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(54) **FRAMING SYSTEM FOR AN AUTOMATED LUMINAIRE**

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F21V 5/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC *F21V 14/06* (2013.01); *F21S 10/007* (2013.01); *F21V 5/008* (2013.01); *F21V 5/02* (2013.01); *F21W 2131/406* (2013.01)

(58) **Field of Classification Search**
CPC F21V 14/06–085; F21V 5/02; F21V 5/008; F21V 5/04; F21V 5/00;
(Continued)

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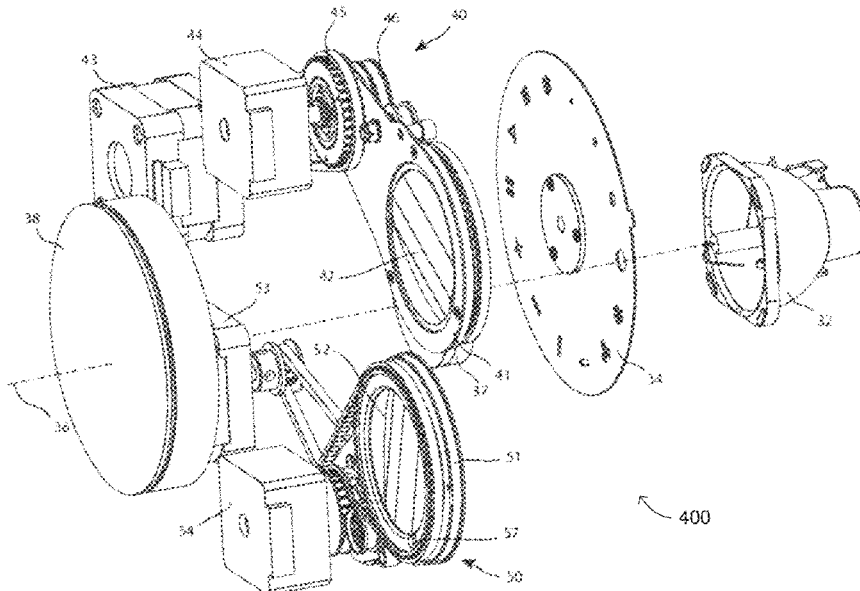(Continued)

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(57) **ABSTRACT**

A framing system, automated luminaire, and method are provided. The framing system includes a first prism system and a second prism system. The first prism system includes a first barrel prism and positions the first barrel prism in a light beam or to remove the first barrel prism from the light beam. The first prism system may rotate the first barrel prism. The second prism system includes a second barrel prism and is configured to position the second barrel prism in the light beam that passes through the first prism system or to remove the second barrel prism from the light beam. The second prism system may rotate the second barrel prism.

20 Claims, 14 Drawing Sheets

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(60) Provisional application No. 62/058,562, filed on Oct. 1, 2014, provisional application No. 62/553,565, filed on Sep. 1, 2017, provisional application No. 62/553,772, filed on Sep. 1, 2017.

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F21S 10/00 (2006.01)
F21V 5/00 (2018.01)
F21W 131/406 (2006.01)

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CPC F21V 13/00; F21V 14/00; F21S 10/007; F21W 2131/406; G02B 5/04
See application file for complete search history.

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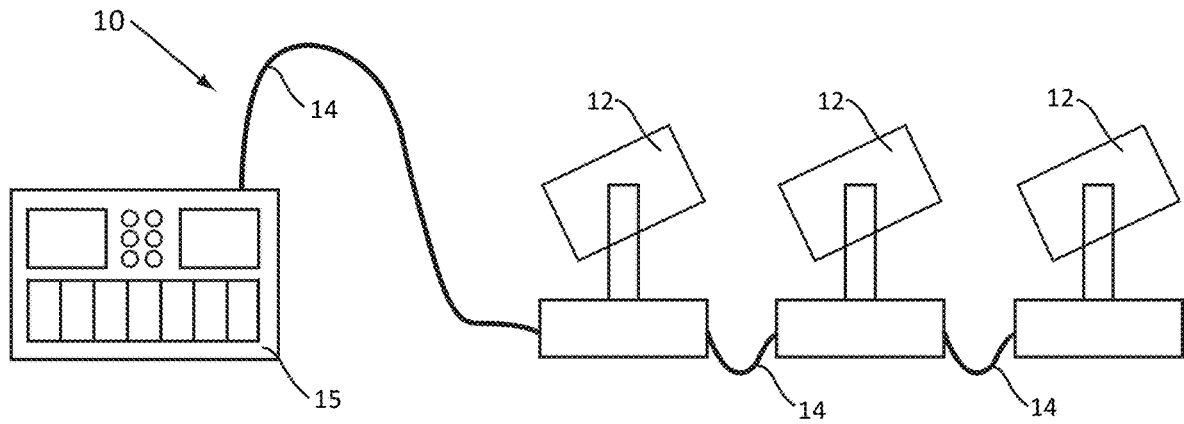
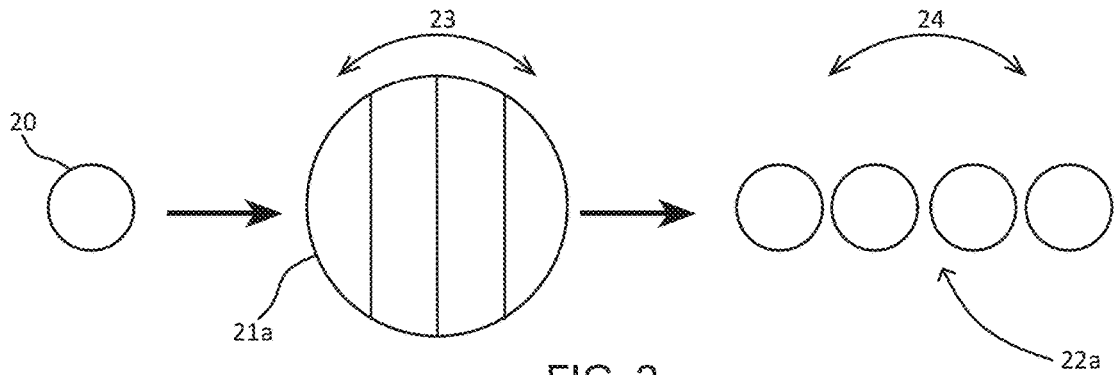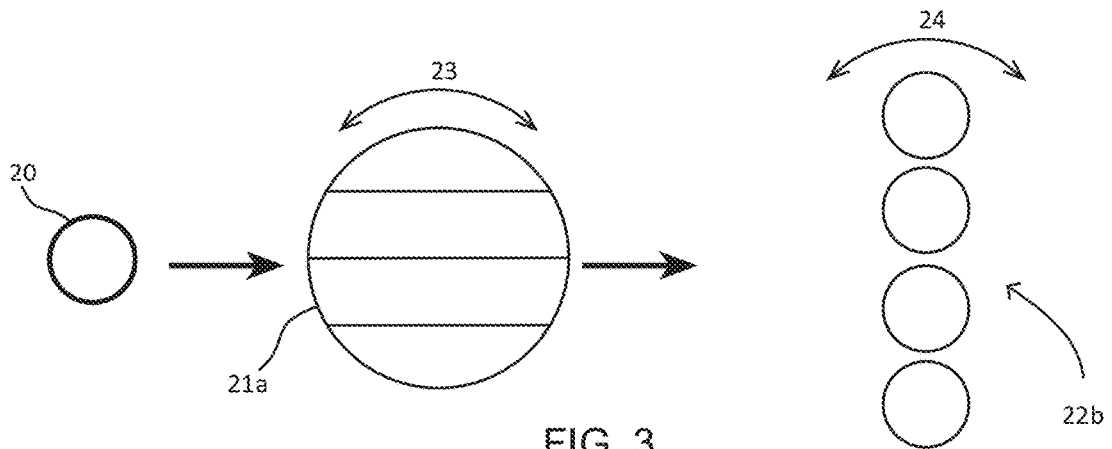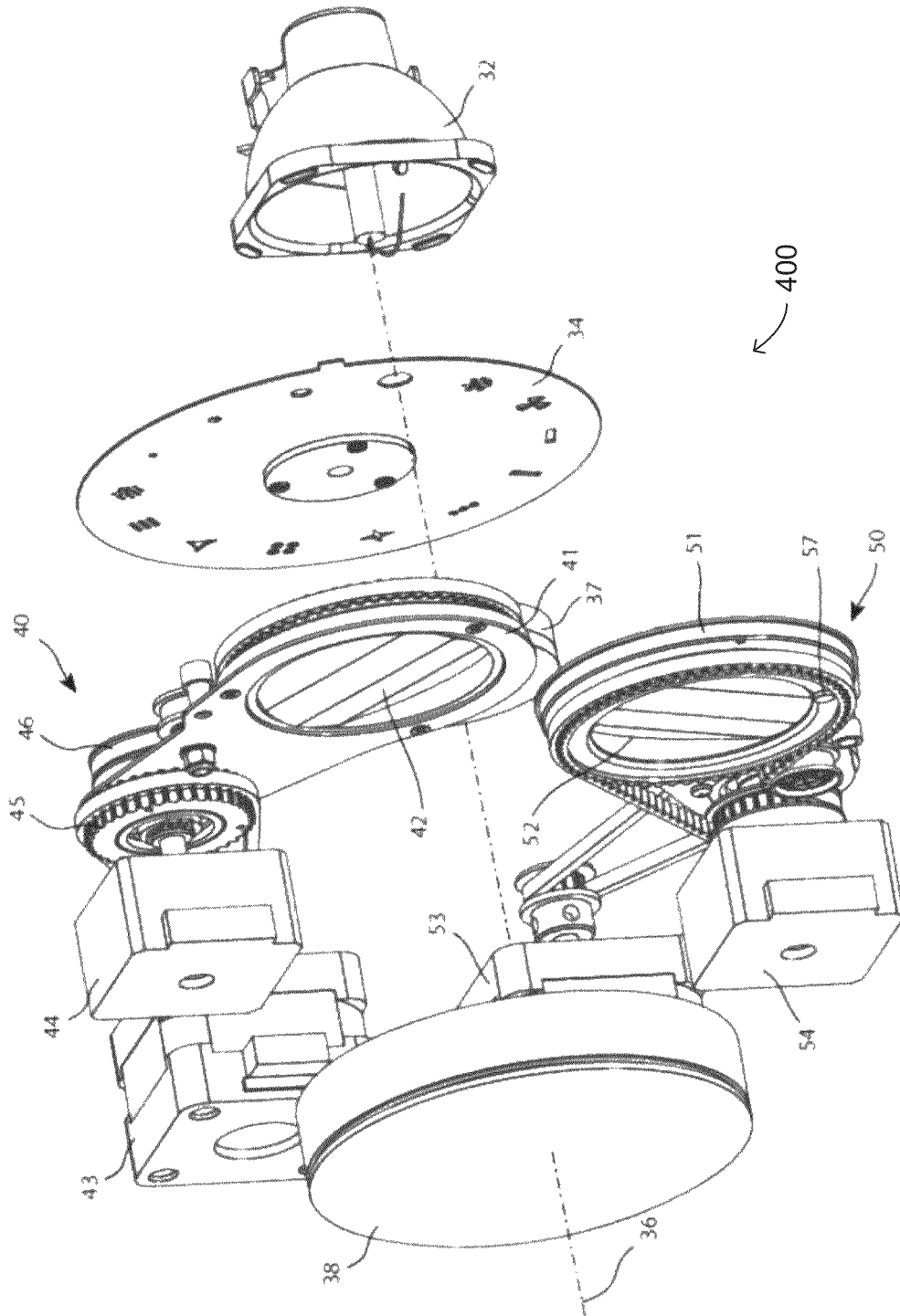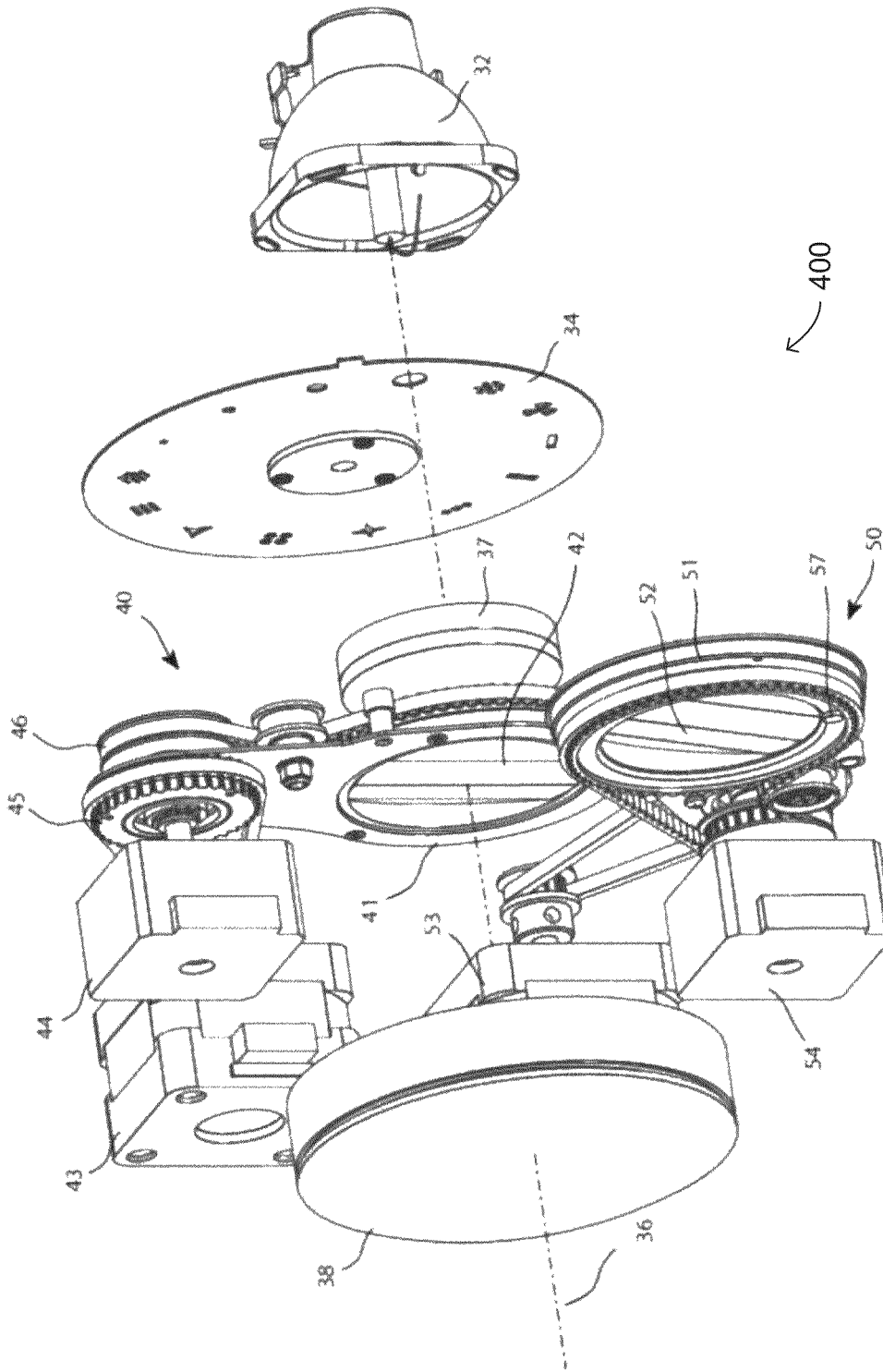* cited by examiner

FIG. 1
PRIOR ART

FIG. 2
PRIOR ART

FIG. 3
PRIOR ART

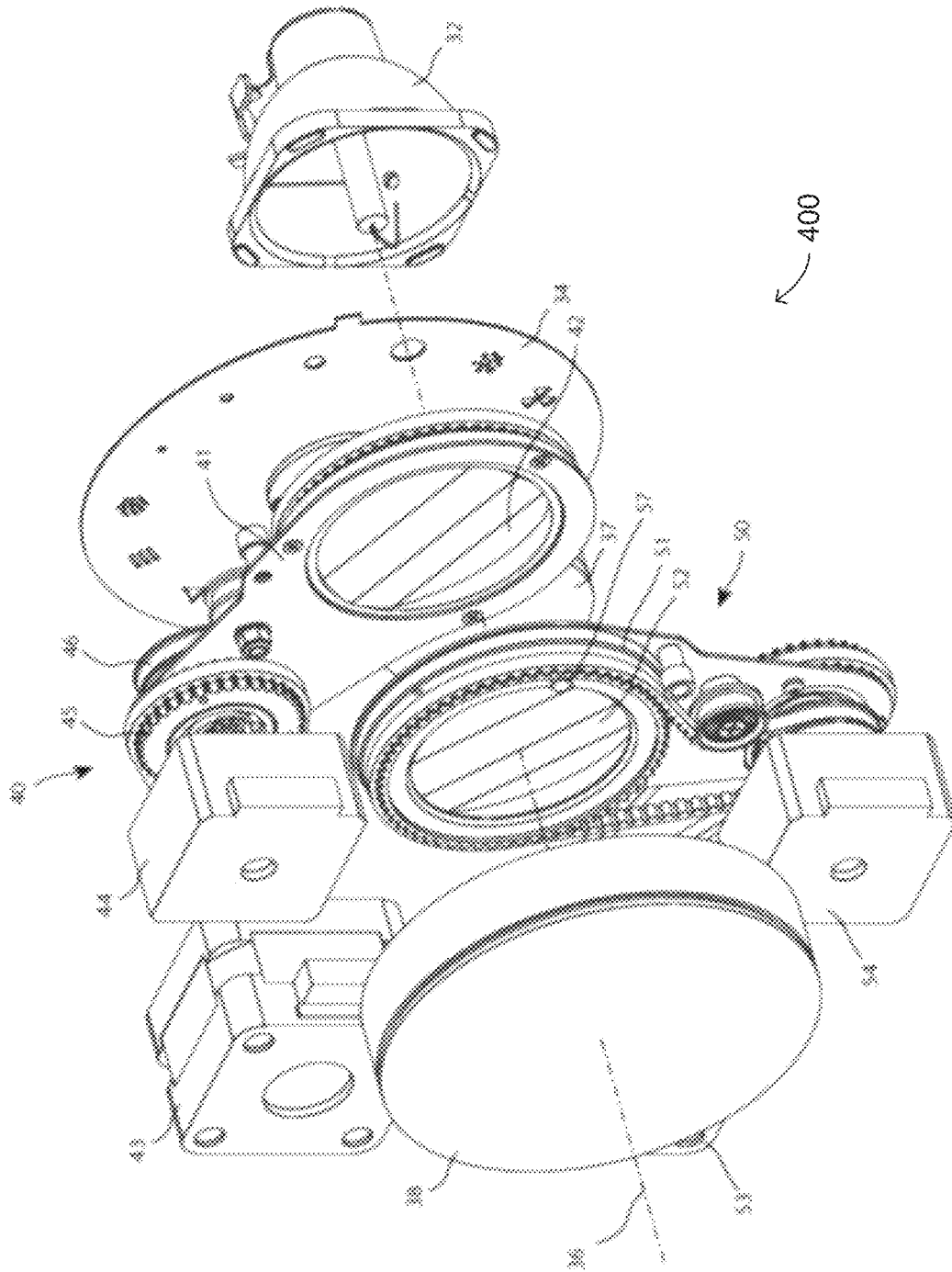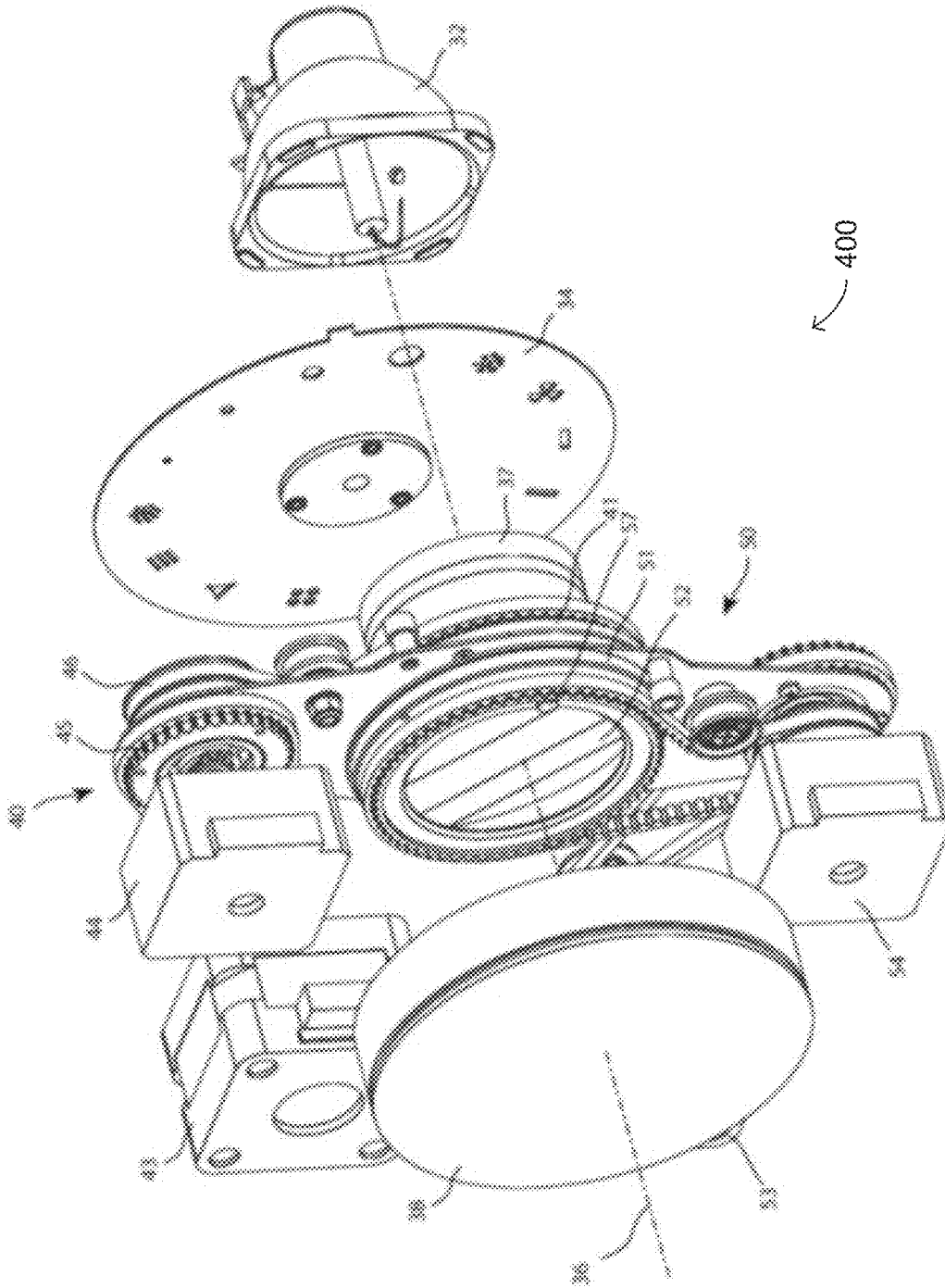FIG. 4

FIG. 5

FIG. 6

FIG. 7

400

FIG. 8

FIG. 9

FIG. 10

52

42

FIG. 11

52

42

FIG. 12

1200

150

152c

137a

152a

151

142c

141

142b

142a

137b

152b

140

FIG. 13

FIG. 14

1500

14

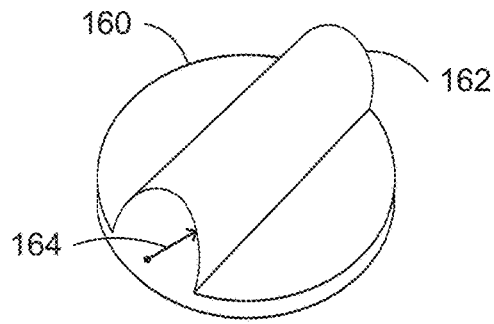| 1506
Comm. Intfc. |
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Sensors /
Actuators |
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Processor |
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Memory |

FIG. 15

160

162

164

FIG. 16
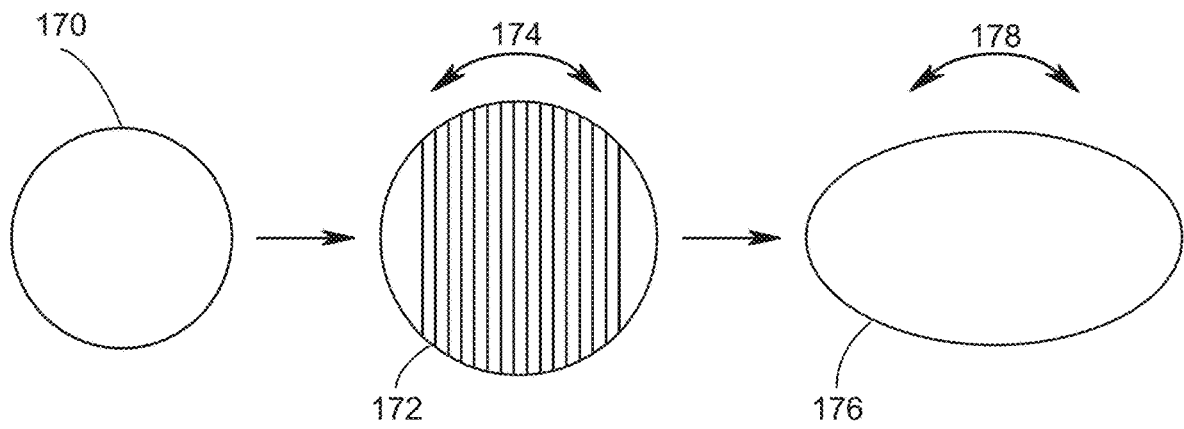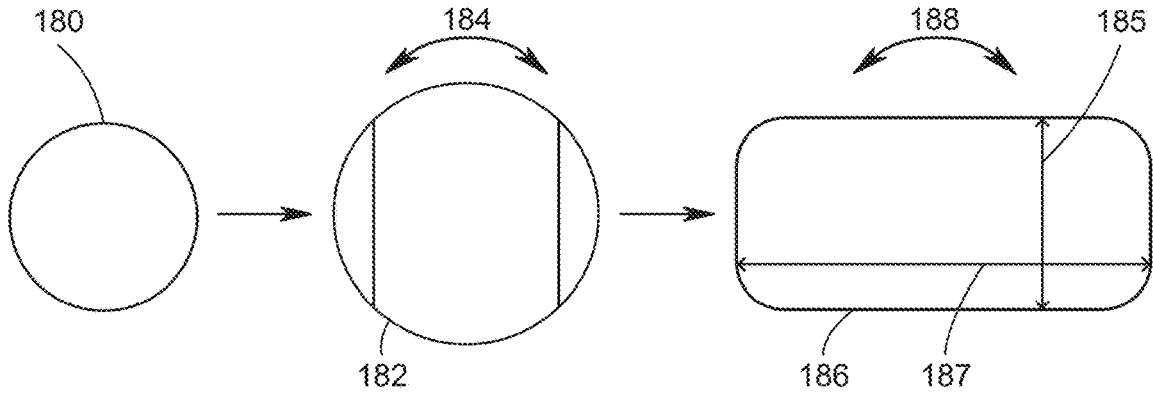
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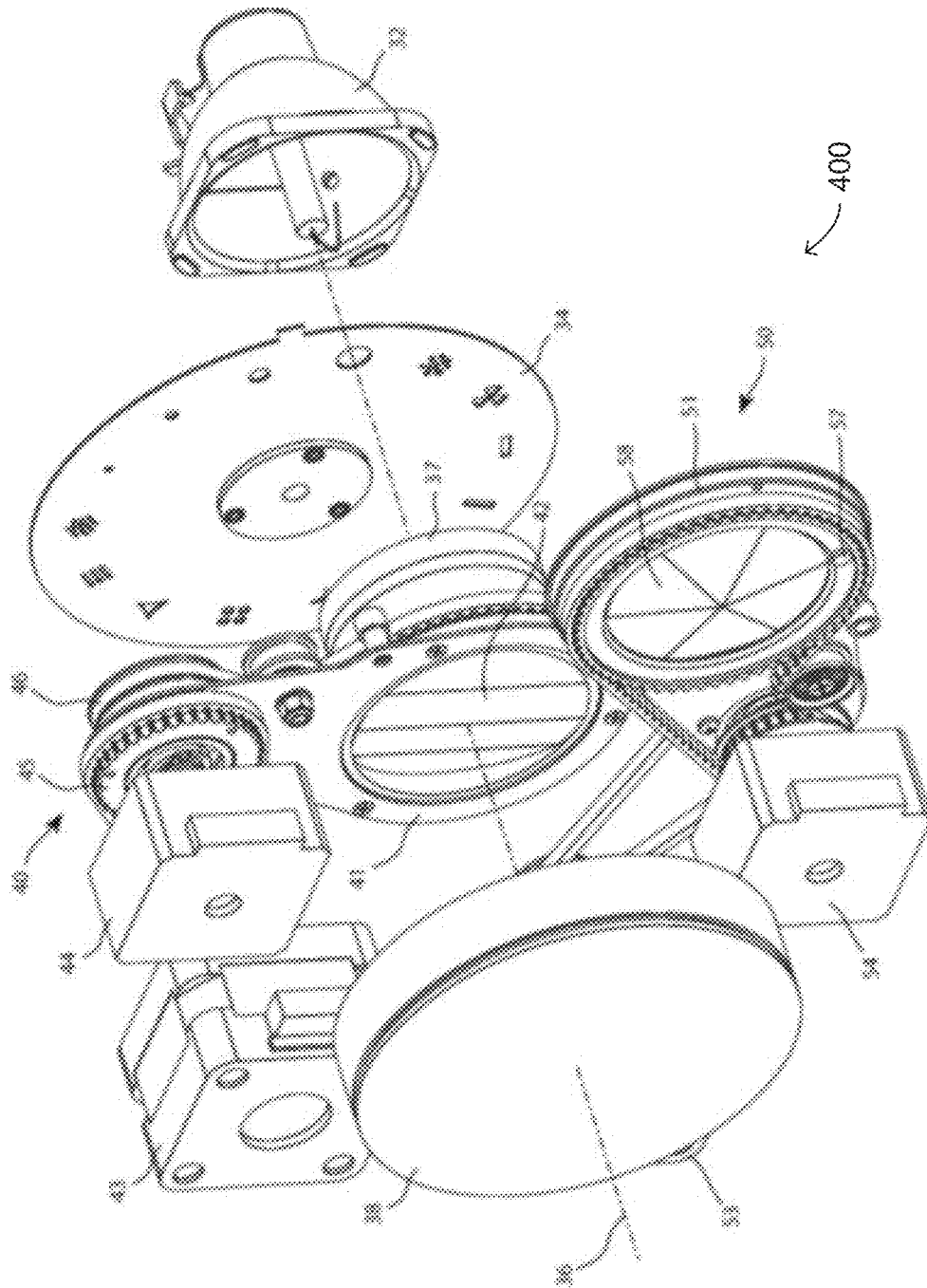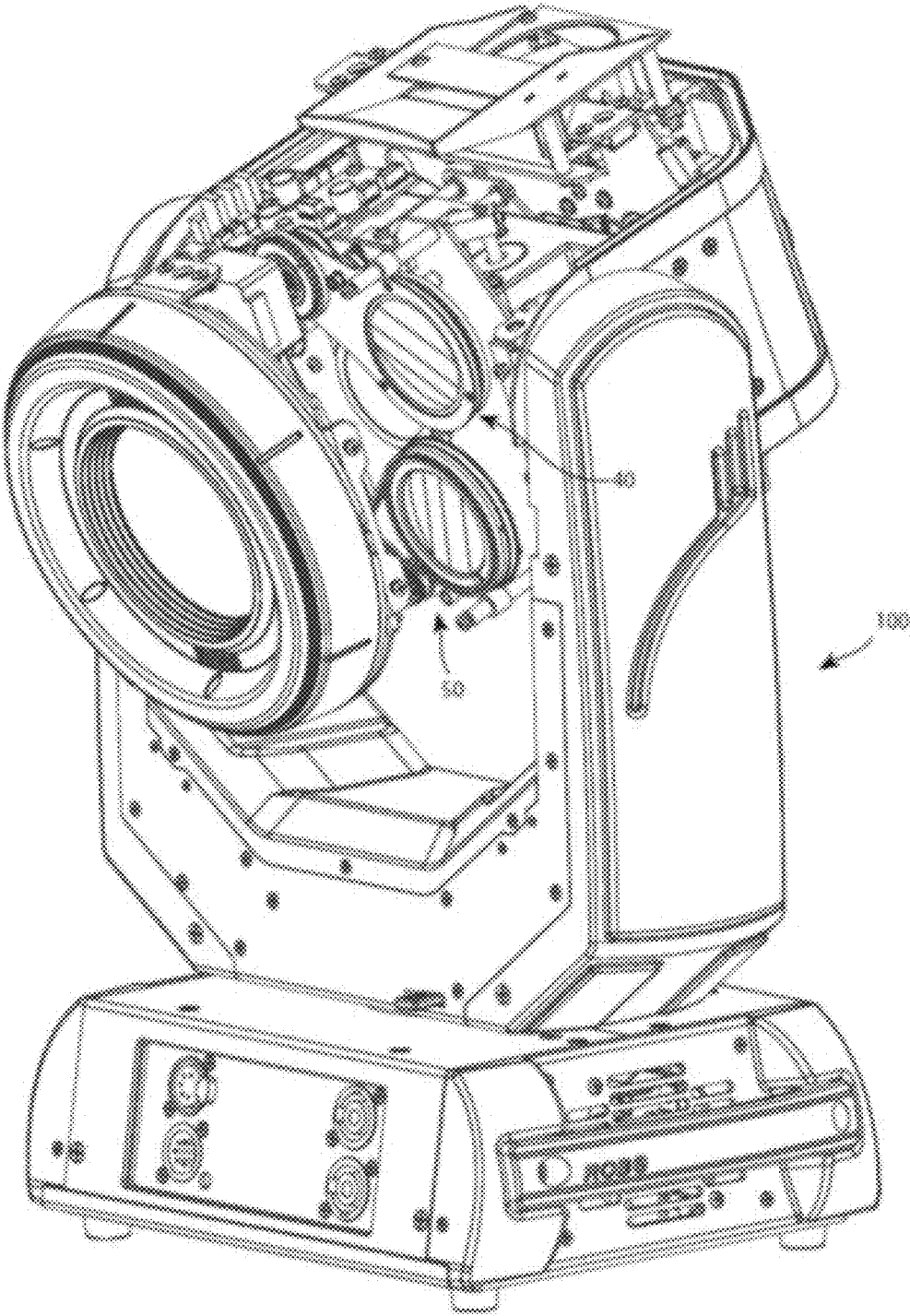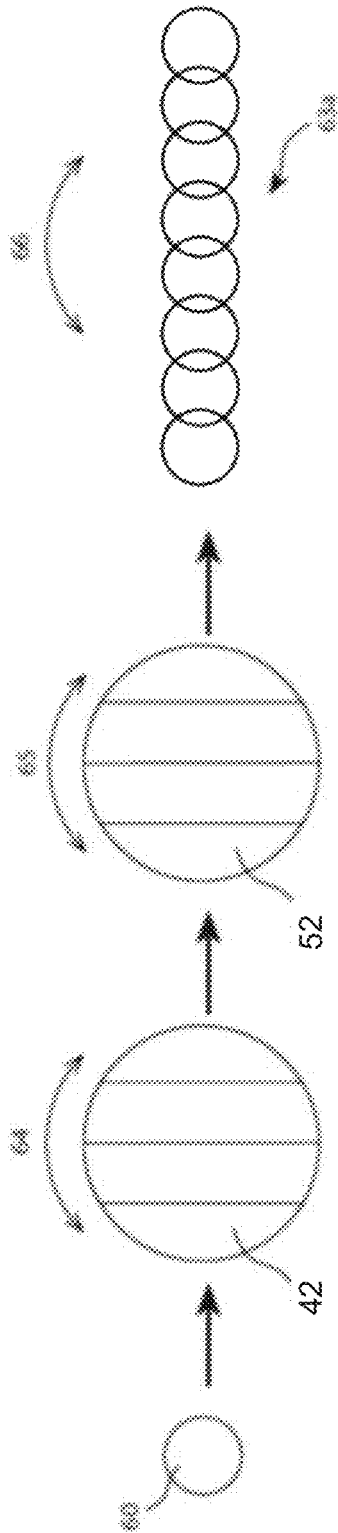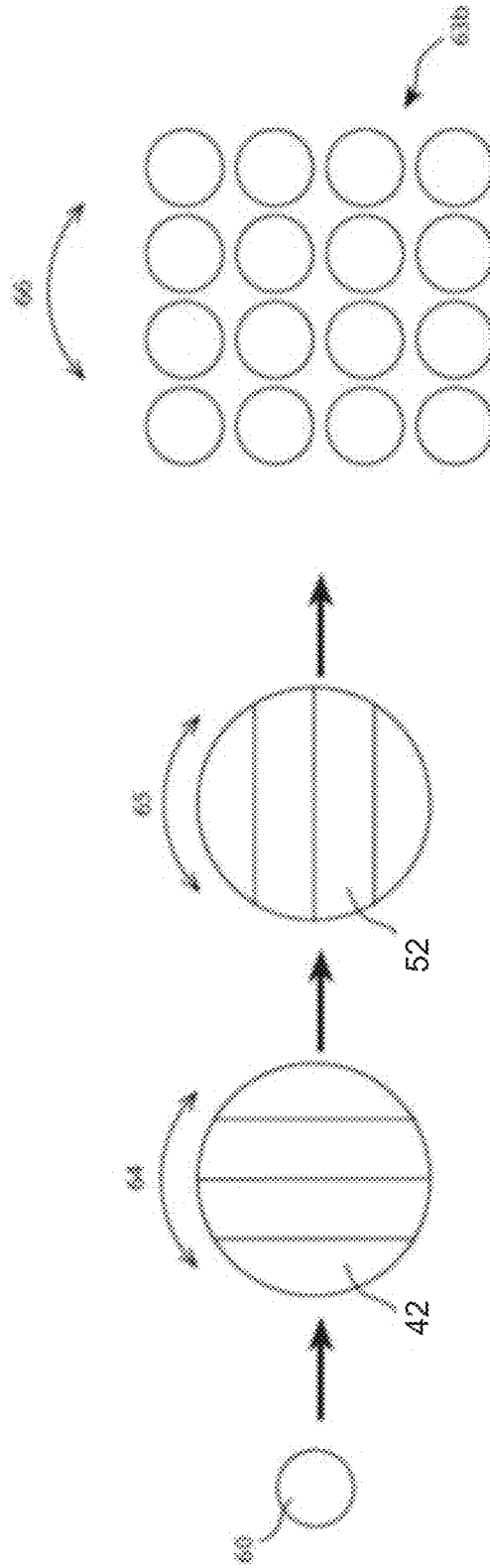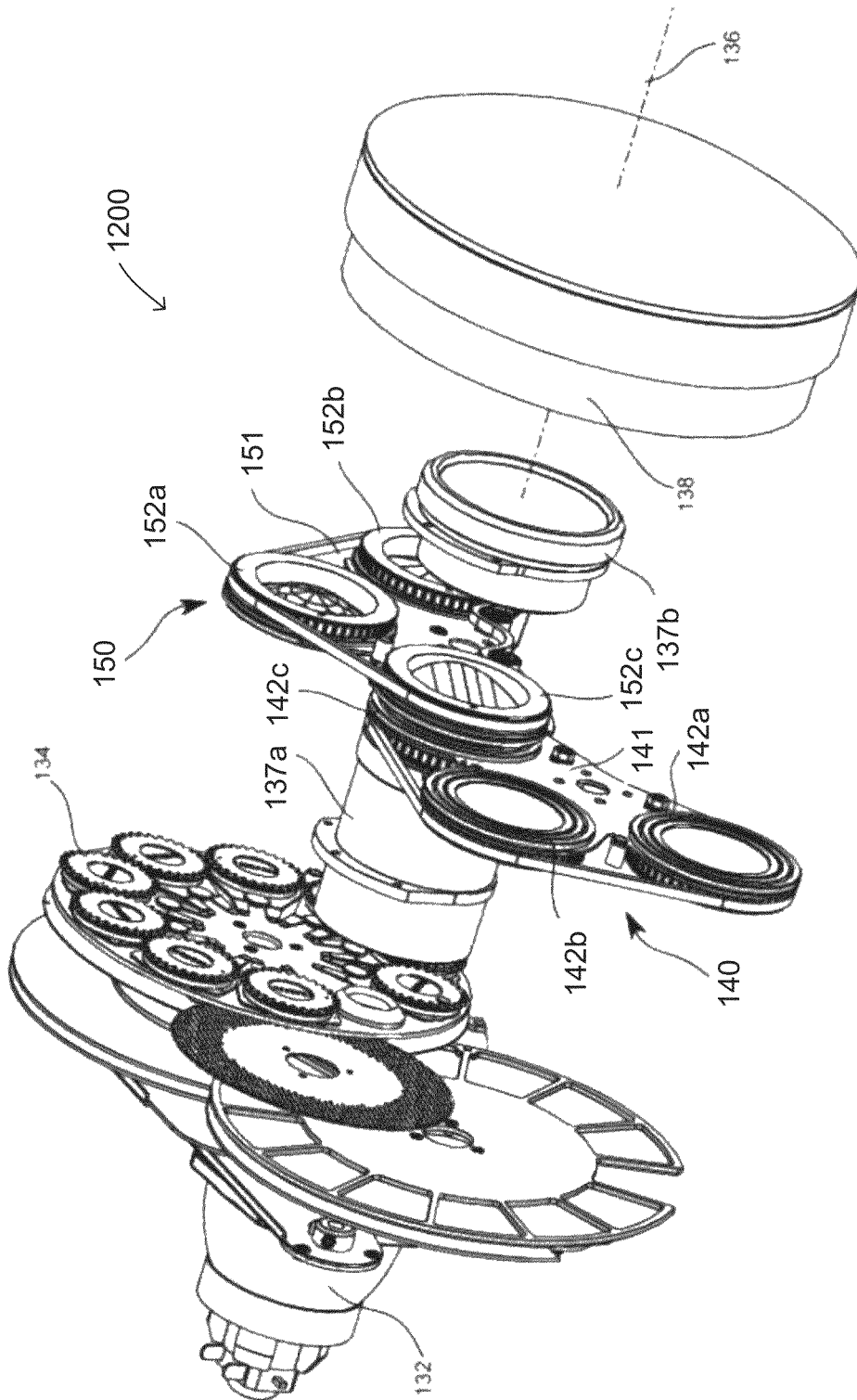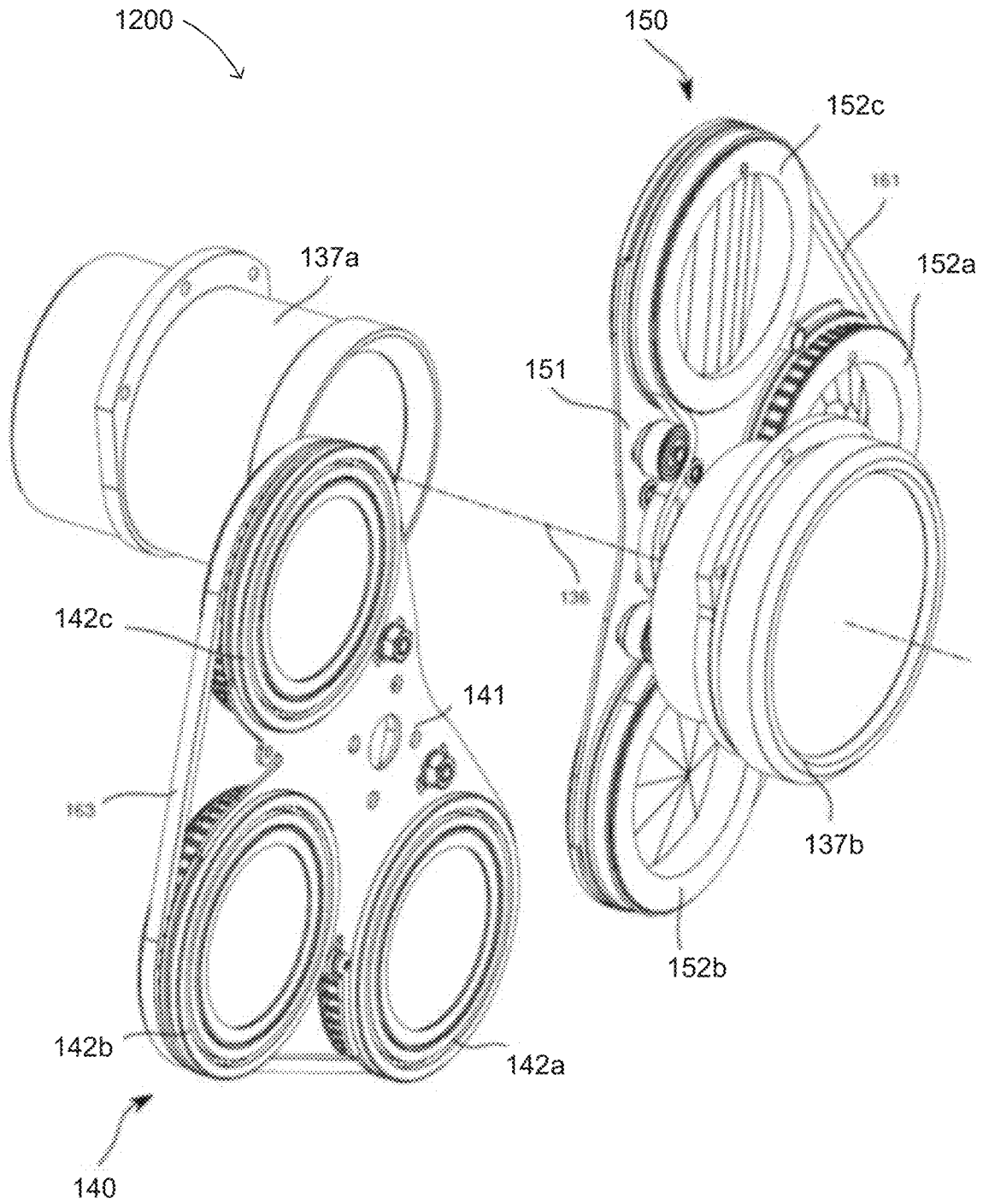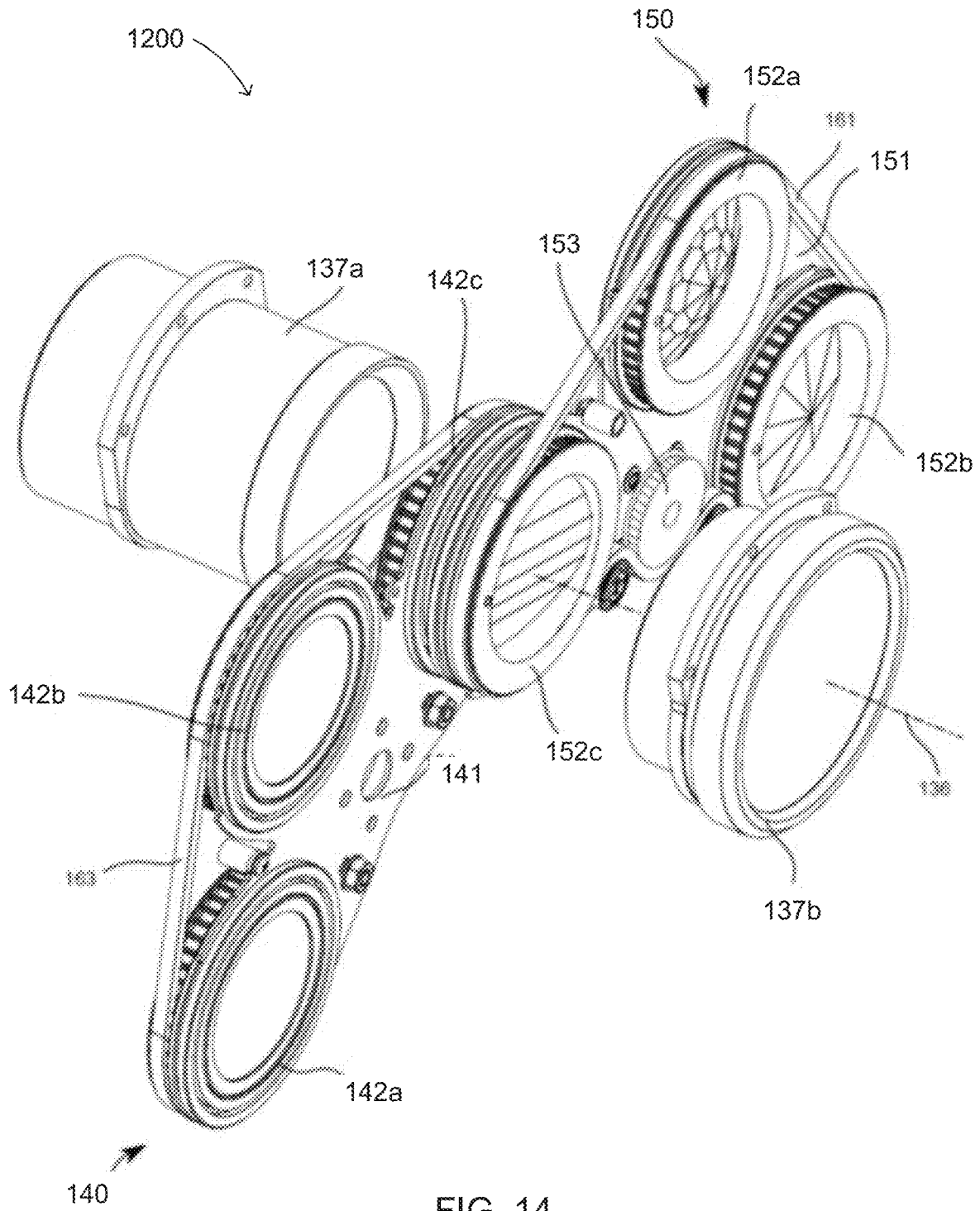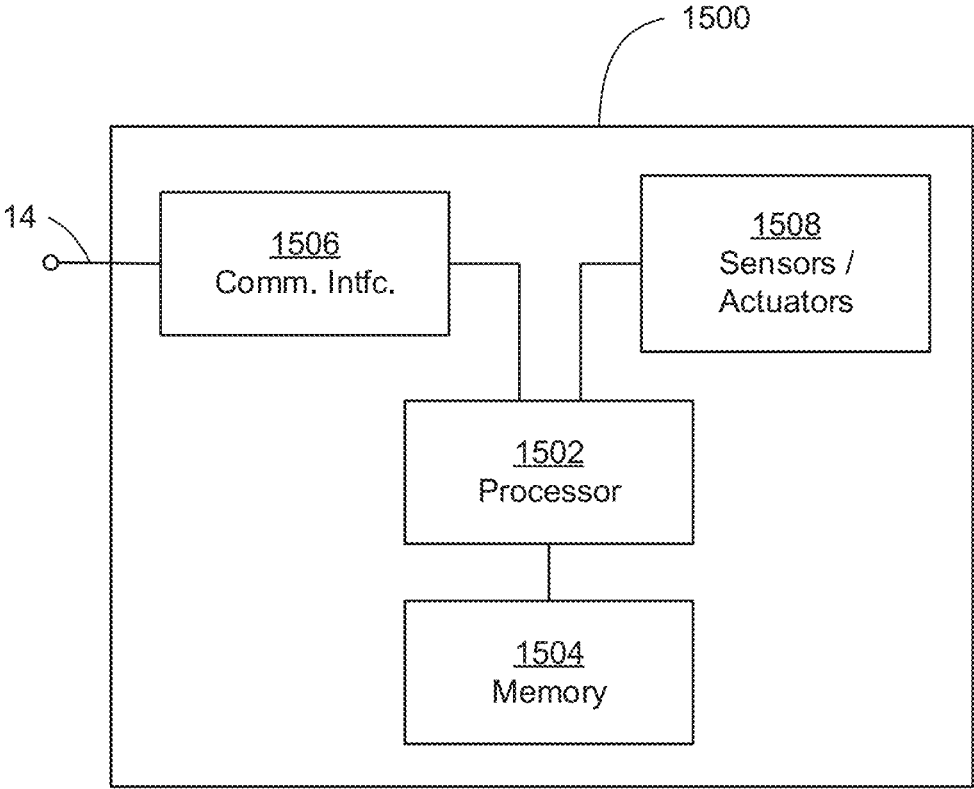
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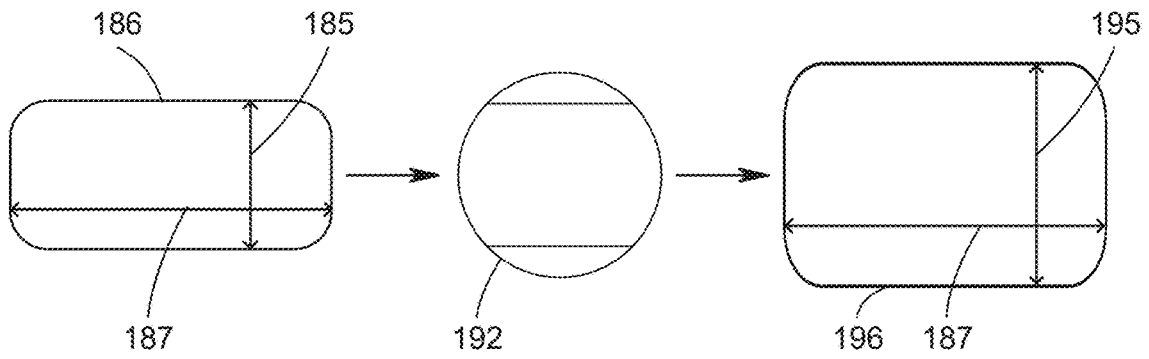FIG. 17
PRIOR ART

FIG. 18

FIG. 19

FRAMING SYSTEM FOR AN AUTOMATED LUMINAIRE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation in part of U.S. patent application Ser. No. 16/113,902 filed Aug. 27, 2018 by Pavel Jurik, et al. entitled, "Coordinated Effects System for an Automated Luminaire", which is a continuation in part of 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". U.S. patent application Ser. No. 16/113,902 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". The present application also claims priority to U.S. Provisional Application No. 62/553,772 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 automated luminaire, and more specifically to a framing system for 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 is 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 framing system includes a first prism system and a second prism system. The first prism system includes a first barrel prism and is configured to position the first barrel prism in a light beam that passes through the first prism system or to remove the first barrel prism from the light beam. The first prism system is further configured to rotate the first barrel prism. The second prism system includes a second barrel prism and is configured to position the second barrel prism in the light beam that passes through the first prism system or to remove the second barrel prism from the light beam. The second prism system is further configured to rotate the second barrel prism.

In a second embodiment, an automated luminaire includes a light source configured to emit a light beam and an optical device coupled to the light source and configured to produce a first image in the light beam. The automated luminaire further includes a first prism system, a second prism system, and a control system. The first prism system includes a first barrel prism and is configured to position the first barrel prism in a light beam that passes through the first prism system or to remove the first barrel prism from the light beam. The first prism system is further configured to rotate the first barrel prism. The second prism system includes a second barrel prism and is configured to position the second barrel prism in the light beam that passes through the first prism system or to remove the second barrel prism from the light beam. The second prism system is further configured to rotate the second barrel prism. The control system is configured to control the optical device, the first prism system, and the second prism system.

In a third embodiment, a method for shaping a light beam projected by an automated luminaire includes forming a circular light beam and modifying the circular light beam

with a selected barrel gobo to form a rounded rectangular beam having a desired aspect ratio. The method further includes rotating the barrel prism to obtain a desired orientation of the rounded rectangular beam and projecting the rotated rounded rectangular beam from an automated luminaire onto a target in a performance space.

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;

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

FIG. 16 illustrates a barrel prism for use in a framing system according to the disclosure;

FIG. 17 illustrates the effect of a prior art ribbed or linear prism;

FIG. 18 illustrates the effect of a framing system according to the disclosure, using a barrel prism of the type shown in FIG. 16; and

FIG. 19 illustrates the effect of a framing system according to the disclosure, using two barrel prisms of the type shown in FIG. 16.

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 corre-

sponding 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 coordinated effects system **400**.

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. The second coordinated effects system **1200** may be used in place of the first coordinated effects system **400** in an automated luminaire according to the disclosure, or elements of the second coordinated effects system **1200** may be added to the first coordinated effects system **400** in the automated luminaire **100**. 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 coop-

eratively 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, and 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 **100** 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, framing system 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 overflow 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).

Conventional framing systems typically use four blades that may be moved independently into and out of the beam, allowing framing a projected image from a lighting fixture to common rectangular shapes, such as picture frames. Often, individual angular control for each blade is provided. Such a framing mechanism enables masking the final output beam to a desired shape by controlling its edges. The framing shutters are typically straight edged so that inserting them into the beam masks an area in a straight line. Motorized systems to both insert and remove and optionally rotate each flag or shutter are often very complex mechanically and add substantial weight and cost to a luminaire.

FIG. **16** illustrates a barrel prism **160** for use in a framing system according to the disclosure. Barrel prism **160** comprises a substrate plane with a single semi-cylindrical prism **162** having a radius of curvature **164**. Semi-cylindrical prism **162** may be of any diameter, here shown as partially covering the plane area, but in practice may cover the entire area or any proportion of the area. In other embodiments, the cross section of the single semi-cylindrical prism may be modified from a semi-cylinder—e.g., semi-paraboloid, semi-ellipse or other non-cylindrical shapes. In all such embodiments, the prism is a single convex shape with a constant cross section along its length.

FIG. **17** illustrates the effect of a prior art ribbed or linear prism **172**. The ribbed prism **172** comprises multiple parallel ribs or other convex shapes and is commonly used to spread the light in a single direction. As illustrated, a source image **170** produced by beam color, size, shape, and/or pattern optical systems passes through the ribbed prism **172**, which may be axially rotated as indicated by arrow **174**. The

resulting output image **176** is an oval transformation of the source image **170**. In particular, if the source image **170** is a circular aperture, then the resultant beam (output image) **176** will be elliptical in shape. This is useful as an effect, but is not useful as a soft edge shutter or framing system, as the sides of the beam are curved. The output image **176** rotates, as shown by arrow **178**, as the ribbed prism **172** rotates.

FIG. **18** illustrates the effect of a framing system according to the disclosure, using a barrel prism **182** of the type shown in FIG. **16**. The barrel prism **182** is suitable for use in any of prism systems **40** and **50** of the coordinated effects system **400** and prism systems **140** and **150** of the coordinated effects system **1200** described with reference to FIGS. **4-8** and **12-14**, respectively. When used in such systems under the control of the control system **1500** in the automated luminaire **100**, one or more such barrel prisms **182** provide a framing system according to the disclosure.

The barrel prism **182** comprises a single convex shape as described above. As illustrated, a source image **180** produced by beam color, size, shape, and/or pattern optical systems passes through the barrel prism **182**, which may be axially rotated as indicated by arrow **184**. A resultant output image **186** is a stretched transformation of the source image **180**, with substantially linear edges. In particular if the source image **180** is a circular aperture, then the output image **186** will be approximately rectangular in shape. This provides a new and useful operational mode for the system as a framing system. The output image **186** will rotate, as shown by arrow **188**, as the barrel prism **182** rotates.

A first dimension **185** of the output image **186** is determined primarily by a diameter of the source image **180**. A second dimension **187** of the output image **186** is determined by the diameter of the source image **180** and additionally by a radius of curvature **164** of the barrel prism **182**. As with lenses, a barrel prism **182** having a larger radius of curvature **164** will spread the source image **180** by a lesser amount, resulting in a smaller second dimension **187**, while a barrel prism **182** having a smaller radius of curvature **164** will spread the source image **180** by a greater amount, resulting in a larger second dimension **187**.

An overall projected size of the output image **186** may be adjusted by varying the zoom setting (focal length) of the optical system of the automated luminaire **100**. Changing the size of the aperture producing the source image **180** will affect both the dimensions **185** and **187**. Using a barrel prism **182** of greater or lesser radius of curvature **164** will make the second dimension **187** shorter or longer, respectively. One advantage of the single barrel prism over the prior art ribbed or linear prisms is the relatively straight edges of the resultant beam, which allows the use of output image **186** as a framing system, creating a generally rectangular output image **186** that may be rotated, if needed, to match the straight edges of set pieces, doorways, windows, or other targets. The corners of the output image **186** are curved, but that is unlikely to be troubling to a user of a framing system according to the disclosure. A homogenizing or frost filter of the automated luminaire **100** may be used to soften the edges of the output image **186**. All of these parameters controlling characteristics of the projected output image **186** may be controlled by a user of the automated luminaire **100** via control signals sent to the control system **1500**.

FIG. **19** illustrates the effect of a framing system according to the disclosure, using two barrel prisms of the type shown in FIG. **16**. The luminaire **100** may be fitted with two barrel prisms that may be combined one after the other as described earlier for the coordinated effects systems **400** and **1200** described with reference to FIGS. **4-8** and **12-14**,

respectively. As described with reference to FIG. **18**, the first barrel prism **182** produces the output image **186** from the source image **180**. The output image **186** is then a source image for a second barrel prism **192**, which produces a resultant output image **196**.

Because the barrel prism **192** is rotated to be oriented orthogonally to the barrel prism **182**, it stretches the dimension **185** of the source image **186** to the larger dimension **195** of the output image **196**. The second dimension **187** of the source image **186** remains substantially unchanged in the output image **196**.

An overall projected size of the output image **196** may be adjusted by varying the zoom setting (focal length) of the optical system of the automated luminaire **100**. Changing the size of the aperture producing the source image **180** will affect the dimensions of the source image **186** and the dimensions of the output image **196**. Using a barrel prism **192** of greater or lesser radius of curvature **164** will make the dimension **195** shorter or longer, respectively.

Thus, by the selection of a size of the source image **180**, the radii of curvature of the barrel prisms **182** and **192**, the setting of the zoom optical system of the automated luminaire, and the use of a frost filter, the user of the automated luminaire **100** is enabled to produce an projected rectangular image having a wide range of size, aspect ratio, and edge softness. Furthermore, by rotating both barrel prisms while retaining their rotational orientation relative to each other, the projected rectangular image may be rotated to align with edges of set pieces, risers, or other targets in a performance space.

Conventional framing systems are complex mechanisms requiring numerous motors/actuators that add significant weight and/or cost to an automated luminaire. Such framing systems typically use as framing shutters thin metallic plates that warp or are otherwise damaged when used in a luminaire having a high beam intensity and/or a pronounced hot spot. A framing system according to the disclosure is less complex, uses fewer actuators, is lighter, less expensive, and is much more resistant to beam intensity and hot spot than conventional framing systems.

One or both of the barrel prisms of a framing system according to the disclosure may also be used as a coordinated effects system as described for the coordinated effects systems **400** and **1200** described with reference to FIGS. **4-8** and **12-14**, respectively. In a first configuration, a barrel prism may be positioned in a light beam that has passed through a prism of another type. The barrel prism will spread the effect of the other prism in a similar way as described above for spreading a circular source image. In a second configuration, two barrel prisms may be positioned in the light beam and rotated relative to each other to produce an output image that changes shape from a first rectangle to a first rhomboid to a second rectangle to a second rhomboid, etc. In such a second configuration, the barrel prisms may be rotated in the same direction at differing speeds, one barrel prism may be rotated while the other barrel prism remains static (i.e., at a rotational speed of zero), or the barrel prisms may be rotated in opposite directions at the same or differing speeds

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 framing system, comprising:

a first prism system comprising a first barrel prism, the first barrel prism comprising a substrate plane with a single curved convex prism having a constant cross section along the entirety of its length, its length extending across a light beam passing through the first prism system, the first prism system configured to position the first prism system in first and second positions, in the first position the first barrel prism being positioned in the light beam passing through the first prism system and in the second position the first barrel prism being removed from the light beam passing through the first prism system, the first prism system further configured to rotate the first barrel prism; and

a second prism system comprising a second barrel prism, the second barrel prism comprising a substrate plane with a single curved convex prism having a constant cross section along the entirety of its length, its length extending across the light beam passing through the first prism system, the second prism system configured to position the second prism system in third and fourth positions, in the third position the second barrel prism being positioned in the light beam passing through the first prism system and in the fourth position the second barrel prism being removed from the light beam passing through the first prism system, the second prism system further configured to rotate the second barrel prism.

2. The framing system of claim **1**, wherein:

the first prism system is configured to detect an orientation of the first barrel prism in the first position; and

the second prism system is configured to detect an orientation of the second barrel prism in the third position.

3. The framing system of claim **1**, wherein:

the first prism system comprises a first plurality of barrel prisms, the curved convex prism of each of the first plurality of barrel prisms comprising a semi-cylindrical prism having a radius of curvature different from the curved convex prisms of other barrel prisms of the first plurality of barrel prisms, wherein in the first position, a selected one of the first plurality of barrel prisms is positioned in the light beam passing through the first prism system, and in the second position all of the first plurality of barrel prisms are removed from the light beam passing through the first prism system; and

the second prism system comprises a second plurality of barrel prisms, the curved convex prism of each of the second plurality of barrel prisms comprising a semi-cylindrical prism having a radius of curvature different from the curved convex prisms of other barrel prisms of the second plurality of barrel prisms, wherein in the third position, a selected one of the second plurality of barrel prisms is positioned in the light beam passing through the first prism system and in the fourth position all of the second plurality of barrel prisms are removed from the light beam passing through the first prism system.

4. The framing system of claim **3**, wherein:

the first prism system comprises a sensor configured to detect an orientation of the selected one of the first plurality of barrel prisms positioned in the light beam passing through the first prism system; and

the second prism system comprises a sensor configured to detect an orientation of the selected one of the second

plurality of barrel prisms positioned in the light beam passing through the first prism system.

5. The framing system of claim 3, wherein:

the first prism system comprises a first stepper motor configured to move the first prism system from the first position to the second position; and

the second prism system comprises a second stepper motor configured to move the second prism system from the third position to the fourth position.

6. The framing system of claim 1, wherein:

the first prism system comprises a first stepper motor configured to rotate the first barrel prism; and

the second prism system comprises a second stepper motor configured to rotate the second barrel prism.

7. The framing system of claim 1, wherein the first prism system comprises:

an arm on which is rotatably mounted the associated barrel prism; and

an actuator coupled to the arm, the actuator configured to rotate the arm from the first position to the second position.

8. An automated luminaire, comprising:

a light source configured to emit a light beam;

an optical device optically coupled to the light source and configured to produce a source image in the light beam;

a first prism system comprising a first barrel prism, the first barrel prism comprising a substrate plane with a single curved convex prism having a constant cross section along the entirety of its length, its length extending across a light beam passing through the first prism system, the first prism system optically coupled to the optical device and configured to position the first prism system in first and second positions, in the first position the first barrel prism being positioned in the light beam passing through the first prism system and in the second position the first barrel prism being removed from the light beam passing through the first prism system, the first prism system further configured to rotate the first barrel prism to produce a modified image from the source image;

a second prism system comprising a second barrel prism, the second barrel prism comprising a substrate plane with a single curved convex prism having a constant cross section along the entirety of its length, its length extending across the light beam passing through the first prism system, the second prism system optically coupled to the first prism system and configured to position the second prism system in third and fourth positions, in the third position the second barrel prism being positioned in the light beam passing through the first prism system and in the fourth position the second barrel prism being removed from the light beam passing through the first prism system, the second prism system further configured to rotate the second barrel prism to produce an output image from the modified image; and

a control system configured to control the optical device, the first prism system, and the second prism system.

9. The automated luminaire of claim 8, wherein:

the optical device is configured to produce a circular light beam; and

the automated luminaire further comprises an optical system optically coupled to the second prism system and configured to project a light beam passing through the second prism system onto a target in a performance space.

10. The automated luminaire of claim 8, wherein the control system is configured to:

detect a first orientation of the first barrel prism;

detect a second orientation of the second barrel prism; and

control rotation of the first barrel prism and rotation of the second barrel prism based on the detected first and second orientations.

11. The automated luminaire of claim 10, wherein the control system is configured to rotate the first barrel prism to a first desired orientation and to rotate the second barrel prism to a second desired orientation.

12. The automated luminaire of claim 10, wherein the control system is configured to rotate the first barrel prism and the second barrel prism while maintaining a desired rotational alignment between the first barrel prism and the second barrel prism.

13. The automated luminaire of claim 8, wherein the control system is configured to rotate the first barrel prism and the second barrel prism at differing rotational speeds.

14. The automated luminaire of claim 8, wherein the control system is configured to rotate the first barrel prism at a first speed and the second barrel prism at a second speed.

15. The automated luminaire of claim 8, 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.

16. A method for shaping a light beam projected by an automated luminaire, comprising:

forming a circular light beam;

modifying the circular light beam with a selected refractive element to form a rounded rectangular beam having a desired aspect ratio;

rotating the selected refractive element to obtain a desired orientation of the rounded rectangular beam; and

projecting the rotated rounded rectangular beam from an automated luminaire onto a target in a performance space.

17. The method of claim 16, wherein the selected refractive element is a first selected refractive element and the rounded rectangular beam is a first rounded rectangular beam, the method further comprising:

modifying the first rounded rectangular beam with a second selected refractive element to form a second rounded rectangular beam having a desired aspect ratio, the first and second selected refractive elements having an orthogonal orientation relative to each other;

rotating the first and second selected refractive elements to obtain a desired orientation of the second rounded rectangular beam while maintaining the orthogonal orientation between the first and second selected refractive elements; and

projecting the second rotated rounded rectangular beam from the automated luminaire onto the target in the performance space.

18. The method of claim 16, further comprising changing a size of the projected rotated rounded rectangular beam by changing a size of the circular light beam or by adjusting a configuration of a zoom optical system of the automated luminaire.

19. The framing system of claim 1, wherein the curved convex prism of the first barrel prism comprises a semi-cylindrical prism and the curved convex prism of the second barrel prism comprises a semi-cylindrical prism.

20. The automated luminaire of claim 8, wherein the curved convex prism of the first barrel prism comprises a

semi-cylindrical prism and the curved convex prism of the second barrel prism comprises a semi-cylindrical prism.

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