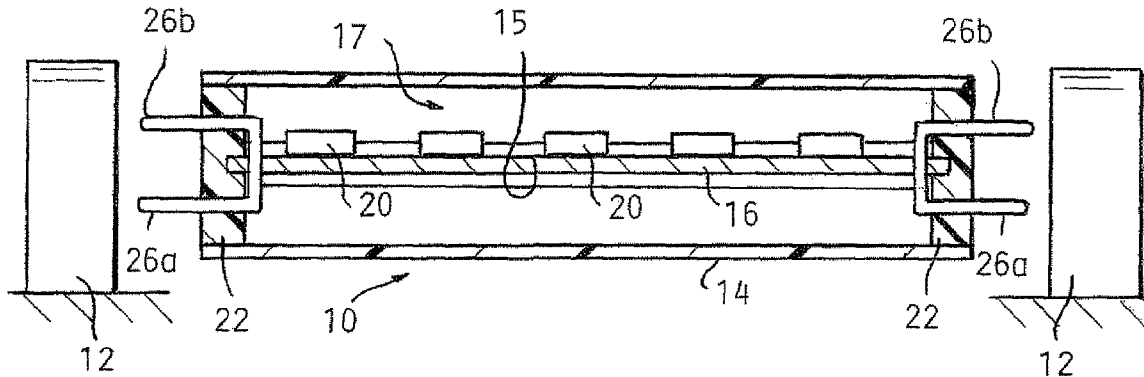




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(54) **Titre : CAPUCHON D'EXTREMITE DE SUBSTITUTION POUR LUMIERE DE REMPLACEMENT A TUBE A BASE DE DEL**
 (54) **Title: END CAP SUBSTITUTE FOR LED-BASED TUBE REPLACEMENT LIGHT**



(57) **Abrégé/Abstract:**

Disclosed herein is a replacement light for a fluorescent tube usable in a fluorescent fixture. The light includes a housing having a first end and a second end opposite the first end. A support structure is disposed within the housing. At least one LED is positioned within the housing and is arranged on the support structure. A first seal has at least one aperture and is disposed within the first end of the housing. The first seal is configured to conform to an inner circumference of the first end of the housing. At least one electrical connector extends through the at least one aperture and is connectable to the fluorescent fixture.

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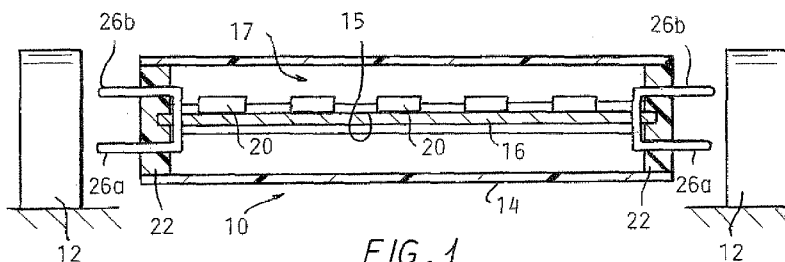
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(54) Title: END CAP SUBSTITUTE FOR LED-BASED TUBE REPLACEMENT LIGHT



(57) Abstract: Disclosed herein is a replacement light for a fluorescent tube usable in a fluorescent fixture. The light includes a housing having a first end and a second end opposite the first end. A support structure is disposed within the housing. At least one LED is positioned within the housing and is arranged on the support structure. A first seal has at least one aperture and is disposed within the first end of the housing. The first seal is configured to conform to an inner circumference of the first end of the housing. At least one electrical connector extends through the at least one aperture and is connectable to the fluorescent fixture.

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END CAP SUBSTITUTE FOR LED-BASED TUBE REPLACEMENT LIGHTTECHNICAL FIELD

[0001] The present invention relates in general to LED replacements for fluorescent lights.

BACKGROUND

[0002] LED-based lights shaped to replace conventional fluorescent tubes have appeared in recent years. Typically, such lights include a hollow tube with two end caps, one at each longitudinal end of the tube. The end caps generally include molded plastic cup-shaped bodies that slide over the ends of the tube to secure the end caps to the tube. End caps can seal ends of the tube to prevent contaminants from interfering with operation of the light. Additionally, each end cap can include one or more pins for compatibility with standard fluorescent fixtures. For example, many end caps carry two pins for compatibility with fixtures designed to receive standard-sized tubes, such as T5, T8, or T12 tubes.

SUMMARY

[0003] Embodiments of a replacement light for a fluorescent tube usable in a fluorescent fixture are disclosed herein. In one such embodiment, the light includes a housing having a first end and a second end opposite the first end. A support structure is disposed within the housing. At least one LED is positioned within the housing and is arranged on the support structure. A first seal has at least one aperture and is disposed within the first end of the housing. The first seal is configured to conform to an inner circumference of the first end of the housing. At least one electrical connector extends through the at least one aperture and is connectable to the fluorescent fixture.

[0004] In another such embodiment, the light includes a housing having a first end and a second end opposite the first end. A support structure is disposed within the housing. At least one LED is positioned within the housing and arranged on the support structure. Sealing means for replacing a conventional end cap are disposed within the first end of the housing.

[0005] Embodiments of a method of manufacturing a seal for a fluorescent tube replacement light containing at least one LED are also disclosed herein. In one such embodiment, the method includes providing a housing having a first end and a second end opposite the first end. A hardenable material is introduced to at least the first end of the housing. The hardenable material is hardened such that it conforms to an inner circumference of the first end.

[0006] In another embodiment there is provided a replacement light for a fluorescent tube usable in a fluorescent fixture, comprising: a housing having a first end and a second end opposite the first end; a support structure disposed within the housing; at least one light emitting diode (LED) positioned within the housing and arranged on the support structure; at least one electrical connector connected to the at least one LED; and a first seal having at least one aperture shaped to receive a pin of the at least one electrical connector, the first seal disposed within the first end of the housing and configured to conform to an inner circumference of the first end of the housing and an outer surface of the pin of the at least one electrical connector, wherein the pin extends through the at least one aperture and is connectable to the fluorescent fixture.

[0006a] In another embodiment there is provided a method of manufacturing a seal for a fluorescent tube replacement light containing at least one light emitting diode (LED), comprising: providing at least one electrical connector; providing a housing having a first end and a second end opposite the first end; introducing a hardenable material to at least the first end of the housing; hardening the hardenable material such that it conforms to an inner circumference of the first end and an outer surface of the at least one electrical connector to form at least one aperture through the hardenable material; and inserting the at least one electrical connector through the at least one aperture.

[0006b] In yet another embodiment there is provided a replacement light for a fluorescent tube usable in a fluorescent fixture, comprising: a housing having a first end and a second end opposite the first end; a support structure disposed within the housing; at least one light emitting diode (LED) positioned within the housing and arranged on the support structure; and sealing means for replacing a conventional end cap disposed

entirely within the first end of the housing, wherein the sealing means includes at least one aperture shaped to receive a pin of at least one electrical connector.

[0006c] In yet another embodiment there is provided a method of replacing a conventional end-cap for a fluorescent tube replacement light containing at least one light emitting diode (LED), comprising: providing a housing having a first end and a second end opposite the first end; providing a first seal; and inserting the first seal entirely into one of the first end and the second end of the housing, the first seal having at least one aperture shaped for receiving at least one electrical connector.

[0007] These and other embodiments will be described in additional detail hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a cross-section of an example of a light tube according to one embodiment of the present invention;

[0009] FIG. 2 is a perspective view of an example of the end cap replacing seal of FIG. 1;

[0010] FIG. 3 is a perspective view of material being poured into a housing to form an end cap replacing seal; and

[0011] FIG. 4 is an exploded side view of an end cap replacing seal being inserted into a housing.

DESCRIPTION

[0012] Examples of LED-based lights including end cap replacing seals for use instead of plastic cup-shaped end caps and other types of end caps are discussed below with reference to FIGS. 1 -4. Figure 1 illustrates a light 10 sized for placement in a fixture 12 designed to receive standard-sized tubes. The fixture 12 can be, for example, of the type for accepting a T5, T8, T12 or any other suitable tube. Alternatively, the

fixture 12 can be of the type for accepting another light, such as a halogen light or an incandescent bulb.

[0013] The light 10, as shown in FIG. 1, includes a tubular housing 14, a circuit board 16, multiple LEDs 20, and two end cap replacing seals 22. The tubular housing 14 defines a through-bore 17. The housing 14 can be made from polycarbonate, acrylic, glass or another light transmitting material (i.e., the housing 14 can be transparent or translucent). For example, a translucent housing 14 can be made from a composite, such as polycarbonate with particles of a light refracting material interspersed in the polycarbonate. While the illustrated housing 14 is cylindrical, housing having a square, triangular, polygonal, or other cross sectional shape can alternatively be used. Similarly, while the illustrated housing 14 is linear, housing having an alternative shape, e.g., a U-shape or a circular shape can alternatively be used. Additionally, the housing 14 need not be a single piece as shown in FIG. 1. Instead, another example of a housing can be formed by attaching multiple individual parts, not all of which need be light transmitting. For example, a housing formed by attaching multiple individual parts can include an opaque lower portion and a lens or other transparent cover attached to the lower portion to cover the LEDs 20. The housing 14 as shown in FIG. 1 can be manufactured to include light diffusing or refracting properties, such as by surface roughening or applying a diffusing film to the housing 14. For compatibility with the fixture 12 as discussed above, the housing 14 can have a length such that the light 10 is approximately 48" long, and the housing 14 can have a 0.625", 1.0", or 1.5" diameter. Of course, housing 14 can have other suitable dimensions. Additionally, the housing 14 can define a groove 15 for slidably receiving the circuit board 16.

[0014] The circuit board 16, as illustrated in FIG. 1, is an elongate printed circuit board. Multiple circuit board sections can be, for example, joined by bridge connectors to create the circuit board 16. The circuit board 16 is slidably engaged with the groove 15 of the housing 14, though the circuit board 16 can alternatively be clipped, adhered, snap- or friction-fit, screwed or otherwise connected to the housing 14. For example, the circuit board 16 can be mounted on a heat sink that is attached to the housing 14. As another example, the circuit board 16 can be secured by the seals 22 as is discussed below in greater detail. Also, other types of circuit boards may be used, such as a metal

core circuit board. Or, instead of a circuit board 16, other types of electrical connections (e.g., wires) can be used to electrically connect the LEDs 20 to a power source.

Additional electrical components, such as a rectifier and filter, can also be mounted on the circuit board 16.

[0015] The LEDs 20 can be surface-mount devices of a type available from Nichia, though other types of LEDs can alternatively be used. For example, although surface-mounted LEDs 20 are shown, one or more organic LEDs can be used in place of or in addition thereto. The LEDs 20 can be mounted to the circuit board 16 by solder, a snap-fit connection, or other means. The LEDs 20 can produce white light. However, LEDs that produce blue light, ultra-violet light or other wavelengths of light can be used in place of white light emitting LEDs 20.

[0016] The number of LEDs 20 can be a function of the desired power of the light 10 and the power of the LEDs 20. For a 48" light, such as the light 10, the number of LEDs 20 can vary from about five to four hundred such that the light 10 outputs approximately 500 to 3,000 lumens. However, a different number of LEDs 20 can alternatively be used, and the light 10 can output a different amount of lumens. The LEDs 20 can be evenly spaced along the circuit board 16, and the spacing of the LEDs 20 can be determined based on, for example, the light distribution of each LED 20 and the number of LEDs 20.

[0017] As shown in FIG. 1, the seals 22 can be positioned in opposing ends of the housing 14 (i.e., in opposing ends of the through-bore 17 defined by the housing 14). The seals 22 can be made from a variety of materials, such as an epoxy or other resin-based substance, rubber, cork, gel, concrete, glass, clay, wax, a polymer, silicone, or another material. The seals 22 can prevent the unintended entry of objects to the interior of the housing 14. The seals 22 can also perform additional functions as described below.

[0018] Each seal 22 can have a perimeter 22a shaped to conform to an inner circumference of the housing 14. As such, each seal 22 can have a perimeter 22a substantially identical to an inner circumference of the housing 14 such that the seal 22 can plug an end of the housing 14. For example, each seal 22 can be generally disc-shaped if the housing 14 is cylindrical. Alternatively, the seals 22 can be shaped to

contact only portions of the inner circumference of the housing 14 when fit into ends of the housing 14. Thus, while the seals 22 can serve to prevent the unintended entry of an object to the interior of the housing 14, the seals 22 need not necessarily be air-tight or water-tight.

[0019] The thickness of the seals 22 (i.e., the distance that each seal 22 extends longitudinally from an end of the housing 14 toward a center of the housing 14) can be based on multiple factors. A large thickness can allow the seals 22 to strengthen the housing 14, can be more securely engaged with the housing 14, and/or can enhance the ability of the seals 22 to prevent unintended entry of an object to the interior of the housing 14. However, a seal 22 with a large thickness can require more material to produce, can be more difficult to install in the housing 14, and can limit the length of the housing 14 through which light can be produced. These factors, among others, can be considered to determine a proper seal shape. Additionally, the seals 22 can protrude from ends of the housing 14 (i.e., the seals 22 need not be fully contained within the housing 14 or flush with ends of the housing 14).

[0020] Each seal 22 can also define two apertures 24a and 24b to allow pins 26a and 26b to communicate between the socket 12 and circuit board 16. The apertures 24a and 24b can be circular, with diameters as large as or larger than diameters of the pins 26a and 26b. However, apertures 24a and 24b can have alternative shapes, such as shapes that allow the pins 26a and 26b to pass through the seal 22. The apertures 24a and 24b can also physically support the pins 26a and 26b. For example, each seal 22 can hold the pins 26a and 26b in position via a friction fit between the apertures 24a and 24b and the pins 26a and 26b, respectively. If the seals 22 are made from a material that is not electrically insulating, a rubber O-ring or other insulator can be included between the seal 22 and the pins 26a and 26b.

[0021] The pins 26a and 26b can physically and electrically connect the light 10 to the fixture 12. The pins 26a and 26b can be the sole physical connection between the light 10 and the fixture 12, though ends of the housing 14 and/or portions of the seals 22 can also contact the fixture 12. The pins 26a and 26b can be directly electrically connected to the circuit board 16 as shown in FIG. 1 to provide power to the LEDs 20 from the fixture 12, or the pins 26a and 26b can be coupled to another structure that in

turn is electrically connected to the circuit board 16. Of the four total pins 26a and 26b, two of the total four pins 26a and 26b can be “dummy pins” that do not provide an electrical connection. Alternatively, instead of pairs of pins 26a and 26b, other types of electrical connectors depending on the type of fixture 12 can extend through the seals 22 or otherwise past the seals 22 into the housing 14. For example, a single pin can be used instead of two pins 26a and 26b for compatibility with a single pin fixture. Alternatively, three of the four total pins 26a and 26b can be “dummy pins” that do not provide an electrical connection, thereby permitting only one of the pins to electrically connect with the fixture 12.

[0022] A variety of methods can be used to manufacture the seals 22. In a first example, the seals 22 are formed from a liquefied or viscous material that is introduced to the housing 14, and then hardened in the position shown in FIG. 1. The liquefied or viscous material can be an epoxy prior to setting or mixing with a hardener, concrete prior to hardening, a polymer heated to above its melting point, melted wax, or another liquefied or viscous material. Several different processes can be used to form the seals 22 from the liquefied or viscous material depending on the characteristics of the material. For example, as shown in FIG. 3, the circuit board 16 can be engaged with the housing 14, and one end of the housing 14 can be sealed with a non-stick mat 28 or other structure while liquefied material 23 is poured into the top of the bore 17 of the housing 14. The seal 22 can be formed when the material 23 dries or cures, and the apertures 24a and 24b can be drilled in the seal 22 for the insertion of pins 26a and 26b. However, prior to inserting the pins 26a and 26b into the apertures 24a and 24b, the housing 14 can be rotated 180° and the seal 22 forming process can be repeated at the other end by pouring liquefied material 23 through one of the apertures 24a or 24b. Finally, the pins 26a and 26b can be inserted into the apertures 24a and 24b in each seal 22 and electrically connected to the circuit board 16. Alternatively, the circuit board 16 can be supported without being attached to the housing 14 during the seal 22 forming process, in which case the seals 22, once hardened or cured, can each define a groove 22b as shown in FIG. 2 for receiving and/or securing the circuit board 16.

[0023] As another example of manufacturing the seals 22, the housing 14 can be inserted into a pool of liquefied or viscous material, and the material can be allowed to

harden to form the seal 22. The insertion can occur with the pins 26a and 26b already coupled to the housing 14 such that the seals 22 are formed to include apertures 24a and 24b without drilling, in which case sleeves can be installed over the portions of the pins 26a and 26b that engage the fixture 12 during insertion of the housing 14 into the pool of material in order to avoid getting material on the pins 26a and 26b.

[0024] If the material is too viscous to be poured into the housing 14, the material can be packed into an end of the housing 14. For example, pliable clay can be packed in an end of the housing 14 and then be allowed to dry, or silicone sealant can be applied in the end of the housing 14.

[0025] In yet another example, seals 28 as shown in FIG. 4 can be shaped prior to insertion into the housing 14. For example, each seal 28 can be made from an elastic material such as rubber or cork, and each seal 28 can be shaped to have a perimeter 28a transitioning from slightly smaller than an inner circumference of the housing 14 to slightly larger than the inner circumference of the housing 14, allowing the seal 28 to be press fit into the housing 14 as shown in FIG. 4. If made from a less elastic material, each seal 28 can be shaped to have a perimeter slightly smaller than an inner circumference of the housing and a rubber O-ring or similar elastic strip can circumscribe the seal 28. By using O-rings, the seals 28 can be inserted into the housing 14 without substantially deforming the seals 28. Also, each seal 28 can define a groove 28b for receiving and/or securing the circuit board 16 similar to the groove 22b in the seal 22.

[0026] Also, regardless of the elasticity of the seals 28, installation of the seals 28 can include inserting the pins 26a and 26b through the apertures 24a and 24b in the seals 28 prior to the pins 26a and 26b being physically attached to the circuit board 16. For example, the pins 26a and 26b can be coupled by flexible wires to the circuit board 16, then inserted into the apertures 24a and 24b of the seals 28, and then the seals 28 can be press-fit into the housing 14. As another example, the pins 26a and 26b can be coupled to the circuit board 16 with the circuit board 16 disconnected from the housing 14. The pins 26a and 26b can then be inserted into the apertures 24a and 24b. Then, the circuit board 16 can be slid into the housing 14 until the seal 28 is press-fit into the housing 14, in which case the circuit board 16 is supported by the seals 28 instead of directly by the housing 14.

[0027] Additionally, structures other than seals 22 or seals 28 can be used instead of plastic end caps. For example, tape can be applied over ends of the housing 14, or the housing 14 can be formed of a solid rod that is drilled to accommodate pins 26a and 26b without end caps.

[0028] 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 structure as is permitted under the law.

What is claimed is:

1. A replacement light for a fluorescent tube usable in a fluorescent fixture, comprising:
 - a housing having a first end and a second end opposite the first end;
 - a support structure disposed within the housing;
 - at least one light emitting diode (LED) positioned within the housing and arranged on the support structure;
 - at least one electrical connector connected to the at least one LED; and
 - a first seal having at least one aperture shaped to receive a pin of the at least one electrical connector, the first seal disposed within the first end of the housing and configured to conform to an inner circumference of the first end of the housing and an outer surface of the pin of the at least one electrical connector,
 - wherein the pin extends through the at least one aperture and is connectable to the fluorescent fixture.
2. The light of claim 1 wherein the at least one electrical connector is a first electrical connector, further comprising:
 - a second seal having at least one aperture shaped to receive a pin of a second electrical connector and disposed within the second end of the housing, the second seal configured to conform to an inner circumference of the second end of the housing and an outer surface of the pin of the second electrical connector.
3. The light of claim 1 or 2, wherein the first seal is made of at least one of epoxy, rubber, cork, gel, concrete, glass, clay, wax, a polymer and silicone.
4. The light of any one of claims 1 to 3, wherein the first seal has a perimeter that is substantially equal to the inner circumference of the first end.
5. The light of any one of claims 1 to 4, wherein the housing has a cylindrical cross-section and the first seal is generally disc-shaped such that the first seal is configured to contact substantially the entire inner circumference of the first end.

6. The light of any one of claims 1 to 4, wherein the first seal contacts only a portion of the inner circumference of the first end.
7. The light of any one of claims 1 to 3, wherein the first seal has a proximal end and a distal end opposite the proximal end, the proximal end one of flush with the first end and outwardly protruding from the first end.
8. The light of claim 7, wherein the distal end has a groove configured to engage one end of the support structure.
9. The light of claim 1, wherein the at least one aperture is shaped to secure the pin of the at least one electrical connector by a friction fit.
10. The light of claim 1 or 9, further comprising:
 - a rubber O-ring disposed around and configured to insulate the at least one electrical connector.
11. A method of manufacturing a seal for a fluorescent tube replacement light containing at least one light emitting diode (LED), comprising:
 - providing at least one electrical connector;
 - providing a housing having a first end and a second end opposite the first end;
 - introducing a hardenable material to at least the first end of the housing;
 - hardening the hardenable material such that it conforms to an inner circumference of the first end and an outer surface of the at least one electrical connector to form at least one aperture through the hardenable material; and
 - inserting the at least one electrical connector through the at least one aperture.
12. The method of claim 11, wherein the hardenable material is one of an epoxy without a hardener, liquid concrete, a polymer heated to above its melting point and melted wax.

13. The method of claim 11 or 12, wherein introducing a hardenable material to the first end of the housing further comprises:
sealing the first end of the housing to a non-stick surface; and
pouring the hardenable material into the second end of housing.
14. The method of claim 13, further comprising:
forming at least one aperture into the hardened material of the first end of the housing;
sealing the second end of the housing to the non-stick surface;
pouring the hardenable material into the at least one aperture; and
hardening the hardenable material so that it conforms to an inner circumference of the second end.
15. The method of claim 11, wherein introducing the hardenable material further comprises:
inserting the first end of the housing into a pool of the hardenable material.
16. The method of claim 15, wherein the housing includes a support structure disposed therein and the at least one electrical connector electrically engaged with the support structure, further comprising:
installing a sleeve over the at least one electrical connector.
17. The method of claim 11, wherein introducing the hardenable material further comprises:
packing the hardenable material into the first end of the housing.
18. A replacement light for a fluorescent tube usable in a fluorescent fixture, comprising:
a housing having a first end and a second end opposite the first end;
a support structure disposed within the housing;
at least one light emitting diode (LED) positioned within the housing and arranged on the support structure; and

sealing means for replacing a conventional end cap disposed entirely within the first end of the housing, wherein the sealing means includes at least one aperture shaped to receive a pin of at least one electrical connector.

19. The light of claim 18, further comprising:
at least one electrical connector extending through the sealing means and connectable to the fluorescent fixture.
20. A method of replacing a conventional end-cap for a fluorescent tube replacement light containing at least one light emitting diode (LED), comprising:
providing a housing having a first end and a second end opposite the first end;
providing a first seal; and
inserting the first seal entirely into one of the first end and the second end of the housing, the first seal having at least one aperture shaped for receiving at least one electrical connector.
21. The method of claim 20 wherein the first seal is configured to conform to an inner circumference of the first end of the housing
22. The method of claim 20 or 21, further comprising:
inserting the at least one electrical connector into the at least one aperture.
23. The method of claim 22, further comprising:
shaping the first seal prior to insertion into the housing.
24. The method of claim 23, wherein the first seal has a proximal end and a distal end opposite the proximal end, and wherein the first seal is shaped to have a perimeter transitioning from slightly smaller at the proximal end than an inner circumference of the housing to slightly larger at the distal end than the inner circumference of the housing.

25. The method of any one of claims 20 to 24, wherein the first seal is press-fit into the housing.

