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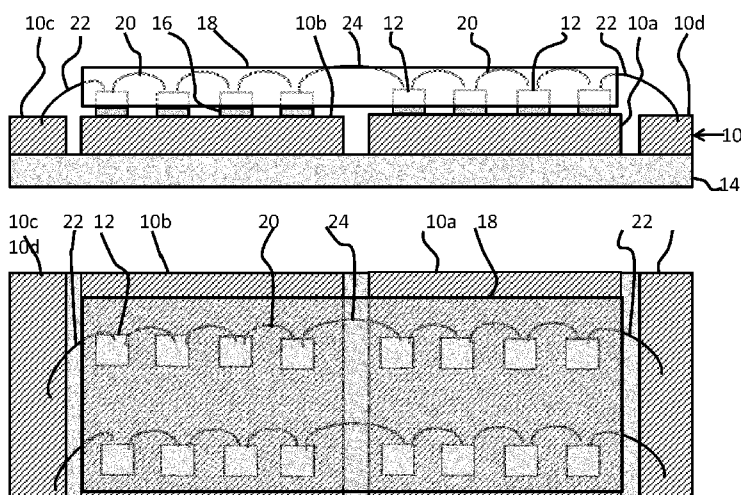
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(54) Title: LED LIGHTING MODULE WITH WIRELESS CAPACITIVE POWER RECEPTION CAPABILITY



(57) Abstract: An LED module has an array of LED chips provided over a substrate. A conductive layer defines the substrate itself, and this conductive layer comprises a first isolated region which functions as a first capacitive power receiving electrode for receiving power from a capacitive power transmitting electrode of an external source and a second isolated region (10b) which functions as a second capacitive power receiving electrode for receiving power from a second capacitive power transmitting electrode of the external source; wherein the module comprises a metal layer as the substrate and said metal layer is re-used as the conductive layer; or the module comprises a metal core printed circuit board package as the substrate, and the metal core layer (30) embedded within the metal core printed circuit board package is re-used as the conductive layer.

FIG. 1

LED Lighting module with wireless capacitive power reception capability

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FIELD OF THE INVENTION

The invention relates to capacitive powering systems for wireless power transfer and, more particularly, to wireless power transfer to LED lighting modules.

10 BACKGROUND OF THE INVENTION

Wireless power transfer is used to supply electrical power without any wires or contacts. One popular application for such contactless powering is for the charging of portable electronic devices, such as mobiles phones, laptop computers, and the like.

One possible implementation for wireless power transfer is by an inductive
15 powering system. In such a system, the electromagnetic inductance between a power source (transmitter) and the device (receiver) allows for contactless power transfer. Both the transmitter and receiver are fitted with electrical coils, and when brought into physical proximity, an electrical signal flows from the transmitter to the receiver.

In inductive powering systems, the generated magnetic field is concentrated
20 within the coils. As a result, the power transfer to the receiver pick-up field is very concentrated in space. This creates hot-spots in the system which limits the efficiency of the system. To improve the efficiency of the power transfer, a high quality factor for each coil is needed. To this end, the coil should be characterized with an optimal ratio of inductance to resistance, be composed of materials with low resistance, and fabricated using a Litze-wire
25 process to reduce skin-effect. Moreover, the coils should be designed to meet complicated geometries to avoid Eddy-currents. Therefore, expensive coils are required for efficient inductive powering systems. A design for contactless power transfer system for large areas would necessitate many expensive coils. Thus, for such applications an inductive powering system may not be feasible.

30 Capacitive coupling is another technique for transferring power wirelessly. This technique is predominantly utilized in data transfer and sensing applications. A car-radio antenna glued on the window with a pick-up element inside the car is an example of the use of capacitive coupling. The capacitive coupling technique is also used for contactless charging of electronic devices. For such applications, the charging unit (implementing the

capacitive coupling) operates at frequencies outside the inherent resonant frequency of the device.

WO 2013/024432 discloses a capacitive contactless powering system which can cover large areas. One example given of the type of device to be powered is an organic LED lighting device, for example by placing power transfer electrodes on the backside of the OLED device.

LED devices are a particularly interesting form of lighting solution because they can be small, thin, low power and lightweight. It is therefore desirable to avoid adding complexity and size to an LED device in order to implement the capability of receiving power over a contactless interface.

WO2012120404A1 discloses an OLED device wherein two capacitive power receiving electrodes are provided on a substrate made of glass, plastic or foil.

US20130033186A1 discloses a LED device wherein the LED chips are placed on electrodes which is placed on a resin substrate.

SUMMARY OF THE INVENTION

It would be advantageous to have a more compact and low cost module implementing the capacitive power transfer to the load.

To better address this concern, the invention is defined by the claims.

According to examples in accordance with an aspect of the invention, there is provided an LED module, comprising:

a substrate;

an array of LED chips provided over the substrate; and

a conductive layer defining the substrate, wherein the conductive layer comprises at least a first isolated region which functions as a first capacitive power receiving electrode for receiving power from a capacitive power transmitting electrode of an external source.

This LED module makes use of the substrate design already used to carry LED chips in order to implement one or more capacitive power receiving electrodes. In this way, the wireless power receiving function can be implemented with minimum additional complexity, weight or size of the module. The conductive layer may for example already be present as part of the substrate technology used, or else it may be applied simply as a conductive layer on an already required non-conducting substrate.

The conductive layer forms only the capacitive power receiving electrodes, and the full capacitor function is not implemented within the module. Thus, within the module, there are no counter electrodes for the capacitive power receiving electrodes. Instead, the full capacitor function is only achieved when the module is brought into
5 proximity with a suitably designed capacitive wireless power transmitting unit (i.e. the external source) which has one or more capacitive power transmitting electrodes. The capacitive power transmitting electrode(s) and the capacitive power receiving electrode(s) together define the full capacitive structure(s). In practical use, there would be two full capacitive structures on both ends of the load, as described in WO 2013/024432. To meet this
10 requirement, two LED modules as defined above can be connected together, each providing one electrode of either one of two full capacitive structures. Alternatively, as defined below, the LED module can further comprises another second isolated region which functions as a second capacitive power receiving electrode.

In a first set of examples, the module may comprise a chip on board package
15 with a metal layer as the substrate and said metal layer of the chip on board package defines the conductive layer.

Chip on board packages already include a substrate suitable for carrying a metal layer or which can even be formed as a metal substrate, so that the addition of the capacitive power receiving electrodes adds minimal additional complexity.

20 An insulation layer may be provided between the LED chips and the metal board. The insulator layer is then the so-called die attach layer. It may be a continuous layer or it may comprise an array of insulator portions.

The metal layer may further comprise a second isolated region which functions as a second capacitive power receiving electrode for receiving power from a second
25 capacitive power transmitting electrode of the external source, and wherein the metal layer comprises a third metal layer region which functions as an LED cathode contact and a fourth metal layer region which functions as an LED anode contact. In this embodiment, the LED module as a whole device can couple to two external transmitter electrodes so as to form a close power loop and receive power.

30 In this way, the metal layer is formed as four regions, which may all be coplanar. The metal layer of the substrate thus provides the anode and cathode contact regions as well as two capacitive power receiving electrodes. The metal layer may comprise separate regions over a continuous substrate, or else the substrate itself may be divided into the four regions with mechanical connection between these four regions. When the substrate

is divided into regions, the substrate may itself be the metal layer rather than being a formed as an insulating support and a metal layer.

A first sub-array of LED chips may be provided over the first metal layer region with wirebonds between the LED chips of the first sub-array, and/or a second sub-
5 array of LED chips may be provided over the second metal layer region with wirebonds between the LED chips of the second sub-array. Wirebonds also connect to the third and fourth metal layer regions to couple power to the LED sub-arrays.

One or both of the first and second metal layer regions carries LED chips, but they do not electrically connect to the first and second metal layer regions. Instead,
10 wirebonds connect the LED sub-arrays to the third and fourth metal layer regions, which function as the LED cathode and anode contacts. The first and second metal layer regions may carry multiple sub-arrays of LED chips, for example multiple series strings of LEDs.

A phosphor encapsulation may be provided over the LED chips and the corresponding wirebonds.

15 A frame may be provided around the substrate, wherein the frame carries circuitry which comprises a power harvesting circuit for receiving power from the first isolated region and the second isolated region for powering the LED chips and an LED driver circuit, and wherein the circuitry comprises input electrical contacts to the first and second metal layer regions and comprises output electrical contacts to the third and fourth metal
20 layer regions.

The frame then provides the additional circuitry needed to drive the LED chips.

An insulation layer may be provided under said metal layer of the chip on board package, said insulation layer being doped with dielectric material. This embodiment
25 also integrates the dielectric layer, an important part of the full capacitive structures, in the LED module, thereby the LED module has more integrated function.

In a second set of examples, the module may comprises a metal core printed circuit board package as the substrate, and the conductive layer comprises the metal core layer embedded within the metal core printed circuit board package.

30 Metal core printed circuit board packages already include a metal heat spreading layer which is (or can be made) suitable for implementing capacitive power receiving electrodes.

The metal layer may then further comprise a second isolated region which functions as a second capacitive power receiving electrode for receiving power from a second

capacitive power transmitting electrode of the external source. In this embodiment, the LED module as a whole device can couple to two external transmitter electrodes so as to form a close power loop and receive power.

An insulating layer is for example provided over the metal core layer. The metal core layer is then on one side of this insulating layer and the LED chips of the array are on the opposite side of the insulating layer.

In this way, the substrate can define electrical contacts and connections on one side for forming the LED circuits, as well as having the metal core layer for forming the capacitive power receiving electrodes on an opposite side.

Circuitry may be provided which comprises a power harvesting circuit for receiving power from the first isolated region and the second isolated region for powering the LED chips and an LED driver circuit. The substrate may then be provided with vias for connection between the circuitry and the capacitive power receiving electrodes of the metal core layer.

The part of the substrate that is under the metal core layer may be doped with dielectric material. This embodiment also integrates the dielectric layer, an important part of the full capacitive structures, in the LED module. The LED module thereby has more integrated functionality.

The power harvesting circuit may for example comprise an inductor in series with the load defined by the array of LED chips.

An optical diffuser may be provided over the array of LED chips.

The invention also provides a lighting system comprising:

a wireless power transmitter system comprising one or more capacitive power transmitting electrodes provided at a surface; and

one or more modules as defined above, each for application to the surface to receive wireless power transfer from the capacitive power transmitting electrode or electrodes to the capacitive power receiving electrode or electrodes of the module.

The surface may for example comprise a panel having an area of at least 1m^2 and each module may have an area of less than 0.04m^2 . Thus, the invention is of particular interest for large area panels which function as the transmitting electrode, over which the modules can be positioned in desired locations.

The invention also provides a method of powering an LED module, the module comprising a substrate, an array of LED chips provided over the substrate, and a metal layer provided on the substrate or defining the substrate, wherein the metal layer

comprises at least a first isolated region which functions as a capacitive power receiving electrode, wherein the method comprises:

receiving power from the first isolated region through capacitive coupling of the module to a wireless power transmitter system comprising at least one capacitive power transmitting electrode provided at a surface; and
illuminating the LED chips using the received power.

The module may comprise a chip on board package or a metal core printed circuit board package in which the metal layer comprises the metal core layer.

10 BRIEF DESCRIPTION OF THE DRAWINGS

Examples of the invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 shows a first example of lighting module;

Figure 2 shows a second example of lighting module;

15 Figure 3 shows a third example of lighting module;

Figure 4 shows a fourth example of lighting module;

Figure 5 shows how a frame can be used to carry circuitry for the lighting module;

Figure 6 shows an example of power harvesting circuit;

20 Figure 7 shows an example of how the lighting module may be used; and

Figure 8 shows two examples of panel used to deliver power to the lighting module.

DETAILED DESCRIPTION OF THE EMBODIMENTS

25 The invention provides an LED module having an array of LED chips provided over a substrate. A conductive layer is provided on the substrate or defines the substrate itself, and this conductive layer comprises at least a first isolated region which functions as a first capacitive power receiving electrode for receiving power from a capacitive power transmitting electrode of an external source.

30 Figure 1 shows a first example of lighting module in cross section and in plan view.

This first example is based on a chip on board substrate design. A common structure of the chip on board design is placing the chip on the conductive layer via an insulation. The conductive layer acts as the substrate and supports the chip. As shown in

figure 1, the substrate is defined as a metal or other conductive layer 10. An array of LED chips 12 is provided over the substrate layer 10.

The LED chips 12 are provided over two metal layer regions 10a, 10b which are isolated from each other. In the example shown, the metal layer regions are completely separate and they are held together by an insulating support layer 14. This insulating layer for example may comprise thermally stable polymers, ceramics, fabrics or other non-conductive materials.

In the context of the present application, besides used as the substrate to physically support the chips, the conductive layers also acts the receiver electrodes of the capacitive power transfer. More specifically, the isolated metal layer regions 10a, 10b function as first and second capacitive power receiving electrode for receiving power from a capacitive power transmitting electrode of an external source. In addition, a power harvesting circuit such as an inductor (not shown in figure 1) is used for handling the received power from these isolated electrodes, for powering the LED chips. In some cases, the LEDs can coupled to the electrodes directly without a specific harvesting circuit.

The first and second regions 10a, 10b function only as capacitor electrodes, and they are isolated from the LED chips 12. A first substrate region 10a functions as a capacitor cathode and a second substrate region 10b functions as a capacitor anode.

There are also third and fourth isolated regions 10c, 10d of the substrate for electrical connection to the LED chips 12. The third region 10c functions as the cathode connection for the LED chips and the fourth region 10d functions as the anode connection for the LED chips. The third and fourth regions 10c, 10d are fully isolated areas to the first and second regions.

In this design, the substrate itself is formed as four separate isolated islands, each therefore able to perform an independent electrical function. The four electrical functions are LED anode terminal, LED cathode terminal, capacitor anode terminal and capacitor cathode terminal.

The LED chips are mounted on the metal layer regions 10a, 10b over individual die attach isolation portions 16. In the example shown, the LED chips are encapsulated with a phosphor encapsulation 18, used for wavelength conversion of the light output from the LED chips. Of course, a simple transparent encapsulation layer may be used if no wavelength conversion is needed.

Additional beam shaping or other optics may also be integrated into the design to control the optical characteristics of the output light.

The LED chips are connected in a daisy chain manner using wirebonds 20 between each adjacent pair of LED chips. The LED chips may be connected in series (each wirebond connecting the anode of one LED chip to the cathode of an adjacent LED chip).

As shown in the plan view, there may be multiple rows of LEDs. Each row
5 can then be a series string of LEDs, and the series strings are connected in parallel.

At the end of each row, there is a terminating wirebond 22, one of which makes connection to the LED cathode region 10c and the other of which makes connection to the LED anode region 10d. These terminating wirebonds bridge over the isolation gaps between the first and fourth metal layer regions 10a, 10d and the second and third metal layer
10 regions 10b, 10c. Central wirebonds 24 bridge over the gap between the first and second metal layer regions 10a, 10b.

Further, there may be the power harvesting circuit and the LED driver connected between the capacitor electrodes region and the LED anode/cathode region, which are not shown in figure 1.

15 The conducting substrate layer 10 serves both as the LED carrier and the power harvesting capacitor electrodes. An LED driver connects to the third and fourth metal layer regions 10c, 10d and a power harvesting circuit connects to the first and second metal layer regions 10a, 10b. The power harvesting circuit may further connect to the LED driver.

This LED module makes use of the conductive substrate of the chip on board
20 already needed to carry the LED chips in order to implement capacitive power receiving electrodes. The example shows two capacitive power receiving electrodes, but there may at the limit be only one, or indeed there may be more than two. If a module has a single power receiving electrodes, two such modules may be coupled together to complete a power transfer circuit with two power transfer capacitors.

25 By using the existing circuit board architecture to define the capacitor power receiving electrodes, the wireless power receiving function can be implemented with minimum additional complexity, weight or size of the module.

The isolating support layer 14 functions not only as a mechanical support but also as a capacitor dielectric. The counter electrodes to the capacitor electrodes are not
30 present in the LED module, so that the full capacitor function is not implemented within the module. The capacitor is only defined when the module is brought into proximity with a suitably designed capacitive wireless power transmitting unit (i.e. an external power source) which has one or more capacitive power transmitting electrodes.

Figure 2 shows a second example in which the metal layer regions 10a, 10b extend fully between the LED cathode and anode contacts 10c, 10d. Thus, the metal layer regions are in rows rather than columns as in the example of Figure 1.

In each case, a first sub-array of LED chips is provided over the first metal layer region with wirebonds between the LED chips and a second sub-array of LED chips is provided over the second metal layer region with wirebonds between the LED chips of the second sub-array. There are also wirebonds to the third and fourth metal layer regions.

Figure 3 shows a third example, which differs from the first example only in that the die attach isolation portions 16 form a continuous layer 17.

In a second set of examples, the module comprises a metal core printed circuit board package as the substrate, and the conductive layer comprises the metal core layer embedded within the metal core printed circuit board package.

Metal core printed circuit board packages already include a metal heat spreading layer. The present application reuses this metal layer as the capacitive transfer electrode.

Figure 4 shows an example. The substrate comprises a metal core layer 30 which is patterned to form first and second metal layer regions 30a, 30b which function as the capacitor anode and cathode.

An insulating layer 32 is provided over the metal core layer 30 which can be understood as the non-conductive board of the PCB. Over the top is a metal circuit layer 34. The circuit layer 34 connects through the insulating layer to form end contacts 36a, 36b. These make contact down to the metal core layer 30 and thus provide capacitor terminal contacts. The circuit layer 34 can be understood as the printed wiring on the PCB.

Driver connection pads 38a, 38b enable coupling between a driver and the end contacts 36a, 36b. Furthermore, the layer 34 is patterned to define the LED anode and cathode contacts 40a, 40b at the ends of a series string of LED chips 12. Each LED chip connects to the next one in the series string using a portion of the layer 34 so that a series circuit is formed between the anode and cathode contacts 40a, 40b. As shown in the plan view, there are multiple series strings, in parallel with each other between the anode and cathode contacts.

In this design, the metal core layer 30 is on one side of the separating insulating layer 32 and the LED chips of the array are on the opposite side. Thus, the metal core layer is at the bottom side of the substrate arrangement and the LED chips are at the top side.

There is again an optional insulation layer 14 beneath the metal core layer (i.e. over the bottom surface of the substrate arrangement). Namely the metal core layer is sandwiched between two insulation layers 32 and 14, which can be understood as the metal core layer is embedded within the non-conductive board of the PCB. The insulation layer 14 functions as (part of) the capacitor dielectric when the module is brought into proximity or contact with a power transmitting panel.

In this way, the substrate has electrical contacts and connections on the top side for forming the LED circuits, as well as having the metal core layer at the bottom side for forming the capacitive power receiving electrodes.

Circuitry can connect to the top side of the substrate, which circuitry comprises the power harvesting circuit and the LED driver circuit. The vias to the end contacts 36a, 36b provide connection between the circuitry and the capacitive power receiving electrodes of the metal core layer.

The insulation layer 14 may be doped with dielectric material particles.

Figure 5 shows that a frame 50 may be provided around the main part 52 of the module, wherein the frame carries circuitry which comprises the power harvesting circuit 54 and an LED driver circuit 56. The circuitry comprises input electrical contacts to the first and second metal layer regions (i.e. the capacitor electrodes) and comprises output electrical contacts to the third and fourth metal layer regions (i.e. the LED anode and cathode).

The frame 50 then provides the additional circuitry needed to drive the LED chips.

The power harvesting circuit may for example comprise an inductor in series with the load defined by the array of LED chips. WO 2013/024432 discloses a suitable power harvesting circuit. Any other known power harvesting circuit may also be used.

Figure 6 shows one example. The power transmission side comprises an AC voltage source Gen which is connected at each end to a capacitive power transmitting electrode. In combination with the capacitive power receiving electrodes, two capacitors are formed C1 and C2. The series inductor L1 and a further series capacitor C3 define a resonant circuit which resonates at the frequency of the voltage source Gen. The capacitor C3 is shorted by a switch S1 under the control of a control unit 58 which receives as input the voltage across the capacitor C3.

A diode bridge rectifier 59 delivers a DC output to the load, represented by the output resistor Rout, smoothed by a buffer capacitor.

Figure 7 shows an example of how the modules may be used.

The modules 60 are mounted on a screen 62 which includes an array of capacitive transmission electrodes for delivering wireless power to the modules. These electrodes may be arranged in lines so that when a module is placed over the screen, there is overlap between the transmitting and receiving electrodes. The capacitive power transmitting electrodes are provided at (i.e. on or beneath) the outer surface. This overlap defines the capacitor function. The capacitor then forms part of a resonant circuit for the wireless transmission of power in known manner.

As shown by arrow 64, the module may be freely positioned and moved over the screen.

Figure 8 shows two examples of possible electrode layout for the screen.

The top image shows a set of alternating vertical electrode bars. One set forms a first electrode 70 an alternate set forms a second electrode 72. A driver module 74 provides power to the two electrodes. The bottom image shows a set of alternating horizontal electrode bars. Again, one set forms a first electrode 70 an alternate set forms a second electrode 72.

The module 60 is placed over a pair of adjacent electrode bars to receive power wirelessly from the electrodes. With vertical bars, the module can be slid up and down while maintaining an electrical connection, whereas there are discrete locations in the horizontal direction at which correct power coupling takes place.

With horizontal bars, the module can be slid left and right while maintaining an electrical connection, whereas there are discrete locations in the vertical direction at which correct power coupling takes place.

The surface may for example comprise a panel having an area of at least 1m^2 and each module may have an area of less than 0.04m^2 . Thus, the invention is of particular interest for large area panels which function as the transmitting electrode, over which the modules can be positioned in desired locations. In one example, the module has a dimension of $8\text{cm} \times 8\text{cm}$

In use, power is received from the module capacitor electrode or electrodes through capacitive coupling of the module to the wireless power transmitter system, and the LED chips are illuminated using the received power.

Some examples of the possible insulation layer materials used as the dielectric layer 14 and/or the layer 16 are:

1. Polymers such as polyester, Polyimide, Polycarbonate (PC), Neoprene rubber, Nylon, Polyamide, PVC, Silicone, Polyvinylidene Fluoride, etc. or other polymers typically with dielectric constant equal or larger than 2.5.

2. The polymers above with insulating fillers or doping. The filler may
5 include a single one or a mixture of dielectric materials chosen from $MxOy$, $MxTiOy$, $MxAlOy$, $MxSiOy$, $MxSOy$, $MxPOy$, wherein $M=Al$, Fe , Ba , Ca , Mn , Mg , Zn , Sr , etc., or inorganic or composite materials with dielectric constant equal or larger than 10.

3. Ceramics, single or mixed dielectric materials selected from $MxOy$, $MxTiOy$, $MxAlOy$, $MxSiOy$, $MxSOy$, $MxPOy$, wherein $M=Al$, Fe , Ba , Ca , Mn , Mg , Zn , Sr ,
10 etc., or other possible inorganic or composite materials with a dielectric constant equal or larger than 5.

The conducting layer used to from the capacitor electrodes may comprise a metal or metal alloys selected from Al , Cu , Ag , Au , Fe , Sn . Alternatively, a polymer with conductive filler particles from the list above, or with carbon or carbon composite filler
15 particles.

The overall device can be made with very low thickness, for example using metal layers and insulating layers each with thickness below 1mm. The substrate arrangements may be formed using lamination processes or deposition processes.

Other variations to the disclosed embodiments can be understood and effected
20 by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measured cannot be used to advantage.
25 Any reference signs in the claims should not be construed as limiting the scope.

CLAIMS:

- 5 1. A light emitting diode (LED) module, comprising:
a substrate;
an array of light emitting diode (LED) chips (12) provided over the substrate;
and
a conductive layer (10) defining the substrate, wherein the conductive layer
10 comprises:
a first isolated region (10a) which functions as a first capacitive power
receiving electrode for receiving power from a capacitive power transmitting electrode of an
external source; and
a second isolated region (10b) which functions as a second capacitive power
15 receiving electrode for receiving power from a second capacitive power transmitting
electrode of the external source;
wherein the module comprises a metal layer as the substrate and said metal
layer is re-used as the conductive layer; or the module comprises a metal core printed circuit
board package as the substrate, and the metal core layer (30) embedded within the metal core
20 printed circuit board package is re-used as the conductive layer.
2. A module as claimed in claim 1, wherein the metal layer comprises a third
metal layer region (10c) which functions as an LED cathode contact and a fourth metal layer
region (10d) which functions as an LED anode contact.
25
3. A module as claimed in claim 2 wherein:
a first sub-array of LED chips (12) is provided over the first metal layer region
with wirebonds between the LED chips of the first sub-array, and/or
a second sub-array of LED chips (12) is provided over the second metal layer
30 region with wirebonds between the LED chips of the second sub-array,
and wherein wirebonds (22) connect to the third and fourth metal layer
regions.

4. A module as claimed in claim 2 or 3, further comprising a phosphor encapsulation over (18) the sub-array of LED chips and the corresponding wirebonds.

5. A module as claimed in claim 2, 3 or 4, further comprising a frame (50) around the substrate, wherein the frame carries circuitry which comprises a power harvesting circuit (54) for receiving power from the first isolated region and the second isolated region for powering the LED chips and an LED driver circuit, and wherein the circuitry comprises input electrical contacts to the first and second metal layer regions and comprises output electrical contacts to the third and fourth metal layer regions.

6. A module as claimed in any one of claims 1 to 5, further comprising an insulation layer (14) under said metal layer of the chip on board package, and said insulation layer being doped with dielectric material.

7. A module as claimed in claim 1, wherein the metal core layer (30) is on one side of the substrate and the LED chips of the array are on the opposite side of the substrate.

8. A module as claimed in claim 7, wherein circuitry is provided on said opposite side of the substrate, which circuitry comprises a power harvesting circuit (54) for receiving power from the first isolated region and the second isolated region for powering the LED chips and an LED driver circuit (56).

9. A module as claimed in claim 8, wherein the substrate is provided with vias for connection between the circuitry and the capacitive power receiving electrodes of the metal core layer (30).

10. A module as claimed in claim 1, wherein the part of the substrate that is under the metal core layer (30) is doped with dielectric material.

12. A lighting system comprising:
a wireless power transmitter system comprising one or more capacitive power transmitting electrodes provided at a surface; and
one or more modules as claimed in any preceding claim, each for application to the surface to receive wireless power transfer from the capacitive power transmitting

electrode or electrodes to the capacitive power receiving electrode or electrodes of the module.

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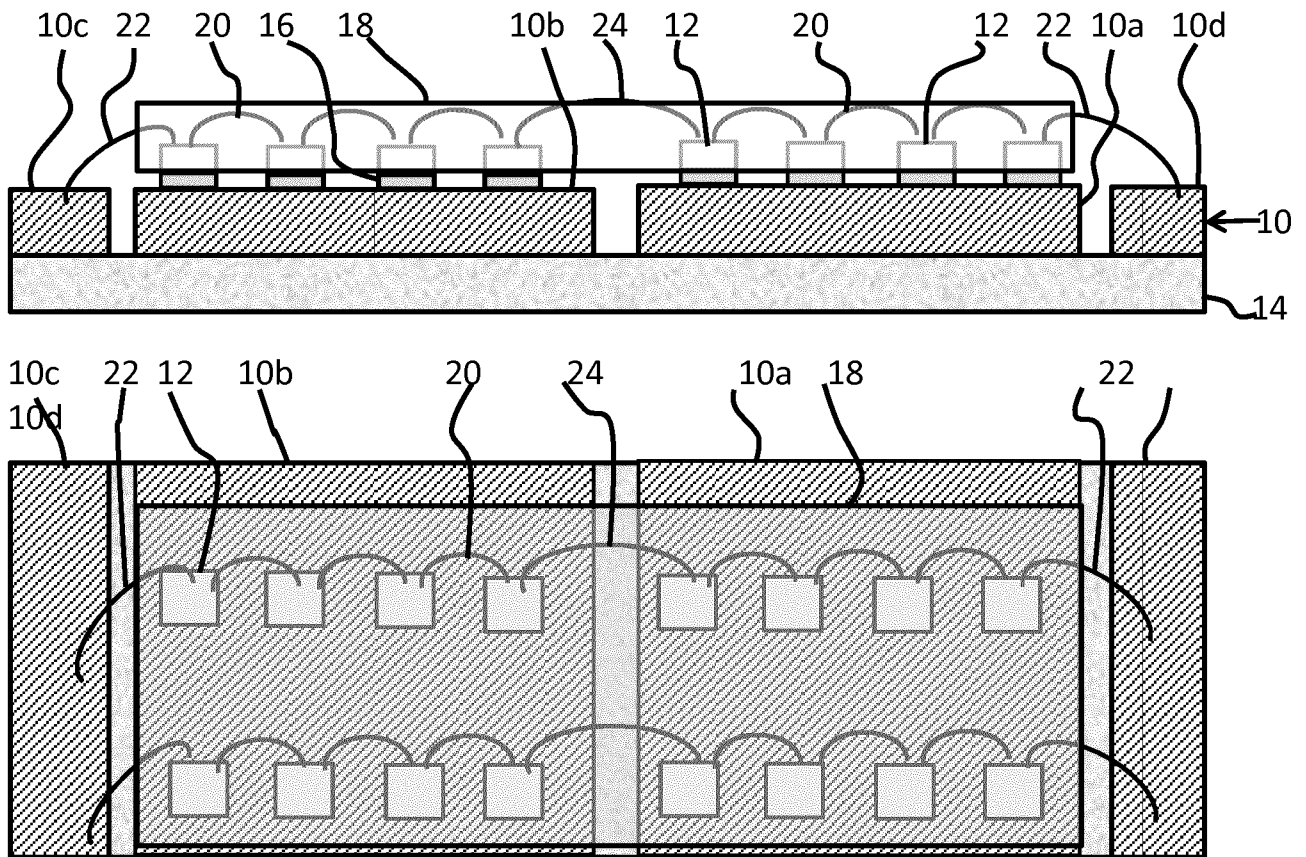


FIG. 1

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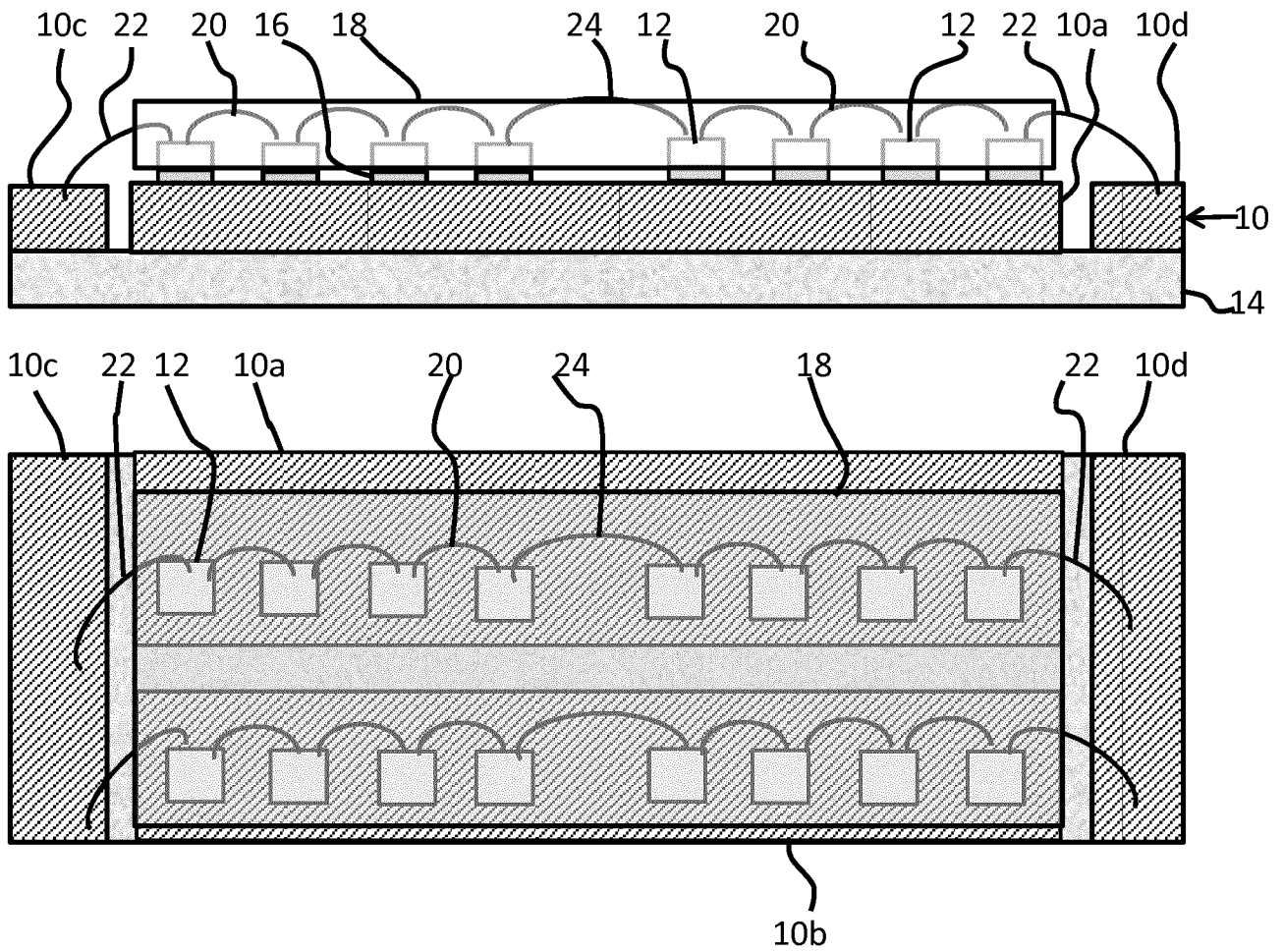


FIG. 2

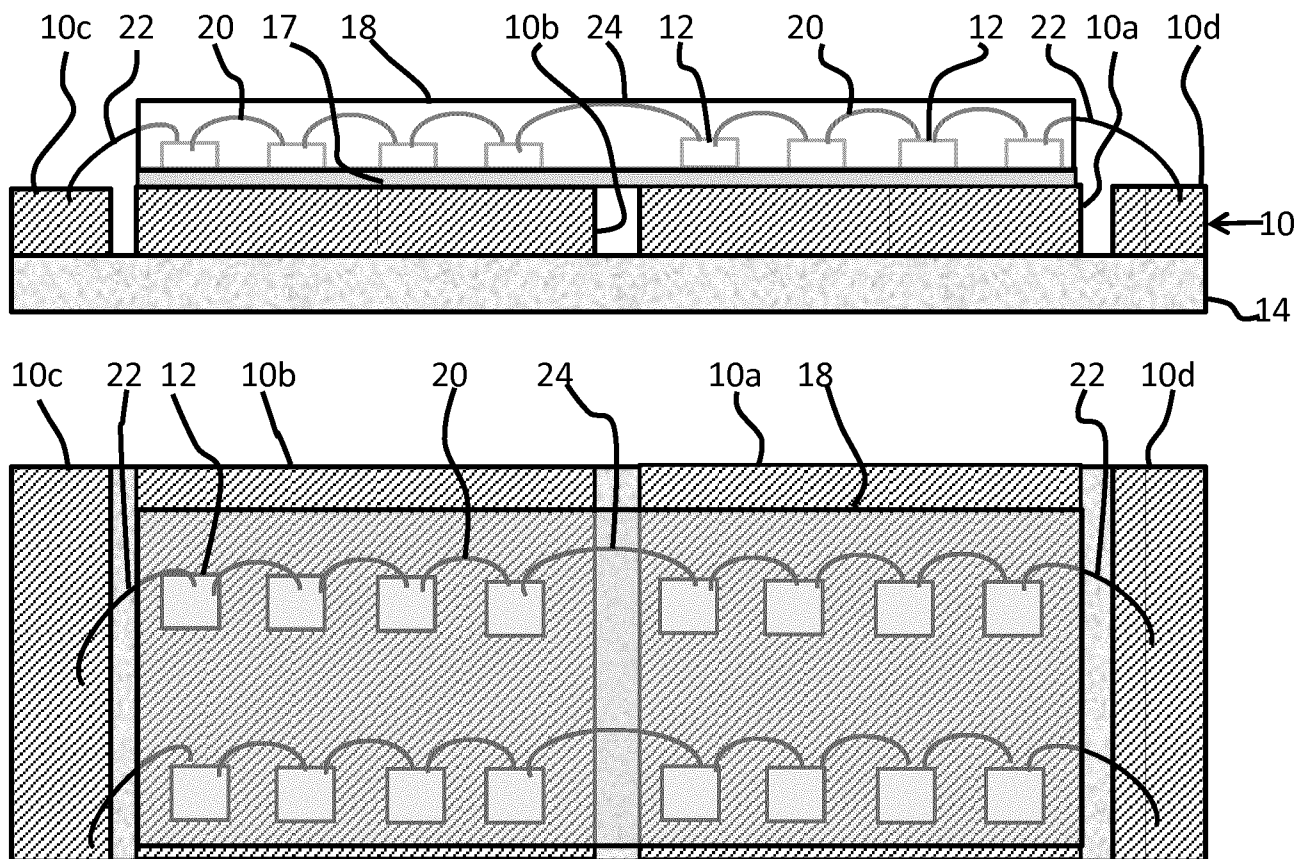


FIG. 3

4/6

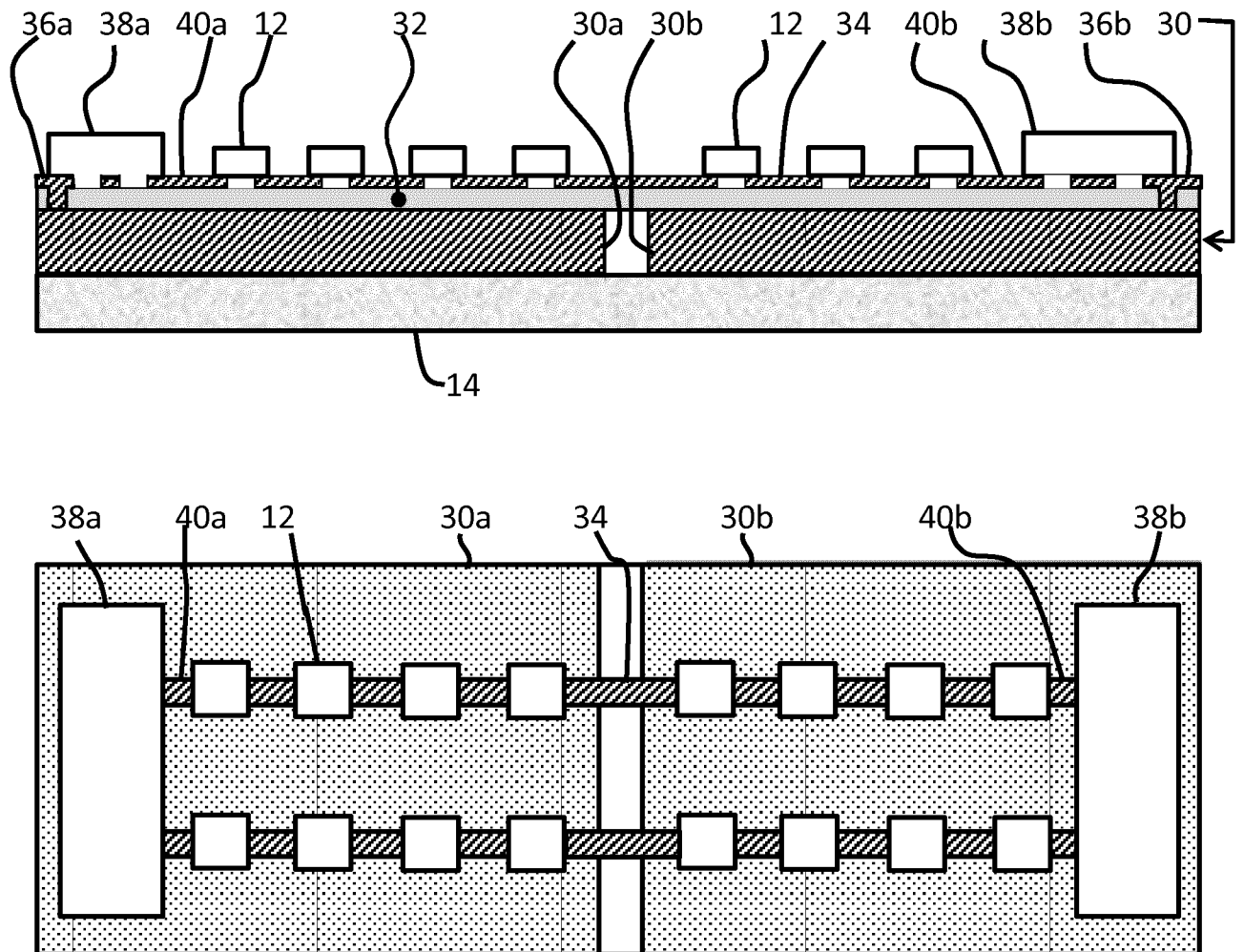
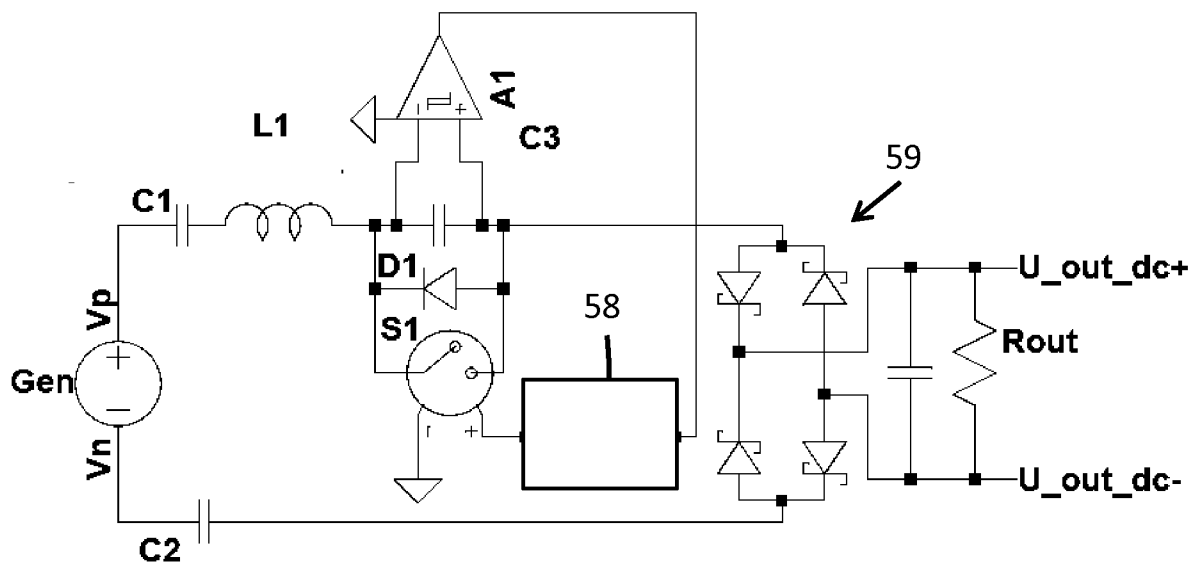
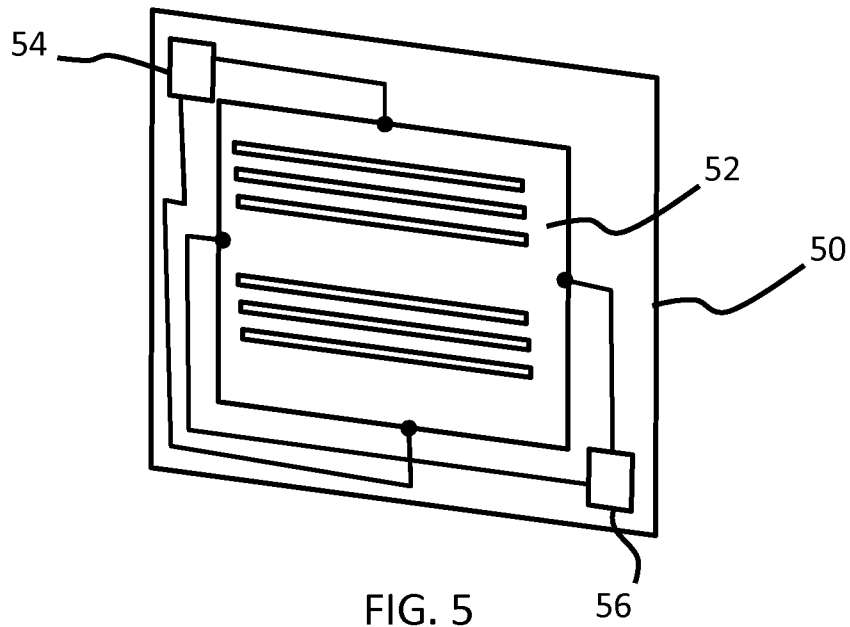


FIG. 4

5/6



6/6

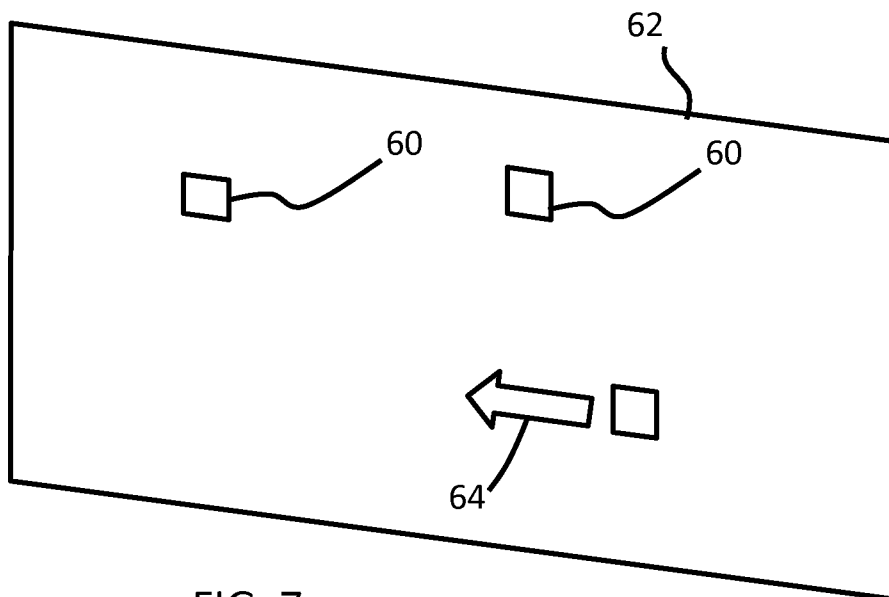


FIG. 7

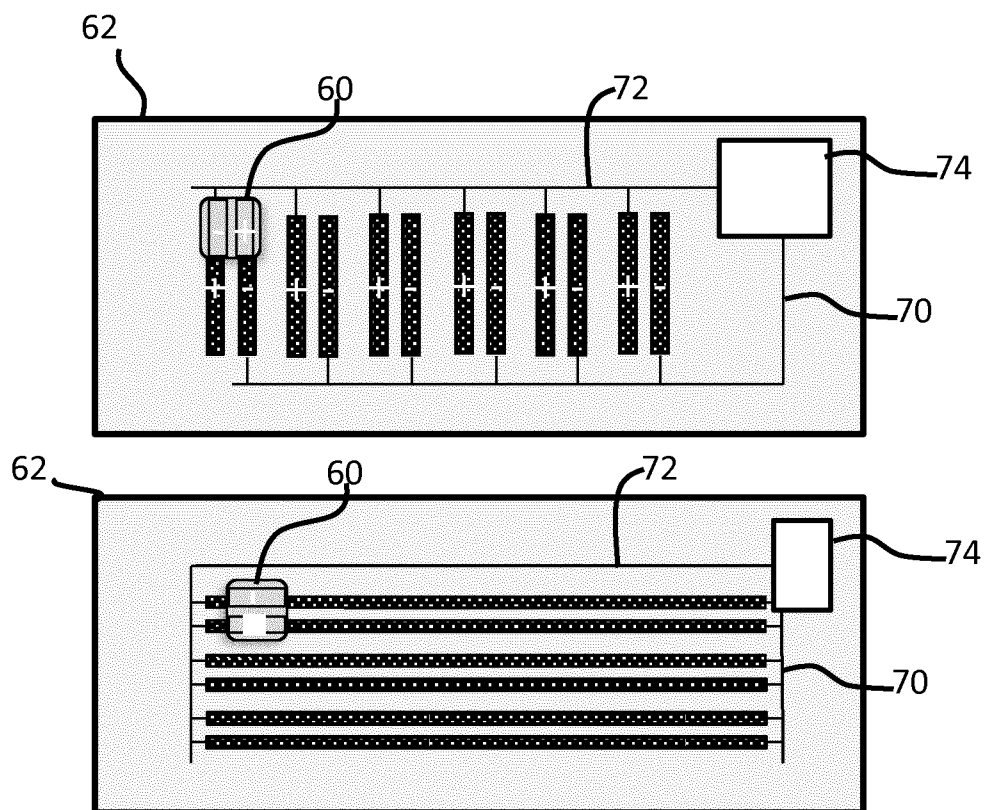


FIG. 8

International application No
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/051028

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