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(54) **VARIABLE FROST SYSTEMS FOR A LIGHTING DEVICE AND LIGHTING DEVICES HAVE THE SAME**

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CPC ***F21V 14/08*** (2013.01); ***F21S 10/007*** (2013.01); ***F21V 3/049*** (2013.01); *F21W 2131/406* (2013.01)

(58) **Field of Classification Search**
CPC F21S 10/00; F21S 10/007; F21V 14/08; F21V 14/085; F21W 2131/406
See application file for complete search history.

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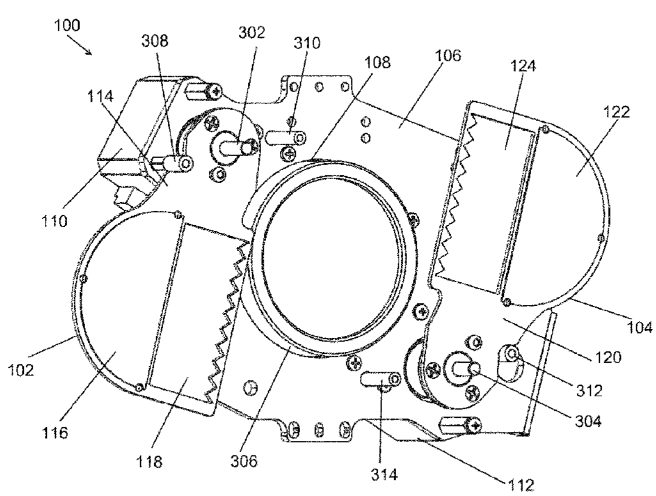
Primary Examiner — Abdulmajeed Aziz
Assistant Examiner — Steven Y Horikoshi

(57) **ABSTRACT**

A variable frost system (**100**) includes a first arm assembly (**102**) that includes a first arm structure (**114**), a first frost component (**116**), and a second frost component (**118**), where the first frost component (**116**) and the second frost component (**118**) are attached to the first arm structure (**114**). The variable frost system (**100**) includes further a second arm assembly (**104**) that includes a second arm structure (**120**), a third frost component (**122**), and a fourth frost component (**124**), where the third frost component (**122**) and the fourth frost component (**124**) are attached to the second arm structure (**120**). The first arm assembly (**102**) and the second arm assembly (**104**) are movable such that one or both of the first frost component (**116**) and the second frost component (**118**) and one or both of the third frost component (**122**) and the fourth frost component (**124**) are positioned to provide an overall frost lighting effect to a light beam (**206**).

20 Claims, 9 Drawing Sheets



(51) **Int. Cl.**
F21V 3/04 (2018.01)
F21W 131/406 (2006.01)

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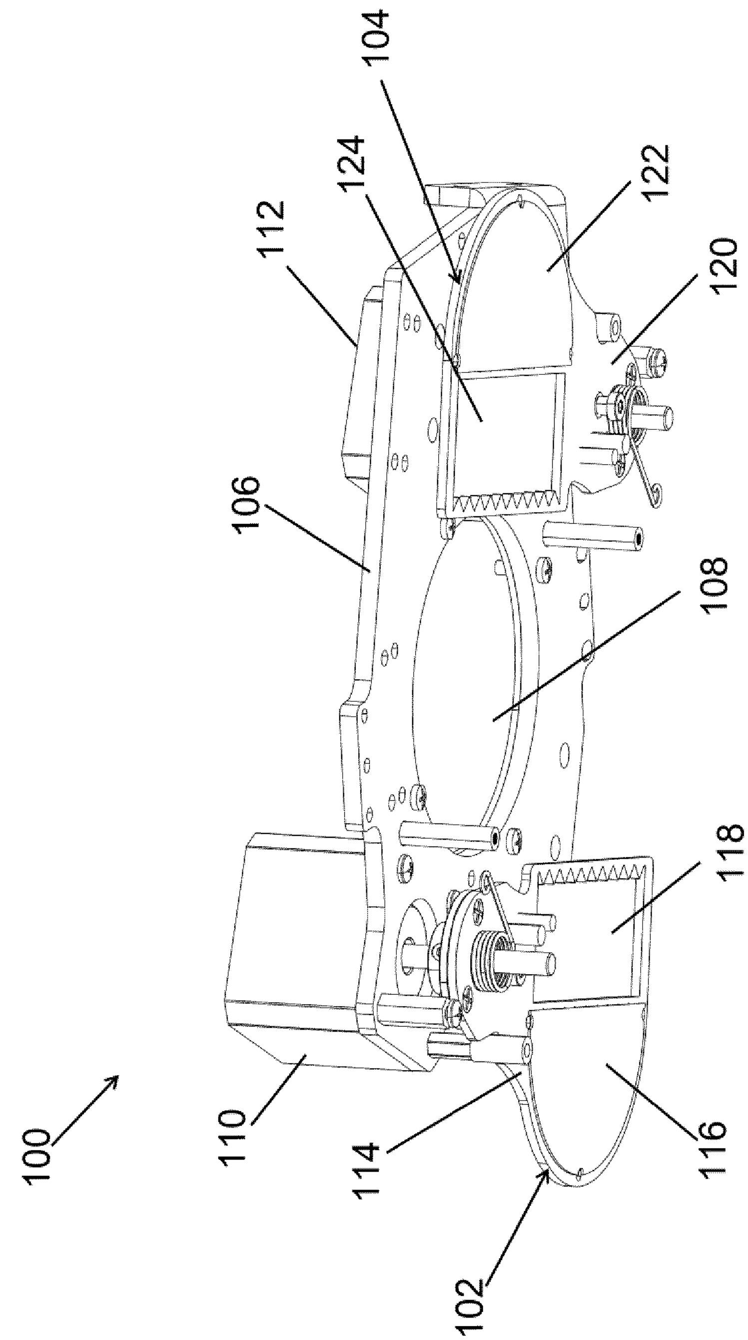

FIG. 1

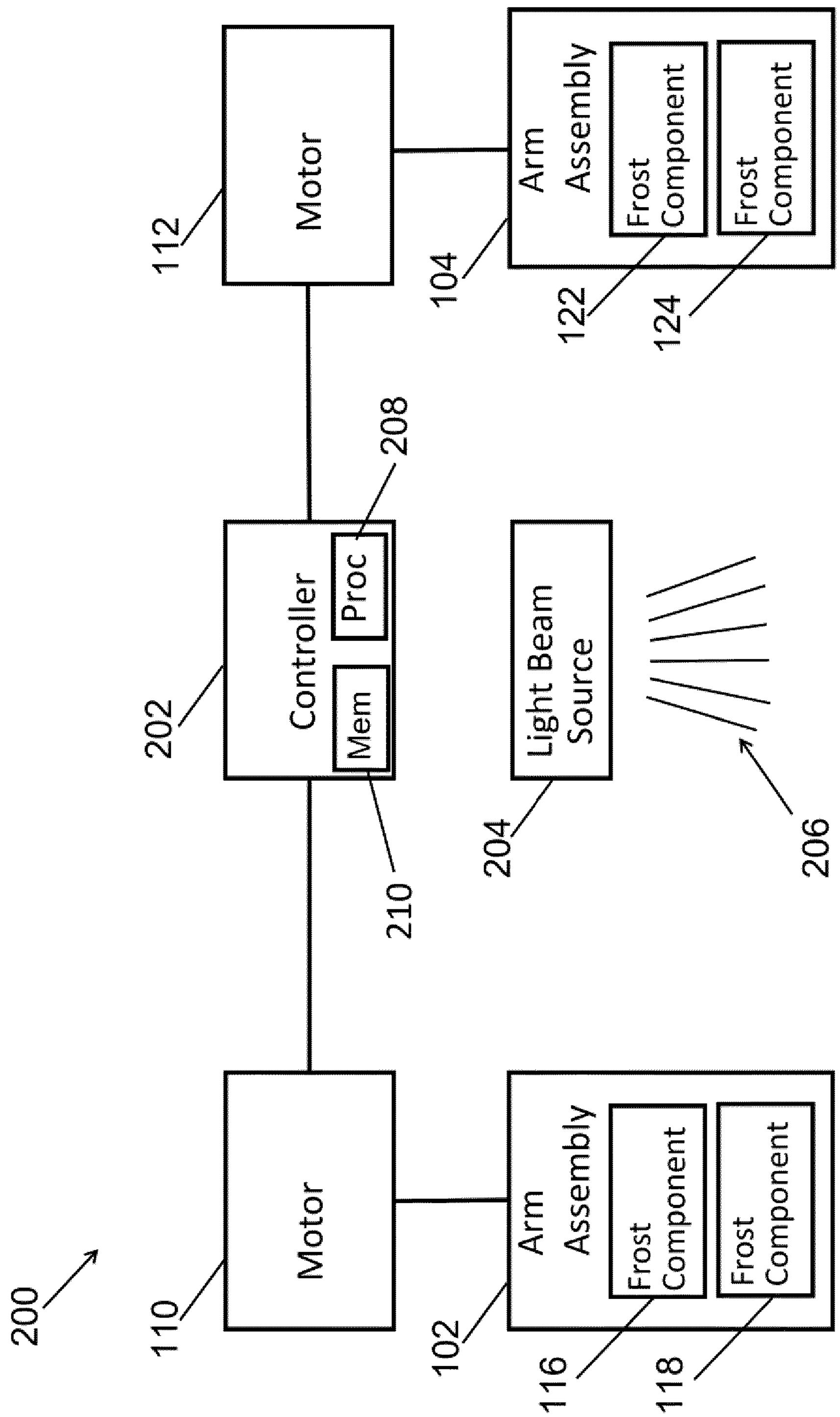
200
110
Motor
112
Motor
202
Controller
Mem
Proc
208
210
102
Arm Assembly
Frost Component
Frost Component
116
118
104
Arm Assembly
Frost Component
Frost Component
122
124
204
Light Beam Source
206

FIG. 2

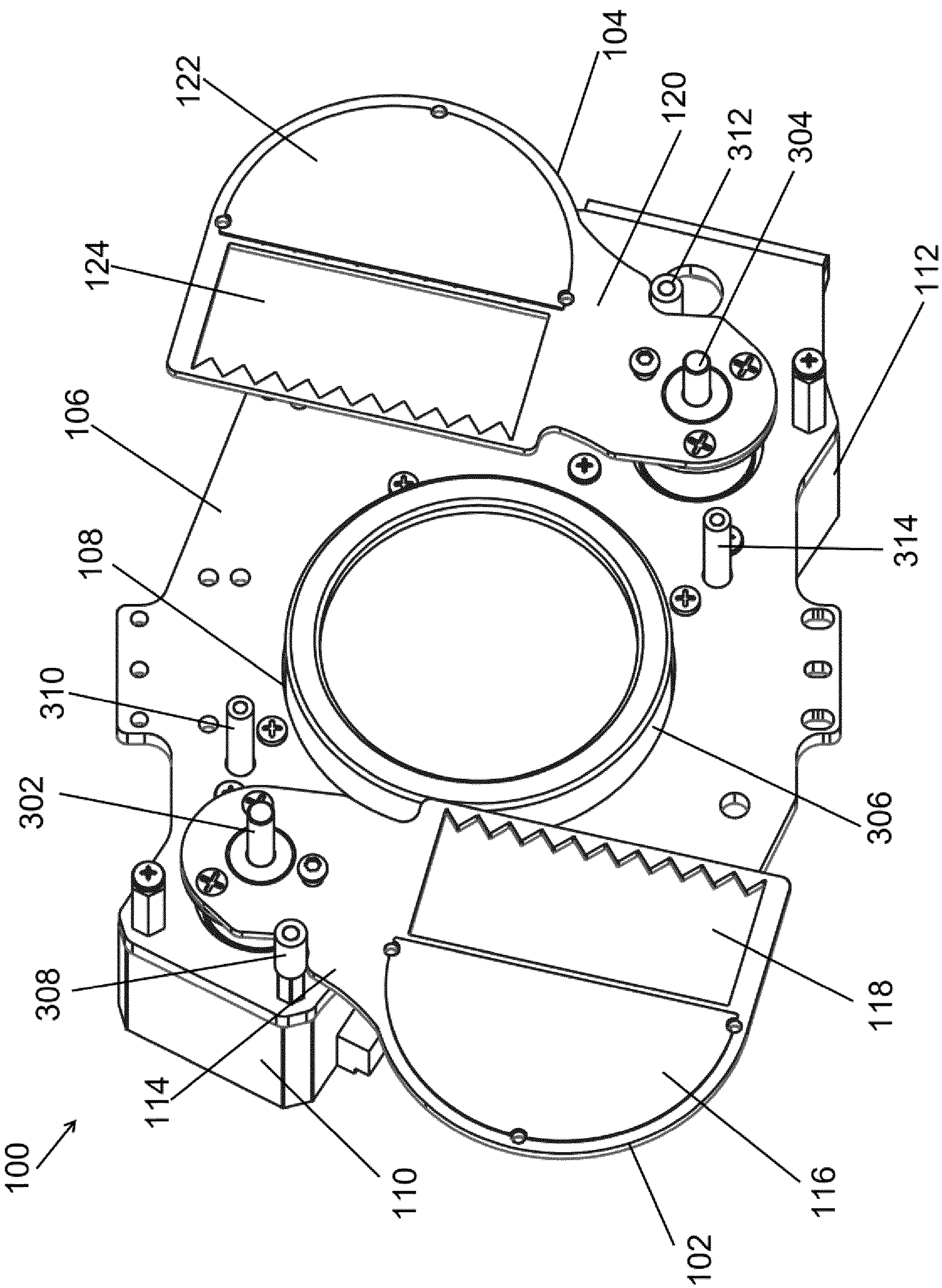
100
102
104
106
108
110
112
114
116
118
120
122
124
302
304
306
308
310
312
314

FIG. 3

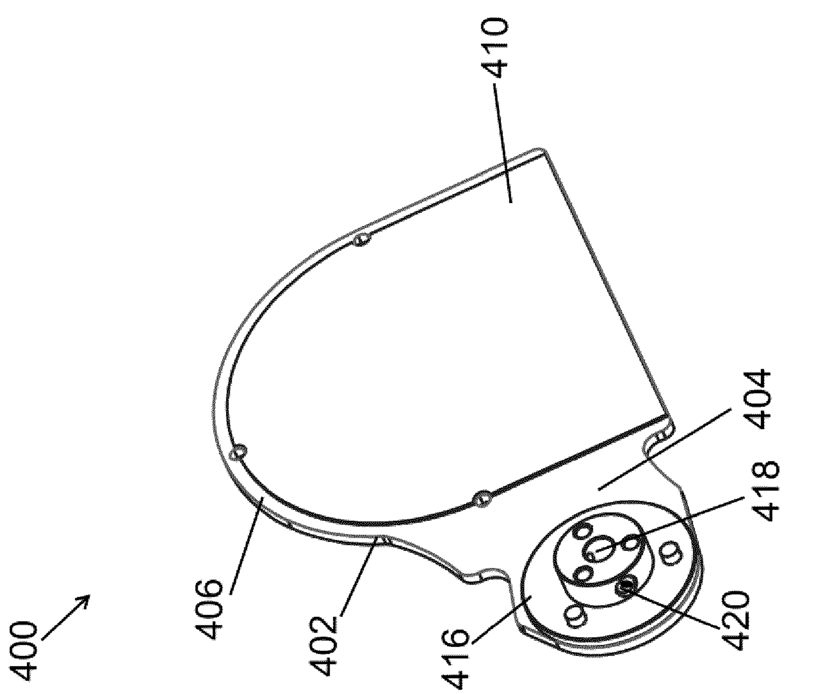
400
406
402
416
410
404
418
420

FIG. 4B

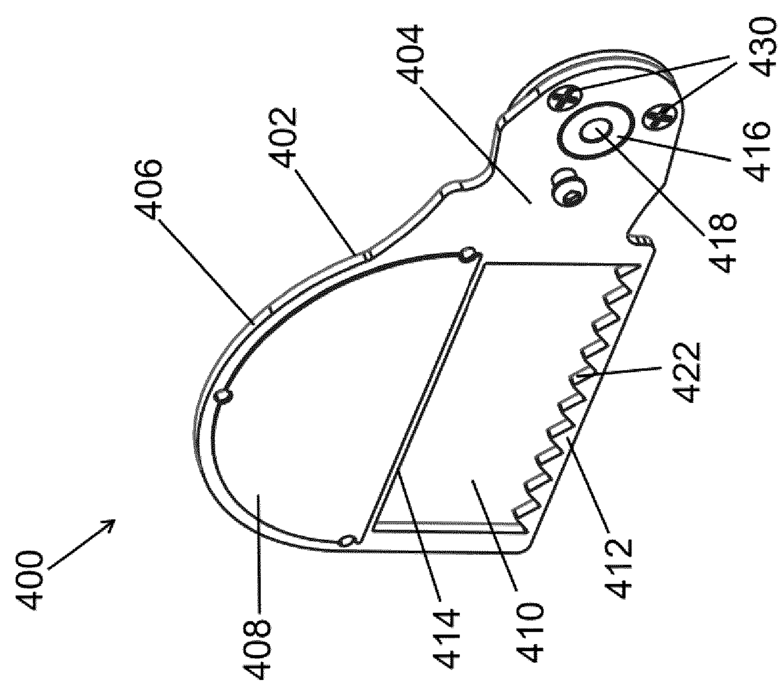
400
408
414
410
412
406
402
404
422
418
416
430

FIG. 4A

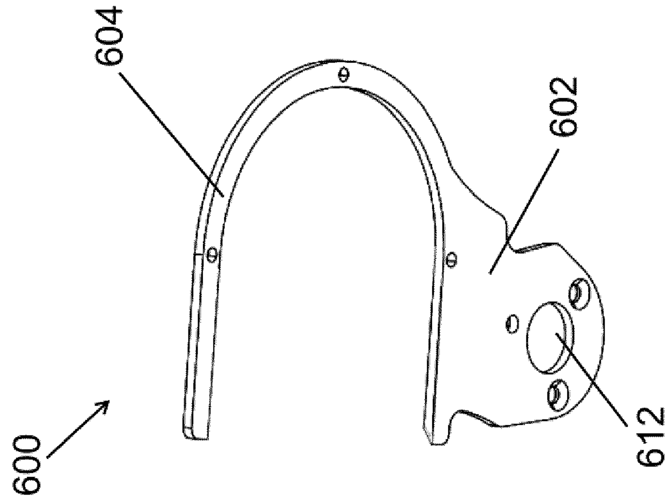

FIG. 6

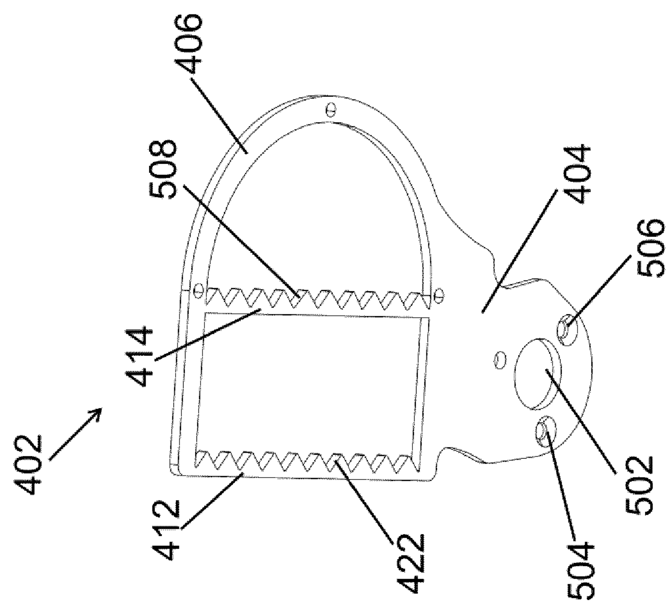

FIG. 5

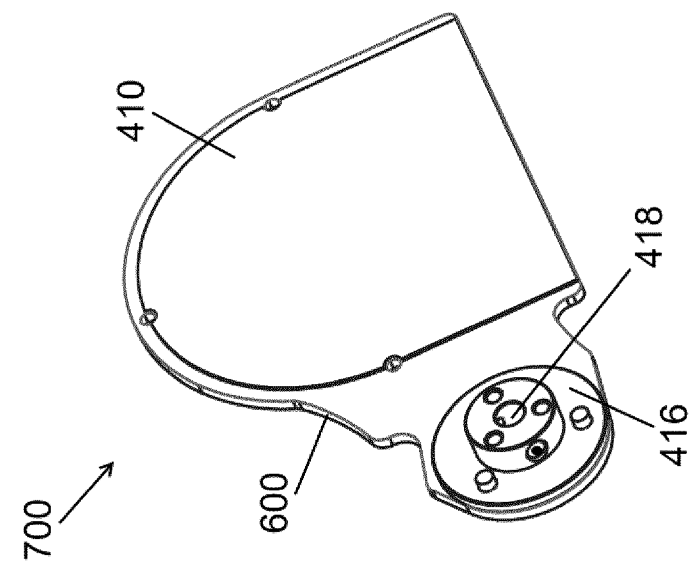

FIG. 7B

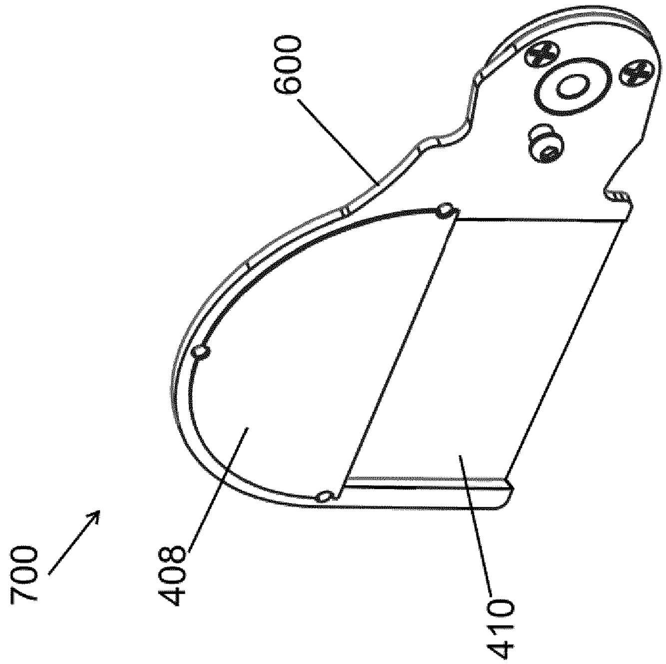

FIG. 7A

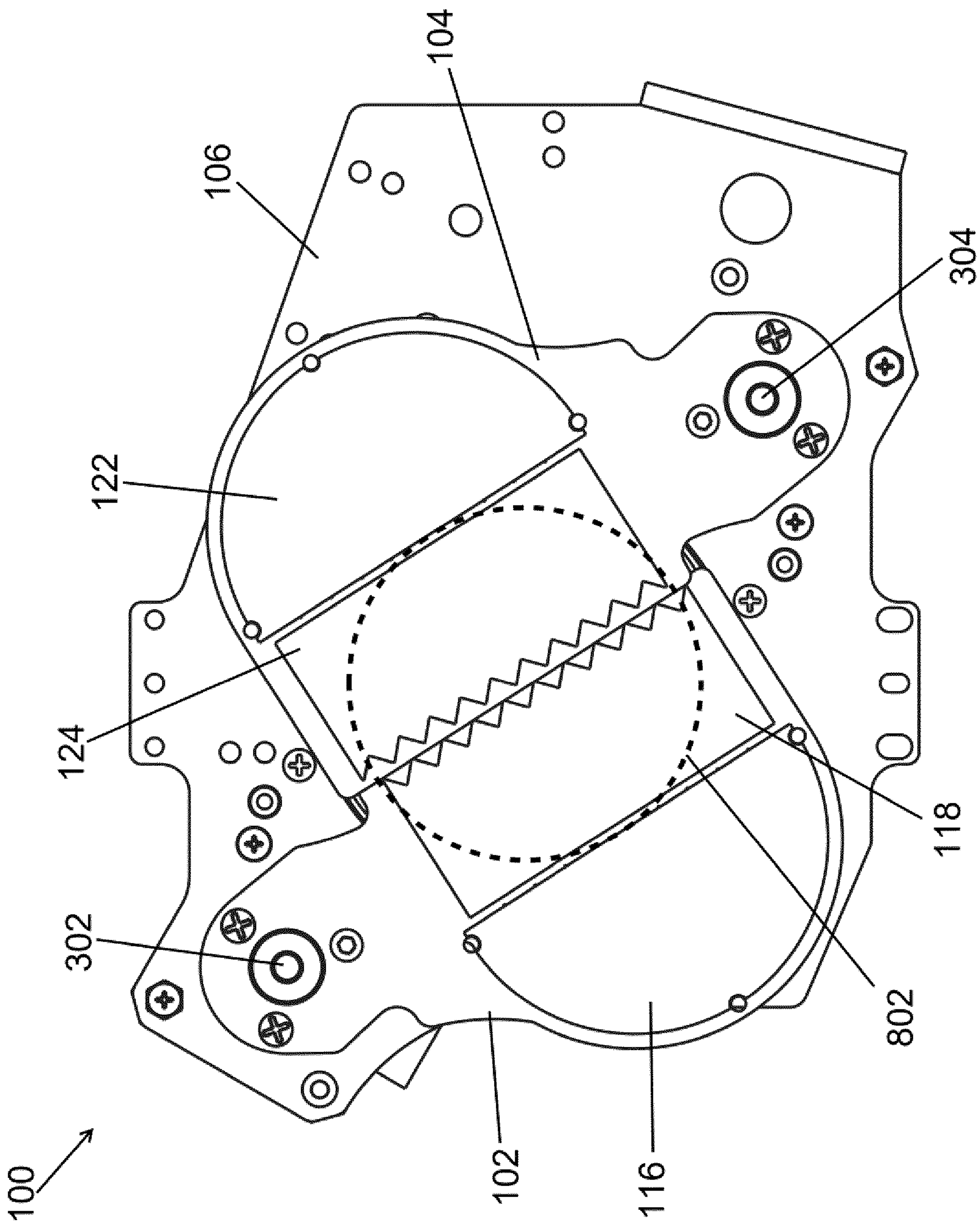

FIG. 8

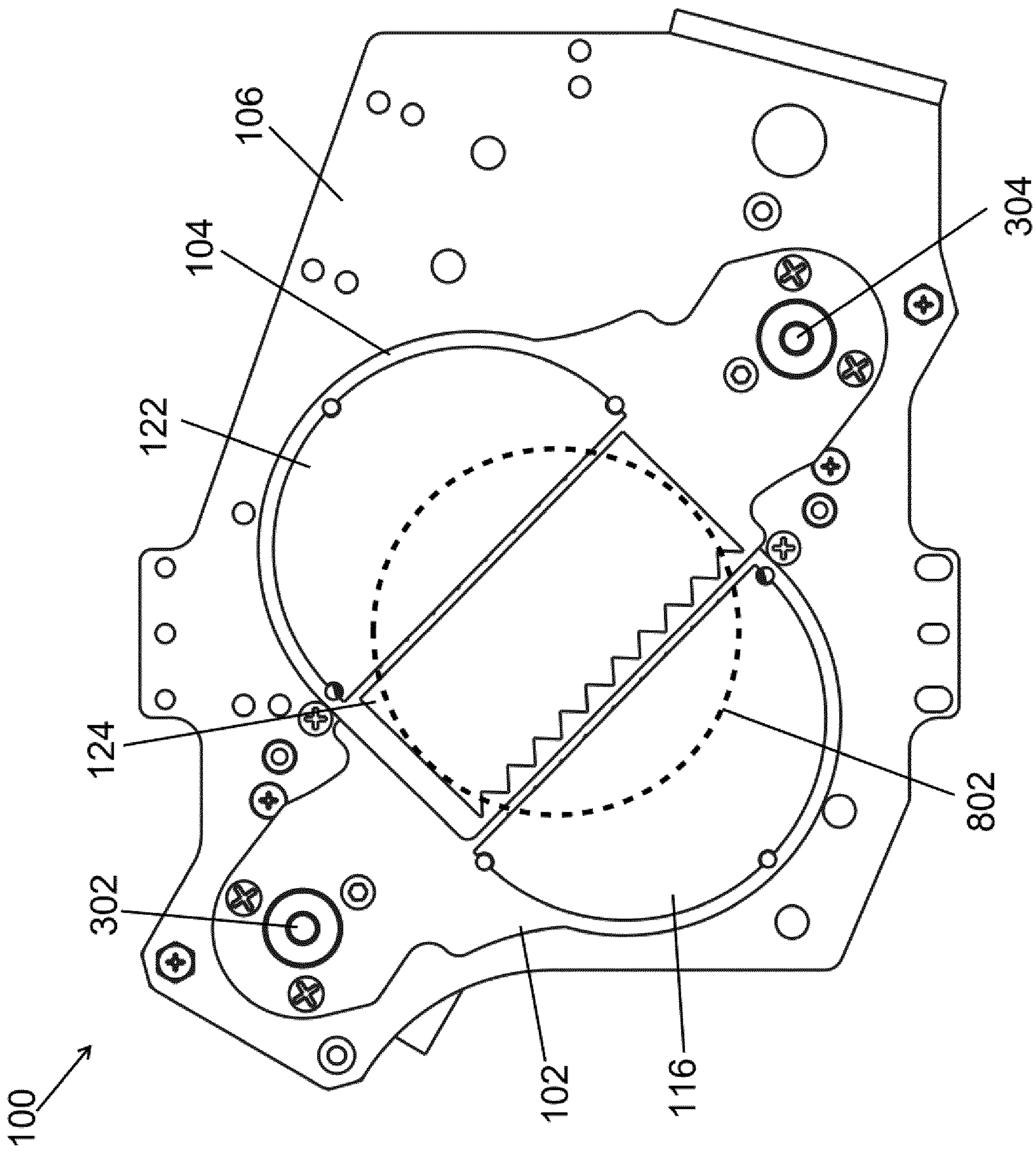

FIG. 9

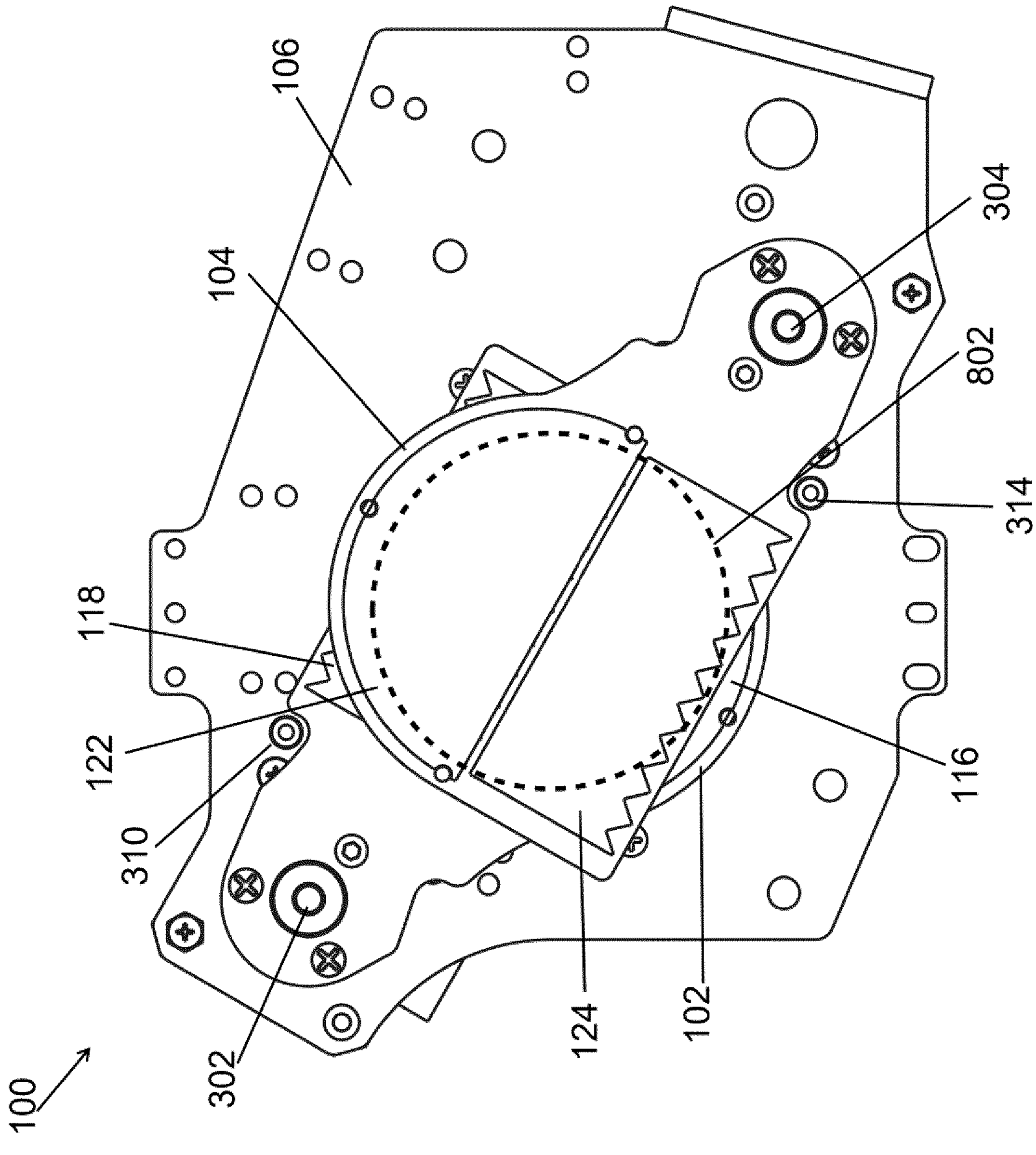

FIG. 10

VARIABLE FROST SYSTEMS FOR A LIGHTING DEVICE AND LIGHTING DEVICES HAVE THE SAME

CROSS-REFERENCE TO PRIOR APPLICATIONS

This application is the U.S. National Phase application under 35 U.S.C. § 371 of International Application No. PCT/EP2022/065466, filed on Jun. 8, 2022, which claims the benefit of European Patent Application No. 21183592.1, filed on Jul. 5, 2021, and U.S. Application Ser. No. 63/214,068, filed on Jun. 23, 2021. These applications are hereby incorporated by reference herein.

TECHNICAL FIELD

The present disclosure relates generally to lighting devices, and more particularly to a variable frost system and luminaires with a variable frost system.

BACKGROUND

Luminaires may be capable of providing different lighting effects. For example, a luminaire (e.g., an automated luminaire), may be capable of providing a frost lighting effect to soften the edges of a beam or projected image. Depending on the application, the level of frost might be very light such that the edges of the beam or image are slightly blurred. Alternatively, a desired level of frost may be very heavy such that the beam or image is significantly or completely obscured. In other cases, the desired frost lighting effect might be at some intermediate level. Because different levels of frost may be desired at different times and/or circumstances, the capability to smoothly change the level of frost to a desired frost level may be useful. Thus, a solution that provides the capability to smoothly vary the level of frost may be desirable.

SUMMARY

The present disclosure relates generally to lighting devices, and more particularly to a variable frost system and luminaires with a variable frost system. In an example embodiment, a variable frost system includes a first arm assembly that includes a first arm structure, a first frost component, and a second frost component, where the first frost component and the second frost component are attached to the first arm structure. The variable frost system includes further a second arm assembly that includes a second arm structure, a third frost component, and a fourth frost component, where the third frost component and the fourth frost component are attached to the second arm structure. The first arm assembly and the second arm assembly are movable such that one or both of the first frost component and the second frost component and one or both of the third frost component and the fourth frost component are positioned to provide an overall frost lighting effect to a light beam.

In another example embodiment, a lighting device includes a variable frost system and a light beam source configured to provide a light beam. The variable frost system includes a first arm assembly that includes a first arm structure, a first frost component, and a second frost component, where the first frost component and the second frost component are attached to the first arm structure. The variable frost system includes further a second arm assembly that includes a second arm structure, a third frost component, and a fourth frost component, where the third frost component and the fourth frost component are attached to the second arm structure. The first arm assembly and the second arm assembly are movable such that one or both of the first frost component and the second frost component and one or both of the third frost component and the fourth frost component are positioned to provide an overall frost lighting effect to a light beam.

These and other aspects, objects, features, and embodiments will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE FIGURES

Reference will now be made to the accompanying drawings, where:

FIG. **1** illustrates a variable frost system according to an example embodiment;

FIG. **2** illustrates a block diagram of a lighting device that includes the variable frost system of FIG. **1** according to an example embodiment;

FIG. **3** illustrates another view of the variable frost system of FIG. **1** according to an example embodiment;

FIGS. **4**A and **4**B illustrate opposite sides of an arm assembly used in the variable frost system of FIG. **1** according to an example embodiment;

FIG. **5** illustrates an arm structure of the arm assembly of FIGS. **4**A and **4**B according to an example embodiment;

FIG. **6** illustrates an arm structure according to another example embodiment;

FIGS. **7**A and **7**B illustrate an arm assembly including the arm structure of FIG. **6** according to an example embodiment;

FIG. **8** illustrates the variable frost system of FIG. **1** adjusted to provide a frost lighting effect according to an example embodiment;

FIG. **9** illustrates the variable frost system of FIG. **1** adjusted to provide a different frost lighting effect from that provided by the variable frost system configured as shown in FIG. **8** according to an example embodiment; and

FIG. **10** illustrates the variable frost system of FIG. **1** adjusted to provide a different frost lighting effect from those provided by the variable frost system configured as shown in FIGS. **8** and **9** according to an example embodiment.

The drawings illustrate only example embodiments and are therefore not to be considered limiting in scope. The elements and features shown in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the example embodiments. Additionally, certain dimensions or placements may be exaggerated to help visually convey such principles. In the drawings, the same reference numerals that are used in different drawings designate like or corresponding but not necessarily identical elements.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

In the following paragraphs, particular embodiments will be described in further detail by way of example with reference to the figures. In the description, well known components, methods, and/or processing techniques are omitted or briefly described. Furthermore, reference to various feature(s) of the embodiments is not to suggest that all embodiments must include the referenced feature(s).

FIG. **1** illustrates a variable frost system **100** according to an example embodiment. In some example embodiments, the variable frost system **100** includes a first arm assembly **102** and a second arm assembly **104**. The arm assembly **102** may include an arm structure **114** and frost components **116**, **118**. The frost components **116**, **118** may be attached to the arm structure **114**, for example, using glue and/or another means such as fasteners. As explained in more detail below, the frost component **116** may be on one side of the arm structure **114**, and the frost component **118** may be positioned on an opposite side of the arm structure **114**. The arm assembly **104** may include an arm structure **120** and frost components **122**, **124**. The frost components **122**, **124** may be attached to the arm structure **120**, for example, using glue and/or another means such as fasteners. As explained in more detail below, the frost component **122** may be positioned on one side of the arm structure **120**, and the frost component **124** may be positioned on an opposite side of the arm structure **120**.

In some example embodiments, the arm assembly **102** may be movable to move the frost components **116**, **118** to different positions relative to an opening **108** in a plate **106**. For example, the arm structure **114** may be attached to a shaft of a motor **110** and may be rotated along with the shaft of the motor **110**. Because the frost components **116**, **118** are attached to the arm structure **114**, the rotation of the arm structure **114** may change the positions of the frost components **116**, **118** relative to the opening **108**. To illustrate, when the variable frost system **100** is integrated in a lighting device, a light beam (e.g., an illumination light or a projected image) may pass through the opening **108** from the area at a back side of the plate **106** to the area below the plate **106** in the orientation of the plate **106** shown in FIG. **1**. The light beam that passes through the opening **108** may pass through one or both of the frost components **116**, **118** depending on the positions of the frost components **116**, **118**, where one or both of the frost components **116**, **118** provide a frost lighting effect to at least a portion of the light beam. As shown in FIG. **1**, if the frost components **116**, **118** are not aligned with the opening **108**, the light beam may not be affected by the frost components **116**, **118**.

In some example embodiments, the arm assembly **104** may be movable to move the frost components **122**, **124** to different positions relative to an opening **108** in a plate **106**. For example, the arm structure **120** may be attached to a shaft of a motor **112** and may be rotated along with the shaft of the motor **112**. Because the frost components **122**, **124** are attached to the arm structure **120**, the rotation of the arm structure **120** may change the positions of the frost components **122**, **124** relative to the opening **108**. To illustrate, a light beam that passes through the opening **108** may pass through one or both of the frost components **122**, **124** depending on the positions of the frost components **122**, **124**, where one or both of the frost components **122**, **124** provide a frost lighting effect to at least a portion of the light beam. If neither of the frost components **122**, **124** is aligned with the opening **108** as shown in FIG. **1**, the light beam may not be affected by the frost lighting effects of the frost components **122**, **124**.

In some example embodiments, the arm assembly **102** and the arm assembly **104** may be positioned across an opening **108** from each other. The motor **110** may be controlled to rotate the arm assembly **102** to change the positions of the frost components **116**, **118** relative to the opening **108**, and the motor **112** may be controlled to rotate the arm assembly **104** to change the positions of the frost components **122**, **124** relative to the opening **108**. The motors **110**, **112** may be controlled such that the arm assembly **102** and the arm assembly **104** move simultaneously or separately. For example, the motors **110**, **112** may be controlled such that the frost components **116**, **118** and the frost components **122**, **124** move simultaneously toward or away from the opening **108** below the plate **106** on opposite sides of the opening **108**. In general, the arm assembly **102** and the arm assembly **104** may be rotated to positions that place the frost components **116**, **118** and the frost components **122**, **124** at desired positions relative to the opening **108** and with respect to each other.

In some example embodiments, the overall frost lighting effect provided by the variable frost system **100** depends on the positions of the frost components **116**, **118** and the frost components **122**, **124** relative to the opening **108**. To illustrate, the frost components **116**, **118** and the frost components **122**, **124** may be positioned such that a light beam passing through the opening **108** passes through one or both of the frost components **116**, **118** and through one or both of the frost components **122**, **124**. For example, the frost component **118** and the frost component **124** may be positioned adjacent and non-overlapping to each other such that a portion of the light beam passes through the frost component **118** and another portion of the light beam passes through the frost component **124**. As another example, the frost component **118** and the frost component **124** may be positioned overlapping each other such that at least a portion of the light beam passes through both the frost component **118** and the frost component **124**. To illustrate, the frost component **118** and the frost component **124** may provide a combined frost light effect to the light beam. As yet another example, the frost component **116** and the frost component **122** may be positioned adjacent and non-overlapping to each other such that a portion of the light beam passes through the frost component **116** and another portion of the light beam passes through the frost component **122**. Alternatively, the frost component **116** and/or the frost component **122** may substantially or fully block portions of the light beam from passing therethrough.

In some example embodiments, the frost lighting effect of the frost component **116** may be more than the frost lighting effect of the frost component **118**, and the frost lighting effect of the frost component **122** may be more than the frost lighting effect of the frost component **124**. For example, the frost component **118** and the frost component **124** may each provide a light frost lighting effect ("light frost"), and the frost component **116** and the frost component **122** may each provide a heavy frost lighting effect ("heavy frost") as can be readily understood by those of ordinary skill in the art with the benefit of the scope of this disclosure. To illustrate, the frost component **118** and the frost component **124** may each include or may be made from Rosco Roscolux **132** Quarter Hamburg Frost Gel sheet, and the frost component **116** and the frost component **122** may each include or may be made from Brightview M-PR04-PE07-S-M diffusion sheet. When the frost component **118** and the frost component **124** are overlapped with each other such that a light beam passes through both, the combined frost lighting effect of the frost components **118**, **124** on the light beam may be between the light frost lighting effect and the heavy frost lighting effect. In general, a light frost lighting effect may fall in a range of frost lighting effects that affect a light or a projected image less than a heavy frost lighting effect that falls in another range of frost lighting effects as can be readily understood by those of ordinary skill in the art with the benefit of the scope of this disclosure.

By moving the arm assemblies **102**, **104**, the overall frost lighting effect provided by the variable frost system **100** can be varied. By moving each of the arm assemblies **102**, **104** to desired positions, the variable frost system **100** can provide a desired frost lighting effect for different circumstances and/or times. By controlling the movements of the arm assemblies **102**, **104**, the frost lighting effect provided by the variable frost system **100** can be smoothly changed. By moving the arm assemblies **102**, **104** such that the frost components **116**, **118**, **122**, **124** do not cover the opening **108** as shown in FIG. **1**, no frost lighting effect may be applied by the variable frost system **100**.

In some alternative embodiments, the arm assemblies **102**, **104** may be at different positions with respect to the opening **108** than shown without departing from the scope of this disclosure. In some alternative embodiments, the arm assemblies **102**, **104** may be at different locations with respect to the plate **106** than shown without departing from the scope of this disclosure. In some alternative embodiments, the frost components of each arm assembly **102**, **104** may be positioned in a different configuration with respect to each other than shown without departing from the scope of this disclosure. In some alternative embodiments, one or more of the arm assemblies **102**, **104** may include more or fewer frost components than shown without departing from the scope of this disclosure. In some alternative embodiments, the opening **108** may have a shape other than a circular shape without departing from the scope of this disclosure. In some alternative embodiments, the arm assemblies **102**, **104** along with the frost components **116**, **118**, **122**, **124** may have different shapes than shown without departing from the scope of this disclosure. In some alternative embodiments, the arm assemblies **102**, **104** may each be attached to the respective motor **110**, **112** in a different manner than shown without departing from the scope of this disclosure.

FIG. **2** illustrates a block diagram of a lighting device **200** that includes the variable frost system **100** of FIG. **1** according to an example embodiment. Referring to FIGS. **1** and **2**, in some example embodiments, the lighting device **200** may be a luminaire and/or a projector device as can be readily understood by those of ordinary skill in the art with the benefit of the scope of this disclosure. For example, the lighting device **200** may be an automated luminaire that is used for stage lighting.

In some example embodiments, the lighting device **200** includes the arm assemblies **102**, **104** of the variable frost system **100**, a controller **202**, and a light beam source **204**. The motor **110** may be directly (e.g., using the motor shaft) or indirectly (e.g., using belt and pulley) connected to the arm assembly **102**, and the motor **112** may be directly or indirectly connected to the arm assembly **104**. As shown in FIG. **1**, the motors **110**, **112** may be positioned on one side of the plate **106**, and the arm assemblies **102**, **104** may be on the opposite side of the plate **106**.

In some example embodiments, the light beam source **204** may produce a light beam **206** that may be, for example, an illumination light or an image. For example, the light beam source **204** may include a light source and one or more image projection components as can be readily understood by those of ordinary skill in the art with the benefit of the scope of this disclosure. The light beam **206** may pass through the opening **108** of the plate **106** to reach, for example, an area or a surface below the lighting device **200**. If some of the frost components **116**, **118**, **122**, **124** of the variable frost system **100** are aligned with the opening **108** of the plate **106**, the light beam **206** may also pass through the particular frost components. The controller **202** can change the overall frost lighting effect applied to the light beam **206** by changing the positions of the arm assemblies **102**, **104**, which changes the positions of the frost components **116**, **118**, **122**, **124** with respect to the light beam **206** passing through the opening **108**.

In some example embodiments, the controller **202** may include a controller/processor **208** and a memory device **210** (e.g., a static memory device). The controller **202** may control the motors **110**, **112** that are used to change the positions of the arm assemblies **102**, **104**, for example, based on a user input. For example, the user input may indicate desired positions of the arm assemblies **102**, **104** or a desired level of frost lighting effect. The controller/processor **208** of the controller **202** may execute software code stored in the memory device **210** to adjust the positions of the arm assemblies **102**, **104** by controlling the rotations of motors **110**, **112**. The memory device **210** may also be used to store data as can be readily understood by those of ordinary skill in the art with the benefit of the scope of this disclosure.

In some alternative embodiments, the controller **202** may include multiple controllers and/or processors and/or memory devices without departing from the scope of this disclosure. In some alternative embodiments, different controllers may control the motors **110**, **112** without departing from the scope of this disclosure.

FIG. **3** illustrates another view of the variable frost system **100** of FIG. **1** according to an example embodiment. Referring to FIGS. **1-3**, in some example embodiments, the motor **110** is positioned on one side of the plate **106**, and the arm assembly **102** is positioned on an opposite side of the plate **106**. A shaft **302** of the motor **110** extends through an opening in the plate **106** and is attached to the arm assembly **102**. To illustrate, the shaft **302** may be attached to the arm structure **114** of the arm assembly **102** using an attachment structure. As described above, the positions of the frost components **116**, **118** with respect to the opening **108** may be changed by changing the position of the arm assembly **102**. Because the arm assembly **102** rotates along with the shaft **302**, the rotation of the shaft **302** may change the position of the arm assembly **102**.

In some example embodiments, the motor **112** is positioned on one side of the plate **106**, and the arm assembly **104** is positioned on an opposite side of the plate **106**. For example, the motors **110**, **112** may be located on the same side of the plate **106**, and the arm assemblies **102**, **104** may be on the opposite side of the plate **106** as shown in FIG. **3**. A shaft **304** of the motor **112** extends through an opening in the plate **106** and is attached to the arm assembly **104**. To illustrate, the shaft **304** may be attached to the arm **120** of the arm assembly **102** using an attachment structure. As described above, the positions of the frost components **122**, **124** with respect to the opening **108** may be changed by changing the position of the arm assembly **104**. Because the arm assembly **104** rotates along with the shaft **304**, the rotation of the shaft **304** may change the position of the arm assembly **104**.

In some example embodiments, the rotational movement of the arm assembly **102** may be limited by stop structures **308** and **310** that may be attached to the plate **106**, and the rotational movement of the arm assembly **104** may be limited by stop structures **312** and **314** that may be attached to the plate **106**. For example, the clockwise rotation of the arm assembly **102** may be limited by the stop structure **308**, and the counterclockwise rotation of the arm assembly **102** may be limited by the stop structure **310**. The clockwise rotation of the arm assembly **104** may be limited by the stop structure **312**, and the counterclockwise rotation of the arm assembly **104** may be limited by the stop structure **314**.

In some example embodiments, an optical component **306** (e.g., a lens) may be positioned at the opening **108** such that the light beam **206** (shown in FIG. **2**) passes through the optical component **306**. For example, the light beam **206** may pass through the optical component **306** before reaching one or more of the frost components **116**, **118**, **122**, **124** that may be aligned with the opening **108** as shown in FIGS. **8-10**. The optical component **306** may be integrated in or separate from the light beam source **204** (shown in FIG. **2**).

In some example embodiments, the plate **106** may be made from plastic and/or metal using methods such as molding, milling, cutting, etc. as can be readily understood by those of ordinary skill in the art with the benefit of the scope of this disclosure. Fasteners, such as screws, may be used to attach different components of the variable frost system **100** as can be readily understood by those of ordinary skill in the art with the benefit of the scope of this disclosure. For example, the motors **110**, **112** may be attached to the plate **106** using screws.

In some alternative embodiments, the motors **110** and **112** may be operationally coupled to the arm assemblies **102** and **104**, respectively, in a different manner than shown without departing from the scope of this disclosure. For example, the motor **110** may be positioned away from the plate **106** and may be operationally coupled to the arm assembly **102** using one or more belts and pulleys or gears as can be readily understood by those of ordinary skill in the art with the benefit of the scope of this disclosure. The motor **112** may also be positioned away from the plate **106** and may be operationally coupled to the arm assembly **104** using one or more belts and pulleys or gears. In some alternative embodiments, the movements of the arm assemblies **102**, **104** may be controlled in a different manner than shown without departing from the scope of this disclosure. For example, the arm assemblies **102**, **104** may be controlled to move laterally instead of rotationally to different positions with respect to the opening **108** of the plate **106** or the optical component **306**.

FIGS. **4**A and **4**B illustrate opposite sides of an arm assembly **400** used in the variable frost system **100** of FIG. **1** according to an example embodiment, and FIG. **5** illustrates the arm structure **402** of the arm assembly **400** of FIGS. **4**A and **4**B according to an example embodiment. Referring to FIGS. **4**A-**5**, in some example embodiments, the arm assembly **400** may correspond to each arm assembly **102**, **104**. The arm assembly **400** includes an arm structure **402** that includes an attachment section **404** and a frame section **406**. A frost component **408** may be attached to the frame section **406** on one side of the arm structure **402**, and a frost component **410** may be attached to the frame section **406** on an opposite side of the arm structure **402**. The frost components **408**, **410** may be glued to the frame section **406**. Alternatively or in addition, one or more fasteners may be used to securely attach the frost components **408**, **410** to the frame section **406**. As can be seen in

FIGS. **4**A and **4**B, the frost component **408** may overlap with a portion of the frost component **410**. The overlapping portions of the frost components **408**, **410** may be spaced from each other, for example, by the thickness of the frame section **406**. Alternatively, the frost components **408**, **410** may not have overlapping portions without departing from the scope of this disclosure.

In some example embodiments, the frame section **406** may have a U-shaped outline along with crossbars **412**, **414** that extend across the frame section **406** as more clearly shown in FIG. **5**. The crossbar **412** may include a sawtooth edge **422** and may overlap an edge portion of the frost component **410** as more clearly shown in FIGS. **4**A and **4**B. The crossbar **414** may include a sawtooth edge **508** and may overlap an edge portion of the frost component **408**. In some cases, the effects of the sawtooth edges **422**, **508** on a light beam that passes through the frost components **408**, **410** may be more desirable than the effects of the edges of the frost components **408**, **410** on the light beam (e.g., the light beam **206** shown in FIG. **2**).

In some example embodiments, an attachment structure **416** may be used to attach the arm assembly **402** to a motor such as the motor **110** or the motor **112** shown in FIG. **1**. To illustrate, the attachment structure **416** may be attached to the attachment section **404** of the arm structure **402** using fasteners **430** that may extend through holes **504**, **506** in the attachment section **404**. An opening **418** in the attachment structure **416** may be aligned with an opening **502** in the attachment section **404**, and the shaft of a motor (e.g., the shaft **302** of the motor **110** or the shaft **304** of the motor **112**) may extend through the opening **418**. A shaft extending through the opening **418** may be securely attached to the attachment structure **416**, and thus to the arm structure **402**, by a screw **420** (e.g., a set screw) that extends through a hole in the attachment structure **416** and reaches the shaft. The screw **420** may be used to securely attach the arm structure **402** to the shaft of a motor at a desired location of the shaft.

In some example embodiments, the arm structure **402** corresponds to each arm structure **114**, **120**. In some example embodiments, the frost component **408** corresponds to each frost component **116**, **122**, and the frost component **410** corresponds to each frost component **118**, **124**. The frost component **408** may have more frost lighting effect on a light beam than the frost component **410**. Alternatively, the frost component **408** may have less frost lighting effect on a light beam than the frost component **410**. As more clearly shown in FIGS. **4**A and **4**B, the frost component **408** may have a generally semicircular shape, and the frost component **410** may have a U-shaped outer perimeter. In general, the frost components **408**, **410** may each have an outer perimeter shape that closely matches the shape of at least a portion of the frame section **406**.

In some example embodiments, the arm structure **402** and the attachment structure **416** may be made from plastic or another suitable material using methods such as molding, milling, cutting, etc. The frost components **408**, **410** may be made from or may include a frost gel material that may be available, for example, from suppliers such as Rosco Laboratories, Brightview Technologies, Lee Filters, Apollo Optical Systems, and others. The frost components **408**, **410** may be made from one or more other materials such as a frost glass panel.

In some alternative embodiments, the frost components **408**, **410** may be reversed such that the frost component **408** is positioned on the side of the arm structure **402** where the frost component **410** is located as shown in FIGS. **4**A and **4**B. In some alternative embodiments, the arm structure **402** may have a different shape than shown without departing from the scope of this disclosure. For example, the frame section **406** may have an outline that is not U-shaped. In some alternative embodiments, a different attachment mechanism than the attachment structure **416** may be used without departing from the scope of this disclosure.

FIG. **6** illustrates an arm structure **600** according to another example embodiment, and FIGS. **7**A and **7**B illustrate an arm assembly **700** including the arm structure **600** of FIG. **6** according to an example embodiment. In some example embodiments, the arm assembly **700** may be used in the variable frost system **100** of FIG. **1** without departing from the scope of this disclosure.

Referring to FIGS. **6**-**7**B, in some example embodiments, the arm assembly **700** includes an arm structure **600** and the frost components **408**, **410** that are attached to the arm structure **600**. In general, the arm assembly **700** is similar to the arm assembly **400** shown in FIGS. **4**A and **4**B. For example, the frost components **408**, **410** are attached to the arm structure **600** in a similar manner. The arm assembly **700** may be made with the same type of material and in a similar manner as described with respect to the arm assembly **400**. In contrast to the arm structure **402** of the arm assembly **400**, the crossbars **412**, **414** of the arm structure **402** are omitted from the arm structure **600**.

In some example embodiments, the arm structure **600** includes an attachment section **602** and a frame section **604**. The attachment section **602** may include a hole **612**. For example, the attachment structure **416** may be positioned at and aligned with the hole **612** as shown in FIGS. **7**A and **7**B. To illustrate, a shaft of a motor (e.g., the shaft **302** or the shaft **304** shown in FIG. **3**) may extend through the hole **418** in a similar manner as described with respect to the arm assembly **400** (shown in FIGS. **4**A and **4**B). A screw (e.g., the screw **420** shown in FIGS. **4**A and **4**B) may securely attach the arm structure **600** to the shaft extending through the hole **418**.

In some alternative embodiments, the arm assembly **700** may have a different shape than shown without departing from the scope of this disclosure. In some alternative embodiments, the arm structure **600** may include one of the crossbars **412**, **414** without departing from the scope of this disclosure. In some alternative embodiments, an attachment structure other than the attachment structure **416** may be used to attach the arm assembly **700** to a motor.

FIG. **8** illustrates the variable frost system **100** of FIG. **1** adjusted to provide a frost lighting effect according to an example embodiment. Referring to FIGS. **1**-**3** and **8**, in some example embodiments, the arm assemblies **102**, **104**, each attached to the respective shaft **302** or **304**, may be rotated to the positions shown in FIG. **8**. To illustrate, the arm assemblies **102**, **104** are rotated such that the frost components **118**, **124** are positioned generally adjacent and non-overlapping to each other and in the path of a light beam passing through the optical component **306**. As described with respect to FIG. **3**, the optical component **306** is positioned at and through the opening **108** of the plate **106**. In FIG. **8**, a dotted line **802** represents an inner perimeter outline of the optical component **306**.

In some example embodiments, the arm assemblies **102**, **104** may be rotated to the positions shown in FIG. **8** starting from the positions shown in FIG. **3** or from other positions. The arm assemblies **102**, **104** may also be rotated to the positions shown in FIG. **8** simultaneously. As shown on FIG. **8**, the frost components **118**, **124** are positioned such that a portion of a light beam (e.g., the light beam **206** shown in FIG. **8**) passes through the frost component **118** and another portion of the light beam passes through the frost component **124**.

In some example embodiments, each of the frost components **118**, **124** may provide a light frost lighting effect, where the overall frost lighting effect applied to the light beam by the variable frost system **100** may be a light frost lighting effect. For example, both of the frost components **118**, **124** may provide generally the same level of frost lighting effect. Alternatively, the frost components **118**, **124** may provide different frost lighting effects from each other. For example, the frost components **118**, **124** may provide light frost lighting effects that are different from each other.

As shown in FIG. **8**, the frost components **116**, **122** may not contribute to the overall frost lighting effect provided by the variable frost system **100**. To illustrate, the frost components **116**, **122** may be positioned generally out of the path of a light beam passing through the optical component **306**.

In some alternative embodiments, the arm assemblies **102**, **104** may be rotated to different positions than shown in FIG. **8** without departing from the scope of this disclosure. In some alternative embodiments, the optical component **306** shown in FIG. **3** may be omitted, and the dotted line **802** may instead represent a perimeter of the opening **108** in the plate **106** without departing from the scope of this disclosure.

FIG. **9** illustrates the variable frost system **100** of FIG. **1** adjusted to provide a different frost lighting effect from that provided by the variable frost system **100** configured as shown in FIG. **8** according to an example embodiment. Referring to FIGS. **1**-**3** and **9**, in some example embodiments, the arm assemblies **102**, **104**, each attached to the respective shaft **302** or **304**, may be rotated to the positions shown in FIG. **9**. The arm assemblies **102**, **104** may be rotated such that the frost components **118**, **124** are positioned generally overlapping each other. For example, the arm assemblies **102**, **104** may be attached to the respective shaft **302** or **304** to allow the frost components **118**, **124** to move past each other to the overlapping positions shown in FIG. **9**. As described with respect to FIG. **3**, the optical component **306** may be positioned at the opening **108** of the plate **106**, where the inner perimeter outline of the optical component **306** is represented by the dotted line **802** shown in FIGS. **8** and **9**. In FIG. **9**, the frost components **118**, **124** are overlapping each other such that portion of a light beam from the optical component **306** passes through both frost components **118**, **124**. In FIG. **9**, the frost component **118** is hidden from view by the frost component **124**. The components **116**, **122** may also be partially aligned with the optical component **306** such that a respective portion of the light beam can pass through the respective component **116**, **122**.

In some example embodiments, each of the frost components **118**, **124** may provide a light frost lighting effect, and each frost component **118**, **124** may provide a heavy frost lighting effect. The combined frost lighting effect applied to the portion of the light beam by the frost component **118**, **124** is more than the light frost lighting effect of the individual frost component **118**, **124**. The overall frost lighting effect applied to the light beam by the variable frost system **100** may be the combination of the frost lighting effects of the frost components **118**, **124** applied to a portion of the light beam and the frost lighting effect of the frost components **116**, **122** applied to other respective portions of the light beam.

In some example embodiments, the arm assemblies **102**, **104** may each be rotated to the positions shown in FIG. **9** starting from the positions shown in FIG. **3**, in FIG. **8**, or from other positions. The arm assemblies **102**, **104** may also be rotated to the positions shown in FIG. **9** simultaneously, for example, starting from the positions shown in FIG. **8**.

In some alternative embodiments, the arm assemblies **102**, **104** may be rotated to different positions than shown in FIG. **9** without departing from the scope of this disclosure. For example, the arm assemblies **102**, **104** may be rotated to respective positions that are between those shown in FIGS. **8** and **9**. In some alternative embodiments, the optical component **306** shown in FIG. **3** may be omitted, and the dotted line **802** may instead represent a perimeter of the opening **108** in the plate **106** without departing from the scope of this disclosure.

FIG. **10** illustrates the variable frost system **100** of FIG. **1** adjusted to provide a different frost lighting effect from those provided by the variable frost system **100** configured as shown in FIGS. **8** and **9** according to an example embodiment. Referring to FIGS. **1-3** and **10**, in some example embodiments, the arm assemblies **102**, **104**, each attached to the respective shaft **302** or **304**, may be rotated to the positions shown in FIG. **10**. The arm assemblies **102**, **104** may be rotated such that the frost components **116**, **122** are positioned generally adjacent and non-overlapping to each other, where the frost component **116** overlaps the frost component **124**, and the frost component **122** overlaps the frost component **118**. As described with respect to FIG. **3**, the optical component **306** may be positioned at the opening **108** of the plate **106**, where the inner perimeter outline of the optical component **306** is represented by the dotted line **802** shown in FIGS. **8-10**. A portion of a light beam from the optical component **306** passes through both frost components **116**, **124**, and another portion of the light beam passes through both frost components **122**, **118**. In addition, because a portion of the frost component **118** overlaps the frost component **116**, the portion of the light beam that passes through the frost components **116**, **124** also passes through the frost component **118**. Also, because a portion of the frost component **124** overlaps the frost component **122**, the portion of the light beam that passes through the frost components **122**, **118** also passes through the frost component **124**.

In some example embodiments, each of the frost components **118**, **124** may provide a light frost lighting effect, and each frost component **116**, **122** may provide a heavy frost lighting effect. For example, the overall frost lighting effect provided by the variable frost system **100** may be the heavy frost lighting effect because of the dominance of the heavy frost lighting effect over the light frost lighting effect of the frost components **116**, **122**.

In some example embodiments, the arm assemblies **102**, **104** may each be rotated to the positions shown in FIG. **10** starting from the positions shown in FIG. **3**, in FIG. **8**, in FIG. **9**, or from other positions. The arm assemblies **102**, **104** may also be rotated to the positions shown in FIG. **10** simultaneously, for example, starting from the positions shown in FIG. **9**.

In some alternative embodiments, the arm assemblies **102**, **104** may be rotated to different positions than shown in FIG. **10** without departing from the scope of this disclosure, which can result in the variable frost system **100** providing a different overall frost lighting effect. For example, the arm assemblies **102**, **104** may be rotated to respective positions that are between those shown in FIGS. **9** and **10**. In some alternative embodiments, the optical component **306** shown in FIG. **3** may be omitted, and the dotted line **802** may instead represent a perimeter of the opening **108** in the plate **106** without departing from the scope of this disclosure.

Although particular embodiments have been described herein in detail, the descriptions are by way of example. The features of the embodiments described herein are representative and, in alternative embodiments, certain features, elements, and/or steps may be added or omitted. Additionally, modifications to aspects of the embodiments described herein may be made by those skilled in the art without departing from the scope of the following claims, the scope of which are to be accorded the broadest interpretation so as to encompass modifications and equivalent structures.

The invention claimed is:

1. A variable frost system, comprising:

a first frost component and third frost component, wherein the first frost component and third frost component are attached to a first arm structure, wherein the first and third frost components are adjacent each other; and

a second frost component and fourth frost component, wherein the second frost component and fourth frost component are attached to a second arm structure, wherein the second and fourth frost components are adjacent each other;

wherein the first arm structure and the second arm structure are located on opposing sides of an aperture for a light beam and both are movable such that, in a first position of the variable frost system, the first frost component and the second frost component are at least partially overlapped with each other such that the first frost component and the second frost component are positioned to provide a combined frost lighting effect to at least a portion of the light beam; and

wherein, in a second position of the variable frost system, the first frost component and the fourth frost component are at least partially overlapped with each other and the second and third frost components are at least partially overlapped with each other.

2. The variable frost system of claim **1**, wherein the first frost component and the second frost component are at least partially non-overlapping with each other and are each positioned to provide a respective frost lighting effect to at least a respective portion of the light beam.

3. The variable frost system of claim **1**, wherein, in the first position of the variable frost system, at least a different portion of the light beam does not pass through the first frost component.

4. The variable frost system of claim **1**, wherein the combined frost lighting effect includes a frost lighting effect of the first frost component and a frost lighting effect of the second frost component, wherein the frost lighting effect of the first frost component is substantially similar to the frost lighting effect of the second frost component.

5. The variable frost system of claim **1**, wherein the first arm structure and the second arm structure are each movable by a motor.

6. The variable frost system of claim **1**, wherein the first frost component and the second frost component each comprises a translucent frost gel sheet or a frosted glass panel.

7. The variable frost system of claim **1**, wherein an overall frost lighting effect is adjustable by changing positions of the first arm structure or the second arm structure.

8. The variable frost system of claim **7**, wherein the first arm structure and the second arm structure are rotatable.

9. The variable frost system of claim **1**, wherein the first arm structure and the second arm structure are simultaneously movable to change positions of at least the first frost component and the second frost component with respect to the light beam.

10. The variable frost system of claim **1**, wherein the first arm structure comprises a first crossbar and a second crossbar, the first crossbar having a first sawtooth edge and the second crossbar having a second sawtooth edge.

11. A lighting device with a variable frost system, comprising:

at least one light source emitting a light beam;

a first frost component, wherein at least the frost component is attached to a first arm structure, wherein the first arm structure comprises a first crossbar and a second crossbar, the first crossbar having a first sawtooth edge and the second crossbar having a second sawtooth edge; and

second frost component, wherein at least the second frost component is attached to a second arm structure, wherein at least the first arm structure and the second arm structure are each rotatable by a motor,

wherein, in a position of the variable frost system, the first arm structure and the second arm structure are rotatable to a position such that first frost component and the second frost component are at least partially overlapped with each other such that the first frost component and the second frost component are positioned to provide a combined frost lighting effect to at least a portion of the light beam of the lighting device.

12. The lighting device of claim **11**, wherein the first arm structure and the second arm structure are movable to a position such that the first frost component provides a lighting effect to a first portion of the light beam and the second frost component provides a lighting effect to a second portion of the light beam.

13. The variable frost system of claim **11**, wherein the first arm structure and the second arm structure are rotatable in the same direction.

14. A lighting device with a variable frost system, comprising:

at least one light source emitting a light beam;

a first frost component and a third frost component, wherein the first and third frost components are associated with a first motor, wherein the first and third frost components are movable by the first motor, wherein the first and third frost components are adjacent each other and have different frost lighting effects, wherein a lighting effect of the first frost component is a lighter frost lighting effect compared to a frost lighting effect of the third frost component;

a second frost component and a fourth frost component, wherein the second and fourth frost components are associated with a second motor, wherein the second and fourth frost components are movable by the second motor, wherein the second and fourth frost components are adjacent each other;

wherein, in a first position of the variable frost system, the first frost component and the second frost component are at least partially overlapped with each other such that the first frost component and the second frost component are positioned to provide a combined frost lighting effect to at least a portion of the light beam of the lighting device; and

wherein, in a second position of the variable frost system, the first frost component and the fourth frost component are at least partially overlapped with each other and the second and third frost components are at least partially overlapped with each other.

15. The lighting device of claim **14**, wherein the first motor and the second motor move simultaneously.

16. The lighting device of claim **14**, wherein the first motor causes the first frost component to move in a clockwise direction and the second motor causes the second frost component to move in a counterclockwise motion.

17. The lighting device of claim **14**, wherein the combined frost lighting effect includes the lighting effect of the first frost component and a lighting effect of the second frost component, and wherein the lighting effect of the first frost component is substantially similar to a lighting effect of the second frost component.

18. The lighting device of claim **14**, wherein, in the second position of the variable frost system, the lighting effect of the first frost component and a lighting effect of the fourth frost component combine to create a different combined frost light effect that is greater than the combined frost lighting effect of the first position of the variable frost system.

19. The lighting device of claim **14**, wherein the combined frost lighting effect is less than the lighting effect of the third frost lighting effect.

20. The lighting device of claim **14**, wherein the first and third frost components do not overlap in the first or second position.

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