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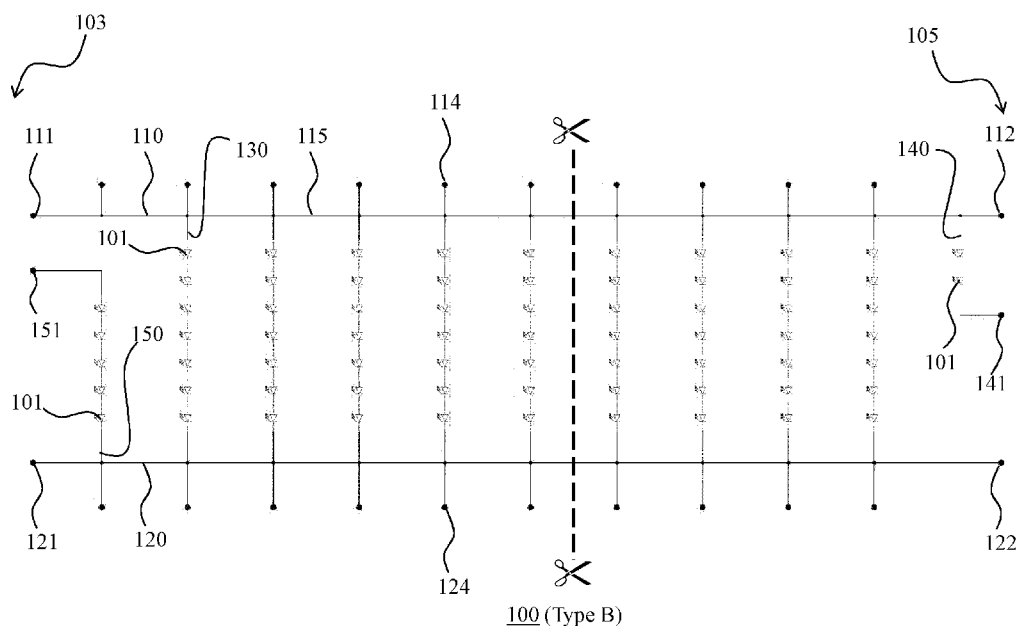


FIG. 1

(57) Abstract: The present invention discloses an elongate substrate (100) having opposing ends (103, 105) in its elongation direction and comprising a conductive line arrangement including a conductive line (110, 110', 110'') arranged to have a first polarity; a further conductive line (120) arranged to have an opposite polarity to the first polarity spatially separated from said conductive line, each of the conductive line and the further conductive line extending between the opposing ends and terminating in respective metal pads (111, 111', 112, 112', 121, 122) at each of the opposing ends; and at least one solid state lighting arrangement (50, 50', 50'') comprising a plurality of strings (130, 130', 130'') of N serially connected solid state elements (101, 101', 101'') in which N is a positive integer, said strings being connected in parallel to the conductive line and the further conductive line, and being separated from each other by spacer sections (115); and at least one of a string (140, 140', 140'') of M serially connected solid state elements in which M is a positive integer

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and M<N, said string being proximal to one (105) of said opposing ends and connected between the conductive line and a first further metal pad (141, 141') at said one of said opposing ends; and a string (150, 150', 150'') of N-M serially connected solid state elements, said string being proximal to the other (103) of said opposing ends and connected between the further conductive line and a second further metal pad (151, 151') at said other of said opposing ends. Further disclosed is a lighting strip assembled from such elongate substrates and an assembly method of such a lighting strip.

SOLID STATE ELEMENT LIGHTING STRIP DESIGN

FIELD OF THE INVENTION

The present invention relates to an elongate substrate having opposing ends in its elongation direction and comprising a conductive line arrangement including a
5 conductive line arranged to have a first polarity; a further conductive line arranged to have an opposite polarity to the first polarity spatially separated from said conductive line, each of the conductive line and the further conductive line extending between the opposing ends and terminating in respective metal pads at each of the opposing ends; and
10 at least one solid state lighting arrangement comprising a plurality of strings of N serially connected solid state elements in which N is a positive integer, said strings being connected in parallel to the conductive line and the further conductive line, and being separated from each other by spacer sections.

The present invention further relates to a lighting strip comprising a plurality of
15 such elongate substrates that are interconnected to form the strip.

The present invention further relates to the manufacture of such a lighting strip.

BACKGROUND OF THE INVENTION

Solid state lighting (SSL) element-based lighting applications require more and
20 more flexibility. As such there is a rapid increase of variations of linear, elongate substrates such as PCBs (printed circuit boards) with surface mounted SSL elements. Such lighting strips may be provided on reels such that allow a lighting strip to be cut to a desired length, in particular where flexible elongate substrates such as flexible PCBs. For example, US 2015/0138772 A1 discloses a LED strip lighting fixture having an array of
25 LEDs mounted on a frangible rigid aluminum base having a predetermined thickness, the thickness including predetermined points of weakness, whereby the rigid, preferably aluminum, base can be broken at the predetermined points of weakness. The rigid base has disposed thereon a laminated integrated circuit on which are mounted a plurality of electrical elements including a plurality of light emitting diodes in series electrical
30 connection on the laminated integrated circuit whereby the frangible sections of the rigid

- 2 -

base provide for easy customization in providing predetermined length dimensions of the rigid aluminum base and LED mounted lighting fixture.

However, the manufacture of such lighting strips is not without challenges. Such strips may be produced with a reel to reel production method, but this typically requires specialist equipment to create the (flexible) elongate substrate and to perform the surface mounting device (SMD) process, in which the chips comprising the SSL elements are mounted onto the elongate substrate. This is rather costly, which is why many manufactures produce such lighting strips using a strip to strip soldering method in which elongate substrates are soldered together to form the lighting strip, after which the lighting strip may be overmoulded to protect and electrically insulate the electrical components exposed on the surface of the lighting strip in order to form the final product. In this manner, lighting strips may be provided in lengths of 5-50m or longer for example, whilst such lighting strips can still be manufacturing using standard tooling as the SMD process of mounting the SSL element chips onto an elongate substrate such as a (flexible) PCB is performed using relatively short substrates, e.g. about 50 cm long substrates, which still can be handled by such standard tooling.

In order to facilitate the cutting of such strips to length, the strips typically comprise a plurality of strings of SSL elements (e.g. LEDS), which strings are connected in parallel such that a lighting strip may be cut in the space between adjacent pairs of such parallel strings. To this end, the lighting strip may comprise markers at such spaces that indicate where the lighting strip may be safely cut, e.g. using scissors. However, in such designs, the space between adjacent parallel strings on neighboring elongate substrates, i.e. the join between such neighboring elongate substrates, cannot be easily cut due to the soldering of the conductive lines extending across the elongate substrates.

In addition, in order to reconnect a cut strip segment, a connector box is typically used into which the cut strip segment is inserted. Where such a strip segment is cut across such solder bumps, the thickness of the solder bump segments typically prevents the insertion of such a cut strip segment into the connector box. For this reason, users of such soldered lighting strips tend to avoid cutting the strip across the soldered interconnections interconnecting adjacent elongate substrates. This however means that the lighting strip

- 3 -

has spaces between strings of SSL elements at regular intervals that cannot be easily cut, which therefore hampers the usage flexibility of such lighting strips.

For example, for a lighting strip compiled of 50cm long substrates that are soldered together, a user wishing to cut a length of the lighting strip that is 50 cm or a multiple thereof cannot simply cut this length of the lighting strip as this would mean cutting across the soldered interconnections in between adjacent substrates. Instead, the user must first cut off a smaller portion, e.g. a 5 cm or 10 cm portion, after which a 50 cm portion or multiple thereof may be cut off the remaining length of lighting strip, as now the cut across the lighting strip at the length of the desired portion will be made at a space located in between strings of SSL elements that are both located on the same substrate. This is rather cumbersome, and leads to unnecessary waste of parts of the lighting strip.

SUMMARY OF THE INVENTION

The present invention seeks to provide an elongate substrate for use in such a lighting strip in which a user can cut the lighting strip between each adjacent pair of strings of SSL elements with the same ease, thereby increasing the usage flexibility of such a lighting strip and reducing its waste.

The present invention further seeks to provide a lighting strip formed from a plurality of such elongate substrates.

The present invention further seeks to provide a method of manufacturing such a lighting strip.

According to a first aspect, there is provided an elongate substrate having opposing ends in its elongation direction and comprising a conductive line arrangement including a conductive line arranged to have a first polarity; a further conductive line arranged to have an opposite polarity to the first polarity spatially separated from said conductive line, each of the conductive line and the further conductive line extending between the opposing ends and terminating in respective metal pads at each of the opposing ends; and at least one solid state lighting arrangement comprising a plurality of strings of N serially connected solid state elements in which N is a positive integer, said strings being connected in parallel to the conductive line and the further conductive line,

- 4 -

and being separated from each other by spacer sections; and at least one of a string of M serially connected solid state elements in which M is a positive integer and $M < N$, said string being proximal to one of said opposing ends and connected between the conductive line and a first further metal pad at said one of said opposing ends; and a string of N-M serially connected solid state elements, said string being proximal to the other of said opposing ends and connected between the further conductive line and a second further metal pad at said other of said opposing ends. When the elongate substrate is interconnected with another elongate substrate with a complementary string of N-M serially connected solid state elements and / or a complementary string of M serially connected solid state elements, the one of the string of M serially connected solid state elements and the string of N-M serially connected solid state elements on the elongate substrate connects with a corresponding one of the complementary string of N-M serially connected solid state elements and the complementary string of M serially connected solid state elements on the another elongate substrate, to form a string of N serially connected solid state elements across the adjacent elongate substrates; wherein said string of N serially connected solid state elements, across the adjacent elongate substrates, is identical in electrical and optical performance with each of the plurality of strings of N serially connected solid state elements.

In accordance with the present invention, an elongate substrate is provided that when used to form a lighting strip by interconnecting a plurality of such substrates ensures that the lighting strip may be cut in between each pair of adjacent strings of solid state lighting (SSL) elements, thereby reducing wastage of such lighting strips and increasing user flexibility thereof. This is achieved by dividing such a string of serially connected SSL elements across adjacent elongate substrates at their intersection, such that a first portion of such a string, i.e. a string of M serially connected solid state elements, is positioned on a first of the adjacent elongate substrates, which first portion can be interconnected to a second portion of such a string, i.e. a string of N-M serially connected solid state elements, on the other of the adjacent elongate substrates, thereby forming a string of $M + (N-M) = N$ serially connected SSL elements across the adjacent elongate substrates. Consequently, the interconnections, e.g. solder bumps, between adjacent elongate substrates are no longer located in between a pair of strings of serially

- 5 -

connected SSL elements but are instead located within such a string, that is, outside a potentially targeted cutting area of a lighting strip formed by a plurality of such interconnected substrates. The string of N serially connected solid state elements, across the adjacent elongate substrates, has the same electrical and optical performance as a
5 normal one of the plurality of strings of N serially connected solid state elements, so that the lighting strip formed by interconnecting such substrates won't have variation along its elongate direction.

In case the elongate substrate comprises only one of the string of M serially connected solid state elements and the string of N-M serially connected solid state
10 elements, the elongate substrate may be used as a terminal substrate of such a lighting strip, as in such a case no further elongate substrates need to be connected to the terminal end of the elongate substrate, such that a string portion at this terminal end is not required. On the other hand, where the elongate substrate is to be used as an intermediate substrate of such a lighting strip, the at least one solid state lighting arrangement
15 comprises the string of M serially connected solid state elements and the string of N-M serially connected solid state elements such that the elongate substrate may be interconnected to another elongate substrate at both its opposing ends in order to form strings of N serially connected SSL elements across the interconnected elongate substrates as explained above.

In the context of the present application, where reference is made to a conductive
20 line arranged to have a particular polarity, it should be understood that this means that the conductive line is intended to be connected to a particular terminal of a power supply, e.g. a positive terminal or a negative terminal. For example, a conductive line arranged to have a first polarity may be intended to be connected to the positive terminal of a power
25 supply, in which case a conductive line having the opposite polarity is intended to be connected to the negative terminal of such a power supply, or vice versa.

Preferably, each of said strings of N serially connected solid state elements extends in the elongation direction of the elongate substrate.

It is further preferable that the elongate substrate is flexible in order to maximize
30 the flexibility of the lighting strip to be formed of a plurality of such interconnected elongate substrates.

- 6 -

Each solid state element may be provided as a separate chip mounted on the elongate substrate. This facilitates a cost-effective manufacture of such an elongate substrate, e.g. using a SMD process.

Embodiments of the present invention are not limited to a single SSL arrangement
5 on an elongate substrate. For example, in a further embodiment the conductive line arrangement comprises a pair of said conductive lines arranged to have said first polarity and a pair of said solid state lighting arrangements including first and second solid state lighting arrangements, wherein the respective strings of the first solid state lighting arrangement where connected to a conductive line arranged to have said first polarity are
10 connected to one of said pair of conductive lines arranged to have said first polarity and the respective strings of the second solid state lighting arrangement where connected to a conductive line arranged to have said first polarity are connected to the other of said pair of conductive lines arranged to have said first polarity. In such embodiments, the elongate substrate comprises multiple SSL arrangements that are individually addressable, which
15 for instance may be used to provide the elongate substrate with different types of SSL elements, such as white light SSL elements in the first SSL arrangement and SSL elements producing a particular colour, e.g. red, green or blue, in the second SSL arrangement. This enhances the functionality of such an elongate substrate and a lighting strip formed of such a plurality of elongate substrates.

20 The elongate substrate typically comprises a first major surface and a second major surface opposing the first major surface. In an embodiment, the pair of conductive lines arranged to have said first polarity and the pair of solid state lighting arrangements are located on the first major surface, and the further conductive line is located on the second major surface. This has the advantage that more space is available on the first
25 major surface, e.g. the major surface acting as the light producing surface that is visible in a lighting strip, which may facilitate the inclusion of further SSL arrangements on the first major surface.

For example, the conductive line arrangement may comprise a third conductive line arranged to have said first polarity, the elongate substrate further comprising a
30 further solid state lighting arrangement, wherein the respective strings of the further solid state lighting arrangement where connected to a conductive line arranged to have said

- 7 -

first polarity are connected to the third conductive line. The further SSL arrangement may further enhance the functionality of the elongate substrate and a lighting strip formed of a plurality of such substrates, e.g. by providing a plurality of SSL elements within such an SSL arrangement that produce light having yet another spectral composition. In this manner, an elongate substrate and lighting strip may be provided having up to four or five different SSL arrangements, such as an elongate substrate and lighting strip comprising one or two SSL arrangements having (different) white light producing SSL elements and three further SSL arrangements having SSL elements producing differently coloured light, such as red, green and blue light respectively.

In an embodiment, each of the conductive lines arranged to have said first polarity and the further conductive line comprises a plurality of further metal pads, wherein each of said further metal pads is conductively connected to a junction between said conductive line and one end of a plurality of strings of N serially connected solid state elements connected to said conductive line. Such further metal pads facilitate the reconnection of a segment of a lighting strip that is cut proximal to such a junction, e.g. when this lighting strip segment is to be used in or as a lighting device. Such further metal pads may be located in said spacer sections such that the design of the elongate substrate is kept particularly compact.

According to another aspect, there is provided a lighting strip comprising a plurality of elongate substrates according to any of the herein described embodiments, wherein respective substrates are interconnected by a pair of interconnections interconnecting the metal pads of corresponding conductive and further conductive lines at facing ends of adjacent elongate substrates, and a further interconnection interconnecting the first further metal pad of each solid state lighting arrangement on one of the adjacent elongate substrates to the second further metal pad of a corresponding solid state lighting arrangement on the other of the adjacent elongate substrates at said facing ends, wherein, said string of N serially connected solid state elements, across the adjacent elongate substrates, is identical in dimension in the elongation direction of the elongate substrates with each of the plurality of strings of N serially connected solid state elements.

- 8 -

The interconnections, e.g. solder bumps, of such a lighting strip are located within an SSL arrangement of N serially connected SSL elements as explained in more detail above, such that the lighting strip can be readily cut in between each pair of adjacent or neighboring SSL arrangements. This is an improvement over the state of the art in which such cuts cannot be easily made in between neighboring SSL arrangements at different substrates, as the solder bumps between such substrates are typically located in between the neighboring SSL arrangements, i.e. in the region to be cut, which in practice precludes such cuts to be made in between SSL arrangements at different substrates. By properly select the length of string of M serially connected solid state elements on one substrate and the length of string of N-M serially connected solid state elements on another (adjacent and complementary) substrate, the length of the string of N serially connected solid state elements across the adjacent elongate substrates can be the same as a normal one of the plurality of strings of N serially connected solid state elements, so that the lighting strip formed by interconnecting such substrates will have even better consistency along its elongate direction.

It is noted that such a lighting strip may be formed of elongate substrates that each comprise both the string portion of M serially connected solid state elements in which M is a positive integer and the string portion of N-M serially connected solid state elements, in which case portions of the terminal elongate substrates of the lighting strip may be cut off to form terminals of the lighting string that may be connected to a power supply or the like. In order to save costs, the portions of the terminal elongate substrates of the lighting strip to be discarded may not carry SSL elements, e.g. are not mounted with SSL elements in an SMD process. It will be understood that such an approach may be feasible when it is known beforehand what length of lighting strip is required by the end user. The advantage of this approach is that only a single type of elongate substrate needs to be produced for the assembly of such a lighting strip, i.e. an elongate substrate comprising both the string portion of M serially connected solid state elements in which M is a positive integer and the string portion of N-M serially connected solid state elements at opposite ends of the substrate.

However, where it is not known how much of the lighting strip is going to be used by an end customer, it is preferred that the lighting strip further comprises a pair of

- 9 -

terminal elongate substrates at opposing ends of the lighting strip, said pair of terminal elongate substrates comprising a first terminal elongate substrate not comprising a string of M serially connected solid state elements such that the terminal end of the first terminal elongate substrate only comprises the metal pads of said conductive and further
5 conductive lines; and a second terminal elongate substrate not comprising a string of N-M serially connected solid state elements such that the terminal end of the second terminal elongate substrate only comprises the metal pads of said conductive and further conductive lines.

According to yet another aspect, there is provided a method of manufacturing a
10 lighting strip according to any of the herein described embodiments, the method comprising interconnecting a plurality of elongate substrates according to any of the herein described embodiments, wherein respective substrates are interconnected by a pair of interconnections interconnecting the metal pads of corresponding conductive and further conductive lines at facing ends of adjacent elongate substrates and a further
15 interconnection interconnecting the first further metal pad of each solid state lighting arrangement on one of the adjacent elongate substrates to the second further metal pad of a corresponding solid state lighting arrangement on the other of the adjacent elongate substrates at said facing ends. Such a method provides a lighting strip that may be easily cut in between any pair of adjacent SSL arrangements at the cost of an additional
20 interconnection in between string portions of an SSL arrangement distributed across a pair of adjacent elongate substrates.

The method may further comprise terminating opposing ends of the lighting strip with a pair of terminal elongate substrates comprising a first terminal elongate substrate not comprising a string of M serially connected solid state elements such that the terminal
25 end of the first terminal elongate substrate only comprises the metal pads of the conductive and further conductive lines; and a second terminal elongate substrate not comprising a string of N-M serially connected solid state elements such that the terminal end of the second terminal elongate substrate only comprises the metal pads of the conductive and further conductive lines; interconnecting the respective metal pads of said
30 conductive lines of the first terminal elongate substrate to the respective metal pads of the corresponding conductive lines of its adjacent elongate substrate at facing ends of said

substrates and interconnecting the one or more second further metal pads of the first terminal elongate substrate to corresponding first further metal pads of its adjacent elongate substrate at said facing ends; and interconnecting the respective metal pads of said conductive lines of the second terminal elongate substrate to the corresponding metal pads of the conductive lines of its adjacent elongate substrate at facing ends of said substrates and interconnecting the one or more first further metal pads of the second terminal elongate substrate to corresponding second further metal pads of its adjacent elongate substrate at said facing ends. In this manner, a lighting strip is manufactured that may be directly connected to a power source or the like at its terminals.

In a preferred embodiment, said interconnecting comprises soldering in order to provide particularly robust and reliable interconnections.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are described in more detail and by way of non-limiting examples with reference to the accompanying drawings, wherein:

FIG. 1 is a circuit diagram of a first type of elongate substrate according to an embodiment;

FIG. 2 is a circuit diagram of a second type of elongate substrate according to an embodiment;

FIG. 3 is a circuit diagram of a third type of elongate substrate according to an embodiment;

FIG. 4 schematically depicts a layout of a portion of an elongate substrate according to an example embodiment;

FIG. 5 is a circuit diagram of a portion of a lighting strip assembled in accordance with an embodiment of the method of the present invention;

FIG. 6 is a circuit diagram of another portion of a lighting strip assembled in accordance with an embodiment of the method of the present invention;

FIG. 7 schematically depicts a layout of a portion of a lighting strip according to an example embodiment;

FIG. 8 is a circuit diagram of a first type of elongate substrate according to another embodiment;

- 11 -

FIG. 9 is a circuit diagram of a second type of elongate substrate according to another embodiment;

FIG. 10 is a circuit diagram of a third type of elongate substrate according to another embodiment;

5 FIG. 11 schematically depicts a layout of a portion of a lighting strip according to another example embodiment;

FIG. 12 is a circuit diagram of a first type of elongate substrate according to yet another embodiment;

10 FIG. 13 is a circuit diagram of a second type of elongate substrate according to yet another embodiment;

FIG. 14 is a circuit diagram of a third type of elongate substrate according to yet another embodiment;

FIG. 15 schematically depicts a layout of a portion of a lighting strip according to yet another example embodiment; and

15 FIG. 16 schematically depicts a layout of a portion of another lighting strip (not part of the present invention).

DETAILED DESCRIPTION OF THE EMBODIMENTS

20 It should be understood that the Figures are merely schematic and are not drawn to scale. It should also be understood that the same reference numerals are used throughout the Figures to indicate the same or similar parts.

FIG. 1 schematically depicts a circuit diagram of a first type of elongate substrate 100 for assembly into a lighting strip in accordance with an embodiment of the present invention. The elongate substrate 100 may be made of any suitable material. For example, the elongate substrate 100 may be a printed circuit board (PCB) and preferably the elongate substrate 100 is a flexible PCB. It is noted that flexible PCBs are well-known per se and for this reason it will not be explained for the sake of brevity only how such flexible PCBs may be provided. The elongate substrate 100 extends in its elongation direction between opposite ends 103 and 105. A further conductive line 120 arranged to have a first polarity and a further conductive line 120 arranged to have an opposite polarity to the first polarity each extend between the opposite ends 103 and 105. For

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30

- 12 -

example, the conductive line 110 may be arranged to be of positive polarity and the further conductive line 120 may be arranged to be of negative polarity or vice versa.

The conductive line 110 terminates at the opposing ends 103 and 105 of the elongate substrate 100 in respective metal pads 111 and 112, which may be used to
5 interconnect the conductive line 110 of the elongate substrate 100 to a corresponding conductive line on a further elongate substrate or to a terminal of a particular polarity of a power supply for example, e.g. a positive terminal. The further conductive line 120 terminates at the opposing ends 103 and 105 of the elongate substrate 100 in respective metal pads 121 and 122, which may be used to interconnect the further conductive line
10 120 of the elongate substrate 100 to a corresponding further conductive line on a further elongate substrate or to a further terminal of a particular polarity of a power supply for example, e.g. a negative terminal. The conductive line 110 and further conductive line 120 may be made of any suitable electrically conductive material such as copper for example. Similarly, the respective metal pads 111, 112, 121 and 122 may be made of any
15 suitable electrically conductive material such as copper for example. The metal pads may further be coated with a further electrically conductive material, e.g. gold or the like to facilitate electrical interconnection of the metal pads to further metal pads, a power supply or the like, for example using soldering.

The elongate substrate 100 further carries an SSL arrangement comprising a
20 plurality of strings 130 of N serially connected SSL elements 101, which strings 130 are connected in parallel between the conductive line 110 and the further conductive line 120. In the context of the present application, N is a positive integer having a value of at least two and preferably having a value of at least five. For example, N may be five, six, seven, eight, nine, ten or more. In FIG. 1, the SSL arrangement further comprises a first
25 further string 140 of M serially connected SSL elements 101, in which M is a positive integer, with $M < N$. The first further string 140 is connected between the conductive line 110 and a first further metal pad 141 at a first end 105 of the elongate substrate 100. The SSL arrangement further comprises a second further string 150 of N-M serially connected
30 SSL elements 101 connected between a second further metal pad 151 and the further conductive line 120 at the other end 103 of the elongate substrate 100. Such an elongate substrate 100 will also be referred to as a Type B substrate in the present application. The

SSL elements 101 within a single SSL arrangement typically are of the same type, i.e. typically produce substantially identical luminous outputs in terms of luminous output intensity and spectral composition.

When interconnecting a pair of Type B elongate substrate 100 into a lighting string, the end portion 105 of a first Type B elongate substrate 100 will face the end portion 103 of a neighboring Type B elongate substrate 100. Such elongate substrates 100 are then interconnected by interconnecting, e.g. soldering, the metal pad 112 of the conductive line 110 on the first Type B elongate substrate 100 to the metal pad 111 of the corresponding conductive line 110 of the neighboring Type B elongate substrate 100 and by interconnecting e.g. soldering, the metal pad 122 of the further conductive line 120 on the first Type B elongate substrate 100 to the metal pad 121 of the corresponding further conductive line 120 of the neighboring Type B elongate substrate 100. Furthermore, the first further metal pad 141 of the first further string 140 on the first Type B elongate substrate 100 is interconnected, e.g. soldered, to the second further metal pad 151 of the second further string 150 on the neighboring Type B elongate substrate 100, thereby forming another string 130 of N serially connected SSL elements 101 that is distributed over the first Type B elongate substrate 100 and its neighboring Type B elongate substrate 100.

Consequently, the spacer or cutting regions 115 in between any neighboring strings 130 at which the elongate substrate 100 (e.g. when forming part of a lighting strip) may be cut as symbolically depicted by the dashed line terminating in pairs of scissors are kept free of interconnections between neighboring elongate substrates 100 as none of the strings 130 terminate in a location that coincides with the edge of an elongate substrate 100 due to the formation of a string 130 by interconnecting the first further string 140 and the second further string 150 across the respective boundaries of adjacent elongate substrates 100. Each of the strings 130 of N serially connected SSL elements 101 may be further connected to a further metal pad 114 of the conductive line 110 and a further metal pad 124 of the further conductive line 120 such that such a further metal pad is conductively connected to a junction between its conductive line and one end of such a string 130. The presence of such further metal pads 114, 124, which may be located in the spacer regions 115 in some embodiments, facilitates reconnection of a cut portion of the

- 14 -

elongate substrate 100, e.g. when forming part of a string or daisy chain of interconnected elongate substrates 100, e.g. a lighting strip or the like.

A Type B elongate substrate 100 may be used as an intermediate substrate within such a daisy-chained arrangement, e.g. a lighting strip according to embodiments of the present invention, which is why string portions 140, 150 are both present at the respective ends 105, 103 of the elongate substrate 100 such as to facilitate interconnection of a Type B elongate substrate 100 to another elongate substrate 100 according to embodiments of the present invention at both ends. However, where such an elongate substrate 100 is to be used as a terminal substrate of such a daisy chain of interconnected elongate substrates 100 (e.g. a lighting strip or the like), only one of its ends 103, 105 is to be connected to another elongate substrate 100 such that the other end is not required to contain a first further string 140 or a second further string 150 of the SSL arrangement.

FIG. 2 schematically depicts a circuit diagram of an elongate substrate 100 suitable for use as such a terminal substrate in which only the first further string 140 of the SSL arrangement is present at its end 105. Such an elongate substrate 100 will also be referred to as a Type A substrate in the present application. Consequently, the opposite end 103 of a Type A elongate substrate 100 does not comprise the second further string 150 and instead only comprises the metal pads 111, 121 for interconnecting the conductive line 110 and further conductive line 120 respectively, for example to a power supply or the like.

FIG. 3 schematically depicts a circuit diagram of an elongate substrate 100 suitable for use as such a terminal substrate in which only the second further string 150 of the SSL arrangement is present at its end 103. Such an elongate substrate 100 will also be referred to as a Type C substrate in the present application. Consequently, the opposite end 105 of a Type C elongate substrate 100 does not comprise the first further string 140 and instead only comprises the metal pads 112, 122 for interconnecting the conductive line 110 and further conductive line 120 respectively, for example to a power supply or the like.

At this point it is noted that each of the Type A, Type B and Type C elongate substrates 100 may comprise any suitable number of strings 130 of N serially connected SSL elements 101. Different types of elongate substrates 100 may comprise different

- 15 -

numbers of strings 130. Similarly, different instances of the same type of substrate 100, e.g. different instances of a Type B elongate substrate 100 may comprise different numbers of strings 130 although preferably different instances of the same type of elongate substrate 100 comprise the same numbers of strings 130 for the sake of manufacturing simplicity.

FIG. 4 schematically depicts a layout of a portion of an elongate substrate 100 according to an example embodiment. In this layout, which depicts a terminal section of such a substrate 100 including its end 105, it can be shown that the strings 130 of N serially connected SSL elements 101 extend in the elongation direction of the elongate substrate 100, with further metal pads 114, 124 positioned in the spacer sections 115 that may be used to cut the elongate substrate 100 in between adjacent strings 130, as symbolically indicated by the dashed lines terminating in opposing pairs of scissors. The SSL elements 101 may be mounted as separate chips onto exposed portions of the conductive line 110 and the further conductive line 120 respectively, e.g. as surface mounted devices using a conventional SMD mounting technique. At the end 105 of the elongate substrate 100 the first further string 140 of the SSL arrangement on the elongate substrate 100 is located in between a spacer section 115 and the metal pad 112 connected to the conductive line 110, the metal pad 122 connected to the further conductive line 120 and the first further metal pad 141 connected to the first further string 140, which metal pads are typically arranged at the edge of the elongate substrate 100 such as to facilitate interconnection of the elongate substrate 100 to another elongate substrate as previously explained. It is noted that although in preferred embodiments each of the strings 130, 140, 150 where present of an SSL arrangement extends in the elongation direction of the elongate substrate 100, it should be understood that alternative arrangements, such as arrangements in which a string of SSL elements 101 meanders between opposing conductive lines, and so on, may also be contemplated.

FIG. 5 schematically depicts a circuit diagram of a first end portion of a lighting strip 10 according to an embodiment of the present invention, in which a Type A elongate substrate 100 is interconnected to a Type B elongate substrate 100 at their facing ends. Specifically, the metal pad 112 of the Type A elongate substrate 100 is interconnected to the metal pad 111 of the Type B elongate substrate 100 by interconnection 12, e.g. a

- 16 -

solder bump or the like, thereby interconnecting the corresponding conductive lines 110 of the respective elongate substrates 100. The metal pad 122 of the Type A elongate substrate 100 is interconnected to the metal pad 121 of the Type B elongate substrate 100 by interconnection 14, e.g. a solder bump or the like, thereby interconnecting the corresponding further conductive lines 120 of the respective elongate substrates 100. The first further metal pad 141 of the Type A elongate substrate 100 is interconnected to the second further metal pad 151 of the Type B elongate substrate 100 by interconnection 16, e.g. a solder bump or the like, thereby interconnecting the first further string 140 on the Type A elongate substrate 100 to the second further string 150 on the Type B elongate substrate 100. As previously explained, the interconnection of the first further string 140 of M serially connected SSL elements 101 on the Type A elongate substrate 100 to the second further string 150 of N-M serially connected SSL elements 101 on the Type B elongate substrate 100 forms a string 130 of N series connected SSL elements 101 distributed across the two adjacent elongate substrates 100, which allows cutting of either elongate substrate 100 at the ends of the distributed string in the spacer or cutting regions 150 proximal to the boundary between these substrates on either of these substrates.

FIG. 6 schematically depicts a circuit diagram of a further end portion of a lighting strip 10 according to an embodiment of the present invention, in which a Type B elongate substrate 100 is interconnected to a Type C elongate substrate 100 at their facing ends. Specifically, the metal pad 112 of the Type B elongate substrate 100 is interconnected to the metal pad 111 of the Type C elongate substrate 100 by interconnection 12, e.g. a solder bump or the like, thereby interconnecting the corresponding conductive lines 110 of the respective elongate substrates 100. The metal pad 122 of the Type B elongate substrate 100 is interconnected to the metal pad 121 of the Type C elongate substrate 100 by interconnection 14, e.g. a solder bump or the like, thereby interconnecting the corresponding further conductive lines 120 of the respective elongate substrates 100. The first further metal pad 141 of the Type B elongate substrate 100 is interconnected to the second further metal pad 151 of the Type C elongate substrate 100 by interconnection 16, e.g. a solder bump or the like, thereby interconnecting the first further string 140 on the Type B elongate substrate 100 to the second further string 150 on the Type C elongate substrate 100. As previously explained,

- 17 -

the interconnection of the first further string 140 of M serially connected SSL elements 101 on the Type B elongate substrate 100 to the second further string 150 of N-M serially connected SSL elements 101 on the Type C elongate substrate 100 forms a string 130 of N series connected SSL elements 101 distributed across the two adjacent elongate
5 substrates 100, which allows cutting of either elongate substrate 100 at the ends of the distributed string in the spacer or cutting regions 150 proximal to the boundary between these substrates on either of these substrates.

In the same manner, two adjacent Type B elongate substrates 100 may be interconnected at their facing ends, i.e. the metal pad 112 of the Type B elongate
10 substrate 100 is interconnected to the metal pad 111 of the adjacent Type B elongate substrate 100 by interconnection 12, e.g. a solder bump or the like, thereby interconnecting the corresponding conductive lines 110 of the respective elongate substrates 100. The metal pad 122 of the Type B elongate substrate 100 is interconnected to the metal pad 121 of the adjacent Type B elongate substrate 100 by interconnection 14,
15 e.g. a solder bump or the like, thereby interconnecting the corresponding further conductive lines 120 of the respective elongate substrates 100. The first further metal pad 141 of the Type B elongate substrate 100 is interconnected to the second further metal pad 151 of the adjacent Type B elongate substrate 100 by interconnection 16, e.g. a solder bump or the like, thereby interconnecting the first further string 140 on the Type B
20 elongate substrate 100 to the second further string 150 on the adjacent Type B elongate substrate 100 in order to form the distributed string 130.

A lighting strip 10 assembled in this manner may take the form $A-[B]_n-C$, which depicts a daisy chain of interconnected elongate substrates of Types A, B and C, in which n is a positive integer, typically a positive integer having a value of at least five,
25 preferably of at least eight and more preferably of at least ten. This therefore requires the provision of three different types of elongate substrates 100, e.g. three different types of (flexible) PCBs. The provision of elongate substrates 100 for use in such an assembly process may be simplified by the provision of divisible elongate substrates comprising a type A elongate substrate portion and a type C elongate substrate portion, such that only
30 two types of different elongate substrates (A+C and B) need to be provided, as the Types A and C elongate substrates 100 may be produced by dividing the divisible Type A+C

- 18 -

elongate substrate. Such a divisible Type A+C elongate substrate typically resembles a Type B elongate substrate 100 in that opposing ends of this substrate comprise the first further string 140 and second further string 150 respectively, with a cutting region provided in between the Type A and Type C substrate portions, with each of these portions comprising the metal pads 111, 121 and 112, 122 respectively proximal (adjacent) to this cutting region.

Alternatively, a lighting strip 10 assembled in accordance with the teachings of the present invention may take the shape [B]_n, i.e. the presence of Type A and C elongate substrates 100 and the opposite ends of the lighting strip 10 may be omitted. As will be understood by the skilled person, in such a scenario the first further string 140 at a first end of the lighting strip 10 and the second further string 150 at the opposite end of the lighting strip 10 will not be used (i.e. are defunct). Preferably, the first further string 140 at a first end of the lighting strip 10 and the second further string 150 at the opposite end of the lighting strip 10 are left unpopulated, i.e. no SSL elements 101 are mounted on these strings of the respective Type B elongate substrates 100 to be positioned at the opposite ends of the lighting strip 10, as such SSL elements 101 would remain unconnected such that their presence would unnecessarily add to the manufacturing cost of such Type B elongate substrates 100 and of a lighting strip 10 including such substrates.

FIG. 7 schematically depicts a layout of a portion of a lighting strip 10 according to an example embodiment in which adjacent elongate substrates 100 are interconnected through previously described interconnections 12, 14 and 16, thereby forming a string 130 of N serially connected SSL elements 101 that is distributed across the adjacent elongate substrates 100. Because the interconnections 12, 14 and 16 are situated within this distributed string 130, the lighting strip 10 may be cut at either side of this distributed string 130 in respective spacer or cutting regions 115. In this manner, a lighting strip 10 is provided that may be cut in between any adjacent pair of strings 130 of N serially connected SSL elements 101 such that the lighting strip 10 may be cut to any desirable length. This improves the user flexibility of such a lighting strip 10 compared to prior art lighting strips in which the interconnections 12 and 14 were typically located in between an adjacent pair of strings 130 of N serially connected SSL elements 101 on adjacent

- 19 -

elongate substrates 100, such that the spacer or cutting region 115 in such an arrangement would coincide with the interconnections 12 and 14 as previously explained. The spacer sections 115 typically are spaced apart in such a lighting strip 10 at regular intervals, such as for example 5 cm or 10 cm intervals. The total length of a lighting strip 10 according to embodiments of the present invention is not particularly limited as the lighting strip 10 may adopt any suitable length, e.g. 5m, 50m or longer.

Embodiments of the present invention are not limited to elongate substrates 100 and lighting strips 10 comprising such elongate substrates that comprise a single SSL arrangement only. For example, FIG. 8 is a circuit diagram of a Type B elongate substrate 100, FIG. 9 is a circuit diagram of a Type A elongate substrate 100 and FIG. 10 is a circuit diagram of a Type C elongate substrate 100, in which the elongate substrates 100 comprise a first SSL arrangement 50 having a first type of SSL elements 101, e.g. SSL elements producing light having a first spectral composition, and a second SSL arrangement 50' having a second type of SSL elements 101', e.g. SSL elements producing light having a second spectral composition that is different to the first spectral composition, such as light of different colours or white light having different colour temperatures. In such an arrangement, each SSL arrangement 50, 50' is connected between a dedicated conductive line 110, 110' arranged to have a first polarity and a common further conductive line 120 arranged to have a polarity opposite to the first polarity.

Each of the conductive lines is connected at opposing ends to the dedicated metal pads, i.e. conductive line 110 is connected between metal pads 111 and 112, conductive line 110' is connected between metal pads 111' and 112' and conductive line 120 is connected between metal pads 121 and 122 such that the respective conductive lines can be interconnected to a corresponding conductive line on an adjacent elongate substrate when assembling the lighting strip 10 comprising such substrates as previously explained. In other words, during such an assembly the metal pad 112 of the conductive line 110 of a first elongate substrate 100 is interconnected to the metal pad 111 of the conductive line 110 on an adjacent elongate substrate, the metal pad 112' of the conductive line 110' of the first elongate substrate 100 is interconnected to the metal pad 111' of the conductive line 110' on the adjacent elongate substrate, and the metal pad 122 of the further

- 20 -

conductive line 120 of the first elongate substrate 100 is interconnected to the metal pad 121 of the conductive line 110 on the adjacent elongate substrate. Similarly, the first further metal pads 141, 141' of the first further strings 140, 140' of the SSL arrangements 50, 50' on the first elongate substrate 100 are interconnected to the corresponding second further metal pads 151, 151' of the second further strings 150, 150' of the SSL arrangements 50, 50' on the first elongate substrate 100, i.e. the first further metal pad 141 on the first elongate substrate 100 is interconnected to the second further metal pad 151 on the adjacent elongate substrate and the first further metal pad 141' on the first elongate substrate 100 is interconnected to the second further metal pad 151' on the adjacent elongate substrate.

Each conductive line at its junction with a string 130, 130' of N serially connected SSL elements 101, 101' may comprise a further metal pad to facilitate the reconnection of a cut section of the elongate substrate 100 e.g. when forming part of a lighting strip 10 as previously explained. For example, a string 130 may be connected between a first conductive line 110 arranged to have the first polarity and the further conductive line 120 to which further metal pads 114, 124 are respectively connected and a string 130' may be connected between a second conductive line 110' arranged to have the first polarity and the further conductive line 120, to which further metal pads 114', 124 are respectively connected. By provision of dedicated conductive lines 110, 110' arranged to have the first polarity to each of the SSL arrangements 50, 50', each SSL arrangement may be individually addressed such that the respective SSL elements 101 and 101' of these SSL arrangements 50 and 50' may be operated independently from each other, thereby providing a lighting strip 10 that is configurable in terms of its luminous output.

FIG. 11 schematically depicts an example layout of part of an elongate substrate 100 comprising multiple (here two) SSL arrangements 50, 50'. In this example embodiment, the first SSL arrangement 50 comprising the strings 130 of N serially connected SSL elements 101 and a further string 140 of M serially connected SSL elements 101 and the further SSL arrangement 50' comprising the strings 130' of N serially connected SSL elements 101' and a further string 140' of M serially connected SSL elements 101' are located on a first major surface 103 of the elongate substrate 100 together with the conductive lines 110, 110' and the metal pads 112, 112', 122, 141, 141'

on the edge or end 105 of the elongate substrate 100. The further conductive line 120 is positioned on the major surface of the elongate substrate 100 that opposes the first major surface 103. In order to connect the respective SSL elements 101, 101' to the further conductive line 120, conductive structures such as vias may extend through the elongate substrate 101 in order to provide such interconnections. The positioning of all the metal pads on one of the major surfaces of the elongate substrate 100 has the advantage that interconnection of the elongate substrate 100 to for example an adjacent elongate substrate as previously explained is easily achieved, whereas the positioning of the further conductive line 120 on the opposite major surface frees up space on the first major surface 103 for the positioning of multiple individually controllable SSL arrangements 50, 50' thereon.

As can be seen from FIG. 11, the strings 130, 130' of the respective SSL arrangements 50, 50' on the first major surface 103 of the elongate substrate 100 are typically aligned in the elongation direction of the elongate substrate 100 such that the spacer or cutting regions 115 extend across the full width of the elongate substrate 100. The respective metal pads 114, 114' and 124 may be located within such a spacer or cutting regions 150 to facilitate the reconnection of a cut section of the elongate substrate 100, e.g. when forming part of a lighting strip 10, to another elongate substrate, a power supply, and so on, e.g. using a wire to substrate (PCB) interconnector or the like.

For example, FIG. 12 is a circuit diagram of a Type B elongate substrate 100, FIG. 13 is a circuit diagram of a Type A elongate substrate 100 and FIG. 14 is a circuit diagram of a Type C elongate substrate 100, in which the elongate substrates 100 comprise a first SSL arrangement 50 having strings 130, 140, 150 comprising a first type of SSL elements 101, e.g. SSL elements producing light having a first spectral composition, a second SSL arrangement 50' having strings 130', 140', 150' comprising a second type of SSL elements 101', e.g. SSL elements producing light having a second spectral composition that is different to the first spectral composition, and a third SSL arrangement 50'' having strings 130'', 140'', 150'' comprising a third type of SSL elements 101'', e.g. SSL elements producing light having a third spectral composition that is different to the first and second spectral compositions. The light having different spectral compositions may be light of different colours and/or white light having different

- 22 -

colour temperatures. As before, each SSL arrangement 50, 50', 50'' is connected between its dedicated conductive line 110, 110', 110'' arranged to have a first polarity and a common further conductive line 120 arranged to have a polarity opposite to the first polarity such that the respective SSL arrangements may be individually controlled. In this manner, an elongate substrate 100 and a lighting strip 10 assembled of a plurality of such elongate substrates 100 as explained in more detail above may comprise any suitable number of SSL arrangements thereon, such as for example a first SSL arrangement comprising white light SSL elements and three further SSL arrangements comprising red, green and blue light producing SSL elements are respectively. In addition, a further SSL arrangement comprising white light SSL elements may be present, thereby providing a pair of SSL arrangements comprising white light SSL elements producing white light of different colour temperatures, e.g. cool white light and warm white light respectively. This may yield a lighting strip comprising such a pair of white light producing SSL arrangements and three such further SSL arrangements producing differently coloured light, in which each SSL arrangement may be individually addressed through respective dedicated conductive lines as explained above. Many other variations will be immediately apparent to the skilled person.

A layout of a portion of an elongate substrate 100 comprising three individually controllable SSL arrangements on a first major surface is schematically depicted in FIG. 15. The first SSL arrangement comprises SSL elements 101 and is connected between a first conductive line 110 on the first major surface and a common further conductive line 120 on the opposing major surface. The first conductive line 110 extends between metal pads 111 and 112 on the first major surface at opposite ends of the elongate substrate as previously explained. Metal pads 114 may be present in the spacer regions between serially connected strings of N SSL elements to allow for reconnection of such strings following the cutting of the elongate substrate in such a region as explained in more detail above. The second SSL arrangement comprises SSL elements 101' and is connected between a second conductive line 110' on the first major surface and the common further conductive line 120 on the opposing major surface. The second conductive line 110' extends between metal pads 111' and 112' on the first major surface at opposite ends of the elongate substrate as previously explained. Metal pads 114' may be present in the

- 23 -

spacer regions between serially connected strings of N SSL elements to allow for reconnection of such strings following the cutting of the elongate substrate in such a region as explained in more detail above. The third SSL arrangement comprises SSL elements 101'' and is connected between a third conductive line 110'' on the first major surface and the common further conductive line 120 on the opposing major surface. The third conductive line 110'' extends between metal pads 111'' and 112'' on the first major surface at opposite ends of the elongate substrate as previously explained. Metal pads 114'' may be present in the spacer regions between serially connected strings of N SSL elements to allow for reconnection of such strings following the cutting of the elongate substrate in such a region as explained in more detail above.

As previously explained, the respective SSL arrangements may be individually controlled through the respective dedicated conductive lines to which they are connected, i.e. the first conductive line 110, the second conductive line 110' and the third conductive line 110'' respectively. Further dedicated conductive lines may be added to the first major surface to which further SSL arrangements may be connected. In this manner, the first major surface may carry any suitable number of individually controllable SSL arrangements as previously explained. This may be facilitated by increasing the width of the elongate substrate 100 if necessary.

As previously explained, the connection of the SSL elements on the first major surface to the further conductive line on the opposing major surface may be provided by connections such as vias that extend through the elongate substrate 100. Preferably also on the first major surface are the respective metal pads of the conductive lines 110, 110' and 110'' as well as of the common further conductive line 120, i.e. metal pads 111, 111', 111'', 112, 112' and 112'' as well as metal pads 121 and 122. The metal pads of the truncated string portions, i.e. the first further string of M serially connected SSL elements and/or the second further string of N-M serially connected SSL elements, here metal pads 141, 141' and 141'', preferably are also on the first major surface. By having all metal pads on the same major surface, interconnection of adjacent elongate substrates 100 such as in a lighting strip 10 is particularly straightforward.

The embodiments of the present invention may be used with any suitable layout of SSL elements on the elongate substrates, such as any suitable pitch of SSL elements,

- 24 -

e.g. a pitch of 10 mm or below. Of course, a pitch in excess of 10 mm may also be contemplated. However, for a pitch in excess of 10 mm, an alternative solution (not part of the present invention) may be contemplated instead. An example layout of this alternative solution is schematically depicted in FIG. 16, which depicts a portion of a lighting strip 10 in which two adjacent elongate substrates 100 are soldered together by a first solder joint 12 interconnecting the respective metal pads 111, 112 of the first conductive line 110 and by a further solder joint 14 interconnecting the respective metal pads 121, 122 of the further conductive line 120. As before, the SSL elements 101 on each elongate substrate 100 are arranged in a plurality of strings 130, each comprising N serially connected SSL elements 101. The pitch P between the SSL elements 101, which preferably are spaced apart equidistantly, is larger than 10 mm. As before, spacer or cutting regions 115 are located in between neighboring strings 130, in which metal pads 114, 124 for reconnecting the first conductive line 110 and the further conductive line 120 respectively may be present.

However, due to the relatively large pitch P, an additional spacer region 115 may be located in between the string 130 that is immediately adjacent or proximal to an end or edge of each elongate substrate 100 and the metal pads 111, 121 or 112, 122 at this edge. In FIG. 16, this spacer region 115 is located in between the metal pads 111, 121 and the first string 130 of the right-hand elongate substrate 100 by way of non-limiting example only; it is equally feasible to locate this spacer region in between the metal pads 112, 122 and the last string 130 of the adjacent elongate substrate 100.

In order to ensure that the pitch P of the SSL elements 101 is maintained across the interconnected adjacent elongate substrates 100, the metal pads on the elongate substrate 100 adjacent to the elongate substrate comprising this spacer region 115 near its edge (here metal pads 111, 121 by way of non-limiting example only) may be located nearer to the terminal SSL element 101 of the final string 130 on this adjacent elongate substrate 100, i.e. the SSL element 101 proximal to its edge. Hence, in this embodiment each string 130 is entirely located on a single elongate substrate 100, i.e. no strings 130 extend across adjacent elongate substrates 100 whilst maintaining a constant pitch P of SSL elements 101 across a lighting strip 10 and providing spacer or cutting regions 115 at regular intervals across the entire lighting strip 10. This obviates the need for an

- 25 -

additional interconnection to interconnect the M SSL elements and N-M SSL elements portions of such a distributed string 130, such that this embodiment is characterized by having fewer interconnections between interconnected adjacent elongate substrates 100 compared to the above described embodiments of the present invention (i.e. interconnection 16 is not present for example).

When interconnecting such adjacent elongate substrates 100, e.g. by soldering the metal pads 111 to the metal pads 112, thereby forming solder bump 12 and by soldering the metal pads 121 to the metal pads 122, thereby forming solder bump 14, care has to be taken that the solder does not flow into the adjacent spacer region 115 intended for cutting, as such solder will make this region harder to cut, which is undesirable. To prevent this, the metal pads adjacent to this spacer region 115, here metal pads 111, 121 by way of non-limiting example, are separated from this spacer region by a barrier structure 20, e.g. a dam structure or a similarly raised structure, which prevents the solder applied to the metal pads from flowing from the metal pads to the adjacent spacer region 115. Such a barrier structure may be a discrete structure located in between the metal pads 111, 121 and the adjacent spacer region 115 or alternatively may be an unexposed region of the metal pads 111, 121 proximal to this spacer region. In other words, when forming the metal pads 111, 121 by removing a covering material therefrom, only part of this covering material may be removed such that the remaining covering material forms the barrier structure 20. This has the further advantage that the area of the metal pads 111, 121 is kept small, which makes it feasible to selectively plate such pads with gold, in order to improve the reliability of the interconnection between the elongate substrates 100.

Finally, it is noted for the avoidance of doubt that the spacer regions 115 in the aforementioned embodiments (both forming part and not forming part of the present invention) symbolically depict two cut lines on either side of such a spacer region merely to indicate that such spacer regions 115 may be cut on either side. This should not be construed as meaning or implying that two cuts have to be made. However, because such spacer regions 115 may be cut on either side, it is possible to re-cut such a spacer region, e.g. after a first cut and subsequent reconnection of the elongate substrate 100 comprising the spacer region.

- 26 -

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim.

- 5 The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention can be implemented by means of hardware comprising several distinct elements. In the device claim enumerating several means, several of these means can be embodied by one and the same item of hardware.
- 10 The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

- 27 -

CLAIMS

1. An elongate substrate (100) having opposing ends (103, 105) in its elongation direction and comprising:

5 a conductive line arrangement including a conductive line (110, 110', 110'') arranged to have a first polarity;

a further conductive line (120) arranged to have an opposite polarity to the first polarity spatially separated from said conductive line, each of the conductive line and the further conductive line extending between the opposing ends and terminating in
10 respective metal pads (111, 111'; 112, 112'; 121, 122) at each of the opposing ends; and

at least one solid state lighting arrangement (50, 50', 50'') comprising:

a plurality of strings (130, 130', 130'') of N serially connected solid state elements (101, 101', 101'') in which N is a positive integer, said strings being connected in parallel to the conductive line and the further conductive line, and being separated from each
15 other by spacer sections (115); and at least one of:

a string (140, 140', 140'') of M serially connected solid state elements in which M is a positive integer and $M < N$, said string being proximal to one (105) of said opposing ends and connected between the conductive line and a first further metal pad (141, 141') at said one of said opposing ends; and

20 a string (150, 150', 150'') of N-M serially connected solid state elements, said string being proximal to the other (103) of said opposing ends and connected between the further conductive line and a second further metal pad (151, 151') at said other of said opposing ends;

wherein, when the elongate substrate (100) is interconnected with another
25 elongate substrate (100) with a complementary string of N-M serially connected solid state elements and / or a complementary string of M serially connected solid state elements, the one of the string of M serially connected solid state elements and the string of N-M serially connected solid state elements on the elongate substrate connects with a corresponding one of the complementary string of N-M serially connected solid state
30 elements and the complementary string of M serially connected solid state elements on

- 28 -

the another elongate substrate, to form a string of N serially connected solid state elements across the adjacent elongate substrates;

wherein said string of N serially connected solid state elements, across the adjacent elongate substrates, is identical in electrical and optical performance with each
5 of the plurality of strings of N serially connected solid state elements.

2. The elongate substrate (100) of claim 1, wherein the at least one solid state lighting arrangement (50, 50', 50'') comprises the string (140, 140', 140'') of M serially connected solid state elements and the string (150, 150', 150'') of N-M serially connected
10 solid state elements.

3. The elongate substrate (100) of claim 1 or 2, wherein each of said strings (130, 130', 130'') of N serially connected solid state elements extends in the elongation direction of the elongate substrate.
15

4. The elongate substrate (100) of any of claims 1-3, wherein the elongate substrate is flexible.

5. The elongate substrate (100) of any of claims 1-4, wherein each solid state
20 element (101, 101', 101'') is provided as a separate chip mounted on the elongate substrate.

6. The elongate substrate (100) of any of claims 1-5, wherein the conductive line arrangement comprises a pair of said conductive lines (110, 110') arranged to have said
25 first polarity and a pair of said solid state lighting arrangements (50, 50') including first and second solid state lighting arrangements, wherein the respective strings (130, 140) of the first solid state lighting arrangement (50) where connected to a conductive line arranged to have said first polarity are connected to one (110) of said pair of conductive lines arranged to have said first polarity and the respective strings (130', 140') of the
30 second solid state lighting arrangement (50') where connected to a conductive line

- 29 -

arranged to have said first polarity are connected to the other (110') of said pair of conductive lines arranged to have said first polarity.

7. The elongate substrate (100) of claim 6, further comprising a first major surface (103) and a second major surface opposing the first major surface, wherein the pair of conductive lines (110, 110') arranged to have said first polarity and the pair of solid state lighting arrangements (50, 50') are located on the first major surface, and the further conductive line (120) is located on the second major surface.

8. The elongate substrate (100) of claim 7, wherein the conductive line arrangement comprises a third conductive line (110'') arranged to have said first polarity, the elongate substrate further comprising a further solid state lighting arrangement (50''), wherein the respective strings (130'', 140'') of the further solid state lighting arrangement where connected to a conductive line arranged to have said first polarity are connected to the third conductive line.

9. The elongate substrate (100) of any of claims 1-8, wherein each of the conductive lines (110, 110', 110'') arranged to have said first polarity and the further conductive line (120) comprises a plurality of further metal pads (114, 114', 124), wherein each of said further metal pads is conductively connected to a junction between said conductive line and one end of a plurality of strings (130, 130', 130'') of N serially connected solid state elements (101, 101', 101'') connected to said conductive line.

10. The elongate substrate (100) of claim 9, wherein said further metal pads (114, 114', 124) are located in said spacer sections (115).

11. A lighting strip (10) comprising a plurality of elongate substrates (100) according to any of claims 1-10, wherein respective substrates are interconnected by a pair of interconnections (12, 14) interconnecting the metal pads (111, 112; 111', 112'; 121, 122) of corresponding conductive and further conductive lines (110, 110', 110''; 120) at facing ends (103, 105) of adjacent elongate substrates, and a further interconnection (16)

- 30 -

interconnecting the first further metal pad (141, 141') of each solid state lighting arrangement (50, 50', 50'') on one of the adjacent elongate substrates to the second further metal pad (151, 151') of a corresponding solid state lighting arrangement on the other of the adjacent elongate substrates at said facing ends;

5 wherein, said string of N serially connected solid state elements, across the adjacent elongate substrates, is identical in dimension in the elongation direction of the elongate substrates with each of the plurality of strings of N serially connected solid state elements.

10 12. The lighting strip (10) of claim 11, further comprising a pair of terminal elongate substrates (100) at opposing ends of the lighting strip, said pair of terminal elongate substrates comprising:

 a first terminal elongate substrate not comprising a string (140, 140', 140'') of M serially connected solid state elements such that the terminal end of the first terminal
15 elongate substrate only comprises the metal pads (111, 111'; 121) of said conductive and further conductive lines (110, 110', 110''; 120); and

 a second terminal elongate substrate not comprising a string (150, 150', 150'') of N-M serially connected solid state elements such that the terminal end of the second terminal elongate substrate only comprises the metal pads (112, 112'; 122) of said
20 conductive and further conductive lines.

13. A method of manufacturing a lighting strip (10) of claim 11 or 12, the method comprising interconnecting a plurality of elongate substrates (100) according to any of claims 1-10, wherein respective substrates are interconnected by a pair of
25 interconnections (12, 14) interconnecting the metal pads (111, 112; 111', 112'; 121, 122) of corresponding conductive and further conductive lines (110, 110', 110''; 120) at facing ends of adjacent elongate substrates and a further interconnection (16) interconnecting the first further metal pad (141, 141') of each solid state lighting arrangement (50, 50', 50'') on one of the adjacent elongate substrates to the second further metal pad (151) of a
30 corresponding solid state lighting arrangement on the other of the adjacent elongate substrates at said facing ends.

- 31 -

14. The method of claim 13, further comprising terminating opposing ends of the lighting strip (10) with a pair of terminal elongate substrates (100) comprising:

5 a first terminal elongate substrate not comprising a string (140, 140', 140'') of M serially connected solid state elements such that the terminal end (103) of the first terminal elongate substrate only comprises the metal pads (111, 111'; 121) of the conductive and further conductive lines (110, 110', 110''; 120); and

10 a second terminal elongate substrate not comprising a string (150, 150', 150'') of N-M serially connected solid state elements such that the terminal end (105) of the second terminal elongate substrate only comprises the metal pads (112, 112'; 122) of the conductive and further conductive lines (110, 110', 110''; 120);

15 interconnecting the respective metal pads of said conductive lines of the first terminal elongate substrate to the respective metal pads of the corresponding conductive lines of its adjacent elongate substrate at facing ends of said substrates and interconnecting the one or more second further metal pads of the first terminal elongate substrate to corresponding first further metal pads of its adjacent elongate substrate at said facing ends; and

20 interconnecting the respective metal pads of said conductive lines of the second terminal elongate substrate to the corresponding metal pads of the conductive lines of its adjacent elongate substrate at facing ends of said substrates and interconnecting the one or more first further metal pads of the second terminal elongate substrate to corresponding second further metal pads of its adjacent elongate substrate at said facing ends.

25 15. The method of claim 13 or 14, wherein said interconnecting comprises soldering.

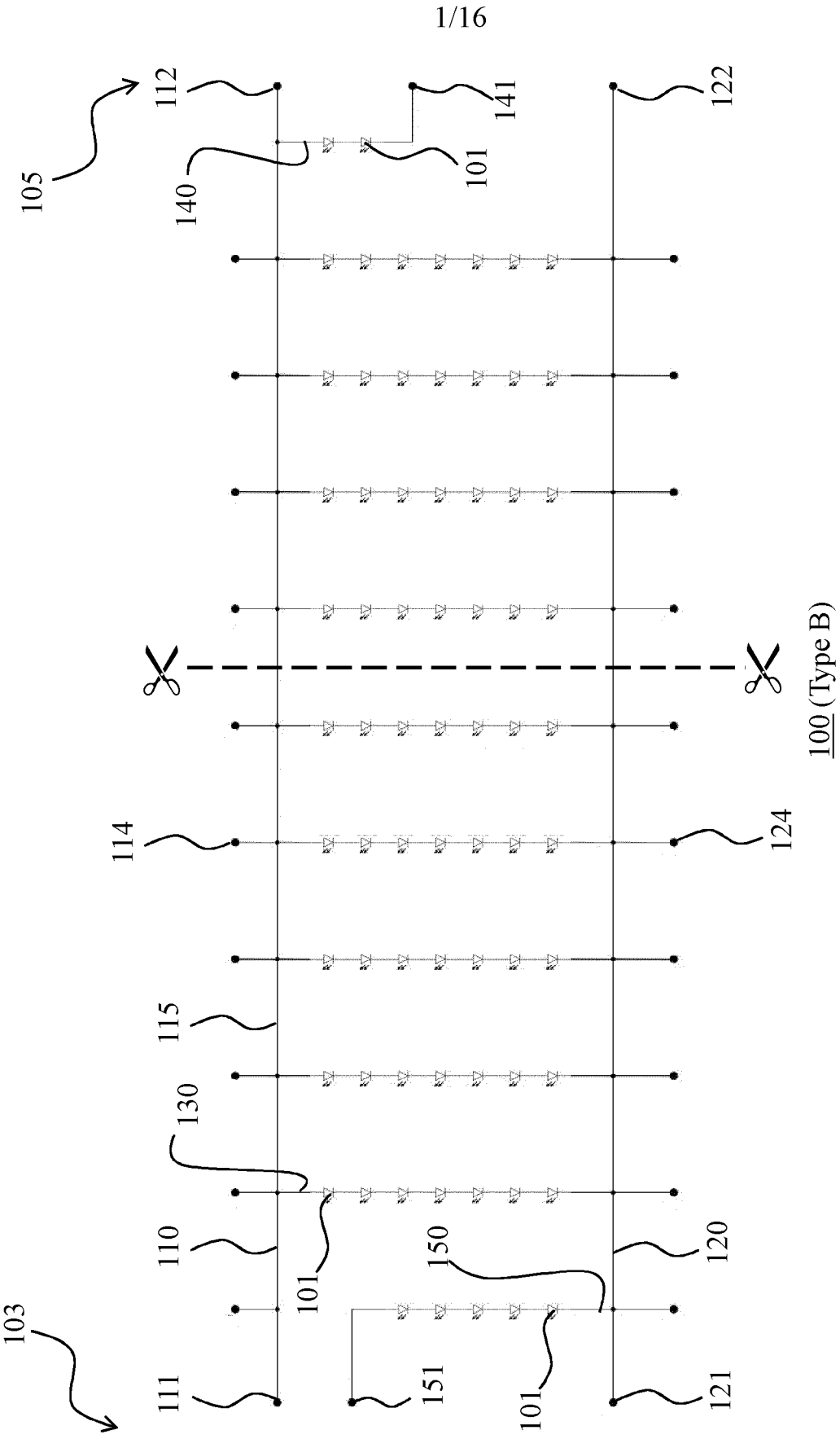


FIG. 1

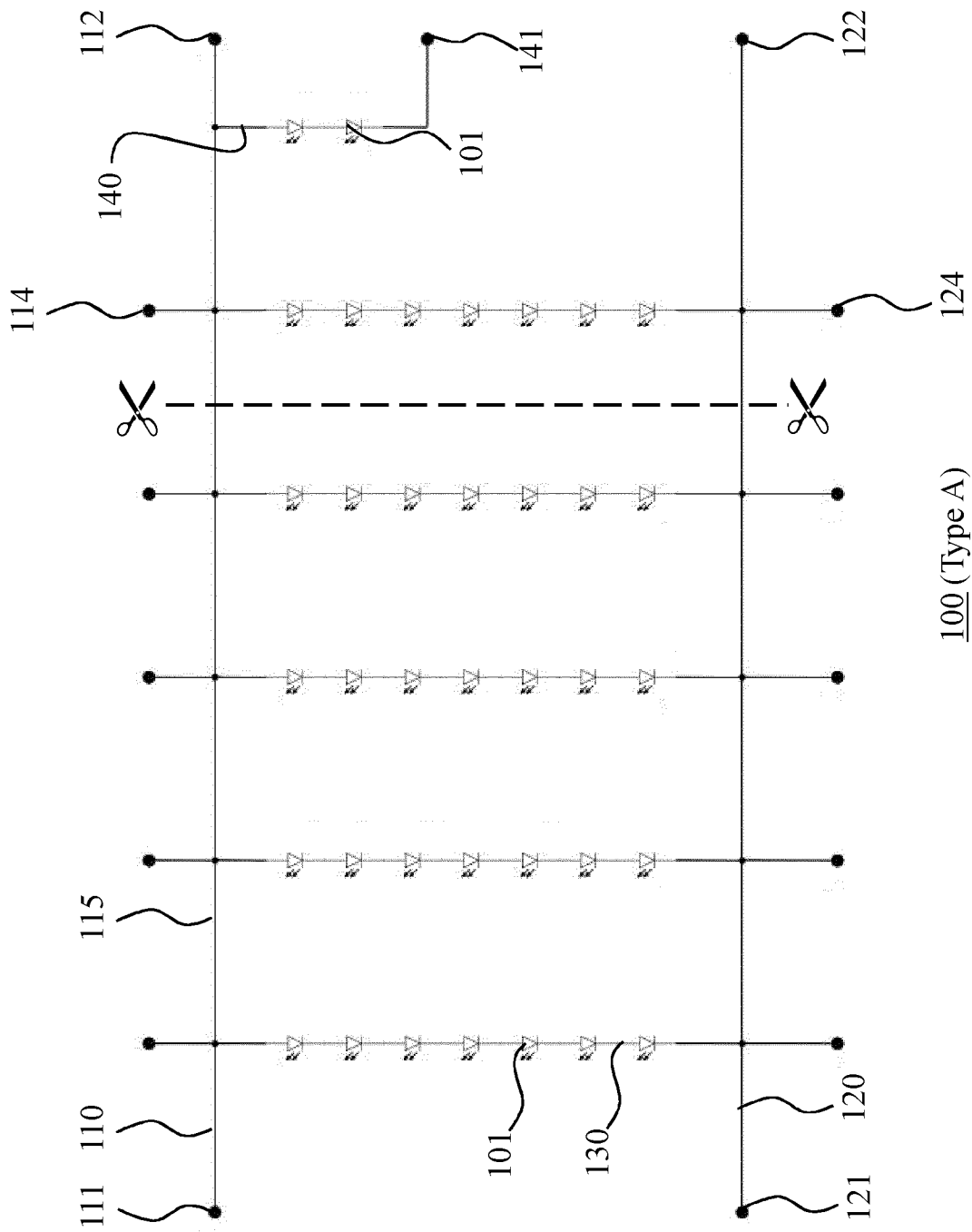
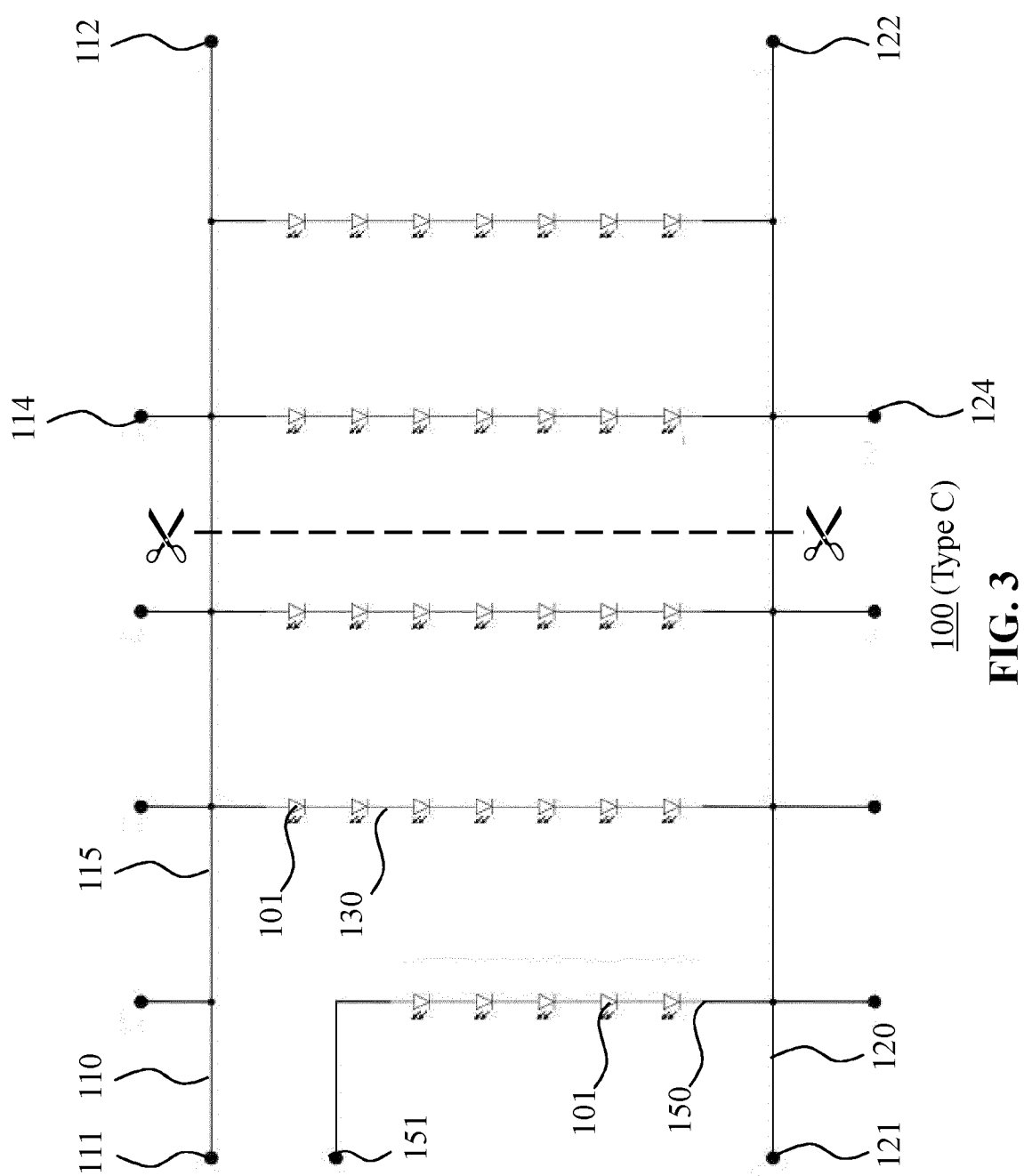
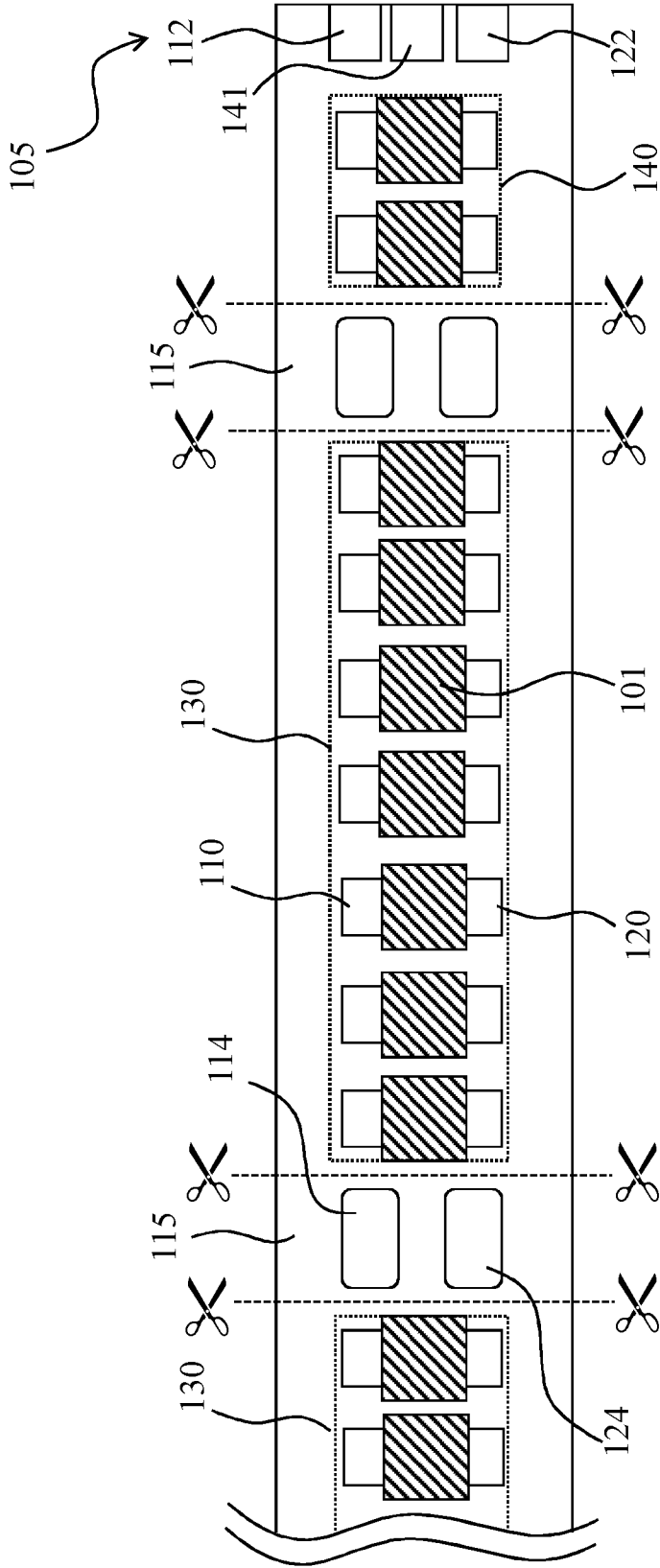
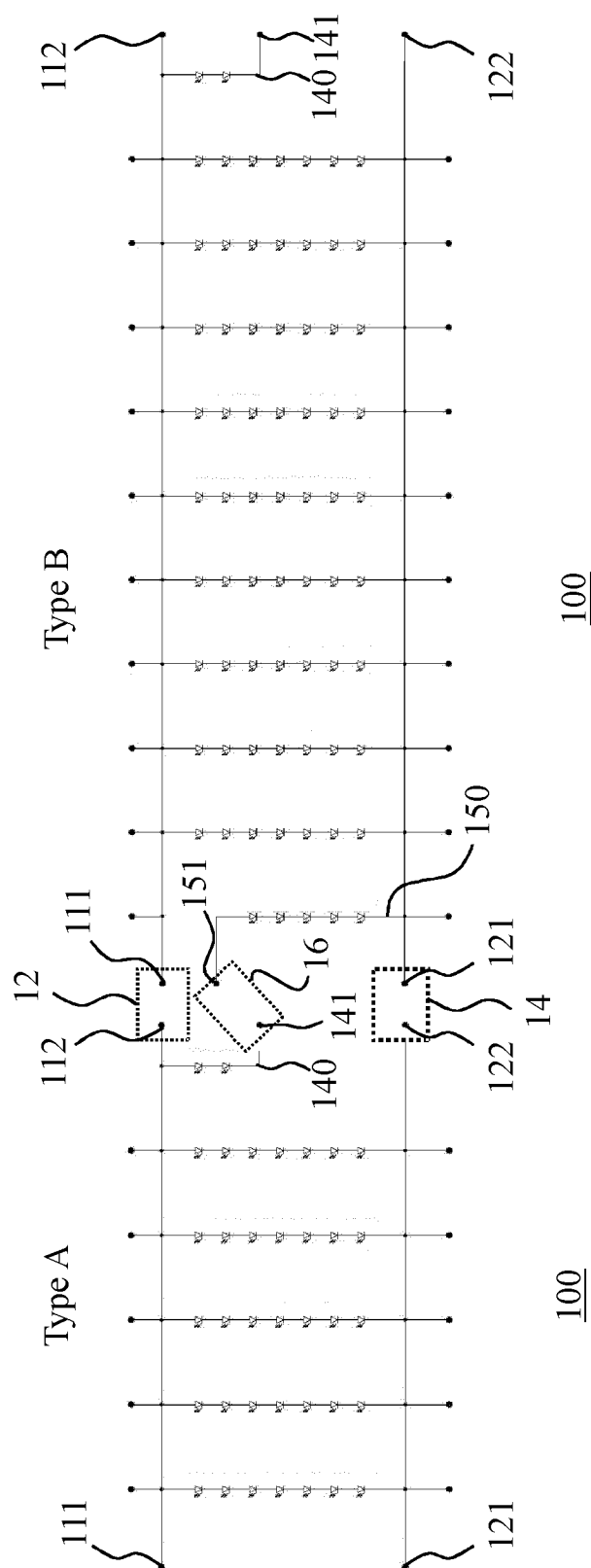


FIG. 2



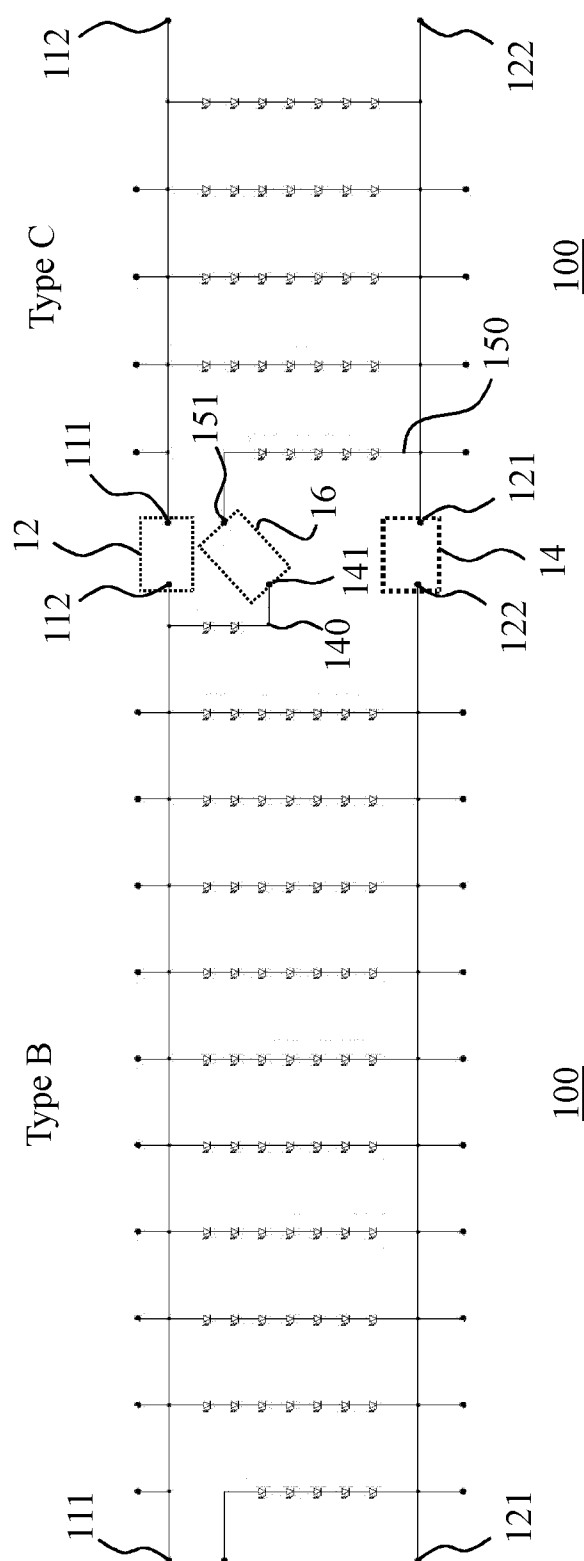


100
FIG. 4



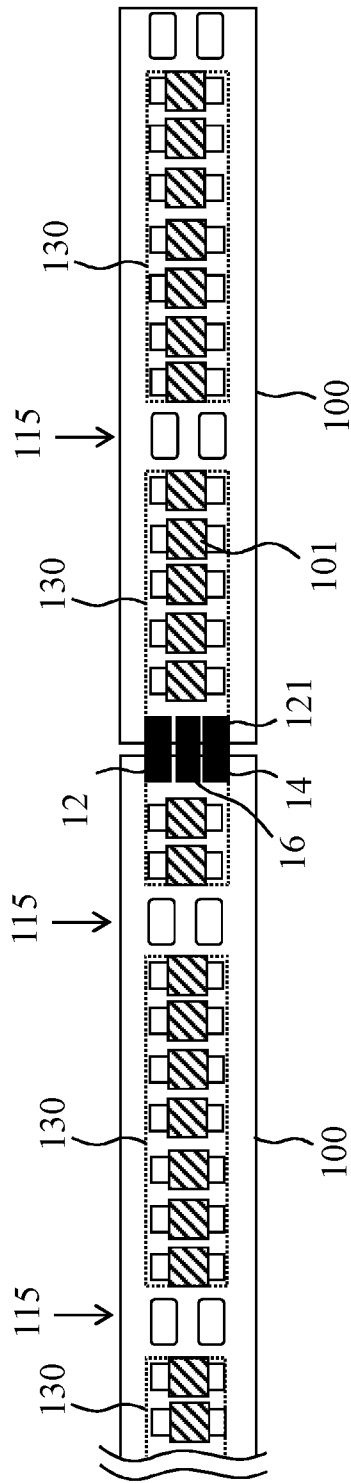
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FIG. 5



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FIG. 6



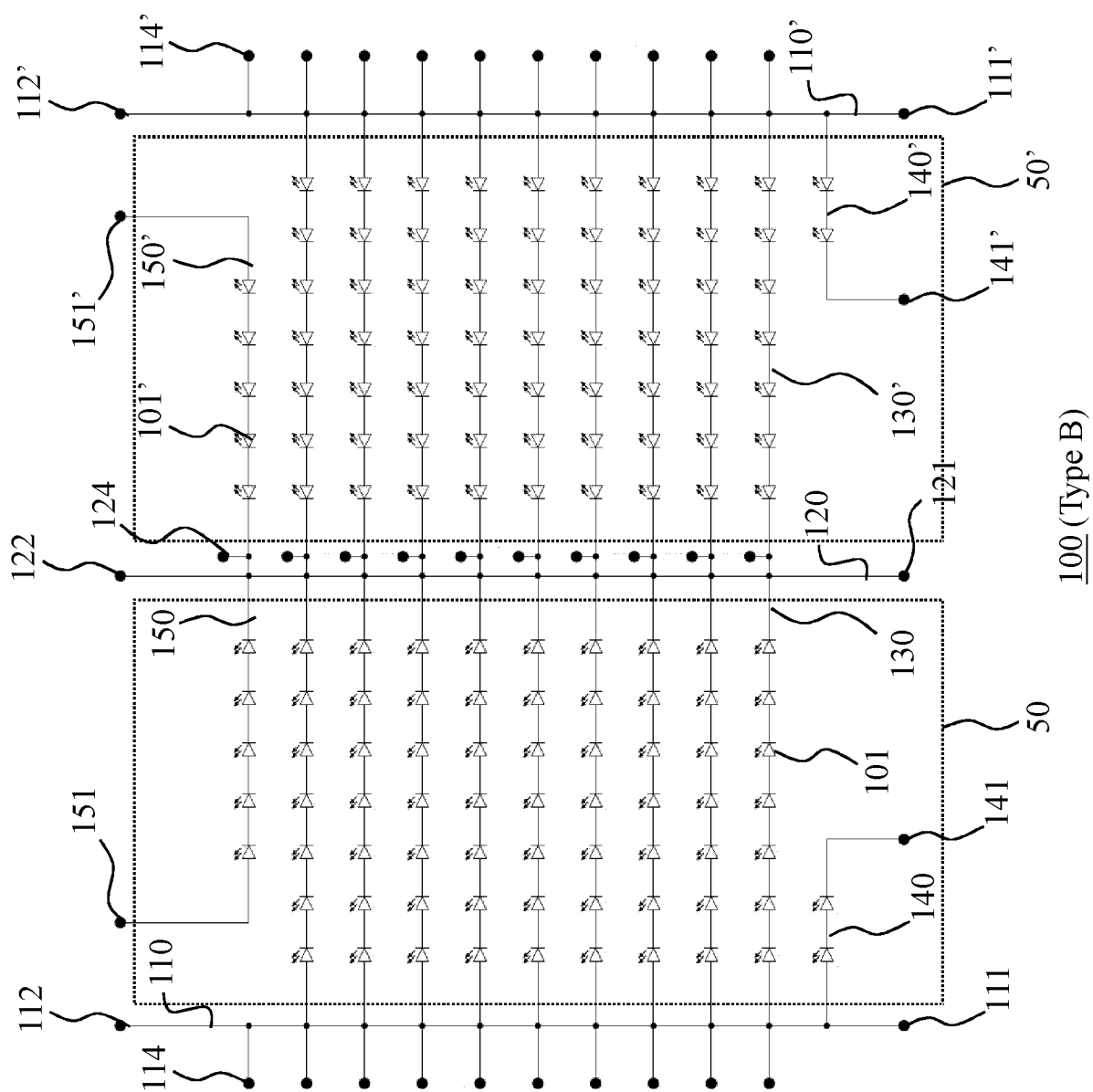


FIG. 8

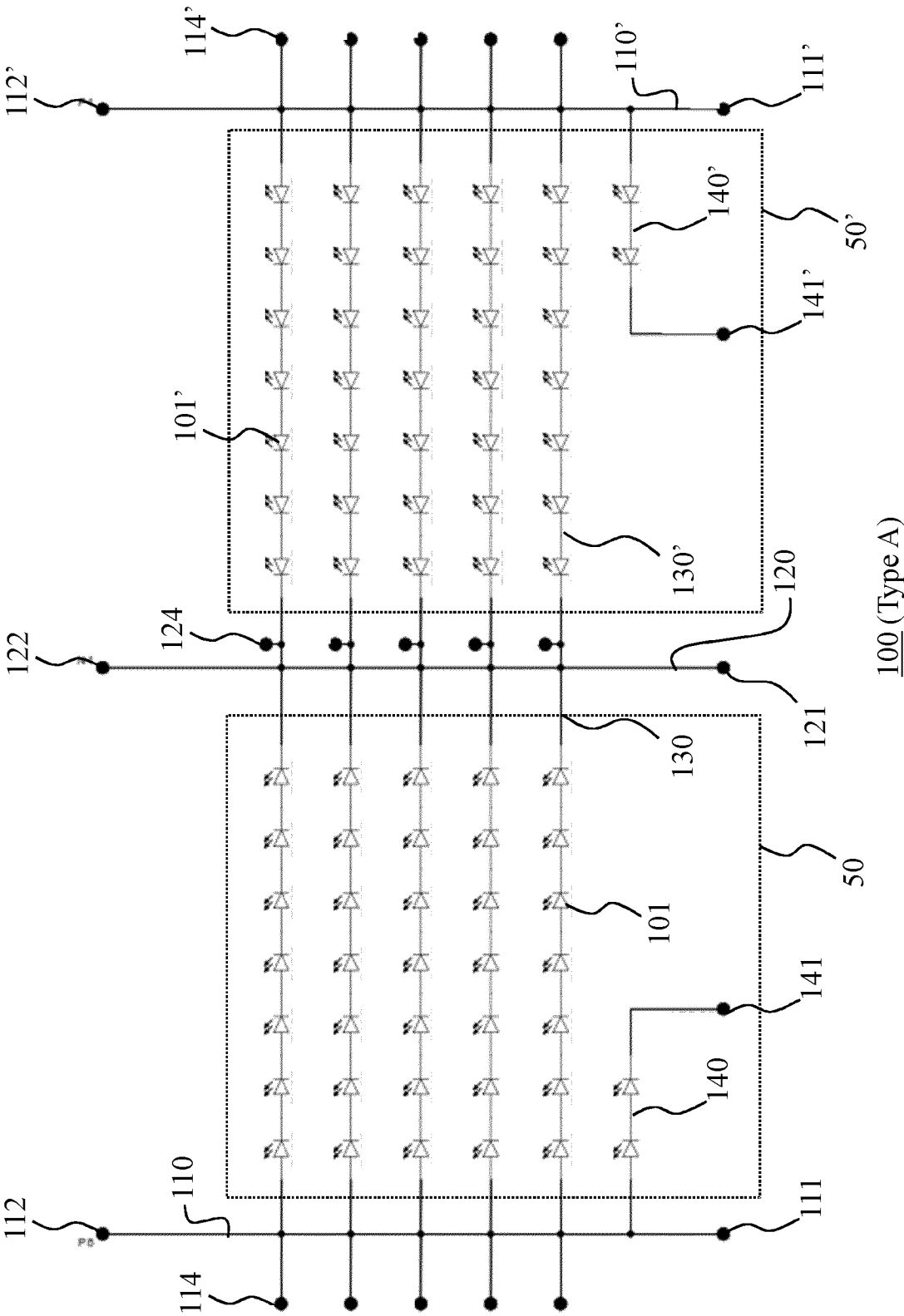


FIG. 9

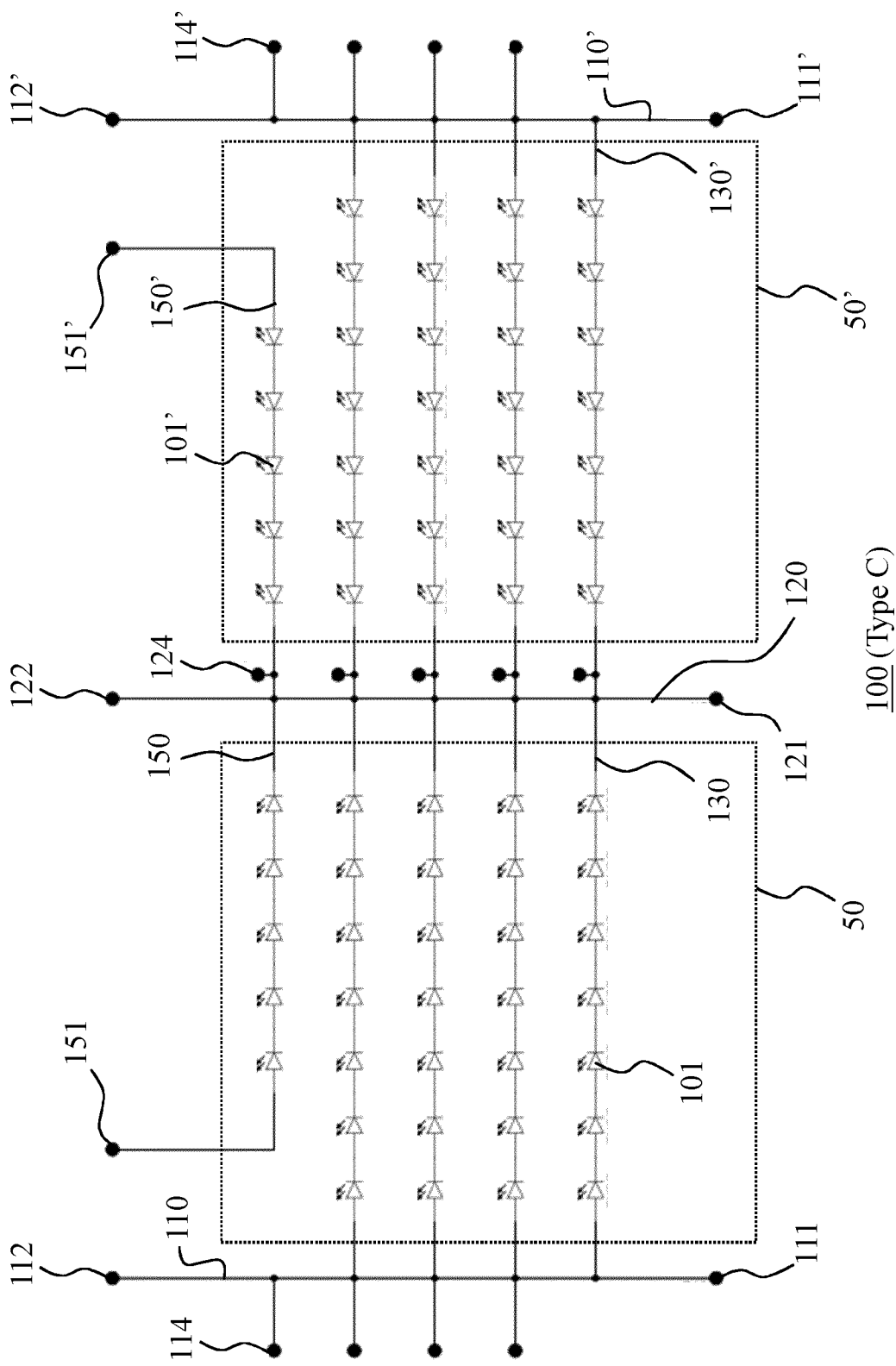
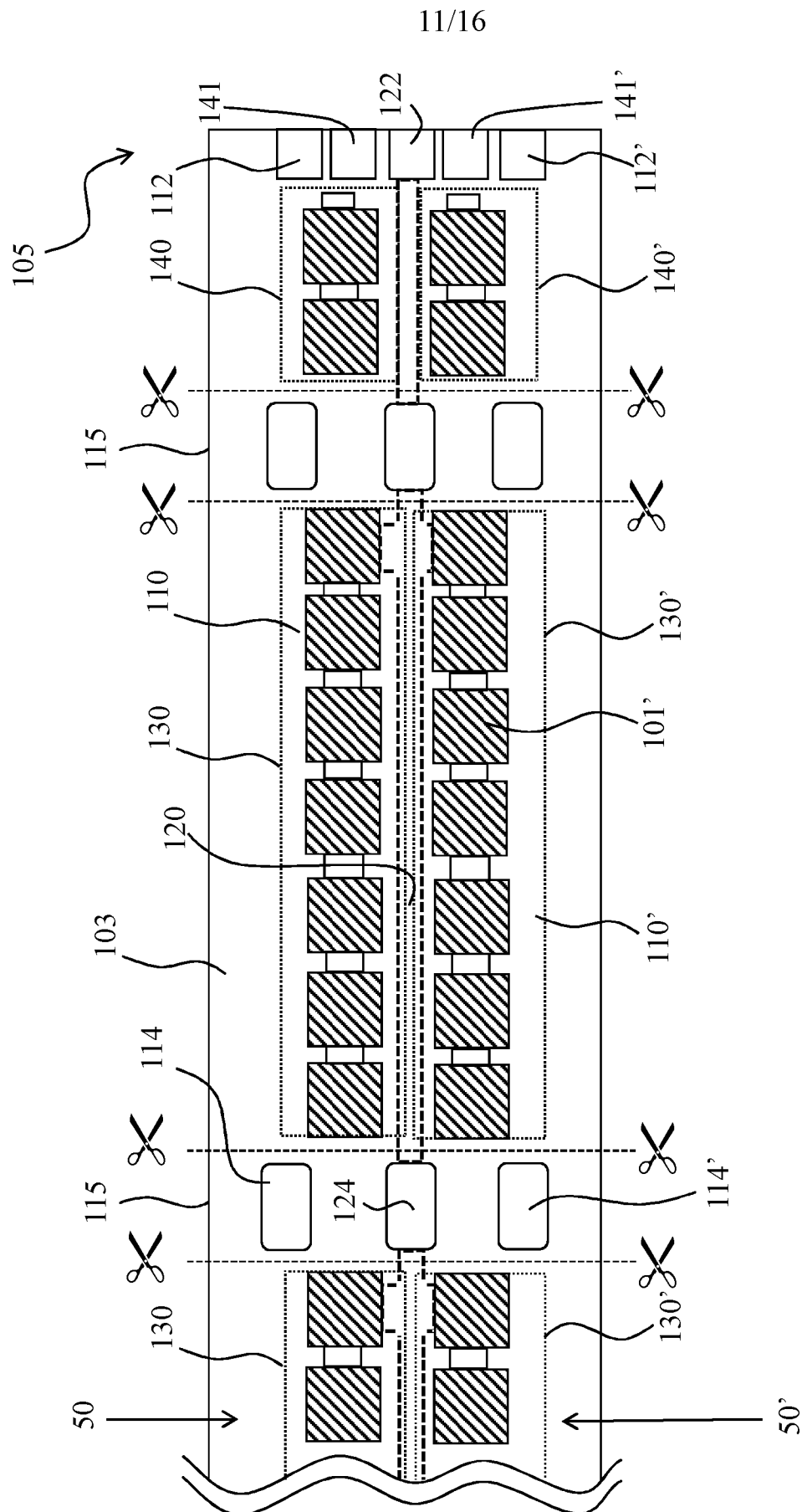


FIG. 10

100

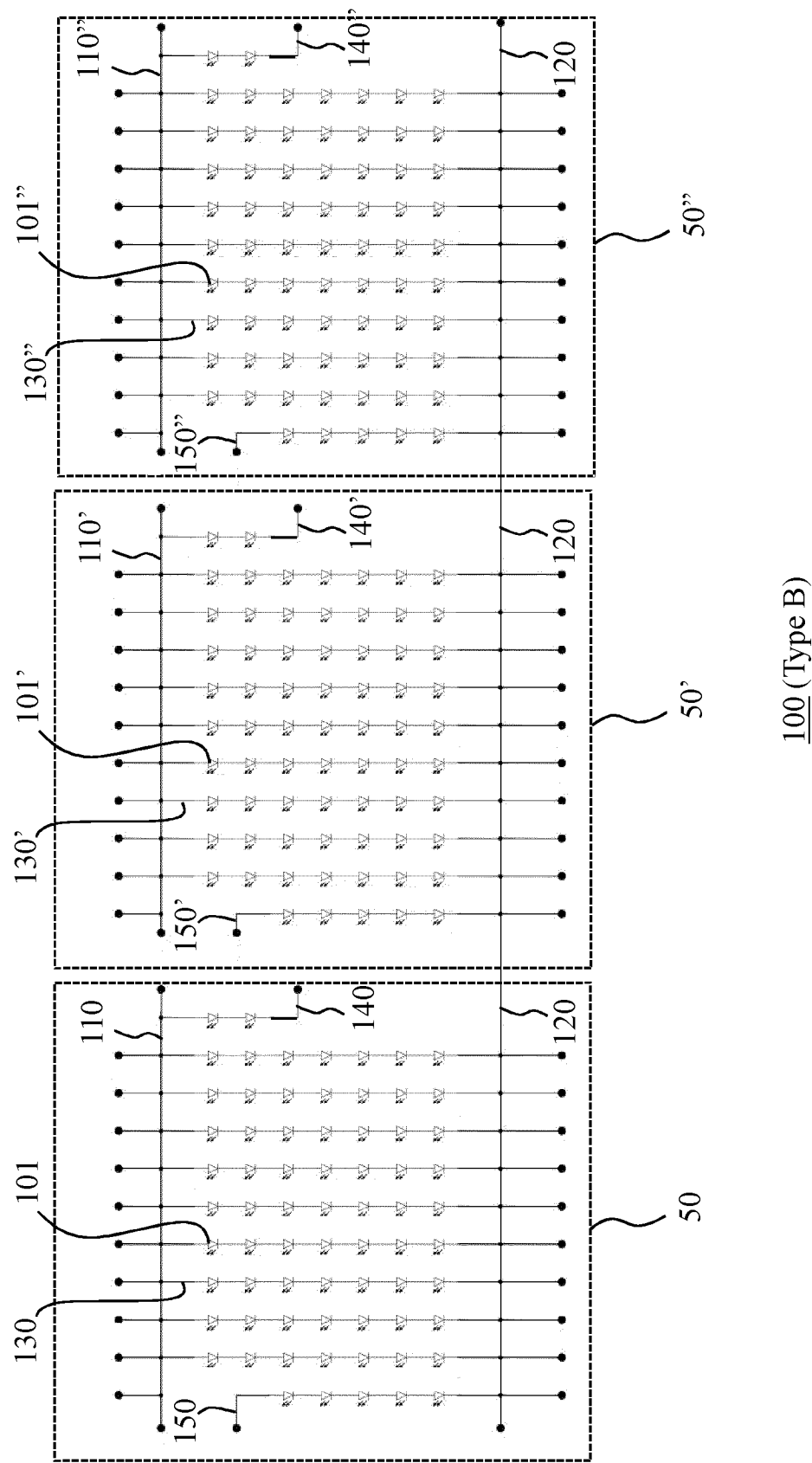


FIG. 12

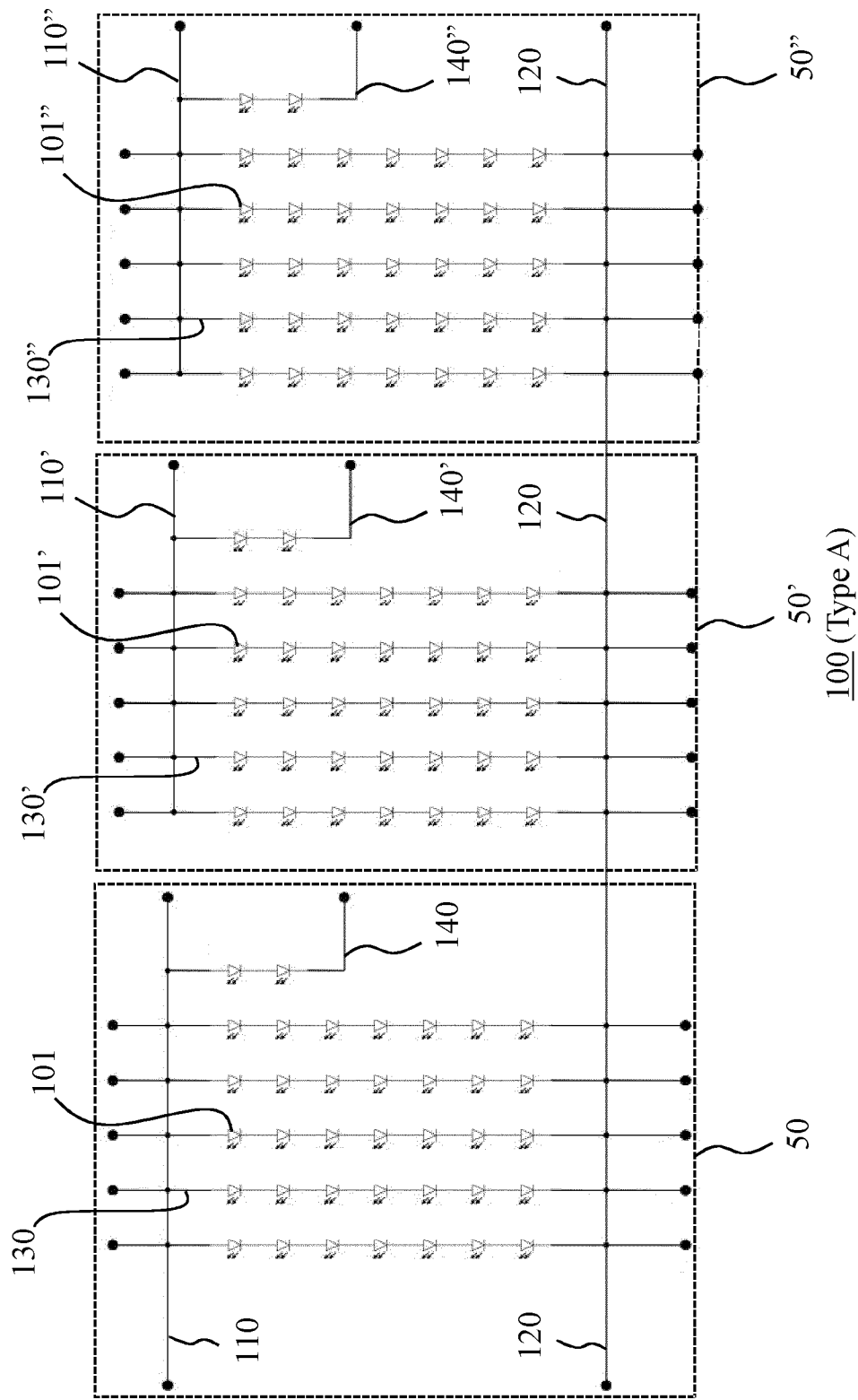


FIG. 13

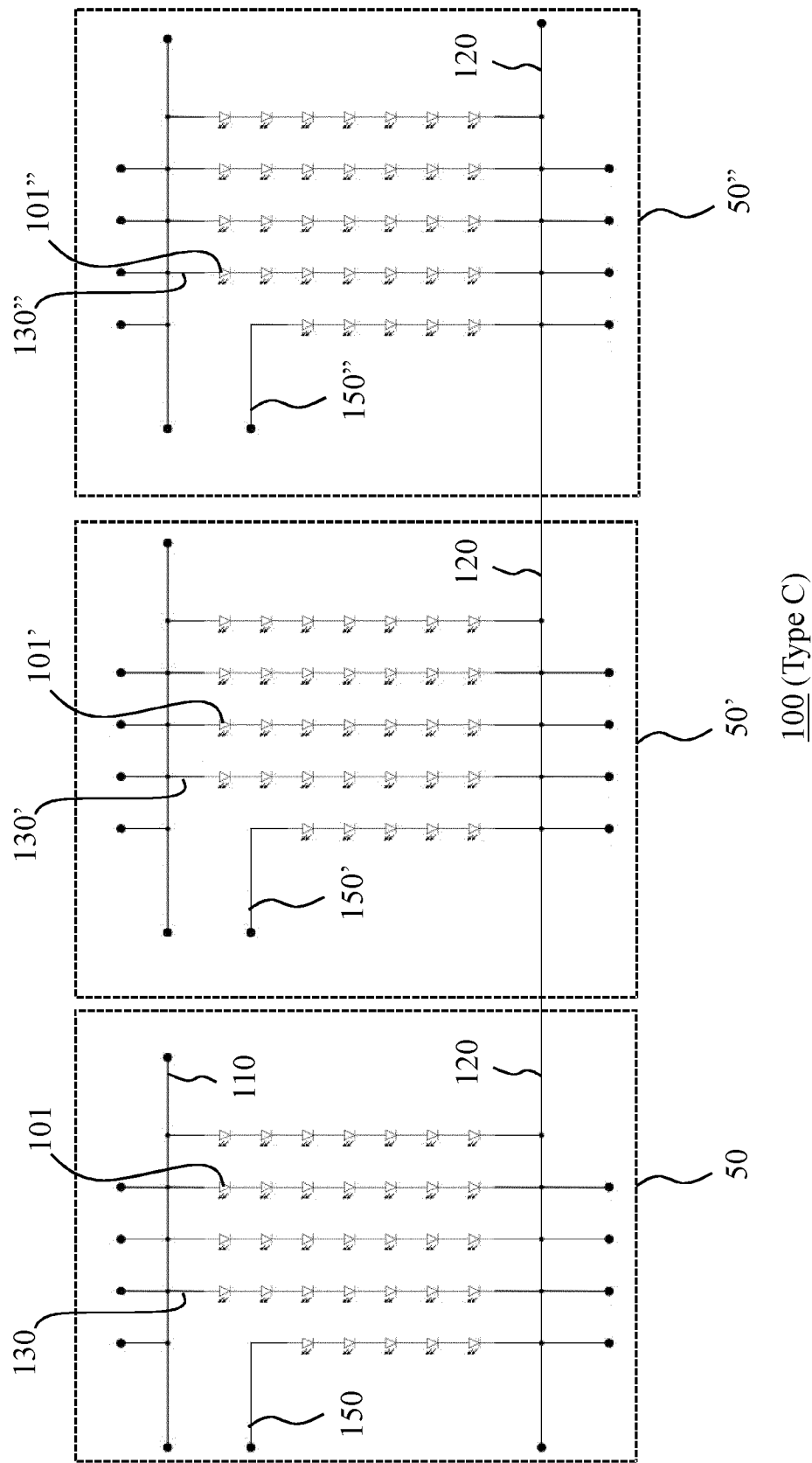
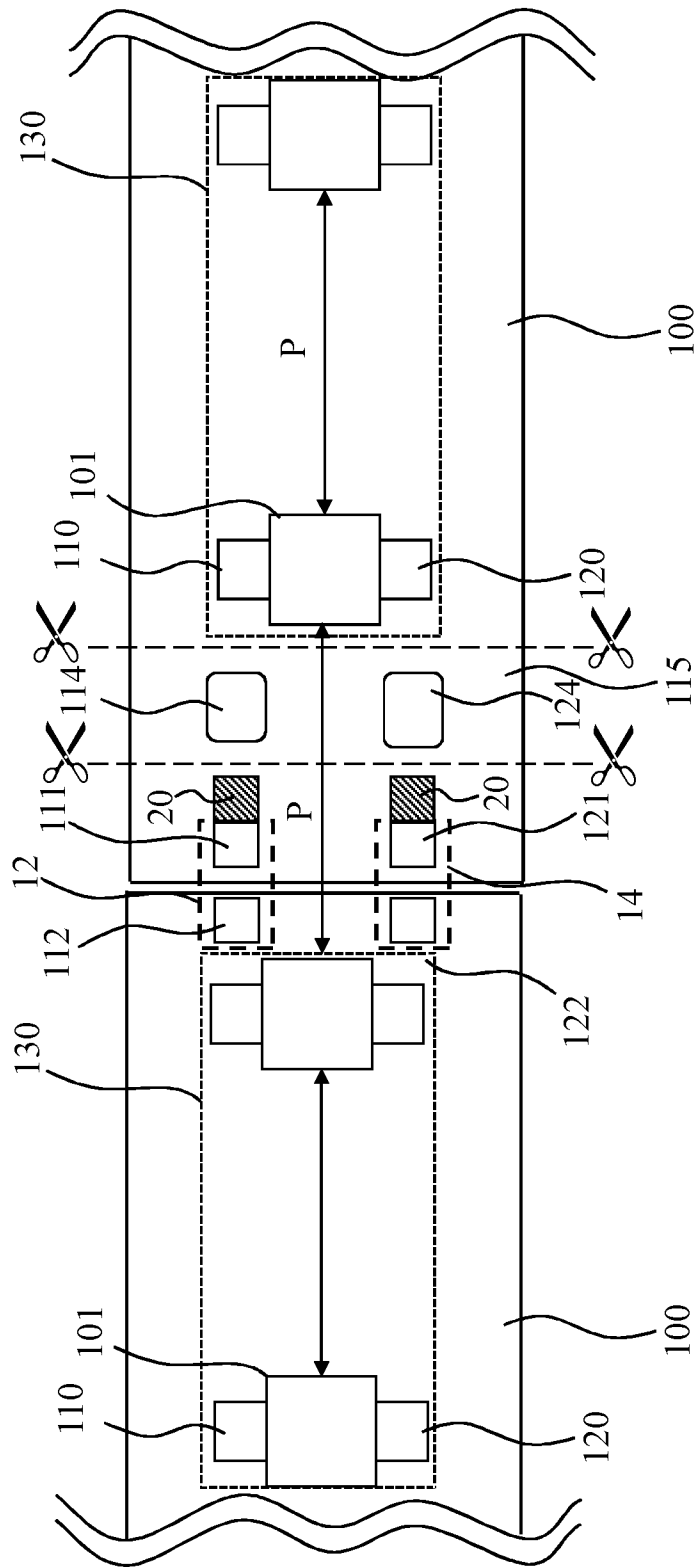


FIG. 14



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FIG. 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/072859

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21S4/24 H05B33/08 H05K1/18
ADD. F21Y103/10 F21Y115/10

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)
F21S F21Y H05B H05K

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 practicable, 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	JP 4 838378 B1 (SASAMURA SATOSHI) 14 December 2011 (2011-12-14)	1,3-5,9, 10
Y	figure 2	6-8
Y	DE 10 2013 206342 A1 (ATEX CO [JP]) 21 November 2013 (2013-11-21) paragraph [0052] - paragraph [0061]; figures 12A-14C	6-8
Y	CN 203 190 171 U (HESHAN LIDE ELECT IND CO LTD) 11 September 2013 (2013-09-11) the whole document	6-8
A	DE 20 2012 103264 U1 (ZUMTOBEL LIGHTING GMBH [AT]) 4 December 2013 (2013-12-04) abstract; figures 1-3	1-15
	-/--	



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Date of the actual completion of the international search

19 September 2019

Date of mailing of the international search report

26/09/2019

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Authorized officer

Thibaut, Arthur

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/072859

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/072859

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