(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 May 2015 (14.05.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/069807 A1

(51) International Patent Classification:
F21S 8/00 (2006.01) *F21V 15/01* (2006.01)
F21Y 105/00 (2006.01)

(21) International Application Number:
PCT/US2014/064182

(22) International Filing Date:
5 November 2014 (05.11.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
14/075,001 8 November 2013 (08.11.2013) US

(71) Applicant: **OSRAM SYLVANIA INC.** [US/US]; 100 Endicott Street, Danvers, Massachusetts 01923 (US).

(72) Inventors: **SPEER, Richard**; 59 Kenney Lane, Concord, Massachusetts 01742 (US). **HAMBY, David**; 105A Elm Street, Andover, Massachusetts 01810 (US). **GROSSMAN, Ken**; 29 Hayes Avenue, Beverly, Massachusetts 01915 (US).

(74) Agent: **MONTANA, Shaun P.**; 100 Endicott Street, Danvers, Massachusetts 01923 (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, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, 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.

(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).

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))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

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

WO 2015/069807 A1

(54) Title: FIXTURE DESIGN FOR FLEXIBLE LED CIRCUIT BOARDS

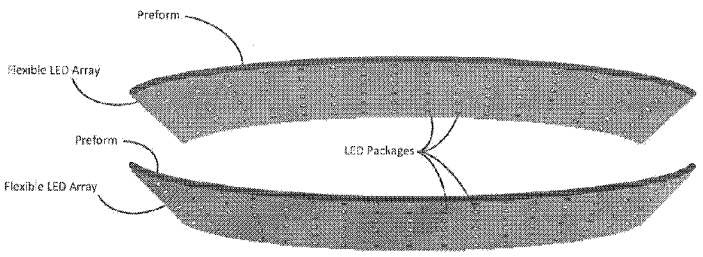


Fig. 8a

Fig. 8b

(57) Abstract: Techniques are disclosed for designing light fixtures for flexible LED circuit boards. The flexible LED circuit boards include an array of LED packages and the surface of the flexible circuit boards is highly reflective. A flexible LED circuit board may be shaped to conform to a rigid preform and the preform may be concave, convex, corrugated, or have any other custom shape. The shape of the preform, as well as the location of the LEDs within the flexible LED circuit may determine the light distribution of the light fixture. Alternatively, the lighting fixture may have multiple rods held in place with side plates and a flexible LED circuit board may be woven between the rods. A set of hole patterns in the side plates determine the location of the rods and the rods will determine the shape of the flexible LED circuit.

FIXTURE DESIGN FOR FLEXIBLE LED CIRCUIT BOARDS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is an international application of, and claims priority to, United States Patent Application No. 14/075,001, filed November 8, 2013, and entitled "Fixture Design for Flexible LED Circuit Boards", which is herein incorporated by reference in its entirety.

FIELD OF THE DISCLOSURE

[0002] This disclosure relates to lighting fixtures, and more specifically to flexible LED circuit board fixtures.

BACKGROUND

[0003] In lighting systems luminaires and LED arrays may be mounted using various lighting fixtures. Once the lighting fixture is assembled, the light distribution pattern it provides is typically fixed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Figure 1 shows a flexible laminated LED circuit.

[0005] Figures 2a-b illustrate two examples of flexible LED circuits fabricated with screen printed Ag ink on polyester including multiple LED strings connected in parallel.

[0006] Figure 3a shows a cross-sectional view of various LED package spacings that may provide different light distributions, according to an embodiment of the present invention.

[0007] Figure 3b shows a view from below of the flexible LED circuit fitted to a corrugated form, according to one embodiment of the present invention.

[0008] Figures 4a-c collectively illustrate an example LED lighting fixture with a flexible LED circuit woven between rods, according to an embodiment of the present invention.

[0009] Figures 5a-f collectively illustrate three LED package spacings along with their corresponding light distribution patterns, according to various embodiments of the present invention.

[0010] Figures 6a-b show graphs of the light distribution coming from two points along a sinusoidal shaped flexible LED circuit, according to two embodiments of the present invention.

[0011] Figure 7 shows an example flexible LED circuit including multiple LED packages woven between transparent rods, according to an embodiment of the present invention.

[0012] Figures 8a-d illustrate various shapes and fixture designs for flexible LED circuits, according to various embodiments of the present invention.

[0013] Figure 9 illustrates a method for fabricating a light fixture for a flexible LED lighting circuit, according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0014] Techniques are disclosed for designing light fixtures for flexible LED circuit boards. The flexible LED circuit boards include an array of LED packages or LED chips and the surface of the flexible circuit boards is highly reflective, in some embodiments. In one example, a flexible LED circuit board may be shaped to conform to a rigid preform and the preform may be concave, convex, corrugated, or have any other custom shape depending on the desired light distribution pattern. In such an example, the shape of the preform as well as the location of the LEDs within the flexible LED circuit will determine the light distribution of the light fixture. Alternatively, the lighting fixture may have multiple rods held in place with side plates and a flexible LED circuit board may be woven between the rods, in some

embodiments. In such embodiments, a set of hole patterns in the side plates will determine the location of the rods and the rods will determine the shape of the flexible LED circuit. In some cases, the side plates may include multiple hole patterns and attaching the rods to different hole patterns will result in different light distributions. The location of the rods as well as how the flexible LED circuit is woven between the rods will determine the final shape of the LED circuit within the lighting fixture.

General Overview

[0015] Flexible substrates with screen printed circuit patterns are used to fabricate flexible circuit boards. However, flexible LED circuit boards with reflective substrates may be configured into multiple shapes and may provide various light distribution patterns with the same physical parts. Furthermore, different LED placements within a flexible circuit board may provide different light distributions even if the shape of the flexible circuit is held constant. A lighting fixture may be designed that takes advantage of these unique characteristics of a flexible LED circuit board.

[0016] Thus, in accordance with an embodiment of the present invention, a lighting fixture is disclosed for housing a flexible circuit board populated with an array of LED packages or LED chips. The flexible substrate of the LED array may be a reflective material (e.g., PET), and the circuit pattern may be screen printed onto the substrate, in some embodiments, which can reduce production cost as compared to standard circuit boards or metal substrate boards. The flexible board may be shaped prior to being used in a light fixture, in some cases, and the flexible board may conform to a non-flat shape, in some embodiments. Such a design has a low input power density such that heat may be dissipated by convection and radiation and no heat sink is required. In one embodiment, a flexible LED array with a reflective surface may provide customized light delivery with a fixed set of parts. For example, the same parts may

be used to provide a highly directed light source or a dissipated light source depending on the contours of the flexible LED array and the spacing of the LEDs within the array.

[0017] In one example embodiment, a flexible LED array is placed against a curved preform and the LED linear arrangements may be either separate strips with appropriate electrical connections or printed circuit patterns on a large flexible sheet. The curved preform may be concave, convex, corrugated, or any other custom shape depending upon the intended light distribution. In some cases, the curved preform may be a section of PVC corrugated roofing material. In another embodiment, the flexible LED array may be laced between a number of rods and the placement of the rods may customize the shape of the LED array and therefore the light distribution. In one such example, the lighting fixture may include two side plates that hold the rods in place.

[0018] In some embodiments, custom screen printed circuits or LED arrays may be matched with the correct fixture configuration in order to achieve the desired light distribution. The variations in shape and LED placement would contribute to the final light distribution and could be customized for particular applications without major changes in parts.

Example Fixtures for Flexible LED Circuits

[0019] Figure 1 shows a flexible laminated LED circuit. As can be seen, the LED circuit includes four copper ribbons and the upper laminate sheet has multiple perforations exposing portions of the copper ribbons for the placement of the LED packages. The upper laminate sheet in this particular embodiment is transparent and the entire copper ribbons are visible, while the lower laminate sheet has a reflective upper surface. In other embodiments, the upper laminate sheet may have a reflective upper surface. Although this particular example shows four copper ribbons laminated between two sheets, other embodiments may include fewer or more copper ribbons and the copper ribbons may be replaced with copper wires, or any other suitable conductive material. In some cases, the thin copper ribbon may be around

.003 inches thick. The LED packages may be attached using a conductive epoxy or solder, in some embodiments. Because the LED packages are being attached to a metallic conductive wire (a copper ribbon in this example), solder may be used in order to avoid the difficulties associated with conductive epoxies.

[0020] Figures 2a-b illustrate examples of flexible LED circuit boards including multiple LED strings connected in parallel. As can be seen in the example of Figure 2a, a flexible LED circuit may be fabricated with screen printed Ag ink on a flexible substrate, in some embodiments. The substrate could be, for example, PET or any other suitable flexible substrate material. LED packages may be connected in series along the conductive traces to form multiple LED strings and the surface of the flexible circuit board may be reflective. Figure 2b illustrates the flexibility of the LED circuit board when it is rolled.

[0021] Figure 3a shows a cross-sectional view of various LED package spacings that may provide different light distributions, according to an embodiment of the present invention. As can be seen in this example, the flexible LED array is arranged in a corrugated shape and the top LED package spacing has the LEDs near the crest of each corrugated wave, while the middle LED package spacing has the LEDs at the center of each corrugated wave, and the lower LED package spacing has the LEDs at the bottom of each corrugated wave. Figure 3b shows a view from below of the flexible LED circuit fitted to a corrugated form, according to one embodiment of the present invention. The direct light path from the LED packages is shown. Such a corrugated shape could be readily used in various area lighting applications including, for example, a drop ceiling light fixtures with dimensions of 2 ft. x 2 ft. or 2 ft. x 4 ft. However, the lighting fixtures described herein could be designed for any area lighting application and the present invention is not intended to be limited to any particular size or set of dimensions.

[0022] Figures 4a-c collectively illustrate an example LED lighting fixture with a flexible LED circuit woven between rods, according to an embodiment of the present invention. In such an embodiment, the flexible circuit board may be mounted within a lighting fixture housing without being attached to the surface of a rigid preform. Such a fixture may provide a more versatile system whereby the "wavelength" and the "amplitude" of the shaped flexible LED circuit would be more customizable based on the location of the rods. The example LED circuit board in Figures 4a-c has the LED packages placed such that they are near the crest of the circuit board wave pattern. As can be seen in Figure 4a, the rods in this example define the shape of the flexible LED circuit when the circuit is woven between the rods. As can be seen in the example of Figure 4b, this design has two side plates, each having hole patterns through which the rods may be placed. Figure 4c shows a view from below of the flexible LED circuit, and the direct light path from the LED packages is shown. The direction of the light from the LED packages may be changed, for example, by changing the spacing and location of the rods.

[0023] Figures 5a-f collectively illustrate three LED package spacings along with their corresponding light distribution patterns, according to various embodiments of the present invention. In these example embodiments, the light distribution is influenced by locating the LED strips at different points along the "curve" or "wave" of the corrugated LED circuit (whether the circuit is attached to a corrugated preform or shaped using rods and side plates). Figure 5a shows the LED strips placed near the crest of the corrugated LED circuit and Figure 5b is a graph of the corresponding polar light distribution. Figure 5c shows the LED strips placed near the middle of the corrugated LED circuit shape and Figure 5d is a graph of the corresponding polar light distribution. Figure 5e shows the LED strips placed near the bottom of the corrugated LED circuit shape and figure 5f is a graph of the corresponding polar light distribution. The polar light distribution plots shown in Figures 5b, 5d, and 5f

graph the light intensity in candelas (CD) and demonstrate that there is a significant difference in the light distribution pattern for each LED strip placement. As can be seen, therefore, the light distribution of a flexible LED circuit is customizable using the same basic parts, depending on the location of the LED strips within the shaped LED circuit.

[0024] Figures 6a-b show graphs of the light distribution coming from two points along a sinusoidal shaped flexible LED circuit, according to two embodiments of the present invention. In these example embodiments, non-diffused reflection is assumed for illustrative purposes. The example in Figure 6a shows the light distribution coming from a point near the crest of the sinusoidal LED circuit, while the example in Figure 6b shows the light distribution coming from a point near the middle of the sinusoidal LED circuit. In one specific example embodiment, a flat array of Lambertian LED packages may produce a Lambertian light distribution when used in a downward facing lighting application, as shown in these example embodiments. As can be seen when comparing the example of Figure 6a with the example of Figure 6b, minor changes in the LED package locations would produce different light distribution patterns other than a Lambertian distribution.

[0025] Figure 7 shows an example flexible LED circuit including multiple LED packages woven between transparent rods, according to an embodiment of the present invention. In this particular example embodiment, the rods are glass tubes and the side plates are ¼ inch aluminum plates having a particular hole-pattern. In other embodiments, side plates may include multiple hole-patterns and the user may configure the rod placement as desired. In still other embodiments, a consumer may specify the type of light distribution desired and the rod placement may be determined and the circuit may be laced for the desired application. The rods could be made of reflective material and may be fastened with setscrews or held with lock nuts on the end of threaded rods, in some embodiments. The rods may also be

replaced with cables laced through the hole pattern and held taught at the ends, in some embodiments. Such cables could be thin and coated with a reflective material.

[0026] Figures 8a-d illustrate various shapes and fixture designs for flexible LED circuits, according to various embodiments of the present invention. Figure 8a shows a flexible LED array attached to a concave down rigid preform, while Figure 8b shows a flexible LED array attached to a concave up rigid preform, and each LED circuit shape provides a specific light distribution pattern. Figures 8c-d show a concave down configuration for a flexible LED circuit utilizing a rod and side plate configuration. Figure 8c is a cross-sectional view of the rod and side plate fixture with the flexible LED circuit woven between the rods while Figure 8d shows the same configuration from below. Various shapes and heights may be used for the rigid forms, and in some cases the flexible LED circuit may be replaced with a new flexible LED board with the same or different pattern and the fixture itself could remain the same. The various preforms and rod arrangements may be incorporated within a light fixture housing, in some embodiments.

Methodology

[0027] Figure 9 illustrates a method for fabricating a light fixture for a flexible LED lighting circuit, according to an embodiment of the present invention. The method may begin with determining 901 the desired light distribution. Once the desired light distribution is known, the method may continue with determining 902 the ideal circuit shape and LED placement in order to achieve the desired light distribution. As discussed above, the light distribution may be manipulated by altering the shape of the flexible LED circuit as well as the placement of the LED strings within the LED circuit. The method may continue with determining 903 whether the flexible LED circuit will be fastened to a rigid form. In some cases, the rigid preform may be concave, convex, corrugated, or any other suitable shape for achieving the desired light distribution. If the LED circuit will be fastened to a rigid form, the method may

continue with fabricating 904 the flexible LED circuit and the rigid form. As discussed above, the shape of the preform as well as the placement of the LED strings within the flexible LED circuit depends on the desired light distribution. The method may then continue with assembling 906 the light fixture housing, which may include attaching the LED circuit to the rigid preform. If the flexible LED circuit is not to be attached to a rigid form, the method may continue with fabricating 905 the flexible LED circuit and light fixture side plates with the desired hole patterns or achieving the intended light distribution. As discussed above, the hole patterns in the side plates are used for inserting the rods which will determine the shape of the flexible LED circuit. The method may then continue with assembling 906 the light fixture housing, which in this particular case includes inserting transparent or reflective rods into the holes of the side plates and weaving the flexible LED circuit between the rods.

[0028] Numerous embodiments will be apparent, and features described herein can be combined in any number of configurations. One example embodiment of the present invention provides a lighting fixture. The lighting fixture includes a lighting fixture housing, and a rigid preform mounted to the housing, the preform having a non-flat shape determined by a desired light distribution pattern produced when a flexible LED circuit is attached to the preform. In some cases, the rigid preform is concave down when mounted to the housing. In some cases, the rigid preform is concave up when mounted to the housing. In some cases, the rigid preform is corrugated. In some cases, the fixture includes the flexible LED circuit conforming to the shape of the rigid preform. In some such cases, the flexible LED circuit has a reflective surface. In other such cases, the spacing of LEDs within the flexible LED circuit is determined by the light distribution pattern produced when the flexible LED circuit is attached to the preform. In some cases, the lighting fixture is configured to provide a

customized light distribution pattern by attaching to the rigid preform flexible LED circuits having different LED arrangements.

[0029] Another embodiment of the present invention provides a method of fabricating a lighting fixture. The method includes determining a desired light distribution pattern, and fabricating a flexible LED circuit housing configured to hold a flexible LED circuit in a desired non-flat shape, the shape being determined based on the desired light distribution pattern. In some cases, the housing for the flexible LED circuit includes a rigid preform and the shape of the preform is determined by the light distribution pattern produced when the flexible LED circuit is attached to the preform. In some cases, the method further includes fabricating the flexible LED circuit wherein the spacing of LEDs within the circuit is determined based on the desired light distribution pattern. In some such cases, the flexible LED circuit has a reflective surface. In some cases, the flexible LED circuit housing is configured to hold the flexible LED circuit in a concave down shape. In some cases, the flexible LED circuit housing is configured to hold the flexible LED circuit in a concave up shape. In some cases, the flexible LED circuit housing is configured to hold the flexible LED circuit in a corrugated shape. In some cases, the housing includes at least two side plates to which the rigid preform is secured. In some cases, determining the desired light distribution pattern includes receiving a desired light distribution pattern from a customer.

[0030] Another embodiment of the present invention provides a lighting fixture. The lighting fixture includes a lighting fixture housing having at least two side plates. The method also includes a flexible LED circuit having a reflective surface, and a rigid preform mounted to the at least two side plates, the preform having a non-flat shape determined by a desired light distribution pattern produced when the flexible LED circuit is attached to the preform. In some cases, the spacing of LEDs within the flexible LED circuit is determined by the light distribution pattern produced when the flexible LED circuit is attached to the preform. In

some cases, the shape of the rigid preform is at least one of concave up, concave down, or corrugated.

[0031] The foregoing description of the embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of this disclosure. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto.

CLAIMS

What is claimed is:

1. A lighting fixture comprising:

a lighting fixture housing; and

a rigid preform mounted to the housing, the preform having a non-flat shape determined by a desired light distribution pattern produced when a flexible LED circuit is attached to the preform.

2. The fixture of claim 1 wherein the rigid preform is concave down when mounted to the housing.

3. The fixture of claim 1 wherein the rigid preform is concave up when mounted to the housing.

4. The fixture of claim 1 wherein the rigid preform is corrugated.

5. The fixture of claim 1 further comprising the flexible LED circuit conforming to the shape of the rigid preform.

6. The fixture of claim 5 wherein the flexible LED circuit has a reflective surface.

7. The fixture of claim 5 wherein the spacing of LEDs within the flexible LED circuit is determined by the light distribution pattern produced when the flexible LED circuit is attached to the preform.

8. The fixture of claim 1 wherein the lighting fixture is configured to provide a customized light distribution pattern by attaching to the rigid preform flexible LED circuits having different LED arrangements.

9. A method of fabricating a lighting fixture comprising:

determining a desired light distribution pattern; and

fabricating a flexible LED circuit housing configured to hold a flexible LED circuit in a desired non-flat shape, the shape being determined based on the desired light distribution pattern.

10. The method of claim 9 wherein the housing for the flexible LED circuit comprises a rigid preform, the shape of the preform determined by the light distribution pattern produced when the flexible LED circuit is attached to the preform.

11. The method of claim 9 further comprising fabricating the flexible LED circuit wherein the spacing of LEDs within the circuit is determined based on the desired light distribution pattern.

12. The method of claim 11 wherein the flexible LED circuit has a reflective surface.

13. The method of claim 9 wherein the flexible LED circuit housing is configured to hold the flexible LED circuit in a concave down shape.

14. The method of claim 9 wherein the flexible LED circuit housing is configured to hold the flexible LED circuit in a concave up shape.

15. The method of claim 9 wherein the flexible LED circuit housing is configured to hold the flexible LED circuit in a corrugated shape.

16. The method of claim 9 wherein the housing comprises at least two side plates to which the rigid preform is secured.

17. The method of claim 9 wherein determining the desired light distribution pattern comprises receiving a desired light distribution pattern from a customer.

18. A lighting fixture comprising:

a lighting fixture housing having at least two side plates;

a flexible LED circuit having a reflective surface; and

a rigid preform mounted to the at least two side plates, the preform having a non-flat shape determined by a desired light distribution pattern produced when the flexible LED circuit is attached to the preform.

19. The fixture of claim 18 wherein the spacing of LEDs within the flexible LED circuit is determined by the light distribution pattern produced when the flexible LED circuit is attached to the preform.

20. The fixture of claim 18 wherein the shape of the rigid preform is at least one of concave up, concave down, or corrugated.

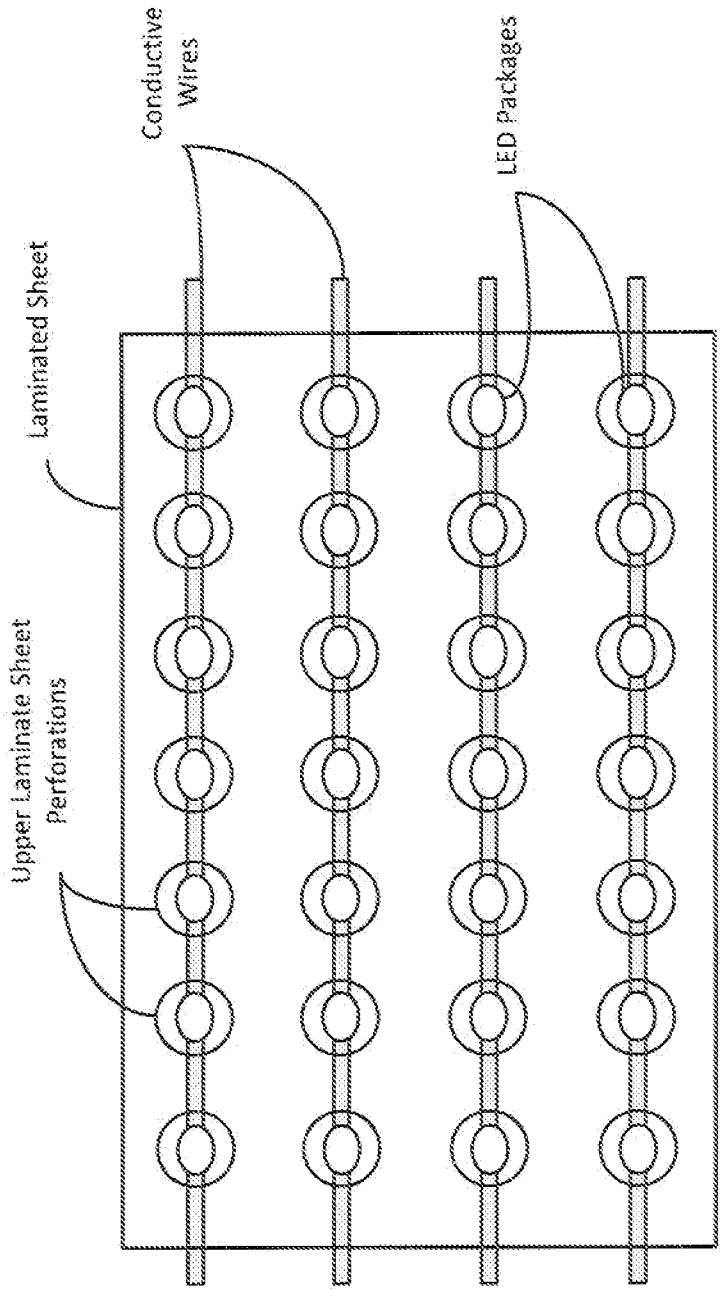

Conductive Wires
LED Packages
Laminated Sheet
Upper Laminate Sheet Perforations

Fig. 1

Fig. 2a

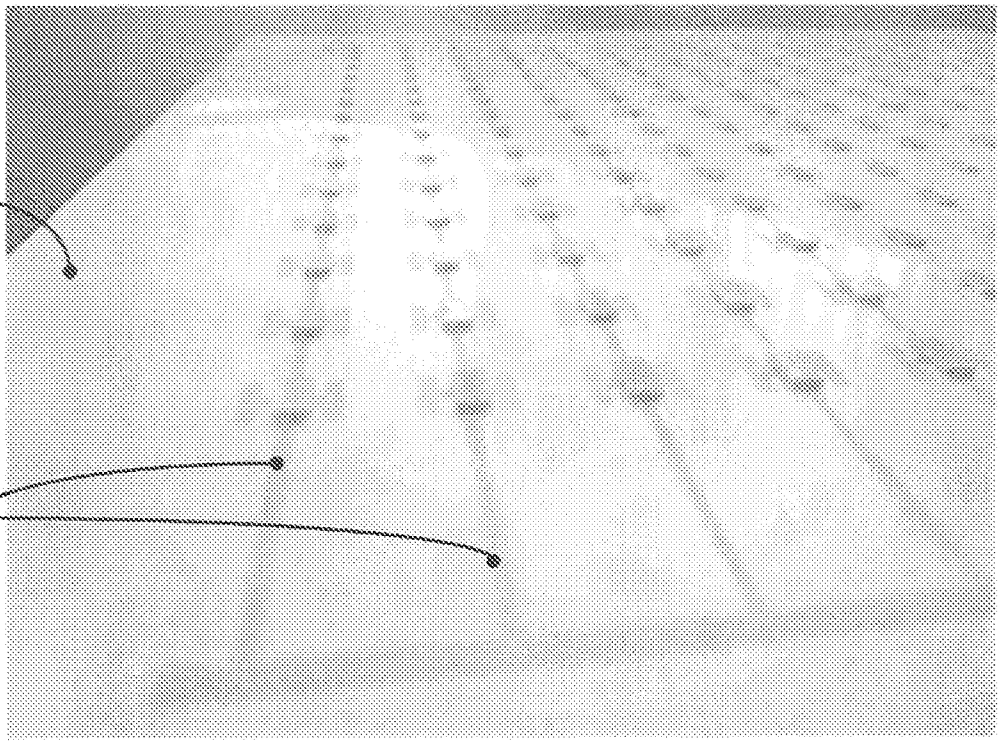
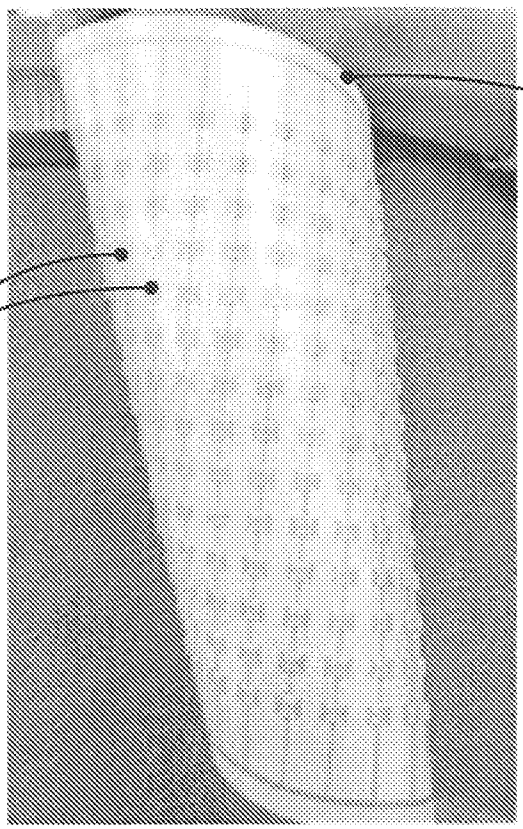

Flexible Circuit Board
LED Strings

Fig. 2b


Flexible Circuit Board
LED Strings

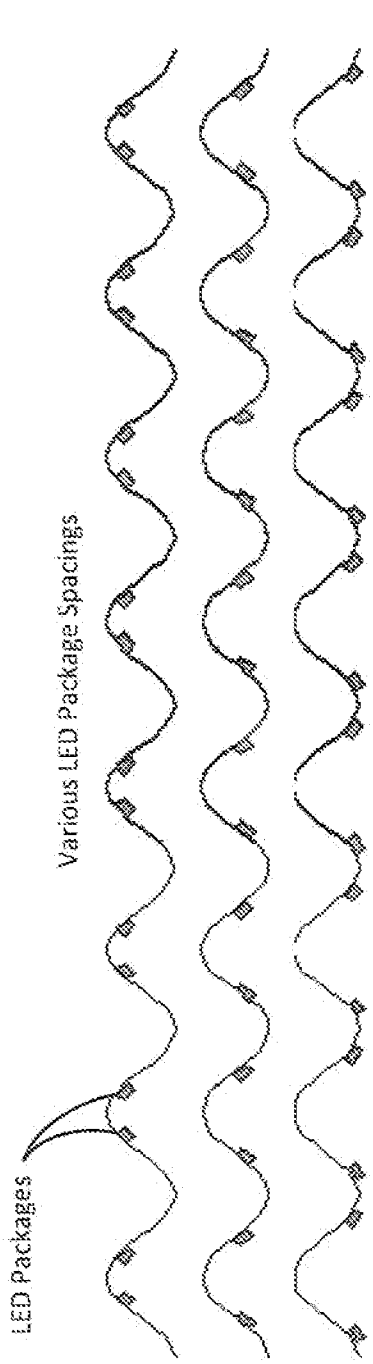

LED Packages
Various LED Package Spacings

Fig. 3a

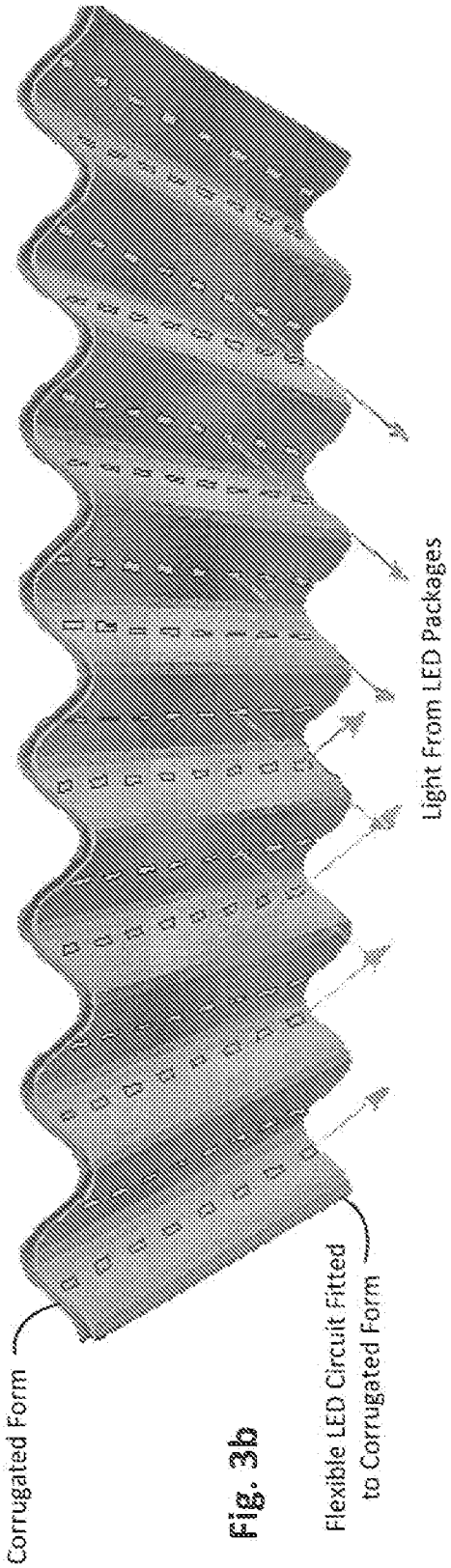

Corrugated Form
Flexible LED Circuit Fitted to Corrugated Form
Light From LED Packages

Fig. 3b

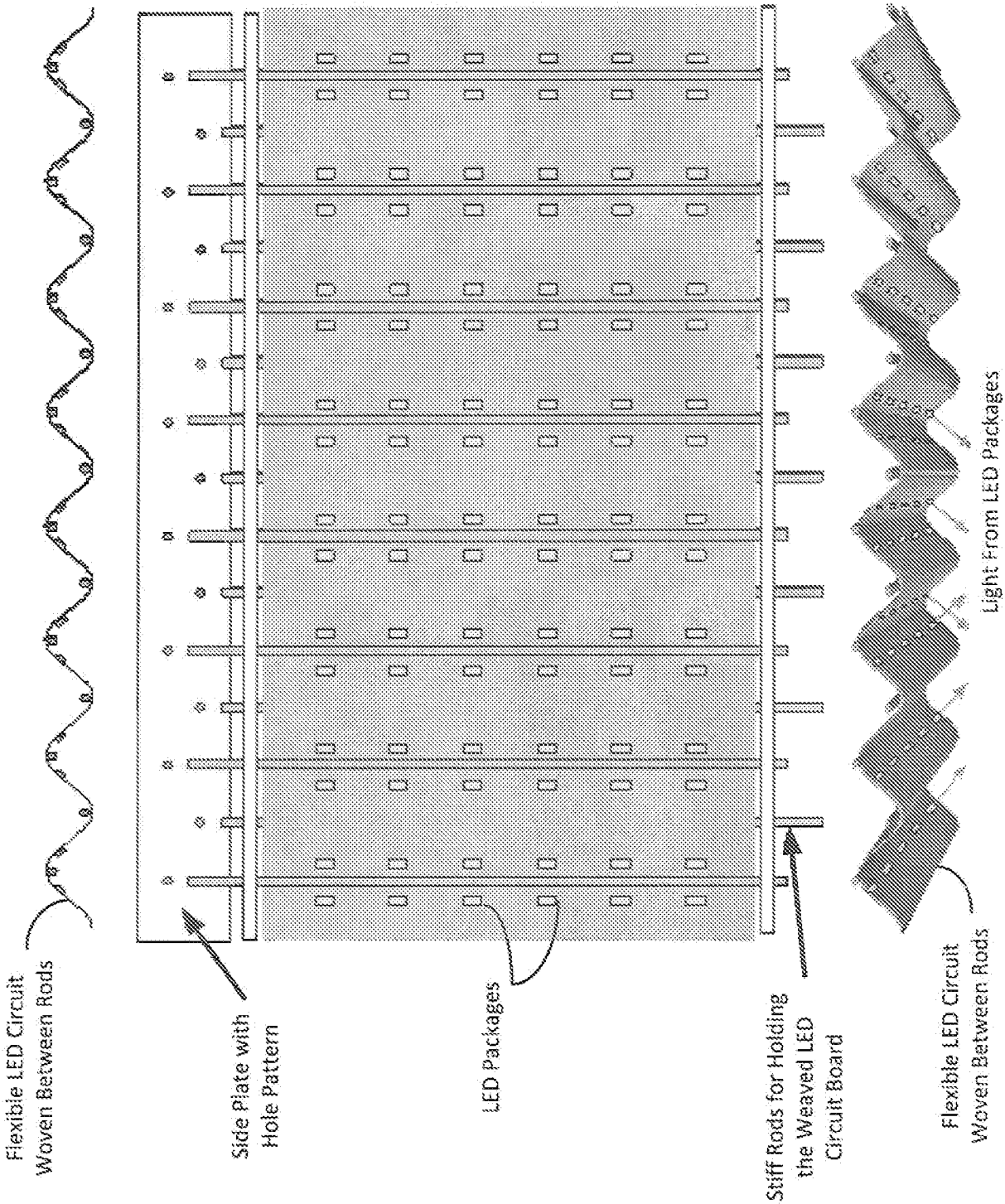


Fig. 4a
Fig. 4b
Fig. 4c
Flexible LED Circuit Woven Between Rods
Side Plate with Hole Pattern
LED Packages
Stiff Rods for Holding the Weaved LED Circuit Board
Flexible LED Circuit Woven Between Rods
Light From LED Packages

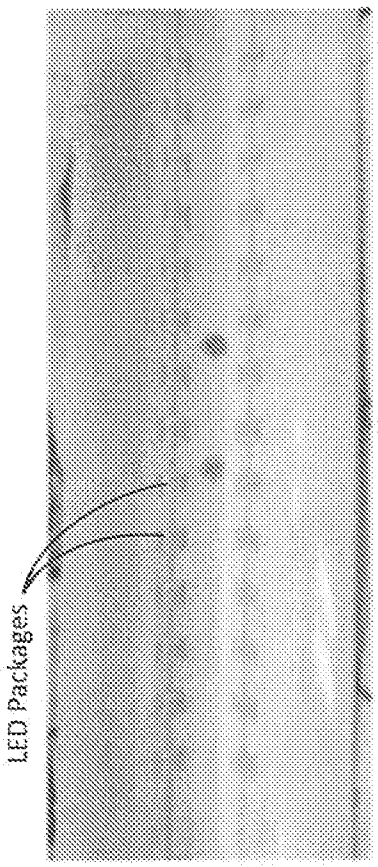


Fig. 5a

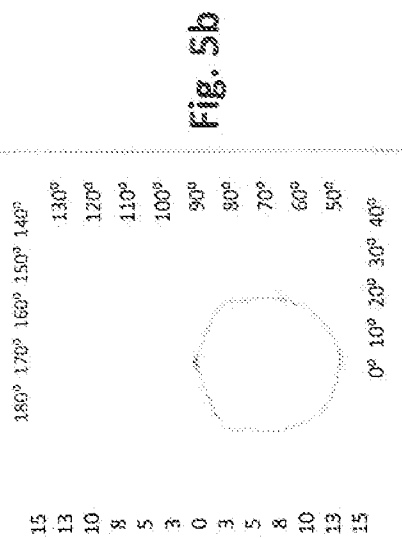


Fig. 5b

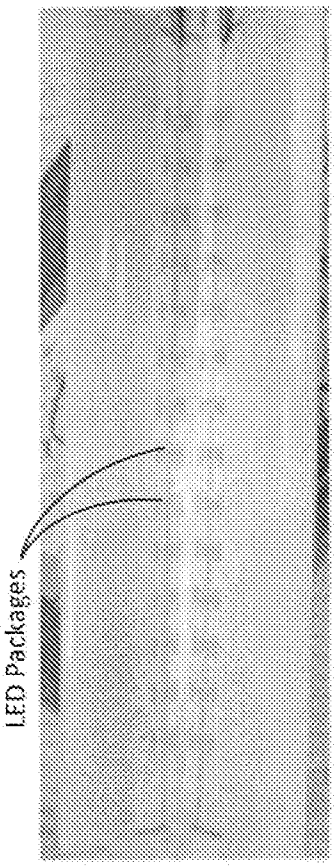


Fig. 5c

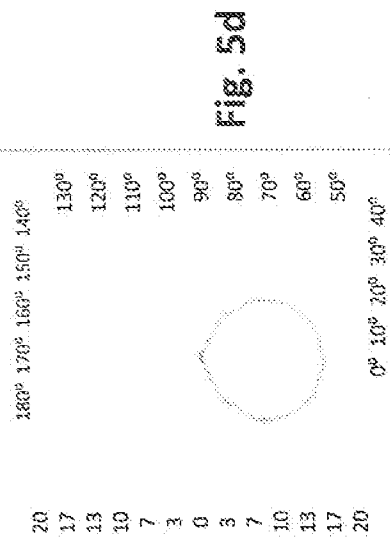


Fig. 5d

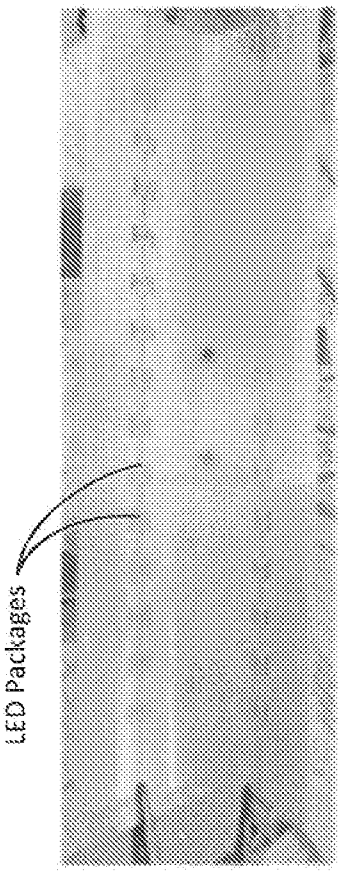


Fig. 5e

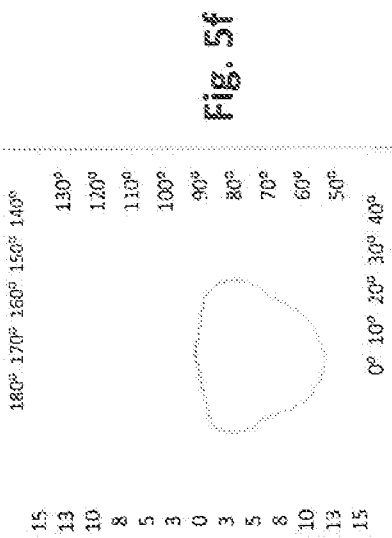


Fig. 5f

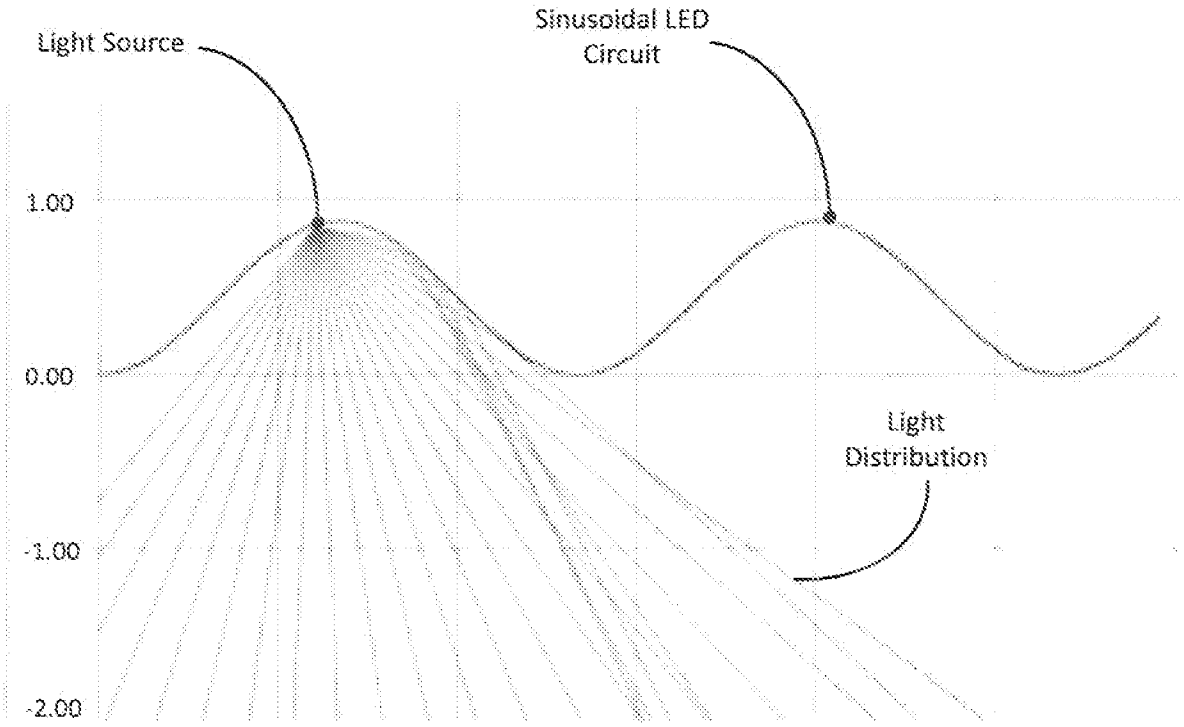

Light Source
Sinusoidal LED Circuit
1.00
0.00
-1.00
-2.00
Light Distribution

Fig. 6a

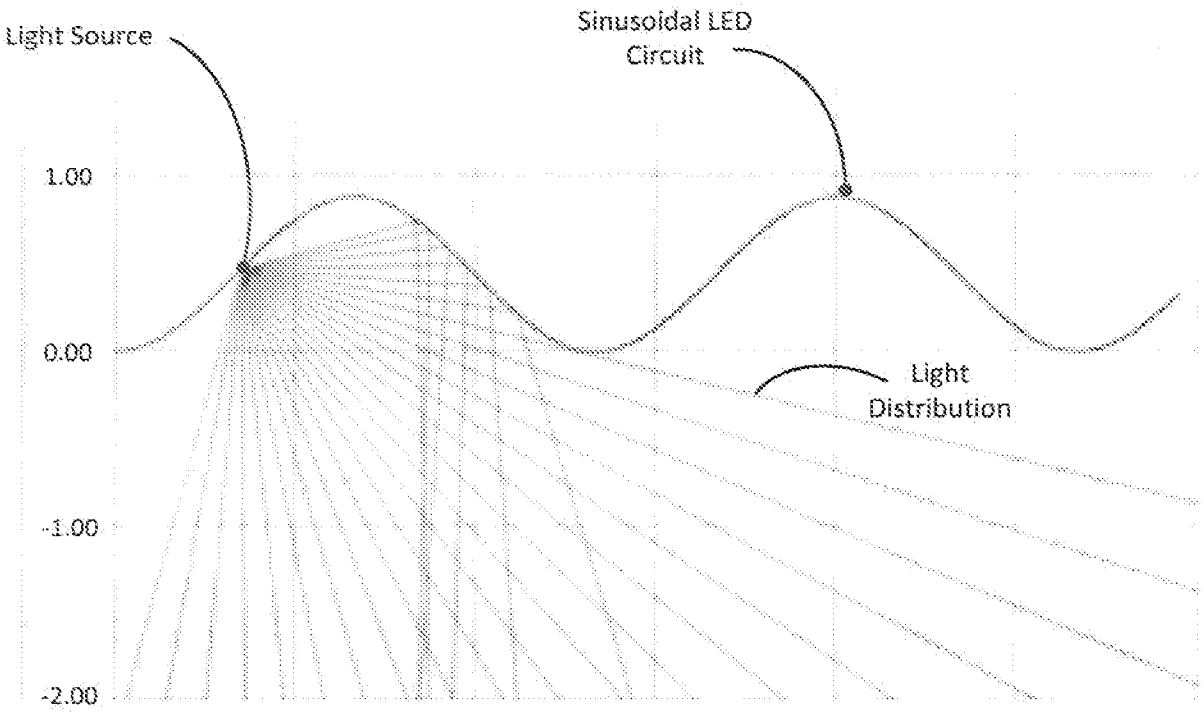
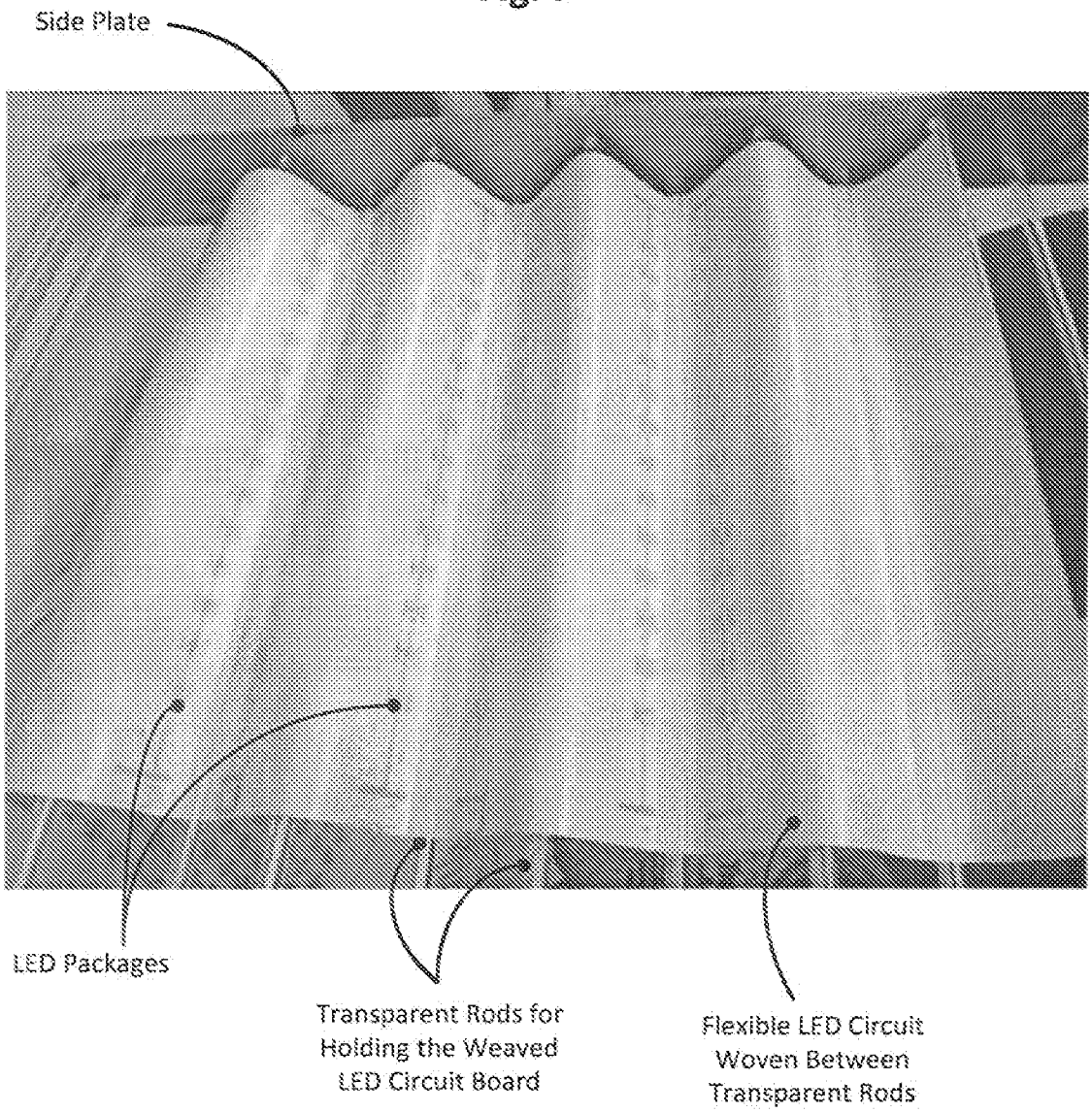

Light Source
Sinusoidal LED Circuit
1.00
0.00
-1.00
-2.00
Light Distribution

Fig. 6b

Fig. 7


Side Plate
LED Packages
Transparent Rods for Holding the Weaved LED Circuit Board
Flexible LED Circuit Woven Between Transparent Rods

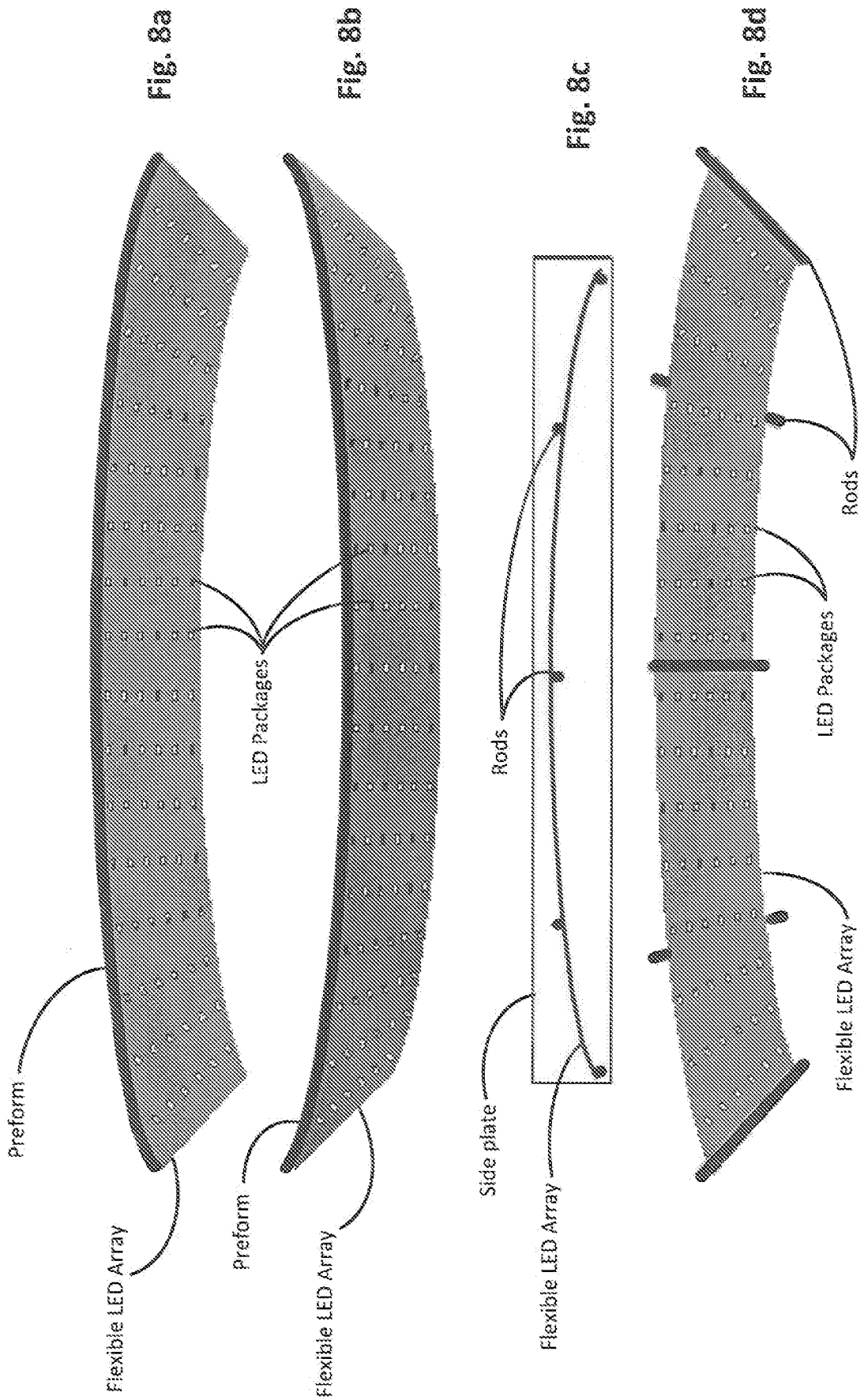


Fig. 8a
Preform
Flexible LED Array
Fig. 8b
LED Packages
Preform
Flexible LED Array
Fig. 8c
Rods
Side plate
Flexible LED Array
Fig. 8d
Rods
LED Packages
Flexible LED Array

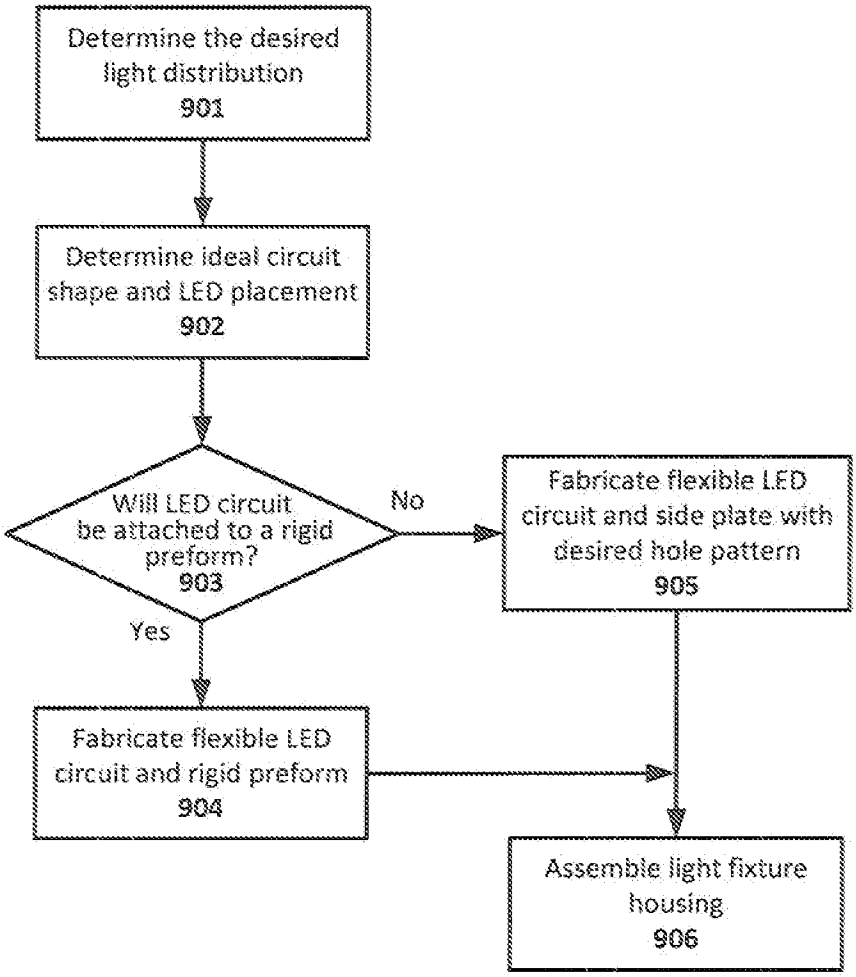

Determine the desired light distribution
901
Determine ideal circuit shape and LED placement
902
Will LED circuit be attached to a rigid preform?
903
No
Yes
Fabricate flexible LED circuit and side plate with desired hole pattern
905
Fabricate flexible LED circuit and rigid preform
904
Assemble light fixture housing
906

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/064182

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21S8/00
ADD. F21Y105/00 F21V15/01

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)
F21S F21V H01L F21Y H05K

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2007 115577 A (MATSUSHITA ELECTRIC WORKS LTD) 10 May 2007 (2007-05-10) the whole document	1-5, 7-11, 13-17 6,12, 18-20

Y A	DE 10 2009 023052 A1 (OSRAM GMBH [DE]) 2 December 2010 (2010-12-02) paragraph [0053] claims 1,7 figures 7,8	6,12, 18-20 1

X A	EP 2 058 581 A2 (SITECO BELEUCHTUNGSTECH GMBH [DE]) 13 May 2009 (2009-05-13) paragraphs [0038], [0047] figures 1,2,4	1-3,5, 7-11,13, 14,17 18

	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] 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 application or patent 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	Date of mailing of the international search report
20 February 2015	27/02/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Cosnard, Denis

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/064182

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/043910 A1 (NAGASHIMA MITSUNORI [JP] ET AL) 23 February 2012 (2012-02-23)	1,2,5, 9-11,14, 17
A	paragraphs [0049], [0051], [0052] figures 6,7	18

X	WO 2010/125513 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; PHILIPS INTELLECTUAL PROPERTY [DE) 4 November 2010 (2010-11-04) the whole document	1-5, 9-11,14, 15

X	US 2012/075853 A1 (TSAI TSUNG-EIN [TW]) 29 March 2012 (2012-03-29)	1,2, 5-12,14, 17
A	paragraphs [0016], [0017], [0021], [0022] figures 2,3	18

A	DE 201 07 420 U1 (RODRIGUES PAIS LUCIA [DE]) 19 July 2001 (2001-07-19) the whole document	1,9,18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/064182

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2007115577 A	10-05-2007	NONE	
DE 102009023052 A1	02-12-2010	CN 102449384 A	09-05-2012
		DE 102009023052 A1	02-12-2010
		EP 2435755 A1	04-04-2012
		US 2012069556 A1	22-03-2012
		WO 2010136333 A1	02-12-2010
EP 2058581 A2	13-05-2009	DE 102007053790 B3	07-05-2009
		EP 2058581 A2	13-05-2009
US 2012043910 A1	23-02-2012	CN 102378448 A	14-03-2012
		US 2012043910 A1	23-02-2012
		US 2014103837 A1	17-04-2014
WO 2010125513 A1	04-11-2010	CN 102414506 A	11-04-2012
		EP 2425179 A1	07-03-2012
		JP 2012525675 A	22-10-2012
		US 2012057347 A1	08-03-2012
		WO 2010125513 A1	04-11-2010
US 2012075853 A1	29-03-2012	CN 102444864 A	09-05-2012
		DE 102011053910 A1	29-03-2012
		TW M422644 U	11-02-2012
		US 2012075853 A1	29-03-2012
DE 20107420 U1	19-07-2001	NONE	