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(54) **COORDINATED EFFECTS SYSTEM FOR AN AUTOMATED LUMINAIRE**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

- 3,584,226 A \* 6/1971 Lerner ..... G06M 1/101 250/221
- 4,891,738 A 1/1990 Richardson et al.  
(Continued)

FOREIGN PATENT DOCUMENTS

- CN 1711441 A 12/2005
- CN 101430073 A 5/2009  
(Continued)

OTHER PUBLICATIONS

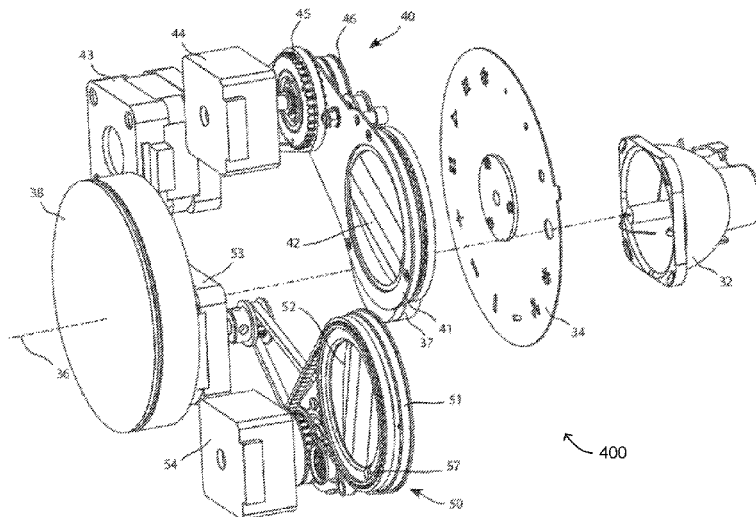
European Extended Search Report; Application No. 18192006.7; dated Nov. 26, 2018; 6 pages.  
(Continued)

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(57) **ABSTRACT**

A coordinated effects system and automated luminaire are provided. The automated luminaire includes a light source, an optical device, a first prism system, a second prism system, and a control system. The light source is configured to emit a light beam. The optical device is configured to produce a first image in the light beam. The first and second prism systems include corresponding first and second pluralities of prisms and are configured to position selected ones of their respective prisms in the light beam or to remove all of their prisms from the light beam. The first prism system is configured to rotate the selected one of its prisms to produce a modified image from the image. The second prism system is configured to rotate the selected one of its prisms to produce an output image from the modified image. The control system is configured to control the first and second prism systems.

**11 Claims, 12 Drawing Sheets**



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 CPC ..... *F21V 5/008* (2013.01); *F21W 2131/406* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,980,806	A *	12/1990	Taylor	.....	G05B 19/0421 315/316
5,537,303	A *	7/1996	Stacy	.....	F21S 10/007 362/284
5,934,794	A *	8/1999	Hutton	.....	F21S 10/007 362/283
6,502,964	B1	1/2003	Simon		
9,664,361	B2 *	5/2017	Hansen	.....	F21S 10/00
2006/0187654	A1 *	8/2006	Jungel-Schmid	.....	F21S 8/02 362/147
2008/0055608	A1	3/2008	Bornhorst		
2009/0268466	A1	10/2009	Allegrì		
2010/0073927	A1	3/2010	Lewin et al.		
2014/0233238	A1	8/2014	Quadri et al.		
2016/0195237	A1	7/2016	Quadri et al.		
2018/0187847	A1	7/2018	Jurik et al.		
2019/0011820	A1	1/2019	Nohechi et al.		

FOREIGN PATENT DOCUMENTS

CN	201416832	Y	3/2010
CN	202532389	U	11/2012
CN	203010295	U	6/2013
CN	103502865	A	1/2014
CN	203868942	U	10/2014
CN	107002973	A	8/2017
DE	10201113036	A1	3/2012
EP	3056804	A1	8/2016
KR	20140143065	A	12/2014
WO	9852386	A1	11/1998
WO	2012138770	A2	10/2012
WO	2016054418	A1	4/2016

OTHER PUBLICATIONS

European Partial Search Report; Application No. 18191994.5; dated Nov. 26, 2018; 11 pages.  
 Jurik, Pavel, et al.; U.S. Appl. No. 16/118,121, filed Aug. 30, 2018; Title: Framing System for an Automated Luminaire; 44 pages.

“Infinity iB-16R Manual”; [https://www.highlite.nl/silver.download/Documents@extem@Manuals/41532\\_MANUAL\\_GB\\_V1.pdf](https://www.highlite.nl/silver.download/Documents@extem@Manuals/41532_MANUAL_GB_V1.pdf); 2015; 44 pages.  
 “Infinity iB-2R Manual”; [https://www.warmlight.at/media/pdf/41531\\_MANUAL\\_GB\\_V1.pdf](https://www.warmlight.at/media/pdf/41531_MANUAL_GB_V1.pdf); 2014; 36 pages.  
 Office Action dated May 11, 2018; U.S. Appl. No. 15/516,399, filed Apr. 1, 2017; 6 pages.  
 Office Action dated Oct. 25, 2018; U.S. Appl. No. 15/516,399, filed Apr. 1, 2017; 17 pages.  
 Office Action dated Oct. 29, 2018; U.S. Appl. No. 16/118,121, filed Aug. 30, 2018; 14 pages.  
 PCT International Search Report; Application No. PCT/US2015/053566; dated Mar. 7, 2016; 5 pages.  
 PCT Written Opinion of the International Searching Authority; Application No. PCT/US2015/053566; dated Mar. 7, 2016; 5 pages.  
 Chinese Office Action; Application No. 201580065444.6; dated Oct. 8, 2018; 12 pages.  
 European Examination Report; Application No. 15820914.8; dated Jul. 25, 2018; 6 pages.  
 Advisory Action dated Jun. 4, 2019; U.S. Appl. No. 15/516,399, filed Apr. 1, 2017; 3 pages.  
 Advisory Action dated Jun. 4, 2019; U.S. Appl. No. 16/118,121, filed Aug. 30, 2018; 5 pages.  
 Final Office Action dated Apr. 3, 2019; U.S. Appl. No. 15/516,399, filed Apr. 1, 2017; 24 pages.  
 Office Action dated Mar. 12, 2019; U.S. Appl. No. 16/118,121, filed Aug. 30, 2018; 27 pages.  
 European Intention to Grant; Application No. 15820914.8; dated Apr. 11, 2019; 10 pages.  
 European Extended Search Report; Application No. 18191994.5; dated Feb. 5, 2019; 10 pages.  
 Final Office Action dated Jan. 29, 2020; U.S. Appl. No. 15/516,399, filed Apr. 1, 2017; 19 pages.  
 Notice of Allowance dated Mar. 30, 2020; U.S. Appl. No. 16/118,121, filed Aug. 30, 2018; 18 pages.  
 European Intention to Grant; Application No. 18191994.5; dated Jan. 3, 2020; 11 pages.  
 Hecht, Eugene; “Chapter 5.5 Prisms”; Optics, 4th Edition; Addison-Wesley; 2002; 8 pages.  
 Office Action dated Jul. 25, 2019; U.S. Appl. No. 15/516,399, filed Apr. 1, 2017; 17 pages.  
 Office Action dated Aug. 20, 2019; U.S. Appl. No. 16/118,121, filed Aug. 30, 2018; 28 pages.  
 Chinese Office Action; Application No. 201580065444.6; dated Jun. 20, 2019; 13 pages.  
 European Examination Report; Application No. 18191994.5; Jun. 24, 2019; 5 pages.  
 Chinese Office Action; Application No. 2015800654446; dated Oct. 9, 2019; 11 pages.  
 Chinese Office Action; Application No. 2018110233256; dated Nov. 21, 2019; 21 pages.  
 Advisory Action dated Jun. 8, 2020; U.S. Appl. No. 15/516,399, filed Apr. 1, 2017; 5 pages.  
 Chinese Notification of Allowance; Application No. 201580065444.6; dated Mar. 18, 2020; 5 pages.  
 Chinese Office Action; Application No. 201811023325.6; dated Apr. 27, 2020; 22 pages.

\* cited by examiner

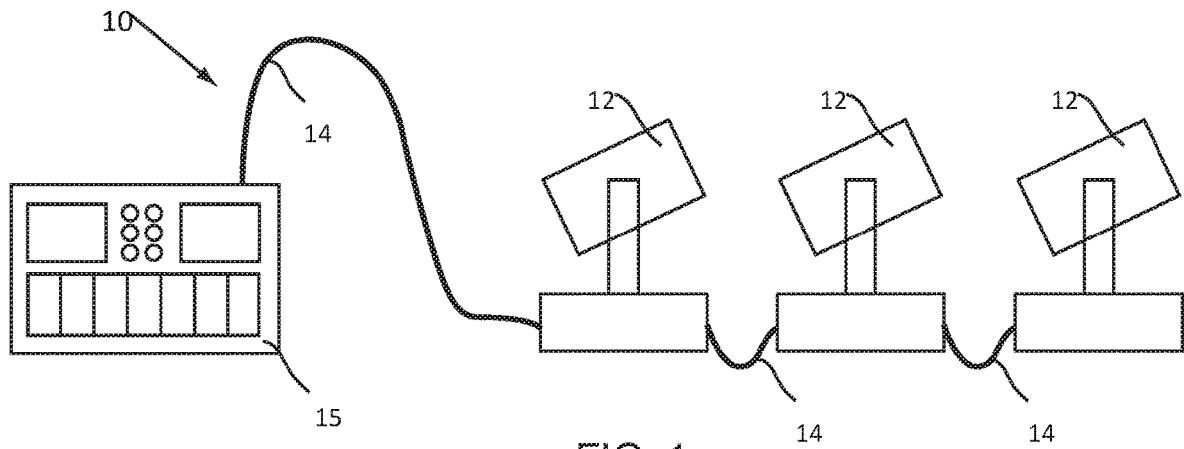


FIG. 1  
PRIOR ART

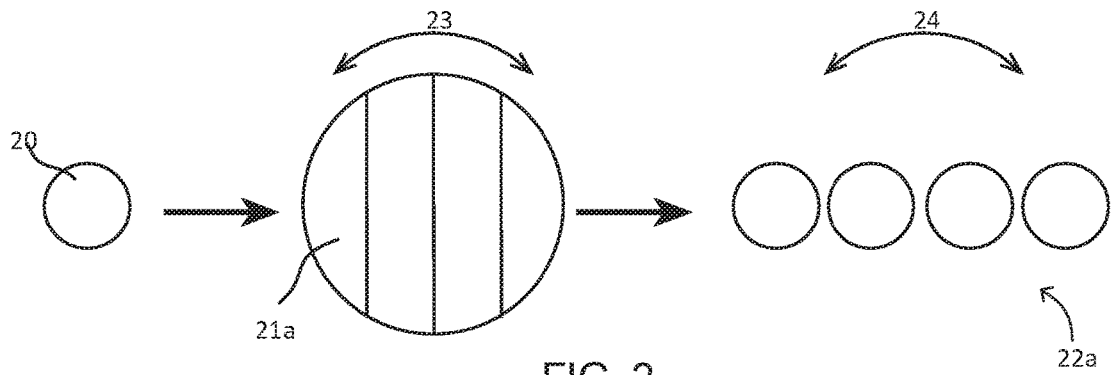


FIG. 2  
PRIOR ART

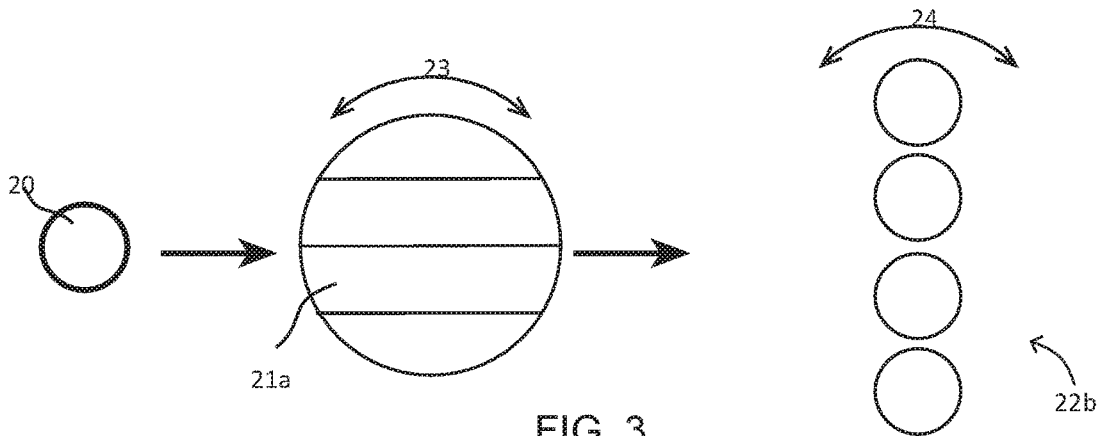


FIG. 3  
PRIOR ART

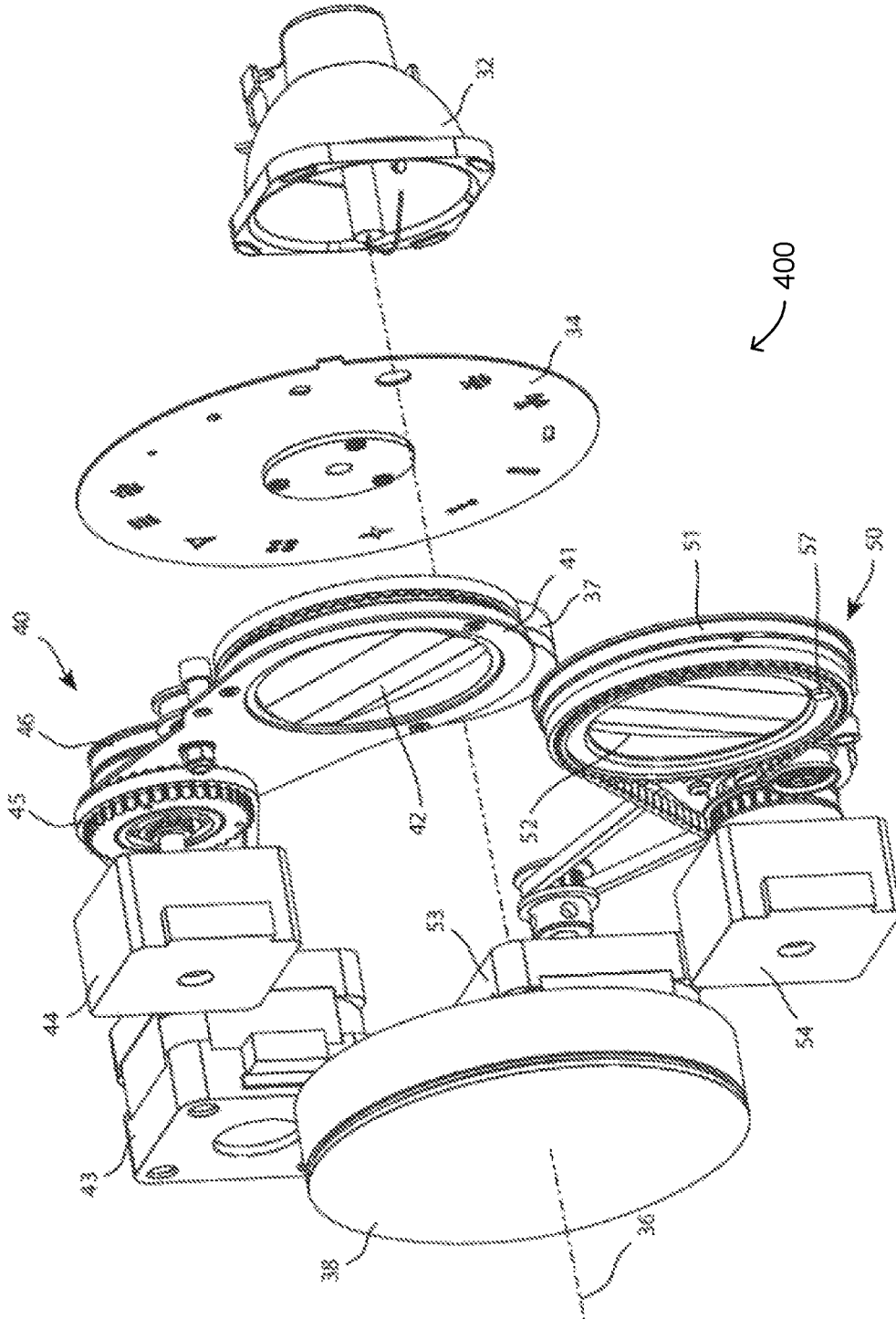


FIG. 4

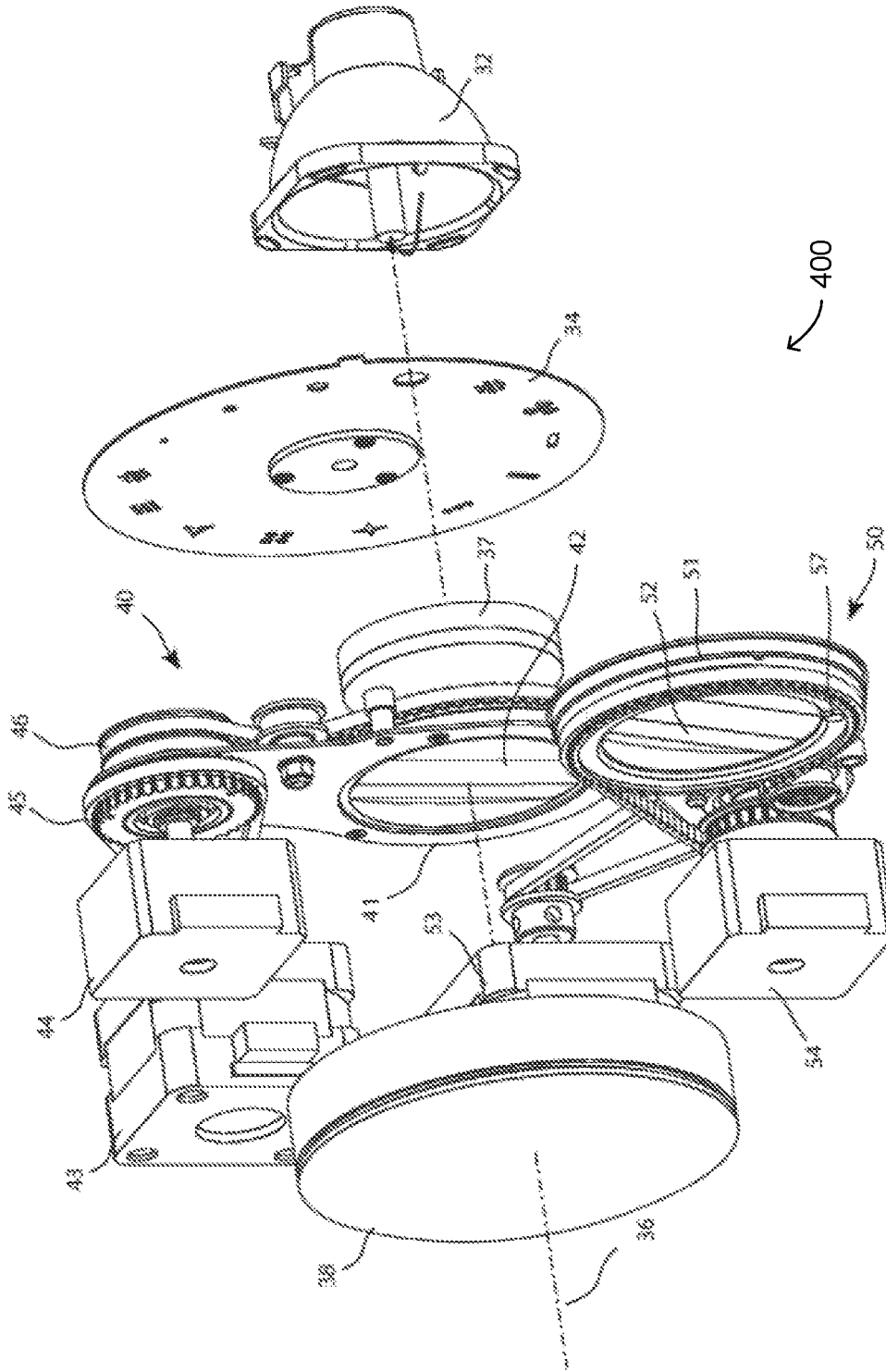


FIG. 5

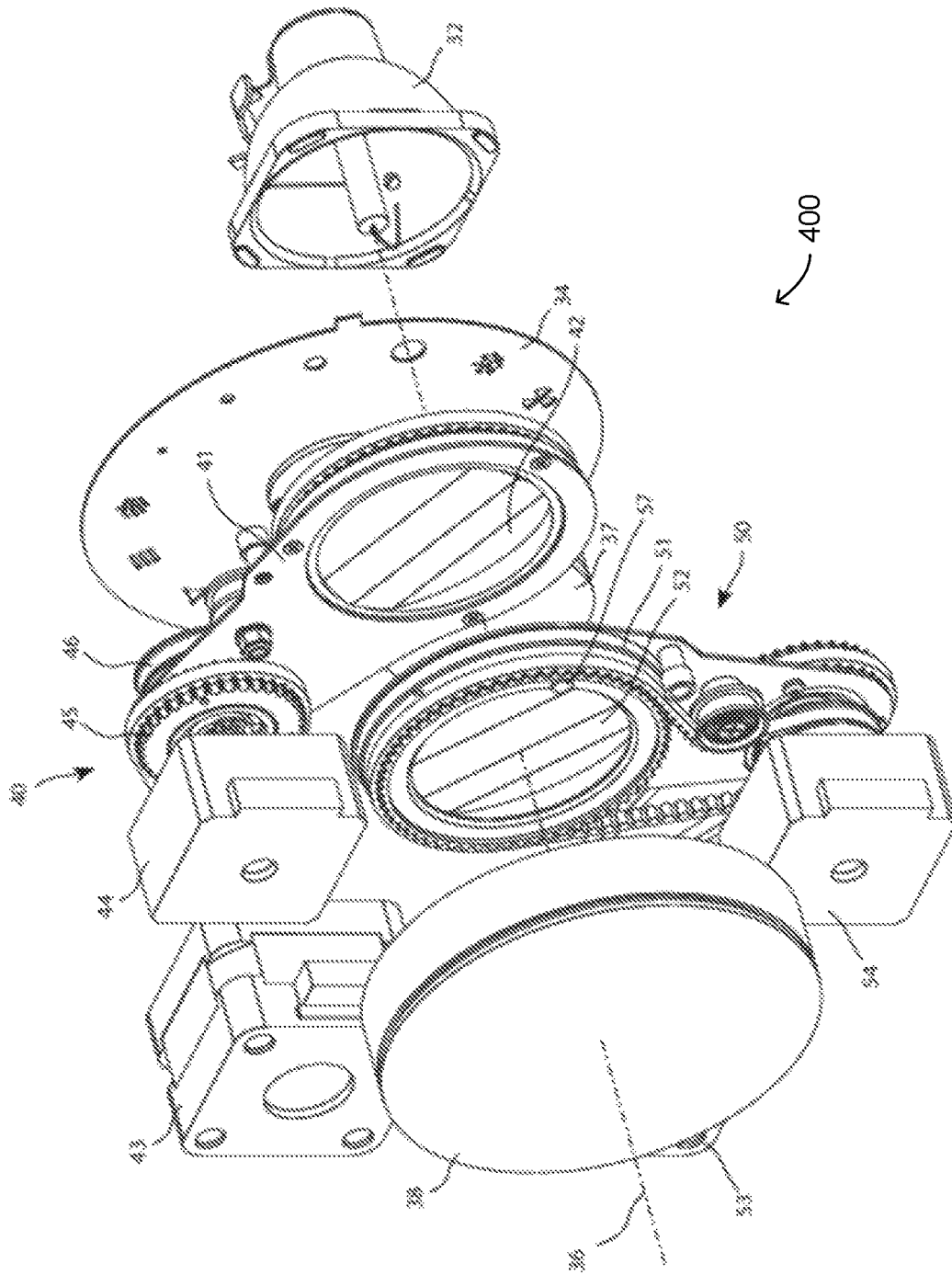


FIG. 6

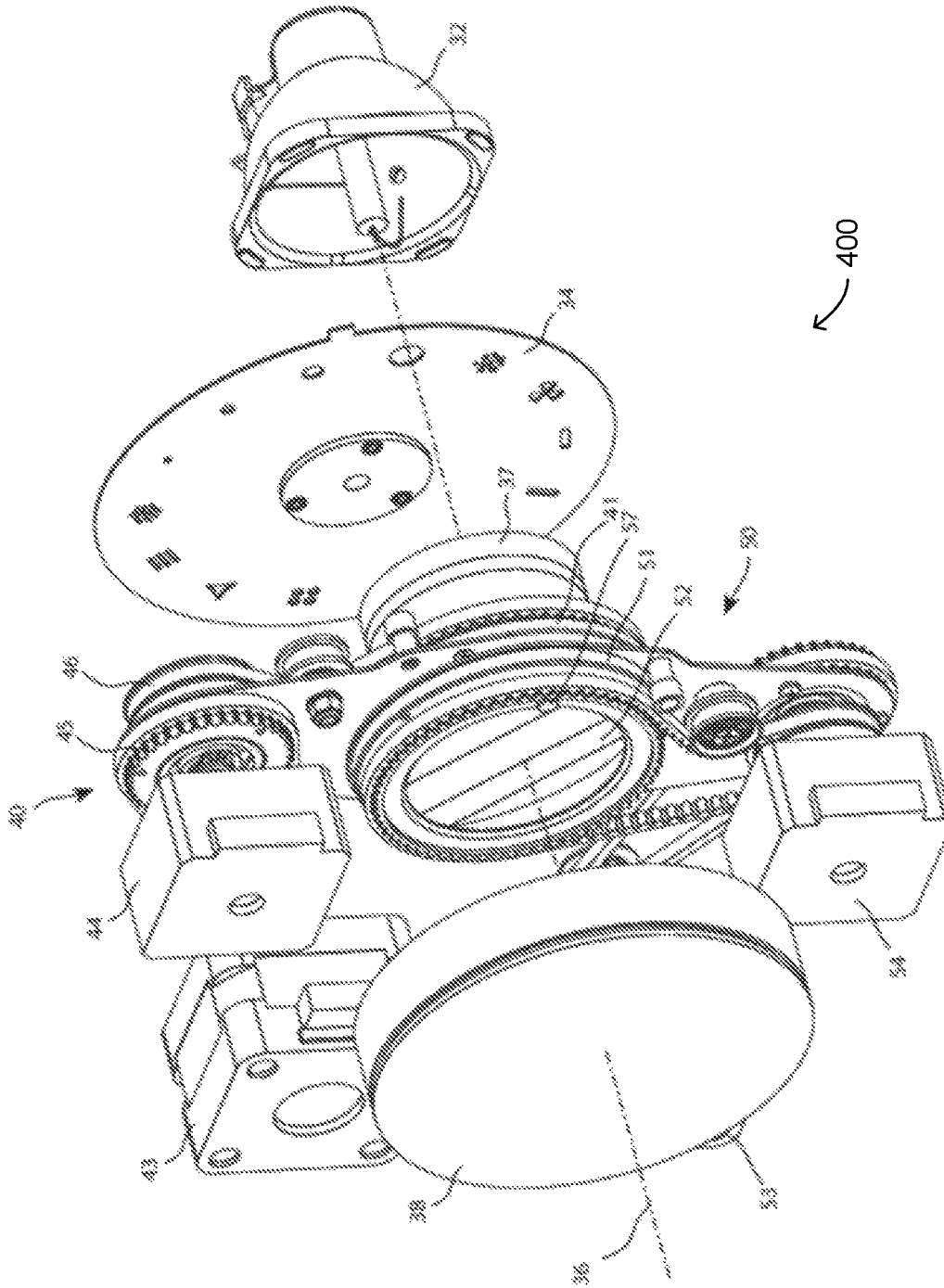


FIG. 7

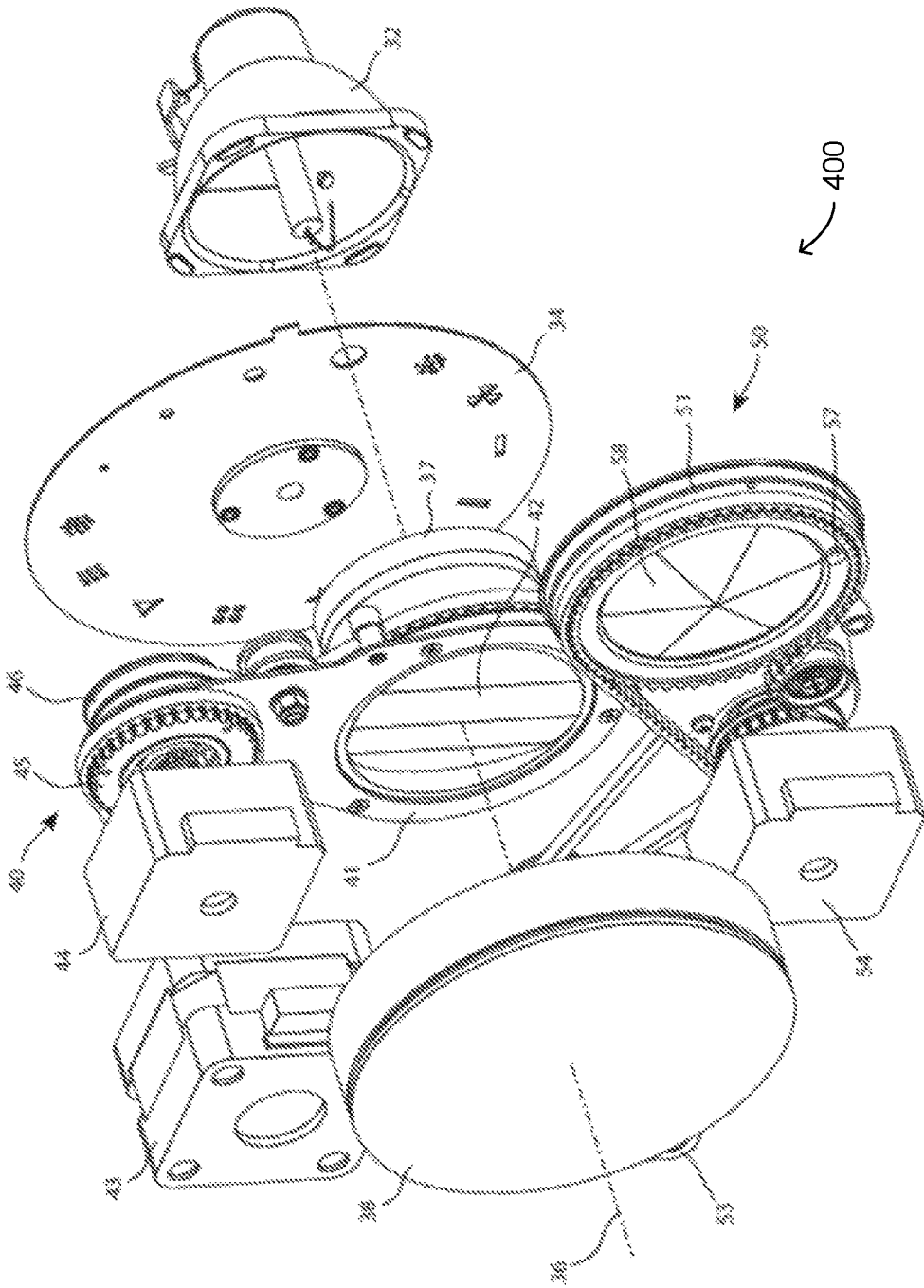


FIG. 8



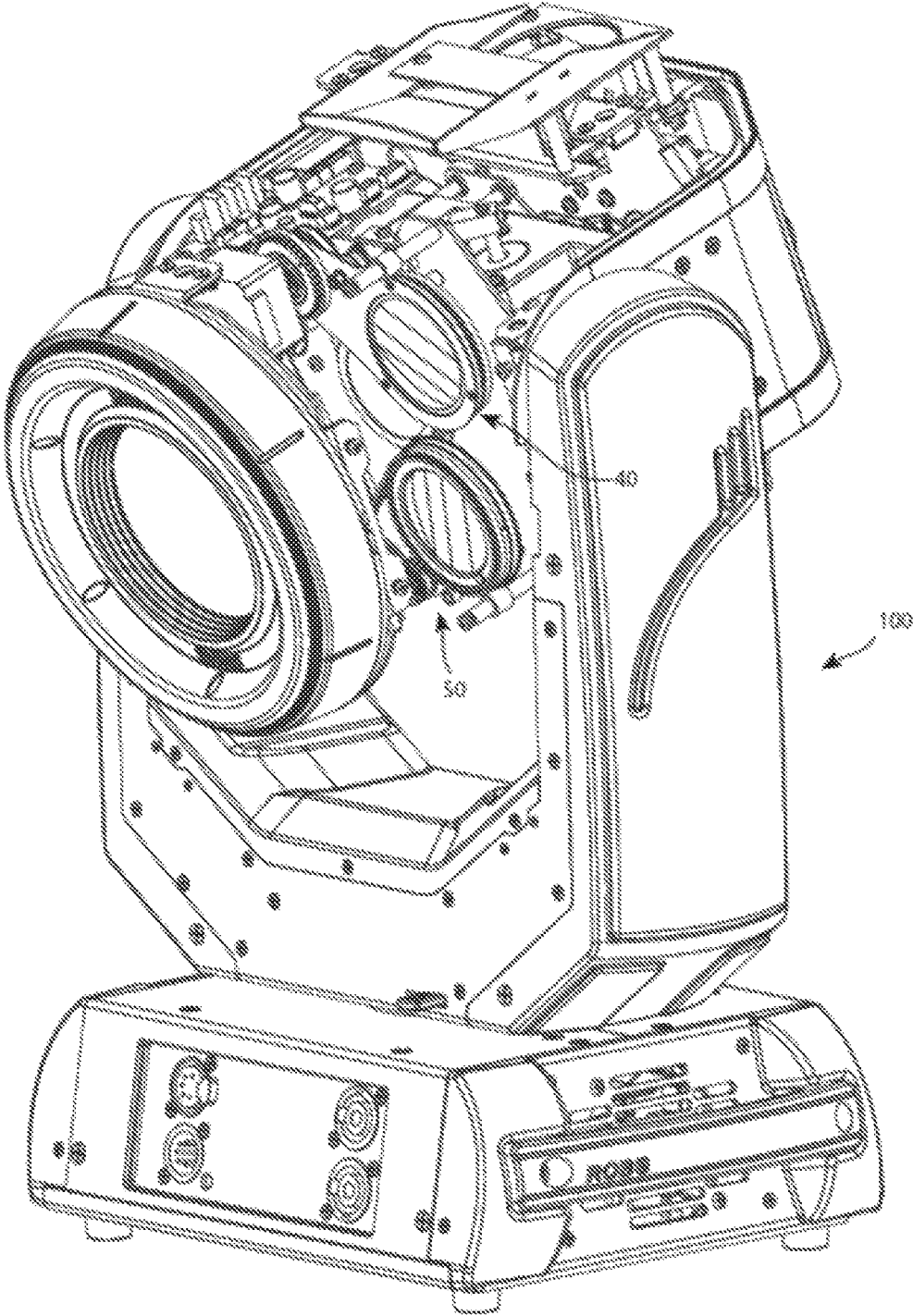
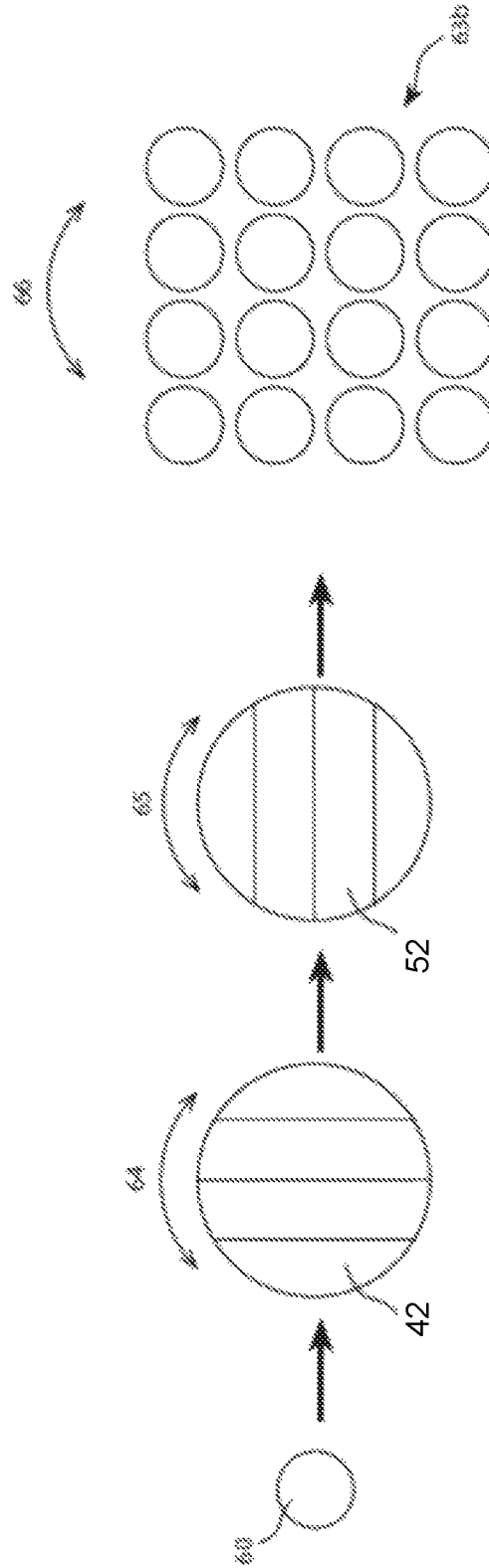
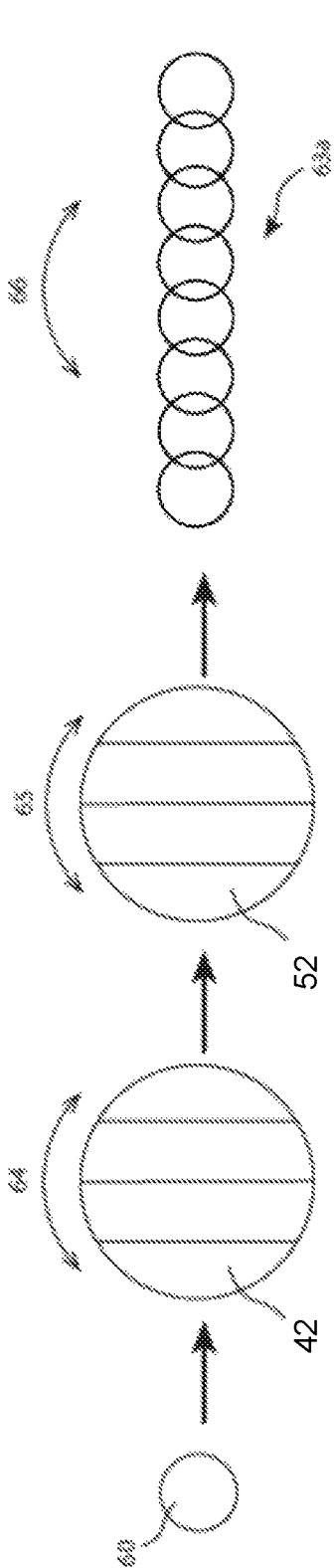


FIG. 9



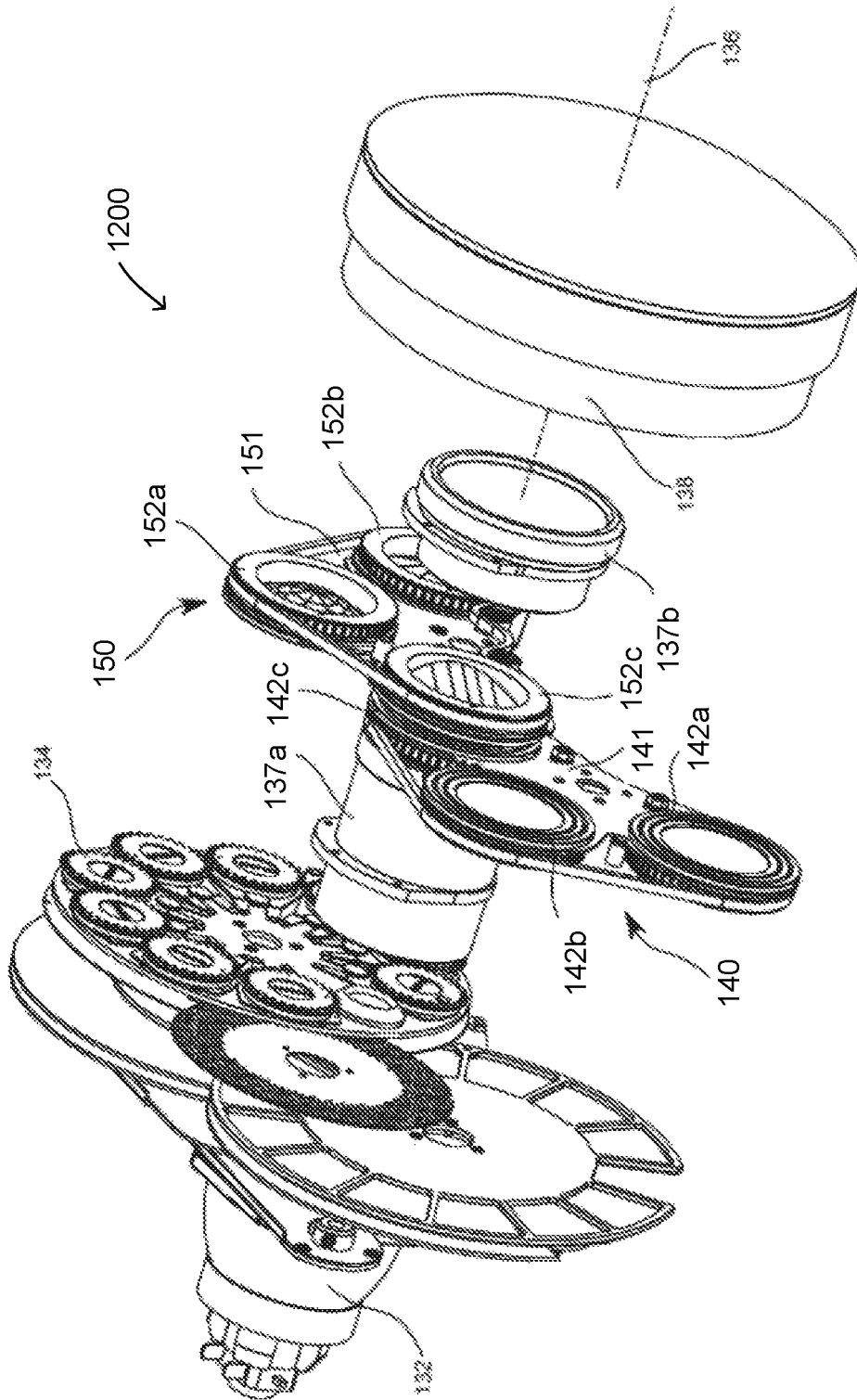


FIG. 12

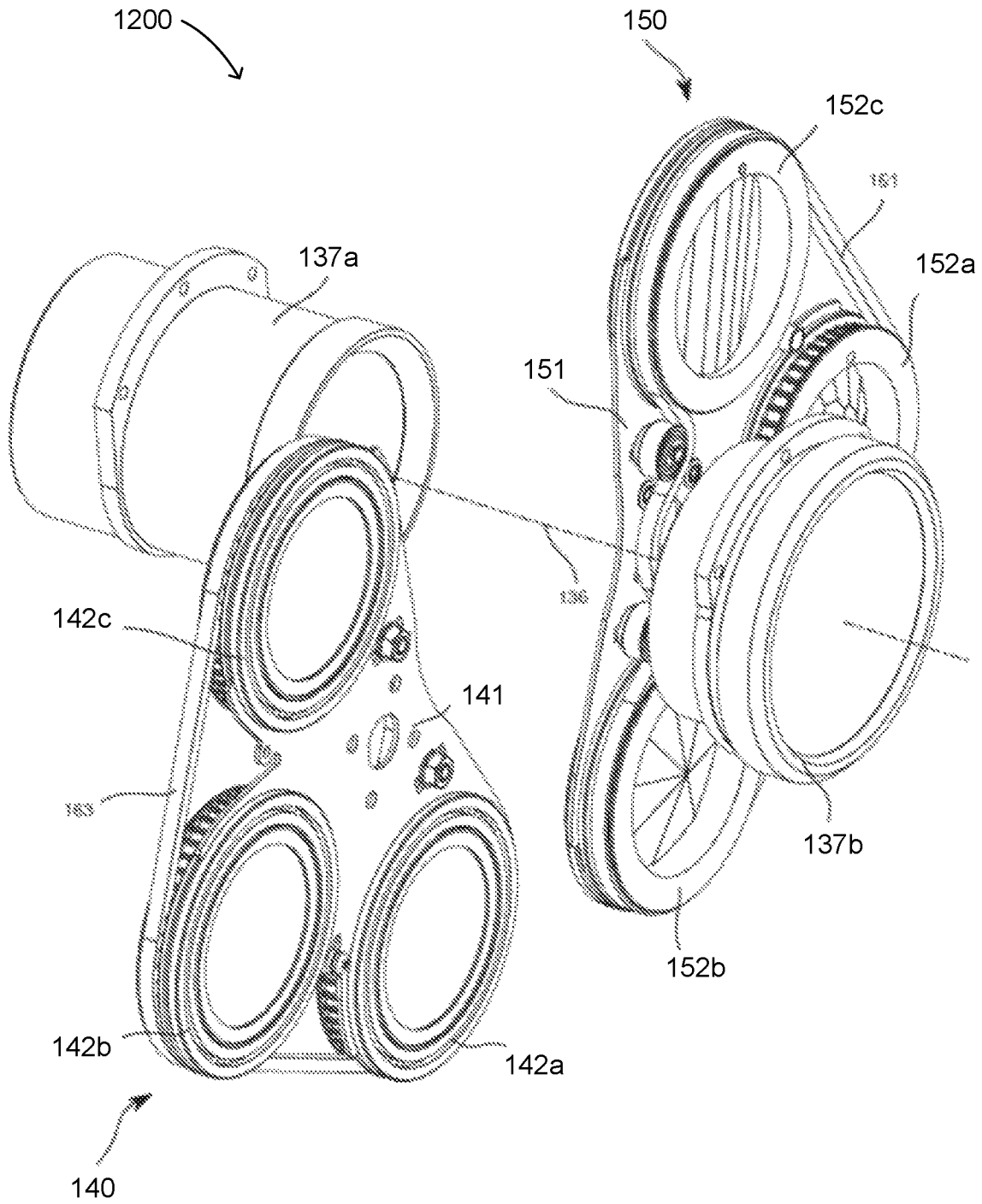


FIG. 13

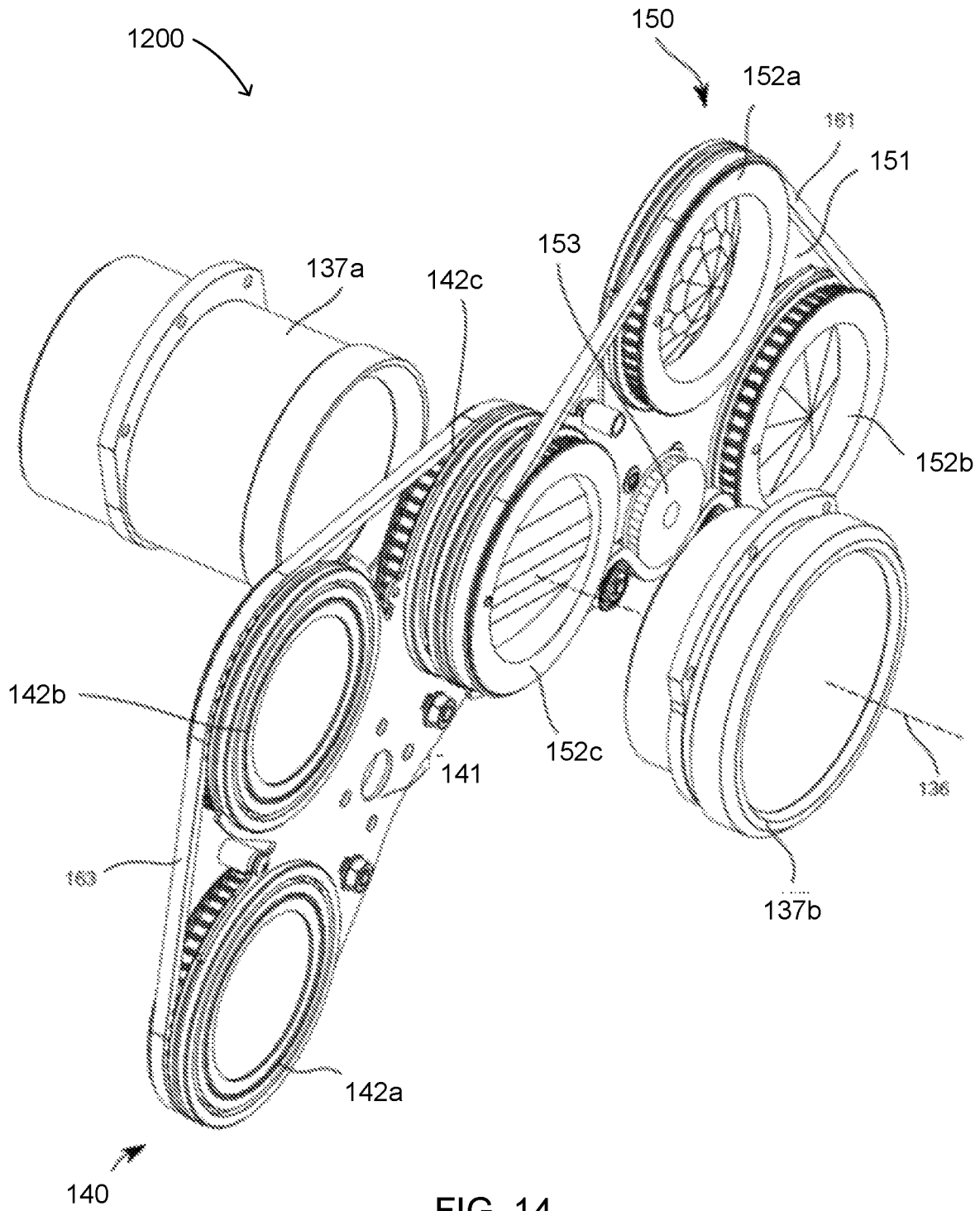


FIG. 14

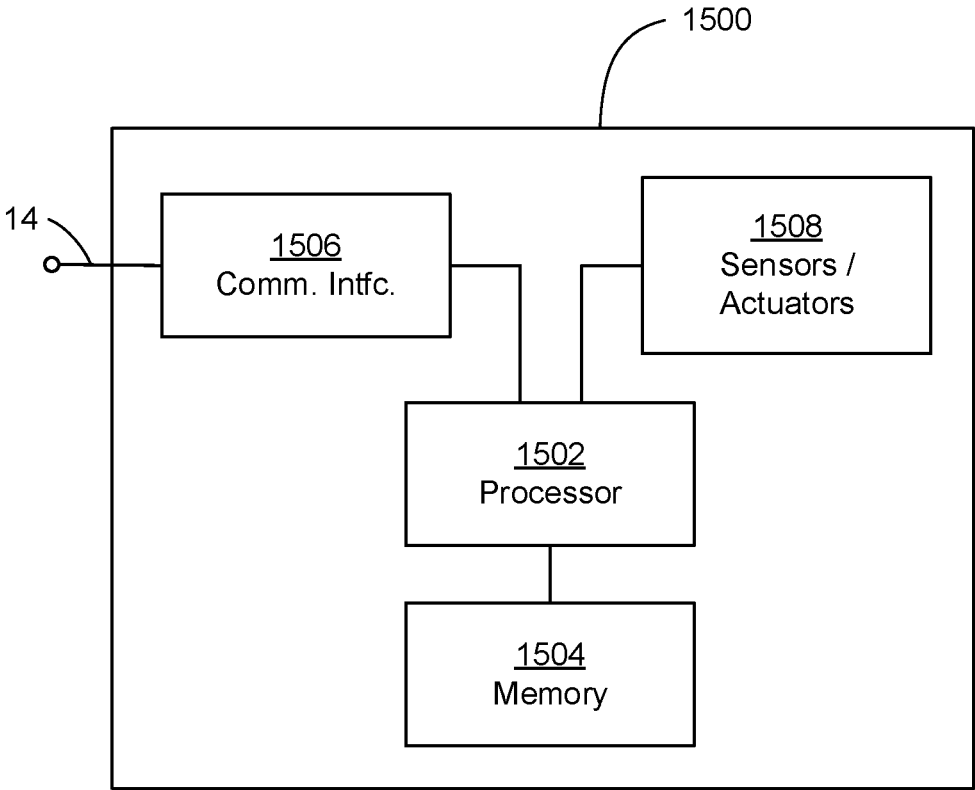


Fig. 15

## COORDINATED EFFECTS SYSTEM FOR AN AUTOMATED LUMINAIRE

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation in part of U.S. patent application Ser. No. 15/516,399 filed Apr. 1, 2017 by Pavel Jurik, et al. entitled, "Improved Coordinated Effects System for an Automated Luminaire", which is a U.S. National Stage of International Patent Application No. PCT/US2015/053566 filed Oct. 1, 2015 by Pavel Jurik, et al. entitled, "Improved Coordinated Effects System for an Automated Luminaire", which claims priority to U.S. Provisional Application No. 62/058,562 filed Oct. 1, 2014 by Pavel Jurik, et al. entitled, "System and Method for Controlling the Movement of LEDs in a Luminaire". This application also claims priority to U.S. Provisional Application No. 62/553,565 filed Sep. 1, 2017 by Pavel Jurik, et al. entitled, "Coordinated Effects System for an Automated Luminaire", all of which are incorporated by reference herein as if reproduced in their entirety.

### TECHNICAL FIELD OF THE DISCLOSURE

The disclosure generally relates to an effects system in an automated luminaire, and more specifically to a system for coordinating multiple effects within an automated luminaire.

### BACKGROUND

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 commonly provide control over the pan and tilt functions of the luminaire allowing the operator to control the direction the luminaire is pointing and thus the position of the light beam on the stage or in the studio. Typically, this position control is done via control of the luminaire's position in two orthogonal rotational axes usually referred to as pan and tilt. Many products provide control over other parameters such as the intensity, color, focus, beam size, beam shape, and beam pattern. FIG. 1 illustrates a typical multiparameter automated luminaire system 10. These systems typically include a plurality of multiparameter automated luminaires 12 which typically each contain on-board a light source (not shown), light modulation devices, 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 12 is connected in series or in parallel via data link 14 to one or more control desks 15. An operator typically controls the automated luminaire system 10 through the control desk 15.

An optical effect that is commonly used in prior art automated luminaires is often referred to as a prism. This is typically a glass or plastic device placed at a point in the optical train such that it converts a single image produced by the beam color, size, shape, and pattern optical systems into multiple beams for display. For example, a linear prism may convert a single beam into a linear array of identical beams. A diagrammatic example of the effects produced by a prior art prism optical system is shown in FIGS. 2 and 3. In FIG. 2, a single image 20 produced by the beam color, size, shape, and pattern optical systems passes through a prism 21a,

resulting in multiple copies of the image 20 as output images 22a. The prism 21a may be rotated as indicated by the arc 23, causing a corresponding rotation in the array of output images as indicated by the arc 24. FIG. 3 shows the same optical system and prism 21a, but with the prism 21a rotated to a new position, resulting in a corresponding rotation of the output images 22b. Image 20 is here shown for clarity as a simple circular image, however the image 20 may be any image, complex or simple, as produced by the automated luminaire, in particular it may have a shape defined by patterns or gobos in the optical train.

In further prior art systems the prism may be different shapes and may be capable of being inserted or removed from the light beam automatically. It may further be possible to select different prisms producing different effects for insertion in the beam. However, the prior art systems are only capable of introducing a single prism at one time.

It would be advantageous to provide a system for an automated luminaire that was capable of introducing a plurality of prisms into the optical effect chain simultaneously such that the effects concatenate. It would further be advantageous to be able to selectively and cooperatively coordinate the insertion, position, and rotation of the plurality of prisms to produce new dynamic lighting effects.

### SUMMARY

In a first embodiment, a coordinated effects system includes a first prism system and a second prism system. The first prism system includes a first plurality of prisms, and is configured to position a selected one of its prisms in a light beam passing through the first prism system or to remove all of its prisms from the light beam passing through the first prism system. The first prism system is also configured to rotate at least one of its prisms. The second prism system includes a second plurality of prisms, and is configured to position a selected one of its prisms in the light beam passing through the first prism system or to remove all of its prisms from the light beam passing through the first prism system. The second prism system is also configured to rotate at least one of its prisms.

In a second embodiment, an automated luminaire includes a light source, an optical device coupled to the light source, a first prism system optically coupled to the optical device, a second prism system optically coupled to the first prism system, and a control system. The light source is configured to emit a light beam. The optical device is configured to produce a first image in the light beam. The first prism system includes a first plurality of prisms and is configured to position a selected one of its prisms in the light beam or to remove all of its prisms from the light beam. The first prism system is also configured to rotate the selected one of its prisms to produce a modified image from the image. The second prism system includes a second plurality of prisms and is configured to position a selected one of its prisms in the light beam or to remove all of its prisms from the light beam. The second prism system is also configured to rotate the selected one of its prisms to produce an output image from the modified image. The control system is configured to control the first prism system and the second prism system.

### BRIEF DESCRIPTION OF THE DRAWINGS

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:

FIG. 1 illustrates a typical prior art automated lighting system;

FIG. 2 illustrates a prior art prism effects system;

FIG. 3 illustrates a prior art prism effects system;

FIG. 4 illustrates an optical system with a first coordinated effects system according to the disclosure in a first configuration;

FIG. 5 illustrates the first coordinated effects system of FIG. 4 in a second configuration;

FIG. 6 illustrates the first coordinated effects system of FIG. 4 in a third configuration;

FIG. 7 illustrates the first coordinated effects system of FIG. 4 in a fourth configuration;

FIG. 8 illustrates the first coordinated effects system of FIG. 4 in the second configuration with an alternative second prism;

FIG. 9 illustrates an automated luminaire according to the disclosure, fitted with the first coordinated effects system of FIG. 4;

FIG. 10 illustrates an effect of the first coordinated effects system of FIG. 4 in the fourth configuration with prisms of the first coordinated effects system in a first position relative to each other;

FIG. 11 illustrates an effect of the first coordinated effects system of FIG. 4 in the fourth configuration with prisms of the first coordinated effects system in a second position relative to each other;

FIG. 12 illustrates an optical system including a second coordinated effects system according to the disclosure in a first configuration;

FIG. 13 presents a simplified view of the second coordinated effects system of FIG. 12 in a second configuration;

FIG. 14 presents a simplified view of the second coordinated effects system of FIG. 12 in the first configuration; and

FIG. 15 presents a block diagram of a control system for an automated luminaire according to the disclosure.

#### DETAILED DESCRIPTION

Preferred embodiments are illustrated in the figures, like numerals being used to refer to like and corresponding parts of the various drawings.

Disclosed herein are a coordinated effects system and an automated luminaire. The automated luminaire includes a light source, an optical device, a first prism system, a second prism system, and a control system. The light source is configured to emit a light beam. The optical device is configured to produce a first image in the light beam. The first and second prism systems include corresponding first and second pluralities of prisms and are configured to position selected ones of their respective prisms in the light beam or to remove all of their prisms from the light beam. The first prism system is configured to rotate the selected one of its prisms to produce a modified image from the image. The second prism system is configured to rotate the selected one of its prisms to produce an output image from the modified image. The control system is configured to control the first and second prism systems.

FIG. 4 illustrates an optical system with a first coordinated effects system 400 according to the disclosure in a first configuration. A light source 32 produces a light beam whose optical axis is shown by dotted line 36. The light beam may pass through gobo wheel 34 and optical lenses 37 and 38 before being emitted from the luminaire. The optical system is shown here much simplified for clarity and, in

practice, an automated luminaire may include further optical devices, including but not restricted to, a color wheel, a color mixing mechanism, a rotating gobo, an effects wheel, an iris, a framing shutters mechanism, and other optical devices as known in the art.

The first coordinated effects system 400 includes a first prism system 40. The first prism system 40 comprises a first prism 42 rotatably mounted to a first prism arm 41. A motor 44 is configured to rotate the first prism 42 within first prism arm 41 via a belt 46. Motor 43 is configured to rotate the first prism arm 41 via a gear 45 to insert or remove the first prism 42 into the light beam. The motors 43 and 44 may be operated in a coordinated manner such that the first prism 42 is inserted or removed from the light beam and rotated within the light beam as desired by an operator. The motors 43 and 44 may be of a type selected from, but not restricted to, stepper motor, servo-motor, actuator, solenoid, and other motor types as known in the art. In the configuration shown in FIG. 4, the first prism 42 is positioned outside of the light beam and has no effect on the light beam emitted from the luminaire.

The first coordinated effects system 400 further includes a second prism system 50. The second prism system 50 comprises a second prism 52 rotatably mounted to a second prism arm 51. The motor 54 is configured to rotate the second prism 52 within the second prism arm 51. A motor 53 is configured to rotate the second prism arm 51 to insert or remove the second prism 52 into the light beam. The motors 53 and 54 may be operated in a coordinated manner such that second prism 52 is inserted or removed from the light beam and rotated within the light beam as desired by the operator. The motors 53 and 54 may be of a type selected from, but not restricted to, stepper motor, servo-motor, actuator, solenoid, and other motor types as known in the art. In the configuration shown in FIG. 4, the second prism 52 is positioned outside of the light beam and has no effect on the light beam emitted from the luminaire.

Either or both of the first prism system 40 and the second prism system 50 may include sensors such that the control system of the automated luminaire is aware of, and able to control, the orientation and/or rotation of the first prism 42 and the second prism 52. For example, as illustrated in FIG. 4, the second prism 52 is fitted with a magnet 57 in its periphery that rotates with the second prism 52. A corresponding sensor or sensors (not shown) such as a Hall effect sensor in second prism system 50 may detect the position of magnet 57, and thus sense the rotational position of second prism 52 at the moment the magnet 57 is detected. Similarly, first prism system 40 may be fitted with a magnet and sensor or sensors such that the rotational position of first prism 42 is known and communicated to the control system of the automated luminaire 100. The sensor systems are not restricted to a magnet and Hall effect sensor, and any sensing system may be utilized in other coordinated effects system according to the disclosure, including, but not restricted to, magnetic sensors, optical sensors, and switch sensors.

FIG. 5 illustrates the first coordinated effects system 400 in a second configuration. In FIG. 5, the motor 43 has been operated from the configuration shown in FIG. 4 to rotate the first prism arm 41, and thus the first prism 42 has been inserted into the light beam. The second prism 52 remains outside the light beam. In this configuration, the first prism 42 alone will produce an effect in the light beam. The first prism 42 may be rotated while in the light beam by the motor 44, producing effects similar to those illustrated in FIGS. 2 and 3.



FIG. 6 illustrates the first coordinated effects system 400 in a third configuration. In FIG. 6, the motor 53 has been operated from the configuration shown in FIG. 4 to rotate the second prism arm 51, and thus the second prism 52 has been inserted into the light beam. The first prism 42 remains outside light beam. In this configuration, the second prism 52 alone will produce an effect in the light beam. The second prism 52 may be rotated within the light beam by the motor 54, producing effects similar to those illustrated in FIGS. 2 and 3.

FIG. 7 illustrates the first coordinated effects system 400 in a fourth configuration. In FIG. 7, the motor 43 has been operated from the configuration shown in FIG. 4 to rotate the first prism arm 41, and thus the first prism 42 has been inserted across the light beam. Further, motor 53 has also been operated to rotate the second prism arm 51, and thus the second prism 52 has been inserted into the light beam. In this position both the first prism 42 and the second prism 52 will produce effects in the light beam. The first prism 42 and the second prism 52 may be rotated while in the light beam by the motors 44 and 54, respectively. The second prism 52 receives the light beam after it has passed through, and been affected by, the first prism 42. Thus, the effect produced by the first prism 42 is then further modified by the second prism 52.

FIG. 8 illustrates the first coordinated effects system 400 in the second configuration with an alternative second prism 58. Similarly, first prism 42 may be replaced with alternative prism designs.

FIG. 9 illustrates an automated luminaire 100 according to the disclosure, fitted with the first prism system 40 and the second prism system 50.

FIGS. 10 and 11 illustrate effects of the first coordinated effects system 400 in the fourth configuration. FIG. 10 illustrates an effect of the first coordinated effects system 400 with the first prism 42 and the second prism 52 in a first position relative to each other. A single image 60 produced by beam color, size, shape, and pattern optical systems of the automated luminaire 100 passes through first prism 42 and second prism 52, resulting in multiple copies of the image 60 as output image 63a. Image 60 is here shown for clarity as a simple circular image, however image 60 may be any complex image as produced by the automated luminaire, in particular it may have a shape defined by the patterns or gobos in the optical train.

Because the first prism 42 and the second prism 52 are both linear prisms and are aligned in a parallel manner, the resulting output image 63a is also linearly aligned. However, both first prism 42 and second prism 52 may be rotated independently, as indicated by arcs 64 and 65, respectively, causing a change in pattern and rotation (as indicated by arc 66) in the output image 63a. For example, if the first prism 42 and second prism 52 are rotated in the same direction at the same speed, maintaining their rotational alignment, the output image 63a will maintain its shape and rotate.

FIG. 11 illustrates an effect of the first coordinated effects system 400 in the fourth configuration with the first prism 42 and the second prism 52 of the first coordinated effects system 400 in a second position relative to each other. The first prism 42 remains in the same position as in FIG. 10; however, the second prism 52 has been rotated 90° to a new position orthogonal to its position in FIG. 10. In this configuration, the linear effect of the first prism 42 still forms a single linear array of the image 60; however, the second prism 52 now acts on that first linear array in an orthogonal direction, resulting in an output image 63b that is a matrix array of the linear array produced by the first

prism 42. As described with reference to FIG. 10, if the first prism 42 and second prism 52 are rotated in the same direction at the same speed, maintaining their rotational alignment, the output image 63b will rotate while maintaining its shape.

Intermediate angles between the first prism 42 and the second prism 52 to the angles shown in FIGS. 10 and 11 will produce output images intermediate between output images 63a and 63b that change shape and configuration smoothly as the angle between the first prism 42 and the second prism 52 changes. If the angle changes slowly, the variation in the output images also changes slowly. Similarly, if the angle changes quickly, the variation in the output images also changes quickly.

The first prism 42 and the second prism 52 may be simultaneously rotated in a coordinated manner, such that the angle between them remains constant. For example, both prisms may be rotated in the same direction at the same speeds, thus maintaining the difference in angle between them. This results in an output image that remains static and rotates at the same rate as the prisms. In some embodiments, such rotation may be performed without information received from sensors fitted to the first prism 42 and the second prism 52. In other embodiments, the sensors fitted to the first prism 42 and the second prism 52 enable the control system of the automated luminaire 100 to maintain improved coordination in the rotation and positioning of the prisms. The first prism 42 and the second prism 52 may be simultaneously rotated in a coordinated manner at differing speeds and/or in differing directions, resulting in output images that change and/or rotate. Either or both of the first prism 42 and the second prism 52 may be rotated while the other is held static (i.e., at a rotational speed of zero). Speeds and rotation directions and positions may be accurately controlled through the sensors to produce accurate and repeatable coordinated effects in the output images.

FIG. 12 illustrates an optical system including a second coordinated effects system 1200 according to the disclosure in a first configuration. A light source 132 produces a light beam whose optical axis is shown by dotted line 136. The light beam passes through a gobo wheel 134 and optical lenses 137a, 137b, and 138 before being emitted from the luminaire. The optical system is shown here much simplified for clarity and, in practice, the automated luminaire may include further optical devices including but not restricted to a color wheel, a color mixing mechanism, a rotating gobo, an effects wheel, an iris, a framing shutters mechanism, and other optical devices as known in the art.

The second coordinated effects system 1200 includes a first prism system 140. The first prism system 140 comprises a prism 142a, a prism 142b, and a prism 142c, all rotatably mounted to a first prism support (or arm) 141. A motor (not shown) is configured to rotate the prisms 142a, 142b, and 142c within the first prism support 141. A second motor (not shown) is configured to rotate the first prism support 141 to insert one of the prisms 142a, 142b, or 142c into the light beam, or to remove all three prisms from the light beam. The motors may be operated in a coordinated manner such that one of the prisms 142a, 142b, and 142c is inserted or removed from the light beam and rotated within the light beam, as desired by the operator. The motors (or actuators) may be of a type selected from, but not restricted to, stepper motor, servo-motor, actuator, solenoid, and other motor types as known in the art. In the configuration shown in FIG. 12, the prisms 142a and 142b are positioned outside of light beam and will have no effect on the exiting light beam, while the prism 142c is positioned in the light beam.

The second coordinated effects system **1200** further includes a second prism system **150**. The second prism system **150** comprises a prism **152a**, a prism **152b**, and a prism **152c** rotatably mounted to a second prism support (or arm) **151**. A third motor (not shown) is configured to rotate the prisms **152a**, **152b**, and **152c** within the second prism support **151**. A fourth motor (not shown) is configured to rotate the second prism support **151** to insert one of the prisms **152a**, **152b**, or **152c** into the light beam, or to remove all three prisms from the light beam. The motors may be operated in a coordinated manner such that one of the prisms **152a**, **152b**, and **152c** is inserted or removed from the light beam and rotated within the light beam, as desired by the operator. The motors (or actuators) may be of a type selected from, but not restricted to, stepper motor, servo-motor, actuator, solenoid, and other motor types as known in the art. In the configuration shown in FIG. **12**, the prisms **152a** and **152b** are positioned outside of light beam and will have no effect on the exiting light beam, while the prism **152c** is positioned into the light beam. In these positions the prism **142c** and the prism **152c** are both positioned in the light beam and will interact to produce results similar to those shown in FIGS. **2**, **3**, **10**, and **11**.

In the first configuration of the second coordinated effects system **1200**, the prism **142c** of the first prism system **140** is positioned in the light beam produced by the light source **132**. The prism **152c** of the second prism system **150** is positioned in the light beam as modified by the first prism system **140**. As described with reference to FIGS. **10** and **11**, the prism **142c** produces a first effect in the light beam (or modified image) and the prism **152c** produces a second effect in the light beam as modified by the prism **142c**, resulting in an output image.

The ability to position selected prisms from one or both of the first prism system **140** and the second prism system **150** in the light beam, and to selectively rotate either or both of the selected prisms enables an operator of an automated luminaire according to the disclosure to concatenate the effects of the selected prisms and to selectively and cooperatively coordinate the insertion and rotation of the selected prisms to produce new dynamic lighting effects.

When the second coordinated effects system **1200** is in a configuration similar to that shown in FIG. **6** (i.e., with the prisms of the first prism system **140** removed from the light beam and a prism from the second prism system **150** positioned in the light beam), the prism from the second prism system **150** is still characterized for purposes of this disclosure as receiving the light beam as modified by the first prism system **140**.

Either or both of the first prism system **140** and the second prism system **150** may further include sensors such that the control system of the automated luminaire is able to detect and control the orientation and/or rotation of the prisms **142a**, **142b**, or **142c** and the prisms **152a**, **152b**, or **152c**. For example, each of the prisms may be fitted with magnets in their respective peripheries that rotate with them. A corresponding sensor or sensors (not shown) such as a Hall effect sensor in the first prism system **140** and the second prism system **150** may detect the position of the magnets, and thus deduce the rotational position of the prisms.

The sensors are not restricted to a magnet and Hall effect sensor, and any sensing system may be utilized in other embodiments of the disclosure, including, but not restricted to, magnetic sensors, optical sensors, switch sensors. In some embodiments, a single sensor may be used for each of the first prism system **140** and the second prism system **150**, mounted in positions that permit them to sense whichever of

the prisms of the first prism system **140** and/or the second prism system **150** are positioned in the light beam.

While the prism systems **140** and **150** are described as each comprising a single motor that rotates all three prisms in its prism system, it will be understood that in other embodiments a prism system according to the disclosure may include one or more actuators to individually rotate one or more associated prisms in the prism system.

FIG. **13** presents a simplified view of the second coordinated effects system **1200** of FIG. **12** in a second configuration. In FIG. **13** both first prism support **141** and second prism support **151** have been rotated to remove all prisms from the light beam. A first motor (not shown) is configured to rotate the prisms **152a**, **152b**, or **152c** within the second prism support **151** via a belt **161**. A second motor (not shown) is configured to rotate the prisms **142a**, **142b**, or **142c** within the first prism support **141** via a belt **163**.

FIG. **14** presents a simplified view of the second coordinated effects system **1200** of FIG. **12** in the first configuration. In the first configuration, the first prism support **141** and the second prism support **151** have been rotated from their positions in the second configuration shown in FIG. **13** to insert both the prism **142c** and the prism **152c** into the light beam. In this first configuration, the prisms will interact to produce results similar to those shown in FIGS. **2**, **3**, **10**, and **11**.

FIG. **14** shows a pulley **153** that is coupled to and driven by the first motor described with reference to FIG. **13**. The pulley **153** engages the belt **161** and causes the prisms **152a**, **152b**, or **152c** to rotate within the second prism support **151**.

Although embodiments with two prism systems have been illustrated and described, in other embodiments any number of prism systems may be utilized to produce complex coordinated effects. Each of the multiple prism systems may be fitted with any number of prisms.

FIG. **15** presents a block diagram of a control system (or controller) **1500** for an automated luminaire **12** according to the disclosure. The control system **1500** is suitable for controlling the coordinated effects systems **400** and **1200** described with reference to FIGS. **4-8** and **12-14**, respectively. The control system **1500** is also suitable for controlling other control functions of the automated luminaire **100**, described with reference to FIG. **9**. The control system **1500** includes a processor **1502** electrically coupled to a memory **1504**. The processor **1502** is implemented by hardware and software. The processor **1502** may be implemented as one or more Central Processing Unit (CPU) chips, cores (e.g., as a multi-core processor), field-programmable gate arrays (FPGAs), application specific integrated circuits (ASICs), and digital signal processors (DSPs).

The processor **1502** is further electrically coupled to and in communication with a communication interface **1506**. The communication interface **1506** is coupled to, and configured to communicate via, the data link **14**. The processor **1502** is also coupled via a control interface **1508** to one or more other sensors, motors, actuators, controls and/or other devices. The processor **1502** is configured to receive control signals via the communication interface **1506** and to control the coordinated effects systems **400** and **1200** and other mechanisms of the automated luminaire **100** via the control interface **1508**.

The control system **1500** is suitable for implementing processes, coordinated effects control, and other functionality as disclosed herein, which may be implemented as instructions stored in the memory **1504** and executed by the processor **1502**. The memory **1504** comprises one or more disks, tape drives, and/or solid-state drives and may be used

as an over-flow data storage device, to store programs when such programs are selected for execution, and to store instructions and data that are read during program execution. The memory 1504 may be volatile and/or non-volatile and may be read-only memory (ROM), random access memory (RAM), ternary content-addressable memory (TCAM), and/or static random-access memory (SRAM).

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 herein. While 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. A coordinated effects system, comprising:
  - a first prism system comprising a first plurality of prisms, the first prism system configured to be moved to first and second positions, in the first position a selected one of the first plurality of prisms being positioned in a light beam passing through the first prism system, and in the second position all of the first plurality of prisms being removed from the light beam passing through the first prism system,
  - the first prism system further comprising a first stepper motor and a first sensor, the first stepper motor configured to rotate the selected one of the first plurality of prisms, and the first sensor configured to detect an orientation of the selected one of the first plurality of prisms in the first position;
  - a second prism system optically coupled to the first prism system and comprising a second plurality of prisms, the second prism system configured to be moved to third and fourth positions, in the third position a selected one of the second plurality of prisms being positioned in the light beam passing through the first prism system, and in the fourth position all of the second plurality of prisms being removed from the light beam passing through the first prism system,
  - the second prism system further comprising a second stepper motor and a second sensor, the second stepper motor configured to rotate the selected one of the second plurality of prisms, and the second sensor configured to detect an orientation of the selected one of the second plurality of prisms in the third position; and
  - a control system coupled to the first and second stepper motors and the first and second sensors and configured to use the first and second sensors to control, simultaneously and in a coordinated manner, rotation directions, rotation speeds, and rotational positions of the selected one of the first plurality of prisms and the selected one of the second plurality of prisms.
2. The coordinated effects system of claim 1, wherein at least one of the first prism system and the second prism system is configured to rotate all of the associated plurality of prisms simultaneously.
3. The coordinated effects system of claim 1, wherein:
  - the first prism system comprises a third stepper motor coupled to the control system and configured to move the first prism system from the second position to the first position; and
  - the second prism system comprises a fourth stepper motor coupled to the control system and configured to move the second prism system from the fourth position to the third position.

4. The coordinated effects system of claim 1, wherein at least one of the first prism system and the second prism system comprises:

- an arm configured to move the first prism system from the second position to the first position; and
- an actuator mechanically coupled to the arm and electrically coupled to the control system, the actuator configured to rotate the arm to move the first prism system from the second position to the first position.

5. An automated luminaire, comprising:
  - a light source configured to emit a light beam;
  - an optical device coupled to the light source and configured to produce a first image in the light beam;
  - a first prism system optically coupled to the optical device and comprising a first plurality of prisms, the first prism system configured to be moved to first and second positions, in the first position a selected one of the first plurality of prisms being positioned in the light beam, and in the second position all of the first plurality of prisms being removed from the light beam,
  - the first prism system further comprising a first stepper motor and a first sensor, the first stepper motor configured to rotate the selected one of the first plurality of prisms to produce a modified image from the image, and the first sensor configured to detect an orientation of the selected one of the first plurality of prisms in the first position;
  - a second prism system optically coupled to the first prism system and comprising a second plurality of prisms, the second prism system configured to be moved to third and fourth positions, in the third position a selected one of the second plurality of prisms being positioned in the light beam, and in the fourth position all of the second plurality of prisms being removed from the light beam,
  - the second prism system further comprising a second stepper motor and a second sensor, the second stepper motor configured to rotate the selected one of the second plurality of prisms to produce an output image from the modified image, and the second sensor configured to detect an orientation of the selected one of the second plurality of prisms in the third position; and
  - a control system coupled to the first and second stepper motors and the first and second sensors and configured to use the sensing system to control, simultaneously and in a coordinated manner, rotation directions, rotation speeds, and rotational positions of the selected one of the first plurality of prisms and the selected one of the second plurality of prisms.
6. The automated luminaire of claim 5, wherein the control system is configured to:
  - control rotation of the selected one of the first plurality of prisms and rotation of the selected one of the second plurality of prisms based on signals received from the first and second sensors, respectively.
7. The automated luminaire of claim 6, wherein the control system is configured to rotate one of the selected one of the first plurality of prisms and the selected one of the second plurality of prisms while not rotating the other one of the selected one of the first plurality of prisms and the selected one of the second plurality of prisms.
8. The automated luminaire of claim 6, wherein the control system is configured to rotate the selected one of the first plurality of prisms and the selected one of the second plurality of prisms in the same direction at the same speed

and maintain a desired rotational alignment between the selected one of the first plurality of prisms and the selected one of the second plurality of prisms.

9. The automated luminaire of claim 5, wherein the control system is configured to rotate the selected one of the first plurality of prisms and the selected one of the second plurality of prisms in opposite directions.

10. The automated luminaire of claim 5, wherein the control system is configured to rotate the selected one of the first plurality of prisms at a first speed and the selected one of the second plurality of prisms at a second speed.

11. The automated luminaire of claim 5, wherein the control system comprises a communication interface and the control system is configured to control the first prism system and the second prism system in response to control signals received via the communication interface.

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