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**Ivey et al.**

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(54) **METHOD OF FORMING LED-BASED LIGHT AND RESULTING LED-BASED LIGHT**

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(52) **U.S. Cl.** .... **362/294**; 362/218; 362/373; 362/249.06

(58) **Field of Classification Search** .................. 362/218, 362/294, 373, 249.02, 249.06, 249.14
See application file for complete search history.

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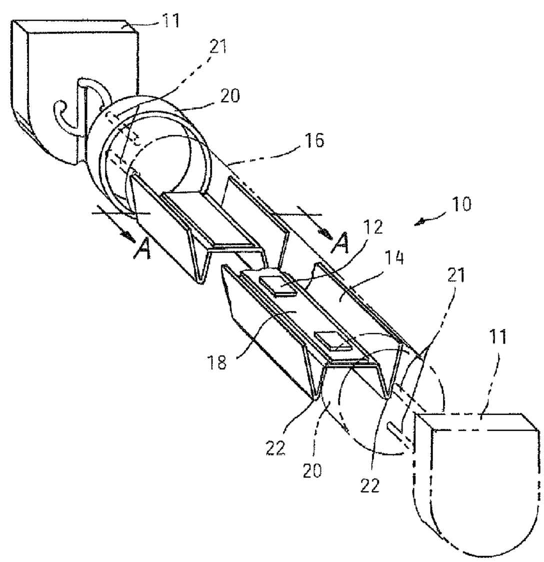
(57) **ABSTRACT**

A method of forming a LED-based light for replacing a conventional fluorescent bulb in a fluorescent light fixture includes shaping an elongate sheet of highly thermally conductive material to fashion a heat sink. Shaping the heat sink allows fashioning the heat sink to define cover and end cap attachment structures, surfaces for mounting LEDs at various angles, and a high surface area to width ratio for dissipating heat.

**22 Claims, 4 Drawing Sheets**



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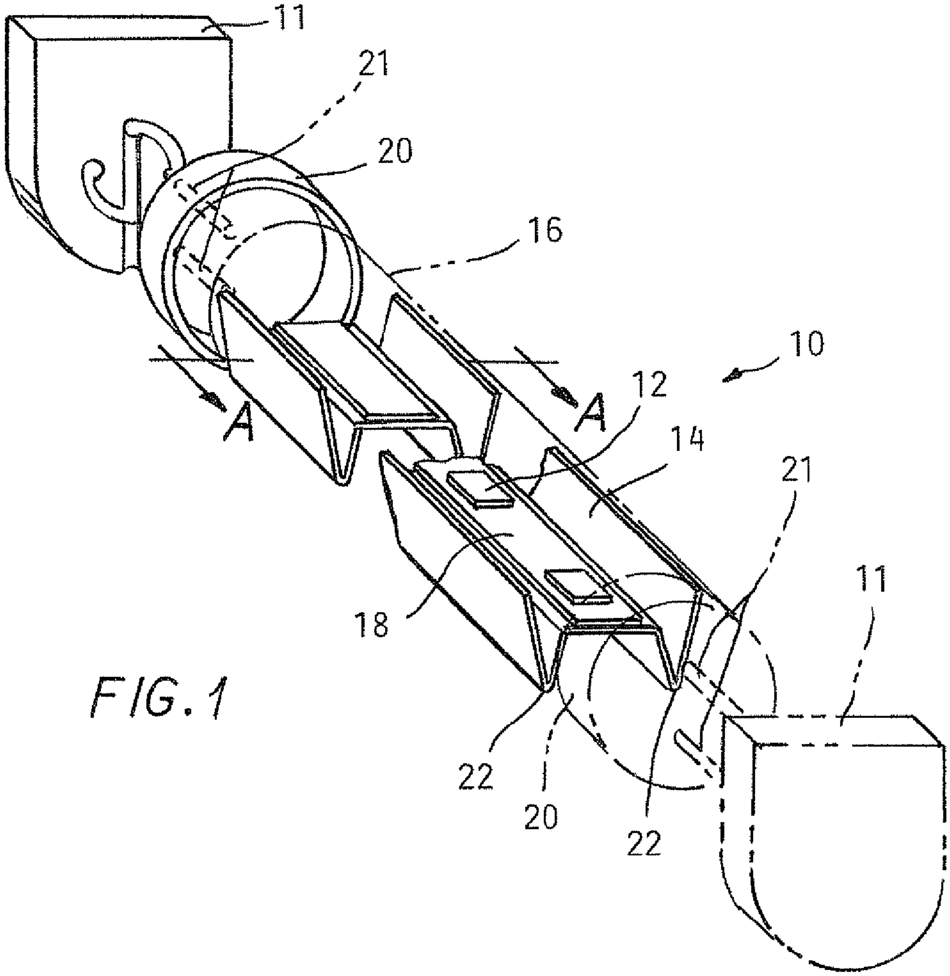
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21
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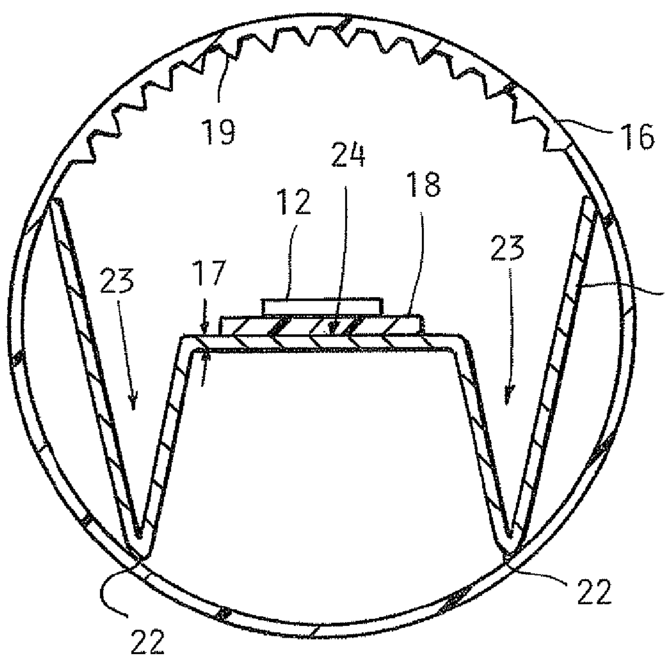
12
A
A
14
21
11
18
22
20
22

FIG. 1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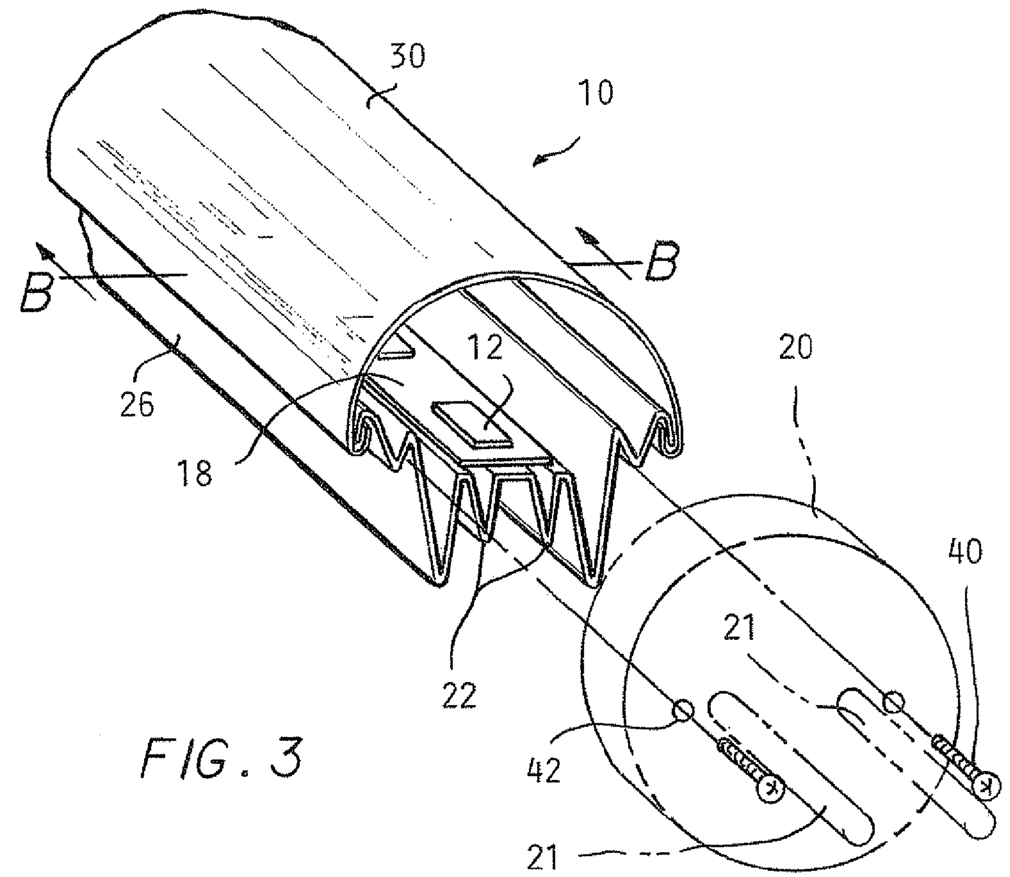
22

FIG. 2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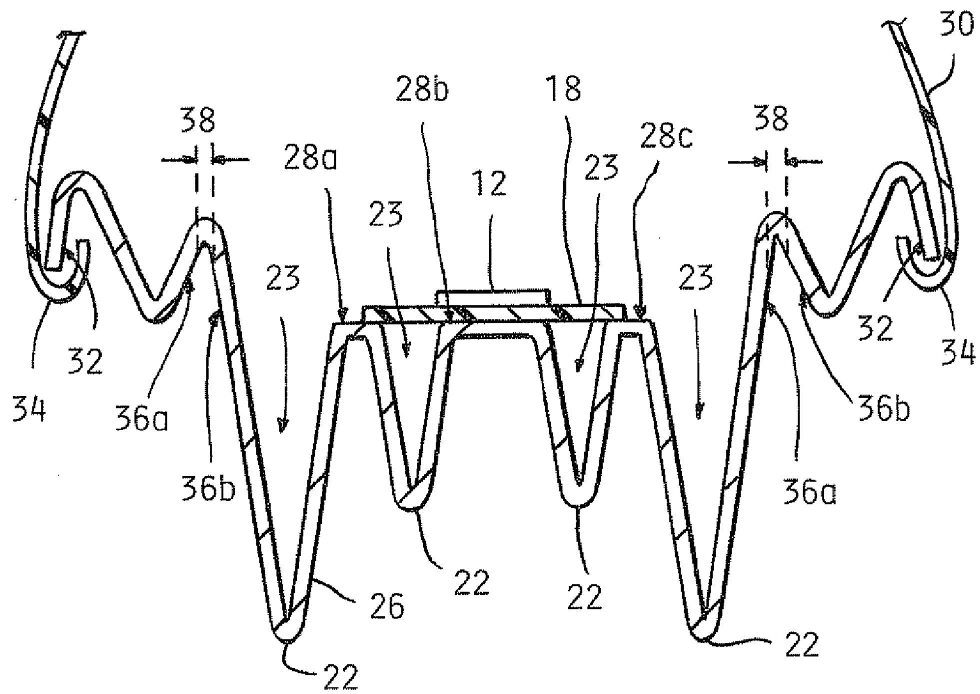
21

FIG. 3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38
28a
12
23
28c
23
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23
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36b
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36b
36a
22
26
22
22
22

FIG. 4

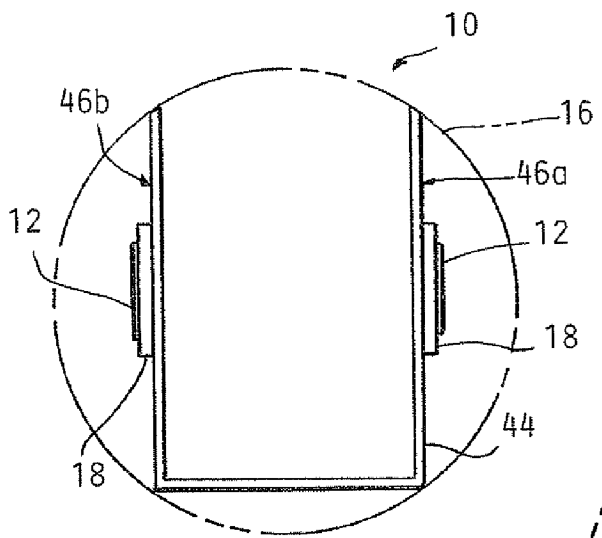


FIG. 5

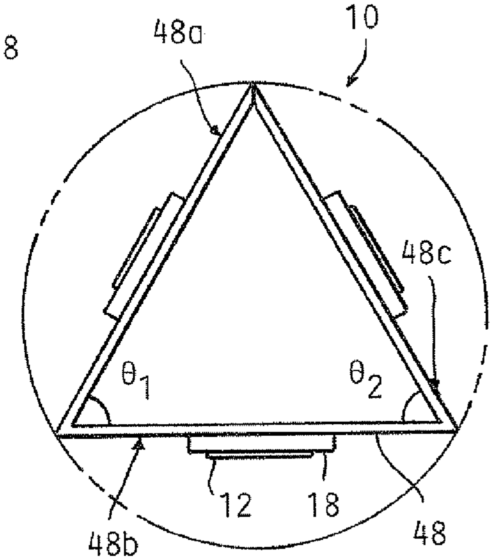


FIG. 6

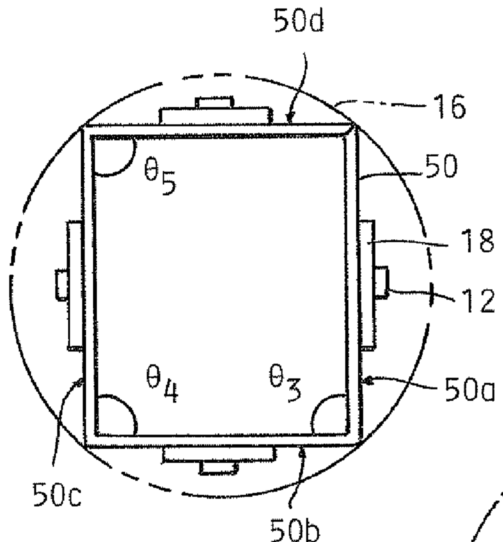


FIG. 7

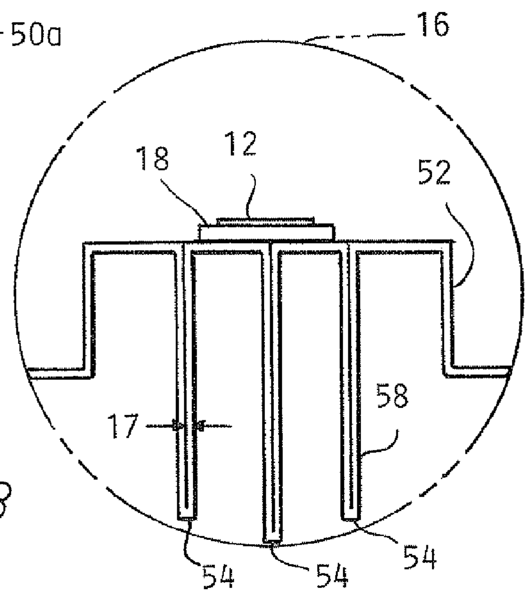


FIG. 8

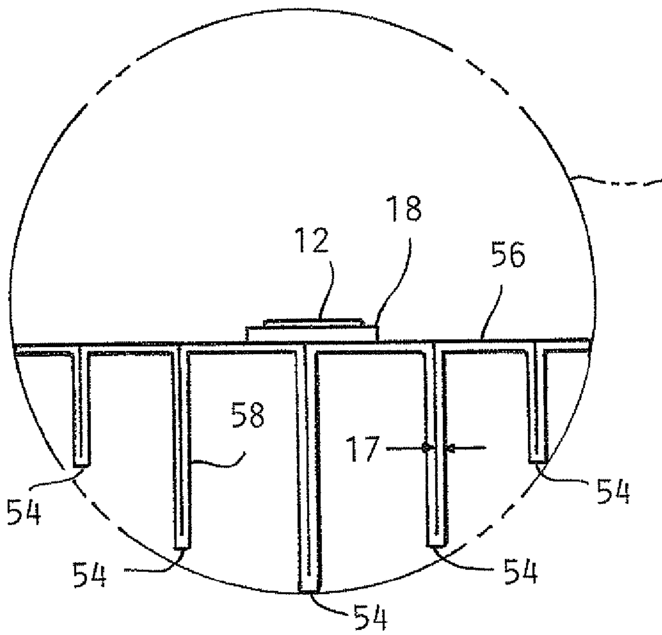


FIG. 9

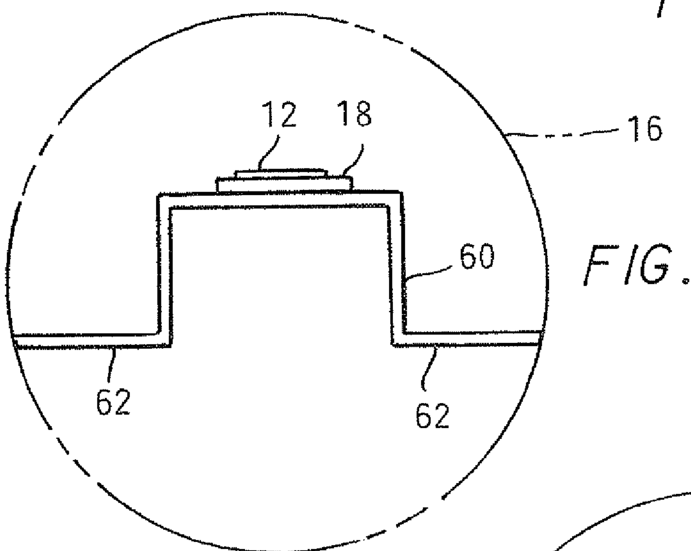


FIG. 10

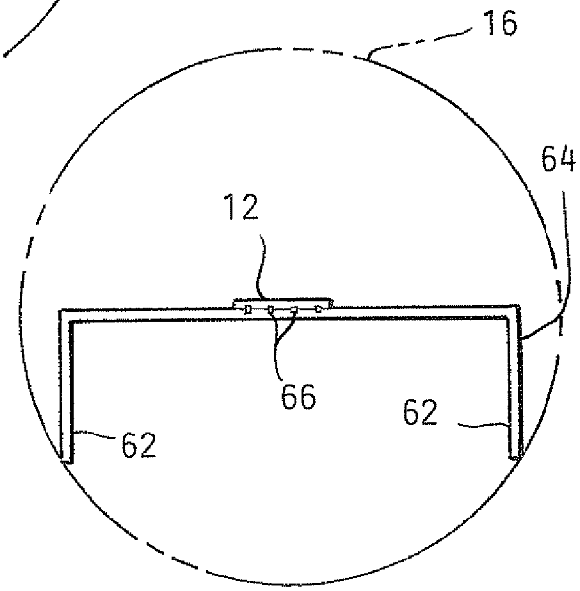


FIG. 11

# METHOD OF FORMING LED-BASED LIGHT AND RESULTING LED-BASED LIGHT

## TECHNICAL FIELD

The present invention relates to a light emitting diode (LED) based light for replacing a conventional fluorescent light in a fluorescent light fixture.

## BACKGROUND

Fluorescent tube lights are widely used in a variety of locations, such as schools and office buildings. Fluorescent tube lights include a gas-filled glass tube. Although conventional fluorescent bulbs have certain advantages over, for example, incandescent lights, they also pose certain disadvantages including, inter alia, disposal problems due to the presence of toxic materials within the glass tube.

LED-based tube lights which can be used as one-for-one replacements for fluorescent tube lights have appeared in recent years. However, LEDs produce heat during operation that is detrimental to their performance. Some LED-based tube lights include heat sinks to dissipate the heat generated by the LEDs, and some of these heat sinks include projections for increasing the surface area of the heat sink. The heat sinks are formed by extruding billets of material, generally aluminum, through a die.

## BRIEF SUMMARY

The present invention provides an LED-based replacement light including a heat sink having a high surface area to width ratio shaped from a flat sheet of thermally conductive material for replacing a conventional fluorescent light in a fluorescent fixture. Compared to an extruded heat sink of a conventional LED-based replacement light, shaping a heat sink from a sheet of highly thermally conductive material can result in a heat sink with a greater surface area to width ratio, and thus a greater ability to dissipate heat. Moreover, a shaped heat sink according to the present invention requires less material to produce and has a lower weight than an extruded heat sink. Further, a shaped heat sink according to the present invention can be produced less expensively than an extruded heat sink. In general, a method of forming an LED-based light according to the present invention includes providing the heat sink by shaping an elongate sheet of highly thermally conductive material to increase the surface area to width ratio thereof. The method also includes mounting a plurality of LEDs in thermally conductive relation with the heat sink along its length, and enclosing the LEDs within a light transmitting cover.

In one illustrative embodiment, an LED-based light formed by the above method for replacing a conventional fluorescent bulb includes a light transmitting cover at least partially defining a tubular housing. A highly-thermally conductive heat sink is engaged with the cover. The heat sink has a high surface area to width ratio. Multiple LEDs are enclosed within the tubular housing and mounted in thermally conductive relation along a length of the heat sink for emitting light through the cover. At least one electrical connector at a longitudinal end of the tubular housing is in electrical communication with the multiple LEDs.

In another illustrative embodiment, an LED-based light for replacing a conventional fluorescent light bulb a fluorescent light fixture includes a hollow, cylindrical light transmitting tube. A heat sink shaped from a sheet of highly thermally conductive material has a width greater than a maximal width of the tube. The heat sink has a central planar portion and two side portions extending perpendicularly to the planar portion from opposing ends of the planar portion. The heat sink is positioned within the tube with the side portions in contact with an interior of the tube. A printed circuit board is mounted on the central planar surface, and multiple longitudinally spaced LEDs are mounted along the length of the circuit board. Two end caps are coupled to opposing ends of the tube, and the end caps carry bi-pin connectors in electrical communication with the circuit board.



## BRIEF DESCRIPTION OF THE DRAWINGS

The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

FIG. **1** is a perspective view of a LED-based replacement light with a heat sink having two longitudinal open fins;

FIG. **2** is a cross-section view of FIG. **1** along line A-A;

FIG. **3** is an exploded perspective view of a LED-based replacement light;

FIG. **4** is a cross-section view of FIG. **3** along line B-B;

FIG. **5** is an end view of a heat sink having opposing facing LEDs positioned in a tube;

FIG. **6** is an end view of a triangular heat sink positioned in a tube;

FIG. **7** is an end view of a rectangular heat sink positioned in a tube;

FIG. **8** is an end view of a first compressed heat sink in a tube;

FIG. **9** is an end view of a second compressed heat sink in a tube;

FIG. **10** is an end view of a first stepped heat sink in a tube; and

FIG. **11** is an end view of a second stepped heat sink in a tube.

## DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Embodiments of an LED-based replacement light **10** according to the present invention are illustrated in FIGS. **1-11**. In an embodiment of the light **10** illustrated in FIG. **1**, the LED-based replacement light **10** includes LEDs **12**, an elongate heat sink **14** shaped from a sheet of highly thermally conductive material, an elongate translucent tube **16**, a circuit board **18**, and end caps **20** carrying bi-pin connectors **21**. The LED-based replacement light **10** can be dimensioned for use in a conventional fluorescent fixture **11**. For example, the LED-based replacement light **10** can be 48" long with an approximately 1" diameter.

The LEDs **12** are preferably high-power, white light emitting LEDs **12**, such as surface-mount devices of a type available from Nichia. The term "high-power" means LEDs **12** with power ratings of 0.25 watts or more. Preferably, the LEDs **12** have power ratings of one watt or more. However, LEDs with other power ratings, e.g., 0.05 W, 0.10 W, or 0.25 W, can alternatively be used. Although the LEDs **12** are shown as surface-mounted components, the LEDs **12** can be discrete components. Also, one or more organic LEDs can be used in place of or in addition to the surface-mounted LEDs **12**. If desired, LEDs that emit blue light, ultra-violet light or other wavelengths of light, such as wavelengths with a frequency of 400-790 THz corresponding to the spectrum of visible light, can alternatively or additionally be included.

The LEDs **12** are mounted along the length of the circuit board **18** to uniformly emit light through a portion of the tube

16. The spacing between the LEDs **12** along the circuit board **18** can be a function of the length of the tube **16**, the amount of light desired, the wattage of the LEDs **12**, the number of LEDs **12**, and the viewing angle of the LEDs **12**. For a 48" light **10**, the number of LEDs **12** may vary from about five to four hundred such mat the light **10** outputs approximately 500 to 3,000 lumens, and the spacing between the LEDs **12** varies accordingly. The arrangement of LEDs **12** on the circuit board **18** can be such as to substantially fill the entire spaced between the end caps **20**. However, LEDs **12** need not be spaced to emit light uniformly.

The circuit board **18** may be made in one piece or in longitudinal sections joined by electrical bridge connectors. The circuit board **18** is preferably one on which metalized conductor patterns can be formed in a process called "printing" to provide electrical connections from the pins **21** to the LEDs **12** and between the LEDs **12** themselves. An insulative board is typical, but other circuit board types, e.g., metal circuit boards, can alternatively be used. Alternatively, a circuit can be printed directly onto the heat sink **14** depending on the heat sink **14** material.

FIG. **2** illustrates a cross-sectional view of the LED-based replacement light **10** of FIG. **1** along line A-A. A sheet of highly thermally conductive material has been shaped into a multi-planar, generally W-shape to fashion the heat sink **14**. The process used to shape the sheet of material can be stamping, punching, deep drawing, bending, roll forming, forging, incremental sheet forming, thermoforming, or another sheet material shaping process. The specific process used can depend on the desired shape of the heat sink **14**, the material properties of the sheet of flat material, and the production batch size. For example, punching may not be suitable to form a heat sink having a very high depth-to-width ratio, in which case deep drawing can be selected. As another example, certain plastics may not be sufficiently ductile for bending while at a normal room temperature and atmospheric pressure, but are formable using thermoforming. As a third example, roll forming may not be economical when a limited size production run is desired, in which case incremental sheet forming may be preferable. Additionally, multiple shaping processes can be carried out on the sheet of thermally conductive material to form a heat sink, examples of which are discussed later in regards to FIGS. **6** to **9**. Also, the heat sink **14** need not be formed into a multi-planar shape. For example, the heat sink can have a curved profile if desired.

The heat conducting material can be aluminum, copper, an alloy, a highly thermally conductive plastic, a combination of materials (e.g., copper plated steel or a plastic impregnated with a metal powder filler), or another material known by one of skill in the art that can be shaped from a sheet to fashion the heat sink **14**. The specific material used can depend on the heat generated by the LEDs **12**, the thermal characteristics of the light **10**, and the process used to shape the material. The material should be plastically deformable under shaping process conditions without fracturing. For example, if the heat sink **14** is to be formed by bending at room temperature and atmospheric pressure, a ductile material such as aluminum is preferably used.

The heat sink **14** can be shaped to include two longitudinally extending, open fins **22**. Open fins **22** are portions of the sheet of material shaped into a "V", resulting in a space or cavity (hereinafter referred to as a depression **23**) between the sides of each open fin **22**. As a result, the sheet of material can have a width prior to shaping that is greater than the maximum width of the tube **16**. Open fins **22** increase the surface area to width ratio of the heat sink **14**, thereby increasing the ability of the heat sink **14** to dissipate heat. A high surface area to



width ratio is a surface area to width ratio greater than twice the length of the heat sink **14** to one, by way of example and not limitation two and a half times the length of the heat sink **14** to one. Further, open fins **22** strengthen the heat sink **14**. While the illustrated fins **22** extend longitudinally, with each fin **22** formed from two relatively obliquely angled integral lengths and of the heat sink **14** that converge at a generally pointed tip, alternative or additional fin shapes are possible. For example, the fins can extend radially instead of longitudinally, or the fins can have squared or U-shaped tips.

The heat sink **14** can also be shaped to include a longitudinally extending planar surface **24**. The circuit board **18** can be mounted on the longitudinally extending planar surface **24** using thermally conductive adhesive transfer tape, glue, screws, a friction fit, and other attachments known to those of skill in the art. Thermal grease can be applied between the circuit board **18** and heat sink **14** if desired.

The tube **16** can be a hollow cylinder of polycarbonate, acrylic, glass, or another transparent or translucent material formed into a tubular shape by, for example, extrusion. The tube **16** can have a circular, oval, rectangular, polygonal, or other cross-sectional shape. The tube **16** can be clear or translucent. If the tube **16** is made of a high-dielectric material, the heat sink **14** is protected from unintentional contact that may transmit a charge resulting from capacitive coupling of the heat sink **14** and circuit board **18** resulting from a high frequency start-up voltage applied by the fixture **11** during installation of the light **10**. However, the heat sink **14** receives less air flow when circumscribed by the tube **16**. The manner in which the heat sink **14** and tube **16** are engaged depends on the structure of the particular heat sink **14** and tube **16**. For example, as illustrated in FIG. **1**, the heat sink **14** can be slidably inserted into the tube **16** and held in place by a friction fit. Alternatively, the heat sink **14** and tube **16** can be attached with glue, double-sided tape, fasteners, or other means known by those of skill in the art.

The light **10** can include features for uniformly distributing light to the environment to be illuminated in order to replicate the uniform light distribution of a conventional fluorescent bulb the light **10** is intended to replace. As described above, the spacing of the LEDs **12** can be designed for uniform light distribution. Additionally, the tube **16** can include light diffracting structures, such as the illustrated longitudinally extending ridges **19** formed on the interior of the tube **16**. Alternatively, light diffracting structures can include dots, bumps, dimples, and other uneven surfaces formed on the interior or exterior of the tube **16**. The light diffracting structures can be formed integrally with the tube **16**, for example, by molding or extrusion, or the structures can be formed in a separate manufacturing step such as surface roughening. The light diffracting structures can be placed around an entire circumference of the tube **16**, or the structures can be placed along an arc of the tube **16** through which a majority of light passes. In addition or alternative to the light diffracting structures, a light diffracting film can be applied to the exterior of the tube **16** or placed in the tube **16**, or the material from which the tube **16** is formed can include light diffusing particles.

Alternatively to the tube **16** illustrated in FIGS. **1** and **2**, the tube can be made from a flat or semi-cylindrical light transmitting cover extending a length and arc of the tube through which the LEDs **12** emit light and a semi-cylindrical dark body portion attached to the light transmitting portion. Due to its high infrared emissivity, the dark body portion dissipates a greater amount of heat to the ambient environment than a lighter colored body.

The end caps **20** as illustrated in FIGS. **1** and **2** carry bi-pin connectors **21** for physically and electrically connecting the LED-based replacement light **10** to the conventional fluorescent light fixture **11**. Since the LEDs **12** are directionally oriented, the light **10** should be installed at a proper orientation relative to a space to be illuminated to achieve a desired illumination effect. Bi-pins connectors **21** allow only two light **10** installation orientations, thereby aiding proper orientation of the light **10**. Also, only two of the four illustrated pins **21** must be active; two of the pins **21** can be "dummy pins" for physical but not electrical connection to the fixture **11**. Alternative end caps can have different connectors, e.g., single pin connectors. Moreover, end caps **20** need not have a cup-shaped body that fits over a respective end of the tube **16**. Alternative end caps can be press fit into the tube **16** or otherwise attached to the LED-based replacement light **10**. Each end cap **20** can include a transformer, if necessary, and any other required electrical components to supply power to the LEDs **12**. Alternatively, the electrical components can reside elsewhere in the LED-based replacement light **10**.

FIGS. **3** and **4** illustrate another embodiment of the light **10** including a heat sink **26** shaped from a sheet of thermally conductive material and engaged with a light transmitting cover **30**. The heat sink **26** is shaped to define three parallel planar surfaces **28***a*, **28***b* and **28***c* with two open fins **22** located between the respective adjacent surfaces. The circuit board **18** spans the fins **22** when mounted to the surfaces **28***a*, **28***b* and **28***c*. This configuration allows additional air flow to the circuit board **18** and increases the surface area of the heat sink **26**. Alternatively, two or greater than three parallel planar surfaces separated by open fins **22** can be included.

The heat sink **26** can be shaped to include at least two longitudinally extending cover retaining surfaces **32**. The cover **30** can include hooked longitudinal edges **34** that abut respective cover retaining surfaces **32** for engaging the cover **30** with the heat sink **26**. The cover retaining surfaces **32** are preferably portions of the inside surfaces of lengths of the heat sink **26** that also define the longitudinal edges of the heat sink **26**. When cover retaining surfaces **32** are portions of the inside surfaces of lengths of the heat sink **26** that also define longitudinal edges of the heat sink **26**, a maximum area of the heat sink **26** remains exposed to the ambient environment surrounding the light **10** after engagement with the cover **30**. Alternatively, the cover retaining surfaces **32** can be any surfaces abutted by the cover **30** for securing the cover **30** to the heat sink **26**. For example, instead of the substantially U-shaped cover **30** illustrated in FIG. **3**, the cover **30** can be nearly cylindrical with the hooked longitudinal edges **34** abutting adjacent cover retaining surfaces located near the middle of the width of a heat sink. Also, the cover retaining surfaces can have alternative shapes to the illustrated flat surfaces. For example, the cover retaining surface can form a groove if the cover includes a "tongue", such as a bulged longitudinal edge.

The heat sink **26** can also be shaped to include two sets of fastening surfaces **36***a* and **36***b* spaced apart in a direction perpendicular to the longitudinal axis of the heat sink **26**. The two fastening surfaces **36***a* and **36***b* are spaced apart at a fastening location by a distance **38** substantially equal to a width of a fastener **40**. The fastener **40** is inserted through an aperture **42** in the end cap **20**, then friction fit, glued, screwed or otherwise attached between the two surfaces **36***a* and **36***b* for securing the end cap **20** to the heat sink **26**. The exact distance **38** the fastening surfaces **36***a* and **36***b* are spaced apart depends on the type of fastener **40**. For example, if the fastener **32** is a self-threading screw, the distance between the surfaces **36***a* and **36***b* can be slightly less than the width of the screw because the self-threading screw creates a concavity in each of the two fastening surfaces **36***a* and **36***b*, thereby preventing movement of the screw relative to the fastening surfaces **36***a* and **36***b*. The surfaces **36***a* and **36***b* can extend longitudinally the length of the heat sink **26** to permit the connection of an end cap **20** at each end of the LED-based replacement light **10**, or the surfaces **36***a* and **36***b* can extend only a portion of the length from one or both ends of the heat sink **26**. As shown, the end cap **20** has two apertures **42** for respective fasteners **40**, but one or more than two connection points are also possible. Shaping the heat sink **26** to include fastening surfaces **36***a* and **36***b* eliminates the need for a separate manufacturing step to configure the heat sink **26** for attachment with end caps **20**.

The cover **30** can be a semi-cylindrical piece of polycarbonate, acrylic, glass, or another translucent material shaped by, for example, extrusion. The cover **30** can have an arced, flat, bent, or other cross-sectional shape. As mentioned above, the cover **30** can include hooked longitudinal edges **34** or other edges configured for engagement with the heat sink **26**. The cover **30** can be clear or translucent. The cover **30** can include light diffracting structures similar to the longitudinally extending ridges **19** illustrated in FIG. **2**. Alternatively, light diffracting structures can include dots, bumps, dimples, and other uneven surfaces formed on the interior or exterior of the cover **30**. The light diffracting structures can be placed around an entire circumference of the cover **30**, or the structures can be placed along an arc of the cover **30** through which a majority of light passes. In addition or alternative to the light diffracting structures, a light diffracting film can be applied to the exterior of the cover **30** or placed between the cover **30** and the heat sink **26**, or the material from which the cover **30** is formed can include light diffusing particles.

The heat sink **26** and cover **30** are engaged by abutting the hooked longitudinal edges **34** with the cover retaining surface **32**. This can be accomplished by sliding the heat sink **26** relative to the cover **30** or, if the cover **30** is made from a flexible material, abutting one hooked edge **34** of the cover with a retaining surface **32** of the heat sink **26**, then flexing cover **30** to abut the other hooked edge **34** with the other retaining surface **32**. Alternatively, the heat sink **26** and cover **30** can be screwed, glued, taped, or attached with other attachments known to those of skill in the art.

Since the heat sink **26** includes a large area exposed to the ambient environment, the heat transfer properties of the heat sink **26** are good. However, if the heat sink **26** is formed of an electrically conductive material, capacitive coupling between the heat sink **26** and circuit board **18** presents a shock hazard potential as described above. This problem can be reduced or eliminated by shaping the heat sink **26** from a sheet of high-dielectric heat conducting material, such as a D-Series material by Cool Polymers of Warwick, R.I.

FIG. **5** illustrates another example of a heat sink **44** according to the present invention inserted in the tube **16**. The heat sink **44** can be shaped to include multiple planar surfaces **46***a* and **46***b* angled relative to one another. As illustrated, the planar surfaces **46***a* and **46***b* are angled at 180° relative to one another. This formation permits two circuit boards **18** carrying LEDs **12** to be mounted facing opposite directions, thereby providing light around a greater amount of the circumference of the tube **16** than the LED-based replacement lights **10** illustrated in FIGS. **1-4**. Alternatively, more than two planar surfaces can be included, and the surfaces can be angled relative to one another at angles other than 180°. For example, the heat sink can be circular, hexagonal, or have a different polygonal shape.

Heat sinks can undergo additional manufacturing steps prior to or following shaping. FIG. **6** illustrates an embodiment of the light **10** including a heat sink **48** having a triangular cross-section. In order to form the heat sink **48** into a triangle, the heat sink **48** is shaped to form an angle $\theta_1$ between sides **48***a* and **48***b*. In a separate shaping operation, side **48***b* is bent at an angle $\theta_2$ to form side **48***c*. Similarly, FIG. **7** illustrates a square heat sink **50**. The square heat sink **50** is formed by shaping an angle $\theta_3$ between sides **50***a* and **50***b* and an angle $\theta_4$ between sides **50***b* and **50***c*. In a separate shaping operation, side **50***c* is bent at an angle $\theta_5$ to form side **50***d*. Thus, by performing multiple shaping operations, the heat sink **50** can include sides **50***a-d* facing around the entire circumference of the tube **16**.

After shaping, heat sinks can be compressed to form different shapes. FIGS. **8** and **9** illustrate examples of compressed heat sinks **52** and **56**, respectively. After shaping a sheet of highly thermally conductive material to include open fins **22** defining a depression **23** as previously described, the shaped sheet can be compressed in a direction perpendicular to the longitudinal axis of the tube **18** to form heat sinks **52** and **56**. By compressing the sheet of material shaped to include fins **22** defining depressions **23**, the depressions **23** between the fins **22** are minimized or eliminated. The resulting closed fins **54** are twice the width **17** of the sheet of material since each closed fin **54** includes two parallel plies of the material abutting one another. Alternatively, compression can occur in a different direction, e.g., parallel to the longitudinal axis of the tube **18**, depending on the orientation of the open fins **22**. Thermal grease **58** can be applied in each depression **23** prior to compression, if desired.

Additional embodiments of the light **10** include heat sinks shaped to include stepped fins **62**. For example, FIGS. **10** and **11** illustrate stepped heat sinks **60** and **64**, respectively, with stepped fins **62** formed along the longitudinal edges of the heat sinks **60** and **64**. Stepped fins **62** increase the surface area of the heat sinks **60** and **64** compared to a simple planar heat sink.

Also as illustrated in FIG. **11**, connectors **66** are printed directly onto the heat sink **64** instead of using a circuit board **18**. The heat sink **64** can be made of a high-dielectric material to avoid a short circuit.

Shaping a sheet of highly thermally conductive material to form a heat sink has several advantages compared to a conventional extruded heat sink. A shaped heat sink according to the present invention can be less expensive to manufacture than a conventional extruded heat sink. A shaped heat sink can simplify assembly of the light **10** by integrally including structures for connecting a cover **30** and end caps **20**. A shaped heat sink can have a high surface area to width ratio to transfer heat from LEDs **12** to an ambient environment surrounding the light **10**. A shaped heat sink can include multiple planar surfaces for mounting circuit boards **18** facing in different directions, thereby allowing LEDs **12** to emit light more uniformly around an arc of the LED-based replacement light **10** than known heat sinks. A shaped heat sink can be enclosed in a tube **16** or be made from a highly thermally conductive dielectric material to reduce a shock hazard potential due to capacitive coupling of a metal heat sink positioned adjacent a circuit board.

The above-described embodiments have been described in order to allow easy understanding of the invention and do not limit the invention. On the contrary, the invention is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law.

What is claimed is:

**1**. A method of forming a LED-based light for replacing a conventional fluorescent bulb in a fluorescent light fixture and including a plurality of LEDs, an elongate heat sink, an elongate light transmitting cover, the method comprising:
- providing the heat sink by shaping an elongate sheet of highly thermally conductive material to include a plurality of longitudinally extending surfaces; wherein at least one longitudinal vertex is formed between two adjacent longitudinally extending surfaces;
- mounting the plurality of LEDs in thermally conductive relation with and substantially along a length of at least one of the plurality of longitudinally extending surfaces; and
- enclosing the plurality of LEDs within the light transmitting cover such that the at least one longitudinal vertex engages an interior of the cover.

**2**. The method of claim **1**, wherein at the least one of the plurality of longitudinally extending surfaces is a planar surface, and further comprising:
- mounting the LEDs to a circuit board; and
- attaching the circuit board to the planar surface.

**3**. The method of claim **2**, further comprising:
- shaping at least one longitudinally extending open fin into the planar surface for dividing the planar surface into two parallel planar surfaces separated by a depression; and
- mounting the circuit board on the two parallel planar surfaces such that it spans the depression.

**4**. The method of claim **1**, further comprising:
- securing a circuit board to each of at least some of the plurality of longitudinally extending surfaces and
- mounting a first group of LEDs on the circuit board secured to a first of the plurality of longitudinally extending surfaces and mounting a second group of LEDs on the circuit board secured to a second of the plurality of longitudinally extending surfaces.

**5**. The method of claim **4**, wherein the first longitudinally extending surface and the second longitudinally extending surface are angled relative to one another by approximately one of 60°, 90° and 180°.

**6**. The method of claim **4**, wherein the plurality of longitudinally extending surfaces form least one at least one of a rectangular and a triangular cross-section, further comprising:
- mounting LEDs on each of the plurality of longitudinally extending surfaces for emitting light through an entire circumference of the cover.

**7**. The method of claim **1** wherein the LED-based light includes at least one electrical connector, further comprising:
- shaping the heat sink to have a high surface area to width ratio and a substantially constant thickness; and
- attaching the at least one electrical connector adjacent to a longitudinal end of the heat sink.

**8**. An LED-based light for replacing a conventional fluorescent bulb in a fluorescent light fixture formed according to the method of claim **1**, wherein:
- the light transmitting cover at least partially defines a tubular housing;
- the heat sink has a high surface area to width ratio;
- the at least one longitudinal vertex engages an interior of the cover; and
- the plurality of LEDs are enclosed within the tubular housing and mounted in thermally conductive relation with

and substantially along a length of at least one of the plurality of longitudinally extending surfaces for emitting light through the cover.

**9**. The LED-based light of claim **8**, wherein the heat sink has a substantially constant thickness.

**10**. The LED-based light of claim **8**, wherein the at least one of the plurality of longitudinally extending surfaces is a planar surface, and wherein at least one LED of the plurality of LEDs is mounted to an elongate circuit board secured to the planar surface.

**11**. The LED-based light of claim **8**, wherein the heat sink includes multiple longitudinally extending planar surfaces angled relative to one another for securing a plurality of circuit boards in different orientations onto the heat sink; and

a first group of LEDs mounted on a first of the multiple planar surfaces and a second group of LEDs on a second of the multiple planar surfaces.

**12**. The LED-based light of claim **8**, wherein the LED-based light includes at least one electrical connector at a longitudinal end of the tubular housing in electrical connection with the plurality of LEDs.

**13**. The LED-based light of claim **8**, wherein the heat sink defines at least one open fin.

**14**. The LED-based light of claim **8**, wherein the plurality of longitudinally extending surfaces includes two surfaces spaced apart in a direction perpendicular to the length the heat sink by a distance substantially equal to a width of a fastener for securing an electrical connector to the heat sink by engaging the fastener between the two surfaces.

**15**. The method of claim **1**, wherein the shaping provides fins.

**16**. The method of claim **15**, wherein the fins are open.

**17**. The method of claim **15**, wherein the fins are closed.

**18**. The method of claim **1** wherein the plurality of longitudinally extending surfaces includes two surfaces spaced apart in a direction perpendicular to a longitudinal axis of the heat sink by a distance substantially equal to a width of a fastener, further comprising:

securing the fastener between the two surfaces for attaching an end cap to the heat sink.

**19**. An LED-based light for replacing a conventional fluorescent light bulb in a fluorescent light fixture, the LED-based light comprising:

a hollow, cylindrical light transmitting tube;

a heat sink shaped from a sheet of highly thermally conductive material having a width greater than a maximal width of the tube, the heat sink having a central planar portion and two side portions extending perpendicularly to the planar portion from opposing ends of the planar portion, the heat sink positioned within the tube with the side portions in contact with an interior of the tube;

a printed circuit board mounted on the central planar portion;

multiple LEDs longitudinally spaced along the length of the circuit board; and

two end caps coupled to opposing ends of the tube, the end caps carrying bi-pin connectors in electrical communication with the circuit board.

**20**. The LED-based light of claim **19**, wherein the heat sink has a substantially constant thickness.

**21**. The LED-based light of claim **19**, further comprising:

at least one other circuit board mounted on at least one of the two side portions, wherein multiple LEDs are longitudinally spaced along the length of the at least one other circuit board.

**22**. The LED-based light of claim **19**, wherein the at least one other circuit board is mounted on at least one of the two side portions, wherein multiple LEDs are longitudinally spaced along the length of the at least one other circuit board.

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