EXHIBIT A

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Guercio et al.

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(54) **LIGHT FIXTURE WITH PERIPHERAL COOLING CHANNELS**

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(51) **Int. Cl.**

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F21V 23/00	(2006.01)
F21V 21/30	(2006.01)
F21Y 101/02	(2006.01)

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

CPC ***F21V 29/004*** (2013.01); *F21V 21/30* (2013.01); ***F21V 23/007*** (2013.01); *F21Y 2101/02* (2013.01); ***F21V 29/507*** (2015.01); ***F21V 29/77*** (2015.01); ***F21V 29/83*** (2015.01); *F21V 29/89* (2015.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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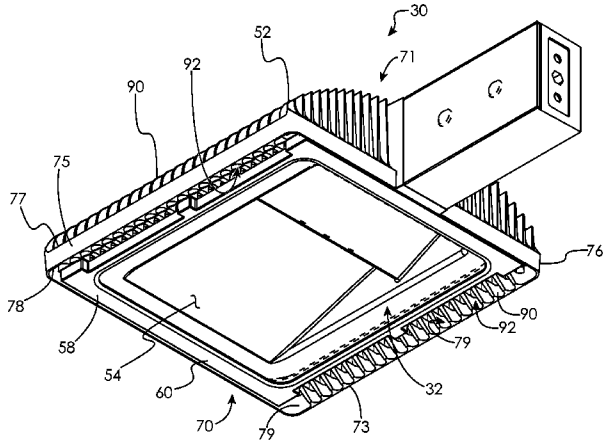
(57) **ABSTRACT**

An illustrative light fixture includes an emitter housing and airflow cooling channels. The airflow cooling channels are defined in the space between opposite edges of the emitter housing and a rim around the periphery of at least the opposite edges of the emitter housing. The airflow channels are further defined by fins spanning between the rim and opposite edges and spanning across a side of the housing opposite the illumination side.

20 Claims, 7 Drawing Sheets



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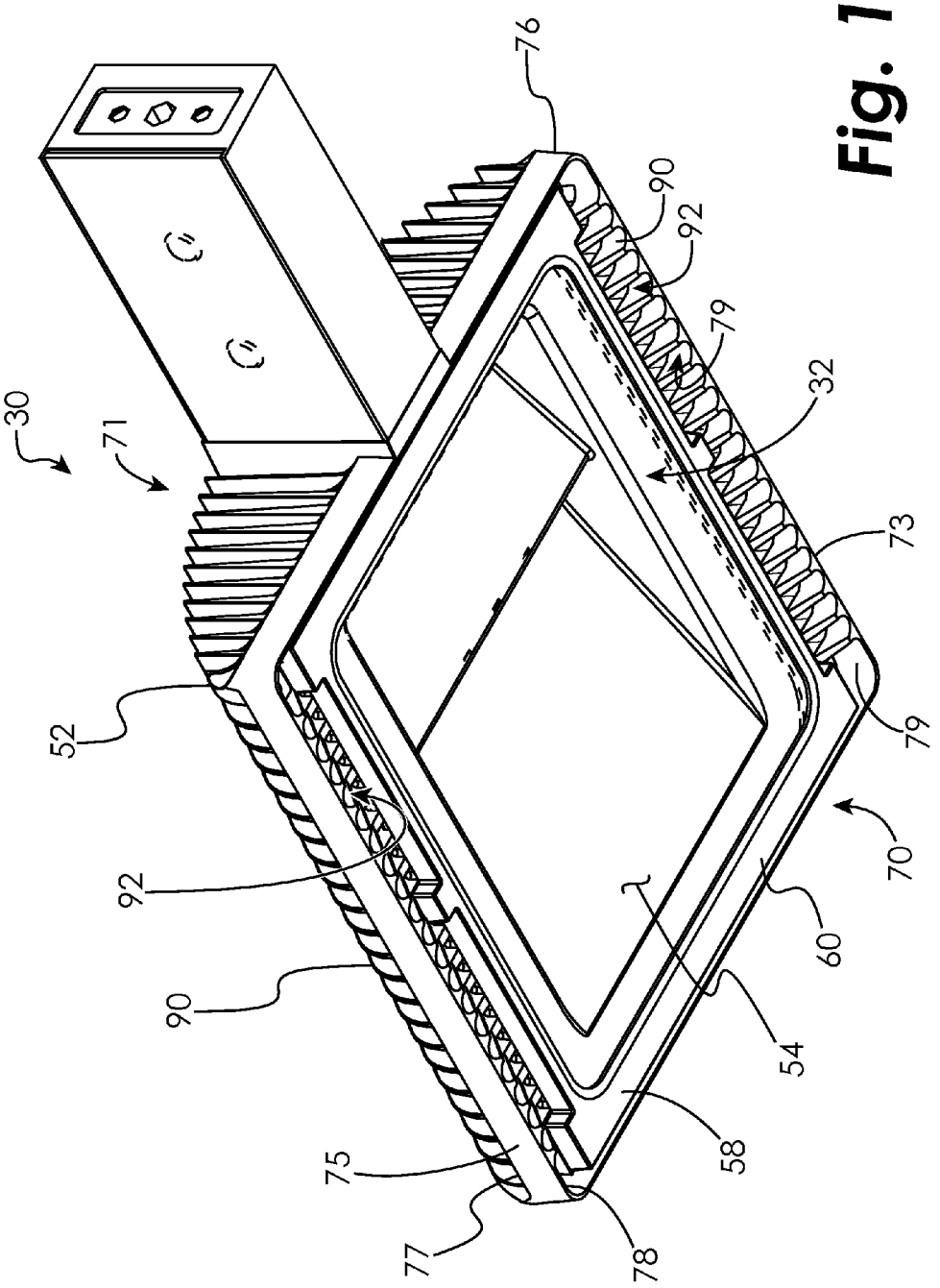


Fig. 1

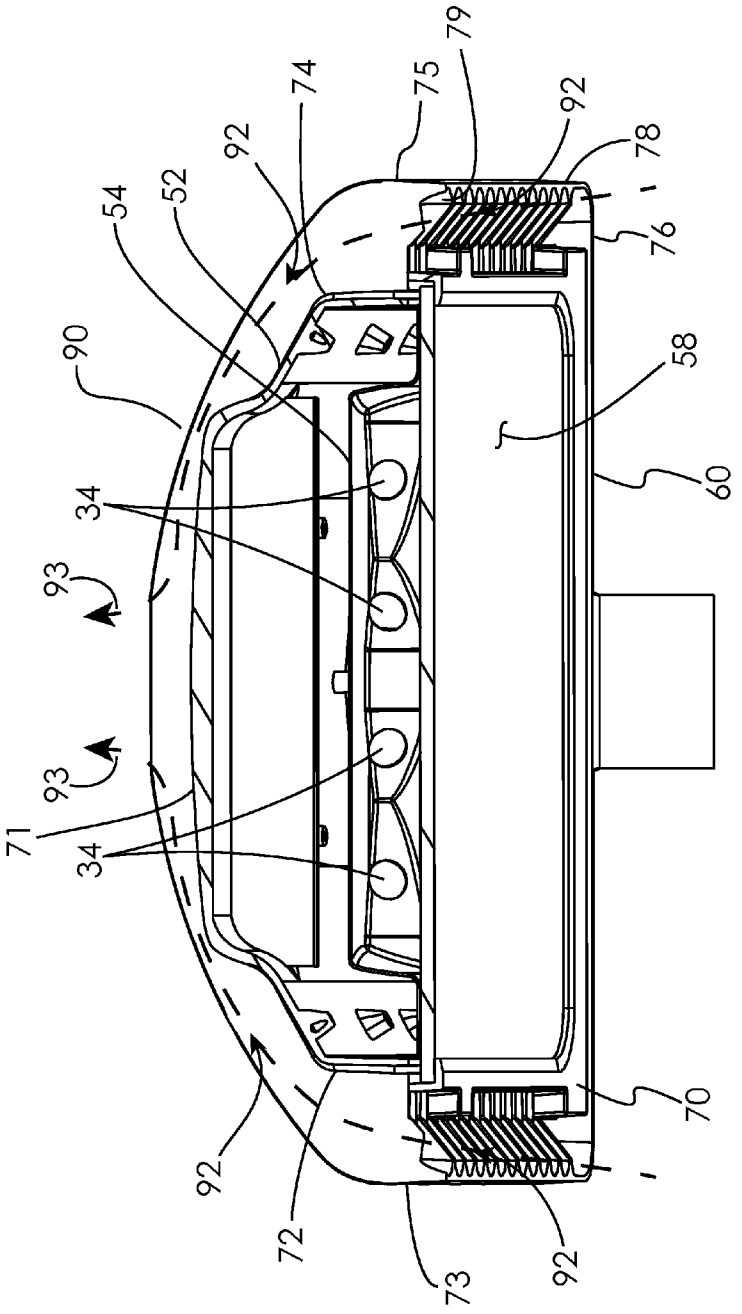
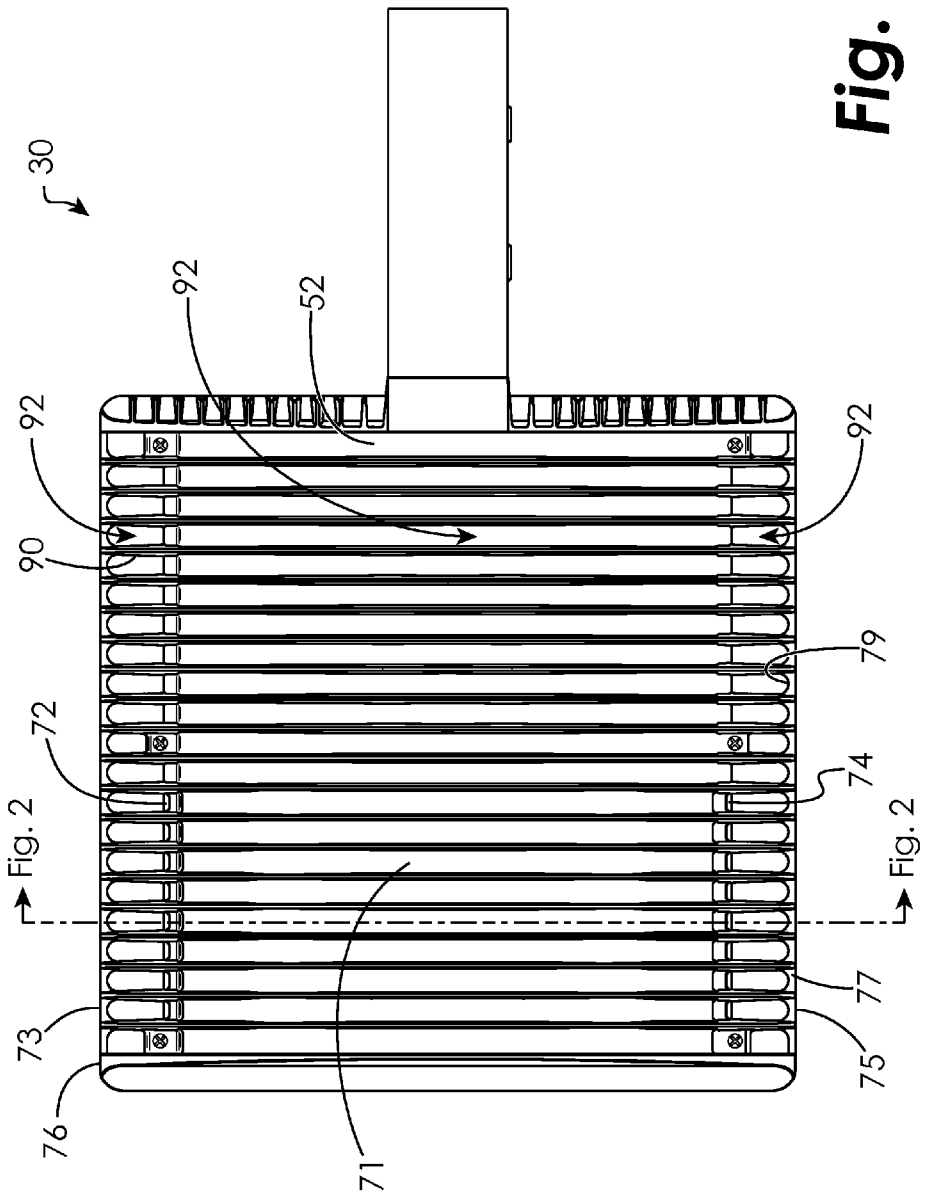


Fig. 2

Fig. 3



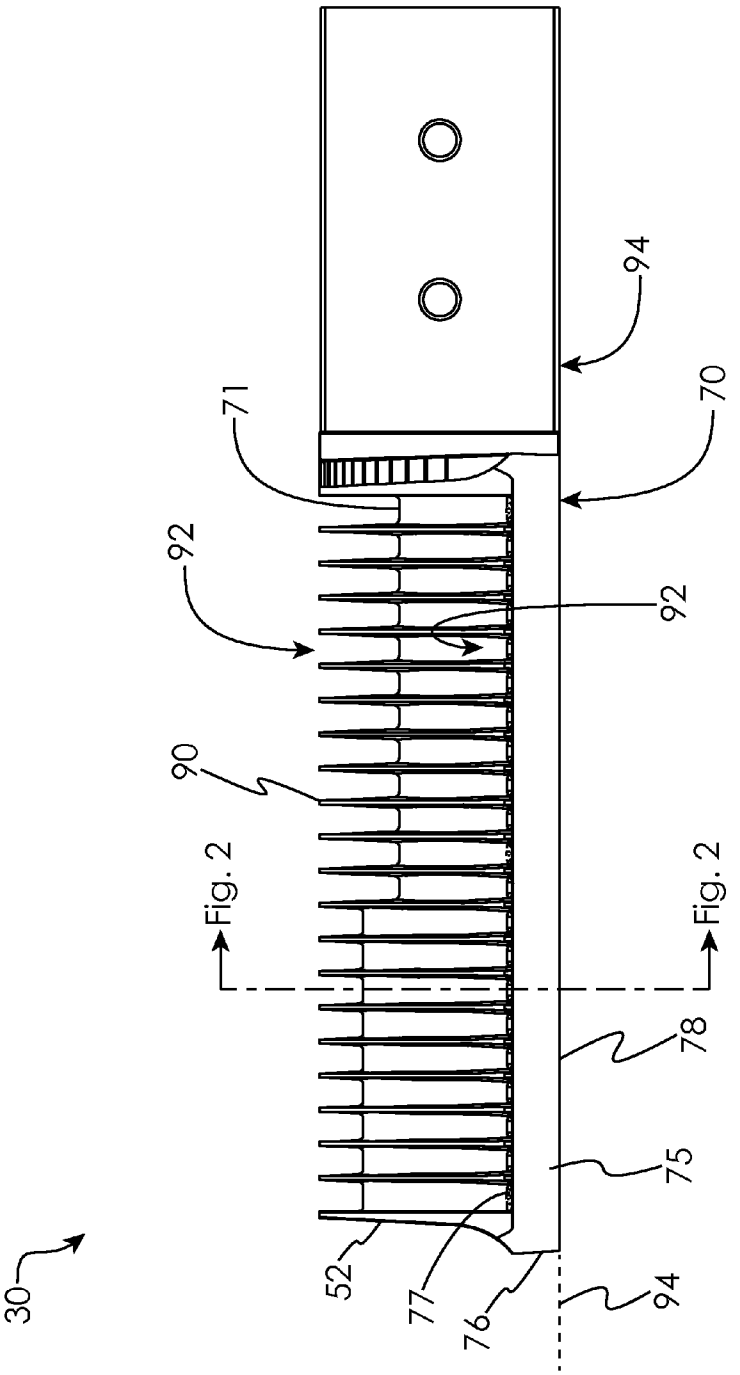


Fig. 4

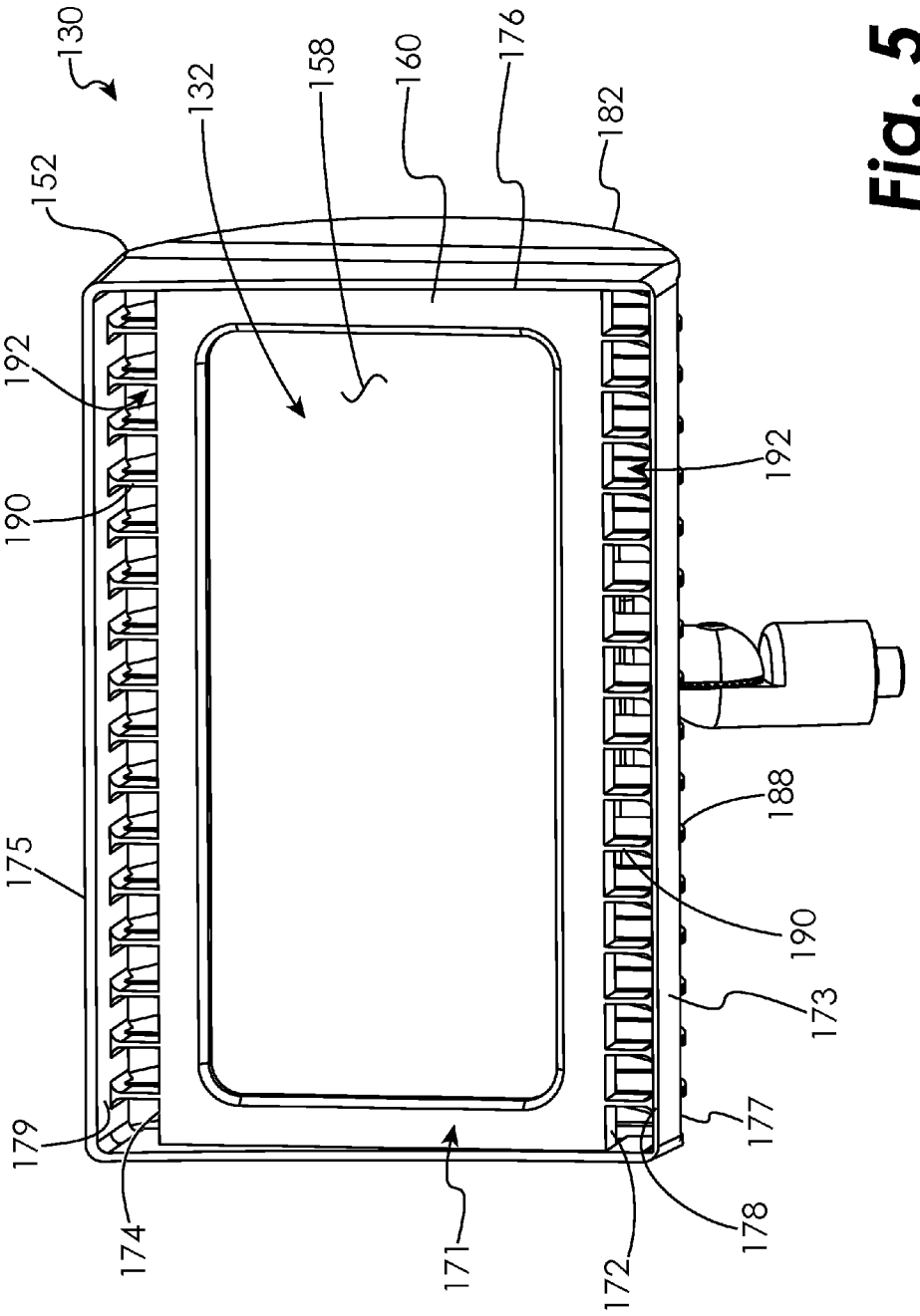

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Fig. 5

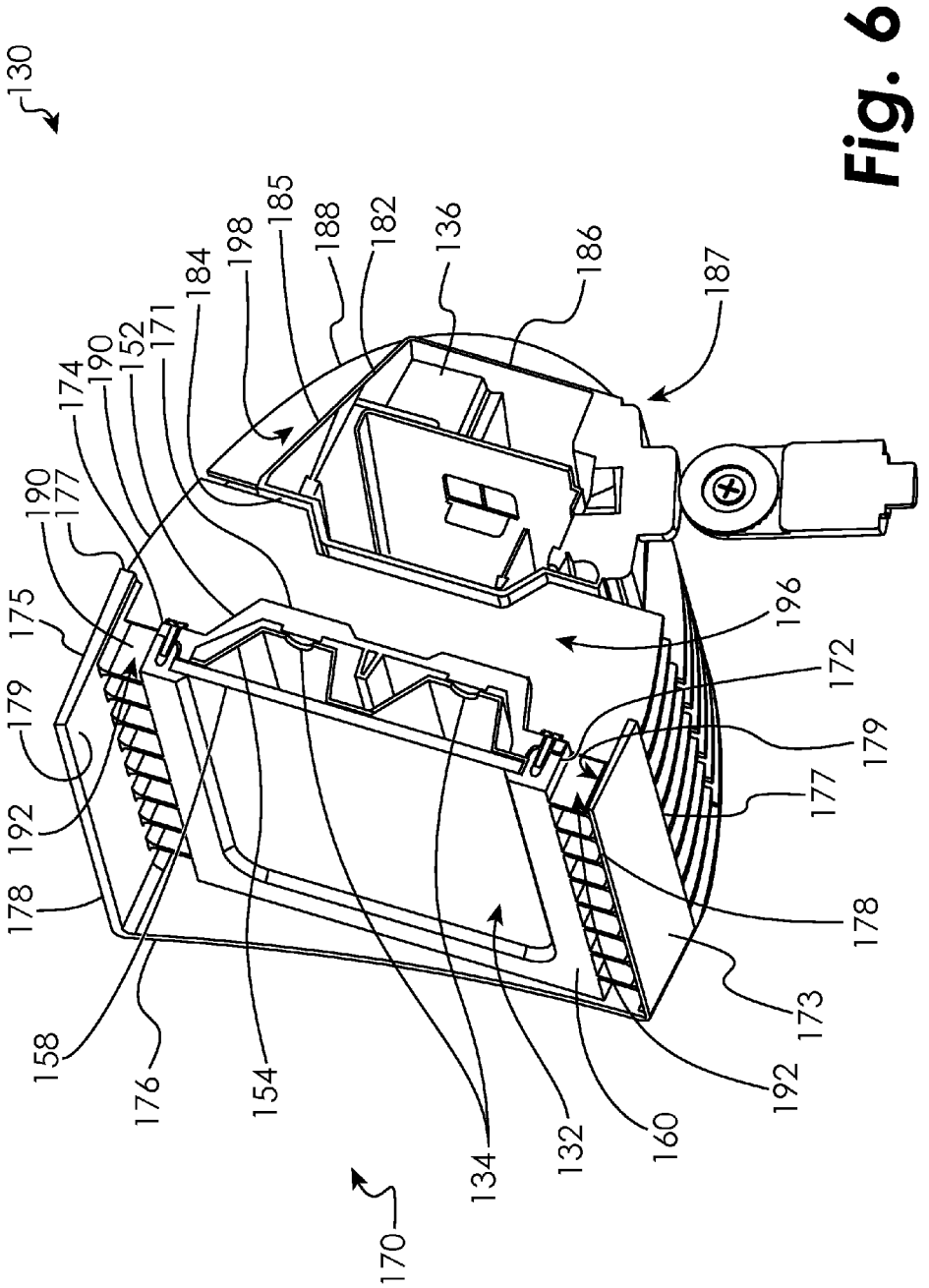
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Fig. 6

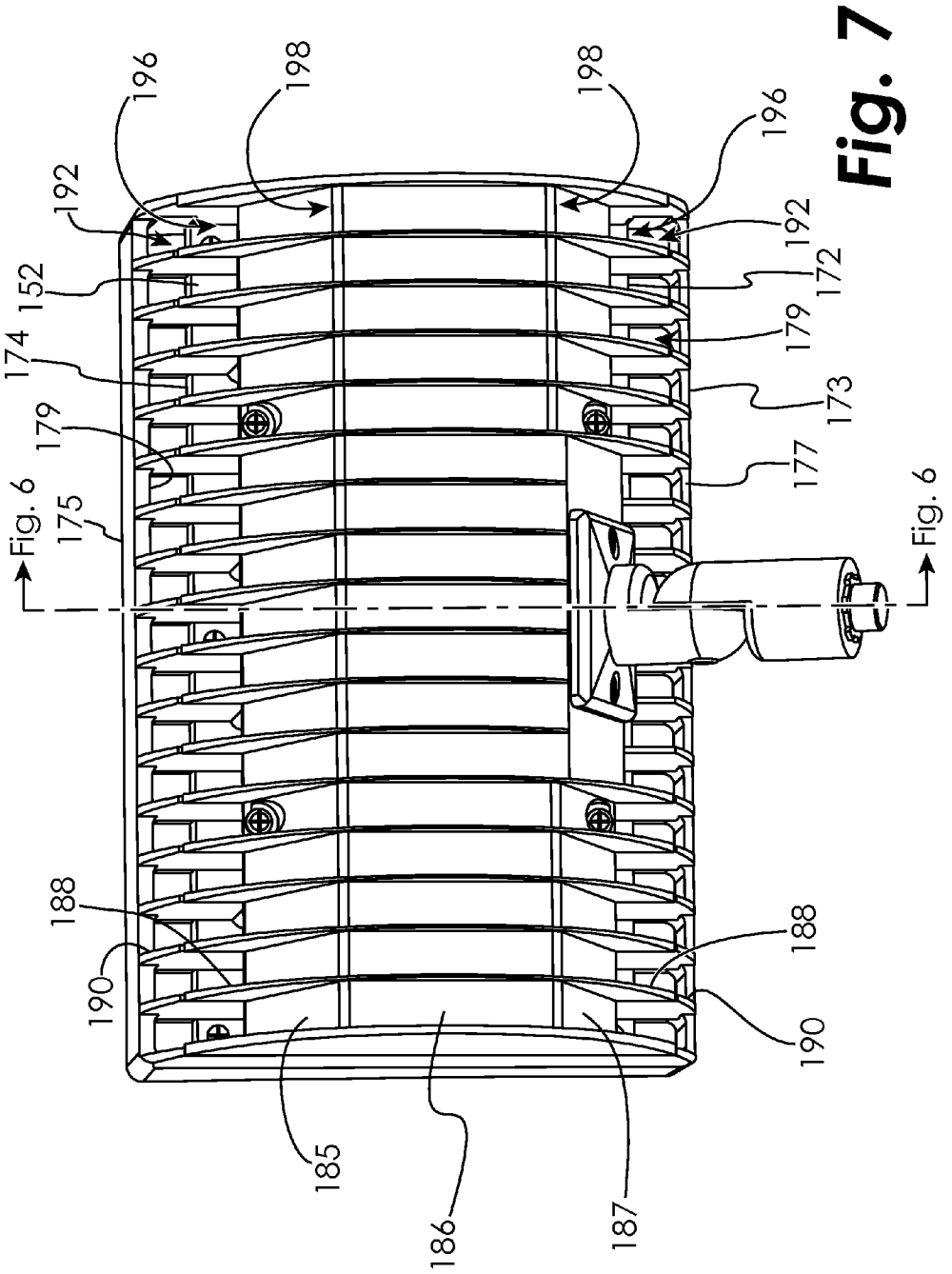
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Fig. 6
Fig. 6
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Fig. 7

LIGHT FIXTURE WITH PERIPHERAL COOLING CHANNELS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a nonprovisional of U.S. Provisional Application No. 61/545,307, filed Oct. 10, 2011, and titled Light Fixture with Peripheral Cooling Channels, which is herein entirely incorporated by reference.

BACKGROUND

The present invention relates to light fixture cooling features, and particularly, to providing a light fixture with external surface features to facilitate cooling.

Managing the temperature of light sources in a light fixture is generally important to performance and longevity. This is particularly true with newer highly efficient lighting technology, for example, light sources such as LEDs or laser diodes. LEDs are generally selected to maximize the light output for a given power consumption at a reasonable cost. Because LED light sources operate at a much lower temperature than typical incandescent light sources, less energy is wasted in the form of heat production. However, LEDs tend to be more sensitive to operating temperature and lower operating temperatures also provide a much smaller temperature difference between the LED and the ambient environment, thus requiring greater attention to thermal management to transfer and dissipate any excess heat generated by the LED driver and emitter so that the design operating temperature for the components are not exceeded.

As temperatures rise, the efficacy of the LED is reduced, reducing the light output, and reducing the lifespan of the LED. LED lighting fixtures generally include both LED drivers and LED emitters. To facilitate dissipation of heat, convection, conduction, and radiation are available modes of heat transfer. For LED light fixtures, dissipation of heat by conduction is often provided by one or more LED packages being mounted on a heat sink. The heatsink is generally integral with or thermally coupled with the light housing, which often includes external cooling fins to further facilitate the dissipation of heat from the light fixture by convection and radiation.

Many prior designs seeking to address these concerns provides a set of fins forming vertical airflow channels extending radially around a light emitter and driver housing; however, the fins forming the airflow channels only abut vertical edges of the housing.

Therefore, it is desirable to provide a lighting fixture design in a unitary fixture that maximizes cooling by thermal convection for the light housing, including convection from horizontal surfaces of the housing, and shields the cooling features from as many viewing angles as practical. Additionally, for some lighting fixture designs, it is also desirable to minimize thermal conduction between emitter and driver housings.

SUMMARY

The present invention may comprise one or more of the features recited in the attached claims, and/or one or more of the following features and combinations thereof.

An illustrative light fixture includes an emitter housing and airflow cooling channels. The airflow cooling channels are defined in the space between opposite edges of the emitter housing and a rim around the periphery of at least the opposite edges of the emitter housing. The airflow channels are further

defined by fins spanning between the rim and opposite edges and spanning across a side of the housing opposite the illumination side.

An illustrative embodiment of a light fixture for a light emitter includes an emitter housing; an illumination side of the emitter housing, the light emitter projecting light from the illumination side; an opposite side of the emitter housing, located opposite the illumination side; a first and second edge defined by the emitter housing, each of the first and second edges spanning between the illumination and opposite sides; a first rim positioned along the first edge of the emitter housing and spanning between the illumination and opposite sides; a second rim positioned along the second edge of the emitter housing and spanning between the illumination and opposite sides; and a first plurality of fins spanning between the first edge and the first rim, the first edge and the second edge, the second edge and the second rim, and the first rim and the second rim.

The light fixture can further include a plurality of airflow channels, each of the plurality of airflow channels defined between adjacent ones of the first plurality of fins, each of the plurality of airflow channels open to the illumination side of the emitter housing between the first rim and the first edge, extending across the opposite side of the emitter housing, and open to the illumination side of the emitter housing between the second rim and the second edge.

In one illustrative embodiment, the light fixture further includes a driver housing, the driver housing defining a front surface; and an airflow passage defined by a space between the opposite side of the emitter housing and the front surface of the driver housing; and wherein the first plurality of fins extend through the airflow passage. The light fixture can further include a second plurality of fins defined by the driver housing. The first plurality of fins and the second plurality of fins can form a plurality of coplanar fins surfaces.

A plane formed across the first rim and the second rim can optionally not be intersected by the first plurality of fins. A plane formed across the first rim and the second rim can optionally not be intersected by the first edge or the second edge. The first plurality of fins can be in thermal conductivity with the light emitter.

The first rim and the second rim can be on opposite sides of the emitter housing. The first plurality of fins can be parallel with one another. The first plurality of fins can be evenly spaced. The light fixture can further include a top surface defined by the emitter housing, and the top edges of the first plurality of fins can be coplanar with the top surface of the emitter housing.

Another illustrative embodiment of a light fixture for a light emitter includes an emitter housing; an illumination side of the emitter housing, the light emitter projecting light from the illumination side; an opposite side of the emitter housing, located opposite the illumination side; a first and second edge defined by the emitter housing between the illumination and opposite sides; a first rim positioned along the first edge of the emitter housing; a second rim positioned along the second edge of the emitter housing; and a first plurality of fins spanning between the first edge and the first rim, across the opposite side of the emitter housing, and between the second edge and the second rim.

In one illustrative embodiment, the light fixture further includes a driver housing, the driver housing defining a front surface; and an airflow passage defined by a space between the opposite side of the emitter housing and the front surface of the driver housing; and wherein the first plurality of fins extend through the airflow passage. The light fixture can further include a second plurality of fins defined by the driver

housing. The first plurality of fins and the second plurality of fins can form a plurality of coplanar fins surfaces.

Another illustrative embodiment of a light fixture for a light emitter, includes a first housing; an illumination side of the first housing, the light emitter projecting light from the illumination side; an opposite side of the first housing, located opposite the illumination side; a first and second edge defined by the first housing between the illumination and opposite sides; a rim extending around at least two opposite edges of the first housing; a first plurality of fins spanning between the rim and the at least two opposite edges of the housing and across the opposite side of the first housing; and a plurality of airflow channels, each of the plurality of airflow channels defined between adjacent ones of the first plurality of fins, each of the plurality of airflow channels open to the illumination side of the first housing between the rim and a first one of the at least two opposite edges of the first housing, extending across the opposite side of the first housing, and open to the illumination side of the housing between the rim and a second one of the at least two opposite edges of the first housing.

In on illustrative embodiment the light fixture further includes a second housing, the second housing defining a front surface; and an airflow passage defined by a space between the opposite side of the first housing and the front surface of the second housing; and wherein the first plurality of fins extend through the airflow passage. The light fixture can further include a second plurality of fins defined by the second housing. The first plurality of fins and the second plurality of fins can form a plurality of coplanar fins surfaces.

Additional features of the disclosure will become apparent to those skilled in the art upon consideration of the following detailed description of the illustrative embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description particularly refers to the accompanying figures in which:

FIG. **1** is a bottom perspective view of a first illustrative lighting fixture according to the present invention;

FIG. **2** is a front perspective cross-sectional view of the lighting fixture of FIG. **1**, taken along section line **2-2** shown in FIGS. **3** and **4**;

FIG. **3** is a top view of the lighting fixture of FIG. **1**;

FIG. **4** is a side view of the lighting fixture of FIG. **1**;

FIG. **5** is a front view perspective view of a second illustrative lighting fixture according to the present invention;

FIG. **6** is a side perspective cross-sectional view of the lighting fixture of FIG. **5**, taken along section line **6-6** shown in FIG. **7**; and

FIG. **7** is a rear perspective view of the lighting fixture of FIG. **5**.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

For the purposes of promoting and understanding the principals of the invention, reference will now be made to one or more illustrative embodiments illustrated in the drawings and specific language will be used to describe the same.

Referring to FIGS. **1-4**, a first illustrative embodiment of a light fixture **30** according to the present invention is illustrated. The light fixture **30** includes a light source **32**, including an emitter **34** (FIG. **2**; as used herein, "emitter" refers to a single emitter or an array of emitters) and a driver **36** (not shown; as used herein, "driver" refers to a single driver or an array of drivers), and an emitter housing **52**. For example, light source **32** may be, but is not limited to, an LED emitter **34** and associated driver **36**, as are typically used in the commercial lighting industry. For example, the associated driver **36** converts AC power to appropriate DC power and may also include additional LED power and control features.

The emitter housing **52** can be formed from, for example, die cast aluminum or an aluminum alloy. The emitter **34** can be thermally coupled and mounted to the emitter housing **52**. As it typical of commercial lighting fixtures, the emitter housing **52** may also include components that enclose the emitter **34** within emitter housing **52**, for example, including a light reflector **54**, lens **58**, and frame **60**. In the first illustrative embodiment of the light fixture **30**, the driver **36** (not shown) is also located within the emitter housing **52**.

Referring to FIGS. **2**, **3**, and **4**, the emitter housing **52** defines an illumination side **70** from which the light source **32** projects light (for example, in the first embodiment defined by the frame **60** and lens **58**), an opposite surface or back side **71**, a left side edge **72**, and a right side edge **74**. The light fixture **30** also includes a rim **76** around the periphery of the light housing **52**, including a left rim **73**, a right rim **75**, a top rim edge **77**, a bottom rim edge **78**, and an interior surface **79**. In the first illustrative embodiment, the left rim **73** is spaced apart from the left side edge **72** of the housing **52**, the right rim **75** is spaced apart from the right side edge **74**, and the remainder of the rim **76** on front and rear sides contacts the housing **52**.

The light fixture **30** also includes a plurality of fins **90**, for example, in the first embodiment defined at least in part by the back side **71** of the emitter housing **52**, thus, the plurality of fins **90** are in thermal conductivity with the emitters **34** and dissipate heat from the emitters to the surrounding environment.

Referring to FIGS. **2** and **3**, in the first illustrative embodiment of the light fixture **30**, airflow cooling channels **92** are defined by the space between opposite side edges **72** and **74** of the emitter housing **52** and the opposite sides of the rim **73** and **75**, and each adjacent fin **90**. The cooling channels **92** extend vertically from the bottom rim edge **78** to the top rim edge **77** and allow air to flow between the illumination side **70** and the back side **71**, for example, typically heating of the housing **52** would draw air from the illumination side to the back side **71**. Optionally, the fins **90** and associated channels **92** can be parallel, and/or evenly spaced, as shown in FIG. **3**.

Additionally, as shown in FIGS. **2-4**, in the first embodiment of the light fixture **30**, the airflow cooling channels **92** spanning between the opposite rims **73** and **75** and edges **72** and **74** (FIG. **2**), specifically spanning across a back side **71** of the housing between adjacent fins **90**, allowing airflow **93** (FIG. **2**) to travel upward from the illumination side **70** of each side **72** and **74** and across the back side **71**. If the light fixture **30** is mounted to illuminate upward, for example, against a ceiling (not shown), mounted with the back side **71** facing downward and the illumination side **70** upward, then the direction of airflow **93** would typically be reversed.

Advantageously, the rims **73** and **75** provide the added functionality of providing support to the fins **90** where they extend beyond the left and right side edges **72** and **74** of the emitter housing **52**, more surface area for convective and radiant heat transfer to the surrounding air, and providing a more aesthetically appealing appearance of the light fixture **30**, limiting the spiny look while retaining the needed cooling fins **90** projecting beyond the housing **52** by providing the rim **76**. For example, the rims **73** and **75** conceal portions of the light fixture **30** because the side edges **72** and **74** of the housing **52** and the fins **90** do not extend below (in the direc-

tion of the illumination side **70**) an plane **94** (FIG. **4**) formed by the bottom edges **78** of the rims **73** and **74**.

Referring to FIGS. **5-7**, a second illustrative embodiment of a light fixture **130** according to the present invention is illustrated. The features described above for the first embodiment of the light fixture **30** may also be selectively incorporated in the light fixture **130**.

Referring to FIG. **6**, the light fixture **130** includes a light source **132**, including an emitter **134** and a driver **136**, an emitter housing **152**, and a driver housing **182**. The emitter housing **152** and driver housing **182** can be formed from, for example, die cast aluminum or an aluminum alloy. The emitter **134** can be thermally coupled and mounted to the emitter housing **152**, and the driver **136** can be thermally coupled and mounted to the driver housing **182**. As it typical of commercial lighting fixtures, the emitter housing **152** may also include components that enclose the emitter **134** within emitter housing **152**, for example, including a light reflector **154**, lens **158**, and frame **160**.

The emitter housing **152** defines an illumination side **170** (FIG. **6**) from which the light source **132** projects light, an opposite surface or back side **171**, a bottom side edge **172**, and a top side edge **174**. The light fixture **130** also includes a rim **176** around the periphery of the emitter housing **152**, including a bottom rim **173**, a top rim **175**, a rear rim edge **177**, a front rim edge **178**, and an interior surface **179**. In the second illustrative embodiment, the bottom rim **173** is spaced apart from the bottom side edge **172** of the housing **152**, the top rim **175** is spaced apart from the top side edge **174**, and the remainder of the rim **176** on left and right sides contacts the housing **152**.

The light fixture **130** also includes a plurality of emitter fins **190**, for example, in the first embodiment defined by the back side **171** of the emitter housing **152**, thus, the plurality of emitter fins **190** are in thermal conductivity with the emitters **134** and dissipate heat from the emitters to the surrounding environment.

The driver housing **182** defines surfaces including a front side **184**, which faces the back side **171** of the emitter housing **152**, a top side **185**, a rear side **186**, and a bottom side **187**. Referring to FIGS. **6** and **7**, a plurality of driver fins **188** are defined by the driver housing **182** and span from the intersection of the front side **184** and top side **185**, across the rear side **186**, to the intersection of the front side **184** and the bottom side **187**. The plurality of driver fins **188** are in thermal conductivity with the driver **136** and dissipate heat from the driver to the surrounding environment. Each of the driver fins **188** can be coplanar with respective ones of the emitter fins **190**, as is shown most clearly in FIG. **7**. Referring to FIG. **6**, a space **196** is defined between the rear side **171** of the emitter housing **152**, and the front side **184** of the driver housing **182**, and will be further referenced below.

As with the first illustrative embodiment, in the second illustrative embodiment of the light fixture **130**, airflow cooling channels **192** are defined by the space between opposite side edges **172** and **174** of the emitter housing **152** and the opposite sides of the rim **173** and **175**, and each adjacent fin **190**. The cooling channels **192** extend from the front rim edge **178** to the rear rim edge **177** and allow air to flow between the illumination side **170** and the back side **171**. Optionally, the fins **190** can be parallel, and/or evenly spaced, as shown in FIG. **7**.

Additionally, as shown in FIG. **6**, in the second embodiment of the light fixture **130**, the airflow cooling channels **192** span between fins **190** through the space **196**. Specifically, the cooling channels **192** span between the opposite rims **173** and **175** and edges **172** and **174**, between and across a back side **171** of the emitter housing **152** and front side **184** of the driver housing **182**.

Additionally, as shown in FIGS. **6** and **7**, the airflow from cooling channels **192** can flow not only through the space **196**, but around the driver housing **186** in the channels **198** defined by adjacent driver fins **188**. The channels **198** can extend fully around the driver housing **186**, from the intersection of the front side **184** and top side **185**, across the back side **186**, and to the intersection of the front side **184** and the bottom side **187**.

While the invention has been illustrated and described in detail in the foregoing drawings and description, the same is to be considered as illustrative and not restrictive in character, it being understood that only illustrative embodiments thereof have been shown and described and that all changes and modifications that come within the spirit and scope of the invention as defined in the claims and summary are desired to be protected.

The invention claimed is:

1. A light fixture for a light emitter, comprising:
- an emitter housing;
- an illumination side of the emitter housing, the light emitter projecting light from the illumination side;
- an opposite side of the emitter housing, located opposite the illumination side;
- a first and second edge defined by the emitter housing, each of the first and second edges spanning between the illumination and opposite sides;
- a first rim positioned along the first edge of the emitter housing and spanning between the illumination and opposite sides;
- a second rim positioned along the second edge of the emitter housing and spanning between the illumination and opposite sides; and
- a first plurality of fins spanning between the first edge and the first rim, the first edge and the second edge, the second edge and the second rim, and the first rim and the second rim.

2. The light fixture of claim **1**, further comprising a plurality of airflow channels, each of the plurality of airflow channels defined between adjacent ones of the first plurality of fins, each of the plurality of airflow channels open to the illumination side of the emitter housing between the first rim and the first edge, extending across the opposite side of the emitter housing, and open to the illumination side of the emitter housing between the second rim and the second edge.

3. The light fixture of claim **1**, further comprising:
- a driver housing, the driver housing defining a front surface; and
- an airflow passage defined by a space between the opposite side of the emitter housing and the front surface of the driver housing; and
- wherein the first plurality of fins extend through the airflow passage.

4. The light fixture of claim **3**, further comprising a second plurality of fins defined by the driver housing.

5. The light fixture of claim **4**, wherein the first plurality of fins and the second plurality of fins form a plurality of coplanar fins surfaces.

6. The light fixture of claim **1**, wherein a plane formed across the first rim and the second rim is not intersected by the first plurality of fins.

7. The light fixture of claim **1**, wherein a plane formed across the first rim and the second rim is not intersected by the first edge or the second edge.

8. The light fixture of claim **1**, wherein the first plurality of fins are in thermal conductivity with the light emitter.

9. The light fixture of claim **1**, wherein the first rim and the second rim are on opposite sides of the emitter housing.

10. The light fixture of claim **1**, wherein the first plurality of fins are parallel with one another.

11. The light fixture of claim **1**, wherein the first plurality of fins are evenly spaced.

12. The light fixture of claim **1**, further comprising a top surface defined by the emitter housing, and wherein the top edges of the first plurality of fins are coplanar with the top surface of the emitter housing.

13. A light fixture for a light emitter, comprising:

an emitter housing;

an illumination side of the emitter housing, the light emitter projecting light from the illumination side;

an opposite side of the emitter housing, located opposite the illumination side;

a first and second edge defined by the emitter housing between the illumination and opposite sides;

a first rim positioned along the first edge of the emitter housing;

a second rim positioned along the second edge of the emitter housing; and

a first plurality of fins spanning between the first edge and the first rim, across the opposite side of the emitter housing, and between the second edge and the second rim.

14. The light fixture of claim **13**, further comprising:

a driver housing, the driver housing defining a front surface; and

an airflow passage defined by a space between the opposite side of the emitter housing and the front surface of the driver housing; and

wherein the first plurality of fins extend through the airflow passage.

15. The light fixture of claim **14**, further comprising a second plurality of fins defined by the driver housing.

16. The light fixture of claim **15**, wherein the first plurality of fins and the second plurality of fins form a plurality of coplanar fins surfaces.

17. A light fixture for a light emitter, comprising:

a first housing;

an illumination side of the first housing, the light emitter projecting light from the illumination side;

an opposite side of the first housing, located opposite the illumination side;

a first and second edge defined by the first housing between the illumination and opposite sides;

a rim extending around at least two opposite edges of the first housing;

a first plurality of fins spanning between the rim and the at least two opposite edges of the housing and across the opposite side of the first housing; and

a plurality of airflow channels, each of the plurality of airflow channels defined between adjacent ones of the first plurality of fins, each of the plurality of airflow channels open to the illumination side of the first housing between the rim and a first one of the at least two opposite edges of the first housing, extending across the opposite side of the first housing, and open to the illumination side of the housing between the rim and a second one of the at least two opposite edges of the first housing.

18. The light fixture of claim **17**, further comprising:

a second housing, the second housing defining a front surface; and

an airflow passage defined by a space between the opposite side of the first housing and the front surface of the second housing; and

wherein the first plurality of fins extend through the airflow passage.

19. The light fixture of claim **18**, further comprising a second plurality of fins defined by the second housing.

20. The light fixture of claim **19**, wherein the first plurality of fins and the second plurality of fins form a plurality of coplanar fins surfaces.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,010,970 B2
APPLICATION NO. : 13/647726
DATED : April 21, 2015
INVENTOR(S) : Vincenzo Guercio and Jiang Hu

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In Column 8, Line 15, please insert the word --first-- after the word “the” first occurrence;

In Column 8, Line 24, please insert the word --first-- after the word “the” and before the word “housing”.

Signed and Sealed this
Tenth Day of November, 2020

Andrei Iancu
Director of the United States Patent and Trademark Office

EXHIBIT B

US008985816B2

(12) **United States Patent**
Guercio et al.

(10) **Patent No.: US 8,985,816 B2**
(45) **Date of Patent: Mar. 24, 2015**

(54) **LIGHT FIXTURE WITH CENTRAL LIGHTING HOUSING AND PERIPHERAL COOLING HOUSING**

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(73) Assignee: **RAB Lighting Inc.**, Northvale, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 99 days.

(21) Appl. No.: **13/908,526**

(22) Filed: **Jun. 3, 2013**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**

F21V 29/00	(2006.01)
F21S 8/04	(2006.01)
F21Y 101/02	(2006.01)

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

CPC ***F21V 29/004*** (2013.01); ***F21S 8/04*** (2013.01); ***F21V 29/2231*** (2013.01); ***F21V 29/2293*** (2013.01); *F21Y 2101/02* (2013.01)

USPC **362/373**; 362/294; 362/249.02; 362/147

(58) **Field of Classification Search**

CPC F21V 29/004; F21V 8/04; F21S 8/04

USPC 362/373, 294, 249.02, 147

See application file for complete search history.

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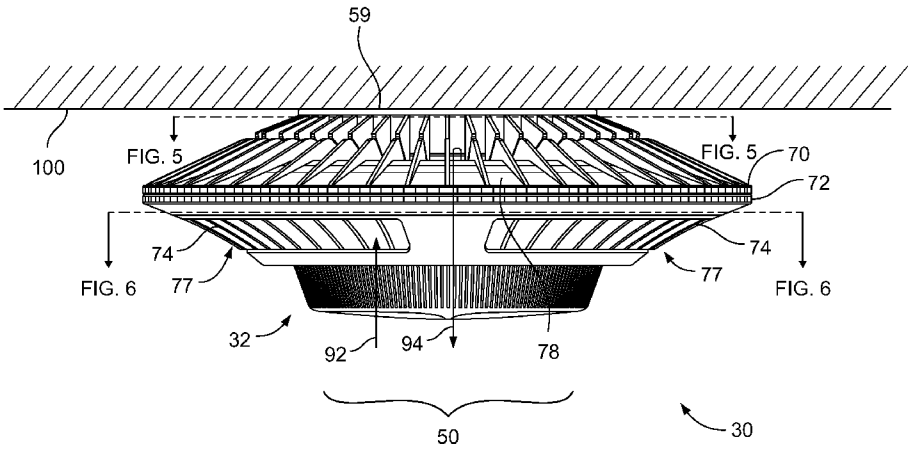
Primary Examiner — Ali Alavi

(74) *Attorney, Agent, or Firm* — SmithAmundsen LLC; Kelly J. Smith; Dennis S. Schell

(57) **ABSTRACT**

An illustrative light fixture includes a cylindrical lighting package housing surrounded peripherally by a cooling housing providing airflow cooling channels. The airflow cooling channels are defined in the space between the circumference of the cylindrical lighting package housing and a rim around the periphery of the light fixture. The cooling housing provides wide and long openings for air to rise vertically from below and through the airflow channels defined in part by cooling fins, and radial exit channels with vertical space for radially outward flow below a ceiling the fixture is mounted on, while also eliminating or minimizing the view through the airflow channels and to the ceiling.

20 Claims, 7 Drawing Sheets



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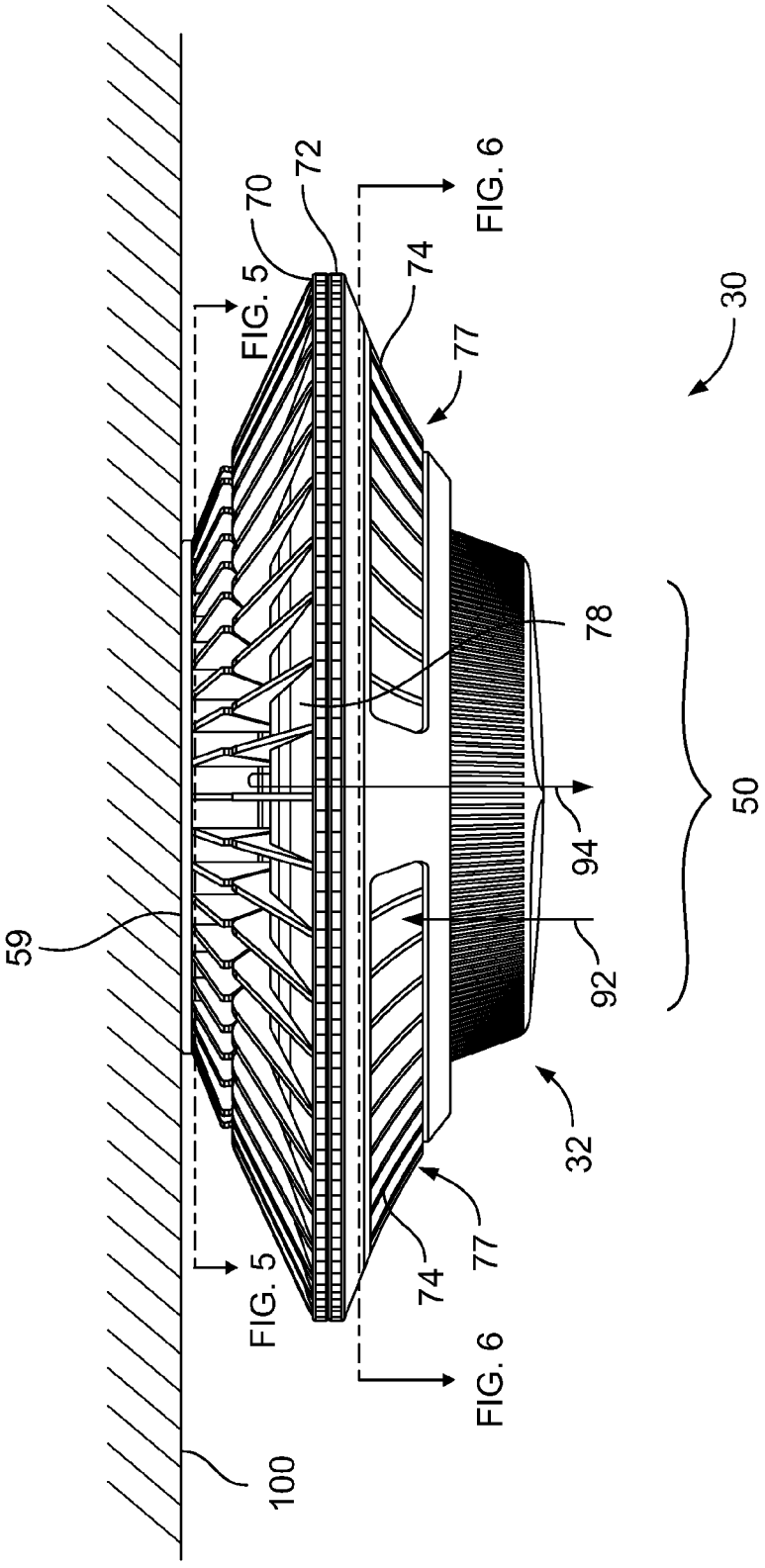

FIG. 1

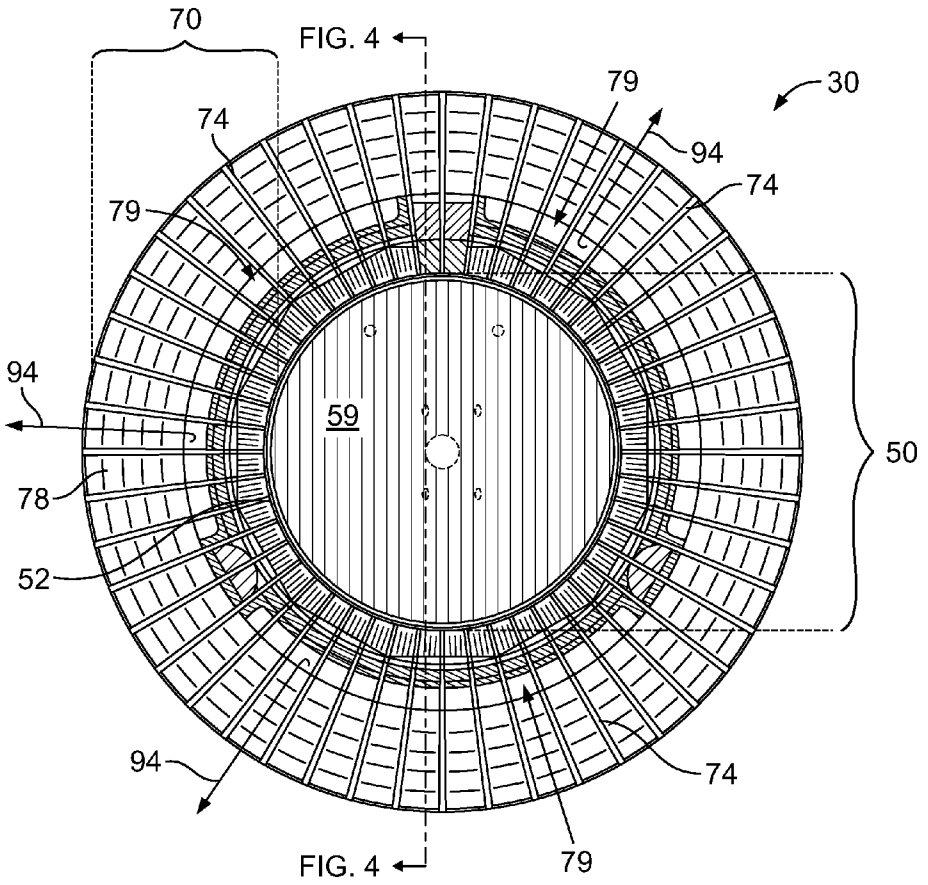

FIG. 2

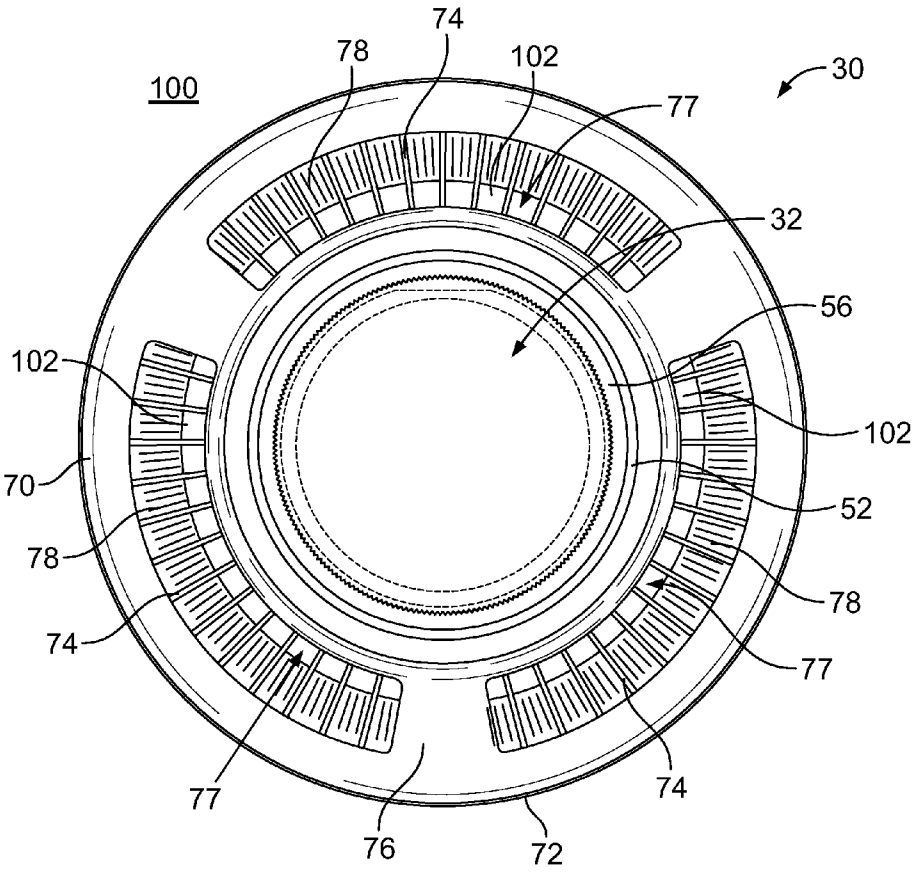

FIG. 3

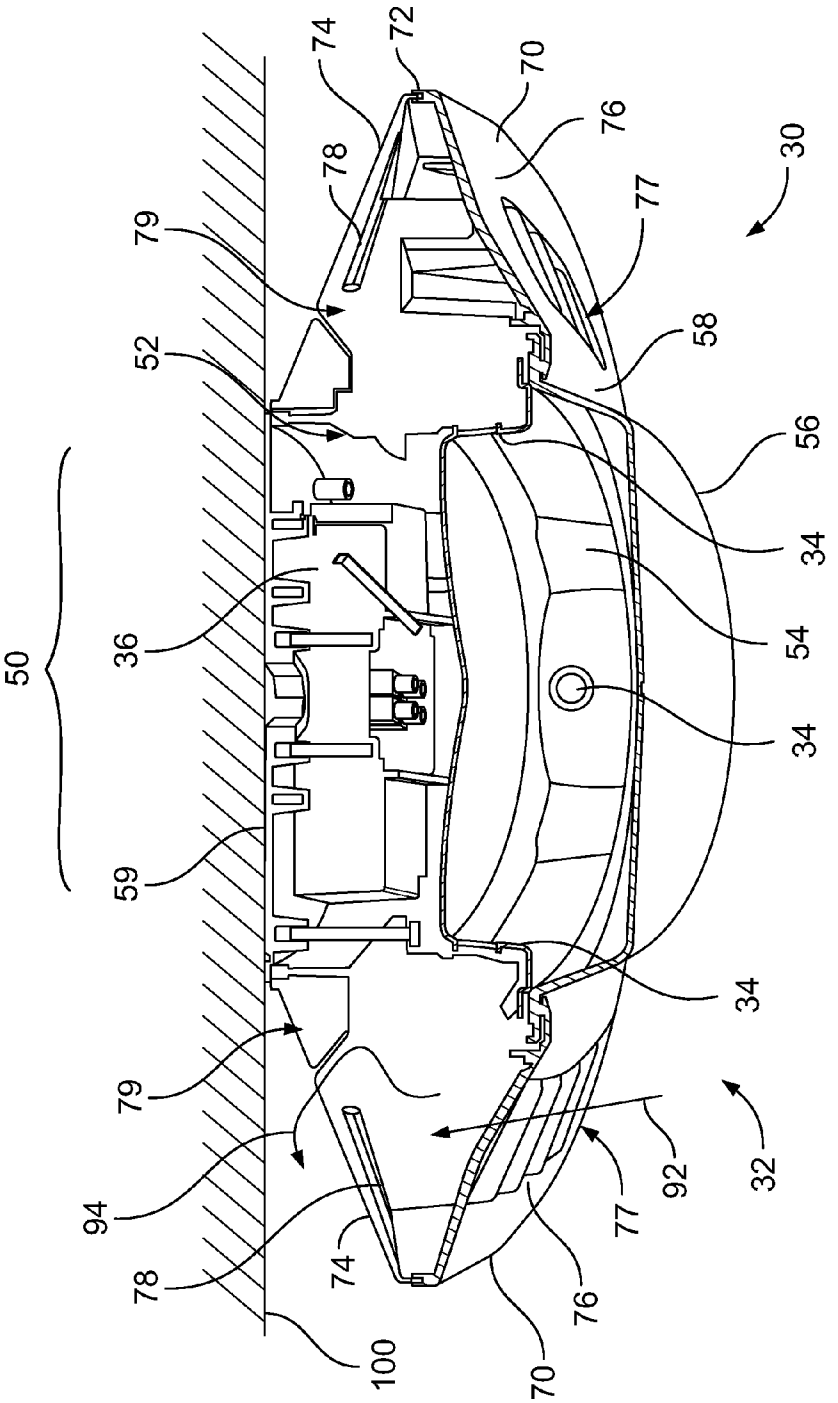
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FIG. 4

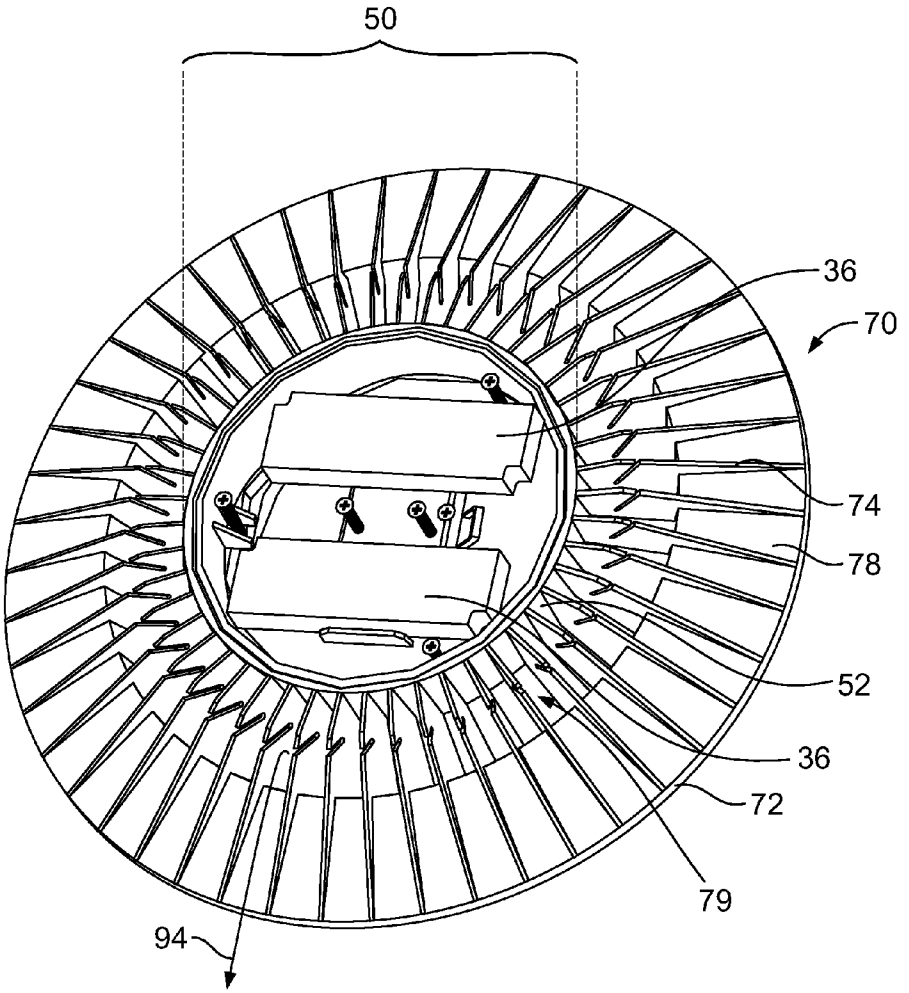

FIG. 5

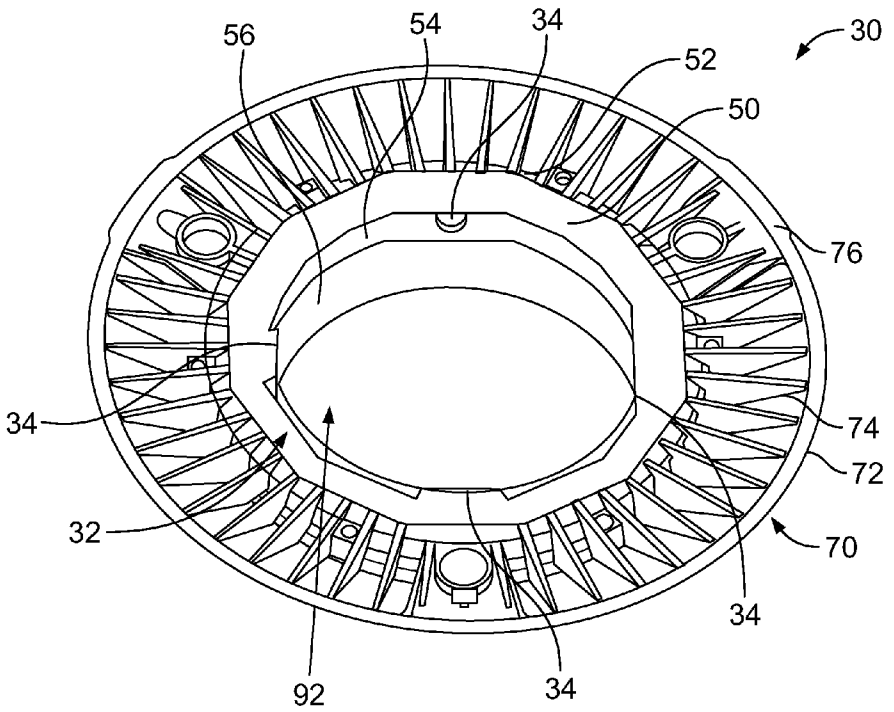

FIG. 6

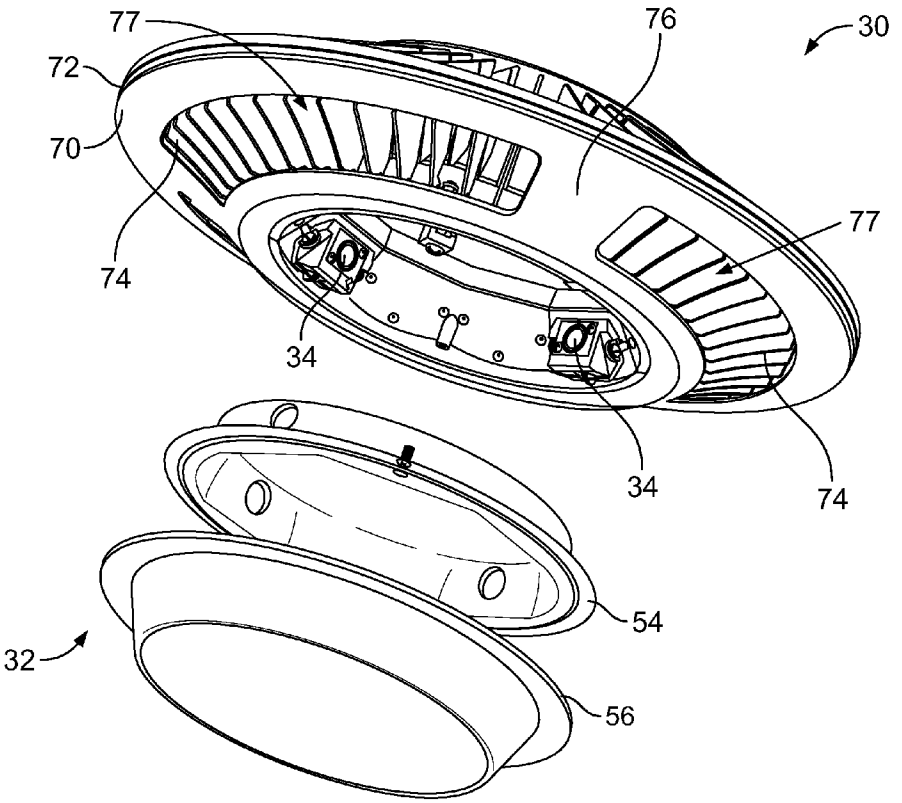

FIG. 7

LIGHT FIXTURE WITH CENTRAL LIGHTING HOUSING AND PERIPHERAL COOLING HOUSING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a nonprovisional of U.S. Provisional Patent Application No. 61/654,761, filed Jun. 1, 2012, and titled Light Fixture with Central Lighting Housing and Peripheral Cooling Housing, which is herein entirely incorporated by reference.

BACKGROUND

The present invention relates to light fixture cooling features, and particularly, to providing a light fixture with internal and external surfaces and cooling paths to facilitate cooling.

Managing the temperature of light sources in a light fixture is generally important to performance and longevity. This is particularly true with newer highly efficient lighting technology, for example, light sources such as LEDs or laser diodes. LEDs are generally selected to maximize the light output for a given power consumption at a reasonable cost. Because LED light sources operate at a much lower temperature than typical incandescent light sources, less energy is wasted in the form of heat production. However, LEDs tend to be more sensitive to operating temperature and lower operating temperatures also provide a much smaller temperature difference between the LED and the ambient environment, thus requiring greater attention to thermal management to transfer and dissipate any excess heat generated by the LED driver and emitter so that the design operating temperature for the components are not exceeded.

As temperatures rise, the efficacy of the LED is reduced, reducing the light output, and reducing the lifespan of the LED. LED lighting fixtures generally include both LED drivers and LED emitters. To facilitate dissipation of heat, convection, conduction, and radiation are available modes of heat transfer. For LED light fixtures, dissipation of heat by conduction is often provided by one or more LED packages being mounted on a heat sink The heatsink is generally integral with or thermally coupled with the light housing, which often includes external cooling fins to further facilitate the dissipation of heat from the light fixture by convection and radiation.

For example, one prior art design seeking to address these concerns provides fins between a central light housing and an outer rim that are thin in width and height, and thus provide vary little surface area to transfer heat from the light to the channel of air passing through the light fixture. Additionally, no structure limits visibility vertically through the cooling channels or redirects airflow horizontally across further surfaces of such a light fixture mounted to a ceiling or similar overhanging structure.

Another prior art design seeking to address these concerns provides a very narrow set of vertical airflow channels around the periphery of the central light housing, the channels formed by an outer ring and vertical cooling fins, and the vertical cooling fins extend radially inwardly above and toward the center of the central light housing. Thus, in the case of mounting the light fixture against a ceiling, any airflow extending upwardly through the very narrow airflow channels flows outwardly between the ceiling and top of the light fixture, and thus will not benefit provide from further heat exchange if the air flow had included flow across the radially inwardly extending fins on the top side of the central light housing.

Therefore, it is desirable to provide a lighting fixture design that maximizes cooling by thermal convection for the light emitter and driver in a central light package housing, shields the cooling features and through the fixture view from as many viewing angles as practical, and redirects vertical airflow to a radially outwardly direction and across further cooling structure when mounted against a ceiling.

SUMMARY

The present invention may comprise one or more of the features recited in the attached claims, and/or one or more of the following features and combinations thereof. An illustrative light fixture includes a cylindrical lighting package housing surrounded peripherally by a cooling housing providing airflow cooling channels. The airflow cooling channels are defined in the space between the circumference of the cylindrical lighting package housing and a rim around the periphery of the light fixture. The cooling housing provides wide and long openings for cool air to rise vertically from below the light fixture into the airflow channels defined in part by cooling fins and a horizontally arranged radial ring supporting the cooling fins. The airflow continues through radial exit channels, providing radially outward flow below a ceiling the fixture is mounted on. The arrangement of the radial ring fin support between the vertical cooling fins also eliminates or minimizes the view through the airflow channels and to the ceiling.

An illustrative embodiment of the light fixture includes a light package housing including emitters; an illumination side of the light package housing, the emitters projecting light from the illumination side; a top side of the light package housing, located opposite the illumination side; and a cooling housing extending peripherally around an outer circumference of the light package housing, the cooling housing including a plurality of cooling fins, a rim, and a radial ring fin support. The rim can couple the cooling fins around an outer circumference of the cooling housing, the plurality of cooling fins can span radially between the outer circumference of the light package housing, and the radial ring fin support can radially spans a portion of adjacent vertical fins between the rim and the outer circumference of the light package.

The radial ring fin support can form an annulus extending from the rim and inwardly toward the outer circumference of the light package housing such that a vertical cooling channel remains between the radial ring fin support, the outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins. The radial ring fin support can span a substantial portion of the vertical openings between the rim, the outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins. The bottom side of the radial ring fin support can redirect radially inwardly at least a substantial portion of the vertical cooling channel path extending upwardly from a bottom side of the support and between adjacent ones of the plurality of cooling fins.

The top side of the light package housing can include a flat portion for mounting the light fixture to a ceiling. The top side of the radial ring fin support, ceiling, and adjacent ones of the plurality of cooling fins can form cooling paths extending radially outward from an upper portion of the outer circumference of the light package housing. The light package housing can be about cylindrical.

The light package housing can further include at least one emitter driver and the cooling housing surrounds the outer

circumference of the portion of the light package housing containing the at least one emitter driver. The cooling housing can surround the outer circumference of the portion of the light package housing containing the emitters.

The rim can spans vertically from the illumination side to the top side. The plurality of cooling fins can each include a top edge adjacent the outer circumference of the lighting package housing that is about coplanar with the top surface of the lighting package housing.

Another illustrative embodiment of a light fixture, includes a light package housing including emitters; an illumination side of the light package housing, the emitters projecting light from the illumination side; a top side of the light package housing, located opposite the illumination side; a cooling housing extending peripherally around an outer circumference of the light package housing, the cooling housing including a plurality of cooling fins, a rim, and a radial ring fin support; and a plurality of vertical cooling channels defined between the rim, outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins. The rim can couple the cooling fins around an outer circumference of the cooling housing; the plurality of cooling fins can span radially between the outer circumference of the light package housing; and the radial ring fin support can radially span a portion of adjacent vertical fins between the rim and the outer circumference of the light package, a bottom side of the radial ring fin support redirects radially inwardly, toward the light package housing, each of the plurality of vertical cooling channels.

Yet another illustrative light fixture, includes a light package housing including emitters; an illumination side of the light package housing, the emitters projecting light from the illumination side; a top side of the light package housing, located opposite the illumination side; a cooling housing extending peripherally around an outer circumference of the light package housing, the cooling housing including a plurality of cooling fins, a rim, and a radial ring fin support; and a plurality of vertical cooling channels defined between the rim, outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins. The rim can couple the cooling fins around an outer circumference of the cooling housing; the plurality of cooling fins can span radially between the outer circumference of the light package housing; and the radial ring fin support can forms an annulus extending from the rim and inwardly toward, but not touching, the outer circumference of the light package housing, and a bottom side of the radial ring fin support redirects radially inwardly, toward the light package housing, each of the plurality of vertical cooling channels.

Additional features of the disclosure will become apparent to those skilled in the art upon consideration of the following detailed description of the illustrative embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description particularly refers to the accompanying figures in which:

FIG. **1** is a side view of an illustrative lighting fixture according to the present invention mounted on a ceiling;

FIG. **2** is a top view of the lighting fixture of FIG. **1**;

FIG. **3** is a bottom view of the lighting fixture of FIG. **1**;

FIG. **4** is a bottom side perspective section view of the lighting fixture of FIG. **1**, taken along sections line **4-4** shown in FIG. **2**;

FIG. **5** is a top perspective section view of the lighting fixture of FIG. **1**, taken along section line **5-5** shown in FIG. **1**;

FIG. **6** is a top perspective section view of the lighting fixture of FIG. **1**, taken along section line **6-6** shown in FIG. **1**; and

FIG. **7** is a bottom side perspective exploded view of the lighting fixture of FIG. **1**;

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

For the purposes of promoting and understanding the principals of the invention, reference will now be made to one or more illustrative embodiments illustrated in the drawings and specific language will be used to describe the same.

Referring to FIGS. **1-4**, a first illustrative embodiment of a light fixture **30** according to the present invention is illustrated. The light fixture **30** includes a light source **32**, including an emitter **34** (FIG. **2**; as used herein, "emitter" refers to a single emitter or an array of emitters) and a driver **36** (FIGS. **4-5**; as used herein, "driver" refers to a single driver or an array of drivers), contained within a central, cylindrical light package housing **50**. The light fixture **30** also includes a cooling housing **60** encircling an outer circumference **52** of the light package housing **50**.

The light source **32** may be, but is not limited to, an LED emitter **34** and associated driver **36**, as are typically used in the commercial lighting industry. For example, the associated driver **36** converts AC power to appropriate DC power and may also include additional LED power and control features.

The light package housing **50** and cooling housing **60** can be formed from, for example, die cast aluminum or an aluminum alloy. The housings **50** and **60** may be separately formed, integrally formed, or a portion of housing **50** may be integrally formed with housing **60**, or vice-versa. The emitter **34** can be thermally coupled and mounted to the light package housing **50**, which is thermally coupled to the cooling housing **60**. For example, as shown in FIG. **7**, the emitters **34** can be coupled with annular heat transfer surface **53**, which are thermally coupled and/or integrally formed with vertical cooling fins **74** (discussed below).

As it typical of commercial lighting fixtures, the light package housing **50** may also include components that enclose the emitter **34** within light package housing **50**, for example, including a light reflector **54** and lens or other cover **56** adjacent a bottom, illumination side **58**. The light package housing **50** further houses and may enclose the driver **36**, for example, adjacent a top side **59**, opposite the illumination side **58**. The top side **59** can be coupled to a ceiling **100** or other mounting, structural, or non-structural member.

Referring to FIGS. **1-4**, the cooling housing **70** defines a rim **72** around on outer circumference and a plurality of cooling fins **74** coupled between the outer circumference **52** of the light package housing **50** and the rim **72**. The cooling housing **70** also defines a shroud **76** on the illumination side **58**, and a radial ring fin support **78** nearer the top side **59**. From the illumination side **58**, the shroud **76** defines windows exposing openings **77** between adjacent cooling fins **74** and extending radially between the rim **72** and the outer circumference **52** of the light package housing **50** (FIGS. **3** and **4**). From the top side **59**, openings **79** are defined between adjacent cooling fins **74** and extend radially between the radial ring fin support **78** and the outer circumference **52** of the light package housing **50** (FIGS. **2** and **4**).

The plurality of fins **74** are in thermal conductivity with the emitters **34** and dissipate heat from the emitters to the surrounding environment. More specifically, referring to FIG. **4**, the first airflow cooling channels **92** are defined through openings **77** by the space between the rim **72**, the outer circumfer-

ence **52** of the light package housing **50**, and each adjacent fin **74**. The cooling channels **92** extend vertically from the bottom side **58** at openings **77**, upwardly toward and along the bottom side of radial ring fin support **78**, through openings **79** on the top side **79**, and radially outward toward rim **72** and between fins **74** and along a top side of the radial ring fin support **78**, as indicated by second airflow cooling channels **94** in FIGS. **2** and **4**.

Advantageously, the above described and illustrated structure provides a path for cool air to flow upwardly into through openings **77**, for heat from the light fixture **30** to be transferred into the airflow from the fins **74**, radial ring fin support **74**, and outer circumference **52** of the light package housing, and for the heated air to exit through openings **79** and flow away from the light fixture **30**. Optionally, the cooling fins **74** can be parallel, and/or evenly spaced, as shown in FIGS. **1-3**. The first and second airflow cooling channels **92** and **94** span around the circumference of the light fixture **30** between the rim **72** and outer circumference **52** of the light package housing **50**, except where interrupted by shroud **76** between adjacent openings **77** (FIG. **3**).

Advantageously, radial ring fin support **78** provides support to the fins **74** and more surface area for convective and radiant heat transfer to the surrounding air than the fins **74** and outer circumference **52** of the light package housing **50** alone provide. Also advantageously, stylistic aspects of the rim **72**, shroud **76**, and the radial ring fin support **78** and their relative arrangement provide a more aesthetically appealing appearance of the light fixture **30**, limiting the spiny look typical of LED lighting fixtures covered with cooling fins, while also retaining the needed cooling surface area, cooling air paths, and arrangement of the cooling fins **74** projecting beyond the outer circumference of the light package housing **50**. For example, in addition to any functionality provided, the rims **72**, shroud **76**, and radial ring fin support **78** also aesthetically conceal portions of the light fixture **30**, and eliminate or substantially limit the vertical see through of the ceiling **100** from the illumination side **58**. As shown in FIG. **3**, only a narrow band **102** of the ceiling **100** is visible through the windows **77** and radially inside of the radial ring fin support **78**. Adding further aesthetic appeal, the illumination side of the cooling housing **60** can slope upwardly between the outer circumference **52** of the light package housing **50** and rim **72**, and the top side of the cooling housing **60** can slope downwardly between the outer circumference of the light package housing and rim.

While the invention has been illustrated and described in detail in the foregoing drawings and description, the same is to be considered as illustrative and not restrictive in character, it being understood that only illustrative embodiments thereof have been shown and described and that all changes and modifications that come within the spirit and scope of the invention as defined in the claims and summary are desired to be protected.

The invention claimed is:

1. A light fixture, comprising:
- an light package housing including emitters;
- an illumination side of the light package housing, the emitters projecting light from the illumination side;
- a top side of the light package housing, located opposite the illumination side; and
- a cooling housing extending peripherally around an outer circumference of the light package housing, the cooling housing including a plurality of cooling fins, a rim, and a radial ring fin support; and wherein:
- the rim couples the cooling fins around an outer circumference of the cooling housing;
- the plurality of cooling fins span radially between the outer circumference of the light package housing and the rim; and
- the radial ring fin support radially spans a portion of adjacent vertical fins between the rim and the outer circumference of the light package.

2. The light fixture of claim **1**, wherein the radial ring fin support forms an annulus extending from the rim and inwardly toward the outer circumference of the light package housing such that a vertical cooling channel remains between the radial ring fin support, the outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins.

3. The light fixture of claim **1**, wherein the radial ring fin support spans a substantial portion of the vertical openings between the rim, the outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins.

4. The light fixture of claim **1**, wherein the bottom side of the radial ring fin support redirects radially inwardly at least a substantial portion of the vertical cooling channel path extending upwardly from a bottom side of the support and between adjacent ones of the plurality of cooling fins.

5. The light fixture of claim **1**, wherein the top side of the light package housing includes a flat portion for mounting the light fixture to a ceiling.

6. The light fixture of claim **5**, wherein the top side of the radial ring fin support, ceiling, and adjacent ones of the plurality of cooling fins form cooling paths extending radially outward from an upper portion of the outer circumference of the light package housing.

7. The light fixture of claim **1**, wherein the light package housing is about cylindrical.

8. The light fixture of claim **1**, wherein the light package housing further includes at least one emitter driver and the cooling housing surrounds the outer circumference of the portion of the light package housing containing the at least one emitter driver.

9. The light fixture of claim **1**, wherein the cooling housing surrounds the outer circumference of the portion of the light package housing containing the emitters.

10. The light fixture of claim **1**, wherein the rim spans vertically from the illumination side to the top side.

11. The light fixture of claim **1**, wherein the plurality of cooling fins each include top edge adjacent the outer circumference of the lighting package housing that is about coplanar with the top surface of the lighting package housing.

12. A light fixture, comprising:
- an light package housing including emitters;
- an illumination side of the light package housing, the emitters projecting light from the illumination side;
- a top side of the light package housing, located opposite the illumination side;
- a cooling housing extending peripherally around an outer circumference of the light package housing, the cooling housing including a plurality of cooling fins, a rim, and a radial ring fin support; and,
- a plurality of vertical cooling channels defined between the rim, outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins; and wherein:
- the rim couples the cooling fins around an outer circumference of the cooling housing;
- the plurality of cooling fins span radially between the outer circumference of the light package housing; and
- the radial ring fin support radially spans a portion of adjacent vertical fins between the rim and the outer circumference of the light package, a bottom side of the radial

ring fin support redirects radially inwardly, toward the light package housing, each of the plurality of vertical cooling channels.

13. The light fixture of claim **12**, wherein the radial ring fin support forms an annulus extending from the rim and inwardly toward the outer circumference of the light package housing.

14. The light fixture of claim **12**, wherein the radial ring fin support spans a substantial portion of the vertical openings between the rim, the outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins.

15. The light fixture of claim **12**, wherein the top side of the light package housing includes a flat portion for mounting the light fixture to a ceiling.

16. The light fixture of claim **15**, wherein the top side of the radial ring fin support, ceiling, and adjacent ones of the plurality of cooling fins form cooling paths extending radially outward from an upper portion of the outer circumference of the light package housing.

17. The light fixture of claim **12**, wherein the light package housing is about cylindrical.

18. The light fixture of claim **12**, wherein the light package housing further includes at least one emitter driver and the cooling housing surrounds the outer circumference of the portion of the light package housing containing the at least one emitter driver.

19. The light fixture of claim **12**, wherein the cooling housing surrounds the outer circumference of the portion of the light package housing containing the emitters.

20. A light fixture, comprising:

an light package housing including emitters;

an illumination side of the light package housing, the emitters projecting light from the illumination side;

a top side of the light package housing, located opposite the illumination side;

a cooling housing extending peripherally around an outer circumference of the light package housing, the cooling housing including a plurality of cooling fins, a rim, and a radial ring fin support; and,

a plurality of vertical cooling channels defined between the rim, outer circumference of the light package housing, and adjacent ones of the plurality of cooling fins; and wherein:

the rim couples the cooling fins around an outer circumference of the cooling housing;

the plurality of cooling fins span radially between the outer circumference of the light package housing; and

the radial ring fin support forms an annulus extending from the rim and inwardly toward, but not touching, the outer circumference of the light package housing, and a bottom side of the radial ring fin support redirects radially inwardly, toward the light package housing, each of the plurality of vertical cooling channels.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,985,816 B2
APPLICATION NO. : 13/908526
DATED : March 24, 2015
INVENTOR(S) : Vincenzo Guercio, Jiang Hu and Dan Wang-Munson

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In Column 5, Line 57, please delete the word “an” and insert the word --a--;

In Column 6, Line 6, after the words “light package” please add the word --housing--;

In Column 6, Line 15, please delete the word “the”;

In Column 6, Line 18, please delete the word “the” second occurrence and insert the word --a--;

In Column 6, Line 20, please delete the word “the” and insert the word --a--;

In Column 6, Line 21, after the word “the” please add the words --radial ring fin--;

In Column 6, Line 35, please delete the word “the” first occurrence and insert the word --an-- and delete the word “the” second occurrence and insert the word --a--;

In Column 6, Line 39, please delete the word “the” first occurrence and insert the word --an-- and delete the word “the” second occurrence and insert the word --a--.

Signed and Sealed this
Tenth Day of November, 2020

Andrei Iancu
Director of the United States Patent and Trademark Office

EXHIBIT C

US00D745202S

(12) United States Design Patent

Guercio et al.

(10) Patent No.: US D745,202 S
(45) Date of Patent: ** Dec. 8, 2015

(54) **BULLET SHAPED LED FLOOD LIGHT**

(71) Applicant: **RAB Lighting Inc.**, Northvale, NJ (US)

(72) Inventors: **Vincenzo Guercio**, Wallkill, NY (US); **Jiang Hu**, Ningbo (CN)

(73) Assignee: **RAB Lighting Inc.**, Northvale, NJ (US)

(**) Term: **14 Years**

(21) Appl. No.: **29/488,867**

(22) Filed: **Apr. 24, 2014**

(51) **LOC (10) Cl.** **26-03**

(52) **U.S. Cl.**
USPC **D26/63**

(58) **Field of Classification Search**
USPC D26/1, 24, 61, 63, 65, 85, 92
CPC F21V 21/14; F21V 15/01; F21V 14/02; F21V 21/30; F21V 21/00; F21V 14/00; F21S 8/00; F21S 8/003; F21S 8/043; F21Y 2105/001
See application file for complete search history.

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Primary Examiner — Brian N Vinson
(74) *Attorney, Agent, or Firm* — SmithAmundsen LLC; Kelly J. Smith; Dennis S. Schell

(57) **CLAIM**

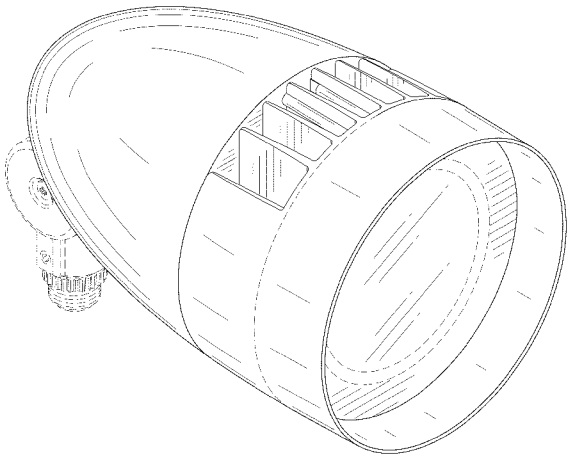
The ornamental design for a bullet shaped LED flood light, as shown and described.

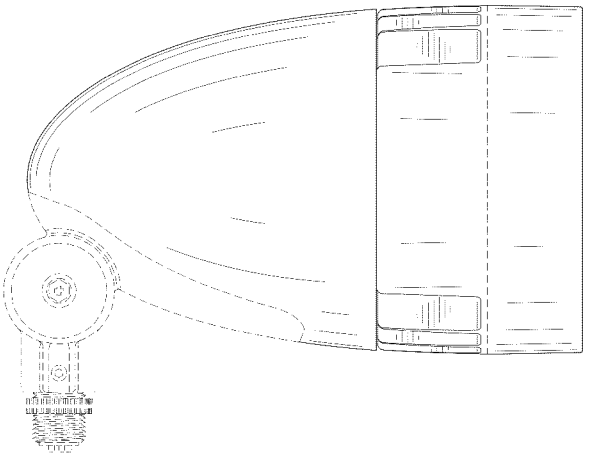
DESCRIPTION

FIG. **1** is a front perspective view of a first embodiment of the new design;
FIG. **2** is a rear perspective view of the first embodiment;
FIG. **3** is a bottom perspective view of the first embodiment;
FIG. **4** is a front view of the first embodiment;
FIG. **5** is a rear view of the first embodiment;
FIG. **6** is a top view of the first embodiment;
FIG. **7** is a bottom view of the first embodiment;
FIG. **8** is a left side view of the first embodiment;
FIG. **9** is a right side view of the first embodiment;
FIG. **10** is a front perspective view of a second embodiment of the new design;
FIG. **11** is a bottom perspective view of the second embodiment; and,
FIG. **12** is a front view of the second embodiment.

The broken lines shown in the drawings are for the purpose of illustrating portions of the article that form no part of the claimed design. The rear perspective view, rear view, top view, bottom view, left side view, and right side view of the second embodiment are identical to the corresponding views of the first embodiment and are therefore omitted.

1 Claim, 10 Drawing Sheets





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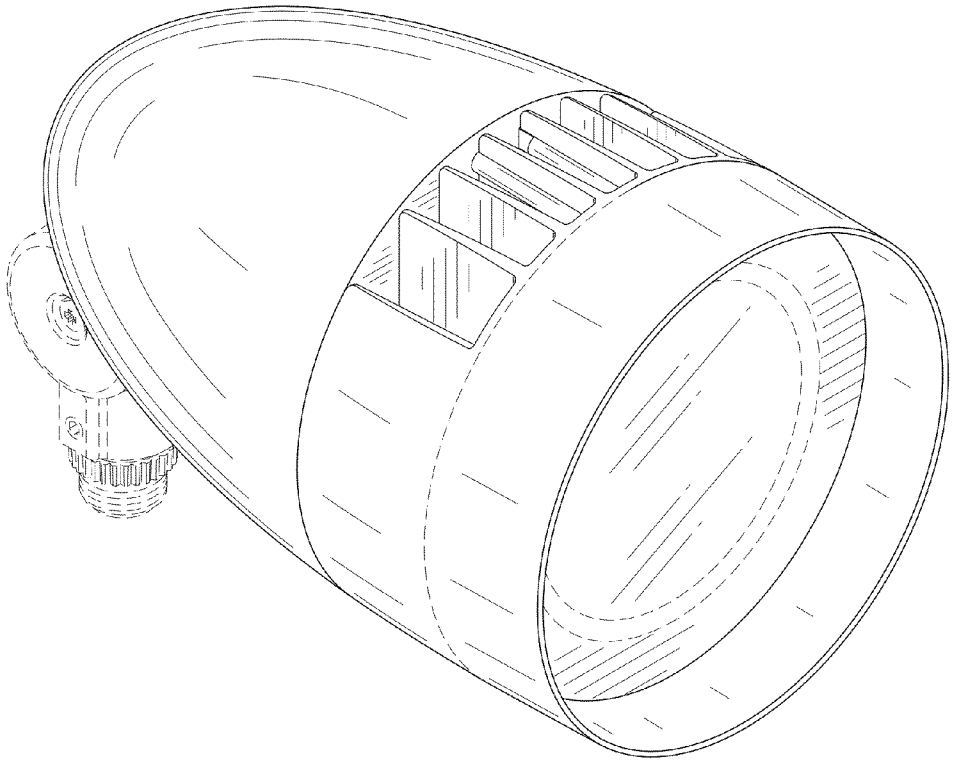

FIG. 1

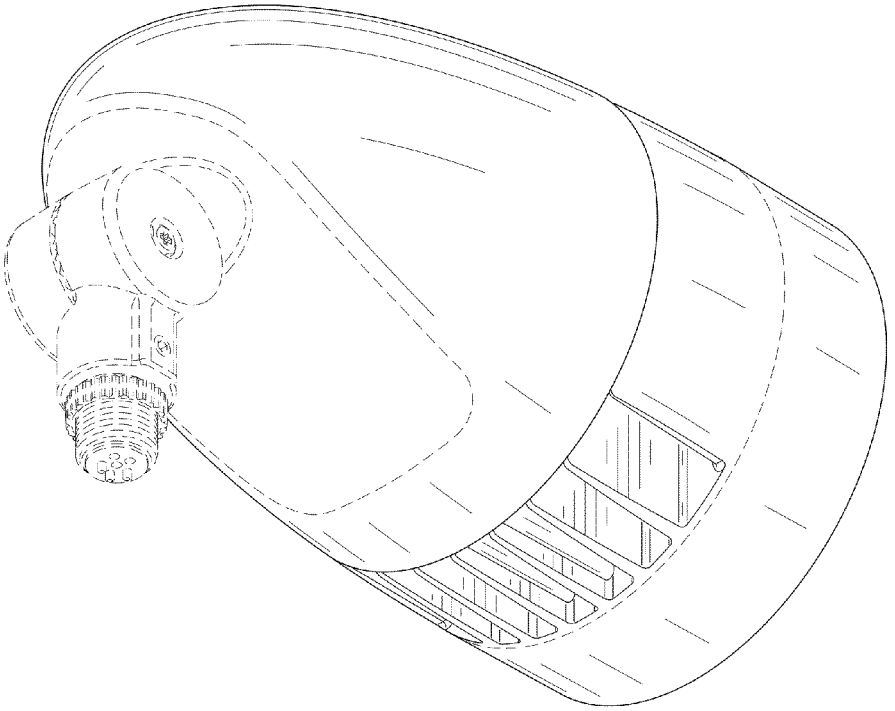

FIG. 2

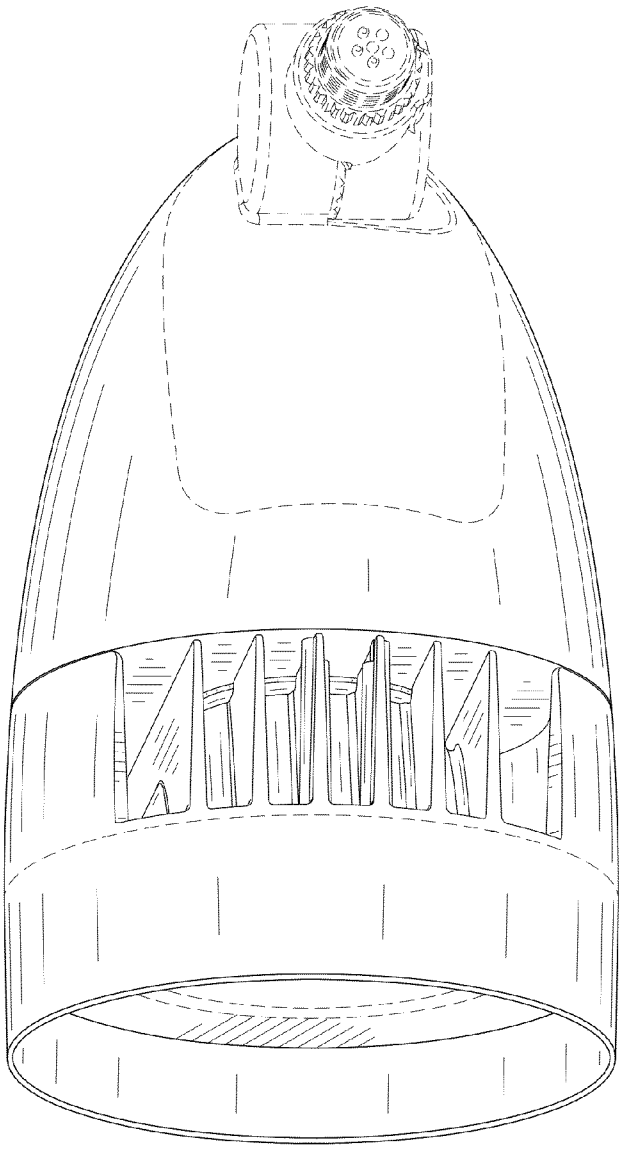

FIG. 3

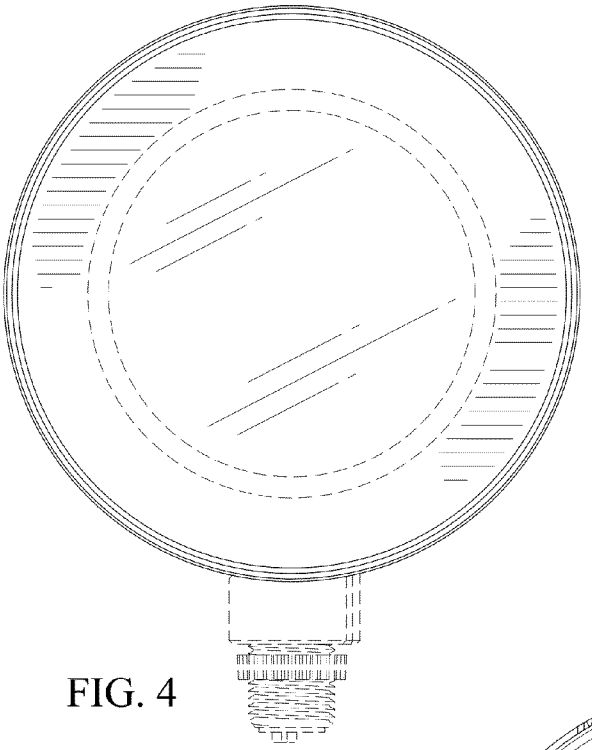

FIG. 4

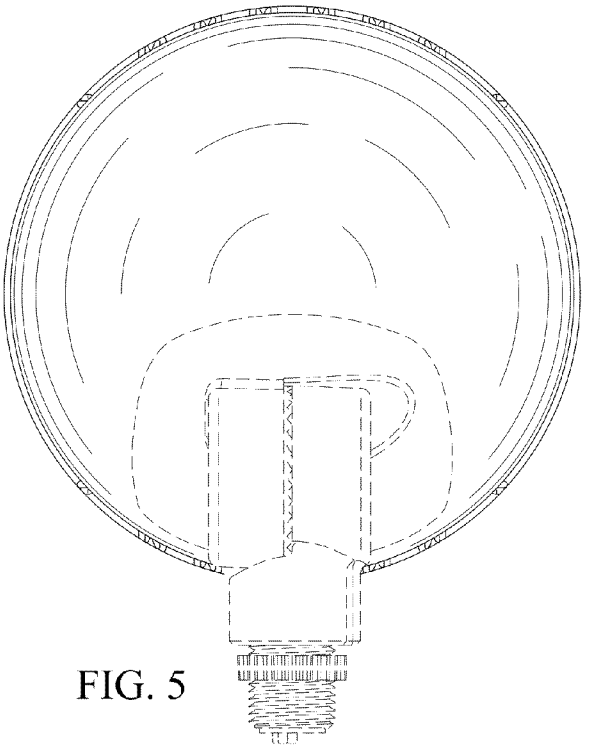

FIG. 5

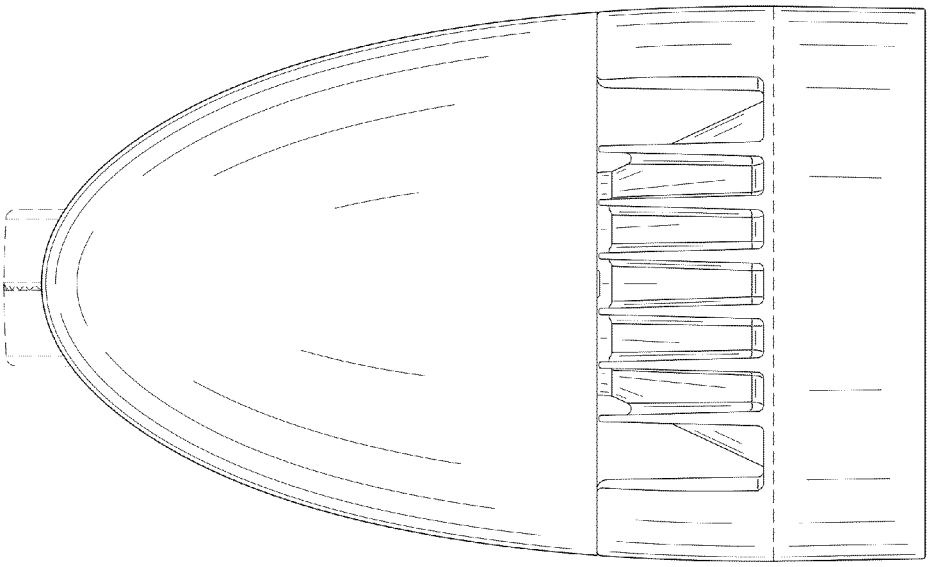

FIG. 6

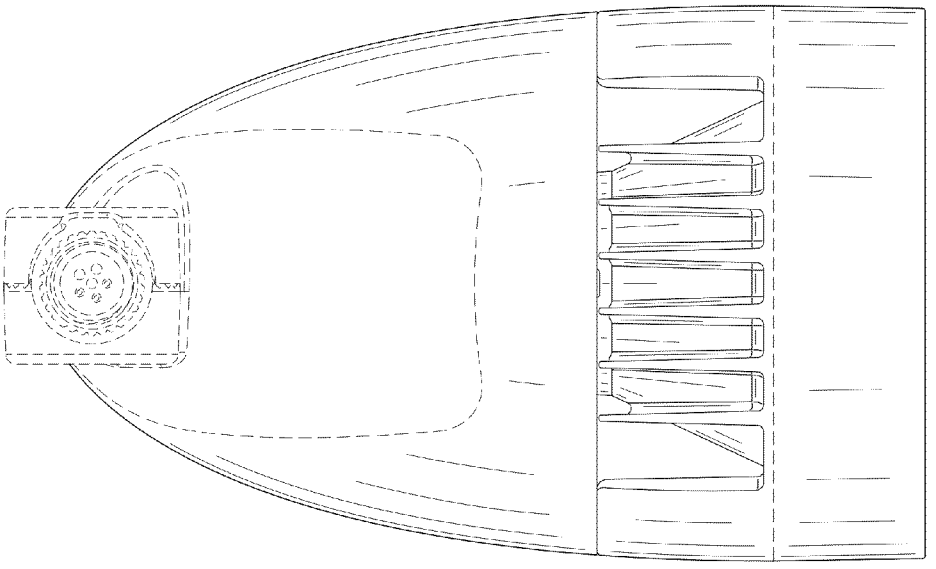

FIG. 7

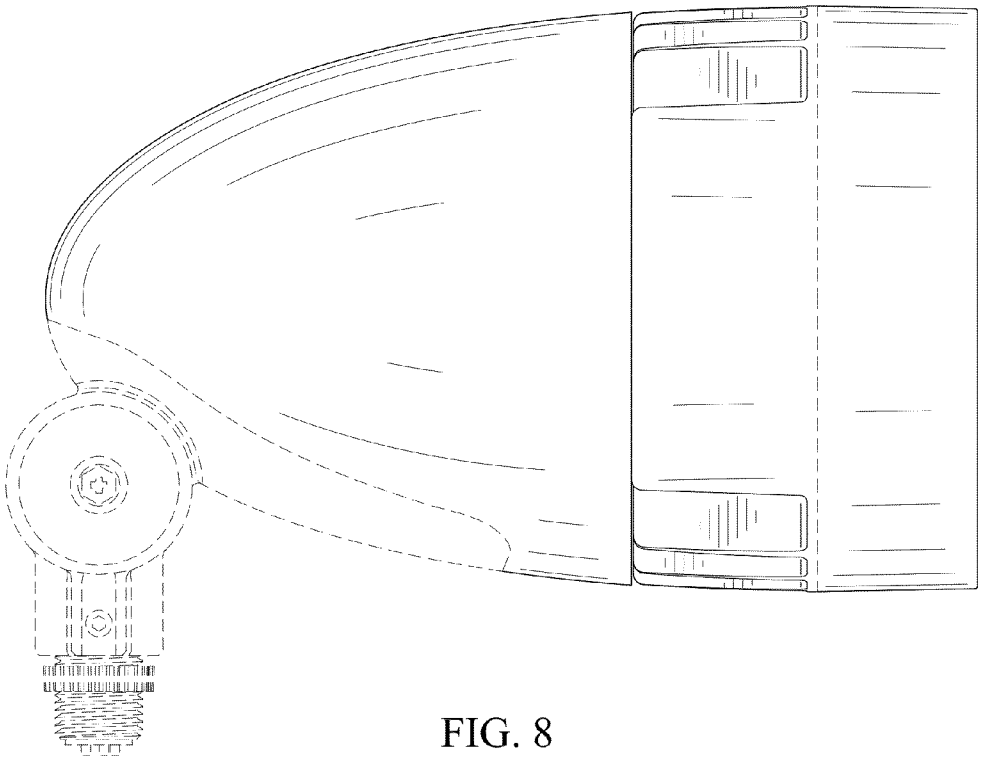

FIG. 8

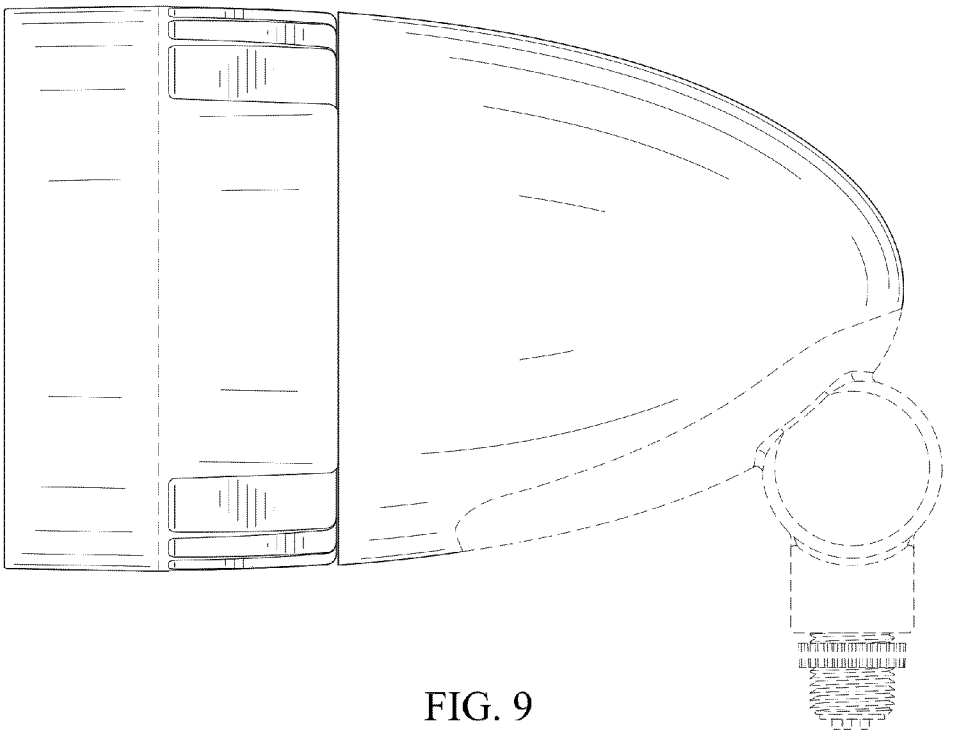

FIG. 9

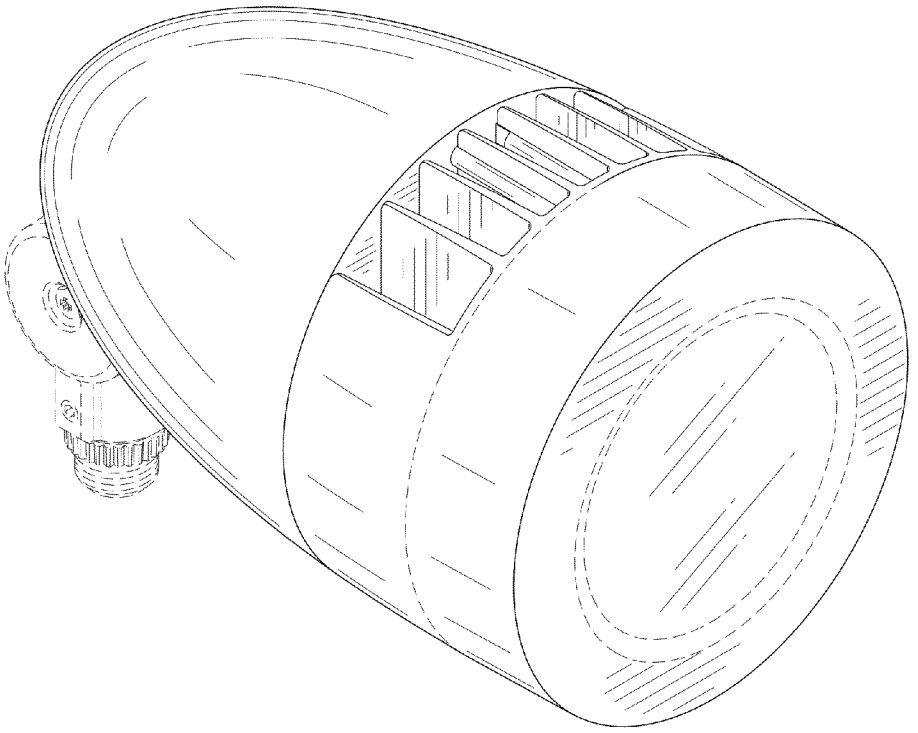

FIG. 10

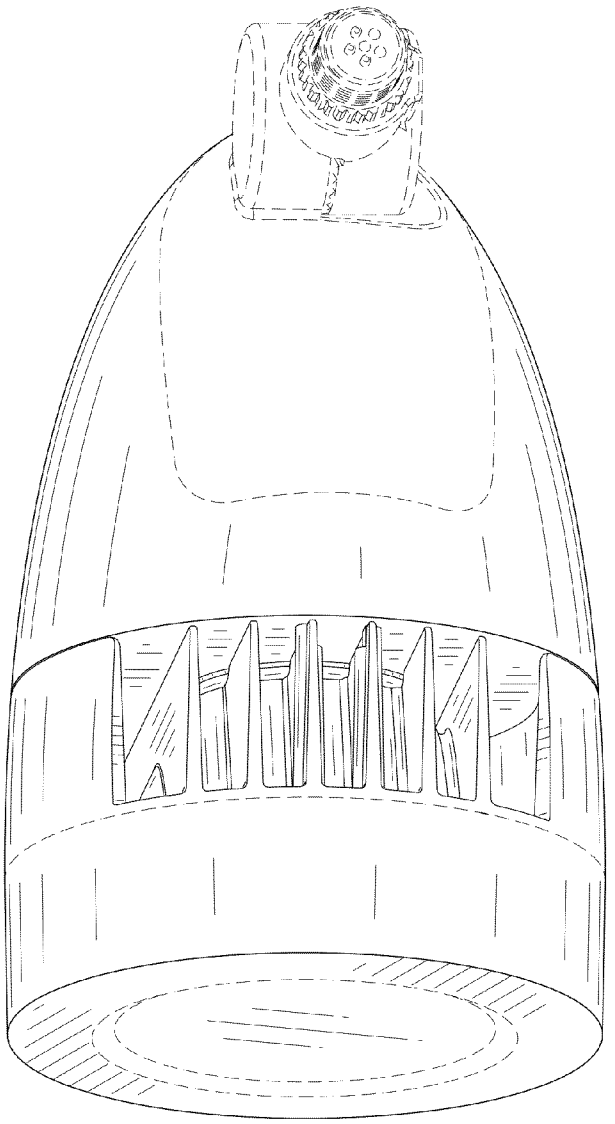

FIG. 11

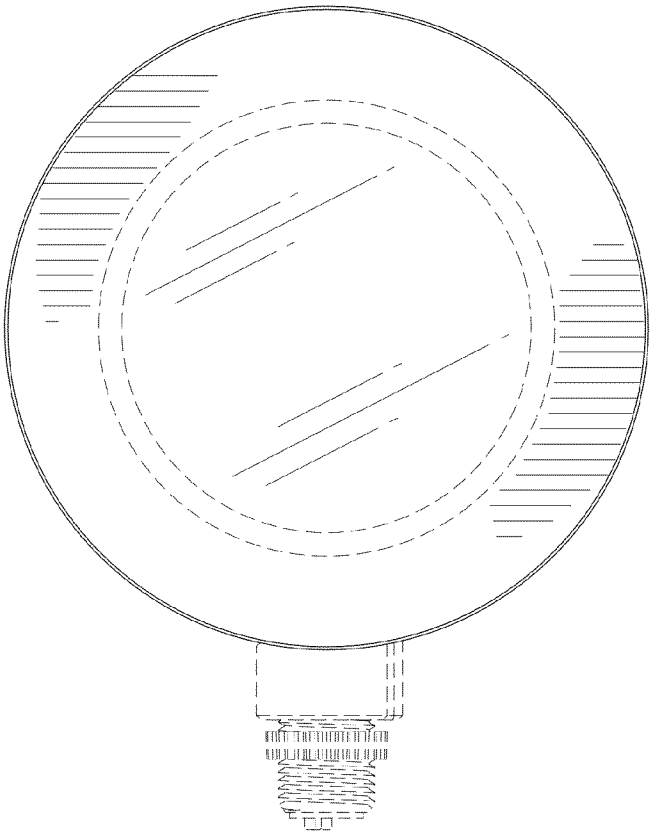

FIG. 12