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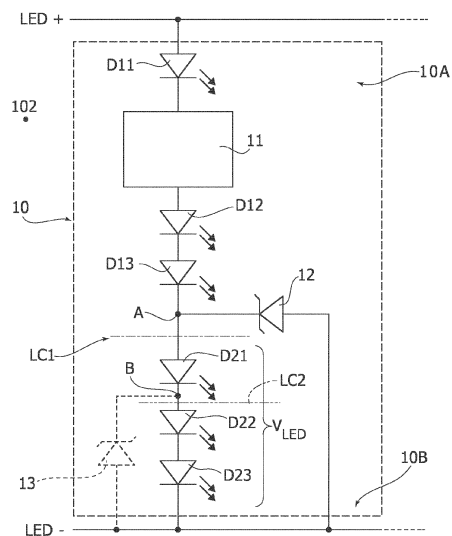
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(54) **A LIGHTING DEVICE AND CORRESPONDING METHOD**

(57) A lighting device comprises an elongated support member (102) with a sequence of consecutive segments having a first end (10A) and a second end (10B), and light radiation sources (e.g. LEDs) distributed along the support member (102) in a sequence of electrical units (10) arranged at respective segments of the support member. The electric units (10) comprise a plurality of sets of electrically-powered light radiation sources (D11, D12, D13; D21, D22, D23; D11, D12, D13, D21; D22, D23), electrically arranged in series between a first (LED+) and a second (LED-) power supply node. At least one set (D21, D22, D23; D22, D23) of light radiation sources can be separated from the electrical unit (10) at a cutting line (LC1, LC2) intermediate between the first end (10A) and the second end (10B) of the respective segment of the support member. An electrically-conductive path (12, 13) parallel to the aforesaid separable set (D21, D22, D23; D22, D23) can be activated by separating this set (D21, D22, D23; D22, D23) from the electric unit (10) so as to maintain the electrical coupling between the first (LED+) and the second (LED-) power supply node.

FIG. 1



Description

Technical field

[0001] The description refers to lighting devices.

[0002] One or more embodiments may be applied to lighting devices comprising electrically-powered light radiation sources, for example, solid-state light radiation sources such as LED sources.

Technological background

[0003] Nowadays, lighting devices are used, comprising an elongated substrate (for example, a flexible strip-like support or a rigid bar) on which sources (e.g. LEDs) of light radiation are distributed with a certain application step (sometimes called "pitch").

[0004] These modules can be cut to length according to the application and use requirements.

[0005] To this end, these devices may comprise a plurality of individual light radiation emitting units electrically connected in parallel with each other and supplied by a constant voltage driver circuit.

[0006] The units can be provided with a current regulator able to regulate the current that crosses the light radiation sources according to a required output light flux.

[0007] It is possible to envisage that the substrate (flexible or rigid) is cut or sectioned by separating two consecutive units, so that the device can be cut to values of a total length equal to a multiple of the length of the individual unit.

[0008] In some applications, the individual units may have a certain length, which results in a limitation of the flexibility offered to the user in choosing the overall length of the device.

[0009] This situation can arise, for example, in devices in which the application pitch of the sources is quite big (for example, in low flux and/or reduced cost modules), or in modules with a high number of LEDs (for example, in modules powered with 48V DC, capable of comprising twice the number of sources compared to modules powered with 24V DC).

[0010] To address this problem, various solutions have been proposed.

[0011] A first solution involves reducing the application step or pitch of the sources.

[0012] This reduction results in individual units that are shorter, so that the possible cutting lines are closer.

[0013] This solution has the drawback of increasing the number of light sources per unit of length, with a consequent increase in the cost of the lighting module. It is therefore a solution that is difficult to propose for low-flux and/or low-cost devices.

[0014] Another solution may envisage reducing the power supply voltage, consequently reducing the number of light sources per unit of length, also reducing their length.

[0015] This leads to a reduction in the overall efficiency

of the module, since the fraction of voltage drop across the current regulator increases with respect to the total voltage applied to the light radiation sources.

[0016] Suppose, for example, that there is a power supply voltage equal to V_s and a voltage drop at the ends of the regulator (linear) equal to V_{reg} , with a voltage drop across the light sources (for example, LEDs) equal to V_{leds} , that is, at n times the voltage drop at the ends of an individual source (for example, 3V for LEDs emitting white radiation). In this case, it is possible to calculate the efficiency of the device in the form $\eta = V_{leds}/V_s$.

[0017] For a module with $V_s = 24V$ and with 7 LEDs in the chain, the efficiency is approximately equal to $\eta = 87.5\%$.

[0018] Reducing V_s to 12V, it is possible to connect (only) three sources in series, so that the efficiency drops to a value of $\eta = 75\%$.

[0019] At most, using just one LED source for each chain with a voltage $V_s = 5V$, the efficiency drops further to a value $\eta = 60\%$.

[0020] The use of multi-chip light radiation sources (for example, LEDs) is also conceivable, in which the individual light-emitting element has a voltage drop equal to a multiple of that of an LED source of the single-chip type.

[0021] This allows reduction of the number of light radiation sources per individual unit and, consequently, the length of the unit.

[0022] However, sources such as multi-chip LEDs have a higher cost than single-chip LEDs, which can negatively impact the overall costs of the device.

[0023] In addition to this, the fact of using multi-chip sources can also have an impact on efficiency.

[0024] For example, if dual-chip LEDs are used in modules powered at 24V DC, it is possible to connect (only) three LEDs in the chain, having to ensure a certain regulation voltage value V_{reg} to facilitate the correct operation of the regulator.

[0025] In this case, the V_{leds} value is equal to 18 volts, with an overall efficiency equal to $\eta = 75\%$ instead of 87.5%.

[0026] Yet another possibility is that of providing each unit of the device with one or more cutting lines provided with contacts (pads) at the cutting lines.

[0027] The user can then cut the module at the cutting lines according to the application and use requirements, in order to have a "final" unit at the cutting line, and to close the circuit by connecting an external element to the contacts provided for the purpose such as, for example, a resistor.

[0028] This solution has the advantage of simplicity, in addition to the fact that the reduction in efficiency due to the replacement of light radiation sources with the external element only affects the last unit of the module.

[0029] The main drawback of this solution lies in the fact that applying the external closing element requires additional operations by the user.

[0030] In addition to this, this external element is practically inapplicable in protected modules (for example,

with an IPx degree of protection) without reduction of the protection against the penetration of external agents.

Object and summary

[0031] One or more embodiments aim to provide a simple and economical solution capable of facilitating and making the cutting-to-length action of the modules discussed above more flexible, overcoming the drawbacks associated with the described solutions.

[0032] According to one or more embodiments, this object can be achieved thanks to a lighting device having the characteristics referred to in the following claims.

[0033] One or more embodiments may concern a corresponding method.

[0034] The claims form an integral part of the technical disclosure provided here in relation to the embodiments.

[0035] One or more embodiments may offer one or more of the following advantages:

- greater flexibility for the user in the choice of the length of a linear module (for example, with LEDs), even in the presence of an application pitch of light radiation sources of a certain relevance, given by the possibility of cutting the module at individual functional units connected in parallel (this may be the case in low-flux and/or reduced-cost modules);
- possibility of applying embodiments to both flexible and rigid linear modules;
- possibility of avoiding additional operations since, after cutting the module, external devices are not applied to close the circuit at the cut;
- possibility of also applying the solution to protected modules without affecting the degree of protection: for example, the cutting operation can be carried out even after applying the protective material, without this cutting operation reducing the degree of protection.

Brief description of the figures

[0036] One or more embodiments will be now described, purely by way of non-limiting example, with reference to the attached figures, wherein:

- Figure 1 is an exemplary circuit diagram of embodiments.
- Figure 2 is an additional exemplary circuit diagram of possible implementations of modalities of use of these embodiments, and
- Figure 3 is a plan view of a lighting module according to embodiments.

[0037] It will be appreciated that, for clarity and simplicity of illustration, the various views in may not be reproduced on the same scale.

Detailed description of examples of embodiments

[0038] The following description illustrates various specific details in order to provide a thorough understanding of various examples of embodiments according to the description. The embodiments can be obtained without one or more of the specific details, or with other methods, components, materials, etc. In other cases, known structures materials or operations are not illustrated or described in detail so that the various aspects of the embodiments and not rendered unclear.

[0039] The reference to "an embodiment" in the context of the present description indicates that a particular configuration, structure or characteristic described in relation to the embodiment is included in at least one embodiment. Thus, sentences such as "in an embodiment", which may be present at various points in the present description, do not necessarily refer to exactly the same embodiment. Moreover, particular configurations, structures or characteristics can be combined in any suitable way in one or more embodiments.

[0040] The references used here are provided simply for convenience and therefore do not define the field of protection or scope of the embodiments.

[0041] In the figures, the reference 10 indicates - overall - a unit included in a lighting device 100 comprising several units 10 connected, for example, electrically parallel to each other so as to be supplied (for example, as DC) with a power supply voltage applied between two lines (rails) LED+ and LED-.

[0042] The various units 10 comprise several electrically-powered light radiation sources.

[0043] In one or more embodiments, it is possible to use solid state light radiation sources, such as, for example, LED sources.

[0044] Lighting devices 100 of the type described herein have been commercially available for some time, for example, in the form of a strip-like or bar/rod-like substrate or support 102, substantially similar to a rigid or flexible printed circuit board, on which electrically-powered light radiation sources are arranged, e.g. LEDs.

[0045] As already mentioned, devices 100 of this type are known in the art, which makes it unnecessary to provide a more detailed description herein.

[0046] For present purposes (see also Figures 2 and 3, which will be referred to below), these lighting devices 100 may include:

- an elongated support member 102 comprising a sequence of consecutive segments, the segments having a first end 10A and a second end 10B opposite to each other in the lengthwise direction of the elongated support member 102,
- electrically-powered light radiation sources distributed along the elongated support member 102 in a sequence of electrical units 10 arranged at respective segments of the elongated support member 102,

[0047] The device 100 (and therefore the electric units 10) has a first power supply line LED+ and a second power supply line LED-, the various units 10 are connected in parallel with each other, with these lines supplying respective power supply nodes for the various unit 10.

[0048] These devices 100 can be cut to length according to the application and use requirements at cutting lines LC provided at positions interposed between successive units 10.

[0049] As described in the introductory part of the present description, this solution can be limitative, for example, in the case of low flux and/or low cost devices 100, or in general, of devices 100 in which the individual units 10 have a length of a certain relevance in the longitudinal extension direction of the type 100, so that the "resolution" available for carrying out the cutting-to-length operation may be excessively rough for various situations of use.

[0050] One or more embodiments as exemplified herein allow the aforesaid cutting-to-length operations to be carried out with a finer resolution, also being able to provide cutting-to-length operations performed within the individual unit 10, for example, at cutting lines LC1 or LC2 (the latter represented with a dashed line in Figure 1) in an intermediate position between the ends 10A and 10B of the support segment which houses a certain unit 10.

[0051] In this way it is possible, e.g. to maintain just a head portion (end 10A) in the unit 10 subjected to cutting, while a tail portion (end 10B) is eliminated as a result of the cutting operation.

[0052] To this end, in one or more embodiments, in the individual units 10, it is possible to provide at least one cutting line LC1 of the support placed in an intermediate position between the ends 10A and 10B of the individual segment/unit. In this way, the string of light radiation sources (for example, LEDs, such as in the example presented here) connected in series between the two power supply lines LED+ and LED- can be seen as comprising (see, for example, Figure 1) at least:

- one first set of sources D11, D12, D13, and
- one second set of sources D21, D22, D23,

with a cutting line LC1 that passes between the two sets.

[0053] The fact of referring to "at least" one first and one second set of sources and (at least) one cutting line LC1 takes into account the fact that, in one or more embodiments, the solution presented here can be extended to the provision of several cutting lines at which the individual unit 10 can be cut according to the application and use requirements, being able in practice to reach a resolution at the level of the individual source D11, ... D13.

[0054] As an example, Figure 1 exemplifies (with a dashed line) the possibility of providing a second cutting line LC2, with the string of sources connected in series between the two power supply lines LED+ and LED-, which can be seen as comprising:

- a first set of sources D11, D12, D13, D21 and
- a second set of sources D22, D23,

with the cutting line LC2 that passes between the two sets.

[0055] It will be appreciated that this criterion can be further extended to:

- i) still different definitions of a first set and of a second set of sources; in order to demonstrate other examples (which of course do not exhaust the range of possibilities):
 - D11, D12, D13, D21, D22 and D23, with a cutting line between D22 and D23,
 - D11, and D12, D13, D21, D22 D23, with a cutting line between D11 and D12,
 - D11, D12, and D13, D21, D22 D23, with a cutting line between D12 and D13,
 - and so on, and/or
- ii) a greater number of cutting lines (in practice, the embodiments are not limited to the presence of one or two cutting lines such as the lines LC1 and LC2 exemplified herein.)

[0056] In whatever way the aforesaid sets are defined, one or more embodiments may envisage the possibility of "eliminating" one of said sets of sources from the unit 10 (e.g. the one placed at the tail or distal position, at the 10B end of the segment, or rather D21, D22, D23 or D22, D23 in the two examples shown in Figure 1), separating it from the unit 10 with a cutting operation of the support or substrate 102 implemented at e.g. the line LC1, the line LC2 or other possible cutting lines, not visible in the drawings for reasons of simplicity.

[0057] This all includes the possibility of cutting the unit 10 to different lengths according to the application and use requirements, at the provided cutting line(s).

[0058] Referring to the example of Figure 1 for simplicity of illustration, we can consider the example of a first set or section of sources D11, D12 and D13 (which can be associated with a current regulator 11, for example, linear) and a second set or section of sources D21, D22 and D23, intended to be separated from the first set (and therefore from the unit 10) with a cutting action carried out at the cutting line LC1.

[0059] In one or more embodiments, it is possible to envisage the presence of an electrically-conductive path extending towards one of the supply nodes of the unit 10 (for example, the node LED-) starting from a node A located in an intermediate position between the set D11, D12, D13 and the set D21, D22, D23 on the side of the cutting line LC1 facing the other power supply node of the unit 10 (e.g. the node LED+), or rather, towards the first set of sources D11, D12, D13.

[0060] Such an electrically-conductive path - activated when the second set of sources D21, D22, D23 is separated from the unit 10 by cutting the substrate 102 along the line LC1 - allows maintenance of the electrical con-

nection between the nodes LED+ and LED- so as to ensure power supply to the set of sources D11, D12, D13 that remains in the unit 10.

[0061] Activation of this electrically-conductive path can take place in different ways (e.g. by means of an electronic switch such as a transistor, an e-fuse or, as exemplified here, a Zener diode).

[0062] A Zener diode 12, as exemplified in the solid line in Figure 1, is an example of an electronic switch that can be closed automatically, activating the associated electrically-conductive path as a result of the fact that the second set of sources D21, D22, D23 is separated from the unit 10 by cutting the substrate 102 along the line LC1.

[0063] For example, the Zener diode 12 can be arranged with the cathode coupled to the node A (i.e. at the end of the first set of sources D11, D12, D13 opposite to the power supply node LED+) and the anode coupled to the node LED-.

[0064] When the unit 10 is cut at the cutting line LC1, the Zener diode 12 makes the current path from the node LED+ to the node LED- conductive, passing through the diodes D11, D12, D13, which can - in this way - be regularly supplied and activated.

[0065] Figure 1 also illustrates (with dashed lines) the possibility of providing, at an intermediate position between the ends 10A and 10B, at least one other possible cutting line, namely the line LC2. In this case, the first set or section of sources (with associated current regulator 11) can be seen to comprise the sources D11, D12, D13 and D21, with the second set or section of sources, intended to be separated from the first set (and therefore from the unit 10) by a cutting action carried out at the cutting line LC2, comprising the sources D22 and D23.

[0066] To this end, in one or more embodiments, it is possible to envisage the presence of another electrically-conductive path extending towards the node LED- starting from a node B located in an intermediate position between the set D11, D12, D13, D21 and the set D22, D23 on the side of the cutting line LC2 facing the other power supply node of the unit 10 (e.g. the node LED+), or rather towards the first set of sources D11, D12, D13, D21.

[0067] Such an electrically-conductive path can be activated when the second set of sources D22, D23 is separated from the unit 10 by cutting the substrate 102 along the line LC2 - again allowing maintenance of the electrical connection between the nodes LED+ and LED- so as to ensure the power supply to the set of sources D11, D12, D13, D21 that remain in the unit 10.

[0068] Once again, activation of this electrically-conductive path can take place (as well as in the other modes mentioned above) by means of a Zener diode 13 as exemplified in the dashed line in Figure 1, also capable of forming an electronic switch intended to close automatically, activating the associated electrically-conductive path, as a result of the fact that the second set of sources D22, D23 is separated from the unit 10 by cutting the substrate 102 along the line LC2.

[0069] The Zener diode 13 can be arranged with the cathode coupled to the node B (i.e. at the end of the first set of sources D11, D12, D13, D21 opposite to the power supply node LED+) and the anode coupled to the node LED-.

[0070] In this way, when the unit 10 is cut at the cutting line LC2, the Zener diode 13 makes the current path from the node LED+ to the node LED- conductive, passing through the diodes D11, D12, D13, D21, which can - in this way - be regularly supplied and activated.

[0071] As already mentioned, the above-exemplified criterion can even be applied to different definitions of a first set and of a second set of sources with the cutting line of the substrate passing between the two sets and/or applied to a number of cutting lines greater than two, with a respective switch associated with each cutting line (e.g. a Zener diode 12, 13, ...) designed to activate a respective conductive path able to maintain the electrical coupling between the nodes LED+ and LED- through the sources D11,..., which remain in the unit 10 and are not removed therefrom due to the cutting to the required length implemented at the line LC1 (or the line LC2 or other provided cutting lines).

[0072] In one or more embodiments, the Zener voltage of the diode 12 - and of the diode 13, or of other diodes of this type provided for the same purpose - can be chosen in such a way as to result (at least slightly) greater than the operating voltage at the ends of the light radiation sources of the set that is separated from the unit 10 due to cutting of the substrate 102.

[0073] This operating voltage indicates the voltage that would be applied to the ends of the light radiation sources of the set that is separated from the unit 10 if, instead of being "cut off" (and being "replaced" by a Zener diode, e.g. 12, 13), this set was left attached to the unit 10.

[0074] For example, referring to the diagram of Figure 1, the Zener voltage of the diode 12 can be chosen so as to be (slightly) higher than the operating voltage at the ends of the light radiation sources D21, D22, D23, which can be separated from the unit 10 by cutting at the cutting line LC1.

[0075] For example, if there are three LED sources, this operating voltage can be in the order of $3 \times 3 = 9$ Volt and the Zener voltage of the diode 12 can be chosen as equal, e.g. $V_Z = 10V$.

[0076] Similar criteria can be adopted for selecting the Zener voltage of the diode 13 associated with the cutting line LC2 with respect to the intended drop in operating voltage at the ends of the sources D22, D23 that can be separated from the unit 10 by cutting at the cutting line LC2.

[0077] As already mentioned several times, this criterion can be extended to virtually any number of cutting lines/sections of light radiation sources.

[0078] The choice of Zener voltages implemented according to the criteria outlined above ensures that, until the corresponding set or section of light radiation sources is included in the unit 10, the Zener diode in question (12

or 13, with reference the example shown in Figure 1) behaves essentially with an open circuit, without affecting the operation of the unit 10 (the relative electrically-conductive path towards the node LED- is in fact inactive, that is, non-conductive).

[0079] Conversely, when the unit 10 is cut, for example, at one of the lines LC1 or LC2, so as to separate a certain set of radiation sources from the unit 10 (for example, the sources D21, D22, D23 - in the case of a cut along the line LC1 - or the sources D22, D23 in the case of a cut along the line LC2), the corresponding Zener diode (the Zener diode 12 in the first case, or the Zener diode 13, in the second case) becomes active (i.e. conductive, passing into Zener mode) allowing closure of the electric circuit between the power supply lines LED+ and LED-, with consequent passage of current of the LEDs still included in the unit 10, which can be thus activated: these can involve, for example, the LEDs D11, D12, D13, in the case of cutting along the LC1 line, or the LEDs D11, D12, D13 and D21 in the case of cutting along the line LC2.

[0080] In any case, the voltage at the ends of the activated Zener diode is equal to its Zener voltage without causing overvoltage to damage the current regulator.

[0081] Figure 2 exemplifies (referring for simplicity to the case of an single cutting line LC1) a possible practical use of the solution exemplified in Figure 1, referring to the possible presence of two units, in which the unit 10 on the left in the figure is - so to speak - "integral" (i.e. it includes all six LEDs D11, D12, D13, D21, D22, D23) while the unit 10' on the right has been cut along the LC1 cutting line so as to include (only) the LEDs D11, D12 and D13 (with the regulator 11) and the correspondingly activated Zener diode 12.

[0082] In this way, the device 100 can also be cut to length at one of the lines LC1 (or LC2), thus achieving a finer resolution in the cutting-to-length possibility of the device 10.

[0083] In the unit 10 on the left (uncut), the current set by the (linear) regulator 11 flows through all the LEDs of the chain because the Zener diode 12 behaves like an open circuit.

[0084] In the unit 10' on the right, the current established by the regulator 11 flows towards the line LED- passing through the LEDs D11, D12 and D13 and through the Zener diode 13 which, with its Zener voltage, "replaces" - so to speak - the LEDs 21, 22, 23 no longer present, reproducing the voltage drop across them and avoiding the generation of overvoltage and/or overloading conditions on the regulator.

[0085] The fact of "replacing", according to one or more embodiments, a certain number of light radiation sources with a Zener diode in the unit 10 that is cut at an intermediate cutting line, such as the line LC1 (or the line LC2), reduces the efficiency in terms of lumens per watt only in the unit 10 in which the cut was made, while the other units 10 of the device 100 are not affected by the cutting action.

[0086] All of this translates into a small reduction in efficiency of the device 100 as a whole, which is acceptable for the end user.

[0087] Figure 3 further exemplifies a solution as represented in Figure 1 at the level of a possible implementation within an elongated device 100 comprising a substrate 102 substantially similar to a (flexible or rigid) printed circuit board, with the various elements already presented with reference to Figures 1 and 2 indicated for simplicity with the same reference numerals, which makes it unnecessary to repeat with reference to Figure 3 the description already provided with reference to Figures 1 and 2.

[0088] A solution, such as that exemplified in Figure 3, can be used in the possible application of resistors in parallel (illustrated in the figure without the assignment of specific references) for the purpose of protection against electrostatic discharge phenomena - ESD), as well as to the production of the device 100 in the form of a protected device (for example, with an IPx degree of protection).

[0089] These protection characteristics are not influenced to an appreciable extent by the cutting operation, even when it is carried out (as well as at the line LC between successive units 10) at an "intermediate" line of one of the units 10, such as the lines LC1 and LC2 exemplified in Figure 1.

[0090] A lighting device (e.g. 100) according to one or more embodiments may comprise:

- an elongated support member (e.g. 102) comprising a sequence of consecutive segments, the segments having a first end (e.g. 10A) and a second end (e.g. 10B) opposite to each other in the lengthwise direction of the elongated support member,
- electrically-powered light radiation sources distributed along the elongated support member in a sequence of electrical units (e.g. 10) arranged at respective segments of the elongated support member, the electrical units comprising a first supply node (e.g. LED+) and a second supply node (e.g. LED-),

wherein at least one electrical unit in the sequence of electrical units comprises:

- a plurality of sets of electrically-powered light radiation sources (e.g. D11, D12, D13 and D21, D22, D23; or D11, D12, D13, D21 and D22, D23) arranged electrically in series between the first supply node and the second supply node of the electrical unit, with at least one set (e.g. D21, D22, D23 or D22, D23) of light radiation sources arranged at one (e.g. 10B) of the first end or the second end of the respective segment of the elongated support member, which can be separated from the electrical unit at a cutting line (e.g. LC1, LC2) of the elongated support member in an intermediate position between the first end (10A) and the second end of the respective segment of the

elongated support member,

- an electrically conductive path (e.g. through 12 or 13) parallel to said at least one separable set (e.g. D21, D22, D23 cut along LC1 or D22, D23 cut along LC2) of light radiation sources, the electrically conductive path can be activated (e.g. by passing a Zener diode into conduction) as a result of the separation of the at least one separable set from the electrical unit at said cutting line of the elongated support member with electrical coupling of the first supply node and the second supply node maintained by the activated electrically conductive path.

[0091] In one or more embodiments, said at least one separable set of light radiation sources (e.g. D21, D22, D23 or D22, D23) is configured to provide a line of current between:

- a coupling node (e.g. A, B) of the at least one separable set of light radiation sources (e.g. D21, D22, D23 or D22, D23) to another set of light radiation sources (e.g. D11, D12, D13 or D11, D12, D13, D21) in the plurality of sets of electrically-powered light radiation sources arranged electrically in series between the first supply node and the second supply node, and
- one (e.g. LED-) of the first supply node and the second supply node,

wherein the electrically conductive path can be activated to couple said node to said one of the first supply node and the second supply node to maintain electrical coupling therebetween with the at least one separable set of light radiation sources separated from the at least one electrical unit.

[0092] In one or more embodiments, the electrically-conductive path can comprise an electronic switch (e.g. 12, 13) switchable between:

- a first, non-conductive, state with the at least one separable set of light radiation sources coupled to the respective electrical unit, and
- a second conductive state, with the at least one separable set of light radiation sources separated from the respective electrical unit.

[0093] In one or more embodiments, the electronic switch may comprise a Zener diode.

[0094] In one or more embodiments:

- said at least one separable set of light radiation sources has an operational voltage drop there-through, and
- the Zener diode may have a higher Zener voltage than said operational voltage drop.

[0095] In one or more embodiments, said at least one electrical unit in the sequence of electrical units may com-

prise:

- a plurality of sets (e.g. D21, D22, D23 or D22, D23) of light radiation sources arranged at one of the first end and the second end of the respective segment of the elongated support member, the sets in the plurality of sets being selectively separable from the electrical unit at respective cutting lines (e.g. LC1 or LC2) of the elongated support member in an intermediate position between the first end and the second end of the respective segment of the elongated support member,
- a plurality of electrically conductive paths (e.g. 12, 13) arranged in parallel to respective sets of light radiation sources in said plurality of sets selectively separable from the electrical unit at said respective cutting lines, said electrically conductive paths can be activated as a result of the respective separable set of light radiation sources being separated from the electrical unit at a respective cutting line of the elongated support member, with electrical coupling of the first supply node and the second supply node maintained by the activated electrically conductive path.

[0096] In one or more embodiments, the elongated support member can be separable at:

- cutting lines (e.g. LC in Figure 2) between consecutive segments in said sequence of consecutive segments, and
- cutting lines (e.g. LC1, LC2) at intermediate positions between the first end and the second end of said segments.

[0097] In one or more embodiments, the at least one electrical unit in the sequence of electrical units may comprise a current regulator (e.g. linear, 11) coupled to a set (e.g. D11, D12, D13 or D11, D12, D13, D21) of light radiation sources in said plurality of electrically-powered light radiation sources that are different from the at least one set (D21, D22, D23 or D22, D23) separable from the electric unit.

[0098] In one or more embodiments, the electrically-powered light radiation sources may comprise solid state sources, preferably LED sources.

[0099] A method according to one or more embodiments may comprise:

- providing an elongated support member with a sequence of consecutive segments, the segments having a first end and a second end opposite in the lengthwise direction of the elongated support member,
- distributing along the elongated support member a sequence of electrical units comprising electrically-powered light radiation sources arranged at respective segments of the elongated support member, the

electrical units comprising a first supply node and a second supply node,

- providing at least one electrical unit in the sequence of electrical units:
 - i) a plurality of sets of electrically-powered light radiation sources (e.g. D11, D12, D13 and D21, D22, D23; or D11, D12, D13, D21; D22, D23) arranged electrically in series between the first supply node and the second supply node of the electrical unit, with at least one set of light radiation sources arranged at one of the first end or the second end of the respective segment of the elongated support member that can be separated from the electrical unit at a cutting line of the elongated support member in an intermediate position between the first end the second end of the respective segment of the elongated support member,
 - ii) an electrically conductive path parallel to said at least one separable set of light radiation sources, and
- separating the at least one separable set from the electrical unit at said cutting line of the elongated support member and maintaining electrical coupling of the first supply node and the second supply node via activation of said electrically conductive path.

[0100] Without prejudice to the underlying principles of the invention, the details of construction and the embodiments may vary, even significantly, with respect to those illustrated here, purely by way of non-limiting example, without departing from the scope of the invention.

[0101] The field of protection is determined by the attached claims.

LIST OF REFERENCE SIGNS

Supply node	LED+
Supply node	LED-
Electrical unit	10
First end	10A
Second end	10B
Support	102
Radiation source	D11
Radiation source	D12
Radiation source	D13
Radiation source	D21
Radiation source	D22
Radiation source	D23
Cutting line	LC1
Cutting line	LC2
Zener diode	12
Zener diode	13
Coupling node	A
Coupling node	B

Claims

1. A lighting device (100), comprising:

- an elongated support member (102) comprising a sequence of consecutive segments, the segments having a first end (10A) and a second end (10B) opposed lengthwise of the elongated support member (102),
 - electrically-powered light radiation sources distributed along the elongated support member (102) in a sequence of electrical units (10) arranged at respective segments of the elongated support member (102), the electrical units (10) comprising a first supply node (LED+) and a second supply node (LED-), wherein at least one electrical unit (10) in the sequence of electrical units comprises:
 - a plurality of sets of electrically-powered light radiation sources (D11, D12, D13; D21, D22, D23; D11, D12, D13, D21; D22, D23) arranged electrically in series between the first supply node (LED+) and the second supply node (LED-) of the electrical unit (10), with at least one set (D21, D22, D23; D22, D23) of light radiation sources arranged at one (10B) of the first end (10A) and the second end (10B) of the respective segment of the elongated support member (102) severable from the electrical unit (10) at a cutting line (LC1, LC2) of the elongated support member (102) intermediate the first end (10A) and the second end (10B) of the respective segment of the elongated support member (102),
 - an electrically conductive path (12, 13) in parallel to said at least one severable set (D21, D22, D23; D22, D23) of light radiation sources, the electrically conductive path activatable as a result of the at least one severable set (D21, D22, D23; D22, D23) being severed from the electrical unit (10) at said cutting line (LC1, LC2) of the elongated support member (102), with electrical coupling of the first supply node (LED+) and the second supply node (LED-) maintained by the activated electrically conductive path (12, 13).
2. The lighting device (100) of claim 1, wherein said at least one severable set of light radiation sources (D21, D22, D23; D22, D23) is configured to provide a current line between:
- a coupling node (A, B) of the at least one severable set of light radiation sources (D21, D22, D23; D22, D23) to another set of light radiation

sources (D11, D12, D13; D11, D12, D13, D21) in the plurality of sets of electrically-powered light radiation sources arranged electrically in series between the first supply node (LED+) and the second supply node (LED-), and
 - one (LED-) of the first supply node (LED+) and the second supply node (LED-),

wherein the electrically conductive path (12, 13) is activatable to couple said node (A, B) to said one (LED-) of the first supply node (LED+) and the second supply node (LED-) to maintain electrical coupling therebetween with the at least one severable set (D21, D22, D23; D22, D23) of light radiation sources severed from the at least one electrical unit (10).

3. The lighting device (100) of claim 1 or claim 2, wherein the electrically conductive path comprises an electronic switch (12, 13) switchable between:

- a first, non-conductive, state with the at least one severable set of light radiation sources (D21, D22, D23; D22, D23) coupled to the respective electrical unit (10), and
 - a second, conductive, state with the at least one severable set of light radiation sources (D21, D22, D23; D22, D23) severed from the respective electrical unit (10).

4. The lighting device (100) of claim 3, wherein the electronic switch comprises a Zener diode (12, 13).

5. The lighting device (100) of claim 4, wherein:

- said at least one severable set of light radiation sources (D21, D22, D23; D22, D23) has an operational voltage drop therethrough, and
 - the Zener diode (12, 13) has a Zener voltage higher than said operational voltage drop.

6. The lighting device (100) of any of the previous claims, wherein said at least one electrical unit (10) in the sequence of electrical units comprises:

- a plurality of sets (D21, D22, D23; D22, D23) of light radiation sources arranged at one (10A) of the first end (10A) and the second end (10B) of the respective segment of the elongated support member (102), the sets in the plurality of sets (D21, D22, D23; D22, D23) selectively severable from the electrical unit (10) at respective cutting lines (LC1, LC2) of the elongated support member (102) intermediate the first end (10A) and the second end (10B) of the respective segment of the elongated support member (102),
 - a plurality of electrically conductive paths (12, 13) in parallel to respective sets of light radiation

sources in said plurality of sets (D21, D22, D23; D22, D23) selectively severable from the electrical unit (10) at said respective cutting lines (LC1, LC2), said electrically conductive paths (12, 13) activatable as a result of the respective severable set (D21, D22, D23; D22, D23) of light radiation sources being severed from the electrical unit (10) at a respective cutting line (LC1, LC2) of the elongated support member (102) with electrical coupling of the first supply node (LED+) and the second supply node (LED-) maintained by the activated electrically conductive path (12, 13).

7. The lighting device (100) of any of the previous claims, wherein the elongated support member (102) is severable at:

- cutting lines (LC) between consecutive segments in said sequence of consecutive segments, and
 - cutting lines (LC1, LC2) intermediate the first end (10A) and the second end (10B) of said segments.

8. The lighting device (100) of any of the previous claims, wherein the at least one electrical unit (10) in the sequence of electrical units comprises a current regulator (11) coupled to a set (D11, D12, D13; D11, D12, D13, D21) of light radiation sources in said plurality of sets of electrically-powered light radiation sources (D11, D12, D13; D21, D22, D23; D11, D12, D13, D21; D22, D23) other than said at least one set (D21, D22, D23; D22, D23) severable from the electrical unit (10).

9. The lighting device (100) of any of the previous claims, wherein the electrically-powered light radiation sources (D11, D12, D13, D21, D22, D23) comprise solid-state sources, preferably LED sources.

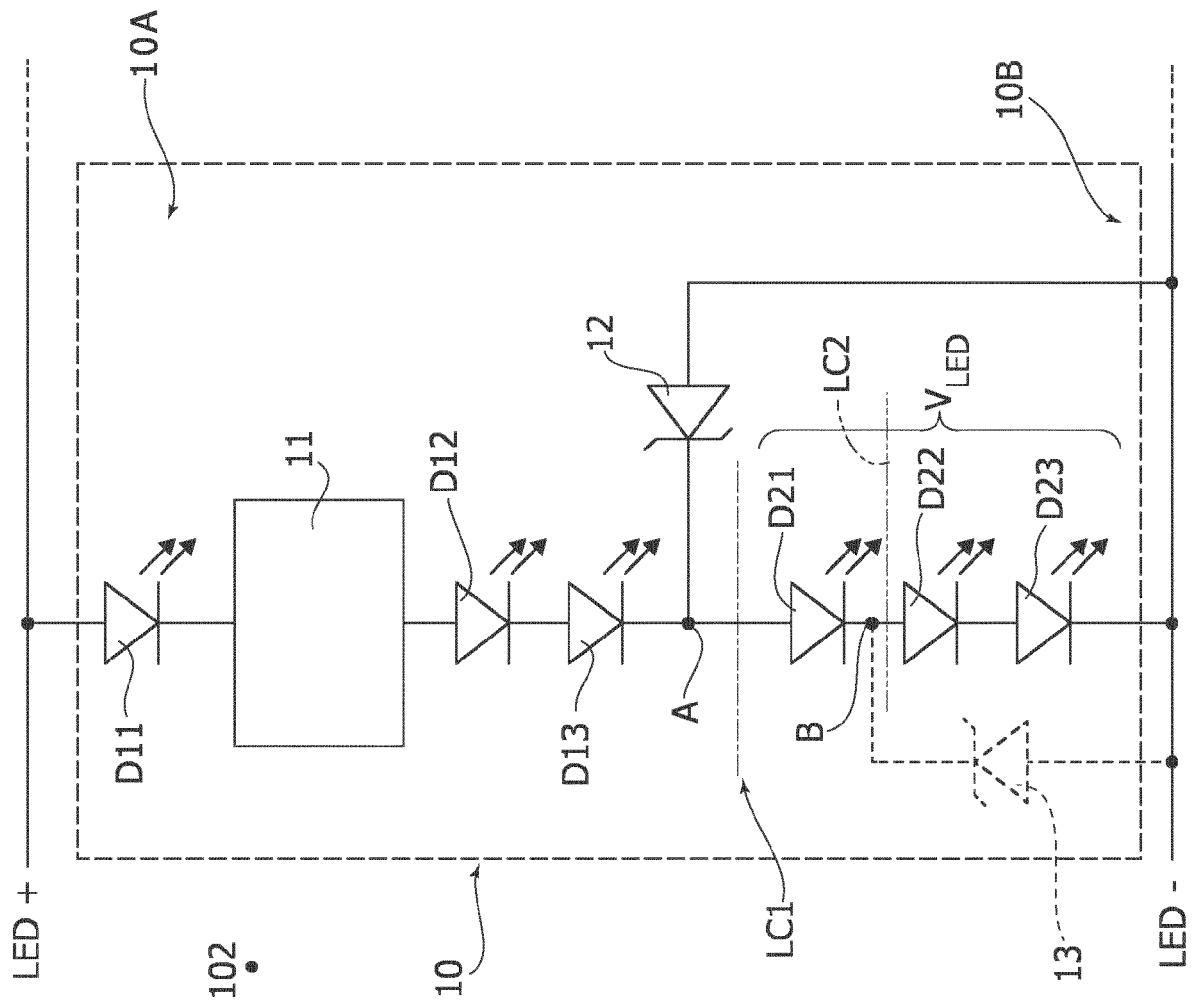
10. A method, comprising:

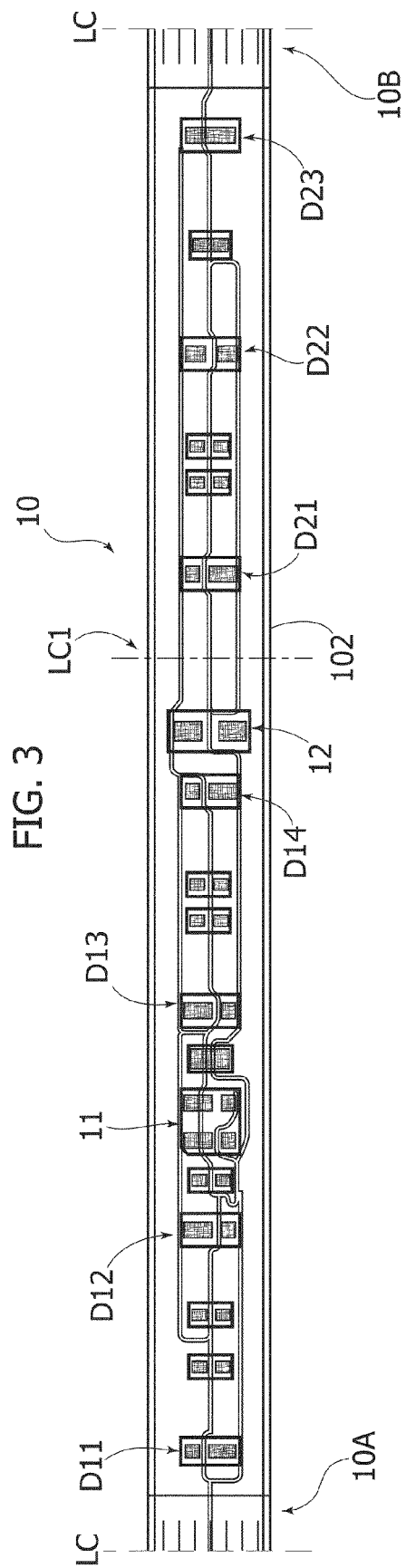
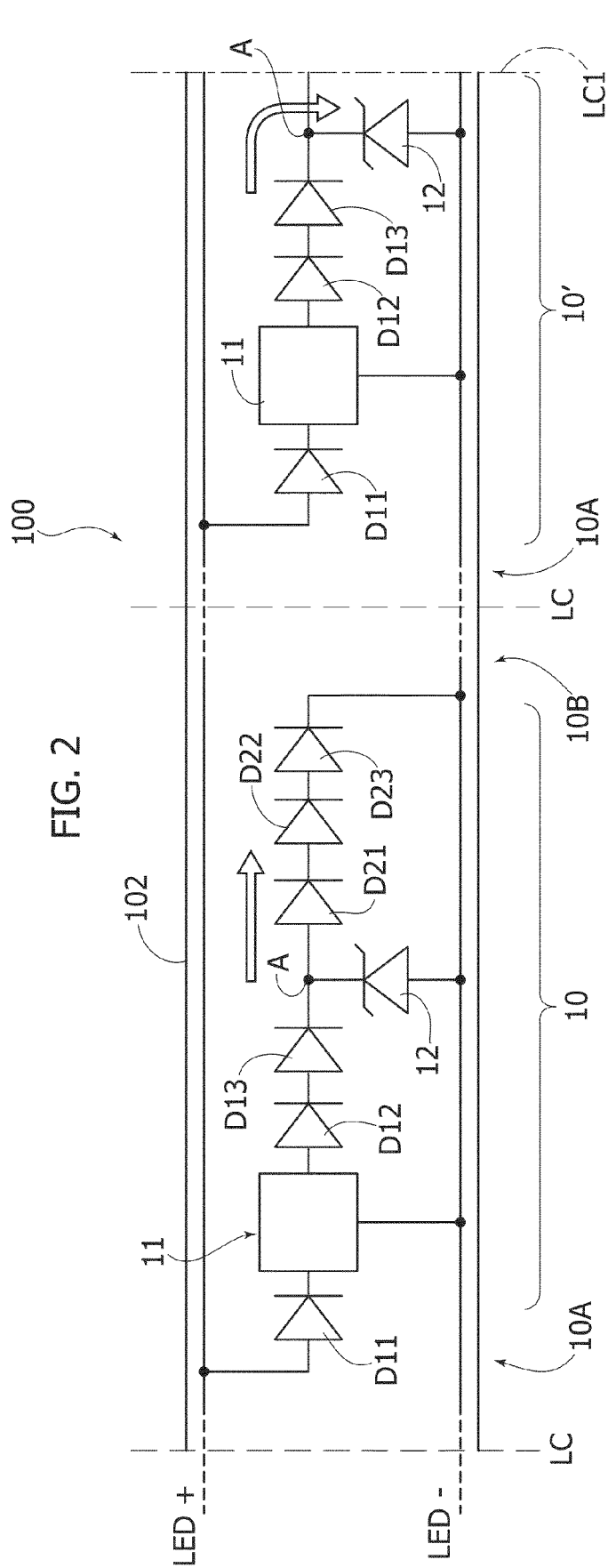
- providing an elongated support member (102) with a sequence of consecutive segments, the segments having a first end (10A) and a second end (10B) opposed lengthwise of the elongated support member (102),
 - distributing along the elongated support member (102) a sequence of electrical units (10) comprising electrically-powered light radiation sources arranged at respective segments of the elongated support member (102), the electrical units (10) comprising a first supply node (LED+) and a second supply node (LED-),
 - providing at at least one electrical unit (10) in the sequence of electrical units:

- i) a plurality of sets of electrically-powered light radiation sources (D11, D12, D13; D21, D22, D23; D11, D12, D13, D21; D22, D23) arranged electrically in series between the first supply node (LED+) and the second supply node (LED-) of the electrical unit (10), with at least one set (D21, D22, D23; D22, D23) of light radiation sources arranged at one (10B) of the first end (10A) and the second end (10B) of the respective segment of the elongated support member (102) severable from the electrical unit (10) at a cutting line (LC1, LC2) of the elongated support member (102) intermediate the first end (10A) and the second end (10B) of the respective segment of the elongated support member (102),
- ii) an electrically conductive path (12, 13) in parallel to said at least one severable set (D21, D22, D23; D22, D23) of light radiation sources,

- severing the at least one severable set (D21, D22, D23; D22, D23) from the electrical unit (10) at said cutting line (LC1, LC2) of the elongated support member (102) and maintaining electrical coupling of the first supply node (LED+) and the second supply node (LED-) via activation of said electrically conductive path (12, 13).

THE







EUROPEAN SEARCH REPORT

Application Number
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X	US 2015/092413 A1 (LI MING [US] ET AL) 2 April 2015 (2015-04-02) * page 1, paragraph 3 - page 1, paragraph 7 * * page 3, paragraph 36; figure 1 * * page 4, paragraph 42 - page 6, paragraph 54; figures 3-8 *	1-10	INV. H05B33/08 F21S4/24
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			TECHNICAL FIELDS SEARCHED (IPC)
			H05B F21S
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 June 2019	Examiner Burchielli, M
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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