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Conrad

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(54) **LIGHTING SYSTEM FOR INDOOR CULTIVATION FACILITY**

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F21S 8/06	(2006.01)
F21V 29/76	(2015.01)
F21V 21/15	(2006.01)
F21S 2/00	(2016.01)
F21Y 103/10	(2016.01)
F21Y 115/10	(2016.01)

(52) **U.S. Cl.**

CPC ***A01G 7/045*** (2013.01); ***F21S 2/005*** (2013.01); ***F21S 8/06*** (2013.01); ***F21V 21/15*** (2013.01); ***F21V 29/767*** (2015.01); *F21Y 2103/10* (2016.08); *F21Y 2115/10* (2016.08)

(58) **Field of Classification Search**

CPC . A01G 7/045; A01G 9/249; F21S 8/06; F21S 2/005; F21W 2131/109; F21Y 2115/10; F21Y 2103/10; Y02A 40/256

See application file for complete search history.

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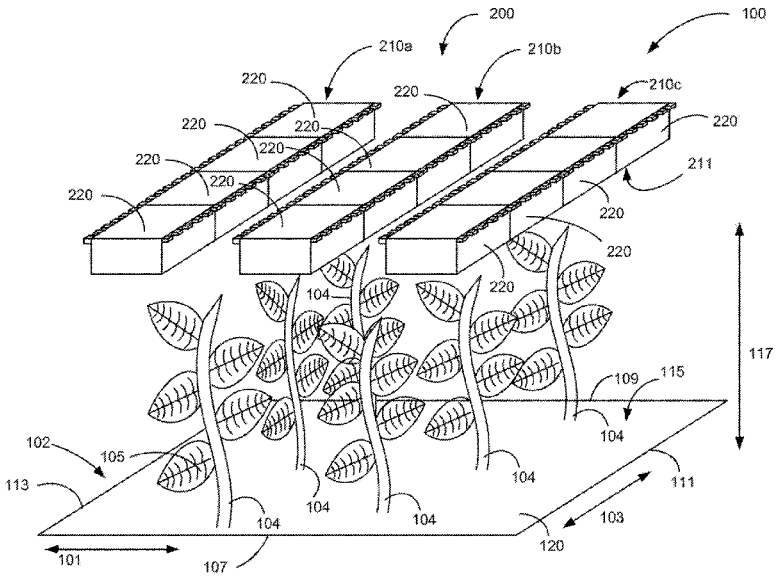
(57) **ABSTRACT**

A lighting system for an indoor growing facility comprises a plurality of lighting units suspended above a growing are and a height adjustment controller operable to selectively raise each lighting unit, wherein a vertical position of each lighting unit with respect to plants positioned in the growing area under each lighting unit is adjustable to maintain a generally consistent separation between the light emitting face of each lighting unit and a top of plants positioned under each lighting unit.

9 Claims, 18 Drawing Sheets



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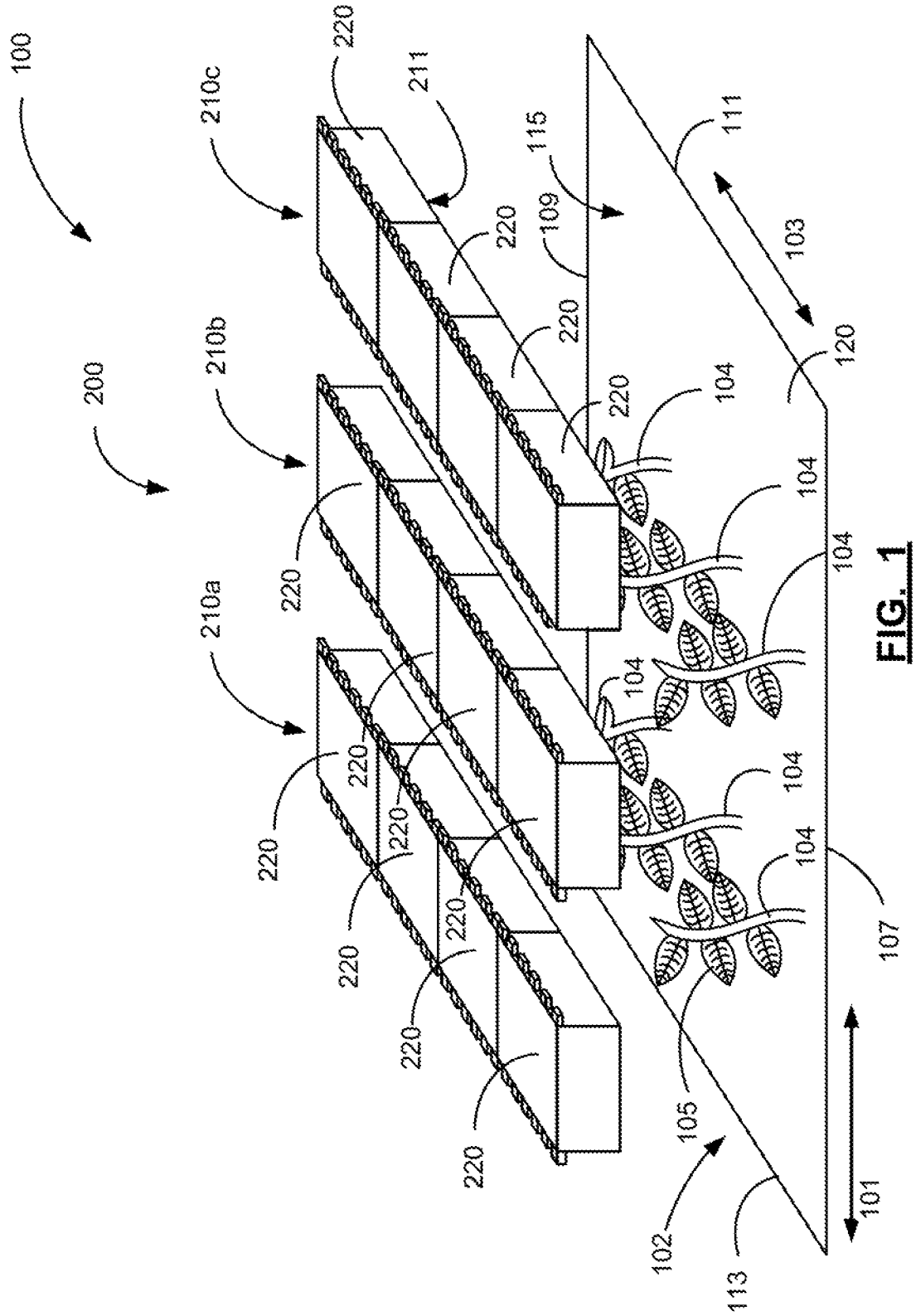
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210a
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210c
211
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104
105
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109
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113
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101
102
103

FIG. 1

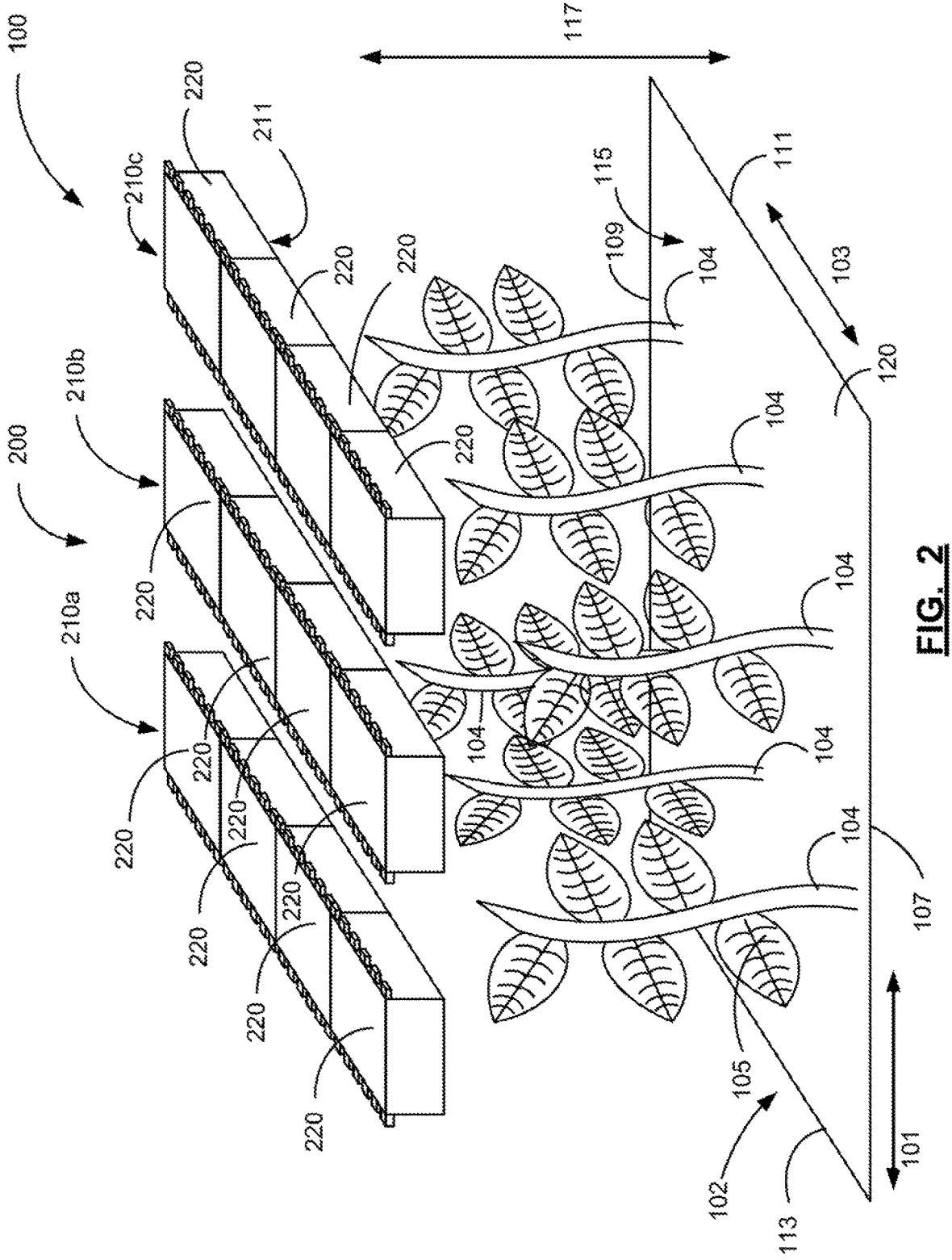
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FIG. 2

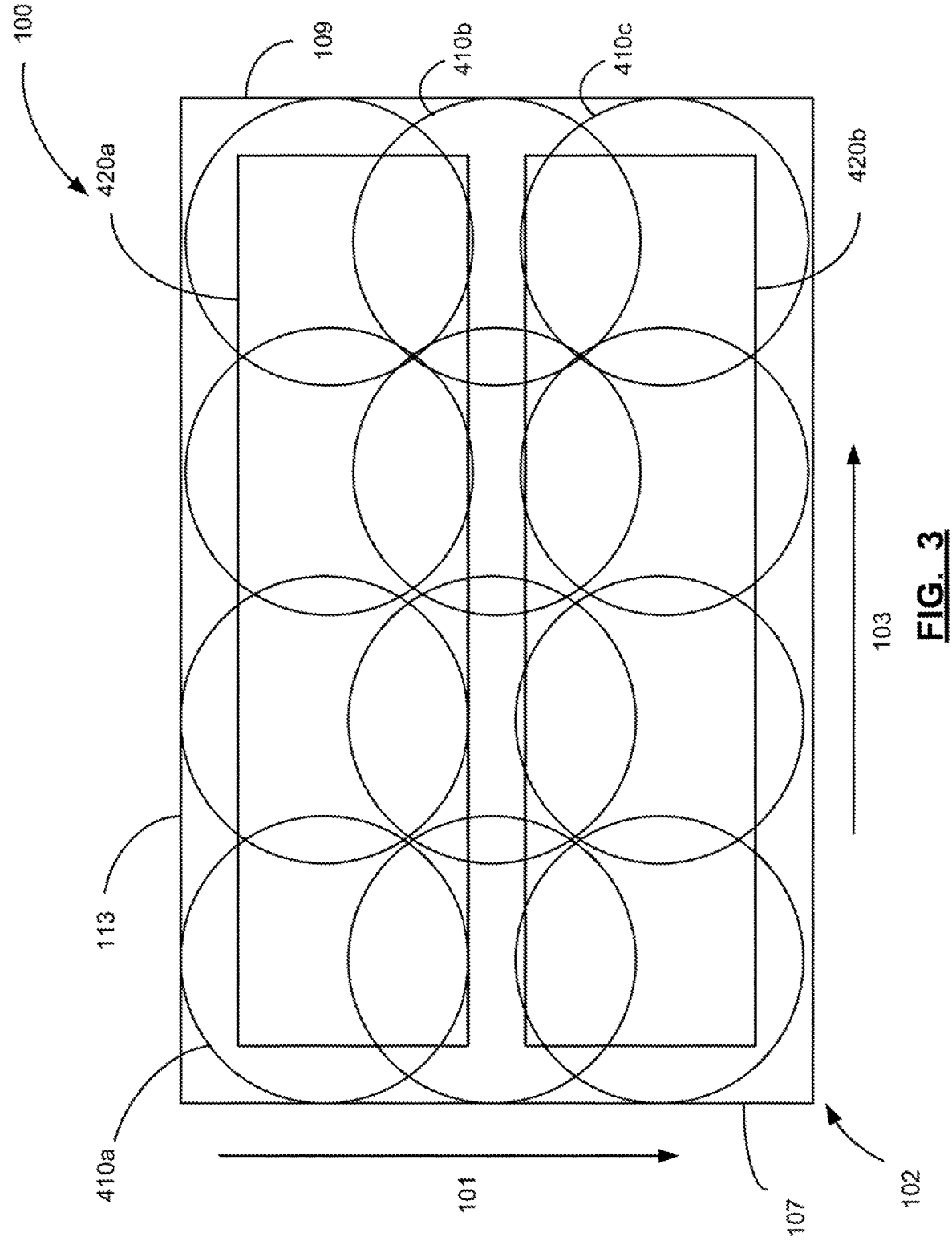
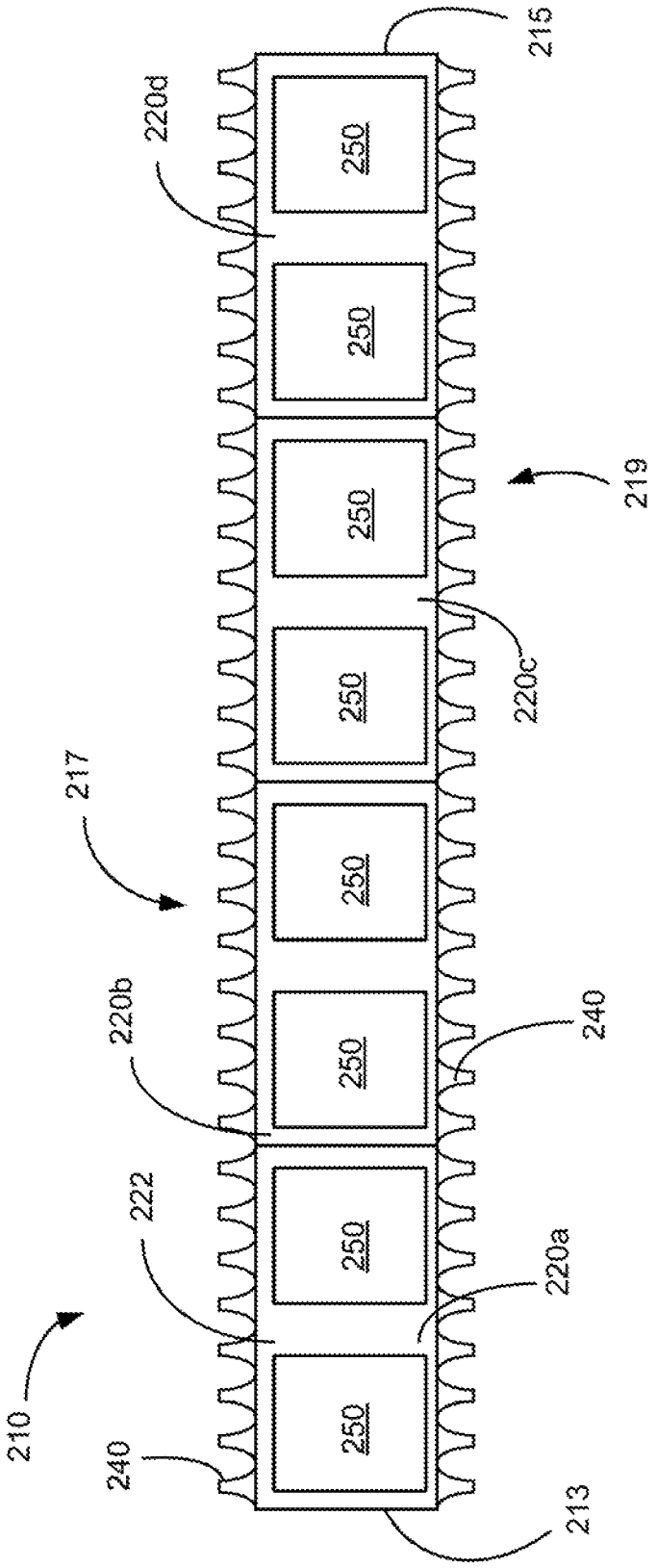


FIG. 3


210
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220a
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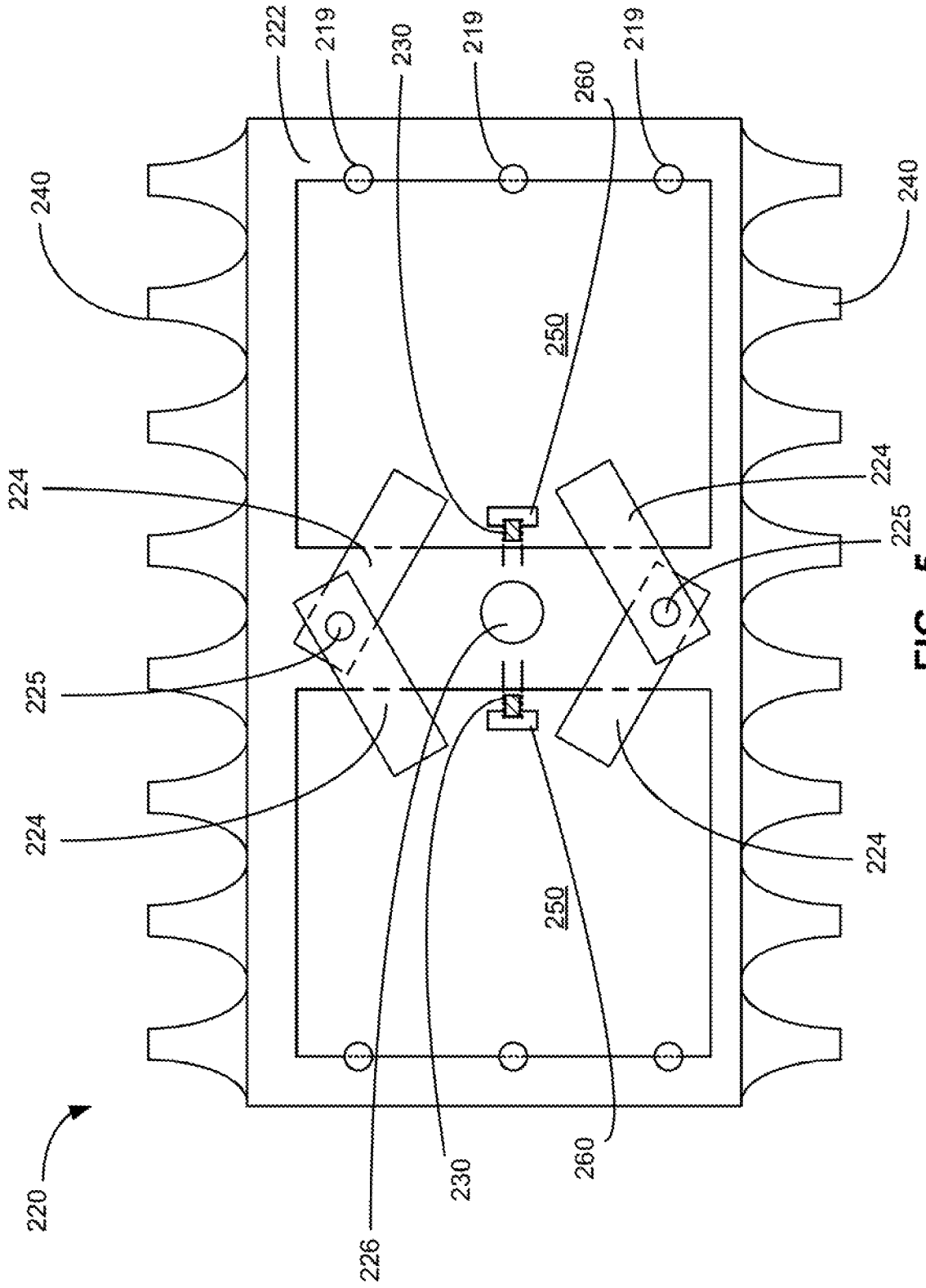
FIG. 4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219
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FIG. 5

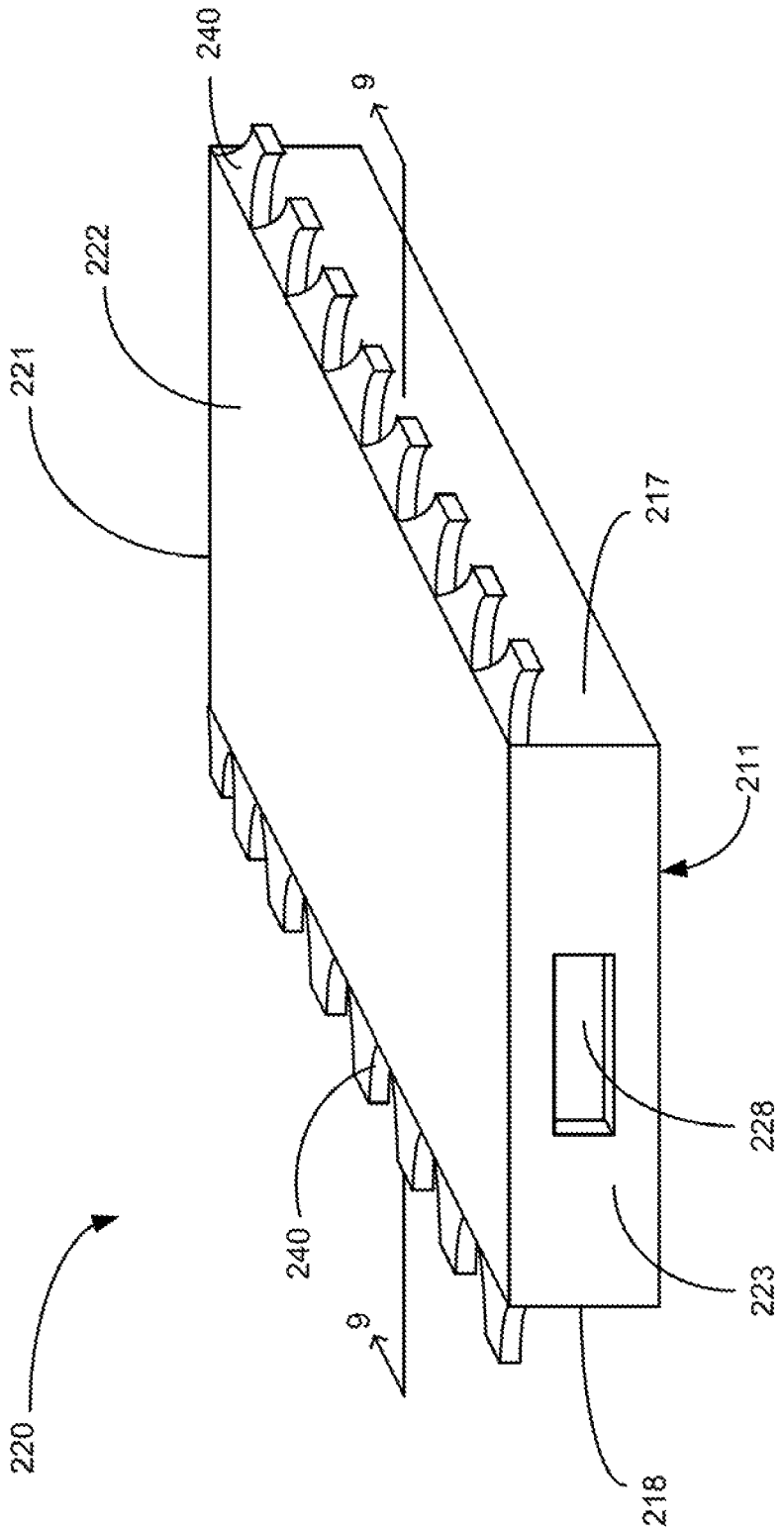

FIG. 6

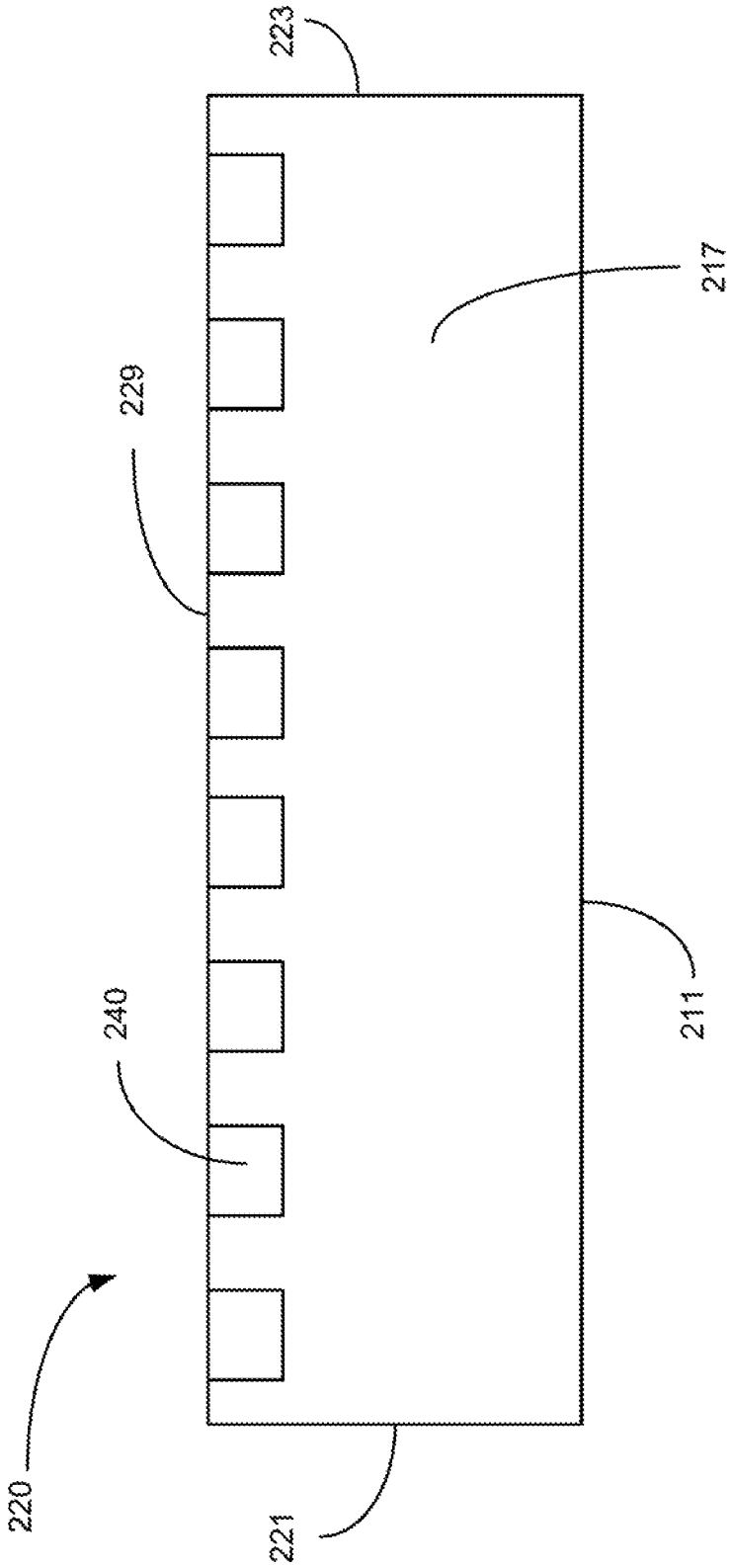

FIG. 7

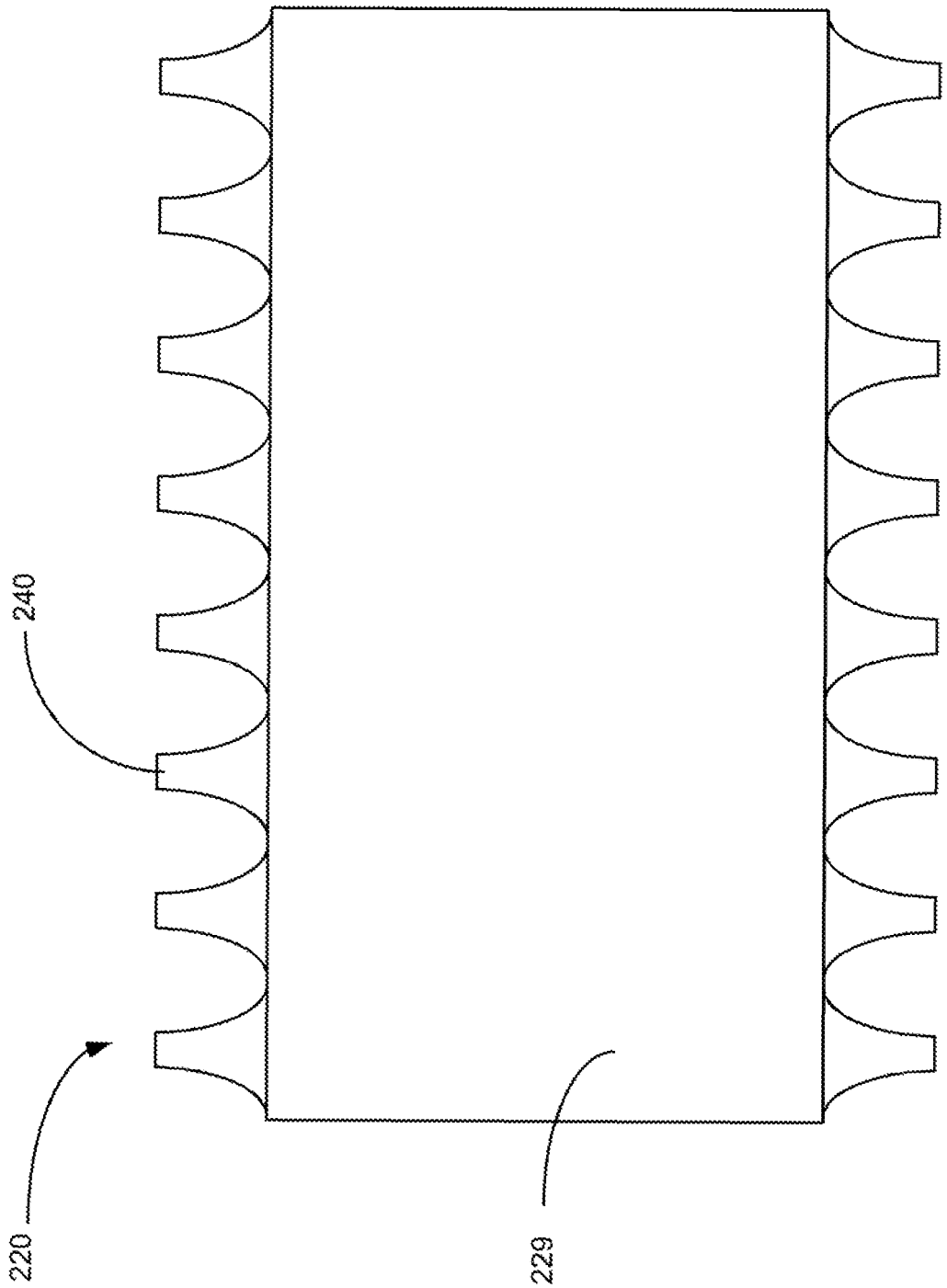

FIG. 8

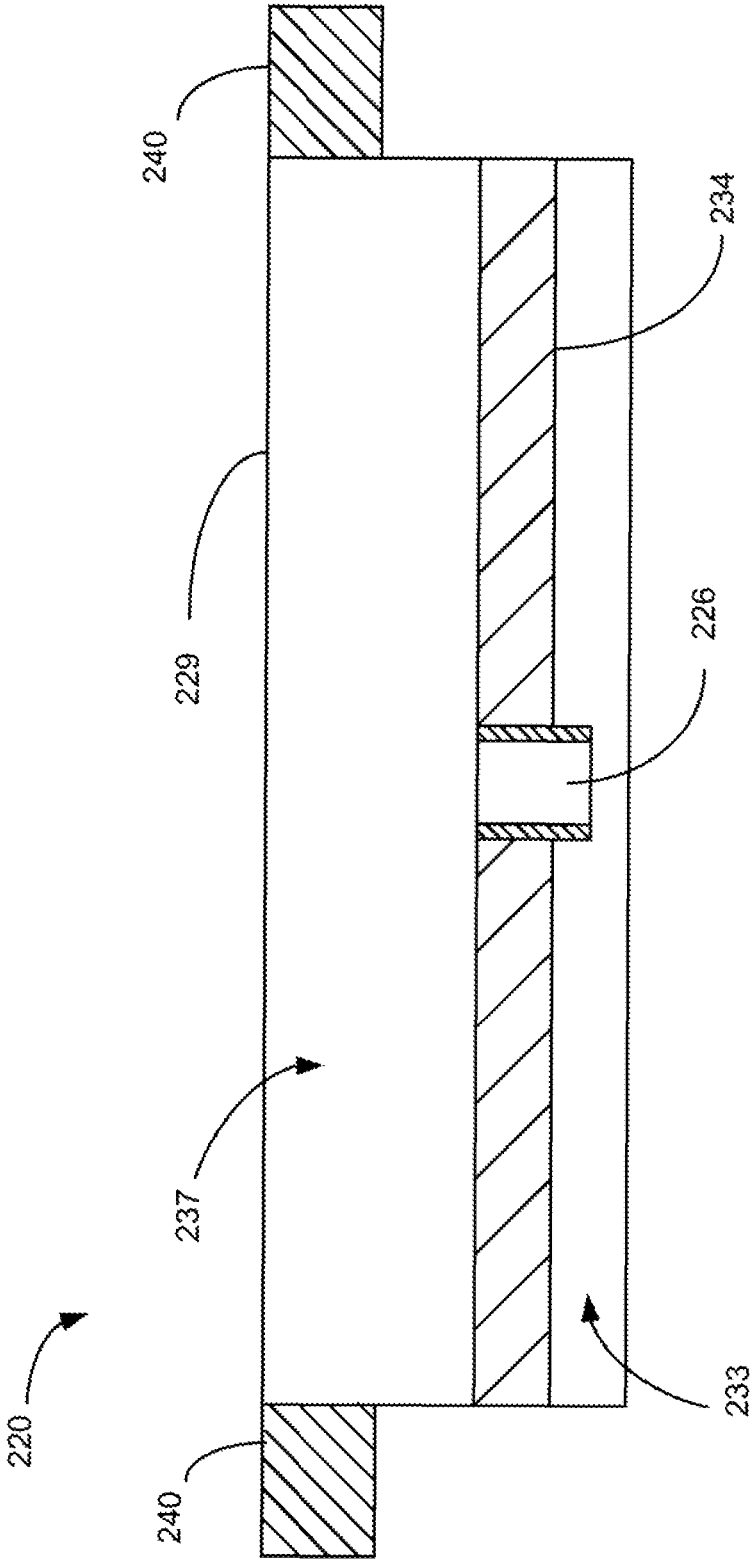

FIG. 9

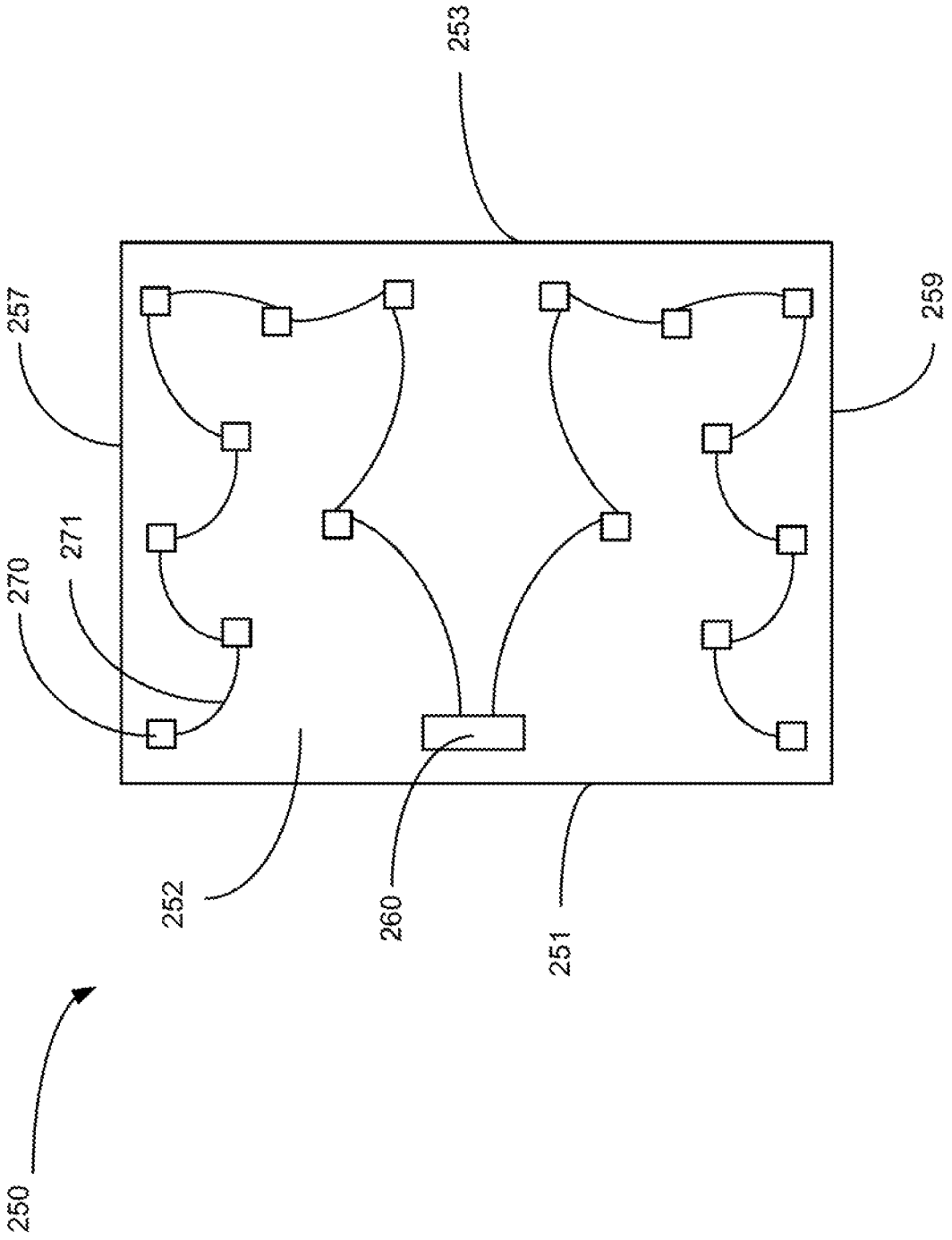

FIG. 10

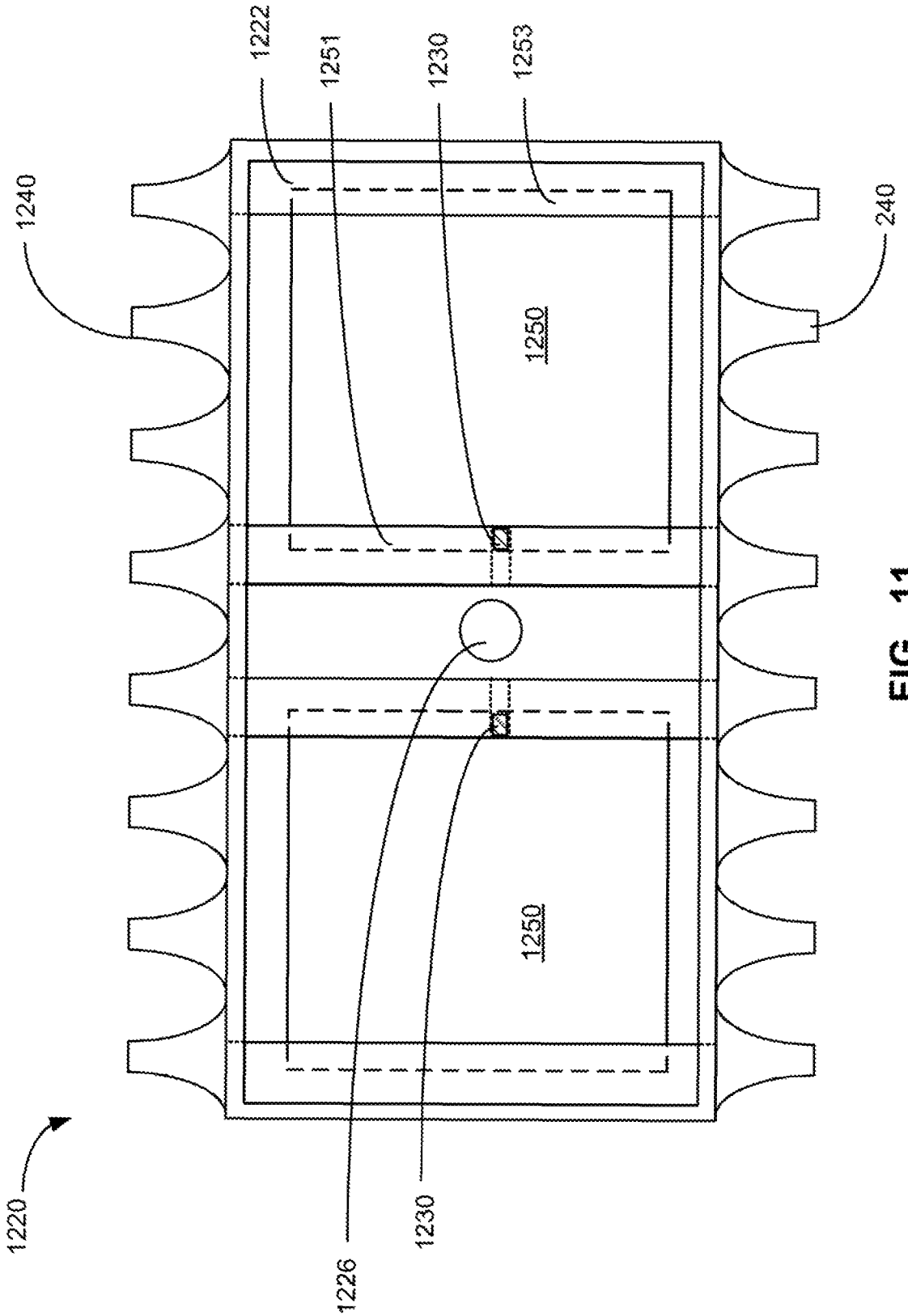

FIG. 11

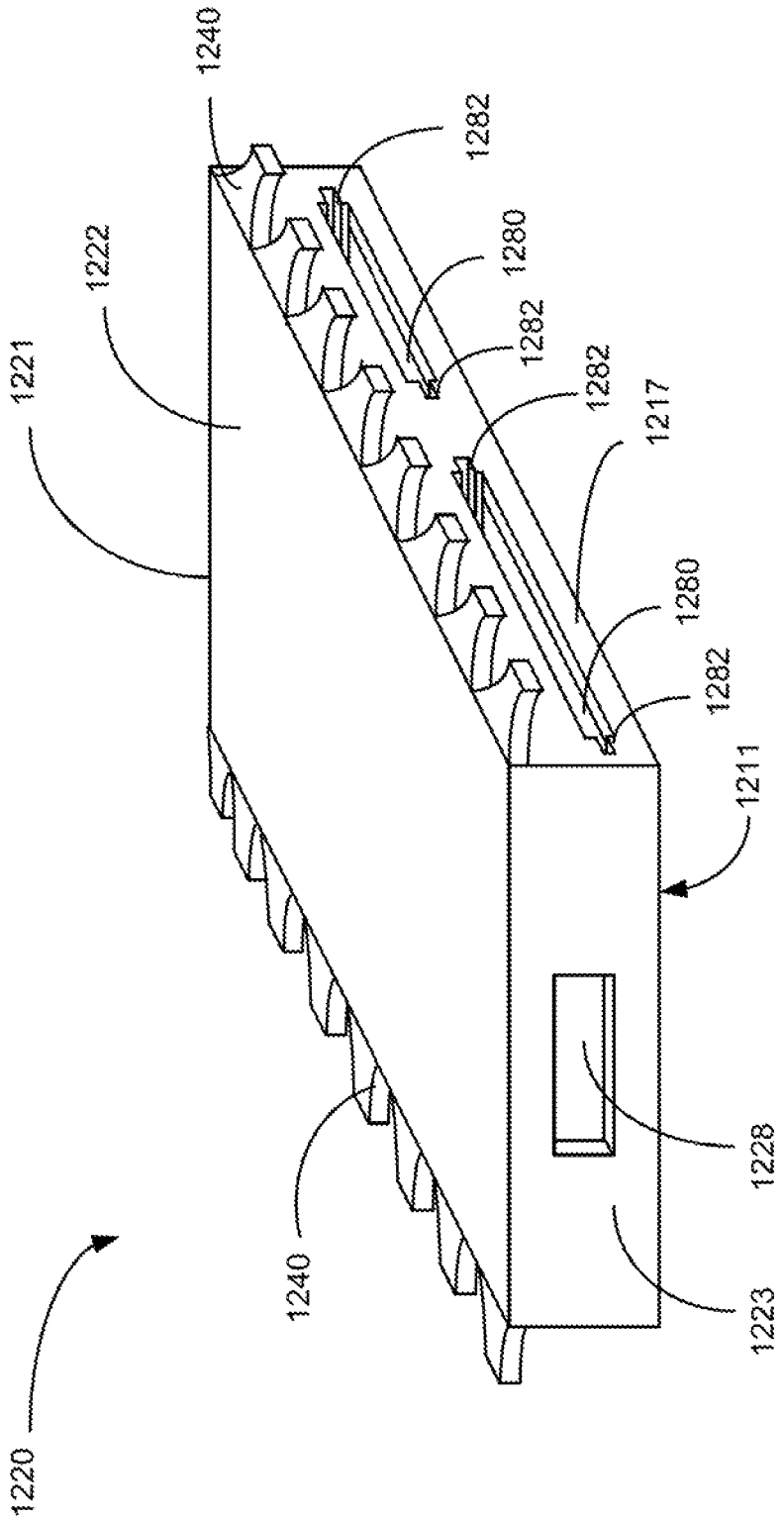
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FIG. 12

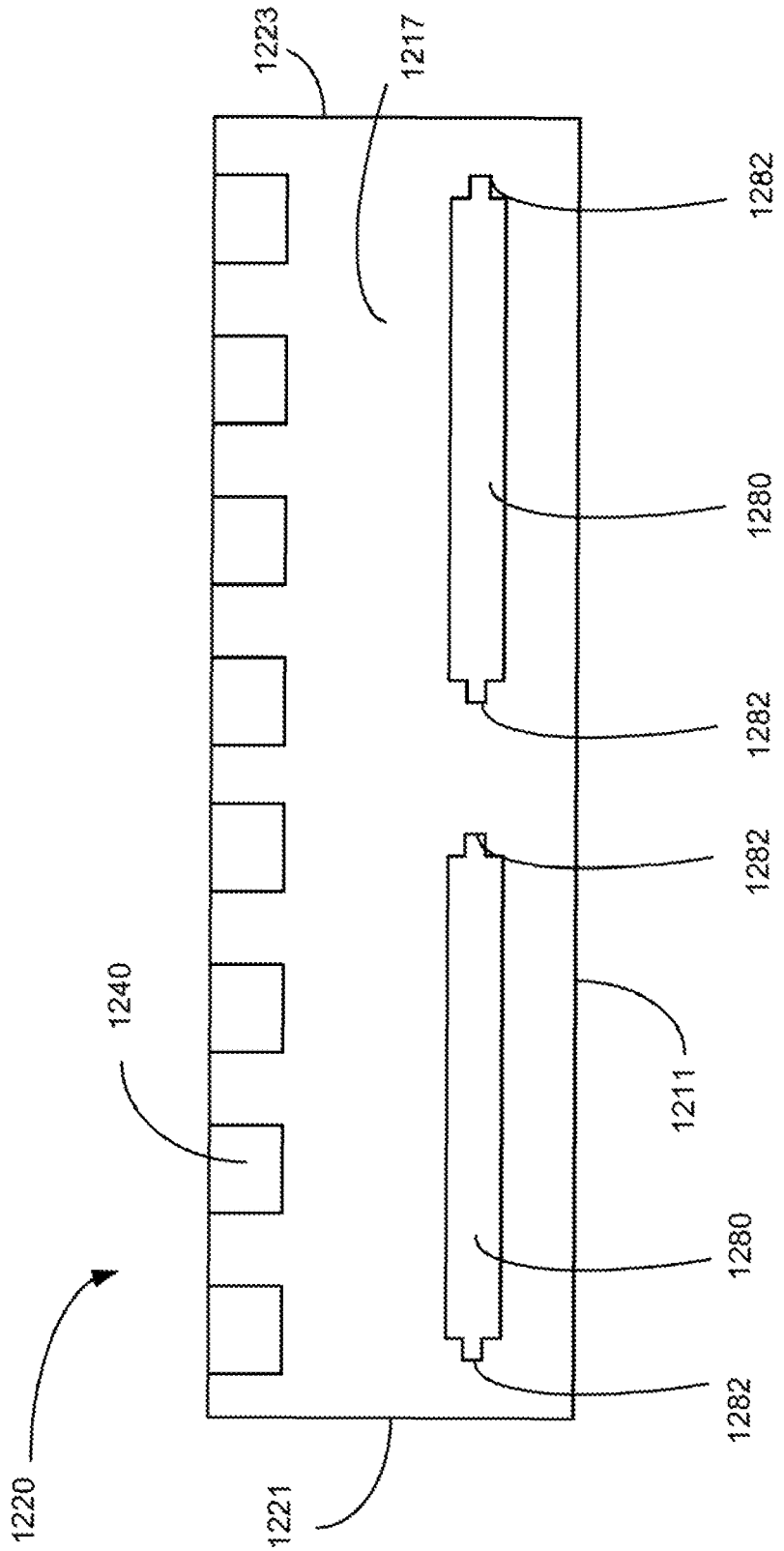


FIG. 13

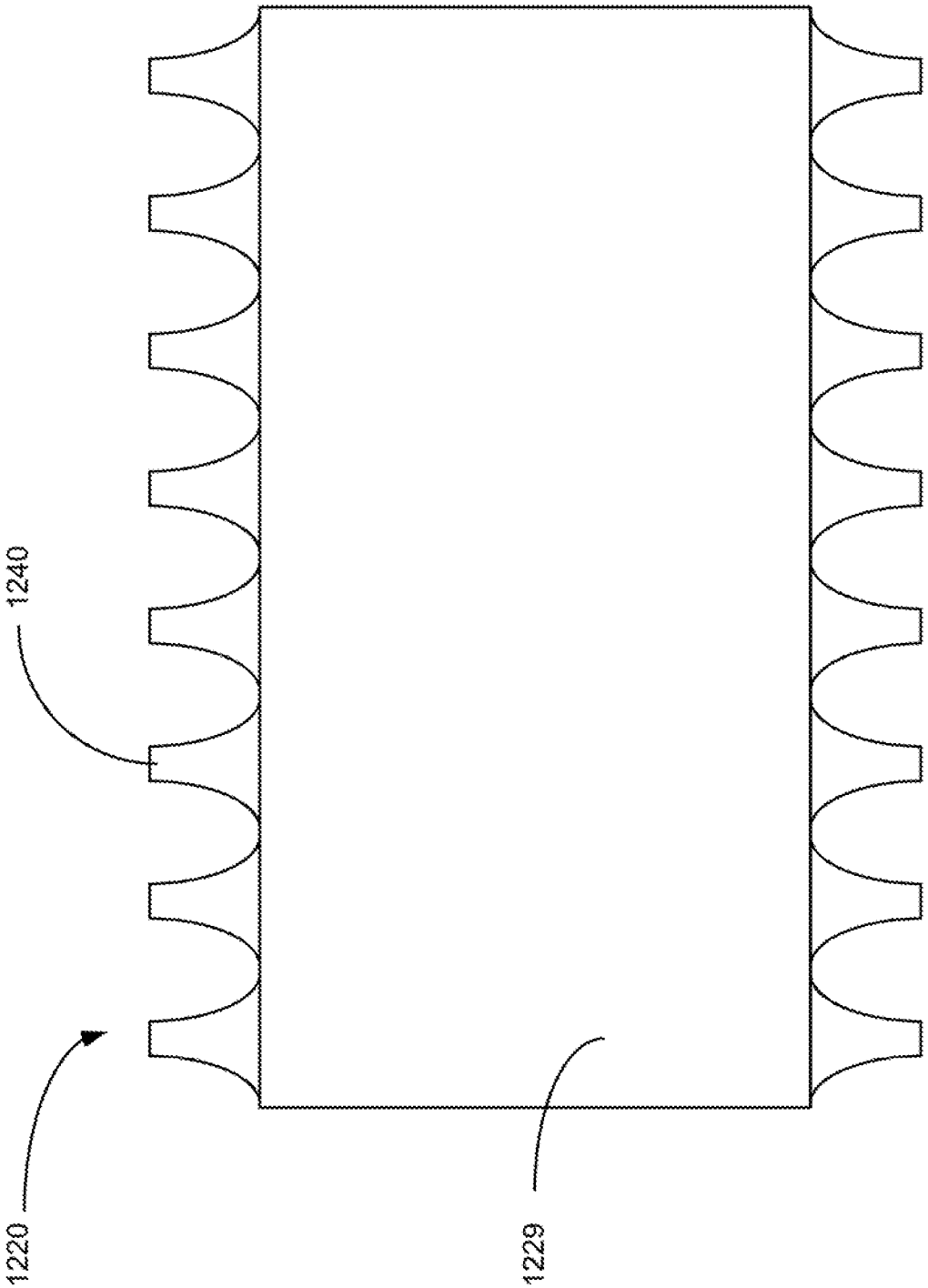
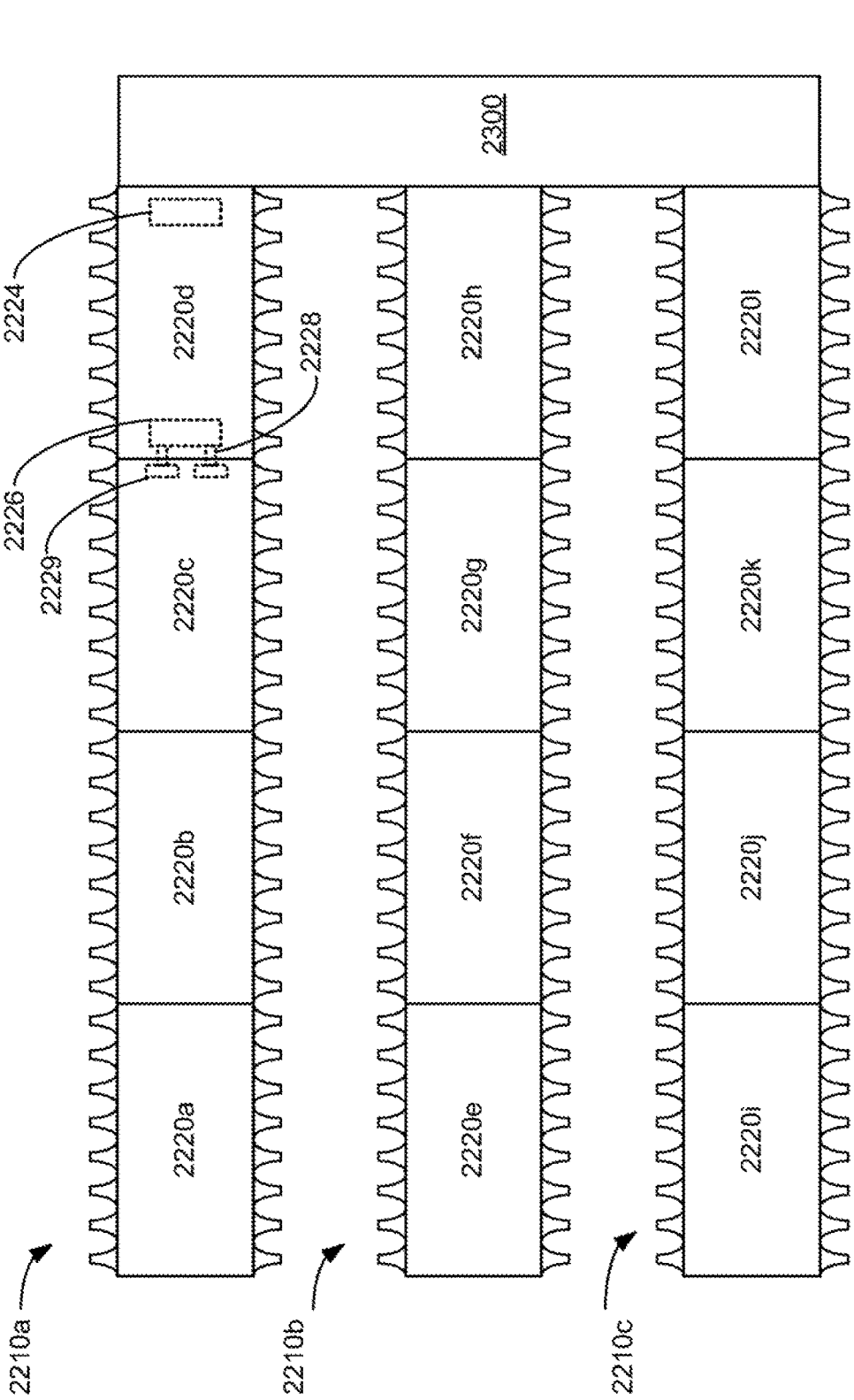


FIG. 14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2300
2224
2226
2228
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2220b
2220c
2220d
2220e
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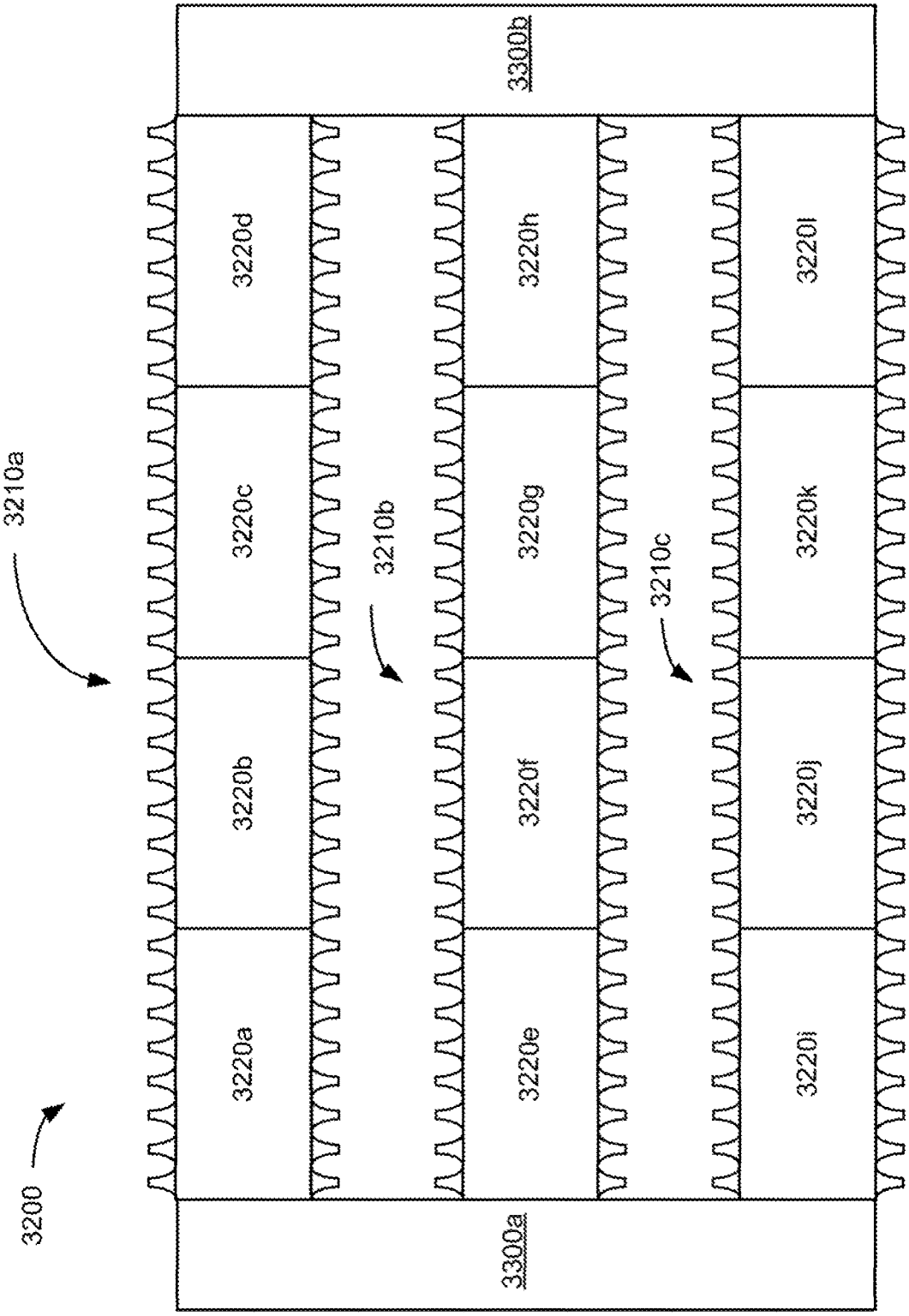
2220g
2220h
2220i
2220j
2220k
2220l
2210a
2210b
2210c

FIG. 15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3210a
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3300a
3300b
3220a
3220b
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3220h
3220i
3220j
3220k
3220l

FIG. 16

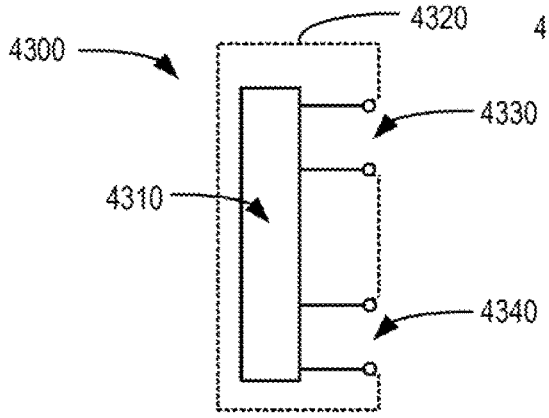

FIG. 17A

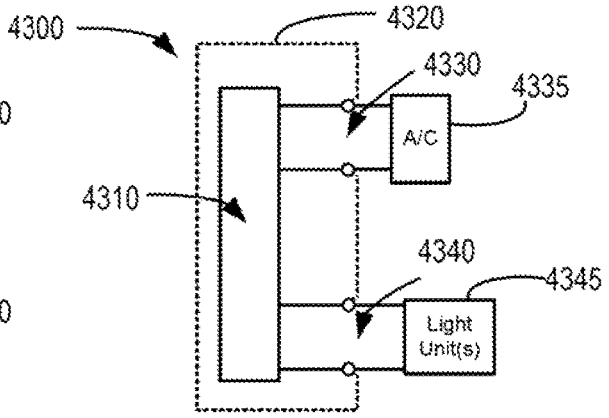

FIG. 17B

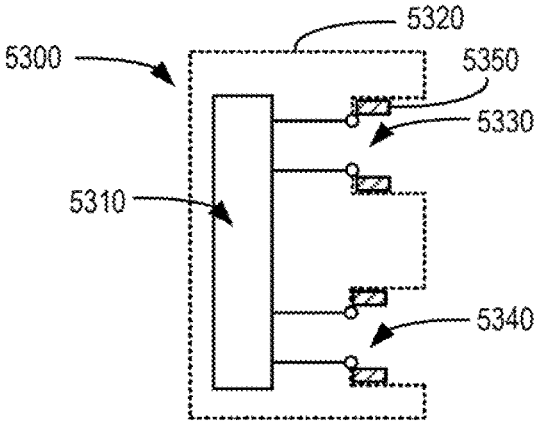

FIG. 17C

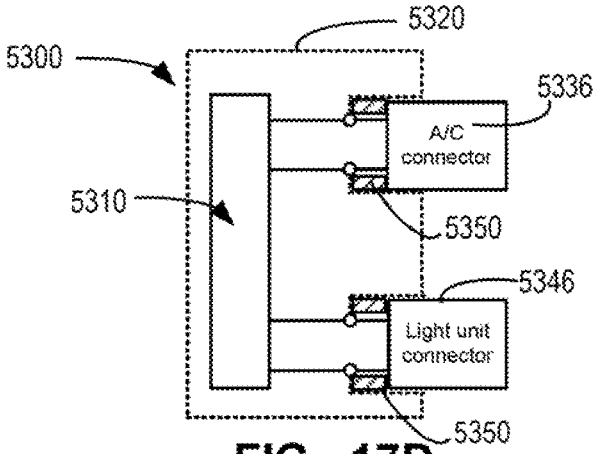

FIG. 17D

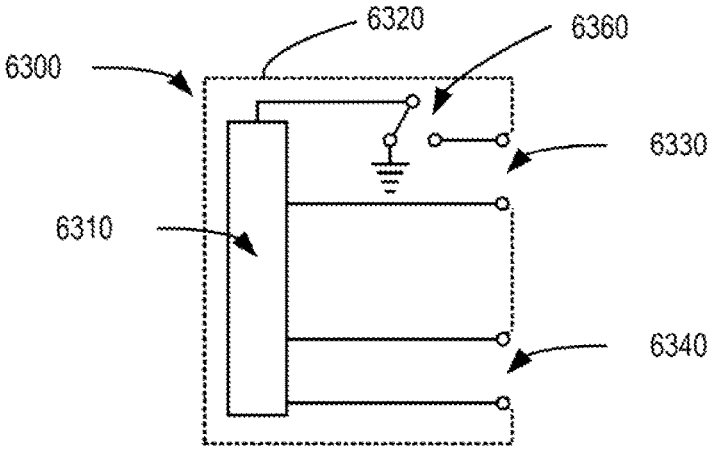

FIG. 17E

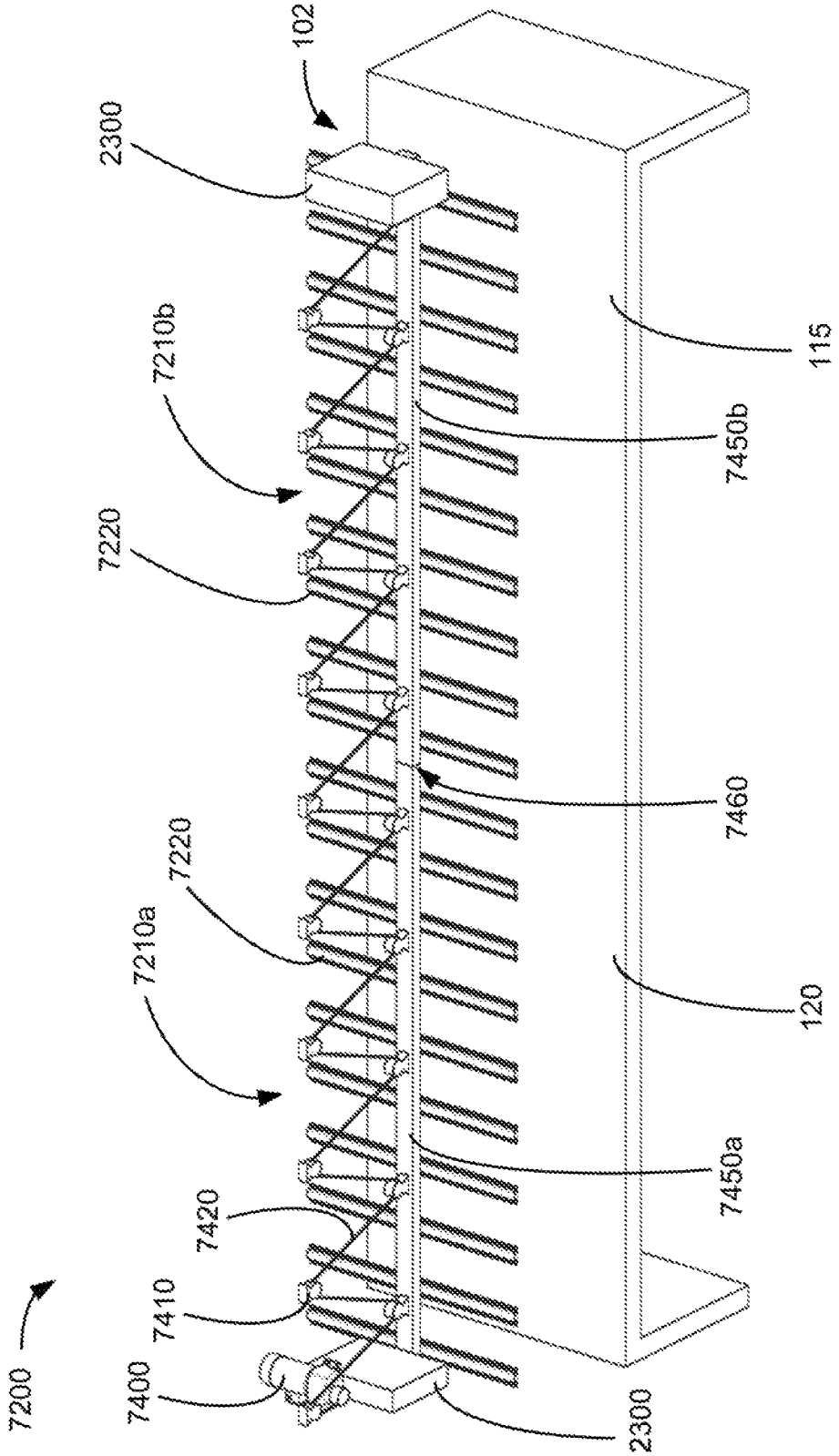
7200
7400
7410
7420
7210a
7220
7460
7450a
120
2300
7450b
7210b
7220
115
2300
102

FIG. 18

LIGHTING SYSTEM FOR INDOOR CULTIVATION FACILITY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Provisional Patent Application No. 62/808,510, filed on Feb. 21, 2019, which is herein incorporated by reference in it entirety.

FIELD

This disclosure relates generally to lighting systems, and in particular lighting systems for indoor cultivation facilities.

INTRODUCTION

The following is not an admission that anything discussed below is part of the prior art or part of the common general knowledge of a person skilled in the art.

Indoor cultivation facilities provide greater control over the environment in which plants are grown. These facilities also allow growers to extend the growing season for different plants and avoid damage that may be caused due to inclement weather.

An important aspect of indoor cultivation is control over the light directed onto the plants being grown. Lighting systems allow cultivators to provide consistent lighting conditions throughout the growing season without concerns about cloud cover. However, it is important to control the intensity of light projected onto different plants within the facility, even as those plants grow.

Lighting systems also pose additional challenges for indoor cultivation facilities. Installing and maintaining the lighting systems can be a complex and expensive undertaking. Furthermore, the power requirements of the lighting system can be costly.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the described embodiments and to show more clearly how they may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:

FIG. **1** is a perspective view of an indoor cultivation facility in accordance with an embodiment;

FIG. **2** is a perspective view of the indoor cultivation facility of FIG. **1** following plant growth in accordance with an embodiment;

FIG. **3** is a schematic illustration of light emitted from an example lighting system that may be used with the indoor cultivation facility of FIG. **1** in accordance with an embodiment;

FIG. **4** is a plan view of an example lighting unit that may be used with an indoor cultivation facility in accordance with an embodiment;

FIG. **5** is a bottom plan view of an example lighting fixture that may be used with the lighting unit of FIG. **4** in accordance with an embodiment;

FIG. **6** is a top front perspective view of the lighting fixture of FIG. **5**;

FIG. **7** is a side view of the lighting fixture of FIG. **5**;

FIG. **8** is a top view of the lighting fixture of FIG. **5**;

FIG. **9** is a cross-sectional view of the lighting fixture of FIG. **5** along line **9-9** shown in FIG. **6** in accordance with an embodiment;

FIG. **10** is a bottom plan view of an example light card that may be used with the lighting fixture of FIG. **5** in accordance with an embodiment;

FIG. **11** is a bottom plan view of another example lighting fixture that may be used with the lighting unit of FIG. **4** in accordance with an embodiment;

FIG. **12** is a top front perspective view of the lighting fixture of FIG. **11**;

FIG. **13** is a side view of the lighting fixture of FIG. **11**;

FIG. **14** is a top view of the lighting fixture of FIG. **11**;

FIG. **15** is a top plan view of an example lighting system including a power supply unit in accordance with an embodiment;

FIG. **16** is a top plan view of an example lighting system including multiple power supply units in accordance with an embodiment;

FIG. **17**A is a schematic illustration of an example power supply unit in accordance with an embodiment;

FIG. **17**B is a schematic illustration of the power supply unit of FIG. **17**A coupled to a power source and a lighting unit in accordance with an embodiment;

FIG. **17**C is a schematic illustration of the example power supply unit of FIG. **17**A including seal members in accordance with an embodiment;

FIG. **17**D is a schematic illustration of the power supply unit of FIG. **17**C coupled to a power source and a lighting unit in accordance with an embodiment;

FIG. **17**E is a schematic illustration of an example power supply unit in accordance with an embodiment; and

FIG. **18** is a perspective view of another example lighting system for an indoor cultivation facility in accordance with an embodiment.

The drawings included herewith are for illustrating various examples of articles, methods, and apparatuses of the teaching of the present specification and are not intended to limit the scope of what is taught in any way.

DESCRIPTION OF EXAMPLE EMBODIMENTS

Various systems, apparatuses, and methods are described below to provide an example of an embodiment of each claimed invention. No embodiment described below limits any claimed invention and any claimed invention may cover apparatuses and methods that differ from those described below. The claimed inventions are not limited to systems, apparatuses, and methods having all of the features of any one system, apparatus, or method described below or to features common to multiple or all of the systems, apparatuses, and methods described below. It is possible that a system, apparatus, or method described below is not an embodiment of any claimed invention. Any invention disclosed in a system, apparatus, or method described below that is not claimed in this document may be the subject matter of another protective instrument, for example, a continuing patent application, and the applicant(s), inventor(s) and/or owner(s) do not intend to abandon, disclaim, or dedicate to the public any such invention by its disclosure in this document.

The terms "an embodiment," "embodiment," "embodiments," "the embodiment," "the embodiments," "one or more embodiments," "some embodiments," and "one embodiment" mean "one or more (but not all) embodiments of the present invention(s)," unless expressly specified otherwise.

The terms "including," "comprising" and variations thereof mean "including but not limited to," unless expressly specified otherwise. A listing of items does not imply that

any or all of the items are mutually exclusive, unless expressly specified otherwise. The terms "a," "an" and "the" mean "one or more," unless expressly specified otherwise.

As used herein and in the claims, two or more parts are said to be "coupled", "connected", "attached", or "fastened" where the parts are joined or operate together either directly or indirectly (i.e., through one or more intermediate parts), so long as a link occurs. As used herein and in the claims, two or more parts are said to be "directly coupled", "directly connected", "directly attached", or "directly fastened" where the parts are connected in physical contact with each other. None of the terms "coupled", "connected", "attached", and "fastened" distinguish the manner in which two or more parts are joined together.

Furthermore, it will be appreciated that for simplicity and clarity of illustration, where considered appropriate, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the example embodiments described herein. However, it will be understood by those of ordinary skill in the art that the example embodiments described herein may be practiced without these specific details. In other instances, well-known methods, procedures, and components have not been described in detail so as not to obscure the example embodiments described herein. Also, the description is not to be considered as limiting the scope of the example embodiments described herein.

Indoor Cultivation Facility

Referring to FIGS. **1** and **2**, exemplary embodiments of an indoor cultivation facility are shown generally as **100**. The following is a general discussion of indoor cultivation facility **100** which provides a basis for understanding several of the features which are discussed herein. As discussed subsequently, each of the features may be used individually or in any particular combination or sub-combination in this or in other embodiments disclosed herein.

The facility **100** is an example of an indoor cultivation facility that may be used to cultivate plants **104**. Various types of plants **104** may be cultivated within facility **100**, such as cannabis plants. The facility **100** may include various environmental control components such as temperature and humidity control components. The facility **100** can also include various environmental monitoring sensors and systems that provide feedback and assist in controlling the environmental conditions within facility **100**. The facility **100** may also include passive environmental control components that assist in maintaining desired environmental conditions within the facility **100** such as insulating elements.

The facility **100** can include a growing area **102** within which plants can be positioned. As shown, the growing area **102** has a first end **107**, a second end **109**, and opposed lateral sides **111** and **113**. The growing area **102** extends between the first end **107** and a second end **109** in a longitudinal direction **103** and between the lateral sides **111** and **113** in a lateral direction **101**.

The size of the growing area **102** may vary depending on the plants **104** being grown. In some embodiments, the growing area **102** may range between about 3 feet and 10 feet wide between the lateral sides **111** and **113** and between about 10 feet and 40 feet long between the first end **107** and a second end **109**. For example, the growing area **102** may be about 4 feet to 6 feet wide and about 16 to 24 feet long. The growing area has a receiving surface on which pots or containers in which the plants are located are placed, such as a table top, wherein the height of the receiving surface is adjustable. Alternately, the growing area may be a plant bed.

A plurality of plants **104** can be positioned within the growing area **102**. In the example shown, the plants **104** are arranged into rows that extend along the length of the growing area **102** in the longitudinal direction **103**. Although FIGS. **1** and **2** show two rows of plants **104** within the growing area **102**, in some embodiments only a single row of plants **104** may be positioned within the growing area **102**. Each row can extend between the first end **107** and the second end **109** in the longitudinal direction **103**.

In some examples, the growing area **102** may be a table **115**. The plants **104** may then be mounted on the surface **120** of table **115**. For example, the table **115** may be about 5 feet wide (in the lateral direction **101**) and about 20 feet long (in the longitudinal direction **103**). The table **115** can define the dimensions of the growing area **102**.

In some embodiments, the facility **100** may include a plurality of growing areas **102**. For example, a plurality of spaced apart tables **115** can be included within the facility **100**. The growing areas **102** (e.g. tables) may be separated by open spaces (e.g. substantially empty aisles) that allow cultivators to access the plants **104** in each growing area **102**. This provides access to the plants **104** for trimming and/or harvesting.

As shown, the facility **100** also includes a lighting system **200**. The lighting system **200** can be positioned above the plants **104** in the growing area **102**. For example, the lighting system **200** may be suspended from the ceiling of the facility or from supports mounted adjacent to the growing area **102**.

The lighting system **200** can include a plurality of light emitting elements facing the plants **104**. In the example shown, the lighting system **200** includes a plurality of lighting units **210***a*-**210***c*. Each lighting unit **210** has a light emitting side **211** positioned facing the surface **120** of the growing area **102**. The lighting unit **210** can be controlled to provide a broad spectrum of light to the plants **104**.

In some embodiments, the operation of the lighting units **210***a*-**210***c* may be controlled to provide a regular cycle of active and inactive periods that may be selected based on the plants **104** being cultivated. For example, the lighting units **210** may be controlled to provide a cycle of 16 hours active periods and 8 hour inactive periods. Various other examples of light activation cycles may be used depending on the desired cultivation environment.

One or more lighting units **210** can be positioned above the same growing area **102**. In the example shown in FIGS. **1** and **2**, three lighting units are positioned above growing area **102**.

Lighting System for an Indoor Cultivation Facility

In some embodiments, it may be desirable to minimize the variation of light intensity at a specified distance from the lighting units in order to provide substantially uniform light intensity for multiple plants within a growing area. This may facilitate more uniform growth for all of the plants within the growing area. This may also minimize the power required for the lighting system to provide a desired level of light intensity. In particular, a large greenhouse may require one or more megawatts of power, such a 5 or more, 10 or more or 15 or more megawatts. Such a power requirement is a factor that may control where a greenhouse is located. Reducing the overall power requirement may facilitation the location of a greenhouse. Providing a more even light intensity across the surface **120** may reduce the power requirements for a greenhouse.

In embodiments described herein, the lighting system can include a plurality of lighting units positioned close to the

top of the plants within the growing area. For example, the lighting units may be positioned within about 6 inches to 18 or 6 to 12 inches of the top of the plants. This may minimize the lateral spread of light emitted from individual lighting elements. This may also help reduce the variance in light intensity across the surface of the plants.

In some embodiments, the lighting units can be arranged so that the overlap of light between adjacent lighting units is reduced. The lighting system for a particular growing area can include lighting units that extend for substantially all of the longitudinal length of the growing area. Multiple lighting units can be laterally spaced to provide substantially even light intensity across the lateral width of the growing area. In some embodiments, the lighting units and/or the point sources of light (e.g., LEDs in the lighting units) may be laterally spaced by between about 6 and 24 inches, 12 and 24 inches or 15 and 20 inches to facilitate more uniform light intensity at the tops of the plants.

In some embodiments, the lighting system may also be vertically movable. The lighting system may include a height adjustment controller operable to raise the lighting units in response to plant growth. This can help maintain a consistent distance between the lighting units and the tops of the plants throughout the growth cycle. Accordingly, as the plants grow, the intensity of the light at the level of the top of the plants may remain generally constant.

It may also be desirable to facilitate installation and maintenance of the lighting system of an indoor cultivation facility. In embodiments described herein, the lighting system may include a plurality of lighting units. Each lighting unit may include a plurality of lighting fixtures. The plurality of lighting fixtures can be connected in sequence to define a longitudinally extending lighting unit. The lighting fixtures can be connected to one another in a modular fashion to facilitate installation and replacement. The light fixtures can be connected to one another in sequence to facilitate routing of the power through the lighting system. In some embodiments, each lighting fixture may include a plurality of light cards. Each light card may include a plurality of light sources. The light cards may be individually replaceable from the corresponding light fixtures.

In some embodiments, it may be desirable to facilitate maintenance of a power supply unit for the lighting system of an indoor cultivation facility. The power supply unit may contain active control circuitry that is configured to control the power provided to the lighting units in the lighting system. When there is a malfunction in the power supply unit, access to the power supply unit may be necessary to ensure proper operation of the lighting system. In some embodiments, the power supply unit (or power supply units) for the lighting system can be positioned at the longitudinal ends of a growing area. This may provide easier access to the power supply units for maintenance and/or replacement since the power supply units can be accessed from outside the growing area (e.g., an aisle between surfaces **120**) and without having to reach across or over the growing area.

The features in this section may be used by itself in any system or facility (e.g., an indoor cultivation facility) or in any combination or sub-combination with any other feature or features described herein.

Referring again to FIGS. **1** and **2**, the lighting system **200** can include a plurality of lighting units **210** positioned above the plants **104**. The lighting units **210** can be mounted above the plants, e.g. suspended from the ceiling of the facility **100**. A light emitting face **211** of each lighting unit **210** can be positioned facing the tops **105** of the plants.

In some embodiments, the lighting unit **210** may be positioned with the light emitting face **211** within about 100 mm to about 400 m of the tops of plants **104**. In some embodiments, the light emitting face **211** may be positioned within about 150 mm to about 300 mm (6 inches-12 inches) of the tops **105** of plants **104**.

Positioning the lighting units **210** in close proximity to the plants **104** may reduce the lateral spread of light emitted from each of the lighting units **210**. By reducing the spread of light emitted from each lighting unit **210**, the variation in light intensity across the surface of the plants **104** may be reduced.

In some embodiments, the lighting units **210** can be movably mounted within the facility **100**. The lighting units **210** may be movable in a vertical direction **117** towards and away from the surface **120** of the growing area **102**. The vertical position of the lighting units **210** can be adjusted to maintain a consistent separation between the light emitting face **211** and the tops **105** of the plants **104** as the plants grow. As shown in FIG. **2**, the lighting units **210** have been raised in the vertical direction in response to growth of the plants **104**.

The lighting system **200** can include a height controller (not shown) that is usable to adjust the position of the lighting units **210**. The controller may be coupled to one or more sensors usable to measure the height of the plants **104** (e.g. cameras positioned facing the growing area **102**). The controller may automatically adjust the height of the lighting units **210** to maintain a consistent separation between the light emitting side **211** and the plants **104**.

In some cases, positioning the lighting units **210** close to the plants **104** may increase the heat emitted from the lighting units **210** proximate the plants **104**. Too much heat on the surface of the plants **104** may harm plant growth. To minimize the impact of heat on plant growth, the lighting units **210** can be configured to reduce the amount of heat that is dissipated towards plants **104**.

In some embodiments, the lighting units **210** can include one or more cooling elements. For example, the lighting units may include a heat sink which may be provided with cooling fins **240**. The heat sink may comprise a thermally conducting material (e.g., aluminum) which is thermally connected to the cooling fins. The cooling fins may be part of a unitary construction with the heat sink (e.g., they may be integrally formed such as by casting). Optionally, the housing or support frame **222** of the light fixture may comprise or consist of the heat sink. For example, the housing of a lighting unit **210** may be made of a heat sink material, such as aluminum, which has cooling fins **240** provides as a unitary or integrally formed member. The cooling fins may promote the dissipation of heat that is generated by the lighting units **210** away from plants **104**.

As shown in FIG. **4**, the lighting units **210** can include a support frame **222** into which a plurality of light emitting units (or light cards) **250** can be mounted. In the example shown, the lighting unit **210** is configured as a plurality of separate light fixtures **220** mounted to one another in sequence. In this example, the individual light fixtures **220** are formed separately (e.g. roll formed) and then secured to one another.

Alternatively, the lighting unit **210** may be formed as a single longitudinally extending fixture. For instance, a single roll formed lighting unit may be manufactured to extend along the length of the growing area. The combined fixture provided by the lighting unit **210** may include mounting elements for the same arrangement and configuration of light emitting units as the separate fixtures shown in FIG. **4**.

The support frame **222** can be manufactured using thermally conductive materials (e.g. metallic materials) predisposed to absorb heat emitted by the light emitting units **250** and any power distribution elements within the lighting unit **210**. The support frame **222** can operate as a heat sink to capture heat from the light emitting units **250** or power distribution elements (such as power transmission wires).

The support frame **222** can be thermally coupled to the cooling fins **240**. The cooling fins **240** can disperse heat from the support frame **222** away from the plants **104**. In some embodiments, the cooling fins **240** may be formed integrally with the support frame **222** when the support frame **222** is manufactured. This may encourage greater heat transfer between the frame and cooling fins **240**.

As shown in FIGS. **1** and **2**, the cooling fins **240** can be positioned on an upper section of the lighting units **210** (away from the plants **104**). The fins **240** may thus distribute the heat from the lighting units **210** at a location further from the plants **104** than where the heat is initially generated. This may further reduce the heat applied to plants **104** by dissipating the heat away from the tops **105** of plants **104**.

As shown in FIGS. **1** and **2**, the lighting system **200** can include multiple lighting units **210**. Each lighting unit **210** may extend substantially the entire longitudinal length of the growing area **102**. The lighting units **210** can be laterally spaced apart above the growing area **102**.

As shown, three lighting units **210** are laterally spaced apart in order to reduce the variation in light intensity across the lateral width of the growing area **102**. In some embodiments, the lighting units **210** may be laterally spaced by between about 10 inches and 24 inches. In some embodiments, the lighting units **210** may be laterally spaced apart by between about 12 inches and 20 inches. In some embodiments, the lighting units may be laterally spaced apart by about 18 inches.

The spacing of the lighting units may promote more uniform light intensity at the tops of the plants **104**. This may also reduce the total number of light emitting elements required to illuminate growing area **102**, which may reduce the overall power required for facility **100**.

FIG. **3** illustrates an example of the light emission regions **410** from the lighting units **210***a*-**210***c* in facility **100**. As shown, the growing area **102** includes a pair of longitudinally extending rows **420***a* and **420***b* of plants. The light emission regions **410**, include regions **410***a* corresponding to lighting unit **210***a*, regions **410***b* corresponding to lighting unit **210***b*, and regions **410***c* corresponding to lighting unit **210***c*. As described in further detail below, the lighting elements within individual light fixtures may be arranged to provide relatively uniform light intensity patterns for the growing area **102**.

In some embodiments, the light emission regions from individual fixtures may include less than 25%, less than 20%, less than 15%, less than 10% or less than 5% overlapping area (at the plant surface) with adjacent light emission regions. The overlap may be adjusted by the spacing of the light sources from each other and the height of the light sources from the top of the plants.

As shown in FIG. **4**, each lighting unit **210** may include a plurality of light fixtures **220**. In the example illustrated, the lighting units **210** include four light fixtures **220***a*-**220***d*. The light fixtures **220** in each lighting unit **210** can be positioned in a sequence end-to-end extending substantially between the first end **107** and second end **109** of the growing area.

Each fixture **220** may include one or a plurality of light cards **250**. Each light card **250** may include a plurality of light emitting elements such as light-emitting diodes (see e.g. FIG. **10**). The light cards **250** may be individually replaceable within each light fixture **220**. This may facilitate modular replacement of the light emitting elements in case of failure of one or more light emitting elements or light cards. Examples of light fixtures **220** with replaceable light cards **250** are described in further detail herein below.

Each of the lighting units **210** may emit light in a rectangular or cone shape pattern with minimal variation across the emission pattern. As will be described in further detail below, the light emitting elements within each fixture **220** can be arranged to provide a light intensity pattern that varies minimally throughout the growing area **102**. The lighting units **210** can be configured with a greater number of light emitting elements positioned near the lateral sides of each lighting unit **210** as compared to light emitting elements positioned near the lateral center of the lighting units **210**. This may assist in maintaining consistent intensity due to overlap of light from light emitting elements within a lighting unit and between laterally adjacent lighting units **210**.

In some embodiments, the power supply unit for the lighting system **220** may be mounted above the growing area **102** to provide close connection to the lighting units **210**. However, when there is a malfunction in the power supply unit, access to the power supply unit may be necessary to ensure proper operation of the lighting system. If the power supply unit is positioned above the growing area **102**, it may be necessary to climb above the tables **115** to access the power supply unit and perform any repairs or replacement.

Mounting the power supply also requires high power wiring to be included above the growing area **102**. As these high power connections may have increased rates of failures, it may be necessary to perform repairs and/or maintenance on a fairly regular basis. This may also increase the concentration of heat emitted above the growing area, which may require additional building insulation in those areas of the facility.

In some embodiments, the power supply unit (or power supply units) for the lighting system **200** can be positioned at one or both of the longitudinal ends **107** and **109** of the growing area **102**. The lighting units **210** can be arrayed longitudinally along the length of the table with the electrical supply at a longitudinal end of the fixtures. The power supply can provide the power connections to the lighting units **210** at the longitudinal end. The power supply unit and wiring connection may then be accessed at the end of a row of plants **104**, rather than above the growing area **102**. This may provide easier access to the power supply units for maintenance and/or replacement since the power supply units can be access from outside the growing area and without having to reach across or over the growing area.

FIG. **15** illustrates a first example of a lighting system **2200** that includes a power supply unit **2300**. As shown in FIG. **15**, the power supply unit **2300** is electrically connected to a plurality of lighting units **2210***a*-**2210***c*. Each lighting unit **2210** includes a plurality of light fixtures **2220**. Lighting unit **2210***a* includes lighting fixtures **2220***a*-**2220***d* connected end to end in sequence, lighting unit **2210***b* includes lighting fixtures **2220***e*-**2220***h* connected end to end in sequence, and lighting unit **2210***c* includes lighting fixtures **2220***i*-**2220***l* connected end to end in sequence.

As shown, the power supply unit **2300** is electrically connected to a first end of light fixtures **2220***d*, **2220***h* and **2220***l*. As shown, in embodiments herein the power supply unit **2300** may not be directly connected to any of the other light fixtures in each lighting unit **2210***a*-**2210***c*. Rather, the

lighting units **2210** may provide internal power routing that connects each light fixture **2220** to the power supply unit **2300**. Routing power through the light fixtures **2220** may simplify maintenance of the power routing structure, as faults in individual light fixtures **2220** can be replaced without having to re-wire the entire system **2200**.

For example, to provide power to the lighting unit **2210***a*, the power supply unit **2300** may have a direct electrical connection to the light fixture **2220***d*. The light fixture **2220***d* may include internal wiring that connects to the power supply unit **2300** and then to adjacent light fixture **2220***c*. Light fixture **2220***c* may thus be connected to the power supply unit **2300** indirectly, via the light fixture **2220***d*. Similarly, light fixture **2200***b* can provide wiring that interconnects light fixtures **2220***c* and **2220***a*. This allows light fixtures **2220***a* and **2220***b* to also be connected indirectly to the power supply unit **2300**. Lighting units **2210***b* and **2210***c* may similarly provide indirect power connections for the light fixtures **2220** that are not directly adjacent to the power supply unit **2300**. This may allow the light fixtures **2220** to be easily replaced without modifying the wiring from the power supply unit.

For example, light fixture **2220***d* may have an internal bus **2224** which interfaces with power supply unit **2300** (e.g., power supply unit **2300** plugs into the bus). Bus **2224** may have 4 sets of outputs, each of which is connected to one of light fixtures **2220***a*, **220***b*, **2220***c* and **2220***d*. For example, light fixture **2220***d* may have a second bus **2226** that is electrically connectable to adjacent light fixture **2220***c* by, e.g., electrical connectors **2228**. Adjacent light fixture **2220***c* may have mating electrical connectors **2229** that are connectable or releasably connectable to electrical connectors **2228**. Accordingly, when light fixture **2220***c* is connected or plugged into light fixture **2220***d*, the LEDs in lighting unit **2220***c* may be electrically connected to power supply unit **2300**. It will be appreciated that bus **2224** may be electrically connected to the light card(s) in light fixture **2220***d* in parallel with bus **2226**.

Alternatively, the power supply unit **2300** may have direct wiring connections to each of the light fixtures **2220***a*-**2220***l*. This may facilitate individual control of the light emitted from each fixture **2220**, without requiring additional control circuitry at the fixture. For example, a first set of wires may extend from bus **2224** to light fixture **2220***c* and a second set of wires may extend from bus **2224** to light fixture **2220***b* and a third set of wires may extend from bus **2224** to light fixture **2220***a*.

Providing integrated power routing through the lighting fixtures **2220** may reduce the number of wiring connections to the power supply unit **2300**. Rather than having separate connections for each fixture **2220**, the power supply unit **2300** may have only a single connection for the plurality of fixtures **2220** in each lighting unit **2210**. This may reduce the total length of wiring required, and simplify repairs and/or replacement of any faulty wires.

FIG. **16** illustrates another first example of a lighting system **3200**. Lighting system **3200** includes power supply units **3300***a* and **3300***b* connected to each longitudinal end of the lighting units **3210**.

As shown in FIG. **16**, each power supply unit **3300** is electrically connected to a plurality of lighting units **3210***a*-**3210***c*. Each lighting unit **3210** includes a plurality of light fixtures **3220**. Lighting unit **3210***a* includes lighting fixtures **3220***a*-**3220***d* connected end to end in sequence, lighting unit **3210***b* includes lighting fixtures **3220***e*-**3220***h* connected end to end in sequence, and lighting unit **3210***c* includes lighting fixtures **3220***i*-**3220***l* connected end to end in sequence.

As shown, the power supply unit **3300***a* is electrically connected to a first end of light fixtures **3220***a*, **3220***e* and **3220***i*. Similarly, the power supply unit **3300***b* is electrically connected to a first end of light fixtures **3220***d*, **3220***h* and **3220***l*. As with system **2200**, the power supply units **3300** may be directly connected to only one light fixture **3220** within a given lighting unit **3210**. The light fixtures **3220** may then provide routing between the internal fixtures and the power supply units **3300**.

In system **3200**, power supply unit **3300***a* may provide power to the fixtures **3220** in a first half of each lighting unit **3210** while the power supply unit **3300***b* provides power to the fixtures **3220** in the other half of each lighting unit **3210**. For example, power supply unit **3300***a* may be electrically connected to light fixtures **3220***a*, **3220***b*, **3220***e*, **3220***f*, **3220***i* and **3220***j* and none of the other lighting fixtures while power supply unit **3300***b* is electrically connected to light fixtures **3220***c*, **3220***d*, **3220***g*, **3220***h*, **3220***k* and **3220***l* and none of the other lighting fixtures.

Providing separate power supply units for the segments of lighting units **3210** may reduce the power being delivered by each individual power supply unit **3300**, while still providing simplified access to the power supply units outside of the growing area **102**.

Alternatively, the power supply units **3300***a* and **3300***b* may both be electrically connected to all of the fixtures **3220**. The power supply units **3300***a* and **3300***b* may then operate as redundant power supplies in case one of the power supply units **3300** malfunction. This may allow the lighting system **3200** to continue operating (although possibly at reduced power levels) during maintenance or repairs of one of the power supply units **3300**.

Additionally or alternatively, one or more power supply units may be positioned centrally above the growing area **102**. This may be necessary in some embodiments to manage the power requirements of the lighting system **3200**.

Referring now to FIG. **18**, shown therein is another example of a lighting system **7200** that may be used in embodiments described herein. As shown, the lighting system **7200** can be positioned above the surface **120** of a growing area **102** such as a table **115**.

In the example shown, the lighting system **7200** includes two lighting units **7210***a* and **7210***b*. Each lighting unit **7210** includes a plurality of light fixtures **7220**. The lighting fixtures **7220** may be generally similar to lighting fixtures **220**, **1220**, and **2220** described elsewhere herein.

Lighting system **7200** is similar to lighting system **3200** in that a pair of power supply units **2300** are positioned at either end of the growing area **102**. In the example shown, each power supply unit **2300** is electrically connected to a corresponding lighting unit **7210**. As mentioned, the power supply unit **2300** may be connected to the interior light fixtures within the lighting units **7210** either directly or indirectly. The fixtures **7220** may be connected to the power supply unit **2300** in parallel. This may ensure that failure of an individual light fixture **7220** does not cause failure of the other light fixtures **7220**.

Unlike lighting systems **200**, **2200** and **3200** described herein above, however, the lighting fixtures **7220** in lighting system **7200** extend transversely across the growing area **102**. In some examples, the lighting system **7200** may include a single row of lighting units **7210**, with a plurality of laterally extending light fixtures **7220** that are spaced apart longitudinally along the growing area **102**.

The lighting system **7200** includes a mounting track **7450**. The light fixtures **7220** are mounted to the underside of the mounting track **7450** with light emitting surfaces facing the surface **120** of the growing area **102**. Each lighting unit **7210***a* and **7210***b* can be mounted to a separate track section **7450***a* and **7450***b* respectively. The track sections **7450***a* and **7450***b* may be joined at a central track joint **7460**.

The track sections **7450***a* and **7450***b* can include a hollow center. The hollow center can be used to route wires between the power supply units **2300** and the light fixtures **7220**.

As exemplified, a power supply unit **2300** is electrically connected to one end of a track **7450**. Track **7450** includes a channel through which wires extend. A separate set of wires may be electrically connected to the power supply **2300** and extend to each light fixture **7220**. For example, one set of wires may extend to the light unit **7210** adjacent power supply unit **2300** and a second set of wires may extend to the second light unit **7210** that is spaced from the power supply unit **2300**, etc. Track **7450** may include a bus from which the wires extend and to which power supply module is electrically connectable.

The lighting units **7210** in lighting system **7200** may be vertically movable. As shown, the lighting system may include a plurality of support mounts **7410** that may be secured to the ceiling of the facility **100** or another support structure. The support mounts **7410** are connected to the mounting track **7450** using a pulley system. A motor **7400** can extend or retract the support cables **7420** to lower or raise the track **7450** and thus raise or lower the light fixtures **2220**.

In some cases, there may be only one light fixture **7220** mounted to the track **7450** at a given longitudinal location above the growing area **102**. The light fixture **7220** may be oriented to extend laterally across at least a portion of the growing area **102**.

Alternatively, two light fixtures **7220** may be mounted extending from either lateral side of the track **7450**. This may facilitate light emission for wider growing areas **102**.

Lighting Fixture for a Lighting System

In some embodiments, it may be desirable to facilitate replacement of individual sections of the lighting units. In embodiments described herein, the light cards within each lighting fixture may be individually replaceable to facilitate maintenance of the lighting system in-situ.

In some embodiments, the light cards may be replaceable from the side of each lighting unit. This may facilitate access to the light cards individually, without removing any cover or lens overlying the light emitting face of the light fixture.

In some embodiments, the light emitting elements within the light fixtures may be arranged to reduce variation in illumination intensity even between adjacent light fixtures. This may promote more even growth of the plants within the cultivation facility.

The features in this section may be used by itself in any system or facility (e.g., an indoor cultivation facility) or in any combination or sub-combination with any other feature or features described herein.

Referring to FIGS. **5-10**, shown therein is an example of a light fixture **220**. The light fixture **220** is an example of a light fixture that may be used with the various examples of plant lighting systems described herein.

As shown, the light fixture **220** includes a fixture frame **222**. The fixture frame **222** can define the structural shape of the light fixture **220**. The fixture frame **222** can also include mounting elements that allow the light fixture **220** to be connected to adjacent light fixtures and to mount light cards within the light fixture **220**.

The light fixture **220** includes light card mounting elements. The light card mounting elements allow one or more light cards **250** to be releasably mounted to the light fixture **220**. In the example shown, two light cards **250** can each be mounted to a single light fixture **220**. It will be appreciated that a single light fixture **220** may house more than two light cards or only a single light card **250**.

As exemplified, the mounting elements include a plurality of retaining arms **224**. The retaining arms **224** can be positioned centrally within the frame **222**. The retaining arms **224** can support a first side of a light card **250** mounted to the frame **222**.

The mounting elements also optionally include a plurality of mounting supports **219**. The mounting supports **219** may project out from the surface of the frame **222** and include an inset section into which the second side of the light card **250** can be mounted.

The retaining arms **224** may be moveably mounted to the frame **222**. This may allow the light cards **250** to be easily mounted and removed from the frame **222**.

As shown, the retaining arms **224** may be pivotally mounted to the frame **222**. Each retaining arm **224** may be secured to the frame **222** by a corresponding pivotal mount **225**. In some cases, retaining arms **224** for adjacent light card mounting regions may share a pivotal mount **225**.

The retaining arm **224** may be rotatable about the pivotal mount **225**. Each retaining arm **224** may be pivotal at least between a support position, where the retaining arm **224** overlies the light card region (in the case of FIG. **5**, the region within which the light card is currently positioned) and an access position in which the retaining arm **224** does not extend over the projection of the light card region. The access position allows a user to insert and/or remove a light card **250** from the light card region.

In the example shown, the light cards **250** may be mounted by first inserting the second end **253** of the light card **250** into the insets provided by the support mounts **219**. The light card **250** can then be rotated vertically to rest within the light card region above the retainer arms **224**. The retainer arms **224** are then pivoted from the access position to the support position overlying the central end **251** of the light card **250** to retain the light card **250** within the light card region.

When mounted to the fixture **220**, each light card **250** can include a power connection **230** with the fixture **220**. The light card **250** may include a connector **260** that is engageable with a corresponding connector provided by the fixture **220** to define the connection **230**.

The connection **230** includes at least power connections to couple the light emitting elements **270** (e.g. light emitting diodes) provided on the light card **250** to a power supply from the light fixture **220**. As the light card **250** is rotated upwards into the light card region, the connector **260** may engage a corresponding connected provided on the frame **222**. This may ensure that the light card **250** is automatically connected to a power source when mounted to the fixture **220** (presuming, of course, that the fixture **220** itself is connected to a power source).

Alternatively, a user may manually connect the connector **260** to a corresponding connector provided by the fixture **220**. For example, the fixture **220** may include connectors that extend downward through the central gap or void region **226**. When installing the light card **250**, a user can simply connect these to the connector **260** on the light card **250**.

It will be appreciated that other mechanical securing members may be used to releasably mount a light card in a fixture **220**.

In some embodiments, the light fixture **220** may include a cover enclosing the light cards **250**. For instance, a plastic cover can be provided on the light emitting face **211** of the fixture **220**. The cover may include sealing members around the periphery of the fixture **220**. This may provide a water-tight seal around the light cards **250** and other electrical components of fixture **220**. For example, the cover may be compliant with various ingress protection standards such as IP65, IP66 and/or IP67.

In some embodiments, the cover may extend across multiple fixtures **220** (e.g. along some or all of the length of a lighting unit **210**). The cover may then seal the lighting unit **210** as a whole, rather than individual lighting fixtures **220**.

In some embodiments, the light fixture **220** may include one or more optical components between the light emitting elements on the light cards **250** and the plants **104**. In some cases, a lens may be provided on the light emitting face **211**. For example, the lens may be provided to further limit the spread of light from the lights cards.

As shown in FIG. **10**, the light cards themselves can include a plurality of light emitting elements **270**. The light emitting elements **270** can be distributed around the emission surface **252** of the light card **250**. The distribution of the elements **270** may be defined to minimize intensity variations experienced at a distance of, e.g., between about 6 inches and 12 inches from the emission surface **252**.

The light emitting elements **270** can be connected using sequential wiring **271** as exemplified or in parallel. Further, as exemplified, the light emitting elements **270** may be connected using two or more sequences of sequential wiring. The elements **270** can be connected to a light card connector **260** that may engage a corresponding connector on the fixture **220** to define power connection **230**.

As shown, the light card **250** has a generally rectangular shape with a first or central end **251**, a second or outer end **253**, and opposed sides **257** and **259**. The central end **251** can be configured to be positioned centrally within the fixture **220** when mounted thereto. It will be appreciated that light card **250** may be of any other shape.

As shown, the light emitting elements **270** can be distributed about the emission surface **252** to promote reduced light intensity variance for the individual light card **250**. The light emitting elements **270** may be distributed about the emission surface to promote reduced light intensity variance for the plurality of light cards **250** arranged within the lighting system **200**, even across multiple fixtures **220** and lighting units **210**.

In some embodiments, the light intensity experienced at an illuminated surface, e.g., about 6 inches-12 inches from the emission surface **252** may vary less than 25%, less than 20%, less than 15%, less than 10% or less than 5% across the illuminated surface.

In general, the light emitting elements can be distributed on the light cards so that with the distribution of light fixtures and lighting units the light emitting elements throughout the lighting system can provide an overlap of lower intensity zones to provide better distribution of intensity across the surface of the plants **104**.

In some embodiments, the light intensity experienced at the plant surface when positioned about 6 inches-12 inches from the emission surface **252** may vary less than 25%, less than 20%, less than 15%, less than 10% or less than 5% across the growing area **102**.

As shown, the lighting elements **270** can be distributed with a greater number of light emitting elements **270** near the external sides **257** and **259** than near the middle of the emission surface **252**. Similarly, more lighting elements can be positioned near the outer end **253** than near the central end **251**.

Where the central end **251** is positioned nearer to an adjacent light card **250** (e.g. the other card within the same fixture) as compared to the second end **253** (which may be adjacent to a light card from a subsequent fixture), the reduced number of light emitting elements may be compensated for by the proximity of the elements from the nearby light card. Although each light emitting element may only slightly overlap with an adjacent light emitting element, the increase number of light emitting elements near the outer edges of the light cards **250** may contribute to an overall consistency in the light intensity distribution.

In a similar manner, positioning a greater proportion of the light emitting elements **250** near the lateral sides **257** and **259** may promote greater light emission onto plants **104** positioned in gaps between laterally adjacent lighting units **210**. This may help ensure that the intensity experienced by plants in a gap is similar to that experienced by plants directly below a lighting unit **210**.

The light fixture **220** itself may have a generally rectangular shape (see e.g. FIG. **6**). The light fixture **220** may have a length dimension that extends between a first end **221** and a second end **223**, and a width dimension that extends between opposed lateral sides **217** and **218**. The frame **222** may have a top surface **229** and sidewalls that extend downwardly therefrom on each of the first end **221**, second end **223**, and laterals sides **217** and **218**.

The end walls of the frame **222** may include an opening or connector section **228**. The connector section **228** may allow cable (wire) routing between adjacent light fixtures **220**, such as lighting unit **210** described herein above. Accordingly, each light fixture **220** or each light card **250** may be individually electrically connected to a power supply unit **2300**. In some embodiments, the adjacent fixtures **220** in the lighting unit **210** may provide alternating current power interconnections. Alternatively, the adjacent fixtures **220** in the lighting unit **210** may provide direct current power interconnections.

In some embodiments, the end walls of the frame **222** may also include fixture mounting elements (e.g., brackets, not shown). The fixture mounting elements may allow adjacent fixtures **220** to be secured to one another end to end and/or to a supporting superstructure, such as a track.

In some embodiments, the fixture **220** may include separate internal compartments. For example, as shown in FIG. **9**, the fixture **220** may be separated into an upper compartment **237** and a lower compartment **233**. A wall member **234** can be positioned partially or fully separating the compartments **233** and **237**. In some embodiments, the frame **222** may be roll formed with the two separate compartments **233** and **237** and wall member **234**.

The upper compartment **237** may be configured to house and route wiring for the lighting unit **210**. For example, the wiring between adjacent lighting fixtures, and the connections to the power supply unit(s) can be housed within the upper compartment.

The lower compartment **233** can be configured to contain the light emitting elements of the fixture **220**. A conduit **226** can be provided between the upper compartment **237** and lower compartment **233** to allow the light cards **250** in the lower compartment **233** to be connected to the power supply.

Separating the light cards **250** from the wiring may help distribute the heat within the fixture **220** (e.g., wall member **234** may assist in transmitting heat from light cards **250** to

cooling fins **240**). This may also help remove the heat generated by power transmission from being in proximity to the plants.

As mentioned above, the fixtures **220** can be configured to promote heat dissipation away from the plants **104**. The frame **222** may be manufactured of thermally conductive materials. For example, the frame **222** may be manufactured using roll formed aluminum. The frame **222** may thus operate as a heat sink to collect heat generated by operating of the lights cards **250** and due to power transmission through the power wiring.

Optionally, as exemplified, the frame **222** can also include cooling fins **240**. The cooling fins can optionally extend laterally outward form the lateral sides **217** and **218** of the frame **222**. The cooling fins **240** can provide added surface area for dissipation of the heat collected by the frame **222**.

In the example shown, the cooling fins **240** are positioned proximate the top surface **229** of the frame **222**. This may encourage more heat to dissipate at a greater distance from the plants **204**.

Referring now to FIGS. **11-14**, shown therein is another example of a light fixture **1220** that may be used in the lighting systems described herein. As with light fixture **220**, the light fixture **1220** includes a fixture frame **1222**, cooling fins **1240**, and a plurality of light cards **1250** mounted to the fixture frame **1222**. However, the light fixture **1220** includes different light card mounting elements than fixture **220**.

As shown in FIGS. **12** and **13**, the light fixture **1220** includes a pair of light card mounting slots **1280** in the sidewall **1217** of the frame **1222**. To mount the light cards within light fixture **1220**, the light cards **1250** can be slid through the mounting slots **1280**. This may allow the light cards **1250** to be replaced without removing a cover of the light fixture **1220**. In some cases, this may also facilitate removing and/or replacing the light cards **1250** from the aisle outside the growing area **102**, since it may only be necessary to access the side **1217** of the light fixture **1220**. It will be appreciated that if slots **1280** are provided, they may be located at the elevation of lower compartment **233** and the cooling fins may be located on the sidewall of upper compartment **237**.

In the example shown, the mounting slots **1280** include support tracks **1282**. The support tracks **1282** may extend substantially the entire width of the light card mounting region. The first and second ends **1251** and **1253** of the light cards can be supported by the tracks **1282**. A user can insert the light card **1250** into the mounting slot with the first and second ends **1251** and **1253** received by respective tracks **1282**. The light card **1250** can then be slid into position within the fixture **1220**.

The light card **1250** may include a power connector that automatically engages the corresponding fixture connector **1230** as the light card **1250** is slid into place. For instance, the central track may include a recess into which the light card connector can nest as the light card **1250** slides into the light card region. This may facilitate connecting the light card **1250** to power wiring coupled through conduit **1226** without needing direct access to the connectors. This may further facilitate removing and/or replacing the light cards **1250** from the aisle outside the growing area **102**, since it is only necessary to access the side **1217** of the light fixture **1220**.

In some embodiments, the fixture **1220** may include a cover for the light card slots **1280**. For example, watertight covers may be used to ensure that the light cards **1250** and the internal fixture wiring are not exposed to water (moisture/humidity) from the growing area **102**. The cover may be similar to a cover used on the light emitting face **211** of the fixture **220**.

Power Supply Unit for a Lighting System

In some embodiments, it may be desirable to simplify maintenance and/or replacement of the power supply units. In embodiments described herein, the power supply unit may be a modular unit that provides connection outlets for incoming power connections from a mains power supply and outgoing power connections to the lighting units. The incoming and/or outgoing power connections may each be connected and disconnected without re-wiring the lighting system or incoming power supply for the cultivation facility. This may reduce the time and cost associated with replacing the power supply unit. This may also enable the power supply units to be replaced without requiring an electrician to perform the replacement operation.

It may also be desirable to ensure that maintenance of the lighting system and/or power supply units can be performed safely. In embodiments described herein, the power supply unit can include automatic shut-off switches to ensure that the lighting system does not have live power during maintenance operations. In some embodiments, the power supply units may include automatic shut-off switches that are activated when the power supply unit is accessed and/or when power connections to the power supply unit are disconnected and/or when the outgoing power connection is disconnected from a light fixture. Alternately, or in addition, in some embodiments, the power supply units may include automatic shut-off switches that are activated when the lighting units are activated, for example in response to the removal of a lighting unit cover.

The features in this section may be used by itself in any system or facility (e.g., an indoor cultivation facility) or in any combination or sub-combination with any other feature or features described herein.

Referring to FIGS. **17**A and **17**B, shown therein is an example of a power supply unit **4300**. Power supply unit **4300** is an example of a power supply unit that may be used in the various lighting systems and indoor cultivation systems described herein, such as lighting systems **200**, **2200** and **3200** described herein above. In general, the power supply unit **4300** can provide electrical power to lighting elements used by lighting systems **200**, **2200** and **3200** to illuminate plants **104** being cultivated.

The power supply unit can include an electrical power input **4330** and an electrical power output **4340**. The electrical power input **4330** can be connected to a stationary power supply **4335**, such as mains power. The electrical power input **4330** can be configured to receive AC power from the stationary power supply **4335**.

The electrical power input **4330** can be configured to receive high level of powers from the stationary power supply **4335**. Accordingly, the control and power distribution circuitry **4310** may include a high voltage circuit section connected to the electrical power input **4330**. The high voltage circuit section can be configured to operate at the high voltage levels at which the power is received.

The electrical power output **4340** can be connected to the lighting system **4345**. For example, the electrical power output **4340** may include separate electrical connections to each of the lighting units in the lighting system **4345** (as shown in FIG. **15**) or a single output that connects to a bus as discussed previously. The electrical power output **4340** can provide power to the lighting units in lighting system **4345**.

The control circuitry **4310** can also include voltage conditioning circuitry. The voltage conditioning circuitry can be configured to convert the high voltage power received at the electrical power input **4330** to a lower voltage that is usable by the lighting system.

The control circuitry **4310** can also include various power controls for the lighting system **4345**. The control circuitry **4310** may be configured to activate and deactivate the lighting units in lighting system **4345**. For example, the control circuitry **4310** may activate and/or deactivate the lighting units in response to user input from a control panel and/or a motion sensor. In some embodiments, the control circuitry **4310** may be configured to adjust the intensity of light emitted by the lighting units in lighting system **4345**.

In some cases, the control circuitry **4310** may include a wireless communication module. The wireless communication module may allow a user to access and control the control circuitry **4310** wirelessly (e.g. using a mobile application on a smartphone or tablet). The wireless communication module may also allow the control circuitry **4310** to output feedback data, e.g. indicating the state of the power supply unit **4300** and/or the lighting system **4345**.

In some embodiments, the control circuitry **4310** may be configured to operate the lighting units in the lighting system **4345** on a regular pattern of activation and deactivation. The illumination pattern used may depend, e.g., on the plants being grown. However, the illumination pattern may include cyclic periods of activation and deactivation (e.g. 16 hours of active illumination followed by 8 hours of the lighting system being inactive).

In some embodiments, the control circuitry **4310** may be configured to activate and/or deactivate individual light fixtures (or adjust the intensity of the individual fixtures). This may provide the lighting system **4345** to provide more granular control of the lighting across the growing area **102**. This may be particularly useful if plants **104** are growing at different rates within the growing area **102**.

In some embodiments, the power output **4340** can also include one or more signal connections between the power supply unit **4300** and the lighting units in system **4345**. For example, the lighting units and/or individual lighting fixtures may include microcontrollers and/or sensor units. The signal connections included in the power output **4340** may allow the control circuitry **4310** to communicate with the controllers and/or sensors to provide commands and/or receive feedback data.

The power input port **4330** and power output port **4340** can be configured as quick connect connectors (e.g., a male electrical connector receivable in a female electrical connector). This may allow a user to easily connect and disconnect the power supply unit **4300**.

For example, the lighting system **4345** and power supply **4335** may have power connectors mounted within the facility **100**. The power supply unit **4300** can then be mounted to the power connectors in order to operate the lighting system **4345**. This may allow the power supply unit **4300** to be easily repaired and/or replaced without requiring extensive re-wiring of the facility **100**.

In some embodiments, the power supply unit **4300** is mounted concurrently (i.e. substantially simultaneously) to the power connectors of both the lighting system **4345** and power supply **4335**. This may ensure that the power output **4340** of the power supply unit **4300** is connected whenever the high voltage power supply **4335** is connected to power supply unit **4300**.

Alternatively, the power supply unit **4300** may be individually connected to the power supply **4335** and the lighting system **4345**. In some cases, the power supply unit **4300** may be individually and separately mounted to each lighting unit within the lighting system **4345**. This may facilitate maintenance of smaller portions of the power supply unit **4300**.

Typically, however, the power supply unit **4300** provides connectors that allow the power supply unit **4300** to be easily connected to both the power supply input **4335** and the lighting system **4345** without requiring any re-wiring.

Referring now to FIGS. **17**C and **17**D, shown therein is an example of a power supply unit **5300**. Power supply unit **5300** is another example of a power supply unit that may be used in the various lighting systems and indoor cultivation systems described herein, such as lighting systems **200**, **2200** and **3200** described herein above. In general, the power supply unit **5300** can provide electrical power to lighting elements used by lighting systems **200**, **2200** and **3200** to illuminate plants **104** being cultivated.

Power supply unit **5300** is generally similar to power supply unit **4300**. Power supply unit **5300** includes a controller **5310**, housing **5320**, electrical input **5330**, and electrical output **5340** that are generally similar to controller **4310**, housing **4320**, electrical input **4330**, and electrical output **4340**. However, power supply unit **5300** is further configured to maintain a watertight seal when connected to the mains power and lighting system.

The housing **5320** of power supply unit **5300** can provide an essentially watertight enclosure for the controller **5310**. The housing **5320** may be substantially watertight apart from the electrical input **5330**, and electrical output **5340**. Accordingly, power supply unit **5300** can also include seal members **5350** positioned within the electrical input **5330** and electrical output **5340**.

When the connector **5336** for the stationary power supply is engaged with the electrical input **5330**, the seal member **5350** can define a watertight seal therebetween. Similarly, when the connector **5346** for the lighting system is engaged with the electrical output **5340**, the seal member **5350** can define a watertight seal therebetween. This may ensure that power supply unit **5300** remains watertight in operation (e.g. compliant with various regulations, such as IP65-IP67). This may be particularly important in an indoor cultivation facility, as the environment may be humid and/or may involve water being sprayed or otherwise applied to plants **104**.

The seal members **5350** may be compressible when the connectors **5336** and **5346** are connected to the power supply unit **5300**. For example, the seal members **5350** may be provided as compressible O-rings around the electrical input **5330** and the electrical output **5340**.

Referring now to FIG. **17**E, shown therein is an example of a power supply unit **6300**. Power supply unit **6300** is another example of a power supply unit that may be used in the various lighting systems and indoor cultivation systems described herein, such as lighting systems **200**, **2200** and **3200** described herein above. In general, the power supply unit **6300** can provide electrical power to lighting elements used by lighting systems **200**, **2200** and **3200** to illuminate plants **104** being cultivated.

Power supply unit **6300** is generally similar to power supply units **4300** and **5300**. Power supply unit **6300** includes a controller **6310**, housing **6320**, electrical input **6330**, and electrical output **6340** that are generally similar to controller **4310**, housing **4320**, electrical input **4330**, and electrical output **4340**. However, the power supply unit **6300** also includes a deactivation switch **6360** that is operable to disconnect the high voltage power being received at the power input **6330**.

The deactivation switch **6360** (which may also be referred to as a power activation switch) can be adjusted between an active position and an inactive position. In the active position, when the power supply unit **6300** is connected to an external power supply, the power supply unit **6300** provides live power. In the inactive position, power from the external power supply is disconnected from the power supply unit **6300**. This may allow a user to perform repairs and/or maintenance on the power supply unit **6300** and/or lighting system **6340** in the absence of live power. As shown in FIG. **17**E, the deactivation switch **6360** has already been moved to the inactive position.

In some embodiments, the deactivation switch **6360** may be manually actuated by a user. For example, the power supply unit **6300** may include an external shut-off switch or lever mounted on housing **6320**. A user may actuate the deactivation switch **6360** prior to performing maintenance on the power supply unit **6300**.

In some embodiments, the actuator for the deactivation switch **6360** can be integrated with an access door on the housing **6320**. For example, the actuator may be drivingly engaged with a lock member of the access door. The lock member may be movable between a locked position in which the access door is locked and an unlocked position in which the access door is openable. The lock member may be adjusted using any sort of lock actuator, such as a rotatable knob.

Adjusting the lock member may drive the switch actuator which in turn can cause the switch **6360** to switch. For example, when the lock member is moved to the unlocked position, the actuator may be driven to cause switch **6360** to move to the deactivated position. This may prevent a user from accessing the power supply unit **6300** until live power has been disconnected.

In some embodiments, the switch **6360** may be actuated in response to a user attempting accessing one of the light fixtures and/or light cards in the light system. For example, the lightings units may include an outer cover enclosing the light emitting elements. The cover may be a plastic cover, such as an IP65, IP66, and/or IP67 compliant cover. Removal of the outer cover may actuate switch to move to the deactivated position. This may ensure that live power is not being provided to the light fixture and/or card when a user is attempting to access the light fixture and/or card (e.g. for replacement in the example of light fixture **220**).

In some embodiments, the lighting system may include one or more light card access switches. For example, each light card may have an associated light card access switch. A user may actuate the light card access switch in order to remove and/or replace a light card. Each light card access switch can be coupled to the power supply unit **6300** so that power can be disconnected (e.g. by operation of switch **6360**) prior to a user accessing the corresponding light card.

In some embodiments, a light card access switch may be coupled to the control unit **6310**. The control unit **6310** may operate to disconnect power from only the corresponding light card (or light fixture) when the light card access switch is operated. This may allow the remaining fixtures to continue illuminating the plants **104** while the user is able to replace a light card in the absence of live power to that fixture.

Although the example embodiments of lighting systems, lighting fixtures, light cards, power supply units and so forth have been described above in the context of indoor cultivation facilities, it should be understood that the various embodiments described herein may also be implemented to provide lighting for other facilities, such as underground parking facilities for example. Various example embodiments described herein may facilitate installation, maintenance, and/or repair of lighting systems for such other facilities. Embodiments described herein may also help reduce the power costs required to provide lighting for those facilities.

As used herein, the wording "and/or" is intended to represent an inclusive-or. That is, "X and/or Y" is intended to mean X or Y or both, for example. As a further example, "X, Y, and/or Z" is intended to mean X or Y or Z or any combination thereof.

While the above description describes features of example embodiments, it will be appreciated that some features and/or functions of the described embodiments are susceptible to modification without departing from the spirit and principles of operation of the described embodiments. For example, the various characteristics which are described by means of the represented embodiments or examples may be selectively combined with each other. Accordingly, what has been described above is intended to be illustrative of the claimed concept and non-limiting. It will be understood by persons skilled in the art that other variants and modifications may be made without departing from the scope of the invention as defined in the claims appended hereto. The scope of the claims should not be limited by the preferred embodiments and examples, but should be given the broadest interpretation consistent with the description as a whole.

I claim:

1. A lighting system for an indoor growing facility, the indoor growing facility having a growing area which contains a plurality of plants, the lighting system comprising:

(a) a plurality of lighting units suspended above the growing area, each lighting unit having a light emitting face wherein each lighting unit comprises at least one light fixture and each lighting unit produces a light emission region from light emitted by at least one light fixture; and,

(b) a height adjustment controller operable to selectively raise each lighting unit, wherein a vertical position of each lighting unit with respect to the plants positioned in the growing area under each lighting unit is adjustable to maintain a generally consistent separation between the light emitting face of each lighting unit and a top of plants positioned under each lighting unit

wherein, at a height of the top of plants positioned under each lighting unit, less than 15% overlap is provided between adjacent light emission regions whereby, as the vertical position of the lighting units is adjusted by different amounts, an amount of light received by the top of plants positioned under each lighting unit is varied by less than 15%.

2. The lighting system of claim **1** wherein the vertical position of each lighting unit with respect to the plants positioned in the growing area under each lighting unit is automatically adjustable to maintain a generally consistent separation between the light emitting face of each lighting unit and a top of plants positioned under each lighting unit.

3. The lighting system of claim **2** further comprising a plant height sensor coupled to the height adjustment controller wherein the height adjustment controller is operable to raise a lighting unit in response to a signal from the plant height sensor.

4. The lighting system of claim **2** further comprising a first plant height sensor coupled to the height adjustment controller, the first plant height sensor positioned to provide a signal in response to plants positioned under a first lighting unit of the plurality of lighting units and a second plant

height sensor coupled to the height adjustment controller, the second plant height sensor positioned to provide a signal in response to plants positioned under a second lighting unit of the plurality of lighting units wherein the height adjustment controller is operable to raise the first lighting unit in response to a signal from the first plant height sensor and to raise the second lighting unit in response to a signal from the second plant height sensor.

5. The lighting system of claim **1** wherein the height adjustment controller is operable to maintain a vertical position of 6 inches to 18 inches between the light emitting face of each lighting unit and a top of plants positioned under each lighting unit.

6. The lighting system of claim **1** wherein each lighting unit comprises a plurality of LEDs.

7. The lighting system of claim **1** wherein a first lighting unit comprises a plurality of separate light fixtures that are mounted to one another in sequence whereby a first light fixture is replaceable by disconnecting the first light fixture from adjacent light fixtures to which the first light fixture s attached.

8. The lighting system of claim **7** further comprising a single power supply electrically connected to a plurality of light fixtures of the first lighting unit.

9. The lighting system of claim **8** wherein the single power supply is provided at an end of a row of the light fixtures of the first lighting unit.

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