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(54) Title: IMPROVED COLLIMATION SYSTEM FOR AN LED LUMINAIRE

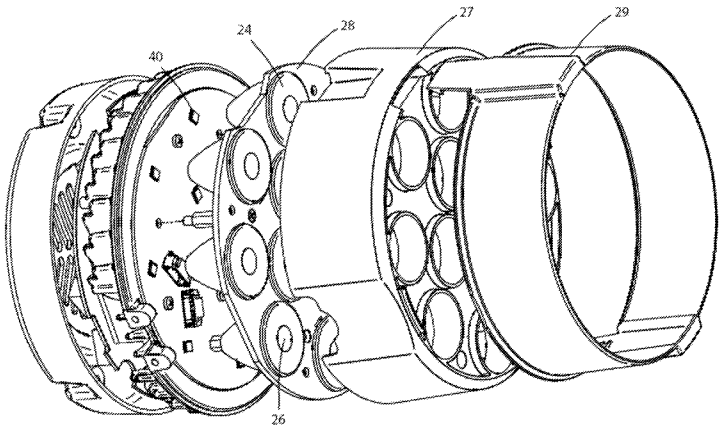


FIG 8

(57) Abstract: An automated luminaire with an array of light sources (40) configured in a plurality of primary TIR optics (24) with central light blocks (26). The light blocks are configured to block or redirect light beam at angles likely to cause undesirable light spill.

IMPROVED COLLIMATION SYSTEM FOR AN LED LUMINAIRE

RELATED APPLICATION

This application is a utility application claiming priority of United States provisional application with the same title Serial No. 61/612,376 filed on 18 Mar 2012.

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention generally relates to a method for controlling the light output from an array of LEDs when used in a light beam producing luminaire, specifically to a method relating to preventing spill light and for controlling the beam angle of the array.

BACKGROUND OF THE INVENTION

[0002] High power LEDs are commonly used in luminaires for example in the architectural lighting industry in stores, offices and businesses as well as in the entertainment industry in theatres, television studios, concerts, theme parks, night clubs and other venues. These LEDs are also being utilized in automated lighting luminaires with automated and remotely controllable functionality. For color control it is common to use an array of LEDs of different colors. For example a common configuration is to use a mix of Red, Green and Blue LEDs. This configuration allows the user to create the color they desire by mixing appropriate levels of the three colors. For example illuminating the Red and Green LEDs while leaving the Blue extinguished will result in an output that appears Yellow. Similarly Red and Blue will result in Magenta, and Blue and Green will result in Cyan. By judicious control of these three controls the user may achieve any color they desire. More than three colors may also be used and it is well known to add an

Amber or White LED to the Red, Green and Blue to enhance the color mixing and improve the gamut of colors available.

[0003] The differently colored LEDs may be arranged in an array in the luminaire where there is physical separation between each LED, and this separation, coupled with differences in die size and placement for each color, may affect the spread of the individual colors and results in objectionable spill light and color fringing of the combined mixed color output beam. It is common to use a lens or other optical device in front of each LED to control the beam shape and angle of the output beam; however these optical devices commonly have differing effect for different colors and color fringing or other aberrations may be visible in the output beam. It would be advantageous to have a system where stray light and aberrations are well controlled.

[0004] There is a need for a beam control system for an LED array based luminaire which provides improvements in spill light reduction and beam angle control.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings in which like reference numerals indicate like features and wherein:

[0006] FIGURE 1 illustrates a prior art system;

[0007] FIGURE 2 illustrates a typical automated lighting system;

[0008] FIGURE 3 illustrates an embodiment of the invention; as fitted to an automated luminaire;

[0009] FIGURE 4 illustrates a detailed view of an embodiment of the invention;

[0010] FIGURE 5 illustrates the optical design of an embodiment of the invention;

[0011] FIGURE 6 illustrates a small louver mask of an embodiment of the invention;

[0012] FIGURE 7 illustrates a top-hat module of an embodiment of the invention;

[0013] FIGURE 8 illustrates an exploded diagram of an embodiment of the invention, and;

[0014] FIGURE 9 illustrates an embodiment of the invention; as fitted to an automated luminaire

DETAILED DESCRIPTION OF THE INVENTION

[0015] Preferred embodiments of the present invention are illustrated in the **FIGURES,** like numerals being used to refer to like and corresponding parts of the various drawings.

[0016] The present invention generally relates to a method for controlling the light output from an array of LEDs when used in a light beam producing luminaire, specifically to a method relating to preventing spill light and for controlling the beam angle of the array.

[0017] **Figure 1** illustrates a prior art system showing two LEDs as may be used in a luminaire. LED **102** and LED **104** may be of differing colors and, due to the different optical properties and construction of the LED dies, produce light beams **106** and **110** that differ in beam spread. The differing beam spreads mean that the light beams from LEDs **102** and **104** will impinge on an illuminated object **118** in such a way that areas **114** and **116** of the object are illuminated by a single LED only rather than the desired mix of both. This results in areas **114** and **116** being colored differently from the central mixed area and appearing as colored fringes. Only Two (2) LEDs are illustrated in **Figure 1** for clarity and simplicity. It should be appreciated that the same problem exists with systems incorporating more than two colors of LED.

[0018] **Figure 2** illustrates a typical multiparameter automated LED luminaire system **10.** These systems commonly include a plurality of multiparameter automated luminaires **12** which typically each contain on-board an array of LEDs, and electric motors coupled to mechanical drives systems and control electronics (not shown). In addition to being connected to mains power either directly or through a power distribution system (not

shown), each luminaire is connected is series or in parallel to data link **14** to one or more control desk(s) **15.** The luminaire system **10** is typically controlled by an operator through the control desk **15.** Consequently, to affect this control, both the control desk **10** and the individual luminaires typically include electronic circuitry as part of the electromechanical control system for controlling the automated lighting parameters.

[0019] **Figure 3** illustrates an automated luminaire embodiment of the invention. Luminaire **20** contains multiple LED modules each of which is fitted with primary optics **24,** central spill light blocker **26,** and small louver masks **27.** Louver masks **27** may have different heights and width. By changing the louver masks **27** to ones with different heights of louver array the user may control the beam angle, stray light and color fringing of the luminaire in addition to that control provided by the central spill light blocker **26** described in greater detail below. Louver mask array **27** may further provide mechanical protection and dust exclusion for the LED modules.

[0020] **Figure 4** illustrates a detailed view of a component of an embodiment of the invention. Primary optics **24,** one for each LED array, are supported by frame **28.** Each primary optic 24 is fitted with a central spill light blocker **26.** Central spill light blocker **26** is an opaque mask applied over the central region of primary optic **24.** Central spill light blocker **26** may be silk screened ink, or a physical disc made of paper, plastic, molded plastic, metal or any other material, adhered to the center of the primary optic **24.** Central spill light blocker **26** may be a thin component as shown in the figures, or may have a tangible thickness or height, where the thickness provides additional spill light masking. Primary optic **24** is most commonly a TIR (Total Internal Reflection) optical lens designed to collimate the output of the associated LED array and produce a narrow output beam. Such TIR optics tend to produce spill light outside of the desired output

beam, much of which passes through the central portion of the output face of the optic. By blocking that central portion with central spill light blocker **26,** much of this spill light may be removed from the output beam, leaving only the narrow beam desired. The central spill light blocker **26** will reduce the overall efficiency of the optical system, but ensures that more of the light produced is within the desired beam angle. The opaque mask may be primarily obsorptive. In alternative embodiments the mask may be reflective. If reflective the mask may be planar however, in some preferred embodiments the reflective mask would be non-planar. Each primary optic **24** is fitted with a key peg **30** which engages in a corresponding key slot **34** at the side of the mounting hole **32** in plate **28.**

[0021] **Figure 5** illustrates operation of the various optical elements of the luminaire as they relate to a single LED module of an embodiment of the invention. The light output from an LED module **40,** which may contain multiple LEDs of the same or differing colors, enters primary optic **24** via a receiving orifice **42.** Primary optic **24** provides beam collimation and may be a reflector or a lens utilizing total internal refection (TIR). As illustrated in this embodiment, the primary optic **24** is generally parabolic in shape and the receiving orifice **42** is generally located proximate to the focus of the parabolic shape. In After passing through and being constrained by primary optic **24** the light beam the light is further constrained by a set of louver masks as disclosed and described in US Patent Application 2010/0103663 It is advantageous in such systems to provide a louver mask system adjacent to the light source such that differing colors of LEDs are constrained to similar output areas and thus minimize color fringing and spill light. Small louver mask **27** is part of the system which provides this function.

[0022] Because LED array **40** is not a true point source, primary optic **24** will tend to also produce stray light rays that are outside the desired output beam angle. Such rays, for example **52** in **Figure 5,** tend to be emitted through the central portion of the output face of primary optic **24.** Central spill light blocker **26** is placed over this central region so as to block many of these stray light rays and prevent them from reaching the output beam. Light rays that are within the desired beam angle, for example **50** in **Figure 5,** miss the central spill light blocker **26** and continue through the optical system.

[0023] **Figure 6** illustrates an array of small louver masks of an embodiment of the invention. Each louver mask **27** aligns with its associated LED array and primary optic. As the array of small louver masks is manufactured as a single component, it may easily be replaced in order to provide different height louver masks for all LEEDs simultaneously.

[0024] **Figure 7** illustrates a top-hat module of an embodiment of the invention. The top-hat module **29** provides a further optional, level of spill light control, in addition to the small louvers and central spill light blockers.

[0025] **Figure 8** illustrates a cut-away view of an assembled embodiment of the invention as fitted to an automated luminaire **100** of **Figure 1.** From left to right individual LED module(s) **40** is/are paired with primary optic(s) **24,** which in turn is/are fitted with individual central spill light blockers 26, and is/are paired with small louver array mask **27.** Optional top-hat module 29 is fitted to the front of the system. In the embodiment illustrated in **Figure 8,** the LED modules **40** are configured in an array.

[0026] In various embodiments Each LED module **40** may comprise a single LED die of a single color or a group of LED dies of the same or differing colors. For example in one embodiment LED **40** may comprise one each of a Red, Green, Blue and White LED

die. In further embodiments LED 40 may comprise LED chip or package while in yet further embodiments LED 40 may comprise multiple LED chips or packages either under a single primary optic or each package with its own primary optic. In some embodiments these LED die(s) may be paired with optical lens element(s) as part of the LED module. Though the LED modules **40** shown are illustrated as individual pieces, in various embodiments these modules **40** may be set out in an array of multiple modules as one piece or multiple pieces. Similarly the primary optics **24** are illustrated as one piece per LED module. In other embodiments the primary optics may be configured in an array of multiple primary optics to be paired with an array of multiple LED modules.

[0027] In one embodiment of the invention every small louver mask **27** on each module in the luminaire is identical but in further embodiments the louver masks **27** may differ within a single module or between different modules across the luminaire. In yet further embodiments the height of louver mask array **27** may be varied to effect different controlled beam angles for the emitted light. Such combinations of differing optical elements and louver array height may be advantageously chosen so as to allow fine control of the beam shape and quality. The louver mask arrays reduce color fringing or halation and control the beam angle to provide the lighting designer with a well controlled and defined beam of a single homogeneous color.

[0028] It can be seen that changing the heights of louver masks **27** will alter the constrained beam angle of the output beam. A taller louver will produce a narrower beam and a shorter louver will produce a wider beam. The louver masks **27** may be of fixed height or may be adjustable. Louver masks **27** may advantageously be non-reflective so as to avoid spill light, this may be achieved by painting or coating the louver mask with matte black paint, anodizing or other coating as known in the art.

[0029] In a further embodiment louver masks **27** may be translucent or transparent to produce a glow effect within the face of the luminaire.

[0030] LED module **40** may contain LEDs of a single color and type or of multiple colors. The invention is not limited by the number, colors, or types of LEDs used and is applicable with any layout of any number of any type and any color of LEDs or OLEDs.

[0031] **Figure 9** illustrates an automated luminaire embodiment of the invention when fitted with the optional top-hat module. Luminaire **20** contains multiple LED modules each of which is fitted with primary optics **24,** central spill light blocker **26,** and small louver masks **27.** This embodiment is also fitted with optional top-hat module **29.** The top-hat module **29** provides a further optional, level of spill light control, in addition to the small louvers and central spill light blockers.

[0032] While the disclosure has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments may be devised which do not depart from the scope of the disclosure as disclosed herein. The disclosure has been described in detail, it should be understood that various changes, substitutions and alterations can be made hereto without departing from the spirit and scope of the disclosure.

WHAT IS CLAIMED IS:

1. An automated luminaire comprising:

an array of LEDs;

an plurality of primary TIR optics which are arrayed to aligning with the LED array where the primary optics include a central light blocks configured in the center of the primary optic

an plurality of louvers that align with the primary optics.

whereby undesirable light spill is limited and whereby a more constrained light beam is produced.

2. An automated luminaire of claim 1 where the light block is light absorptive.

3. An automated luminaire of claim 1 where the light block is light reflective.

4. An automated luminaire of claim 3 where the light block is light planar.

5. An automated luminaire of claim 3 where the light block is light non planar.

6. An automated luminaire of claim 1 where the primary optic is generally parabolic with a receiving orifice proximate to the focus of the parabola.

7. An automated luminaire comprising:

an array of LEDs;

a plurality of primary optics which are aligned with the LED array where the primary optics include a central light blocks configured in the center of the primary optic

whereby undesirable light spill is limited and whereby a more constrained light beam is produced.

8. An automated luminaire of claim 7 where the primary optic is a solid TIR.

9. An automated luminaire of claim 1 where the primary optic is generally parabolic .

10. An automated luminaire of claim 7 where the light block is light absorptive.

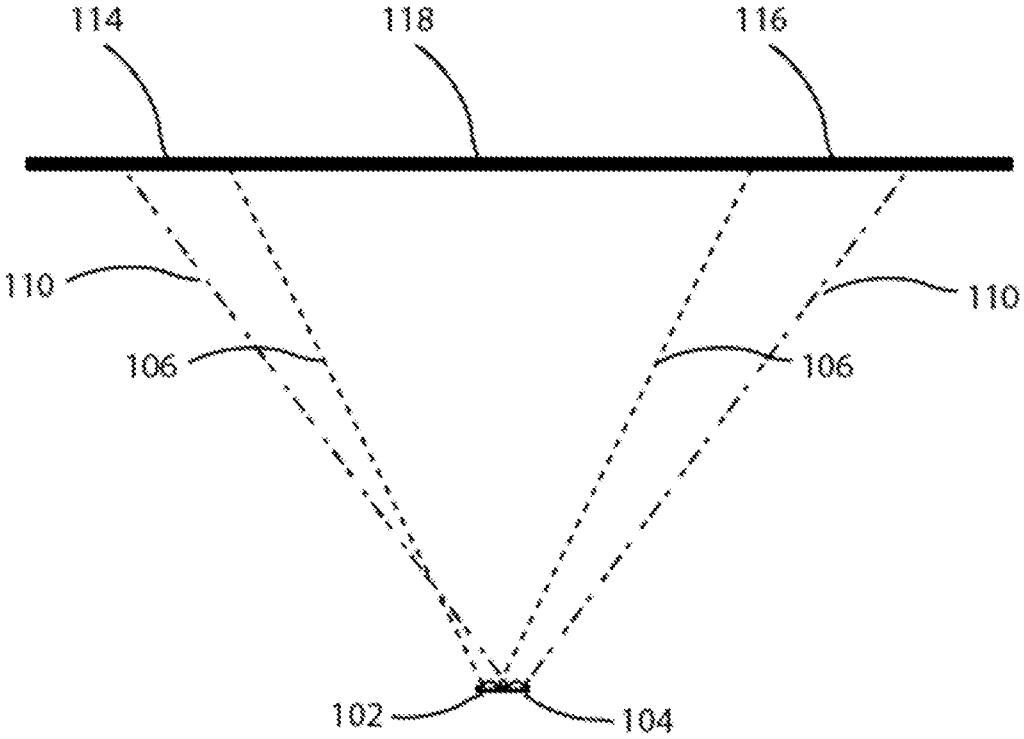
11. An automated luminaire of claim 7 where the light block is light reflective.

12. An automated luminaire of claim 11 where the light block is light planar.

13. An automated luminaire of claim 11 where the light block is light non-planar.

14. An automated luminaire of claim 7 further comprising a plurality of louvers that individually align with individual primary optics.

15. An automated luminaire of claim 14 the array of primary optic louvers are surrounded a larger louver surrounding the individual primary optic louvers.



(Prior art)

FIG 1

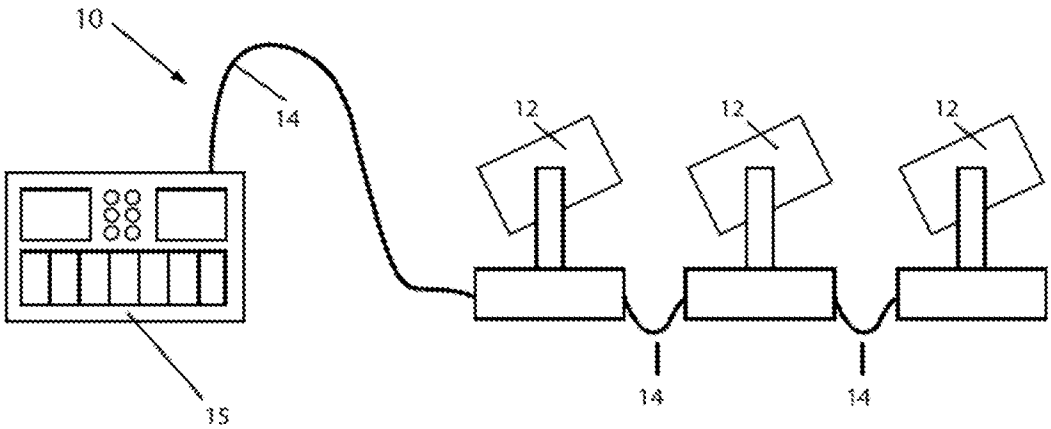


FIG 2

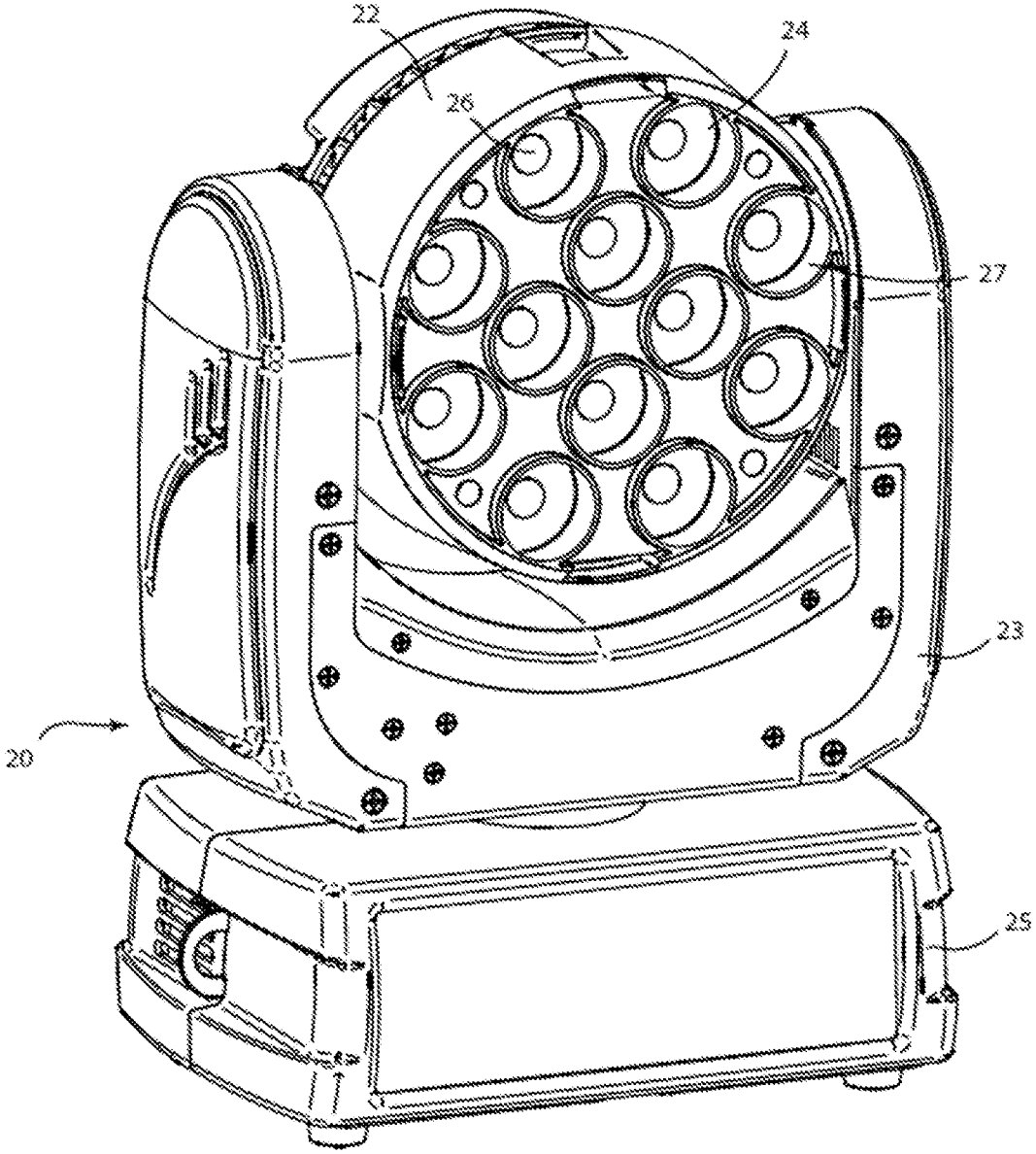


FIG 3

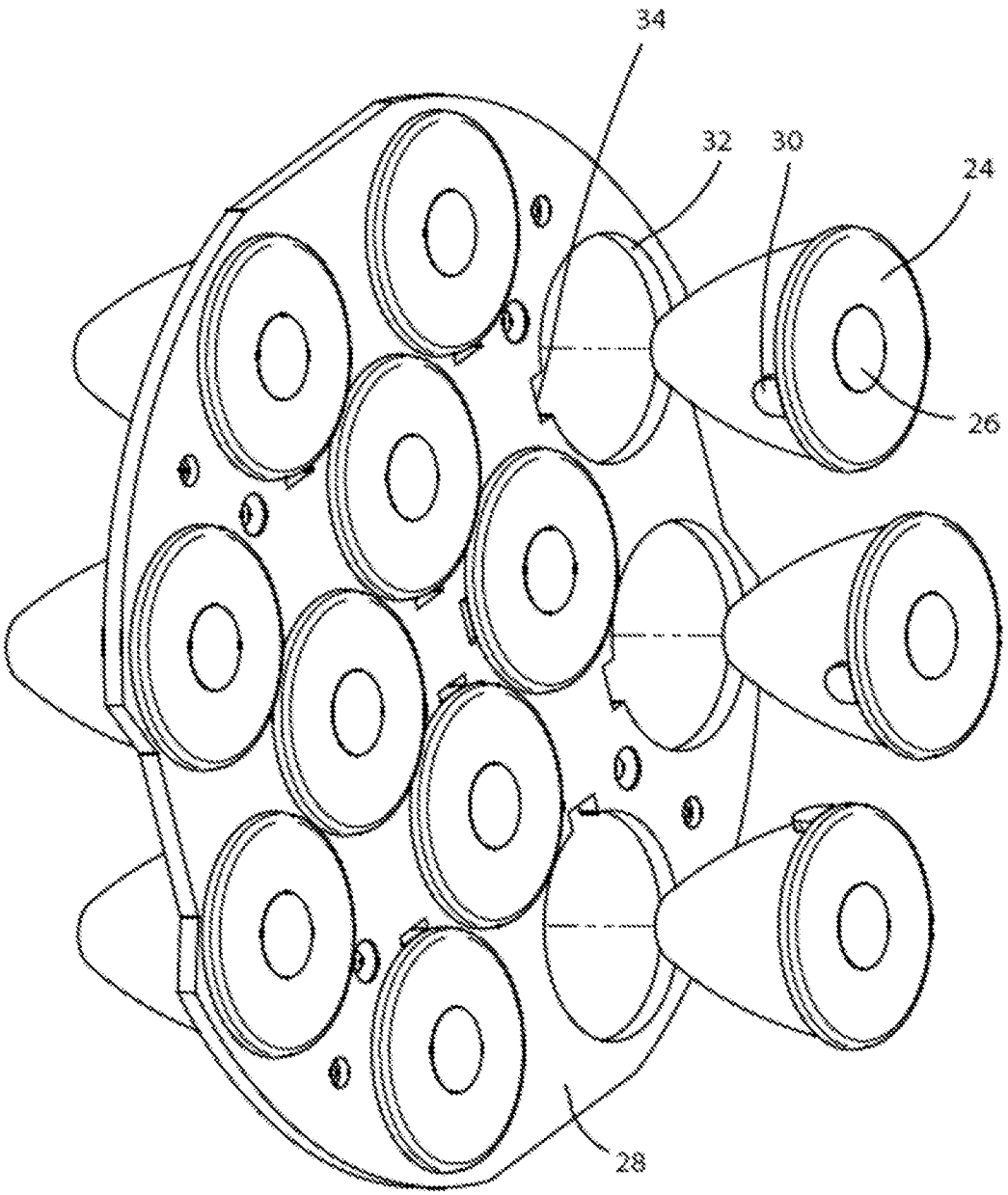


FIG 4

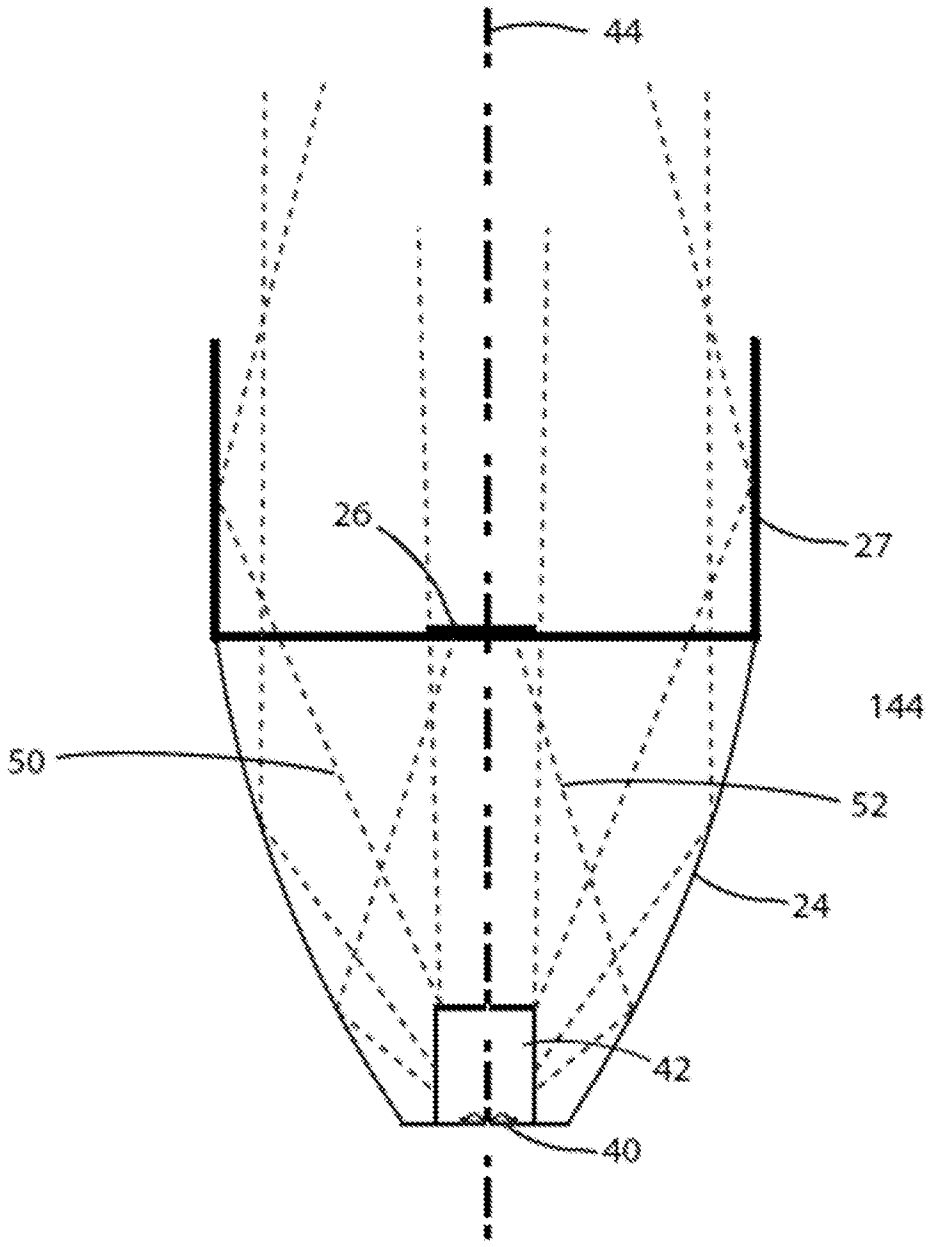


FIG 5

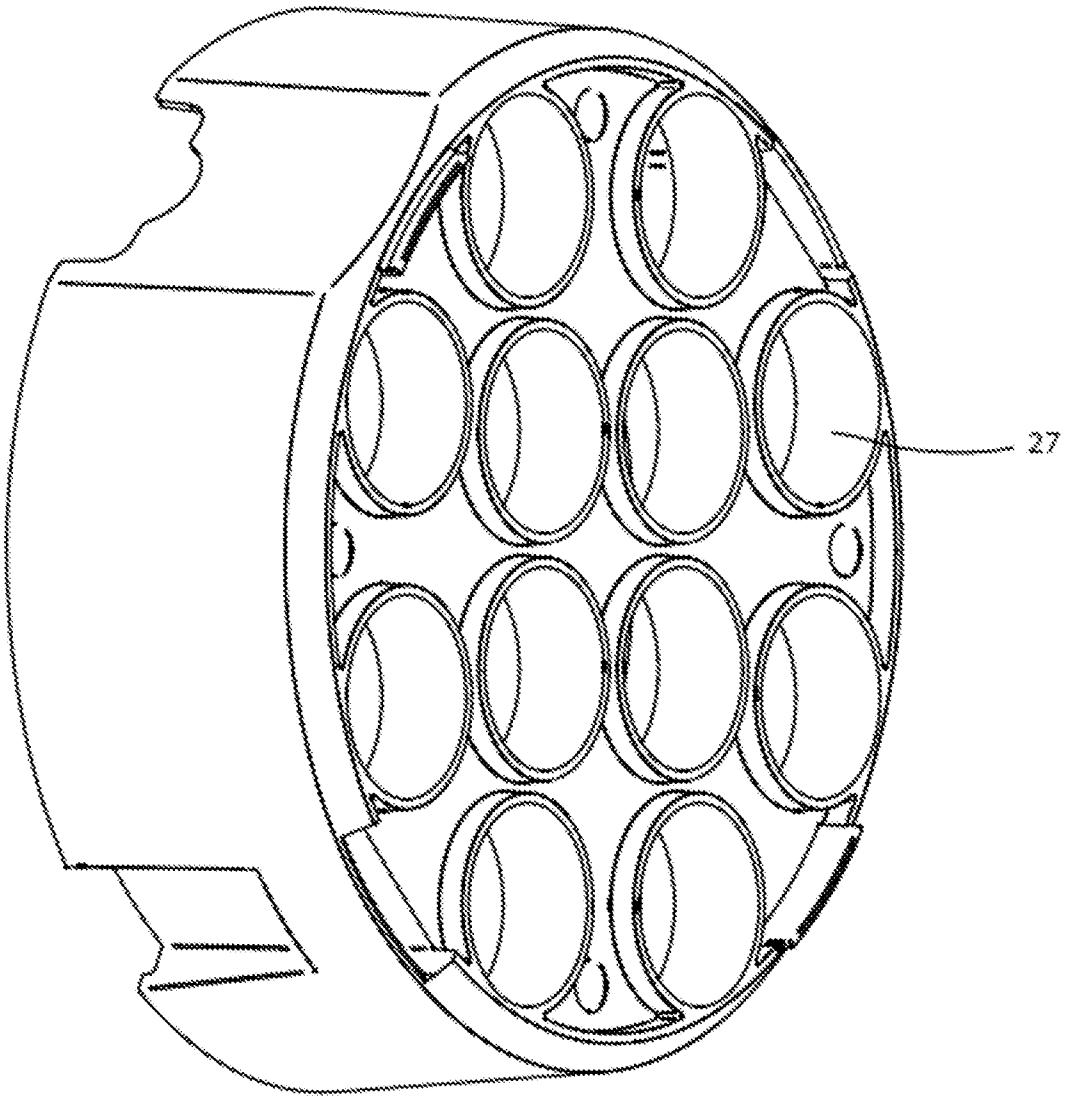


FIG 6

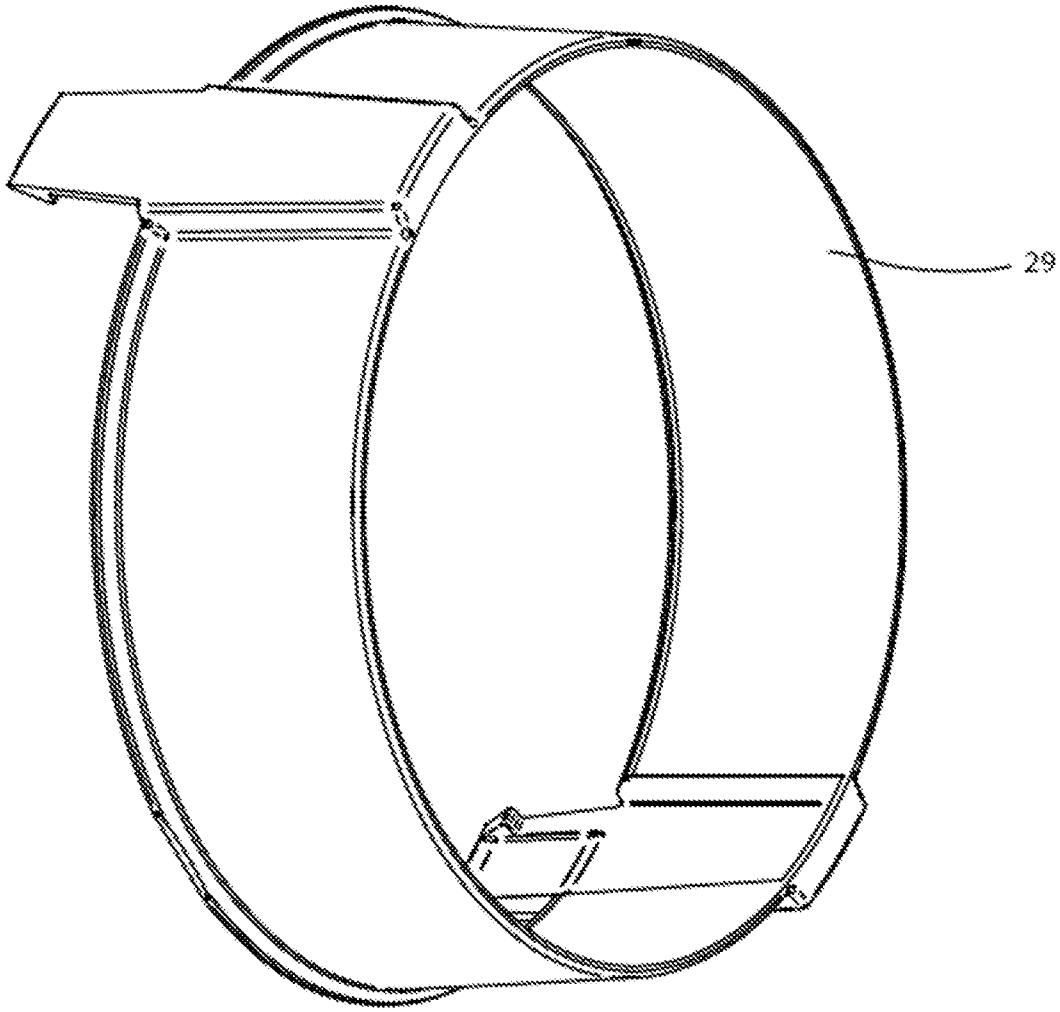


FIG 7

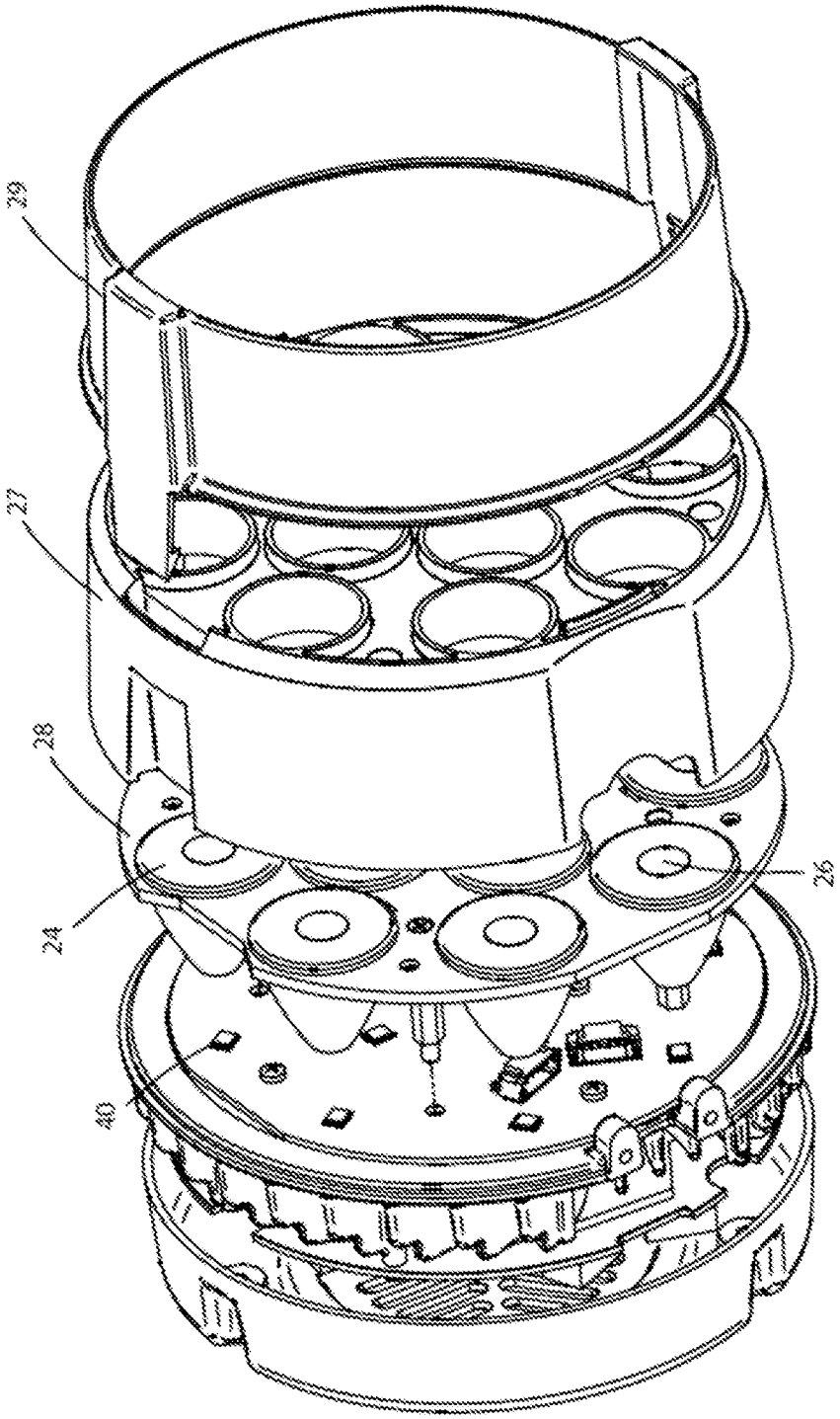


FIG 8

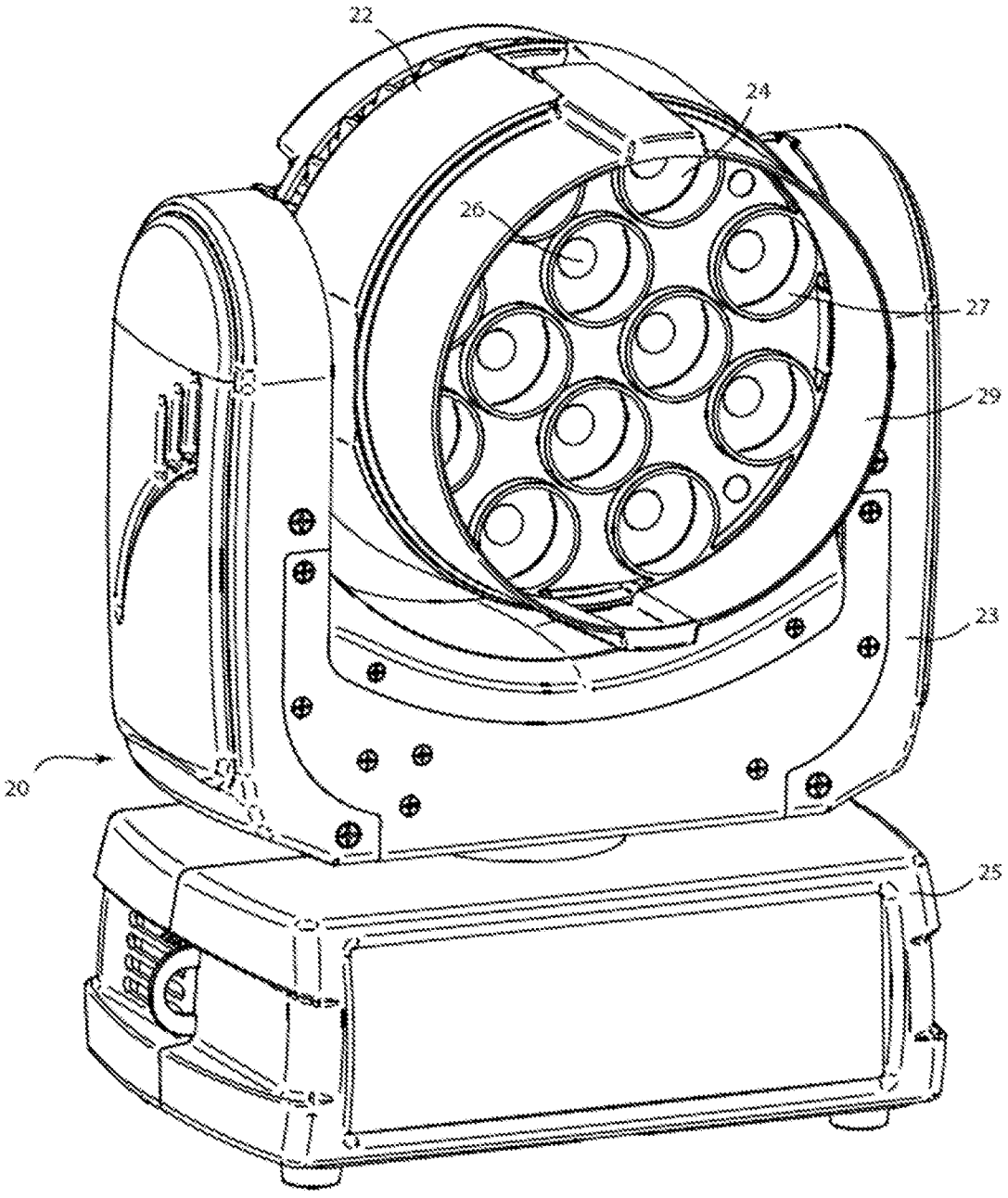


FIG 9

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V5/00 F21V5/04 F21V7/00 F21V11/06 G02B19/00
ADD. F21W131/406 F21Y101/02

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)
F21W F21Y 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 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.
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Y	WO 2011/033424 A1 (KONINKL PHILIPS ELECTRONICS NV [NL] ; HOLTEN PETRUS ADRIANUS JOSEPHUS [ ]) 24 March 2011 (2011-03-24) page 4, line 18 - line 34 page 5, line 4 - line 8 page 5, line 20 - line 22 page 7, line 26 - line 30 figures 1,2,5 -----	1-15

-/- .

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

[X] See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 July 2013	19/07/2013

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/032851

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/204841 A1 (CHEMEL BRIAN [US] ET AL) 12 August 2010 (2010-08-12)	15
A	paragraph [0097] - paragraph [0098] figures 3A,3B	1,7
A	EP 1 710 495 A1 (IGUZZINI ILLUMINAZIONE [IT]) 11 October 2006 (2006-10-11) paragraph [0010] - paragraph [0014] figures 1-3	1,2,6,7, 9,10
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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