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(54) Title: OLED LIGHTING DEVICES INCLUDING ELECTRODES WITH MAGNETIC MATERIAL

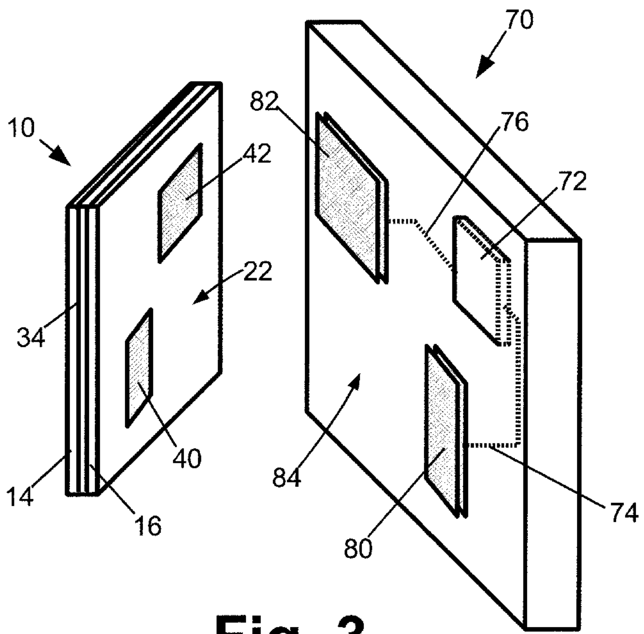

Fig. 3

(57) Abstract: An article of manufacture comprises a thin film solid state lighting device (10), such as an organic light emitting diode (OLED) device, having a planar light emitting side and an opposite planar mounting side (22) and including electrodes (40,42) disposed on the planar mounting side of the thin film solid state lighting device (10), the electrodes including a magnetic material configured to conductively convey electrical drive current to drive the thin film solid state lighting device (10) to emit light at the planar light emitting principal side. The article of manufacture may further comprise a fixture having a planar surface with magnets (80,82) arranged to mate with the electrodes to magnetically secure the thin film solid state lighting device (10) with the fixture (70) and to concurrently form electrically conductive paths including the magnetic material of the electrodes (40,42) configured to conductively convey electrical drive current. Thus this magnetic connection provides both mechanical support and electrical conduction path.

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OLED LIGHTING DEVICES INCLUDING ELECTRODES WITH MAGNETIC MATERIAL

BACKGROUND

[0001] The following relates to the illumination arts, lighting arts, solid state lighting arts, organic light emitting diode (OLED) device arts, and related arts.

[0002] Thin film solid state lighting technologies such as thin film electroluminescent (TFEL) devices, organic light emitting diode (OLED) device arts, and so forth have become prevalent display and lighting technologies. These devices can be made thin (e.g., a few millimeters or less in thickness). Additionally, TFEL and OLED devices produce illumination over large area, with the illumination output area sometimes being close to coextensive with the area of the active OLED device film structure. These geometric aspects make thin film solid state lighting devices useful as light sources in "illuminated walls" or other architectural accent or illumination lighting, in undercabinet lighting, and in other types of lighting where space is at a premium and a thin and large-area planar light source is advantageous. Still further, some thin film solid state lighting technologies can be fabricated in flexible form so as to enable flexible lighting sources suitable for use in flexible cards or for mounting on curved support surfaces such as curved pillar walls or the like.

[0003] One deficiency in the state of the art lies in the mounting and electrical interconnect technologies for such devices. Although thin film solid state lighting devices can be made thin, large-area, and optionally flexible, these advantages are currently lost to a substantial degree due to size, bulkiness, and rigidity of existing mounting and electrical power input structures. Indeed, in most existing thin film solid state lighting devices the mounting and electrical power input structures are several times thicker than the active light-producing structure, which is typically in the form of a thin film disposed on thin glass or plastic substrates.

[0004] For example, one technique currently in use for packaging OLED devices is to employ edge connectors for the electrical input. In such a configuration, the active

OLED layers are sandwiched between glass plates or plastic films, and electrodes connecting with edges of the OLED layers extend outside the edges of the sandwiching glass or plastic confinement to form edge connectors. This approach requires an electrically conductive mating structure connecting with the electrodes at the edges of the device. A disadvantage is that the lateral area occupied by the edge electrodes and corresponding mating structures reduces the light emission area of the packaged lighting device, thus reducing the value of the large illumination area of the unpackaged device. For OLED devices which are susceptible to damage from ambient moisture or oxygen, the edge connectors also compromise the hermetic seal at the edges of the confining glass or plastic plates or films.

[0005] Other packaging techniques are disclosed in WO 2008/012702 A1 and WO 2008/099305 A1. The approach of WO 2008/012702 A1 employs wireless inductive power transmission in which the OLED device has an "on-board" power receive inductor and on-board power conditioning electronics. Although the on-board inductive coil is described as "planar", the addition of these on-board component inherently introduces additional complexity, bulk, and thickness to the OLED device.

[0006] WO 2008/099305 A1 likewise discloses on-board power conversion and control circuitry which increases bulk and thickness. The electrical connections in WO 2008/099305 A1 are disposed on a backside of the lighting module which connect with bus lines when the lighting module is secured to a printed circuit board mounting structure by on-board clamps, on-board screws, or on-board magnets. The on-board mounting clamps, screws, or magnets contribute still further to the complexity, bulk, and thickness of the OLED lighting devices.

BRIEF SUMMARY

[0007] In some illustrative embodiments disclosed herein, an article of manufacture is disclosed, comprising a thin film solid state lighting device having a planar light emitting side and an opposite planar mounting side and including electrodes disposed on the planar mounting side of the thin film solid state lighting device, the electrodes including a magnetic material configured to conductively convey electrical drive current to drive the thin film solid state lighting device to emit light at the planar light emitting principal side. This method of electrical and mechanical connections thus preserves the thin form factor and hermetic seal of the package.

[0008] In some illustrative embodiments disclosed herein, an article of manufacture is disclosed, comprising a thin film solid state lighting device having a planar light emitting side and an opposite planar mounting side including a magnetic material disposed on the planar mounting side, wherein the magnetic material is not magnetized to define a permanent magnet and is not a component of an inductive element. This method of electrical and mechanical connections thus preserves the thin form factor and hermetic seal of the package.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention may take form in various components and arrangements of components, and in various process operations and arrangements of process operations. The drawings are only for purposes of illustrating preferred embodiments and are not to be construed as limiting the invention.

[0010] FIGURES 1 and 2 diagrammatically illustrate cross-sectional views of two embodiments of a disclosed thin film solid state lighting device.

[0011] FIGURE 3 diagrammatically illustrates the thin film solid state lighting device of FIGURE 1 in position for magnetic attachment along with concurrent electrical connection to a fixture.

[0012] FIGURES 4-9 illustrate some examples of lighting fixtures employing the disclosed the thin film solid state lighting device mounting techniques.

[0013] FIGURE 10 illustrates a tiled arrangement of the fixtures of FIGURE 4.

[0014] FIGURES 11-14 show side-sectional views of some illustrative hermetically sealed OLED devices suitably used as the thin film solid state lighting device of FIGURE 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] With reference to FIGURE 1, a thin film solid state lighting device **10** includes a thin film light emitting structure **12**. In the illustrated embodiments, the thin film light emitting structure **12** is a light emitting polymer or multilayer structure including one or more layers of light emitting polymer, and the thin film solid state lighting device **10** is of a type known as an organic light emitting diode (OLED) device. Other types of thin film light emitting structures are also contemplated, such as a thin film electroluminescent (TFEL) light emitting structure. The thin film light emitting structure **12** may have an electrical polarity, as is typically the case for OLED devices, in which case there are distinguishable positive and negative electrical terminals. Alternatively, the thin film light emitting structure **12** may be non-polar and have no particular electrical polarity. Although diagrammatically illustrated for simplicity as a single layer, the thin film light emitting structure **12** may include multiple layers of different materials, or may be divided laterally into electrically distinct portions interconnected electrically in series or otherwise electrically configured, or so forth.

[0016] The illustrated OLED device **10** includes the thin film light emitting structure **12** disposed between confining layers or structures **14**, **16**, such as confining glass plates or sheets, confining layers of plastic, or so forth. The front confinement layer **14** is transparent or translucent so that a front surface **20** is a planar light emitting side **20**. The back confinement layer **16** defines an opposite planar mounting side **22**. In some embodiments the confinement layers **14**, **16** and the planar OLED device **10** as a whole is flexible, while in other embodiments the confinement layers **14**, **16** and the planar OLED device **10** as a whole is substantially rigid. The term "planar" as used herein is to be understood as encompassing such flexibility.

[0017] The thin film light emitting structure **12** includes electrical inputs in the form of metallic or other electrically conductive layers configured to transfer drive electrical current into the light emitting polymer or other optically active material in order to cause the optically active material to emit light. In FIGURE 1, one such electric input is illustratively shown, namely an indium tin oxide (ITO) layer **24** disposed on or proximate to the front confinement layer **14**. Advantageously, ITO is optically transparent or translucent over at least most of the visible light spectrum, and its use therefore promotes light emission at the planar light emitting side **20**. Typically, at least two metallic or other electrically conductive layers configured to transfer drive electrical current into the light emitting polymer or other optically active material are provided, in order to permit drive current to flow through the optically active material. Although not illustrated, the metallic or other electrically conductive layers may be lithographically patterned or otherwise laterally confined or patterned to define a selected electrical configuration. For example, in OLED devices these layers are sometimes patterned to electrically define a plurality of series-interconnected regions of light emitting polymer material.

[0018] In the illustrative case of an OLED device, the light emitting polymer is typically sensitive to moisture and oxygen and degrades upon excessive environmental exposure. Accordingly, the thin film solid state lighting device **10** is designed as a hermetically sealed planar unit. Some glass and transparent or translucent plastic materials typically used for the confinement layers **14**, **16** are permeable to moisture to an undesirably high degree. To reduce this source of moisture ingress, an aluminum layer or other water-impermeable layer **30** is optionally disposed between the thin film light emitting structure **12** and the confinement layer **16**. To avoid electrical shorting or shunting via the electrically conductive aluminum, suitable insulating cladding material **32** surrounds the aluminum layer **30**. To suppress moisture ingress from the sides, water-impermeable peripheral adhesive **34** or another suitable sealant is disposed around the periphery of the confinement layers **14**, **16** to complete the hermetical sealing of the thin film light emitting structure **12**. Although the sealing structures **30**, **34** are described herein as sealants against moisture ingress, these and optionally additional or other sealant structures can be provided to seal against ingress of various potentially detrimental contaminants such as oxygen.

[0019] In order to apply electrical drive current to the thin film light emitting structure **12** in order to cause it to emit light, electrodes **40**, **42** are provided. The illustrated electrodes **40**, **42** pass through vias formed in the back confinement layer **16** and in the optional water-impermeable layer **30**. In the latter case, a suitable via insulation arrangement (not shown) electrically isolates the electrodes **40**, **42** from the illustrative aluminum **30**. Further features not shown in diagrammatic FIGURE 1 may be added to promote hermetic sealing around the electrodes **40**, **42**. (See FIGURES 11-14 for some illustrative examples of suitable hermetic sealing arrangements). The electrodes extend outside of the hermetically sealed planar unit, or in other words the electrodes **40**, **42** are exposed at the planar mounting side **22** to provide external electrical access to the thin film light emitting structure **12**.

[0020] Furthermore, the electrodes **40**, **42** include a magnetic material. In some preferred embodiments, the magnetic material is nickel or a nickel alloy. Other suitable magnetic materials include iron or iron alloys, cobalt or cobalt alloys, or other ferromagnetic elements or alloys thereof. The magnetic material is also electrically conductive to conductively convey electrical drive current to drive the thin film solid state lighting device **10** to emit light at the planar light emitting principal side **20**.

[0021] Aluminum, which is a conventional material for use as the electrodes of OLED devices, is not a magnetic material. Accordingly, since the electrodes **40**, **42** include a magnetic material, they cannot be made entirely of aluminum. However, it is contemplated to include other materials in the electrodes, including nonmagnetic materials. For example, In FIGURE 1 the electrode **42** includes a portion **48** that is made of aluminum. The aluminum portion **48** provides improved electrical transport between the bulk of the electrode **42** which is made of nickel, a nickel alloy, or another magnetic material, and the ITO layer **24**.

[0022] Manufacturing of the thin film light emitting device **10** employs a suitable combination of material deposition steps, photolithography steps or other pattern definition steps, and other conventional material fabrication operations. For example, in one approach the confinement layer **14** is a glass or plastic substrate with some rigidity that serves as a starting substrate. The ITO layer **24** is formed on the substrate **14** by vacuum evaporation or another suitable technique and, optionally, patterned to define a pattern of serial interconnects or other electrical features. The light emitting polymer layer or layers and optionally other material layers comprising the thin film light emitting structure **12** are next deposited using deposition techniques suited for the particular materials, followed by processing to form the hermetic electrodes **40**, **42** and to ensure hermetic sealing. See examples set forth in FIGURES 11-14 for some illustrative fabrication examples.

[0023] In illustrative FIGURE 1, the electrodes **40**, **42** are shown with their exposed surfaces arranged flush with the exposed surface of the confinement layer **16** at the planar mounting side **22**. However, it is also contemplated for the electrodes **40**, **42** to extend outside and over a proximate portion of the exposed surface of the confinement layer **16**. Such extension may be the case, for example, if the electrodes **40**, **42** are formed by electroplating which mushrooms outside of the via inside which the magnetic material is electroplated.

[0024] The thin film solid state lighting device **10** shown in FIGURE 1 is an illustrative example. Other configurations can be employed in which the electrodes are disposed on the planar mounting side **22** opposite the planar light emitting side **20**, and in which the electrodes include a magnetic material.

[0025] With reference to FIGURE 2, for example, a modified thin film solid state lighting device **10'** is similar to that of FIGURE 1, except that the electrodes **40**, **42** of FIGURE 1 are replaced by side extending electrodes **50**, **52** that pass through gaps in the peripheral sealing adhesive **34**. The electrodes **50**, **52** are wrapped around to the planar mounting side **22** by respective conductive trace portions **54**, **56** made of aluminum or another conductive material to electrically contact electrode portions **60**, **62** which are made of a magnetic material and are disposed on the planar mounting side **22** opposite the planar light emitting side **20**. In other words, the electrode **50**, **54**, **60** defines a first electrical input to the thin film light emitting structure **12**, while the electrode **52**, **56**, **62** defines a second electrical input to the thin film light emitting structure **12**. Although in FIGURE 2 only the electrode portions **60**, **62** are made of a magnetic material such as nickel or a nickel alloy, optionally some or all of the other electrode portions **50**, **52**, **54**, **56** may also be made of a magnetic material.

[0026] With returning reference to FIGURE 1 and with further reference to FIGURE 3, advantages of the disclosed thin film solid state lighting device **10** (or equivalently, of the disclosed thin film solid state lighting device **10'**) include the features that the electrodes **40**, **42** enable convenient simultaneous magnetic and electrical connection of the thin film solid state lighting device **10** to a connection element such as an illustrated connecting element or fixture **70**, or to a jumper element configured to electrically interconnect in series two of the thin film solid state lighting devices **10** shown in FIGURE 1, or so forth. The fixture **70** includes an electrical power supply component **72** (shown in phantom in FIGURE 3) which is disposed in or on a backside of the fixture **70**.

[0027] The electrical power supply component **72** supplies electrical drive power or current suitable for energizing the thin film solid state lighting device **10** via electrical traces or conductors **74**, **76** (again shown in phantom in FIGURE 3). The electrical drive power or current is available at mating electrodes **80**, **82** of the connection element **70**. The mating electrodes **80**, **82** are arranged on a planar surface **84** of the connection element **70** such that the mating electrodes **80**, **82** align with and contact respective electrodes **40**, **42** disposed on the planar mounting side **22** of the thin film solid state lighting device **10** when the two planar mounting side **22** is placed onto the planar surface **84** of the connection element **70**. Note that FIGURE 3 illustrates a point at which the thin film solid state lighting device **10** is being moved with the planar mounting side **22** facing toward the planar surface **84** of the fixture **70**, but before contact is actually made. This view reveals the general alignment of the electrodes **40**, **42** of the thin film light emitting device **10** with the corresponding mating electrodes **80**, **82** of the connection element **70**.

[0028] In the illustrated embodiment, the mating electrodes **80**, **82** are magnetized to define permanent magnets. As a result, as the planar mounting side **22** facing toward the planar surface **84** of the fixture **70** is moved toward the fixture **70**, the magnetic mating electrodes **80**, **82** magnetically attract the magnetic material of the proximate corresponding electrodes **40**, **42**. This effectuates a "drawing in" of the thin film solid state lighting device **10** toward the planar surface **84** of the fixture **70**, and additionally the electrodes **40**, **42** are automatically aligned by the magnetic attraction with the magnetic mating electrodes **80**, **82**. The effect is that the thin film solid state lighting device **10** automatically snaps into place when moved close enough to the planar surface **84** of the fixture **70** with the electrodes **40**, **42** correctly positioned and in conductive electrical contact with the correct corresponding mating electrodes **80**, **82**. In this way, the thin film solid state lighting device **10** mechanically mates with the fixture **70** and electrically connects with the fixture **70** to concurrently form an electrically conductive drive current path from the fixture **70** to the thin film solid state lighting device **10** that includes the electrodes **40**, **42** disposed on the planar mounting side **22** of the thin film solid state lighting device **10**.

[0029] In the case of the illustrated OLED device **10**, which is a polar device, there is only one correct direction of current flow, since the OLED device will not operate if the current flow is in the wrong or "reverse" direction. Accordingly, the electrodes **40**, **42** and corresponding mating electrodes **80**, **82** are keyed by size and/or shape, as illustrated for example in FIGURE 3, in order to ensure that the OLED device **10** is magnetically attached to the fixture **70** with the correct electrical polarity. Instead of keying the electrodes themselves, other keying features can be included on the planar mounting side **22** of the thin film solid state lighting device **10** and correspondingly on the planar surface **84** of the connection element **70** such that the connection can only be made (or can only easily be made) in the correct orientation.

[0030] In embodiments in which the electrodes **40**, **42** are not magnetized to define permanent magnets, there are no permanent magnets on the thin film solid state lighting device **10**. As a result, the thin film solid state lighting device **10** is not a hazard to neighboring digital storage media such as magnetic disks or FLASH memory units. The fixture **70** does include magnets, namely the electrodes **80**, **82** which are magnetized to define permanent magnets. However, if the fixture **70** is a mounting element affixed to a wall or other fixed structure, then the likelihood of problems from stray magnetic fields is reduced.

[0031] It is also contemplated to have the mating electrodes **80**, **82** of the fixture **70** be made of a magnetic material but not magnetized, and to have the electrodes **40**, **42** of the thin film solid state lighting device **10** be magnetized to form permanent magnets. The observed operation is the same as already described, except that it will be appreciated that when not attached to the fixture **70** the thin film solid state lighting device will have permanent magnets and consequent stray magnetic fields.

[0032] In yet other contemplated embodiments, both the electrodes **40**, **42** and the mating electrodes **80**, **82** are magnetized to form permanent magnets. In these embodiments, the polarity of the permanent magnets must be such that magnetic attraction is generated, rather than magnetic repulsion. That is, the magnet of the electrode **40** facing the mating electrode **80** should have opposite magnetic polarity to that of the mating electrode **80**, i.e. either "north/south" or "south/north". The analogous situation holds for the electrode/mating electrode pair **42**, **82**. In some such embodiments, the electrodes **40**, **42** may have the same polarity (either both being north poles or both being south poles). In other such embodiments, the electrodes **40**, **42** may have the opposite polarity – in these latter embodiments, the magnetic polarities of the electrodes **40**, **42** can also be used to magnetically key the electrodes to the correct corresponding mating electrodes **80**, **82**, since in these latter embodiments attempting to connect (for example) electrode **40** to the wrong mating electrode **82** would result in a repulsive "north/north" or "south/south" combination.

[0033] The magnetic material of the electrodes **40**, **42** (or of the electrodes **60**, **62**) is not a component of an inductive element, such as might be used in a wireless inductive power delivery system. As a result, the electrodes **40**, **42** do not have associated inductor windings, are simple to fabricate, and can be made highly planar or even (as shown in FIGURE 1) made flush with the planar mounting side **22**. Moreover, since power transfer is conductive rather than wireless inductive, there is no need for a.c./d.c. power conversion circuitry on the thin film solid state lighting device **10**. Indeed, in some embodiments including the illustrated embodiments the thin film solid state lighting device **10** is planar and does not include any power conditioning electronics. Instead, in the illustrated embodiments the power conditioning electronics **72** are disposed entirely on the fixture **70**, which enables the planar thin film solid state lighting device **10** to be made exceedingly thin. Although the illustrated thin film solid state lighting device **10** does not include any power conditioning electronics, it is contemplated to include power conditioning electronics on other (not illustrated) embodiments of the thin film solid state lighting device.

[0034] The illustrated fixture **70** includes the electrical power supply component **72** which generates the drive electrical power or current. However, in other embodiments the drive electrical power or current may be delivered from elsewhere to the fixture. For example, in some embodiments the fixture may include one or more jumper elements configured to electrically interconnect in series two of the thin film solid state lighting devices **10**. In this case, the connecting jumper element does not generate the drive electrical current, but rather receives the electrical drive current from one thin film solid state lighting device **10** and conducts it to the next thin film solid state lighting device **10**.

[0035] As used herein, "magnetized to define a permanent magnet" or similar phraseology denotes magnetization to generate a permanent magnet having magnetic strength sufficient to mechanically secure the thin film solid state lighting device **10** with the fixture **70** and to effectuate conductive electrical connection between the electrodes **40**, **42** and the corresponding mating electrodes **80**, **82**. The phrase "magnetized to define a permanent magnet" does not encompass residual magnetization such as may remain in magnetic material that is a component of an inductive element when the inductive element is de-energized or other stray fields left in ferromagnetic materials when exposed to permanent magnetic fields.

[0036] The mating electrodes **80, 82** may remain electrically energized when the thin film solid state lighting device **10** is disconnected. In this case, the voltage present at the energized mating electrodes **80, 82** should be at a non-hazardous level, such as at a level comporting with an Underwriters Laboratory (UL) class II power supply standard used in the United States.

[0037] With reference to FIGURES 4-9, some illustrative embodiments are shown which illustrate the flexibility of the disclosed arrangements for mounting thin film solid state lighting devices for general illumination purposes.

[0038] FIGURES 4 and 5 illustrate a mounting configuration for mounting a generally planar OLED device **100** in or on an overhead fixture **102**. The OLED device includes a light emissive lower surface **104** facing generally downward, and an upper surface (not visible in FIGURES 4 and 5) which includes electrodes containing magnetic material corresponding to the electrodes **40**, **42** (FIGURES 1 and 3) or to the electrodes **60**, **62** (FIGURE 2). The overhead fixture **102** corresponds to the fixture **70** shown in FIGURE 3, and includes magnetic mating electrodes **106**, **108** corresponding to the mating electrodes **80**, **82** of the fixture **70** shown in FIGURE 3. With this arrangement, achieving both electrical connection and mechanical mounting of the OLED device **100** onto or into the overhead fixture **102** is accomplished by raising or lifting the OLED device **100** up with the device roughly aligned with the overhead fixture **102** until the magnetic mating electrodes **106**, **108** are close enough to the electrodes containing magnetic material of the OLED device **100**. At that point, magnetic attraction will automatically complete the lifting of the OLED device **100** up onto or into the overhead fixture **102** and will advantageously simultaneously align and electrically conductively connect its electrodes with the magnetic mating electrodes **106**, **108** of the overhead fixture **102**.

[0039] With reference to FIGURES 6-8, the approach is readily employed with flexible or curved thin film solid state lighting devices. FIGURES 6-8 illustrate a flexible OLED device **110** connecting with a curved lighting fixture **112**. The flexible planar OLED device **110** includes a light emissive lower surface **114** facing generally downward, and an upper surface (not visible in FIGURES 6-8) which includes electrodes containing magnetic material corresponding to the electrodes **40**, **42** (FIGURES 1 and 3) or to the electrodes **60**, **62** (FIGURE 2). The lighting fixture **112** corresponds to the fixture **70** shown in FIGURE 3, but has a curved mounting surface **115** that includes a set of magnetic mating electrodes **116** (either anode electrodes or cathode electrodes) and a set of magnetic mating electrodes **118** (either cathode electrodes or anode electrodes, being opposite of the type of the electrodes **116**). The magnetic mating electrodes **116**, **118** correspond to the mating electrodes **80**, **82** of the fixture **70** shown in FIGURE 3. With this arrangement, achieving both electrical connection and mechanical mounting of the OLED device **110** onto or into the lighting fixture **112** is accomplished by raising or lifting the flexible OLED device **110** up with the device roughly flexed and aligned with the mounting surface **115** of the lighting fixture **102** until the magnetic mating electrodes **116**, **118** are close enough to the electrodes containing magnetic material of the OLED device **110**. At that point, magnetic attraction will automatically complete the lifting of the OLED device **110** up onto or into the lighting fixture **112** and will advantageously simultaneously align and electrically conductively connect its electrodes with the magnetic mating electrodes **116**, **118** of the lighting fixture **112**.

[0040] With particular reference to FIGURE 8, depending upon the weight of the flexible OLED device **110**, the total area and locations of the magnetic mating electrodes **116**, **118**, the magnetic strength of the magnetic mating electrodes **116**, **118**, and other factors, the magnetic coupling may be insufficient by itself to ensure mechanical retention of the flexible OLED device **110** on the mounting surface **115** of the lighting fixture **112**. In such cases, additional mechanical support may be provided. In FIGURE 8, cornered tabs **120**, **122** formed in the edges of the mounting surface **115** of the lighting fixture **112** provide such additional support. Although the OLED device **110** is flexible, it has substantial resistance to in-plane shear stress (in other words, it resists "crumpling" due to in-plane compressive stress). Accordingly, the flexible OLED device **110** can be compressed against the tabs **120**, **122** with the shear stress pressing the central region of the OLED device **110** against the central area of the mounting surface **115**, so as to impart additional mechanical retentive force. Advantageously, the tabs **120**, **122** also assist in aligning the flexible OLED device **110** in the lighting fixture **112**. By way of example, in a suitable approach the installer may press the edge of the flexible OLED device **110** against the mating tab **122**, then push the central area of the OLED device **110** up flush against the mounting surface **115** until the opposite edge of the flexible OLED device **110** matches up and presses against the distal tab **120**.

[0041] FIGURE 8 also diagrammatically shows internal electrical components of the lighting fixture **112**. An electrical power supply component **124** corresponding to the electrical power supply component **72** shown in phantom in FIGURE 3 is mounted at a convenient internal location in the lighting fixture **112**, and connects with the magnetic mating electrodes **116**, **118** via wiring **126**. A wire pigtail **128** or other electrical coupler provides for delivery of electrical power to the lighting fixture **112**.

[0042] With reference to FIGURE 9, it is to be understood that the connecting element or fixture can be integrated with another structure, that is, the lighting fixture can be integrated with another structure. By way of example, FIGURE 9 illustrates a cabinet **130** having a horizontal shelf **132**. The fixture is integrated with the horizontal shelf **132**, or in other words the horizontal shelf **132** also serves as a lighting fixture for mounting a planar OLED device **140** having a lower (downward facing) light emission surface **142** and an opposite (upward facing) surface **144** including electrodes **146**, **148** containing magnetic material. Toward this end, the horizontal shelf **132** has on its lower surface magnetic mating electrodes **150**, **152** corresponding to the mating electrodes **80**, **82** of the fixture **70** shown in FIGURE 3, which are electrically connected with an electrical power supply component **154** also mounted in the shelf **132**. The electrical power supply component **154** corresponds to the electrical power supply component **72** shown in phantom in FIGURE 3. The operation is analogous to that described for the embodiment of FIGURES 4 and 5, namely that the planar OLED device **140** is lifted up with its face **142** facing the bottom (mounting surface) of the horizontal shelf **132** until its electrodes **146**, **148** containing magnetic material are drawn by magnetic attraction to the magnetic mating electrodes **150**, **152** so as to effectuate both conductive electrical connection and mechanical mounting.

[0043] With reference to FIGURE 10, fixtures **102** corresponding to the fixture **102** shown in FIGURE 4 are shown in a tiled arrangement. FIGURE 10 shows the fixtures **102** in a laterally exploded view, with each fixture **102** viewed from the opposite side from the mounting side seen in FIGURE 4. In the view of FIGURE 10, the magnetic mating electrodes **106**, **108** are not directly visible, but corresponding magnet mounting recesses **106'**, **108'** are visible, along with recesses **160** for mounting an electrical power supply component in each fixture **102**. Electrical jumpers **162** electrically interconnect the fixtures **102** at edges of the fixtures **102**. The electrical interconnection of the fixtures **102** is controlled by the configuration of the electrical jumpers **102** and circuitry of the electrical power supply components, and in general the tiled fixtures **102** can be electrically interconnected in parallel, series, or another electrical layout.

[0044] With reference back to FIGURES 1 and 2, the disclosed lighting devices, lighting fixtures, lamp mounting techniques, and the like can be used or performed in conjunction with various types of thin film solid state lighting devices that have a planar light emitting side and an opposite planar mounting side and that include electrodes disposed on the planar mounting side of the thin film solid state lighting device. One class of such devices is the class of organic light emitting diode (OLED) devices. These devices can include electrodes **40**, **42** contacting the thin film light emitting structure **12** through backside vias (FIGURE 1) or can have electrical connection passing out sides of the device with electrodes **50**, **52** wrapped around to the planar mounting side **22** by respective conductive trace portions **54**, **56** to electrically contact electrode portions **60**, **62** (FIGURE 2). The former arrangement is particularly convenient insofar as it reduces device complexity and potential points of moisture ingress, which is advantageous since some OLED active materials degrade rapidly upon exposure to moisture or some other environmental contaminants.

[0045] With reference to FIGURES 11-14 some additional illustrative embodiments of OLED devices having electrodes contacting the thin film light emitting structure **12** through backside vias are described.

[0046] In general, OLED devices can be produced using various fabrication processes. The OLED active light-emitting material or materials can be formed by vacuum deposition, using solution processed materials, or so forth, using various substrates such as glass or plastic film. OLED devices produced in a flat thin format find use in applications such as display or general illumination applications. The use of a plastic substrate facilitates low cost roll to roll production. Various barrier films are suitably used, such as barrier layers comprising a thin transparent oxide layer on a transparent plastic film. Various "layers" comprising the illustrative devices may be variously embodied as coatings, films, discrete sheets, or so forth, a given layer may comprise a composite of two or more constituent layers.

[0047] With reference to FIGURE 11, an illustrative OLED device **300** includes a glass or plastic substrate **309**, a barrier layer **301**, a transparent conductive layer **302** that forms a first electrode layer (referred to as an anode layer herein by way of example, although an opposite polarity device is also contemplated), one or more light emitting layers **303**, and second electrode layer **304** (referred to herein as a cathode layer, although again a reversed polarity device is also contemplated). Other layers (not illustrated) may also optionally be included, such as one or more of the following optional layers: hole injecting, hole transporting, electron injection and electron transporting layers, or so forth. Illustrated layer **305** is an optional insulating layer that may be used to provide mechanical protection to the cathode layer **304** during fabrication and, to prevent electrical shunting or shorting to other package elements during processing, or for other purposes.

[0048] The cathode layer **304** has an exposed region **306** and the anode layer **302** has an exposed region **307**. These exposed regions **306**, **307** are used to form an electrical connection to electrically energize the device **300**. It will be appreciated that there may be multiple exposed regions of the contact layers **302**, **304** for making electrical contact. For example, electrically isolated segments or portions of the light emitting layer or layers **303** may optionally be formed by patterning of the layers **302**, **303**, **304** to form electrically isolated segments or portions with exposed regions of the electrical contact layers **302**, **304** that are electrically interconnected in series, parallel, or another electrical configuration using electrically conductive interconnect traces (features not shown). Barrier layer **308** is another optional layer that may be included to provide additional protection to the cathode layer **304**. In the OLED device **300**, a surface **310** is the light emitting side, and a surface **311** is the non-emitting back side.

[0049] The OLED device **300** of FIGURE 11 is an illustrative example, and other OLED device configurations can be used in the hermetically sealed packages described herein. Some other suitable OLED devices are described, for example, in U.S. Pat. No. 6,661,029, U.S. Pat. No. 6,700,322, U.S. Pat. No. 6,800,999 and U.S. Pat. No. 6,777,871, each of which is incorporated herein by reference in its entirety.

[0050] With reference to FIGURE 12, an exploded view of a hermetically sealed electrical package is shown, which includes the OLED device **300** along with a backsheet **400** and electrically conducting elements **410**, **411** that electrically contact the exposed areas **306**, **307** of the contact layers **302**, **304**. In the hermetically sealed package, the backsheet **400** and the glass or plastic substrate **309** on which the OLED device **300** is formed cooperatively define a sandwiching confinement structure for the hermetically sealed package. Some suitable materials for the substrate **309** in this sealed package include transparent flexible plastics, such as polyesters and polycarbonates, particularly optical grades of such plastics. Suitable materials for barrier layer **301** include materials having a low moisture permeability rate, for example a moisture permeability rate of preferably less than about 10^{-4} cc/m^2/day, and more preferably less than 10^{-5} cc/m^2/day, and still more preferably less than about 10-6 cc/m^2/day, these values being specified for a temperature of about 23°C. Some suitable materials for the barrier layer **301** include UHB materials, such as described for example in U.S. Pat. No. 7,015,640, U.S. Pat. No. 6,413,645, U.S. Pat. No. 6,492026, U.S. Pat. No. 6,537,688, and U.S. Pat. No. 6,624,568, each of which is incorporated herein by reference in its entirety, or flexible or rigid glass, transparent metals and oxides having sufficient moisture and/or oxygen barrier properties, such as indium tin oxide (ITO), and combinations of these.

[0051] In the illustrated embodiment, the backsheet **400** is a multilayer foil which is made up of a thin interface layer **401**, a barrier layer **402**, and an optional insulating layer **403**. Some suitable materials for use as the backsheet **400** include commercially available multilayer packaging or lidding materials having moisture- and optionally oxygen-barrier properties in the form of films or sheets, such as heat-sealable materials. Lidding materials are typically composed of multiple thin polymer layers; lidding foils may also include a metal foil, such as aluminum, sandwiched between polymer layers. One example of a suitable material is Tolas TPC-0814B lidding foil, produced by Tolas Healthcare Packaging, Feasterville, PA, USA, a division of Oliver-Tolas, Grand Rapids, MI, USA. Holes or vias **404**, **405** are formed in the backsheet **400** using any suitable method, such as punching, die cutting, laser machining, lithographic etching, or so forth. The holes **404**, **405** can be round or of another lateral geometry or shape, can be of varied diameter or size, or of other shapes and aspect ratios depending on the layout of the OLED device and other design factors.

[0052] Patches **408**, **409** corresponding to holes or vias **404**, **405**, respectively, suitably comprise conductive foil elements such as aluminum of sufficient thickness and homogeneity to be impermeable to moisture or other detrimental environmental contaminants. As used herein, the term "patch" refers to a piece or sheet of electrically conductive material used to cover the holes or vias **404**, **405**. The patches **408**, **409** provide hermetic sealing for respective holes or vias **404**, **405**, and are of sufficient thickness to be impermeable to moisture, oxygen, and/or other contaminants that may have a deleterious effect on the OLED device **300**. The patches **408**, **409** may, for example, comprise metal foils of sufficient thickness. To further facilitate sealing, the patches **408**, **409** are sized to be substantially larger than respective holes or vias **404**, **405**. In the illustrated embodiment, the patches **408**, **409** are sealed to the barrier layer **402** by the interface layer **401** to form respective seal zones **416**, **417**. The holes or vias **404**, **405** may be round, square, or otherwise shaped, and the corresponding patches **408**, **409** may be round, square, or otherwise shaped. The patch does not have to have the same shape as the corresponding hole, although this may be the case. The illustrated patches **408**, **409** cover holes **404**, **405** for the anode and cathode, respectively; however, in general the patches can be configured to cover multiple holes so as to provide lateral busing of electrical current or to facilitate other electrical interconnection configurations (such as is the case in the embodiment of FIGURES 6-8, by way of example). In one example, the patches **408**, **409** are fabricated from 0.001 inch thick aluminum foil. The patches **408**, **409** are suitably die cut from a foil sheet or otherwise fabricated, and should be sufficiently planar to facilitate hermetic sealing of the respective holes or vias **404**, **405**.

[0053] Some suitable materials for the patches **408**, **409** include aluminum, stainless steel, nickel, and brass. In one example, patches are fabricated from 0.001 inch thick aluminum foil. In another example, the patches are fabricated from 0.001 stainless steel. The patches may be die cut from a foil sheet, or may be otherwise formed. The patches should be sufficiently free of burrs at the cut edges of the patches to avoid compromising the package sealing. In some embodiments, the patches **408**, **409** are made of a magnetic material such as nickel, a nickel alloy, stainless steel, or another suitable magnetic material that provides the magnetic material for the magnetic mounting described generally with reference to FIGURES 3-10. In these embodiments, the patches **408**, **409** may be magnetized or unmagnetized.

[0054] The patch **408** is electrically coupled to the exposed area **306** of the cathode layer **304** through electrically conductive element **410**. Similarly, the patch **409** is electrically coupled to the exposed area **307** of the anode layer **302** through the electrically conductive element **411**. The conductive elements **410**, **411** can comprise an electrically conductive adhesive, such as Staystik 571 (available from Cookson Electronics, Alpharetta, GA, USA), that is placed between electrical contact areas **306**, **307** and the corresponding patches **408**, **409**. The adhesive **410**, **411** can be formed or disposed by various fabrication approaches, such as manual dispensation or an automated adhesive dispenser. The vias **404**, **405** of the backsheet **400**, the corresponding patches **408**, **409**, the corresponding conductive elements **410**, **411**, and the corresponding electrode contacts **306**, **307** of the OLED device **300** are aligned and laid up in preparation for a lamination process. In some embodiments, the lamination process is performed at a temperature preferably between 90 ^{o}C and 130 ^{o}C, and more preferably at about 120 ^{o}C, and at a pressure of preferably 1 psi to 30 psi, and more preferably about 15 psi, for a time preferably between 1 second and 10 minutes, and more preferably about 30 seconds. These lamination process parameters are merely illustrative examples, and other lamination processes may be used. The lamination produces the hermetically sealed electrical package in which the patches **404**, **405** make electrical connections with respective anode and cathode layer contact areas **306**, **307** through respective conductive elements **410**, **411**. To avoid shunting or shorting of the device, it will be appreciated that the patches **404**, **405** should be electrically isolated from each other, and similarly the conductive elements **410**, **411** should be electrically isolated from each other. However, as already noted, if a plurality of vias of the same conductivity type are included (for example, multiple vias accessing exposed areas of the anode layer **302**) it is contemplated to employ a single patch extending across and sealing these multiple vias of the same conductivity type, thus providing convenient internal electrical interconnection of the vias of the same conductivity type.

[0055] In illustrative FIGURE 12, the anode layer contact **306** and corresponding patch **408** and via **404** are all generally centrally aligned; and similarly, the cathode layer contact **307** and corresponding patch **409** and via **405** are all generally centrally aligned. However, this is not required, so long as the patches **408**, **409** completely cover and seal respective openings **404**, **405**. Indeed, it is contemplated that some offset orientation between these components may prove advantageous in optimizing the OLED device layout and the package design.

[0056] The disclosed illustrative combination of materials can be laminated using a single lamination process for bonding both the conductive elements **410**, **411** and the interface layer **401** under the same lamination conditions. However, it is also contemplated to use two or more lamination processes to form these bondings. Moreover, it may be desirable to create a subassembly of selected elements prior to final lamination. For example, the patches **404**, **405** are optionally attached to the backsheet **400** in a first operation, followed by lamination of the OLED device **300** to the backsheet **400** in a second operation.

[0057] Various lamination processes can be used, such as pouch lamination, roll lamination, hot press lamination, or so forth, using various process-dependent lamination parameters. The lamination process or processes may optionally employ release films, press pads, tooling plates, or so forth as appropriate or beneficial for the lamination process or processes. Other process operations are also contemplated to enhance the OLED device fabrication process. For example, operations to clean and remove moisture from package materials may be advantageous, such as baking the backsheet **400** at 80 °C for 12 hours under vacuum to eliminate moisture. Various process operations may also optionally be performed in an inert atmosphere or other steps may be taken to prevent contamination by moisture, oxygen, or other potentially detrimental contaminants.

[0058] The patches **408**, **409** and backsheet **400** are sealed in such a way that the aforementioned seal zones **416**, **417** are created in a way that presents a geometrically unfavorable ingress path for moisture and oxygen. The geometry of the seal zones **416**, **417** can be described as a ratio R_l of seal zone path length to the thickness of interface layer **401**. A large ratio R_l provides a more difficult ingress path for a given material set. Depending on the shape, size and alignment of respective holes **404**, **405** and patches **408**, **409** the ratio R_l could vary depending on the particular path chosen for analysis. In one illustrative embodiment, the vias **404**, **405** have a diameter of 0.25 inch (0.635 cm) and the patches **408**, **409** have a diameter of 1.25 inches (3.175 cm), so that seal zone path length is 0.5 inches (1.27 cm), and ratio R_l is approximately 500:1. (It is to be understood that the dimensions are not depicted to scale in the drawings). In general, reduction in the thickness of interface layer **401** (that is, the permeation path between barrier **402** and the patch **408**, **409**) is expected to increase the ratio R_l and improve the hermetic sealing of the via **404**, **405**. In addition, it may be desirable to minimize the diameters of vias **404**, **405**. For example, reduction to a diameter of approximately 0.025 inch (0.064 cm) using suitable fabrication and alignment procedures is expected to enhance sealing. Depending on the layout of device OLED device **300**, smaller vias **404**, **405** may be desirable to achieve other design objectives such as maximizing the light-emitting area of the device.

[0059] It is also contemplated for the backsheet to include an electrically conductive layer, in which case the via or vias of one conductivity type can be omitted, as the electrically conductive layer of the backsheet can replace one of the patches (embodiment not illustrated). In such an embodiment the via or vias for accessing the electrical contact layer of the other conductivity type must be electrically insulated using a suitable annular insulating insert, insulating coating, or so forth, to avoid shorting or shunting to the electrically conductive layer of the backsheet.

[0060] With reference to FIGURE 13, an exploded view of an alternative embodiment is shown, in which the internally located patches **408**, **409** are replaced by externally located patches **508**, **509** that are located on the opposing face of backsheet **400** with respect to the device **300**. To facilitate hermetic sealing, the patches **508**, **509** optionally include an interface layer **501**, such as an adhesive. Materials suitable for use in interface layer **501** have low permeability to at least moisture and oxygen. In addition, the materials preferably can be processed at relatively low temperatures, for example preferably less than 150°C, and more preferably less than 120°C. In one example, PRIMACOR 3460 thermoplastic adhesive (available from Dow Chemical, Midland, Michigan, USA) is used to prepare a 0.001 inch thick layer. The patches **508**, **509** (with optional interface layer **501**) are aligned to the openings **404**, **405** of the backsheet **400** and are laminated therewith. In some embodiments, the lamination process parameters include a temperature of preferably between 95 °C and 125 °C, and more preferably about 115 °C, and a pressure of preferably between 5 psi to 20 psi, and more preferably about 10 psi, for a time preferably between 1 minute and 10 minutes, and more preferably about 2 minutes. Various lamination processes are suitable, such as pouch lamination, roll lamination hot press lamination, or so forth, and optionally may employ release films, press pads, tooling plates, or so forth (not shown). Other materials suitable for use as the optional interface layer **501** include thermosets and thermoplastic adhesives.

[0061] The arrangement of FIGURE 13 enables the aforementioned ratio R_l to be generally larger as compared with the embodiment of FIGURE 12, because the sizes of the patches **508**, **509** are not limited by the size and location of the OLED device **300** and its exposed anode and cathode layer areas **306**, **307**. Indeed, the illustrative patch **508** extends beyond the edge of the package, as illustrated for the patch **508**. In one quantitative example, the path length may be 1.0 inches (2.54 cm), and the interface layer **501** may have a thickness of 0.001 inch (0.0025 cm), so as to yield the ratio R_l=1000:1.

[0062] In the illustrative embodiment of FIGURE 13, the OLED device **300** is laminated with the backsheet **400** in a separate lamination process from the lamination process that binds the backsheet **400** and the patches **508**, **509**. In this lamination process are aligned and laid up the backsheet **400**, the OLED device **300**, and the conductive elements **410**, **411**. The patches **508**, **509** can be laminated with the backsheet **400** first, followed by lamination of the OLED device **300** with the backsheet **400**. Alternatively, the backsheet **400** can be laminated with the OLED device **300** first, followed by lamination of the patches **508**, **509**. In this second alternative lamination sequence, the first lamination process results in a sealed package in which the OLED device **300** is protected from mechanical damage and moisture ingress, but the seal is less than ideal due to the lack of the patches **508**, **509**. Nonetheless, due to protection of the OLED device **300** afforded by the first lamination process, it is contemplated to perform the second lamination process which joins the conductive elements **410**, **411** and patches **508**, **509** after a lapse of time. In yet other contemplated embodiments, the first and second lamination processes are combined as a single lamination process.

[0063] With reference to FIGURE 14, an exploded view of yet another embodiment of a hermetically sealed package is illustrated, which again includes the OLED device **300**, the backsheet **400** with openings or vias **404**, **405**, and the electrically conducting elements **410**, **411**. In this embodiment patches **608**, **609** forming respective seal zones **616**, **617** are sandwiched between the backsheet **400** and a second backsheet **600** having openings or vias **604**, **605** corresponding to the openings or vias **404**, **405**, and including a thin interface layer **601**, a barrier layer **602**, and an optional insulating layer **603** similar to the respective layers **401**, **402**, **403** of the backsheet **400**. The patches **608**, **609** are optionally provided with adhesive **611**. This embodiment allows a large ratio R_l for the reasons analogous to those described for the embodiment of FIGURE 13. Various lamination processes and process sequences are contemplated for the embodiment of FIGURE 14.

[0064] Some illustrative examples of OLED devices comprising a hermetically sealed package having backside contacts passing through vias in a backsheet and including sealing patches have been described. Some additional illustrative examples are set forth in Farquhar et al., "Hermetic Electrical Package", Atty. Docket No. 237484-1, serial no. __/____,____ filed ______, 2009, which is incorporated herein by reference in its entirety. Additionally, although the devices of FIGURES 11-14 are described herein as OLED devices by way of illustrative example, other thin film solid state lighting devices can be similarly constructed by employing a suitable light emitting material or material structure as the one or more light emitting layers **303**.

[0065] With continuing reference to FIGURES 11-14, modification of the devices to incorporate a magnet or magnetic material in the electrodes can be done in various ways. In one approach, the patches **408**, **409**, **508**, **509**, **608**, **609** are suitably made of nickel, a nickel alloy, stainless steel, or another suitable magnetic material. If a permanent magnet is desired, the patches can be magnetized. This approach is advantageous in that the patches **408**, **409**, **508**, **509**, **608**, **609** are of large area and hence provide a substantial mass of magnetic material to facilitate magnetic mounting and simultaneous magnetic conductive electrical connection with the fixture **70**, **102**, **112**, **132**.

[0066] In other embodiments, additional external magnetic electrode material may be added to complete the electrode. For example, in the embodiment of FIGURES 11 and 12, the vias **404**, **405** are optionally filled with additional electrically conductive material (not shown) to provide electrical contact with the buried patches **408**, **409**. Similarly, in the embodiment of FIGURE 14 the vias **604**, **605** of the second backsheet **600** are preferably filled with additional electrically conductive material (not shown) to provide electrical contact with the buried patches **608**, **609**. (It should be noted that when performing such via filling, if the barrier layer **402** or barrier layer **602** is made of an electrically conductive material then the via walls must be insulated using a deposited insulator, insulating bushing element, or the like).

[0067] The embodiment of FIGURE 13 is particularly attractive for inclusion of magnetic material-based electrical and mechanical mounting to a lighting fixture because in that embodiment the patches **508**, **509** are directly exposed on the surface of the hermetically sealed OLED package, making magnetic coupling therewith by mating magnetic electrodes particularly effective.

[0068] The preferred embodiments have been illustrated and described. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

CLAIMS

1. An article of manufacture comprising:

an organic light emitting diode (OLED) device having a planar light emitting side and an opposite planar mounting side, the OLED device including a backsheet sealing the planar mounting side and electrodes providing an electrically conductive pathway for electrically energizing the OLED device to cause the planar light emitting side to emit light, the electrodes passing through holes in the backsheet, the electrodes including patches of electrically conductive magnetic material that are part of the electrically conductive pathway and that seal the holes in the backsheet such that the OLED device, backsheet, and patches of electrically conductive magnetic material together define a sealed planar package; and

a fixture having mating electrodes arranged to mate with the electrodes of the OLED device, the mating electrodes of the fixture including magnetic material that magnetically attracts the patches of electrically conductive magnetic material to mechanically connect the OLED device with the fixture and simultaneously electrically connect the OLED device with the fixture.

2. The article of manufacture as set forth in claim 1, wherein the magnetic material of the mating electrodes of the fixture are magnetized to define permanent magnets that magnetically attract the patches of electrically conductive magnetic material to mechanically connect the OLED device with the fixture and simultaneously electrically connect the OLED device with the fixture.

3. The article of manufacture as set forth in claim 1, wherein the patches of electrically conductive magnetic material are magnetized to define permanent magnets that magnetically attract the magnetic material of the mating electrodes to mechanically connect the OLED device with the fixture and simultaneously electrically connect the OLED device with the fixture.

4. The article of manufacture as set forth in claim 1, wherein:

the patches of electrically conductive magnetic material are magnetized to define permanent magnets; and

the magnetic material of the mating electrodes of the fixture are magnetized to define permanent magnets; and

the polarities of the defined permanent magnets of the OLED device and the fixture are selected to form a keyed attachment such that the OLED device can only be connected with the fixture with a correct electrical polarity.

5. The article of manufacture as set forth in claim **1**, wherein the OLED device is planar and does not include any power conditioning electronics.

6. The article of manufacture as set forth in claim **1**, wherein the fixture further comprises:

an additional mechanical support element providing additional mechanical connection of the OLED device with the fixture.

7. The article of manufacture as set forth in claim **6**, wherein the additional mechanical support element of the fixture comprises:

tabs formed in the fixture that compressively hold the OLED device to impart additional mechanical retentive force.

8. An article of manufacture comprising:

a thin film solid state lighting device having a planar light emitting side and an opposite planar mounting side and including electrodes disposed on the planar mounting side of the thin film solid state lighting device, the electrodes including a magnetic material configured to conductively convey electrical drive current to drive the thin film solid state lighting device to emit light at the planar light emitting principal side.

9. The article of manufacture as set forth in claim **8**, wherein the thin film solid state lighting device comprises an organic light emitting diode (OLED) device.

10. The article of manufacture as set forth in claim **9**, wherein the OLED device including the electrodes define a hermetically sealed planar unit with the electrodes exposed at the planar mounting side.

11. The article of manufacture as set forth in claim **10**, wherein the magnetic material of the electrodes comprises a ferromagnetic material.

12. The article of manufacture as set forth in claim **10**, wherein the electrodes pass through holes in the hermetically sealed planar unit, the electrodes comprising:

patches of magnetic material configured to conductively convey electrical drive current to drive the thin film solid state lighting device to emit light at the planar light emitting principal side, the patches also hermetically sealing the holes through which the electrodes pass.

13. The article of manufacture as set forth in claim **12**, wherein the patches are substantially larger in area than the holes through which the electrodes pass.

14. The article of manufacture as set forth in claim **10**, further comprising:

a fixture having magnets arranged to mate with the electrodes exposed at the planar mounting side of the OLED device to magnetically secure the OLED device with the fixture and to concurrently form electrically conductive paths including the magnetic material of the electrodes configured to conductively convey electrical drive current from the fixture to the OLED device.

15. The article of manufacture as set forth in claim **10**, wherein the electrodes exposed at the planar mounting side are not permanent magnets.

16. The article of manufacture as set forth in claim **8**, wherein the magnetic material is magnetized to define magnetized electrodes including permanent magnets.

17. The article of manufacture as set forth in claim **16**, wherein the magnetized electrodes have magnetization polarities configured to define magnetically keyed magnetized electrodes.

18. The article of manufacture as set forth in claim **8**, wherein the magnetic material of the electrodes do not define permanent magnets.

19. The article of manufacture as set forth in claim **8**, further comprising:

a fixture having mating electrodes including magnetic material arranged to mate with the electrodes disposed on the planar mounting side of the thin film solid state lighting device;

wherein at least one of (i) the electrodes disposed on the planar mounting side of the thin film solid state lighting device and (ii) the mating electrodes of the fixture are permanent magnets such that mating the electrodes disposed on the planar mounting side of the thin film solid state lighting device with the mating electrodes magnetically secures the thin film solid state lighting device with the fixture and concurrently forms an electrically conductive drive current path from the fixture to the thin film solid state lighting device that includes the electrodes disposed on the planar mounting side of the thin film solid state lighting device.

20. The article of manufacture as set forth in claim **19**, wherein:

the mating electrodes are permanent magnets; and

the electrodes disposed on the planar mounting side of the thin film solid state lighting device and including the magnetic material are not permanent magnets.

21. The article of manufacture as set forth in claim **19**, wherein the fixture includes jumpers electrically interconnecting a plurality of said thin film solid state lighting devices.

22. The article of manufacture as set forth in claim **8**, wherein the thin film solid state lighting device is planar and does not include any power conditioning electronics.

23. An article of manufacture comprising:

a sealed thin film solid state lighting device having a planar light emitting side and an opposite planar mounting side having electrodes providing an electrically conductive pathway for electrically energizing the sealed thin film solid state lighting device to cause the planar light emitting side to emit light; and

a fixture having mating electrodes magnetically mating with the electrodes of the sealed thin film solid state lighting device to mechanically connect the sealed thin film solid state lighting device with the fixture and simultaneously electrically connect the sealed thin film solid state lighting device with the fixture.

24. The article of manufacture as set forth in claim **23**, wherein the electrodes of the sealed thin film solid state lighting device are magnetized to define permanent magnets magnetically mating with the mating electrodes of the fixture.

25. The article of manufacture as set forth in claim **23**, wherein the mating electrodes of the fixture are magnetized to define permanent magnets magnetically mating with the electrodes of the sealed thin film solid state lighting device.

26. The article of manufacture as set forth in claim **23**, wherein the sealed thin film solid state lighting device comprises:

an organic light emitting diode (OLED) device.

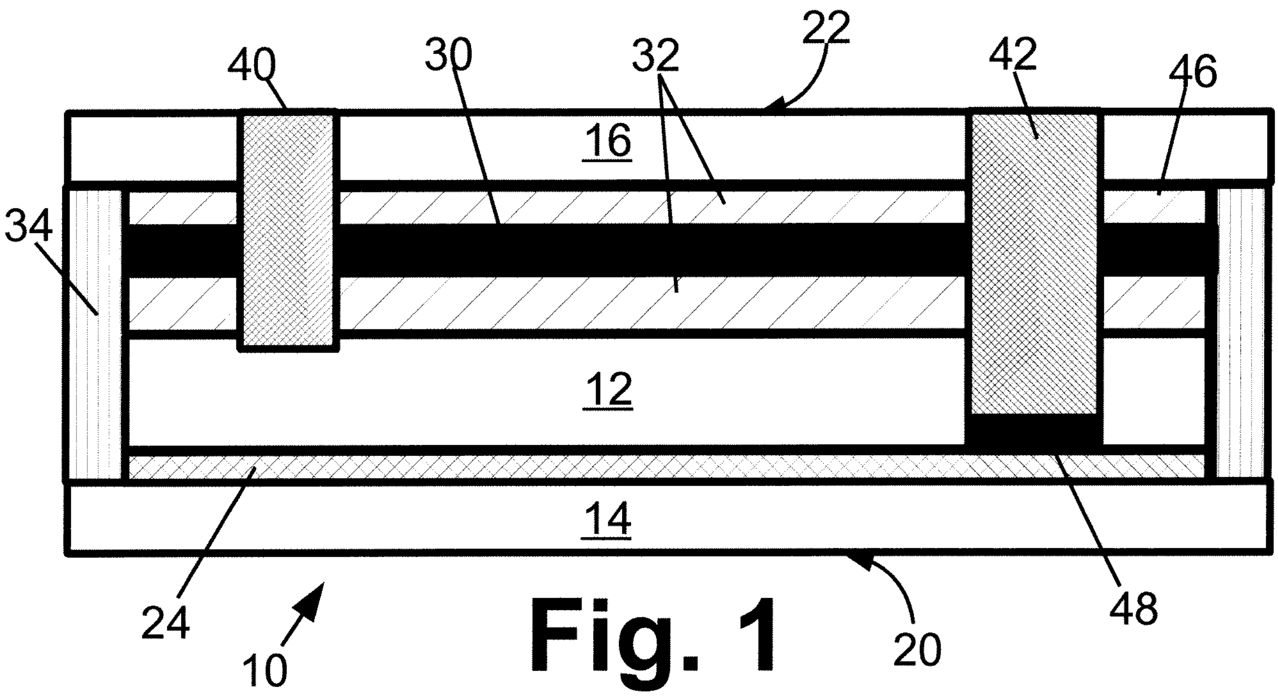
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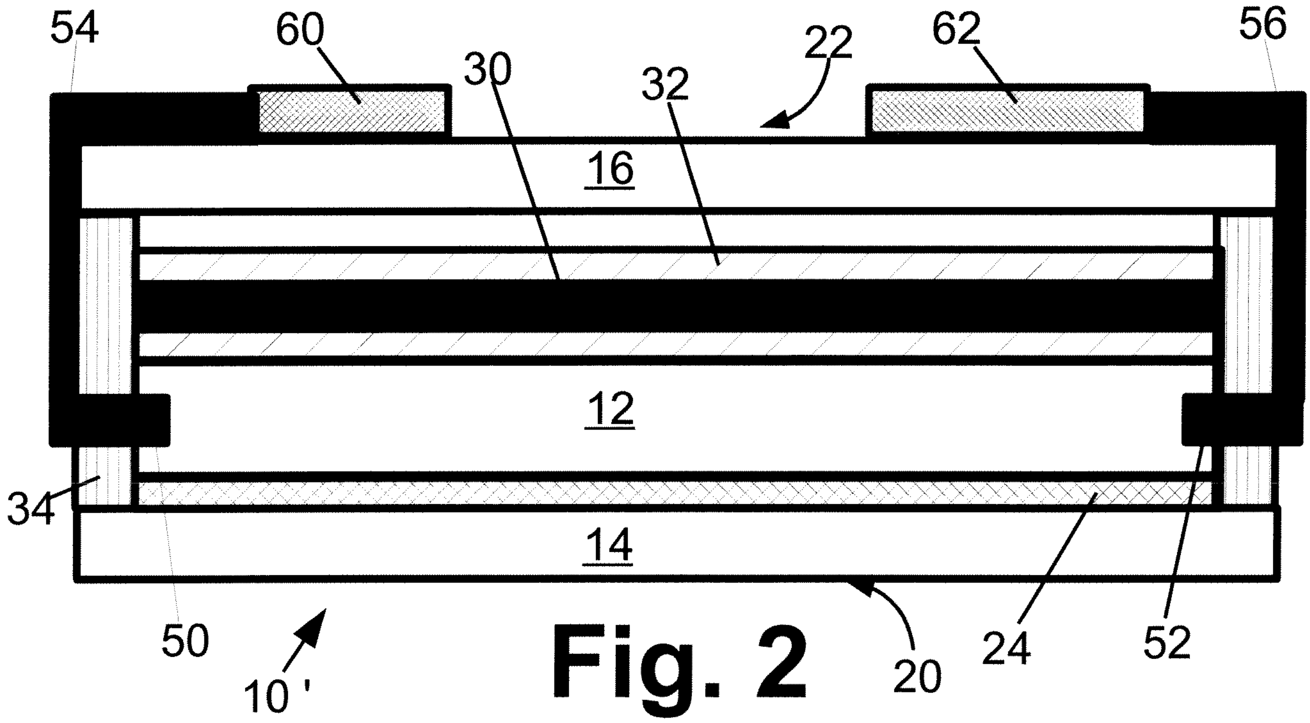
Fig. 1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52

Fig. 2

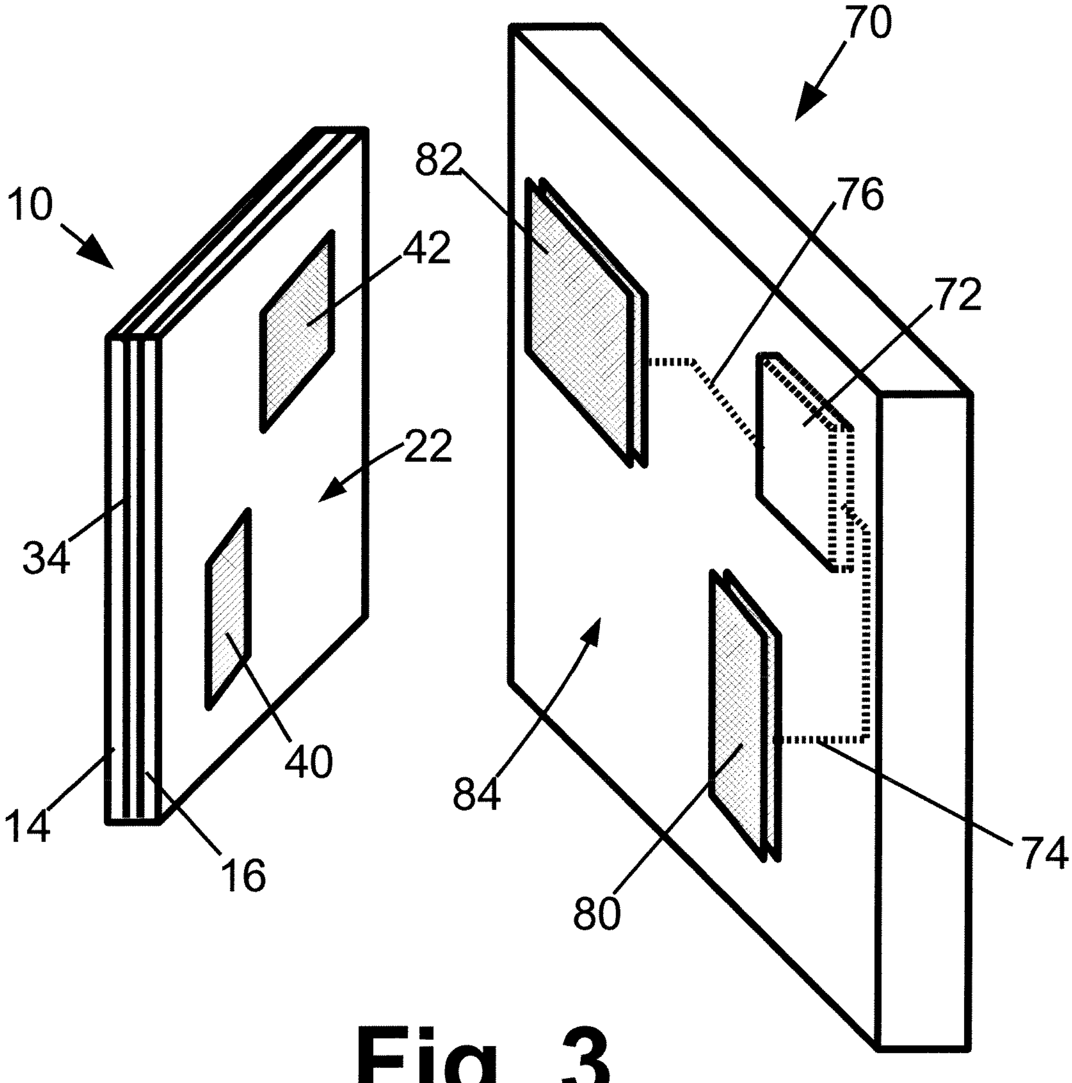


Fig. 3

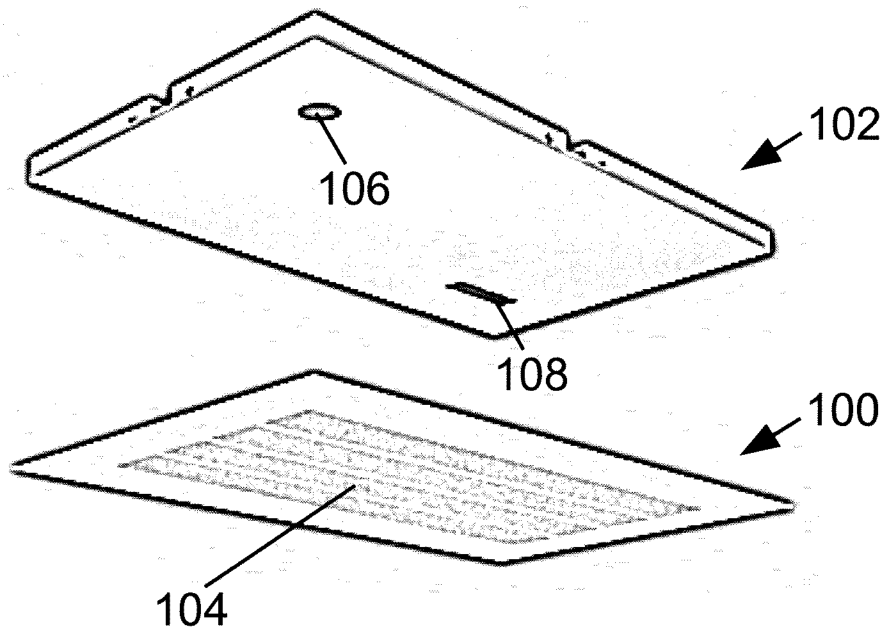
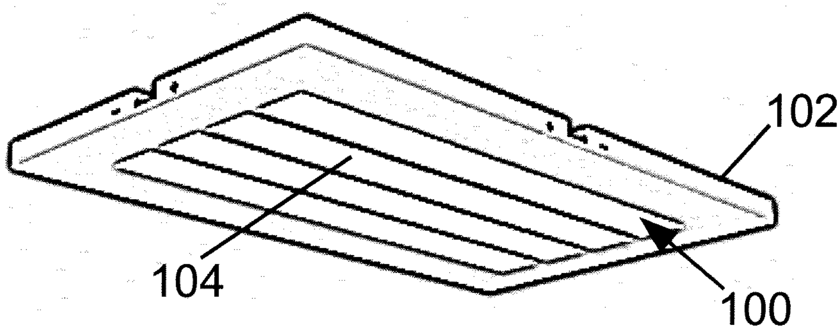


Fig. 4



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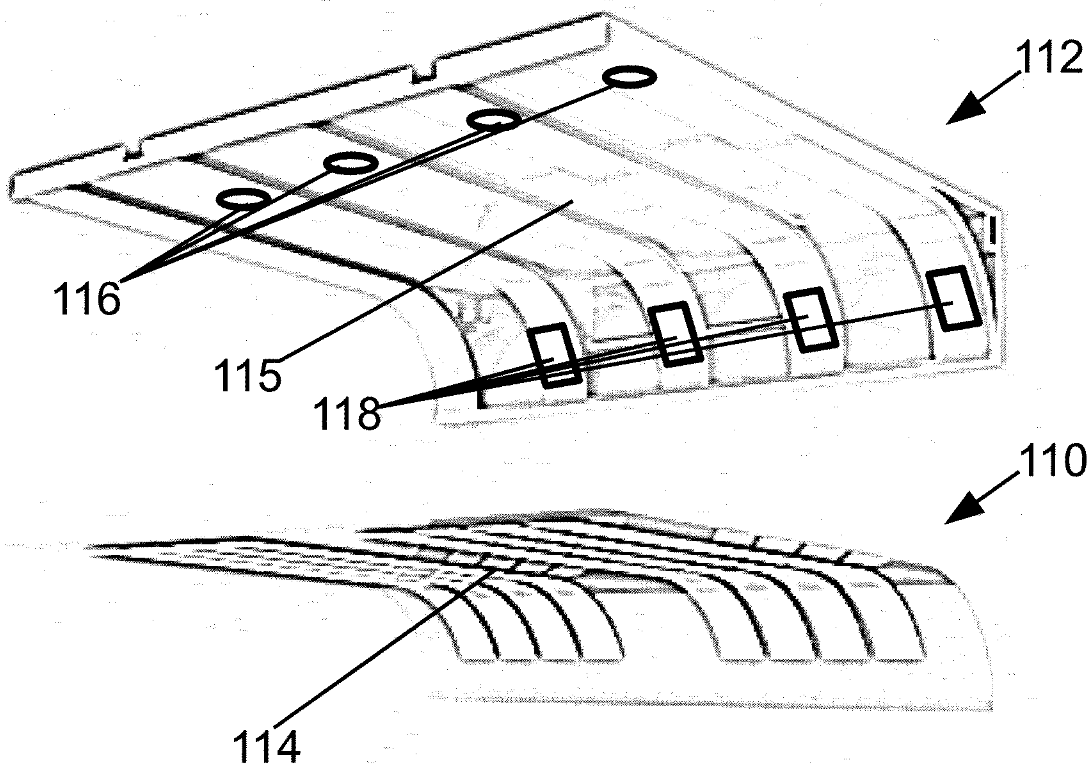

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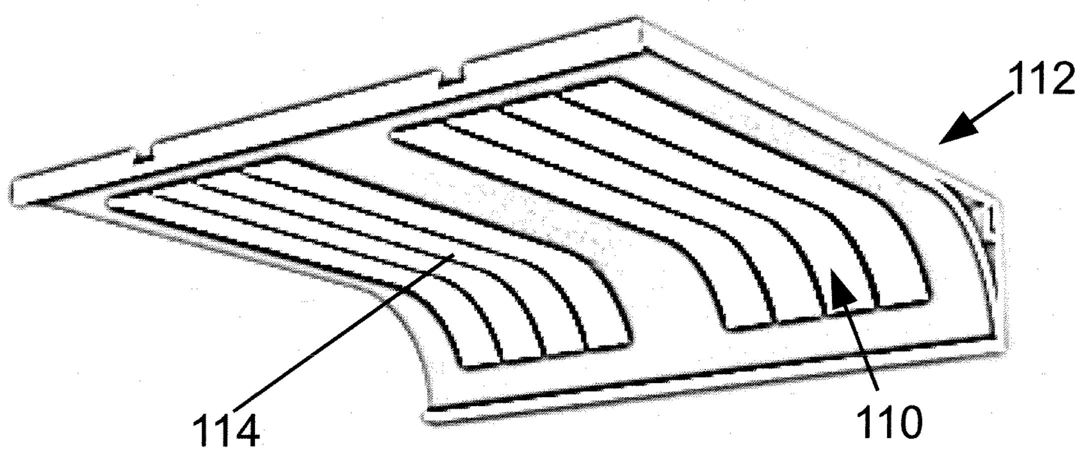

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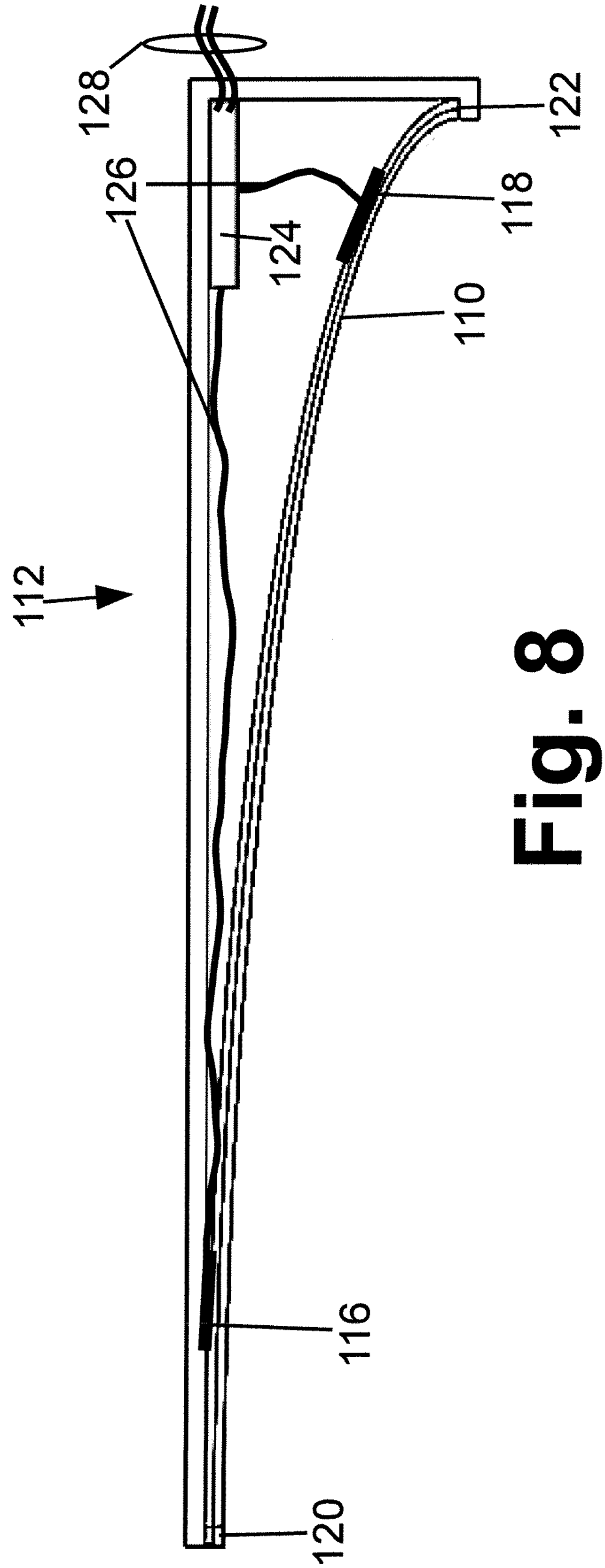

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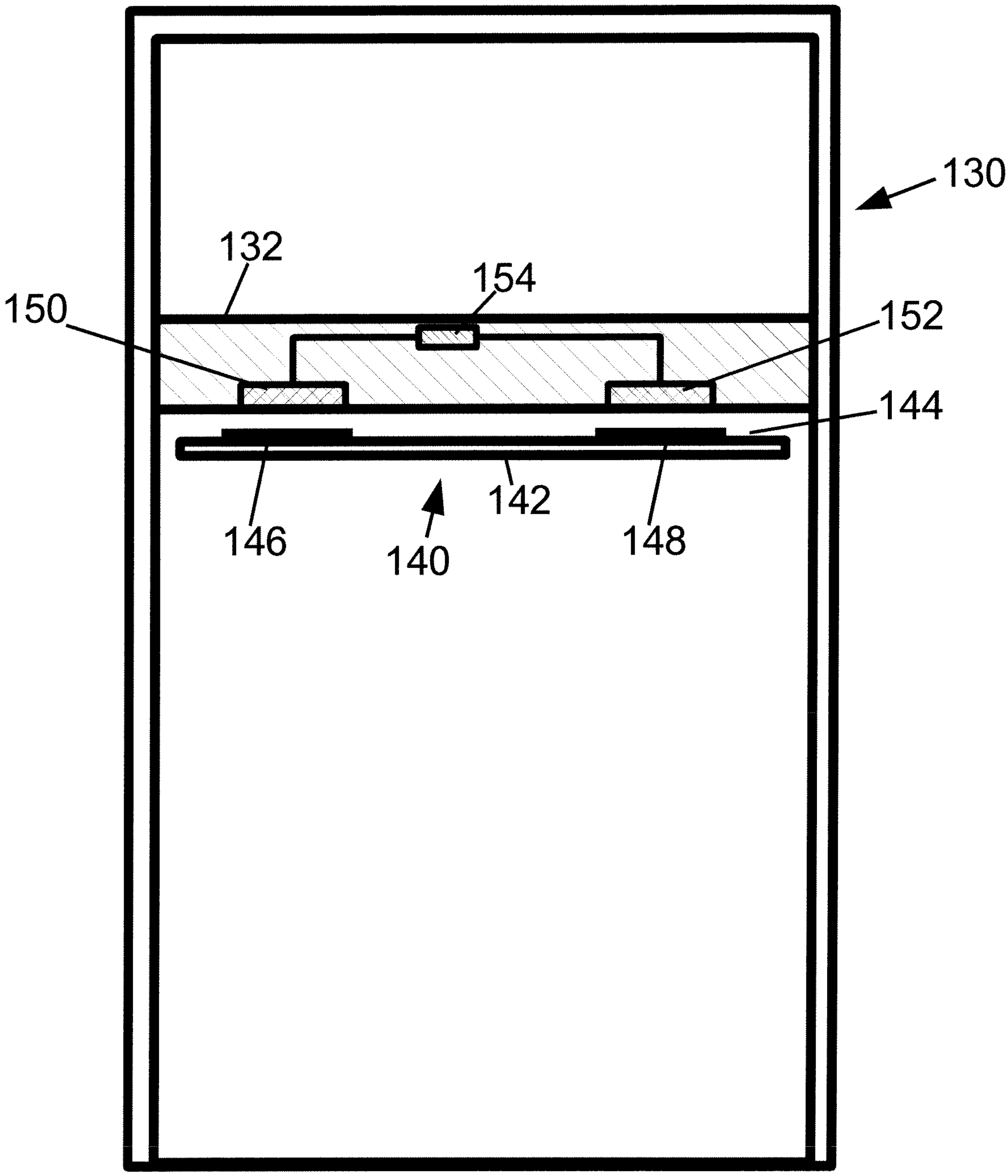

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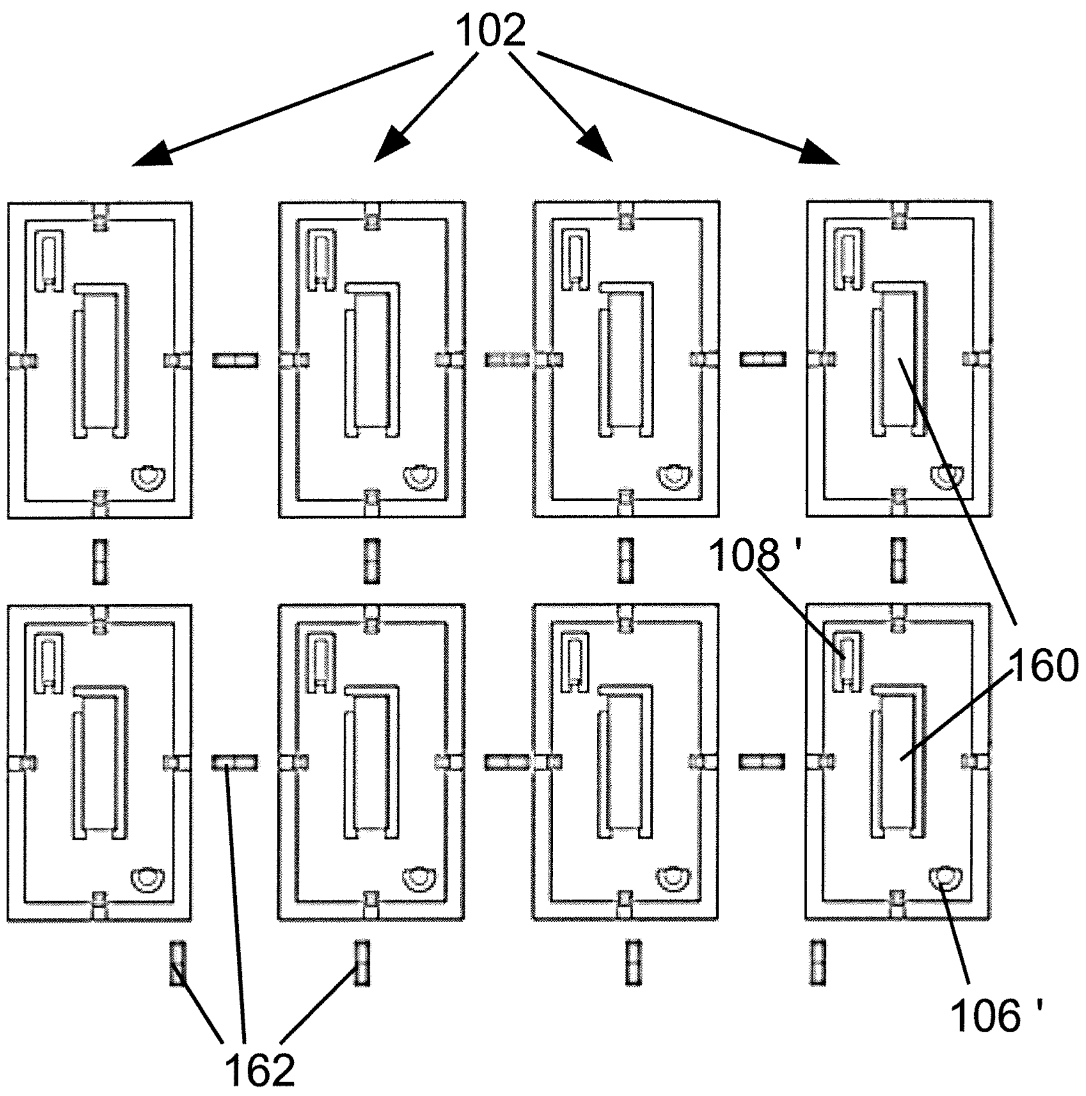
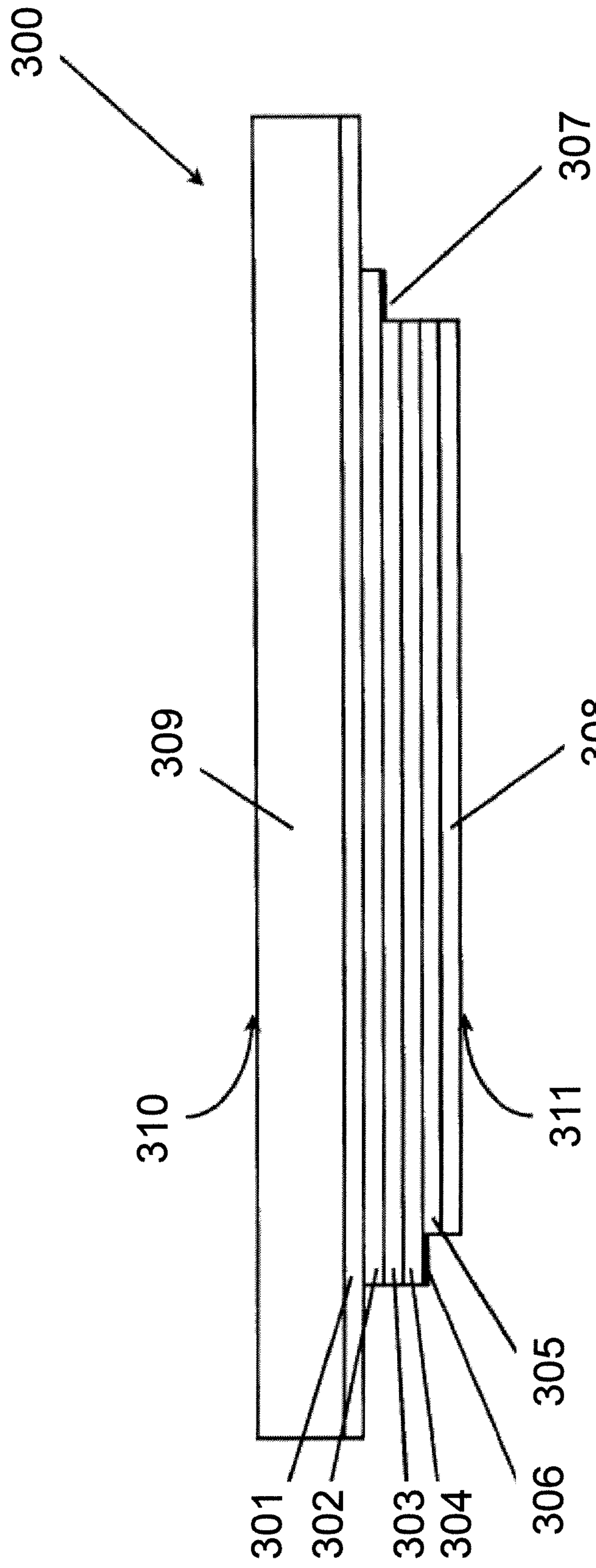


Fig. 10



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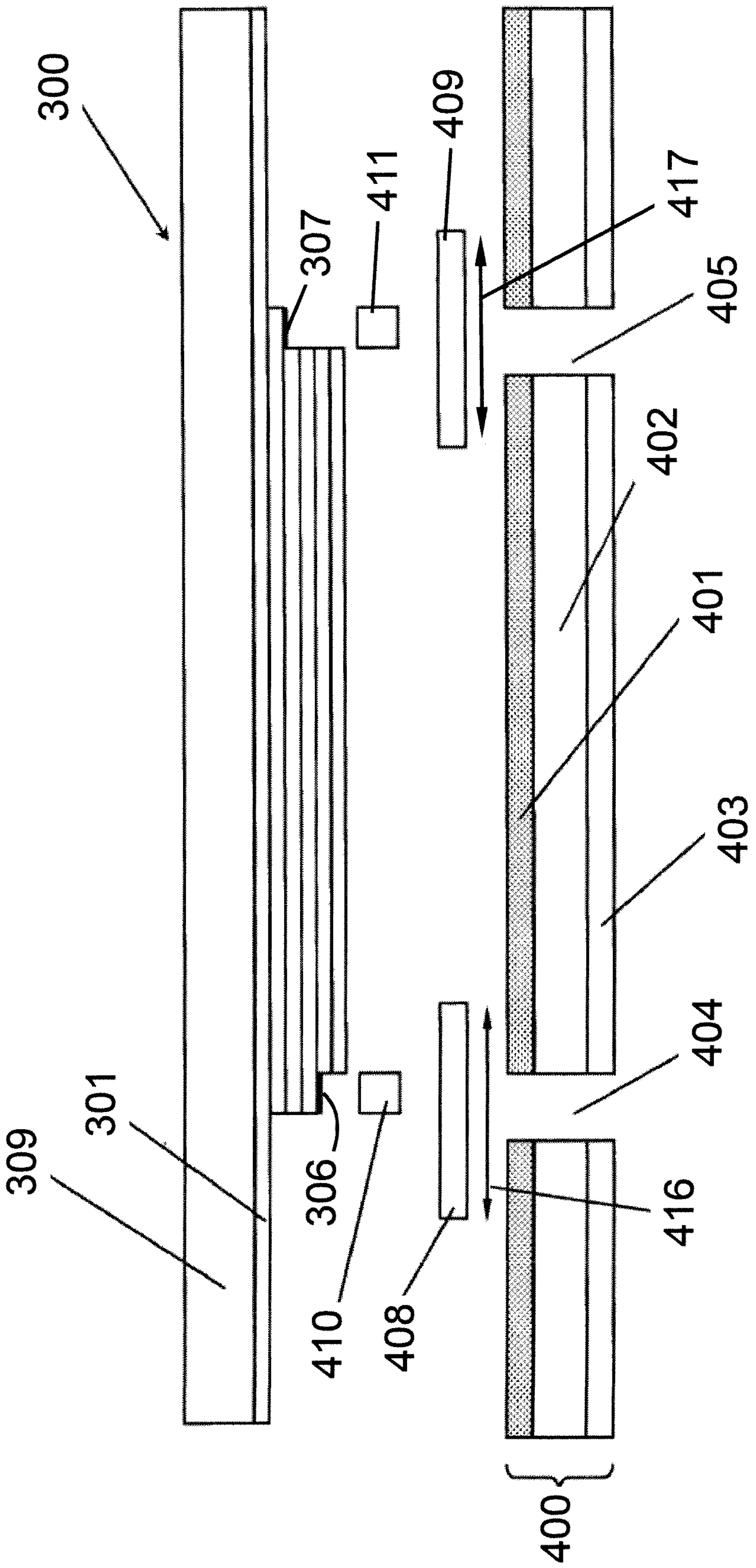
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Fig. 12

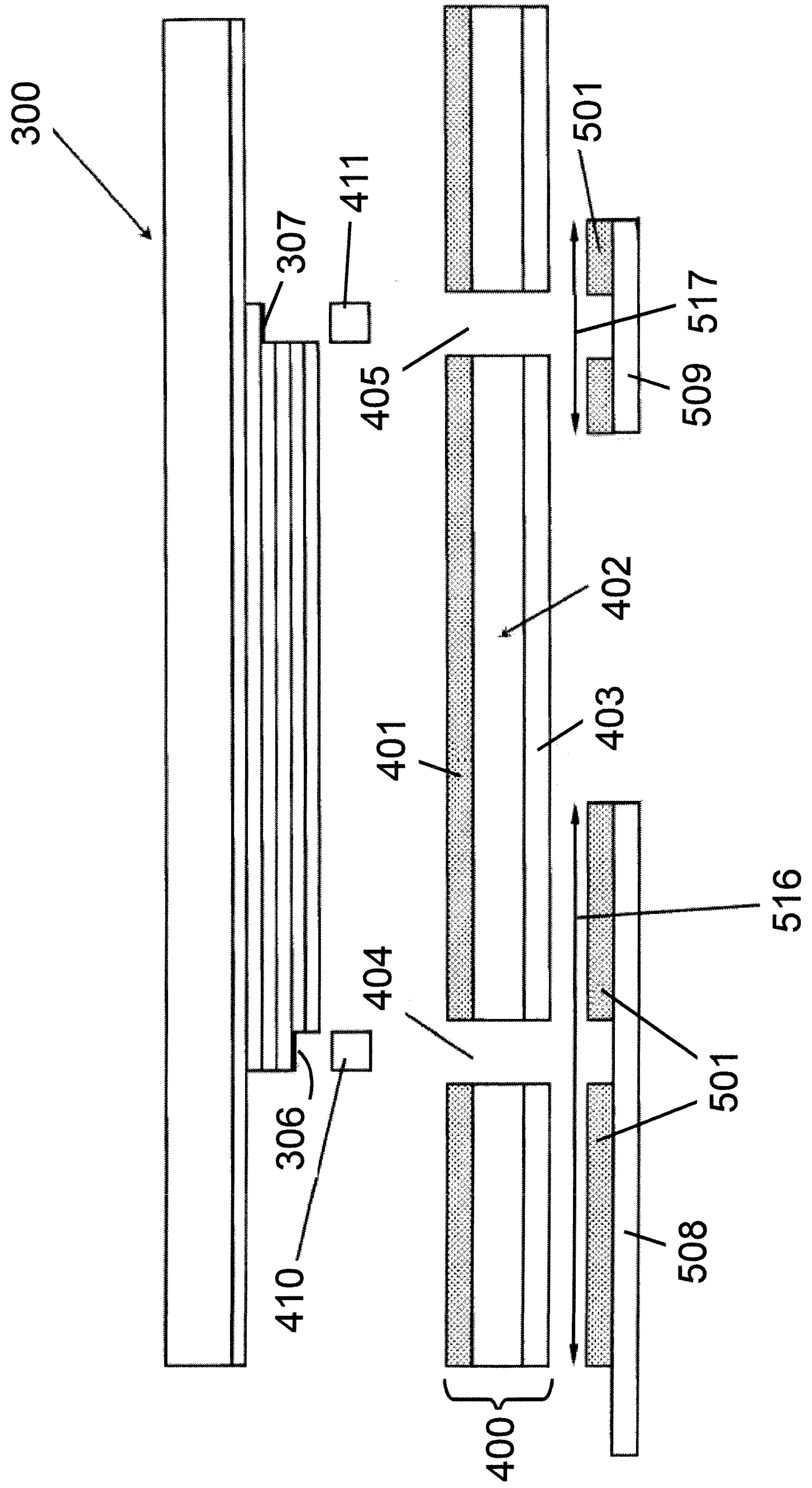
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Fig. 13

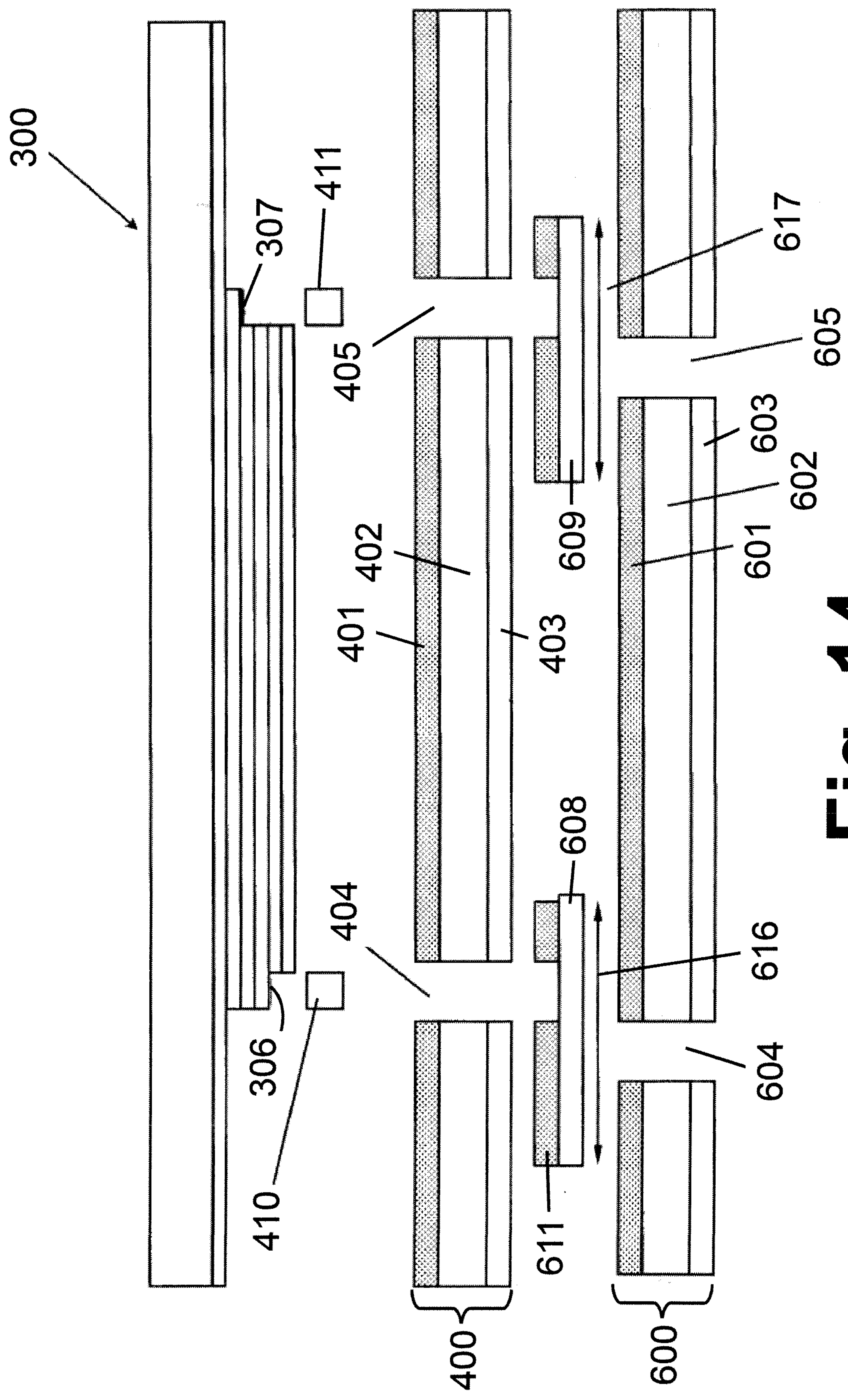
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Fig. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/030072

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L51/52 F21V21/096 H01R13/62
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L F21V H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/043561 A2 (OSRAM GMBH [DE]; OSRAM SYLVANIA INC [US]; KRAUS ROBERT [DE]; BURKARD K) 9 April 2009 (2009-04-09) the whole document	1-26
X	DE 20 2007 017609 U1 (MAAS & ROOS AG [DE]) 10 April 2008 (2008-04-10) the whole document	8,16,17, 19,22-25
A	DE 20 2008 015553 U1 (MAAS & ROOS AG [DE]) 19 February 2009 (2009-02-19) paragraph [0025] - paragraph [0032]; figure 2	1,8,23
A	US 2004/121508 A1 (FOUST DONALD F [US] ET AL) 24 June 2004 (2004-06-24) * abstract	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 June 2010	30/06/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Persat, Nathalie

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/030072

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2008/023008 A1 (SIEMENS AG [DE]; GAERDITZ CHRISTOPH [DE]; SEIDEL STEFAN [DE]) 28 February 2008 (2008-02-28) * abstract	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2010/030072

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