light emitting diode (LED) devices or other light sources. The circuit board can further include electronic components for providing and/or conditioning power to the LED devices, including larger electronic components associated with, for instance, a filter circuit and/or a flicker reducing circuit. In some embodiments, all of the electronic components and LED devices associated with the low profile lighting fixture are disposed on the same circuit board. According to example aspect of the present disclosure, the electronic components for providing and/or conditioning power to the LED devices can be arranged on the circuit board relative to the LED devices in a manner that reduces shadowing effects when the LED devices become illuminated, providing a more uniform output of light from the lighting fixture.

[0019] For example, in some embodiments, a lighting fixture can include a fixture housing. The fixture housing can be circular in shape, rectangular in shape, square in shape, or can have other suitable shapes. The fixture housing can have a length dimension (e.g., a long dimension in the case of a rectangular shape, a diameter in the case of a circular shape, etc.). The fixture housing can also have a depth dimension. The depth dimension can be indicative of how far the lighting fixture extends from a surface when the lighting fixture is mounted to the surface. In some embodiments, a ratio of the length dimension to the depth dimension is about 0.25 or less. As used herein, the use of the term “about” in conjunction with a numerical value is intended to refer to within 25% of the stated numerical value.

[0020] The lighting fixture can include a single circuit board (e.g., a circuit board associated with a light engine) that includes a plurality of LED devices and a plurality of electronic components for providing and/or conditioning power to the LED devices. For instance, the electronic components can be associated with a driver circuit and/or a filter circuit. In some embodiments, the filter circuit can be associated with a flicker reducing circuit. The flicker reducing circuit can include one or more capacitors for filtering power signals for driving the LED devices.

[0021] According to particular aspects of the present disclosure, the LED devices can be located on a first portion of the circuit board and the one or more electronic components can be located on a second portion of the circuit board that is separated from the first portion of the circuit board. For instance, in some embodiments, the second portion of the circuit board can be spaced radially apart from a center point on the circuit board relative to the first portion. In some embodiments, the second portion of the circuit board can at least partially surround the first portion of the circuit board. In some embodiments, the first portion of the circuit board can be located at a center portion of the circuit board and the second portion of the circuit board can be located at a peripheral portion of the circuit board. In some embodiments, none of the electronic components associated with the driver circuit and/or filter circuit are located in the first portion of the circuit board.

[0022] By separating the electronic components associated with the driver circuit, filter circuit, and/or flicker reducing circuit from the LED devices on the circuit board, the LED devices can provide illumination (e.g., as a result of electrons moving through a semiconductor material) without interference from the electronic components with the light output from the LED devices. In this way, potential shadows that may have resulted from the one or more electronic components, particularly larger electronic components (e.g., capacitors) associated with, for instance, a flicker reducing circuit can be reduced.

[0023] FIGS. 1-5 depict an example lighting fixture 100 according to example embodiments of the present disclosure. The lighting fixture 100 can be a surface mount, low profile lighting fixture. For instance, the lighting fixture 100 can include a fixture housing 110. The fixture housing 110 can be adapted to be surface mounted to a ceiling, wall, or other surface.

[0024] The fixture housing 110 illustrated in FIGS. 1-5 is generally circular in shape. Those of ordinary skill in the art, using the disclosures provided herein, will understand that the lighting fixture 100 can have other shapes without deviating from the scope of the present disclosure, such as rectangular shape, a square shape, a triangular shape, a polygonal shape, etc.

[0025] The fixture housing 110 can include a length dimension L and a width dimension D. The length dimension L can be, for instance, the diameter of a

generally circular lighting fixture as shown in FIG. 1. The length dimension L can also be a dimension associated with a line that passes through a center point of the fixture housing 110 and having ends on a peripheral portion of the fixture housing 110.

[0026] The depth dimension D can be associated with a distance from a top portion of the fixture housing 110 to a bottom portion of the fixture housing 110 when the fixture housing is oriented as shown in FIG. 1. The depth dimension D can represent a distance that the fixture housing 110 extends from a surface to which the lighting fixture 100 is mounted.

[0027] According to example embodiments of the present disclosure, the lighting fixture 100 can be a low profile lighting fixture such that the depth dimension does not extend a far distance from the surface to which it is mounted. In some embodiments, a ratio of the depth dimension D to the length dimension L can be about 0.25 or less, such as about 0.18 or less.

[0028] The lighting fixture 100 can include a spring clip 200 that can engage a bracket 210 in order to surface mount the lighting fixture 100 to a surface such as a ceiling or other surface. For instance, the bracket 210 can be secured to a junction box recessed within a ceiling. The spring clip 200 can engage the bracket 210 (e.g., by being inserted through an opening in the bracket 210) to retain the fixture 100 adjacent the surface. Other suitable mounting techniques can be used without deviating from the scope of the present disclosure.

[0029] The lighting fixture 100 can include, for instance, a waterproof gasket 120. The waterproof gasket 120 can provide a seal between a surface to which the lighting fixture 100 is mounted and the fixture housing 110 so that moisture, water, and/or other elements are prevented from entering the interior of the fixture housing 110. In this way, internal components (e.g., circuit board 300) can be protected from damage from external sources.

[0030] The lighting fixture can include a silicone (e.g., silicone rubber) ring 125 and a lens 142. The lens 142 can be used to protect internal components of the lighting fixture (e.g., circuit board 300) and/or to condition light emitted from one or more LED devices mounted on circuit board 300 to provide a desired light output for

the lighting fixture 100. The lens 142 can be, for instance, a glass, polycarbonate, acrylic, or silicone lens (with or without UV protection) or other suitable lens.

[0031] As shown in FIG. 5, the lighting fixture 100 can include a circuit board 300 having one or more LED devices as light sources for the lighting fixture 100. The circuit board 300 can be mounted on a heat sink 130 that is configured to transfer heat away from the circuit board 300. The heat sink 130 can be formed from any suitable heat conducting material, such as a metal material.

[0032] The circuit board 300 can be associated with a light engine that includes all of the necessary electronic components for powering the one or more LED devices located on the circuit board 300. For instance, the circuit board 300 can include one or more electronic components associated with a driver circuit configured to convert an input power (e.g., an input 120 V AC power) to a suitable DC power for driving the LED devices. In some embodiments, the driver circuit can be a dimmable driver circuit. The driver circuit can include various components, such as switching elements (e.g. transistors) that are controlled to provide a suitable driver output. For instance, in some embodiments, the driver circuit can include one or more transistors. Gate timing commands can be provided to the one or more transistors to convert the input power to a suitable driver output using pulse width modulation techniques

[0033] In addition, the circuit board 300 can include electronic components (e.g., semiconductor chips, capacitors, etc.) associated with a filter circuit used as part of, for instance, a flicker reducing circuit. The filter circuit can smooth power signals provided from the driver circuit so that light flicker in light emitted from the LED devices on the circuit board 300 is reduced. In some embodiments, a flicker reducing circuit can include one or more capacitors that are used to smooth the driver output of a driver circuit implemented on the circuit board 300. In some embodiments, a flicker reducing circuit can include one or more integrated circuit chips (e.g., application specific integrated circuits) that control various electronic components (e.g., transistors) based on input signals from the driver circuit to reduce light flicker in light emitted from the LED devices on the circuit board 300.

[0034] In some embodiments, the electronic components associated with a driver circuit and a flicker reducing circuit are located on the same circuit board 300 so that only one circuit board has to be included in the lighting fixture 100. This can allow

for the fixture housing 110 to have a reduced depth relative to housings configured to accommodate multiple circuit boards, allowing the lighting fixture 100 to be more easily implemented as a low profile lighting fixture.

[0035] FIG. 6 depicts an example circuit board layout for circuit board 300 according to example embodiments of the present disclosure. As shown, the circuit board 300 includes a plurality of LED devices 302. The LED devices 302 are arranged as a circular array in a first portion 310 of the circuit board 300. The circuit board 300 also includes electronic components for providing and conditioning power to the plurality of LED devices 302. For instance, the circuit board 300 can include electronic components associated with a driver circuit and one or more filter circuits (e.g., including one or more capacitors). The filter circuit(s) can be associated with, for instance, a flicker reducing circuit for reducing flicker in the light output of the LED devices 302.

[0036] As shown in FIG. 6, the electronic components can include, for instance, a fuse 330, capacitors 322, integrated circuits 324, and other electronic components. Certain of the electronic components can be bulky components that extend a greater distance from the circuit board 300 relative to the LED devices 302. For instance, as shown in FIG. 7, an LED device can extend a first distance d_1 from the circuit board 300. A capacitor 322 associated with, for instance, a flicker reducing circuit can extend a distance d_2 from the circuit board. The distance d_2 can be greater than the distance d_1 , such as at least two times greater than the distance d_1 , such as at least four times greater than the distance d_1 , such as at least ten times greater than the distance d_1 .

[0037] Referring to FIG. 6, the electronic components associated with driver circuit and flicker reducing circuit can be located in a second portion 320 of the circuit board. The second portion 320 of the circuit board 300 can be disposed in a completely separate location of the circuit board 300 relative to the first portion 310 of the circuit board 300 such that none of the electronic components associated with the driver circuit or the flicker reducing circuit are located in the first portion 310 of the circuit board 300. In the example of FIG. 6, the first portion 310 of the circuit board 300 can be located in a center portion of the circuit board 300. The second portion of the circuit board 300 can be located in a peripheral portion of the circuit board 300.

[0038] As shown in FIG. 6, the second portion 320 of the circuit board 300 is spaced radially apart in the radial direction R from a center point 330 on the circuit board 300. As used herein, the term “spaced radially apart” is not limited to generally circular structures but can refer to being spaced away from a central portion of the circuit board 300 towards a peripheral portion of the circuit board 300 irrespective of the shape of the circuit board 300. As shown in FIG. 6, the second portion 320 of the circuit board at least partially surrounds the first portion 310 of the circuit board 300 such that the electronic components associated with the driver circuit and/or filter circuit at least partially surround the circular array of LED devices 302.

[0039] In this way, the electronic components (e.g., fuse 330, capacitors 322, integrated circuit 324, and other components) associated with the driver circuit and the flicker reducing circuit can be positioned on the circuit board 330 at a location that does not interfere with light emitted from the LED devices 302. This can reduce shadowing effects in the light output from the lighting fixture 100 that may result from certain electronic components of the flicker reducing circuit or driver circuit (e.g., one or more capacitors) that can extend a greater distance from the circuit board 300 relative to the LED devices.

[0040] While the present subject matter has been described in detail with respect to specific example embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such embodiments. Accordingly, the scope of the present disclosure is by way of example rather than by way of limitation, and the subject disclosure does not preclude inclusion of such modifications, variations and/or additions to the present subject matter as would be readily apparent to one of ordinary skill in the art.

WHAT IS CLAIMED IS:

1. A lighting fixture, the lighting fixture comprising:
a fixture housing associated a depth dimension and a length dimension, a ratio of the depth dimension to the length dimension being about 0.25 or less;
one or more light emitting diode (LED) devices disposed on a circuit board;
and
one or more electronic components associated with a filter circuit disposed on the circuit board;
wherein the one or more LED devices are disposed on first portion of the circuit board and the one or more electronic components are disposed on a second portion of the circuit board, wherein the second portion of the circuit board is spaced radially apart from a center point of the circuit board relative to the first portion.
2. The lighting fixture of claim 1, wherein the second portion at least partially surrounds the first portion of the circuit board.
3. The lighting fixture of claim 2, wherein the first portion is associated with a center portion of the circuit board and the second portion is associated with a peripheral portion of the circuit board.
4. The lighting fixture of claim 2, wherein the second portion is located on the circuit board relative to the first portion such that the one or more electronic components do not interfere with light emitted from the one or more LED devices disposed on the first portion.
5. The lighting fixture of claim 1, wherein the filter circuit is associated with a flicker reducing circuit.
6. The lighting fixture of claim 1, wherein the one or more electronic components comprise one or more capacitors associated with the filter circuit.
7. The lighting fixture of claim 1, wherein the lighting fixture includes a heat sink disposed in proximity to the circuit board.
8. The lighting fixture of claim 1, wherein none of the electronic components associated with the filter circuit are located on the first portion of the circuit board.
9. The lighting fixture of claim 1, wherein the one or more LED devices are disposed in a circular array.

10. The lighting fixture of claim 9, wherein the one or more electronic components associated the filter circuit are disposed in the second portion such that the one or more electronic components at least partially surround the circular array.
11. The lighting fixture of claim 1, wherein the one or more LED devices extend a first distance from the circuit board, the one or more electronic components extend a second distance from the circuit board, the second distance being greater than the first distance.
12. A surface mount, low profile lighting fixture, comprising:
a fixture housing configured to be surface mount to a surface, the fixture housing having a length dimension and a depth dimension, a ratio of the depth dimension to the length dimension being about 0.25 or less;
a driver circuit;
a flicker reducing circuit; and
one or more light emitting diode (LED) devices;
wherein the driver circuit, flicker reducing circuit and the one or more LED devices are at least partially disposed on the same circuit board;
wherein the one or more LED devices are disposed on a first portion of the circuit board and one or more electronic components associated with the flicker reducing circuit are disposed on a second portion of the circuit board;
wherein the second portion is located on the circuit board relative to the first portion of the circuit board such that the one or more electronic components do not interfere with light emitted from the one or more LED devices disposed on the first portion.
13. The surface mount, low profile lighting fixture of claim 12, wherein the fixture housing has a generally circular shape.
14. The surface mount, low profile lighting fixture of claim 12, wherein the one or more electronic components comprise one or more capacitors.
15. The surface, mount low profile lighting fixture of claim 12, wherein the second portion of the circuit board is spaced radially apart from a center point of the circuit board relative to the first portion.
16. The surface mount, low profile lighting fixture of claim 15, wherein the second portion at least partially surrounds the first portion of the circuit board.

17. The surface mount, low profile lighting fixture of claim 16, wherein the first portion is associated with a center portion of the circuit board and the second portion is associated with a peripheral portion of the circuit board.
18. The surface mount, low profile lighting fixture of claim 14, wherein the one or more capacitors are not located in the first portion of the circuit board.
19. The surface mount, low profile lighting fixture of claim 12, wherein the one or more LED devices are disposed in a circular array.
20. The surface mount, lighting fixture of claim 19, wherein the one or more electronic components associated with the driver circuit and the flicker reducing circuit are disposed in the second portion such that the one or more electronic components at least partially surround the circular array.

1/5

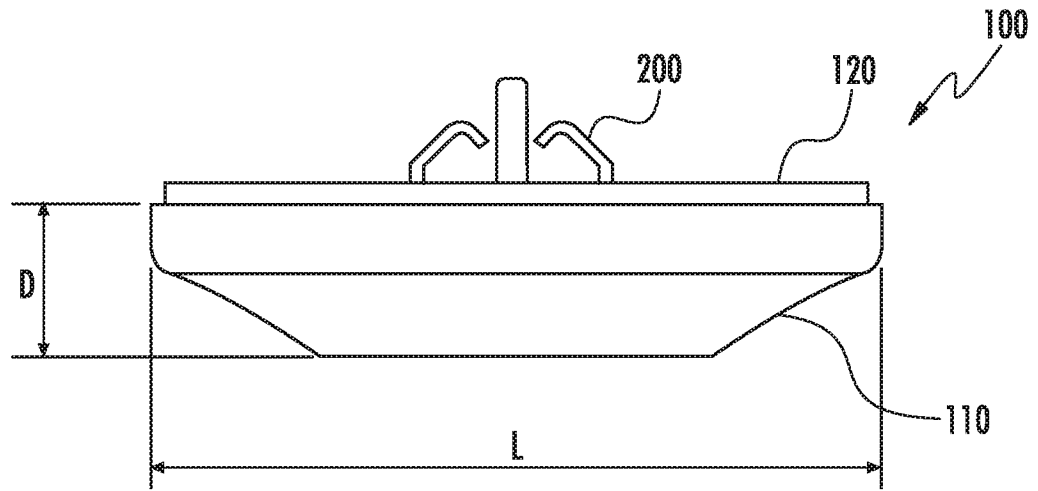


FIG. 1

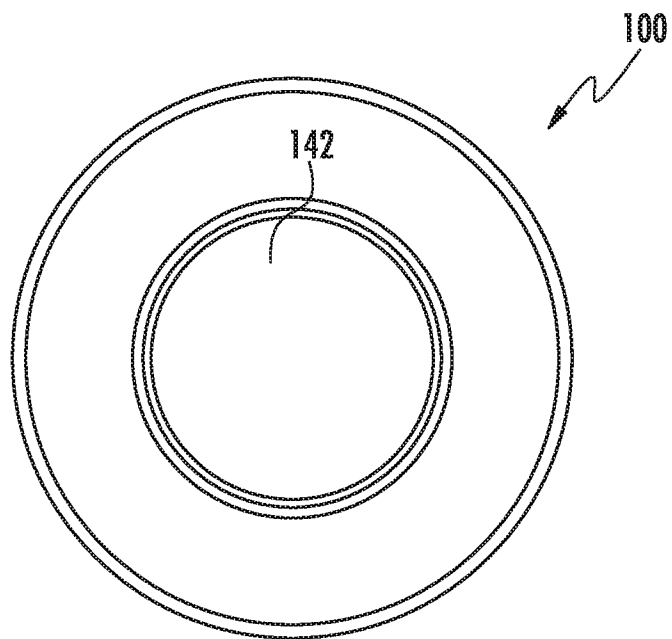


FIG. 2

2/5

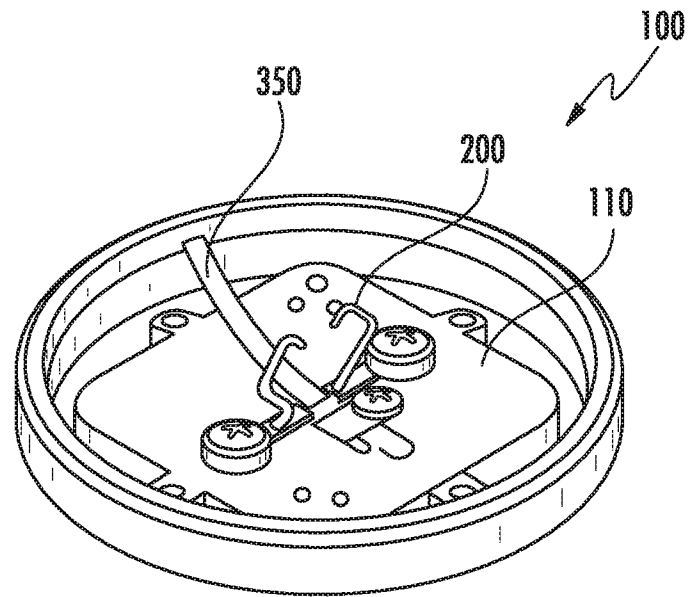


FIG. 3

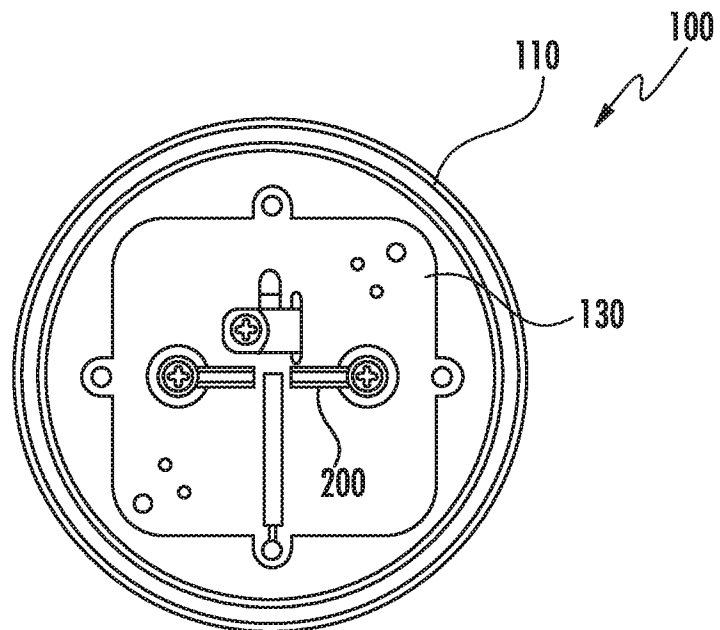
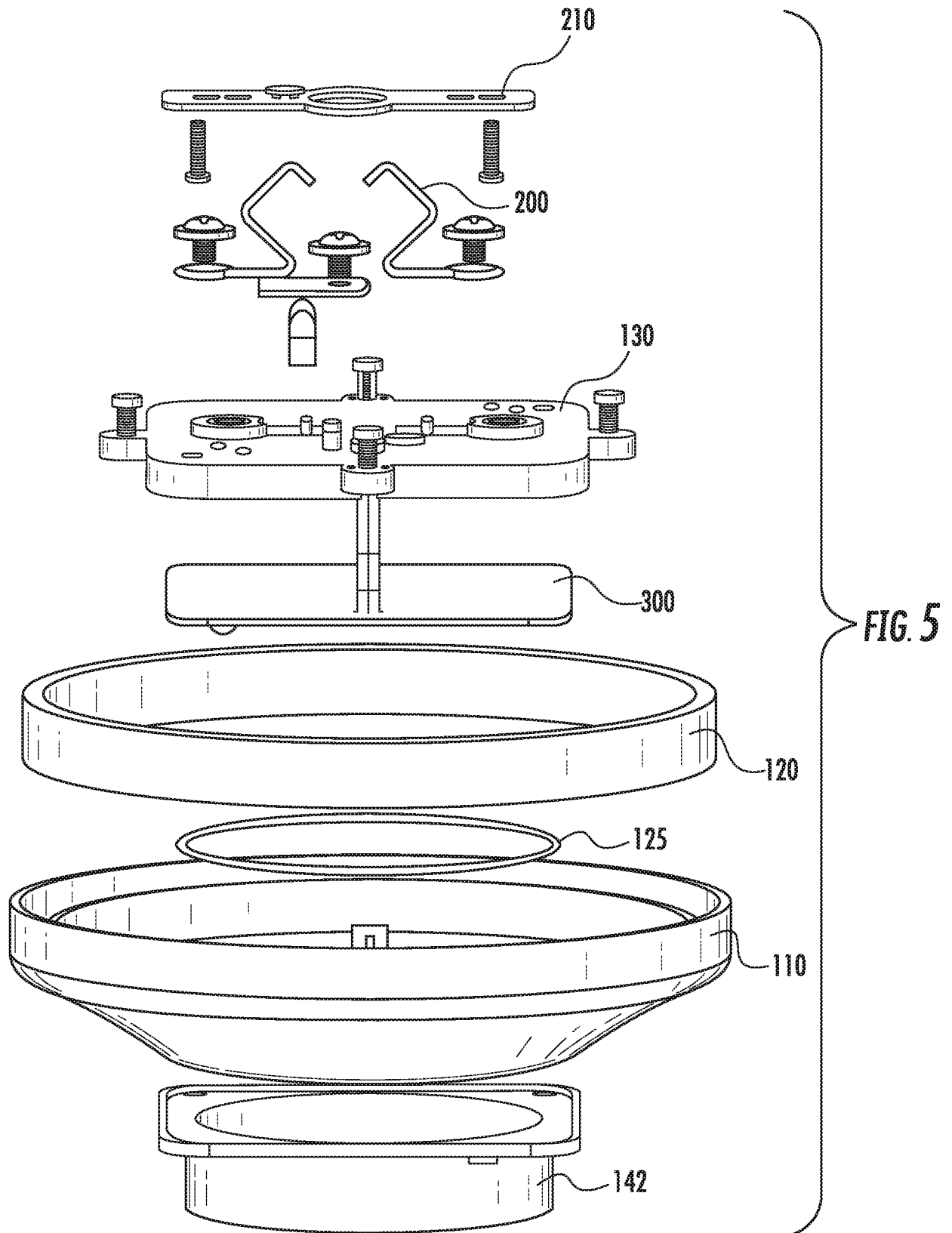


FIG. 4

3/5



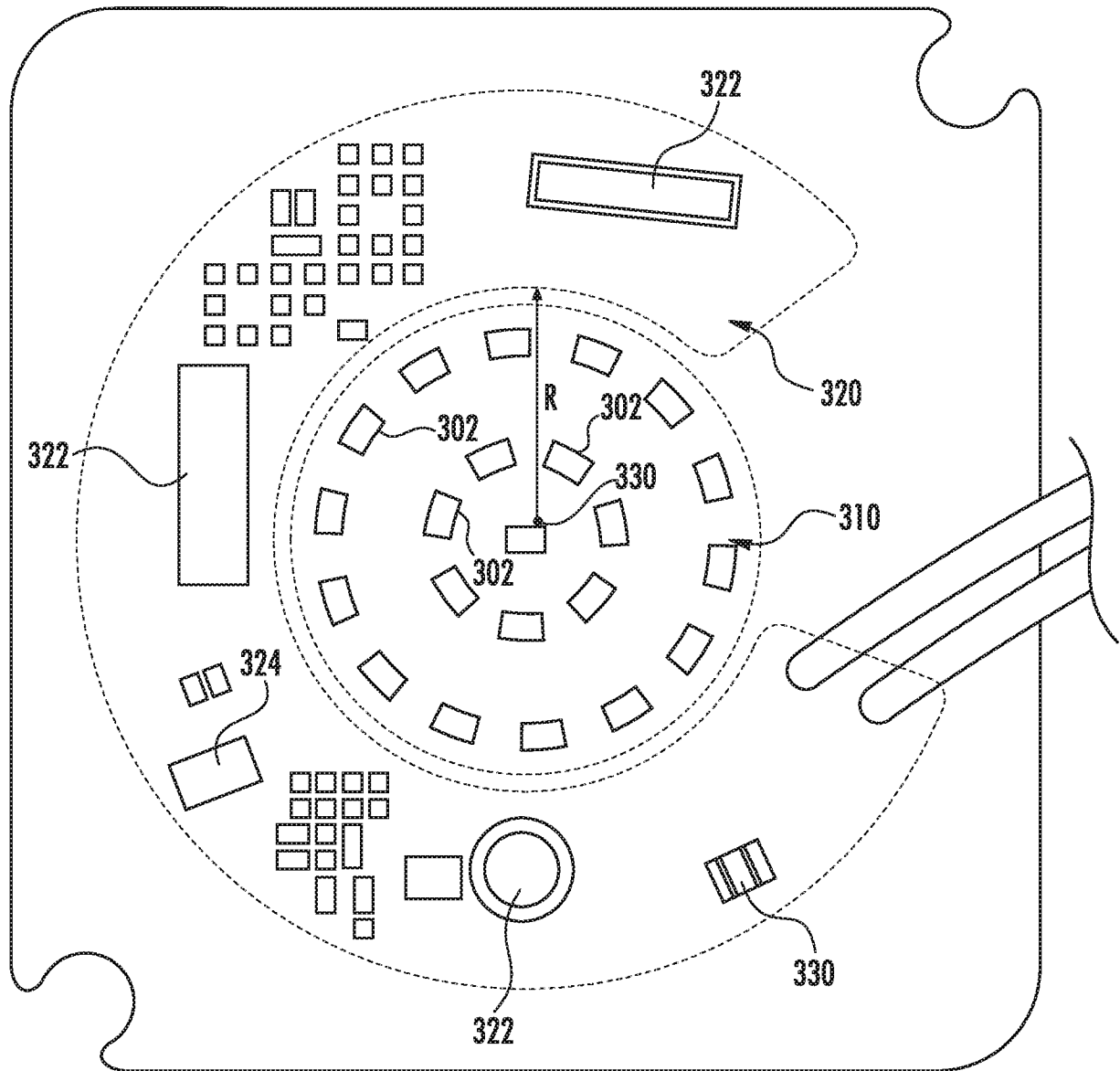
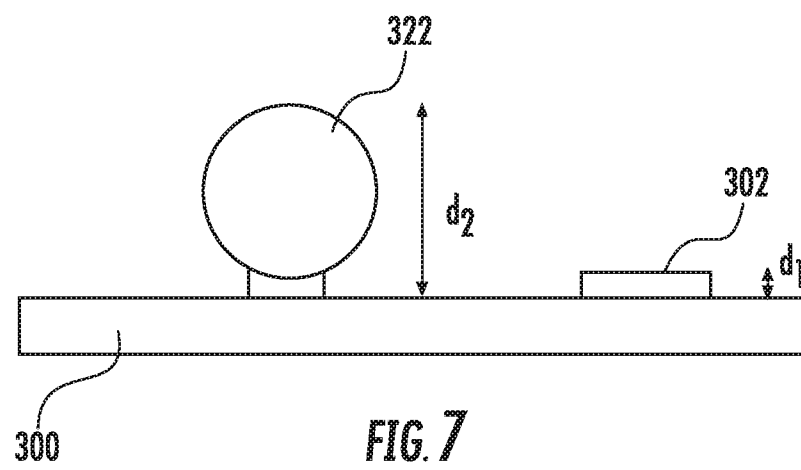


FIG. 6

5/5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 17/62517

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - F21V 23/00; F21Y 105/10 (2018.01)
 CPC - H05K 2201/10106; F21V 23/003, F21V 23/004, F21V 23/005; F21Y 2105/00, F21Y 2105/10, F21Y 2105/12; Y02B 20/30, Y02B 20/38, Y02B 20/70, Y02B 20/72

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)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015/0252970 A1 (CREE, INC) 10 September 2015 (10.09.2015), para [0003], [0052], [0068]-[0072]	1-20
Y	US 2014/0036516 A1 (SAMPSELL et al.) 06 February 2014 (06.02.2014), para [0015], [0042]	1-20
Y	US 2012/0286663 A1 (PUVANAKIJJAKORN et al.) 15 November 2012 (15.11.2012), para [0028], [0038]	5, 12-20
Y	US 2013/0188353 A1 (HUBBELL INCORPORATED) 25 July 2013 (25.07.2013), para [0020], [0074]	9-10, 19-20
A	EP 2 799 766 A1 (TRIDONIC JENNERSDORF GMBH) 05 November 2014 (05.11.2014), entire document	1-20
A	US 2015/0366037 A1 (ACTIVOCAL, LTD.) 17 December 2015 (17.12.2015), para [0073]	1-20
A	US 2007/0195532 A1 (REISENAUER et al.) 23 August 2007 (23.08.2007), para [0008], [0010], [0025]-[0029], [0032], [0037]	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

25 January 2018

Date of mailing of the international search report

21 FEB 2018

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
 P.O. Box 1450, Alexandria, Virginia 22313-1450
 Facsimile No. 571-273-8300

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300
 PCT OSP: 571-272-7774