(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 436 740 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
28.05.2025 Bulletin 2025/22

(21) Application number: **17733564.3**

(22) Date of filing: **01.04.2017**

(51) International Patent Classification (IPC):
F21S 10/00 *(2006.01)* ***F21V 7/00*** *(2006.01)*
F21V 13/02 *(2006.01)* ***F21V 14/06*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F21V 14/06; F21S 10/005; F21V 7/0091; F21V 13/02; F21W 2131/406; F21Y 2115/10

(86) International application number:
PCT/US2017/025658

(87) International publication number:
WO 2017/173429 (05.10.2017 Gazette 2017/40)

(54) A WASH LIGHT LUMINAIRE WITH SPECIAL EFFECTS CAPABILITIES

EINE WASH LIGHT LEUCHTE MIT SPEZIALEFFEKTEN

UN LUMINAIRE WASH LIGHT AVEC DES CAPACITÉS D'EFFETS SPÉCIAUX

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **01.04.2016 US 201615089116**

(43) Date of publication of application:
06.02.2019 Bulletin 2019/06

(73) Proprietor: **ROBE lighting s.r.o.**
75661 Roznov pod Radhostem (CZ)

(72) Inventors:
- **JURIK, Pavel**
  Prostredni Becva, 756 56 (CZ)
- **VALCHAR, Josef**
  Prostredni Becva, 756 56 (CZ)

(74) Representative: **Murgitroyd & Company**
165-169 Scotland Street
Glasgow G5 8PL (GB)

(56) References cited:
EP-A2- 2 177 816
EP-A2- 2 177 816
EP-B1- 1 550 908
WO-A1-2010/113100
WO-A1-2015/022644
WO-A2-2014/031641
WO-A2-2015/051034

EP 3 436 740 B1

Description

TECHNICAL FIELD OF THE DISCLOSURE

[0001] The present disclosure generally relates to a method for providing a wash light luminaire, specifically to optical systems and a method relating to providing single and multiple beams from a wash light luminaire.

BACKGROUND OF THE DISCLOSURE

[0002] Luminaires with automated and remotely controllable functionality are well known in the entertainment and architectural lighting markets. Such products are commonly used in theatres, television studios, concerts, theme parks, night clubs, and other venues. A typical product will provide control over the functions of the luminaire allowing the operator to control the intensity and color of the light beam from the luminaire that is shining on the stage or in the studio. Many products also provide control over other parameters such as the position, focus, beam size, beam shape, and beam pattern. In such products that contain light emitting diodes (LEDs) to produce the light output it is common to use more than one color of LEDs and to be able to adjust the intensity of each color separately such that the output, which comprises the combined mixed output of all LEDs, can be adjusted in color. For example, such a product may use red, green, blue, and white LEDs with separate intensity controls for each of the four types of LEDs. This allows the user to mix almost limitless combinations and to produce nearly any color they desire.

[0003] Figure 1 illustrates a typical multiparameter automated luminaire system 10. These systems typically include a plurality of multi parameter automated luminaires 12 which typically each contain on-board a light source (not shown), light modulation devices, electric motors coupled to mechanical drive 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 automated luminaire 12 is connected in series or in parallel to data link 14 to one or more control desks 15. The luminaire system 10 is typically controlled by an operator through the control desk 15.

[0004] Luminaires have been provided using non-LED light sources designed to produce a single narrow beam or a plurality of such beams. Such luminaires may use low etendue, High Intensity Discharge (HID) light sources with a small arc gap in order to facilitate the production of tight, almost parallel light beams. U.S. Patent Application Nos. 14/042,758 and 14/042,759 provide examples of such a system. Single and multi-color LED sourced luminaires have also been produced with narrow beam capability using sophisticated collimation systems as, for example, disclosed in U.S. Patent Application No. 14/405,355. LEDs however are high etendue light sources by comparison with HID and it is difficult to produce multiple beam systems using LED light sources.

[0005] Prior art optical systems utilizing multiple LED emitters may be unforgiving when it is desired to produce a homogeneous image with a light output capable of being blended between units to provide seamless coverage. This mode of operation is often called a wash light as it washes the stage with light. Prior art systems will commonly utilize multiple LED light sources and attempt to blend them into a homogeneous whole. This approach is often unsuccessful because the individual differently colored LED emitters are still visible producing a multi-colored effect when viewing the light rather than the desired appearance of a single color. Other prior art systems use a secondary lens but that has the drawback that the output lens may not then be filled completely and all the light will appear to be emitted from a portion at the centre of the output lens. This reduces the performance of the luminaire as a wash light as it is an important feature of wash luminaires that the effective light source be as large as possible in order to soften and reduce shadowing.

[0006] Reference is made to EP2177816, WO2014031641, WO 2010/113100, WO 2015/022644, and EP 1 550 908 which have been cited as relating to the state of the art of the present invention.

[0007] There is a need for a method for producing and controlling a light beam or multiple light beams from an LED sourced wash light luminaire to produce controllable lighting effects from a luminaire with a wash light distribution with a large effective source and true blending output distribution.

Summary

[0008] It will be appreciated that the scope of the invention is in accordance with the claims. Accordingly, there is provided an automated luminaire as defined in claim 1. Further features are provided in accordance with the dependent claims. The specification may also include description of arrangements outside the scope of the claims provided as background and to assist in understanding the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] For a more complete understanding of the present disclosure 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:

FIGURE 1 illustrates a multiparameter automated luminaire lighting system;

FIGURE 2 illustrates the layout of embodiments of major components of a light engine of a luminaire generating a flower effect;

FIGURE 3 illustrates more detail of some of the embodiments of the major components and layout

of the light engine illustrated in Figure 2;
FIGURE 4 illustrates an embodiment of additional support structure for the light guide assembly;
FIGURE 5 illustrates an embodiment of a light guide without any supporting structure;
FIGURE 6 illustrates detail of an embodiment of the optical softening diffuser arm;
FIGURE 7 illustrates a luminaire including an embodiment of the light guide;
FIGURE 8 illustrates Figure 7 with the output lenses in place;
FIGURE 9 illustrates detail of an embodiment of the optical system with the lenses in the wide angle position;
FIGURE 10 illustrates detail of an embodiment of the optical system with the lenses in the narrow angle position;
FIGURE 11 illustrates a complete luminaire used in a lighting system illustrated in Figure 1; and
FIGURE 12 illustrates detail of a lens of the optical system

DETAILED DESCRIPTION OF THE DISCLOSURE

[0010] Preferred embodiments of the present disclosure are illustrated in the Figures, like numerals being used to refer to like and corresponding parts of the various drawings.

[0011] The present disclosure generally relates to a method for providing special effects in wash light luminaires, specifically to a method relating to providing controllable lighting effects from a luminaire with a wash light distribution with a large effective source and true blending output distribution.

[0012] Figure 2 illustrates the layout of embodiments of major components of one light engine 120 of a luminaire generating a flower effect. Light emitting module 20 comprises a single LED or an array of LEDs, which may include a primary optic (not shown). Light emitting module 20 may contain a single color of LEDs or may contain multiple dies, each of which may be of common or differing colors. For example, in one embodiment light emitting module 20 may comprise one each of a Red, Green, Blue and White LED. In further embodiments light emitting module 20 may comprise a single LED chip or package while in yet further embodiments light emitting module 20 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 light-emitting module. In a further embodiment light emitting module 20 may comprise more than four colors of LEDs. For example, seven colors may be used, one each of a Red, Green, Blue, White, Amber, Cyan, and Deep Blue/UV LED die.

[0013] The light output from the LEDs in light emitting module 20 enters light guide optic 22 contained within protective sleeve 24. Light guide optic 22 may be a device utilizing internal reflection so as to collect, homogenize and constrain and conduct the light to exit port 23. Light guide optic 22 may be a hollow tube with a reflective inner surface such that light impinging into the entry port may be reflected multiple times along the tube before leaving at the exit port 23. Light guide optic 22 may be a square tube, a hexagonal tube, a heptagonal tube, an octagonal tube, a circular tube, or a tube of any other cross section. In a further embodiment, light guide optic 22 may be a solid rod constructed of glass, transparent plastic, or other optically transparent material where the reflection of the incident light beam within the rod is due to "total internal reflection" (TIR) from the interface between the material of the rod and the surrounding air. The integrating rod may be a square rod, a hexagonal rod, a heptagonal rod, an octagonal rod, a circular rod, or a rod of any other cross section. Light guide optic 22, whether solid or hollow, and with any number of sides, may have entry port 21 and exit port 23 that differ in cross sectional shape. For example, a square entry port 21 and an octagonal exit port 23. Further, light guide optic 22 may have sides which are tapered so that the entrance aperture is smaller than the exit aperture. The advantage of such a structure is that the divergence angle of light exiting the light guide optic 22 at exit port 23 will be smaller than the divergence angle for light entering the light guide optic 22. The combination of a smaller divergence angle from a larger aperture serves to conserve the etendue of the system. Thus, a tapered light guide optic 22 may provide similar functionality to a condensing optical system. In a preferred embodiment of the disclosure, light guide optic 22 has both a square entry port 21 and a square exit port 23. For the desired flower reminiscent effect, it is advantageous to use shapes with opposing sides and to have the same shape cross section along the length of the light guide optic 22.

[0014] Light guide optic 22 may have an aspect ratio where its length is much greater than its diameter. The greater the ratio between length and diameter, the better the resultant mixing and homogenization will be. Light guide optic 22 may be enclosed in a tube or protective sleeve 24 that provides mechanical protection against damage, scratches, and dust. In the preferred embodiment, light guide optic 22 is of such a length so as to collimate and direct but deliberately provide incomplete homogenization of the light coming from individual LEDs on light emitting module 20. This incomplete homogenization may be advantageously utilized in the remainder of the optical system. Similarly, the exit port of light guide 22 is polished, rather than being diffused or textured, to maintain the incomplete homogenization of the input light beams. In one embodiment the beams are less than 50% homogenized such that individual beams or colors from separate LEDs are still clearly visible.

[0015] Light guide optic 22 within its protective sleeve 24 is mounted such that it may be freely rotated along its long, optical, axis through gear 32 and motor (not shown) supported by bearing 66. Rotating light guide 22 will

cause the emitted light beams from exit port 23 to also rotate around the optical axis of the system. In fact, the light beam movement and rotation will be complex, as a function of the rotation of the input port of light guide optic 22 across the array of LEDs in fixed light emitting module 20 and the total internal reflection within the rotating light guide. Thus, the light beams exiting the light guide optic 22 will present a complex and dynamic pattern of moving beams. Light guide optic 22 may be rotated in either direction and at any speed under control of the operator.

[0016] With the disclosure in its basic form, the light from the exit port 23 of light guide optic 22 will be directed towards and through lens 40 that serves to further control the angle of the emitted light beam. Lens 40 may be moved towards and away from light guide optic 22 in the direction 43 along the optical axis of the system shown by line 41. In the position where lens 40 is at its furthest separation from the exit port 23 of light guide optic 22 the emitted light beam will have a narrow beam angle. In the position where lens 40 is at its closest separation from the exit port 23 of light guide optic 22 the emitted light beam will have a wide beam angle. Intermediate positions of lens 40 with respect to exit port 23 of light guide optic 22 will provide intermediate beam angles. Lens 40 may advantageously be configured as an achromat so as to minimize chromatic aberration of the emitted light beam or beams. The system illustrated herein utilizes a single lens element as lens 40 to provide output beam control. The disclosure is, however, not so limited, and further embodiments may contain different numbers and types of lenses or other optical systems as well known in the art. In particular, further embodiments may utilize systems where lens 40 comprises multiple elements. In further embodiments, lens 40 may comprise a number of optical lens elements whose relationship to each other is not fixed, and can alter. The elements of lens 40 may be meniscus lenses, plano convex lenses, bi-convex lenses, holographic lenses, aspheric lenses, or other lenses as well known in the art. The elements of lens 40 may be constructed of glass, transparent plastic, or other optically transparent material as known in the art.

[0017] In a preferred embodiment, lens 40 comprises a single element constructed, by the use of aspheric surfaces or otherwise, to exhibit achromatic properties such that the colors in the light beam remain homogenized and do not produce objectionable colored fringing to the light beam.

[0018] With the layout as described, the effect from the luminaire will be that of a complex pattern of a plurality of light beams created by the reflection of the individual beams from the LEDs in light emitting module 20 within light guide optic 22. As no diffusion or other homogenization is provided, these beams will remain in differing colors and patterns through projection lens system comprising lens 40. As the light guide optic 22 is rotated, and lens 40 is moved towards and away from the exit port 23 of light guide optic 22, the effect will be that of a flower or spreading pattern of beams that opens and closes as the lenses are moved.

[0019] To change the luminaire into wash light mode instead of beam effect, diffuser arm 26 may be swung across the light beam proximate to exit port 23 of light guide optic 22. Diffuser arm 26 may contain a number of diffusers each of which may have different diffusion properties. In the embodiment illustrated, diffuser arm 26 is fitted with first diffuser 28 and second diffuser 30, however further embodiments may have differing numbers of diffusers. In operation diffuser arm 26 is rotated such that one of the diffusers 28 or 30 is positioned proximate to exit port 23 of light guide optic 22 and will serve to diffuse and homogenize the light beams emitting from exit port 23 before they pass into the remainder of the optical system. The diffuser serves to merge the light beams into a single homogenized beam and to increase the spread of the light beam. Differing strengths or properties of diffuser 28 or 30 may provide narrow or wide homogenized beams without the flower effect or for lower powered diffusers a softening of the flower effect. In this mode of operation lens 40 will continue to control the overall size of the homogenized beam.

[0020] Figure 3 illustrates more detail of some of the embodiments of the major components and layout of the light engine 120 illustrated in Figure 2. More specifically, in Figure 3, exit port 23 of light guide optic 22 and the means for moving diffuser 28 and 30 across that exit port can more clearly be seen. Sub Figure 3a illustrates the system in beam flower effect mode where diffuser arm 26 is rotated such that neither diffuser 28 nor diffuser 30 are positioned across exit port 23. In this position the undiffused light beam presents the flower effect.

[0021] Motor 33 provides the motion for rotating light guide optic 22 through gear 32, and motor 35 provides the motion for diffuser arm 26. Similar motors and drive systems as well known in the art provide the motion for lens 40 along the optical axis of the luminaire. Motors 33 and 35 may be stepper motors, servo motors, linear actuators, solenoids, DC motors, or other mechanisms as well known in the art. In the embodiment shown, the motors 33 and 35 operate through gear systems. For example, motor 33 drives gear 32. Other mechanisms for actuating the desired movement as are well known in the art are also contemplated.

[0022] Sub Figure 3b illustrates the system in wash light mode where diffuser arm 26 is rotated such that second diffuser 30 is positioned across exit port 23. In this position the light beam is diffused by second diffuser 30 and presents a homogenized beam without the flower effect.

[0023] Figure 4 illustrates the light guide assembly including its support structure. Sub Figures 4a, 4b, 4c, and 4d show the assembly from fully exploded (4a) through fully assembled (4d) to aid comprehension of the structure. Light guide optic 22 with exit port 23 is inserted into protective sleeve 24. Protective sleeve 24 has, as part of its structure, bearing support surfaces 64 and 68. Bearing support surfaces 64 and 68 engage with

bearings 66 and 70 respectively. This allows protective sleeve 24 (and thus light guide optic 22) to rotate within bearings 66 and 70. Also attached to protective sleeve 24 is gear 62 which meshes with gear 32 shown in Figure 3 that is in tum driven by motor 33. The assembly formed by protective sleeve 24, light guide optic 22, bearings 66 and 70, and gear 62, is supported within holder 72 such that (as shown in Figure 4d) light guide optic 22 protrudes from the base of holder 72 and aligns with light emitting module 20. This assembly also serves to maintain a small separation between entry port 21 of light guide optic 22 and light emitting module 20 such that light transfer from light emitting module 20 and light guide optic 22 is maximized but the two surfaces do not touch.

[0024] It is envisaged that light guide assemblies as shown in Figure 4 could be used in multiples or arrays within a single luminaire. For example, an array of rotating light guide assemblies may be used where each light guide is positioned above its own light emitting module. In these embodiments a single motor may drive the rotation of multiple light drive assemblies.

[0025] Figure 5 illustrates an embodiment of a light guide optic 22 without its support structure. Light guide optic 22 contains entry port 21 and exit port 23. In the embodiment illustrated, light guide optic 22 is tapered and has both a square entry port 21 and a square exit port 23.

[0026] Figure 6 illustrates detail of an embodiment of the optical softening diffuser arm 26. Diffuser arm 26 is shown in two positions in Figure 6. In position A, diffuser arm 26 is positioned such that second diffuser 30 is across exit port 23 (shown dashed as it is under the diffuser). Also illustrated is an optional feature of diffuser arm 26. First diffuser 28 includes mask 29 which serves to constrain the light to a masked shape. Mask 29 is an opaque mask with a central open aperture with, in this case, a hexagonal shape. Mask 29 helps to constrain the projected beam into a more rounded, non square, shape. Mask 29 may be of any shape, not just the hexagon illustrated herein, including but not limited to circular, hexagonal, or octagonal.

[0027] In position B, diffuser arm 26 is positioned such that first diffuser 28 including mask 29 is across exit port 23 (shown dashed as it is under the diffuser). Diffusers 28 and 30 may offer differing amounts or types of diffusion producing different beam spreads in the output. Diffusers 28 and 30 may be patterned or molded glass, or plastic, or may be holographic diffusers or other diffuser types as well known in the art. Although two different diffusers 28 and 30 are shown here the disclosure is not so limited and any number of diffusers or homogenizers may be affixed and selected as part of diffuser arm 26.

[0028] Figure 7 illustrates the layout of the optical support plate 100 of an alternative embodiment of a wash light with special effects luminaire employing an array of light engine modules. Optical support plate 100 includes a number of LED light sources each with their own associated light guide 104. In the illustrated embodiment 19 LED light sources arranged with a single centre LED light source having two concentric rings of 6 and 12 LED light sources around it are utilized but in practice use of any number is envisaged. For example, the outer ring may be omitted providing a system with 7 LED light sources, or an extra ring or rings may be added providing larger numbers of LED light sources. The 19 LED light sources and light guides 104 are here arranged in concentric rings but may be also arranged in other configurations. Some percentage of the LED light sources and light guides 104 may be fitted with the optical softening diffuser arm 26 system to provide a module as illustrated in Figures 2 through 6. In the embodiment illustrated, a single central LED light source is fitted with the system as light engine 120. In practice any number of the light guides 104 may be fitted with optical softening diffuser system 120. However, in a preferred embodiment, the use of a single centrally mounted light engine 120 surrounded by LED light sources with "fully homogenizing" or at least more homogenizing light guides 104 provides a good combination of effects and standard wash light usage. Light guides 104 that are not fitted with optical softening diffuser system 120 may have the exit ports patterned, textured, or diffused or may have diffusion filters similar to diffusers 28 and 30 permanently attached to or constructed as part of the exit port of the light guide or the light guides may be otherwise designedly shaped to "fully homogenize" light such that these guides always produce a smooth, homogenized light output. In contrast, light guides 104 that are fitted with optical softening diffuser system 120 may be remotely controlled to produce either a smooth homogenized output, or a harder edged flower effect as desired by inserting or removing the diffusers 28 and 30 across the beam.

[0029] Figure 8 illustrates the system shown in Figure 7 with the optical support plate 100, this time fitted with output lens module 130. Output lens module 130 contains an array of lenses, equal in number to the LED light sources and associated light guides shown in Figure 7. The lenses may be of differing outline shapes in order to fit together into an aesthetically pleasing design and also to minimize any space wasted in between lenses. Such gaps between lenses may reduce the output of the system, and produce undesirable visible gaps in light output when viewing the luminaire. The design presented here is similar to that of a spider's web and provides both functional purpose and aesthetic appeal. The lenses, although of differing shapes, may have substantially the same optical properties. For example, central lens 132 may be the same optical strength and provide the same optical effect as edge lens 134. In other embodiments, the lenses associated with LED light sources that are fitted with optical softening diffuser system 120 such as the central lens 132 associated with the central LED light source in Figure 7, may have the same or different optical properties as the edge lenses 134 associated with standard light guide 104.

[0030] Figures 9 and 10 illustrate side elevation views

of the system as shown in Figure 8. In Figure 9 the output lens module 130 containing an array of lenses 134 and 132 is positioned close to the light guides 104 and optical softening diffuser system 120 on the central light engine module. In the embodiment illustrated only the central light engine module (light engine 120) is of the reduced homogenization type in a center position. In other embodiments this type of module can be placed in a non central location. In further embodiments there may be more than one of these types of light engines 120. While the reduced homogenizing module may include an electable diffusion module so that its light may be included in a full wash light mode, in other embodiments a full wash light mode can be achieved by a reduced homogenizing light module without a diffuser but a system that dims to dim out such light modules during a full wash light mode. This dimming may be automatically tied in operation when the user selects a full wash mode or in other embodiments it might be manual. In further embodiments all of the modules are of the reduced homogenization type and they all have selectable diffusion module(s). In some embodiments the individual light engine modules are controlled individually and in other embodiments the modules are controlled in groups. The groups may be of like with like or of like geometric location in the array such as outer ring, inner ring, etc. These controls may include a color intensity diffusion flag if so equipped, image multiplier if so equipped, and zoom lens if mechanically configured to be independently controllable (not shown in the figures).

[0031] In the position of output from lenses 134 and 132 in Figure 9 the light output will be at a wider angle. In Figure 10 output lens module 130 has been moved in direction 136 away from light guides 104 and optical softening diffuser system 120. In this position the output from lenses 134 and 132 will be a narrow angle. Positions of lens module 130 intermediate to those positions shown in Figures 9 and 10 will produce intermediate beam angles. As the lens module is moved there will be a continuously variable beam angle, or zoom, of the light beams emitted from the light guides 104.

[0032] If optical diffusers 28 and 30 are not positioned across the beam in light engine 120 then the lens when it is in its distant, narrow angle, position may be focused on the LED and the multiple internal reflections in light guides optically multiply the chip shape which creates a sharp distinct flower effect. If the lens is moved to the close, wide angle, position then, even without the diffusers 28 and 30 in place, light engine 120 will produce a smoother wash style beam with a less distinct flower effect. In either case, with diffuser 28 or 30 in place the system in light engine 120 will produce a smooth homogenized effect, without the flower effect.

[0033] In the embodiment illustrated, the movement of output lens module 130 is produced by motors 106 acting on lead screws 108. Although a lead screw system is illustrated here, the disclosure is not so limited and other methods of moving the lenses such as belt systems, linear actuators, rack and pinion gears, and other methods well known in the art are envisaged. The output lens module 130 is supported by guides 110 such that the motion is constrained to be back and forth along the optical axis of the luminaire.

[0034] In the embodiment illustrated the entire array of lenses 134 and 132 moves together as a single module. However, in further embodiments individual lenses or groups of lenses may have their own motor drive systems and be capable of independent movement along the optical axis. In particular, any lenses associated with LED light sources that are fitted with optical softening diffuser system 120 such as the central light engine module in Figure 7, may move with the output lens module 130, may be fitted with independent motor control separate from that for the output lens module 130, or may be static with a fixed beam angle.

[0035] The design of lenses 132 and 134 in output lens module 130 is such that the individual homogenized beams of light from each of the light beams emitted from the light guides 104 are constrained to further overlap and mix as they leave the output lens module 130 providing a smooth, contiguous light beam with a wash light distribution with a large effective source (comprising the total output lens module 130) and true blending output distribution.

[0036] Figure 11 illustrates a complete automated luminaire 150as may be used in a lighting system such as that illustrated in Figure 1. Lens array 130 is visible on the external face of the automated luminaire 150.

[0037] Figure 12 illustrates a further embodiment of the output lenses 134 or 132 as may be used in the described system. As previously described, it is advantageous for such lenses to be achromatic in their behavior. In other words, they should present as little as possible difference between their optical effect on different colors of light to avoid objectionable colored fringing around the edge of light beams. In a preferred embodiment edge lens 134 comprises a single element constructed, by the use of aspheric surfaces or otherwise, to exhibit achromatic properties. In the embodiment illustrated in Figure 12, the edge lens 134 does not have a smooth surface, instead there is a microstructure on the lens surface or surfaces. The lens surface or surfaces are covered with small engineered depressions similar to those on a golf ball. The depressions 140 are shown here larger than in reality for ease of illustration. In one embodiment the depressions 140 may be 0.3 mm (millimeter) - 0.4 mm in diameter with a depth of only 0.0001 mm. These depressions 140, along with the use of aspheric lens surfaces, may be used on one or both sides of edge lens 134 so as to provide achromatic operation of the lens.

[0038] In operation of the luminaire, the LED sources feeding light guides 104 and optical softening diffuser system 120 may be individually or collectively controlled as to color and intensity to provide either a coordinated wash light or an effects unit as desired. In particular, any LED sources fitted with optical softening diffuser system 120 may be controlled such that either they produce the

aforementioned dynamic flower effect, or produce a smooth wash beam to match standard light guides 104. The operator may choose to combine or mix these effects to achieve a desired result.

[0039] 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 scope of the disclosure.

Claims

1. An automated luminaire, comprising:

a first central light engine module (120) comprising:

a first light emitting diode (LED) array source (20) configured to emit a first plurality of colored light beams;
a first light guide (22) optically coupled to the first LED array source and configured to receive the first plurality of colored light beams emitted by the first LED array source and emit a first homogenized light beam, the first homogenized light beam including visible separation of at least some of the received first plurality of colored light beams; and
a first lens (40, 132) optically coupled to the first light guide and configured to receive the first homogenized light beam and to move along an optical axis of the first light guide, the first lens (40, 132) being configured to project a pattern of the visibly separated colored light beams in the first homogenized light beam, the pattern changing size as the first lens moves along the optical axis of the first light guide; and
a plurality of second non-central light engine modules (104) surrounding the first light engine module, each second light engine module comprising:

a second LED array source (20) configured to emit a second plurality of colored light beams;
a plurality of second light guides (22) optically coupled to the second LED array sources and configured each to receive the second plurality of colored light beams emitted by the second LED array sources and emit a second homogenized light beam, wherein the second light guides are more homogenizing than the first light guide; and
a plurality of second lenses (134) optically coupled to the second light guides (22) and configured each to receive a second homogenized light beam and to move along an optical axis of the second light guides, wherein the second lenses project each a light beam having a beam angle determined by a distance of the second lens from the second light guide;
wherein the plurality of the lenses (40,120) defines a zoom lens system;
wherein the zoom lens system is configured to project the received light with a flower reminiscent effect.

2. The automated luminaire of claim 1, wherein the first light guide (22) is configured to rotate about the light beam axis.

3. The automated luminaire of claim 1, wherein at least one light engine module of the first light engine module and the plurality of second light engine modules comprises an image multiplying optical modulator configured to be moved into the light beam emitted by the light guide of the at least one light engine module.

4. The automated luminaire of claim 1, wherein at least one light engine module of the first light engine module and the plurality of second light engine modules comprises a diffuser (28, 30) configured to be moved into the light beam emitted by the light guide (22) of the at least one light engine module.

5. The automated luminaire of claim 1, wherein at least one lens of the first lens and the second lenses of the plurality of second light engine modules comprises a surface including a plurality of depressions (140).

6. The automated luminaire of claim 1, wherein the second lenses of the plurality of second light engine modules are mechanically coupled and move together relative to their associated second light guides.

7. The automated luminaire of claim 1, wherein the first light engine module is one of a plurality of first light engine modules.

8. The automated luminaire according to any of claims 1, 2, 3, 4, 6 or 7, further comprising control electronics coupled to the first light engine module and the plurality of second light engine modules and configured to control the first light engine module and the

plurality of second light engine modules.

9. The automated luminaire of Claim 8, wherein the control electronics is configured to individually control a brightness of one or more LEDs in the first LED array source and to individually control a brightness of one or more LEDs in each of the second LED array light sources.

10. The automated luminaire of Claim 1, wherein the light guides comprise a collimating rod.

Patentansprüche

1. Eine automatische Leuchte, die Folgendes beinhaltet:

ein erstes, mittiges Light-Engine-Modul (120), das Folgendes beinhaltet:

eine erste Leuchtdioden(LED)-Array-Quelle (20), die dazu konfiguriert ist, eine erste Vielzahl von farbigen Lichtstrahlen auszustrahlen;
einen ersten Lichtleiter (22), der optisch mit der ersten LED-Array-Quelle gekoppelt ist und dazu konfiguriert ist, die von der ersten LED-Array-Quelle ausgestrahlte erste Vielzahl von farbigen Lichtstrahlen zu empfangen und einen ersten homogenisierten Lichtstrahl auszustrahlen, wobei der erste homogenisierte Lichtstrahl eine sichtbare Trennung mindestens einiger der empfangenen ersten Vielzahl von farbigen Lichtstrahlen umfasst; und
eine erste Linse (40, 132), die optisch mit dem ersten Lichtleiter gekoppelt ist und dazu konfiguriert ist, den ersten homogenisierten Lichtstrahl zu empfangen und sich entlang einer optischen Achse des ersten Lichtleiters zu bewegen, wobei die erste Linse (40, 132) dazu konfiguriert ist, ein Muster der sichtbar getrennten farbigen Lichtstrahlen in dem ersten homogenisierten Lichtstrahl zu projizieren, wobei das Muster seine Größe ändert, während sich die erste Linse entlang der optischen Achse des ersten Lichtleiters bewegt; und

eine Vielzahl von zweiten, nicht mittigen Light-Engine-Modulen (104), die das erste Light-Engine-Modul umgeben, wobei die zweiten Light-Engine-Module jeweils Folgendes beinhalten:

eine zweite LED-Array-Quelle (20), die dazu konfiguriert ist, eine zweite Vielzahl von farbigen Lichtstrahlen auszustrahlen;
eine Vielzahl von zweiten Lichtleitern (22), die optisch mit den zweiten LED-Array-Lichtquellen gekoppelt sind und dazu konfiguriert sind, jeweils die von den zweiten LED-Array-Lichtquellen ausgestrahlte zweite Vielzahl von farbigen Lichtstrahlen zu empfangen und einen zweiten homogenisierten Lichtstrahl auszustrahlen, wobei die zweiten Lichtleiter homogenisierender sind als der erste Lichtleiter; und
eine Vielzahl von zweiten Linsen (134), die optisch mit den zweiten Lichtleitem (22) gekoppelt sind und dazu konfiguriert sind, jeweils einen zweiten homogenisierten Lichtstrahl zu empfangen und sich entlang einer optischen Achse der zweiten Lichtleiter zu bewegen, wobei die zweiten Linsen jeweils einen Lichtstrahl projizieren, der einen durch einen Abstand der zweiten Line von dem zweiten Lichtleiter bestimmten Strahlwinkel aufweist;

wobei die Vielzahl der Linsen (40,120) ein Zoom-Linsensystem definiert;
wobei das Zoom-Linsensystem dazu konfiguriert ist, das empfangene Licht mit einem blumenähnlichen Effekt zu projizieren.

2. Automatische Leuchte gemäß Anspruch 1, wobei der erste Lichtleiter (22) dazu konfiguriert ist, sich um die Lichtstrahlachse zu drehen.

3. Automatische Leuchte gemäß Anspruch 1, wobei mindestens ein Light-Engine-Modul von dem ersten Light-Engine-Modul und der Vielzahl von zweiten Light-Engine-Modulen einen bildmultiplizierenden optischen Modulator beinhaltet, der dazu konfiguriert ist, in den von dem Lichtleiter des mindestens einen Light-Engine-Moduls ausgestrahlten Lichtstrahl bewegt zu werden.

4. Automatische Leuchte gemäß Anspruch 1, wobei mindestens ein Light-Engine-Modul von dem ersten Light-Engine-Modul und der Vielzahl von zweiten Light-Engine-Modulen einen Diffusor (28, 30) beinhaltet, der dazu konfiguriert ist, in den von dem Lichtleiter (22) des mindestens einen Light-Engine-Moduls ausgestrahlten Lichtstrahl bewegt zu werden.

5. Automatische Leuchte gemäß Anspruch 1, wobei mindestens eine Linse von der ersten Linse und den zweiten Linsen der Vielzahl von zweiten Light-Engine-Modulen eine eine Vielzahl von Vertiefungen (140) umfassende Oberfläche beinhaltet.

6. Automatische Leuchte gemäß Anspruch 1, wobei die zweiten Linsen der Vielzahl von zweiten Light-

Engine-Modulen mechanisch gekoppelt sind und sich miteinander relativ zu ihren zugehörigen zweiten Lichtleitern bewegen.

7. Automatische Leuchte gemäß Anspruch 1, wobei das erste Light-Engine-Modul eines einer Vielzahl von ersten Light-Engine-Modulen ist.

8. Automatische Leuchte gemäß einem der Ansprüche 1, 2, 3, 4, 6 oder 7, die ferner Folgendes beinhaltet: Steuerelektronik, die mit dem ersten Light-Engine-Modul und der Vielzahl von zweiten Light-Engine-Modulen gekoppelt ist und dazu konfiguriert ist, das erste Light-Engine-Modul und die Vielzahl von zweiten Light-Engine-Modulen zu steuern.

9. Automatische Leuchte gemäß Anspruch 8, wobei die Steuerelektronik dazu konfiguriert ist, eine Helligkeit von einer oder mehreren LEDs in der ersten LED-Array-Quelle einzeln zu steuern und eine Helligkeit einer oder mehrerer LEDs in jeder der zweiten LED-Array-Quellen einzeln zu steuern.

10. Automatische Leuchte gemäß Anspruch 1, wobei die Lichtleiter einen Kollimationsstab beinhalten.

Revendications

1. Un luminaire automatisé, comprenant :

un premier module générateur de lumière central (120) comprenant :

une première source à réseau de diodes électroluminescentes (DEL) (20) configurée pour émettre une première pluralité de faisceaux lumineux colorés ;
un premier guide de lumière (22) couplé optiquement à la première source à réseau de DEL et configuré pour recevoir la première pluralité de faisceaux lumineux colorés émis par la première source à réseau de DEL et émettre un premier faisceau lumineux homogénéisé, le premier faisceau lumineux homogénéisé incluant une séparation visible d'au moins certains faisceaux lumineux parmi la première pluralité de faisceaux lumineux colorés reçue ; et
une première lentille (40, 132) couplée optiquement au premier guide de lumière et configurée pour recevoir le premier faisceau lumineux homogénéisé et pour se déplacer le long d'un axe optique du premier guide de lumière, la première lentille (40, 132) étant configurée pour projeter un motif des faisceaux lumineux colorés visiblement séparés dans le premier faisceau lumineux homogénéisé, le motif changeant de taille lorsque la première lentille se déplace le long de l'axe optique du premier guide de lumière ; et

une pluralité de deuxièmes modules générateurs de lumière non centraux (104) entourant le premier module générateur de lumière, chaque deuxième module générateur de lumière comprenant :

une deuxième source à réseau de DEL (20) configurée pour émettre une deuxième pluralité de faisceaux lumineux colorés ;
une pluralité de deuxièmes guides de lumière (22) couplés optiquement aux deuxièmes sources à réseau de DEL et configurés chacun pour recevoir la deuxième pluralité de faisceaux lumineux colorés émis par les deuxièmes sources à réseaux de DEL et émettre un deuxième faisceau lumineux homogénéisé, dans lequel les deuxièmes guides de lumière sont plus homogénéisants que le premier guide de lumière ; et
une pluralité de deuxièmes lentilles (134) couplées optiquement aux deuxièmes guides de lumière (22) et configurées chacune pour recevoir un deuxième faisceau lumineux homogénéisé et pour se déplacer le long d'un axe optique des deuxièmes guides de lumière, dans lequel les deuxièmes lentilles projettent chacune un faisceau lumineux ayant un angle de faisceau déterminé par une distance de la deuxième lentille au deuxième guide de lumière ;

dans lequel la pluralité de lentilles (40, 120) définit un système de lentilles à focale variable ;
dans lequel le système de lentilles à focale variable est configuré pour projeter la lumière reçue avec un effet rappelant une fleur.

2. Le luminaire automatisé de la revendication 1, dans lequel le premier guide de lumière (22) est configuré pour tourner autour de l'axe de faisceau lumineux.

3. Le luminaire automatisé de la revendication 1, dans lequel au moins un module générateur de lumière parmi le premier module générateur de lumière et la pluralité de deuxièmes modules générateurs de lumière comprend un modulateur optique multiplicateur d'images configuré pour être déplacé dans le faisceau lumineux émis par le guide de lumière de l'au moins un module générateur de lumière.

4. Le luminaire automatisé de la revendication 1, dans lequel au moins un module générateur de lumière

parmi le premier module générateur de lumière et la pluralité de deuxièmes modules générateurs de lumière comprend un diffuseur (28, 30) configuré pour être déplacé dans le faisceau lumineux émis par le guide de lumière (22) de l'au moins un module générateur de lumière.

5. Le luminaire automatisé de la revendication 1, dans lequel au moins une lentille parmi la première lentille et les deuxièmes lentilles de la pluralité de deuxièmes modules générateurs de lumière comprend une surface incluant une pluralité de creux (140).

6. Le luminaire automatisé de la revendication 1, dans lequel les deuxièmes lentilles de la pluralité de deuxièmes modules générateurs de lumière sont couplées mécaniquement et se déplacent ensemble par rapport à leurs deuxièmes guides de lumière associés.

7. Le luminaire automatisé de la revendication 1, dans lequel le premier module générateur de lumière est un module parmi une pluralité de premiers modules générateurs de lumière.

8. Le luminaire automatisé selon n'importe laquelle des revendications 1, 2, 3, 4, 6 ou 7, comprenant en outre un dispositif électronique de commande couplé au premier module générateur de lumière et à la pluralité de deuxièmes modules générateurs de lumière et configuré pour commander le premier module générateur de lumière et la pluralité de deuxièmes modules générateurs de lumière.

9. Le luminaire automatisé de la revendication 8, dans lequel le dispositif électronique de commande est configuré pour commander individuellement une luminosité d'une ou plusieurs DEL dans la première source à réseau de DEL et pour commander individuellement une luminosité d'une ou plusieurs DEL dans chacune des deuxièmes sources de lumière à réseau de DEL.

10. Le luminaire automatisé de la revendication 1, dans lequel les guides de lumière comprennent une tige de collimation.

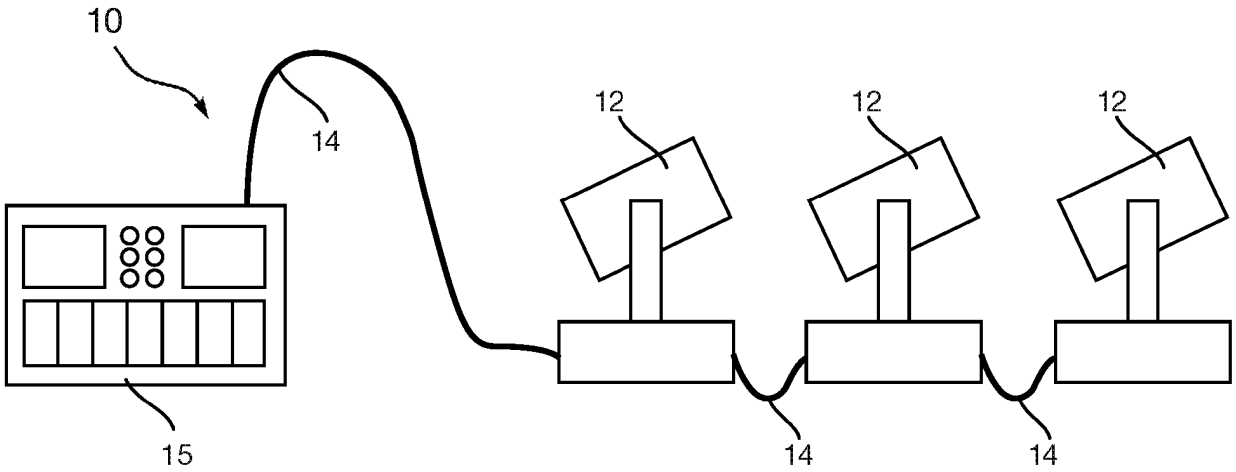


FIG 1

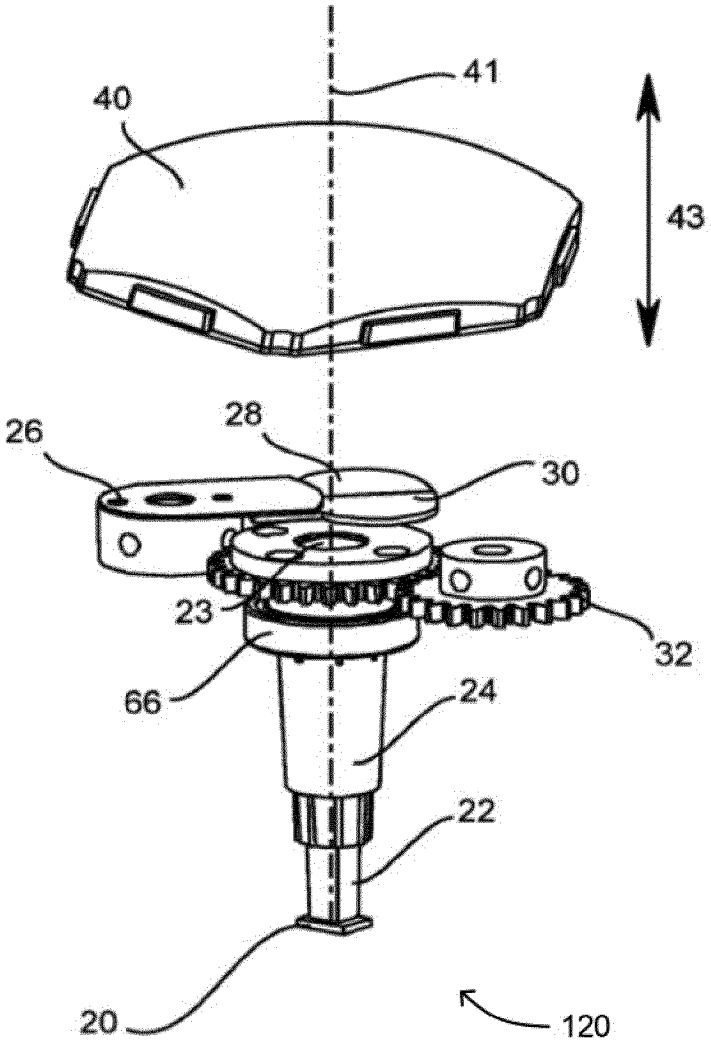
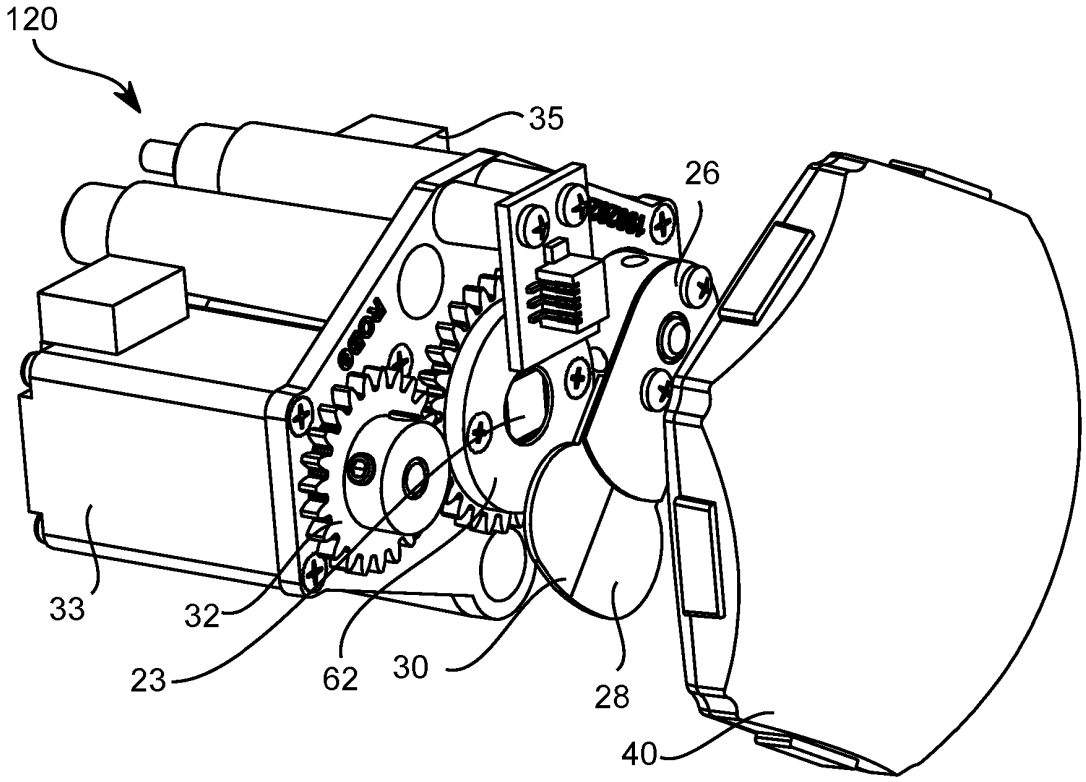
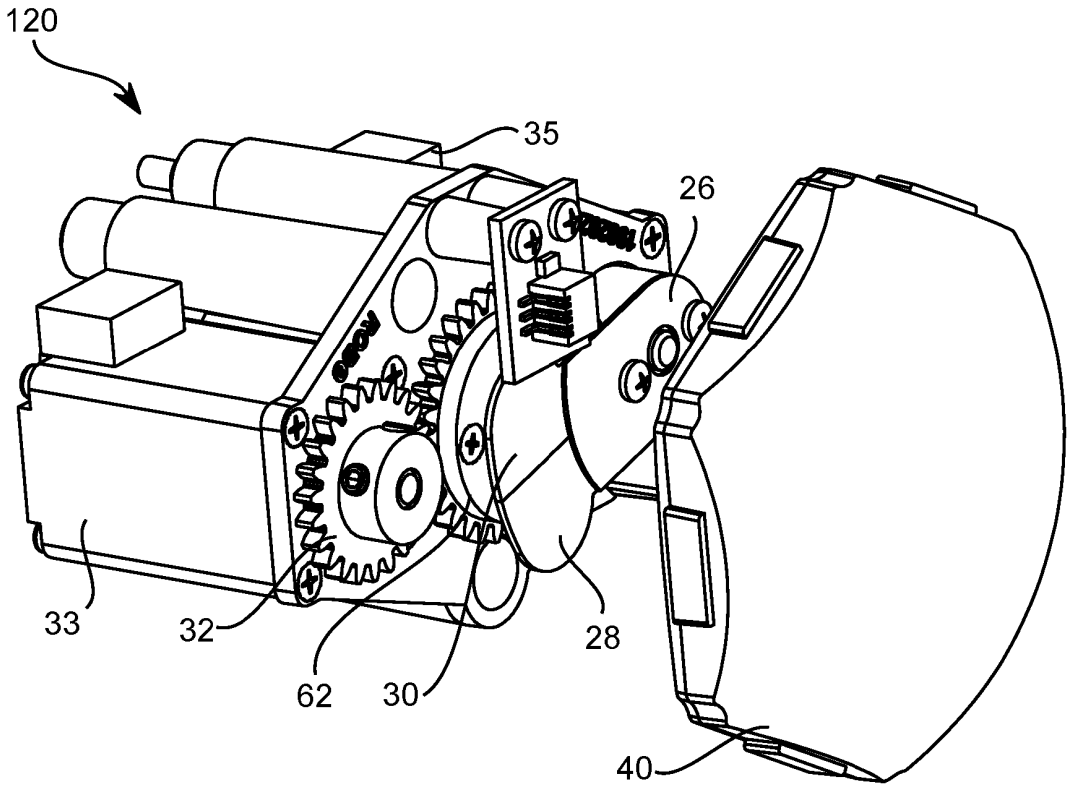


FIG 2

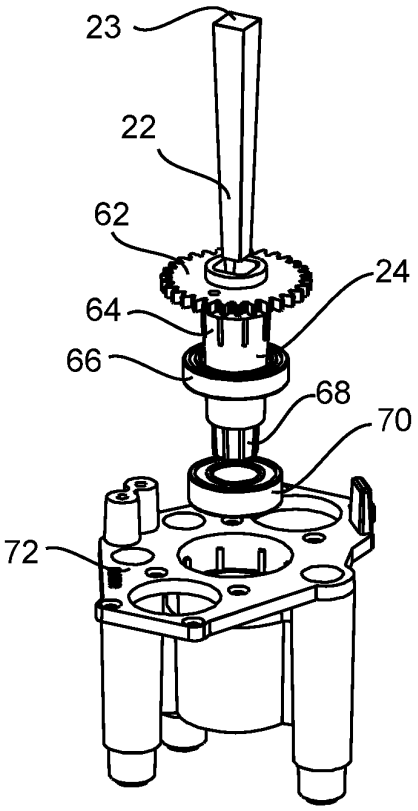


3a

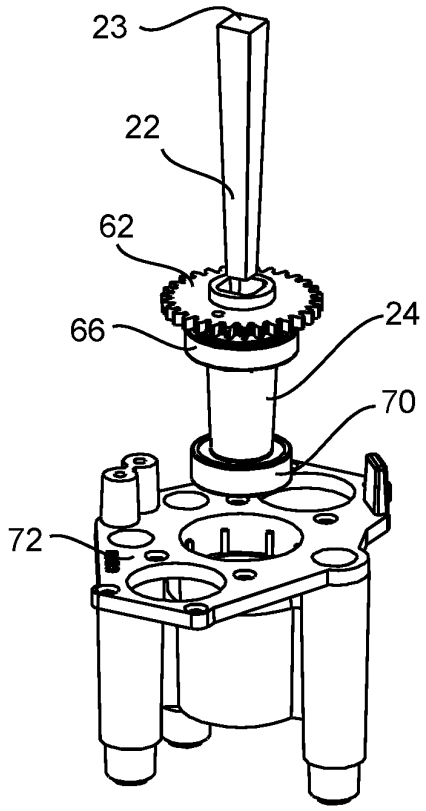


3b

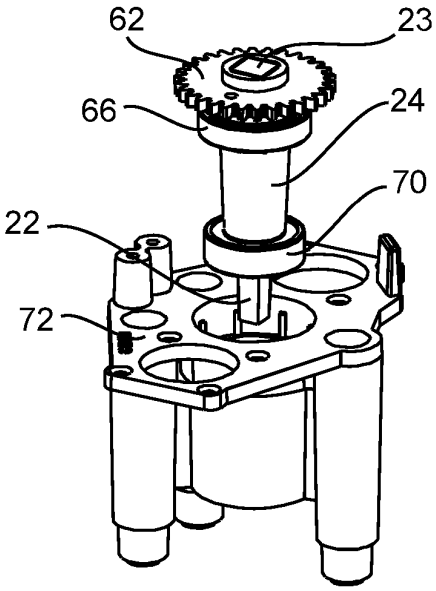
FIG 3



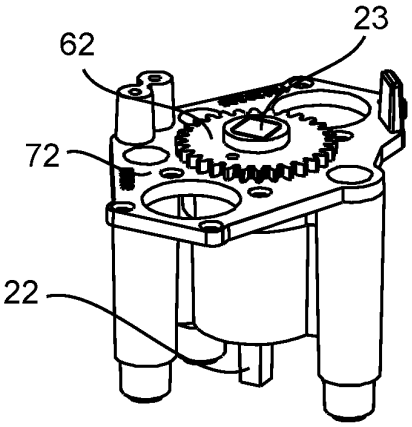
4a



4b



4c



4d

FIG 4

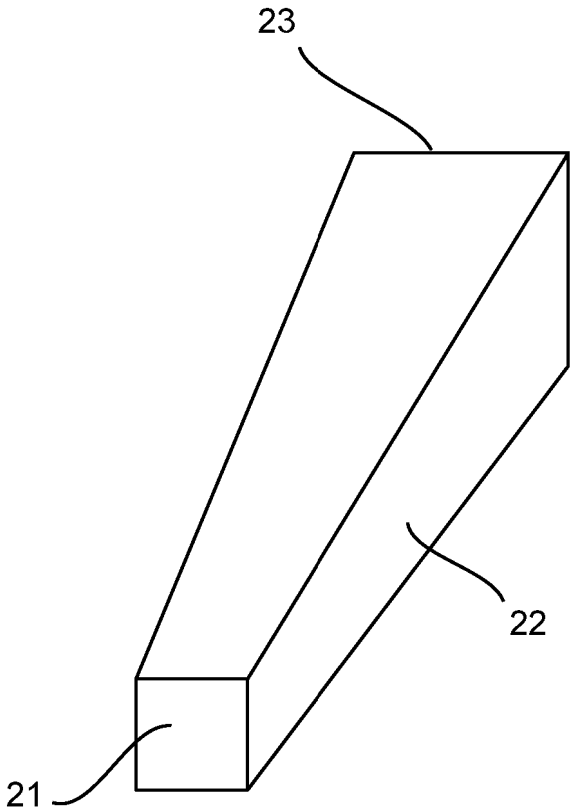


FIG 5

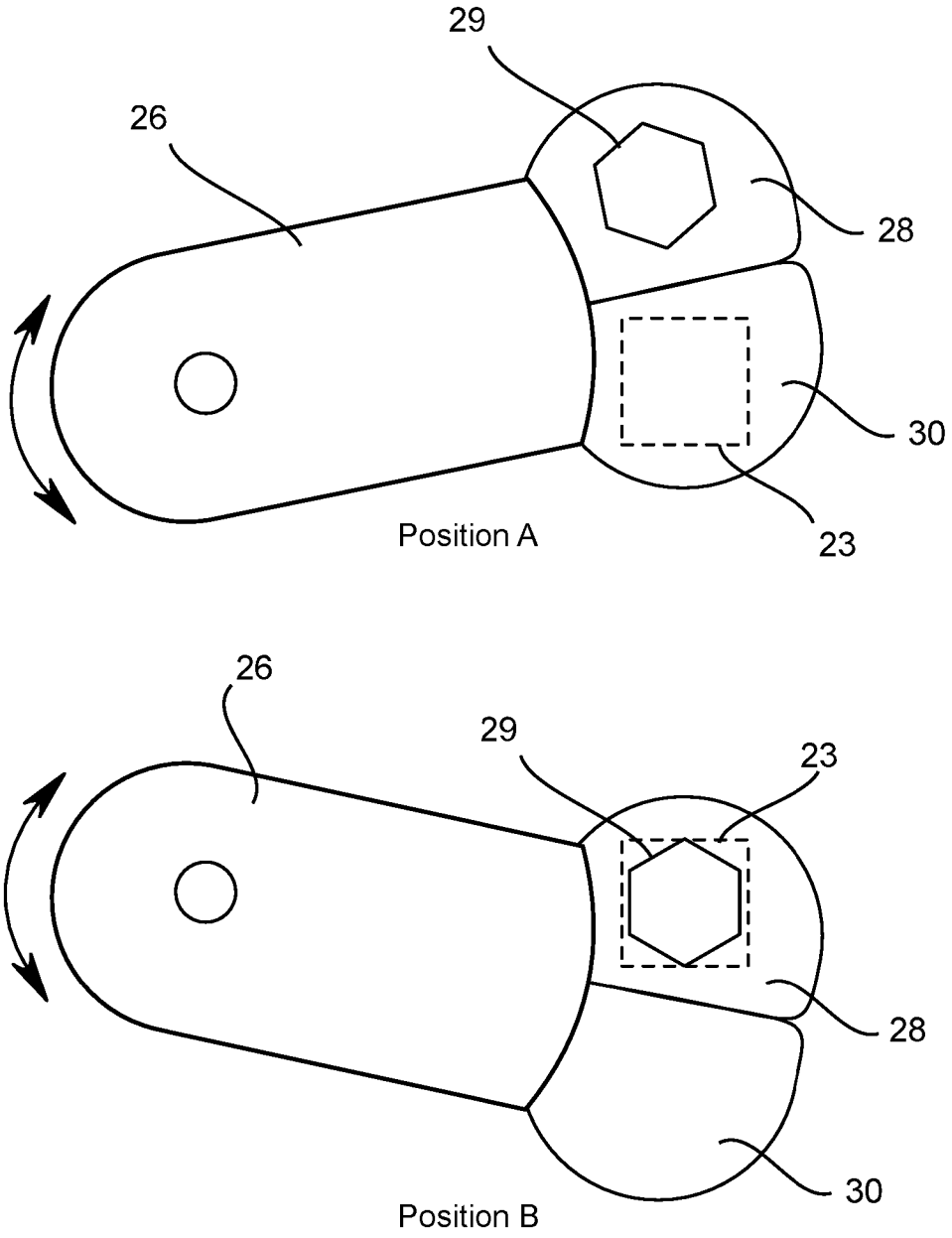


FIG 6

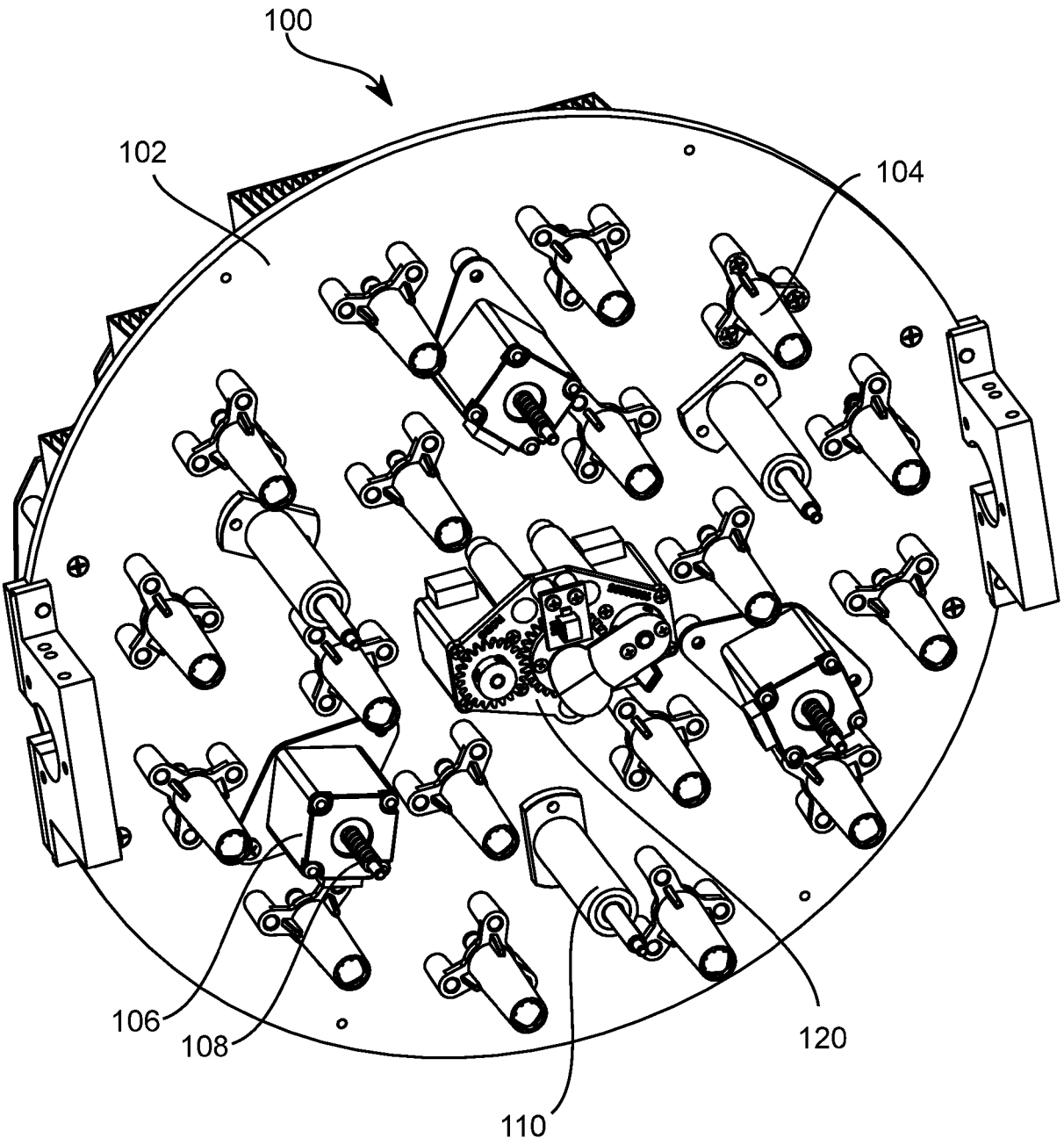


FIG 7

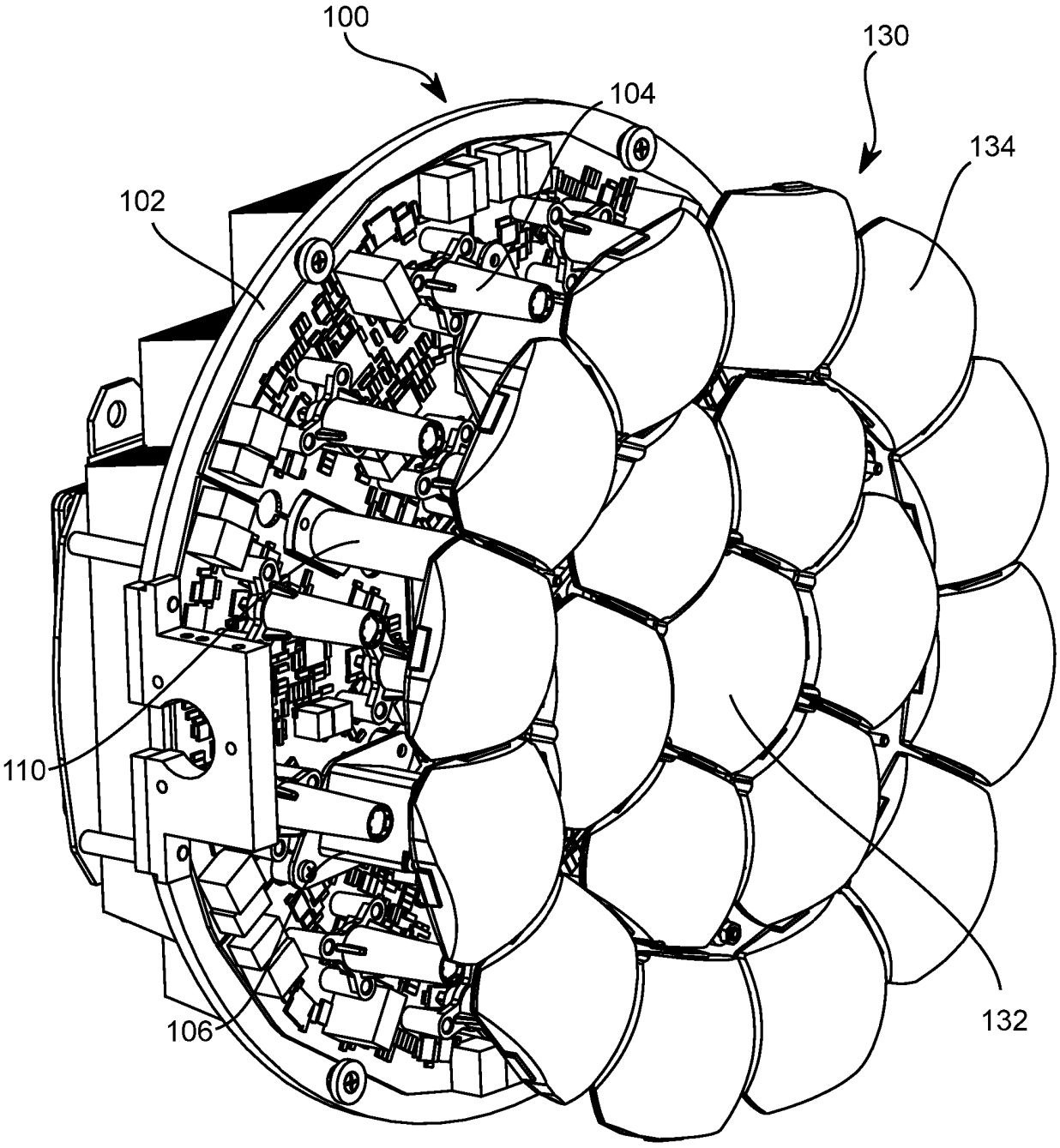


FIG 8

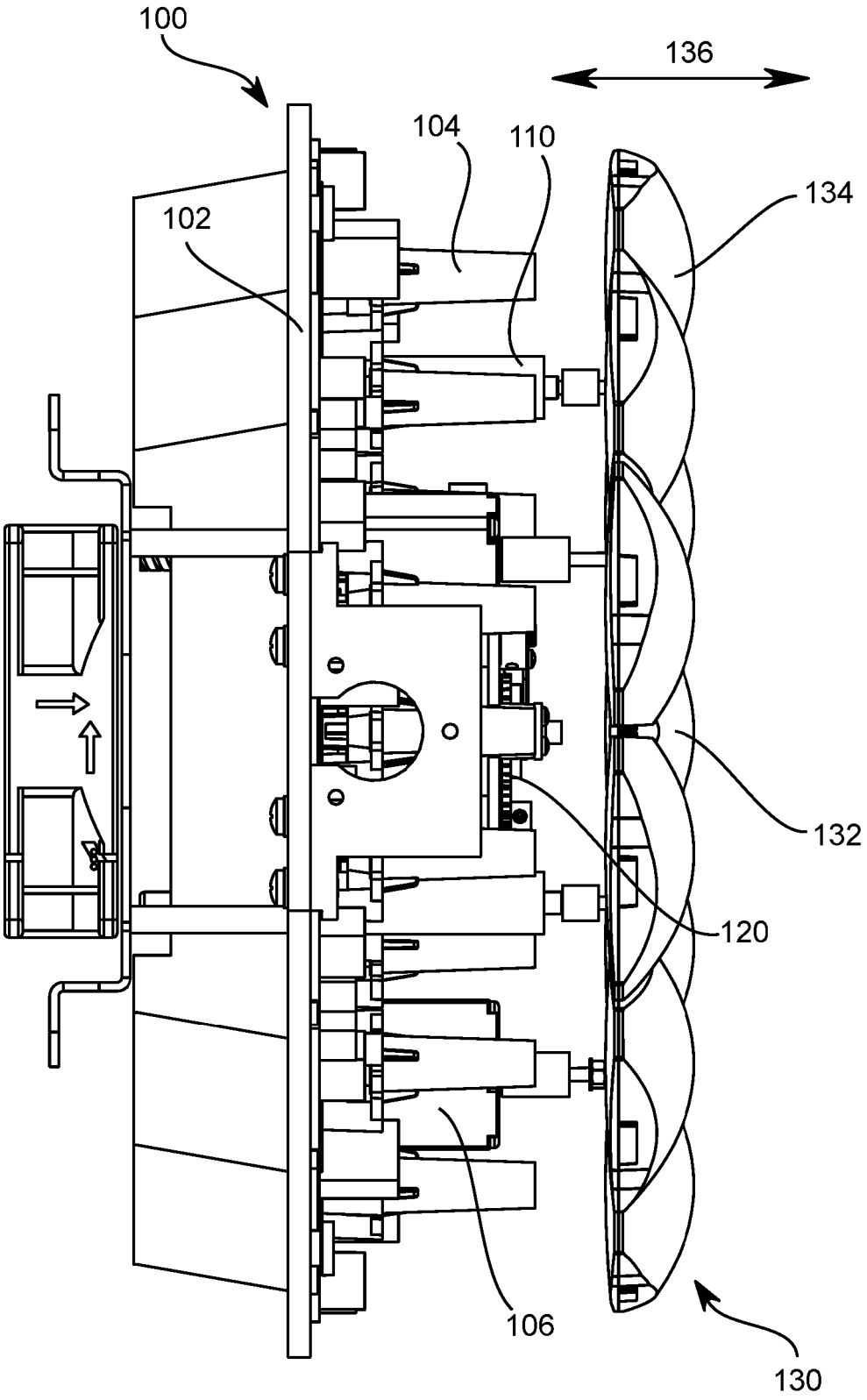


FIG 9

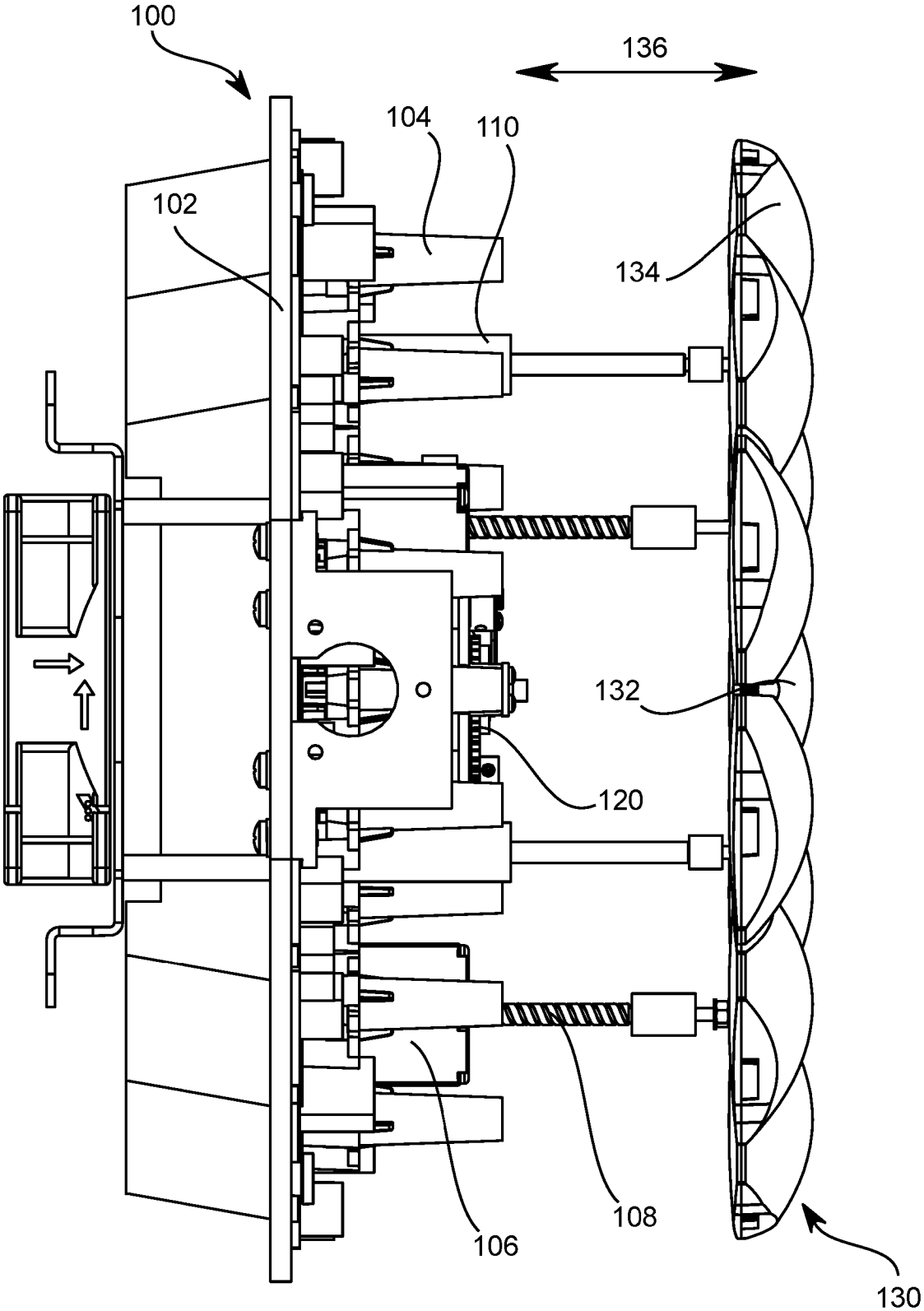


FIG 10

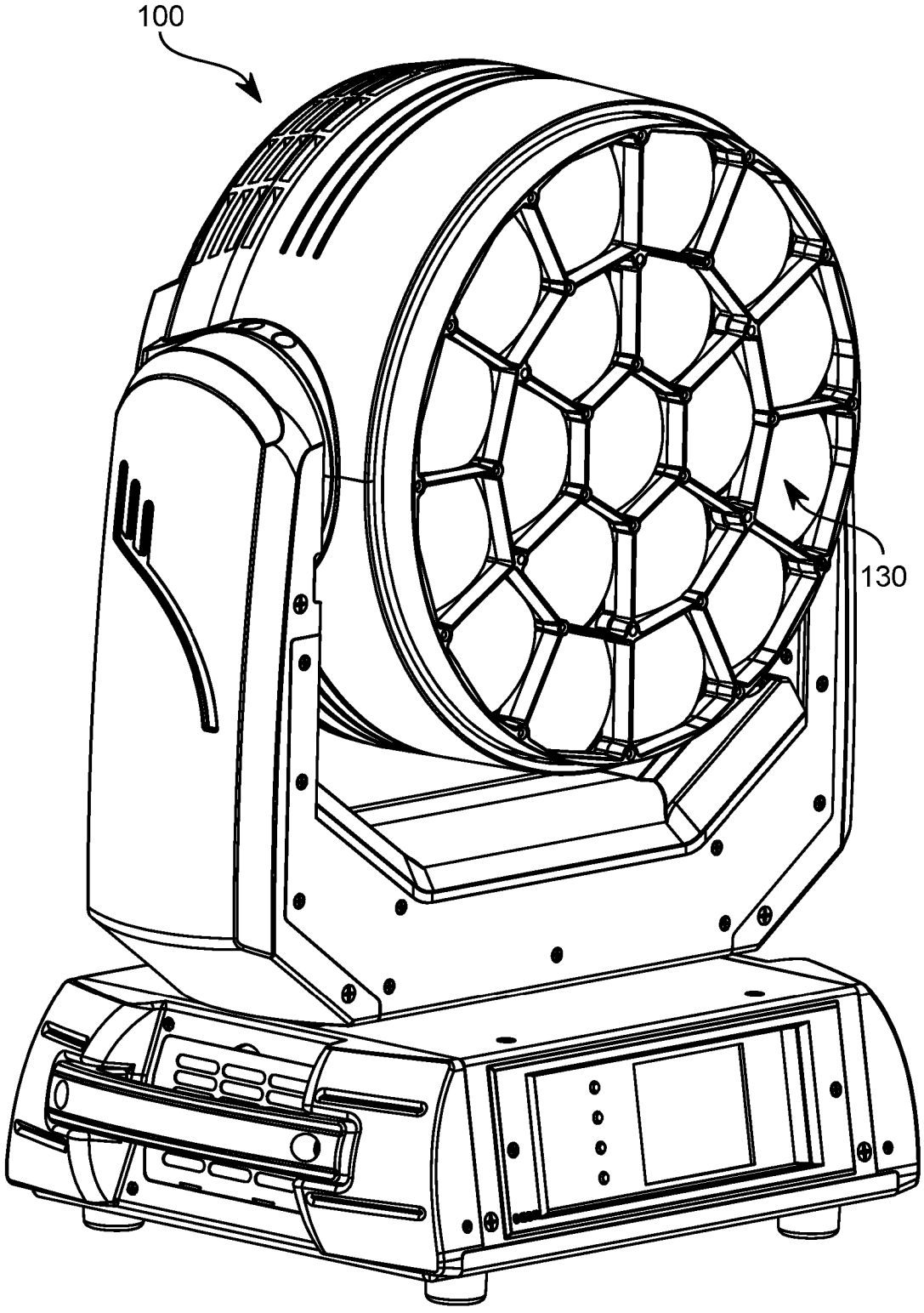


FIG 11

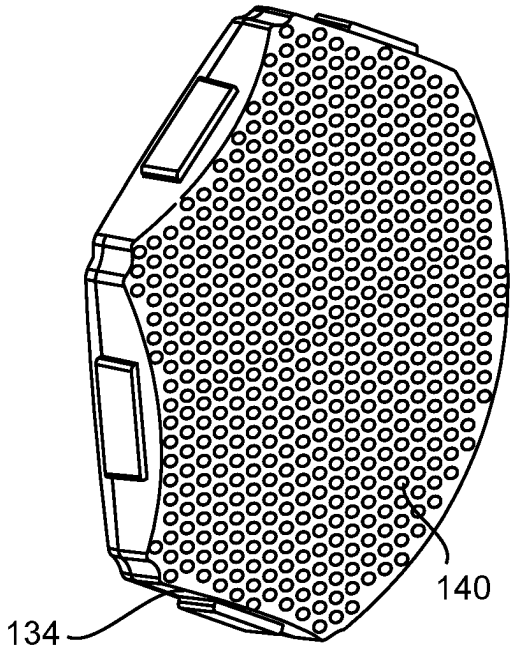


FIG 12

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 042758 **[0004]**
- US 14042759 B **[0004]**
- US 405355 **[0004]**
- EP 2177816 A **[0006]**
- WO 2014031641 A **[0006]**
- WO 2010113100 A **[0006]**
- WO 2015022644 A **[0006]**
- EP 1550908 A **[0006]**