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(54) **AUTOMOTIVE LUMINOUS DEVICE**

(57) The invention provides an automotive luminous device (10) for an automotive vehicle. It comprises a plurality of light branch groups (2) and a driver element (7). Each light branch group contains a plurality of light branches (3) connected in parallel. Each light branch (3) comprising a plurality of light units (11, 12, 13) being connected in series. The driver element (7) comprises a plurality of control inputs (8), wherein each control input is connected to each one of the group outputs (5). Each

first light unit (11) comprises an input connected to the power supply (1) and an output connected to the at least one intermediate light unit (12) and to the outputs of the first light units (11) of the same light branch group. Each last light unit (13) comprises an input and an output, wherein the input is connected to the output of one intermediate light unit (12) and to the inputs of the last light units of the same light branch group and an output connected to the corresponding group output (5).

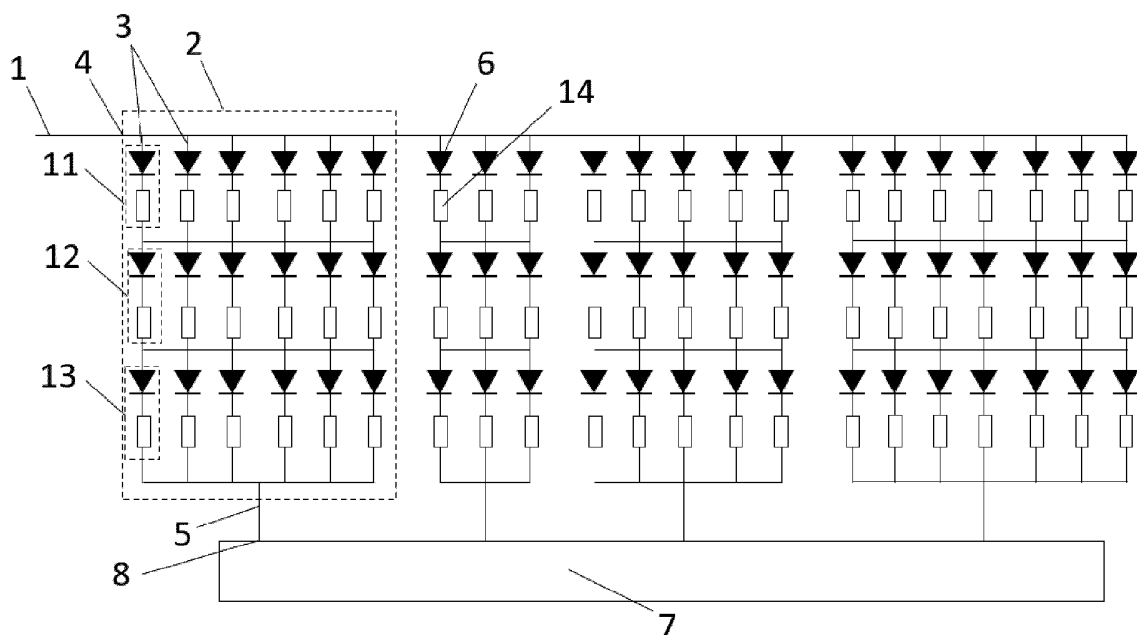


Fig. 1

Description

by the interposition of a group resistor;

TECHNICAL FIELD

wherein

[0001] This invention is related to the field of automotive luminous devices which are controlled to provide luminous (signalling and/or lighting) functionalities.

STATE OF THE ART

[0002] Automotive luminous devices are designed to perform different functionalities. To do so, the luminous device comprises different lighting modules, each of them being in charge of one of the luminous functions.

[0003] These luminous functions are often provided by an arrangement of solid-state light sources. These types of light sources have proven to be efficient and powerful enough to fulfil the regulations, but have some issues with temperature. For those lights sources which are turned on, it is necessary to adapt the current and voltage of the battery or body controllers to the expected performance so as to maintain performance in the all the ranges of lifetime temperatures.

[0004] Further, the manufacturers' requirements are in constant evolution. In some scenarios, a luminous function is intended to be carried out by a relatively high number of light sources, but with a relatively low number of animation segments (or even without them). In these cases, the absence of active elements reduces the final cost of the device but, at the same time, a control of the current in the light sources is needed to avoid overheating.

[0005] However, due to the increasing number of light sources, a high number of control devices, such as drivers, is needed. These drivers are expensive and usually involve complex diagnosis algorithms and information which is not always needed in the normal operation of a lighting device.

[0006] A solution for this problem is therefore sought.

DESCRIPTION OF THE INVENTION

[0007] The invention provides a solution for the light source control while keeping the number of drivers low by means of an automotive luminous device for an automotive vehicle, the luminous device comprising

- a power supply;
- a plurality of light branch groups, each light branch group comprising a group input, a group output and a plurality of light branches, each light branch in a group being connected between a respective group input of the group and a respective group output of the group, each light branch comprising a plurality of light units being connected in series; and
- a driver element comprising a plurality of control inputs, wherein each control input is connected to a single corresponding group output, either directly or

- 5 - each plurality of light units consists of a first light unit, a last light unit, and a series arrangement of at least one intermediate light unit;
- each light branch in the light branch group comprising a same number of light sources;
- 10 - each light unit comprises a series arrangement of a solid-state light source connected between said light unit's respective light unit input and said light unit's respective light unit output, so that the light source emits light when current is flowing from the light unit input to the light unit output;
- 15 - each first light unit comprises a first input connected to the power supply and a first output connected to the at least one intermediate light unit and to the outputs of the first light units of the same light branch group;
- 20 - each intermediate light unit comprises a second input and as second output, a second input and as second output, the first output of the first light unit of the same branch being connected to the second input of one intermediate light unit;
- 25 - each last light unit comprises a third input and a third output, the third input being connected both to a second output of one intermediate light unit of the same light branch group and to the third inputs of the last light units of the same light branch group, and the third output being connected to the corresponding group output;
- 30 - the driver element being configured to individually control the current flowing through each of the control inputs.
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[0008] The term "solid state" light source refers to a light source emitting light by solid-state electroluminescence, which uses semiconductors to convert electricity into light. Compared to incandescent lighting, solid state lighting creates visible light with reduced heat generation and less energy dissipation. The typically small mass of a solid-state electronic luminous device provides for greater resistance to shock and vibration compared to brittle glass tubes/bulbs and long, thin filament wires. They also eliminate filament evaporation, potentially increasing the life span of the illumination device. Some examples of these types of lighting comprise semiconductor light-emitting diodes (LEDs), organic light-emitting diodes (OLED), or polymer light-emitting diodes (PLED) as sources of illumination rather than electrical filaments, plasma or gas.

[0009] In the present invention, within a group, every branch contains the same number of light units. But in a different group, the number of light units may be different. Hence, in each group, the number of light units per branch is the same, so that the number of intermediate light units is also the same. For example, in the first light branch

group, all the light branches comprise three light units, but in the second light branch group, the light branches may comprise four light units. The fact is that, within the same light branch group, all the light branches contain the same number of light units, although this number may differ from the number of light units per branch of a different light branch group.

[0010] By a series arrangement of at least one electronic component, it is meant that said components are connected in a daisy chain, with an input of the arrangement being connected to an input of a first component, an output of the arrangement being connected to an output of a last component, and, when there are more than one component, at least one intermediate component having its input connected to the output of the previous component.

[0011] In the invention, the light units of a given light branch group are connected in a matrix arrangement, with a same number on light units per light branch, said light units being connected in a daisy chain in the light branch; an input of the light branch group being connected to an input of all first light units of the group, forming a first row of light units having all their inputs connected together in a first row input and having all their outputs connected together in a first row output; an output of the light branch group being connected to an output of a last light unit forming a last row of light units having all their inputs connected together in a last row input and having all their outputs connected together in a last row output; and at least one intermediate row of intermediate light sources having all their inputs connected together in an intermediate row input, and having all their outputs connected together in an intermediate row output, wherein each row's input is connected to the previous row's output.

[0012] Provided this condition, the connection feature requires that each output of a light unit is connected, not only to the input of the next light unit of the same branch, but also with the output of the corresponding light unit of the rest of the branches of the same group: if the invention provides a first light branch group of four branches, with three light sources per branch, the output of the first light unit of the first branch is connected, not only to the second light unit of the first branch, but to the output of the first light unit of the other three branches of the same group. And successively with the rest of the light units. Hence, a matrix connection between all the light units of the same light branch group is achieved.

[0013] This device is specially adapted to include a high number of light units per function, since it is designed to manage the operation of matrixes of LEDs with a single control input of the driver. Hence, for example, a matrix of five branches and three light sources per branch is controlled by a single control input. Hence, the 15 LEDs may be turned on or off at the same time, but this is often advantageous if no animation is required (for example, in some static functions as position light or stop light).

[0014] Further, in these applications, the need of diagnosis

is reduced, since there is no need to identify a single failure of a light source, since the rest of the LEDs compensate the total flux and there is no need to turn off the function. Only global short circuit is relevant, and this may be identified internally by the driver element.

[0015] In some particular embodiments, each light unit comprises a solid-state light source and a compensation resistor.

[0016] An individual compensation resistor for each solid-state light source is advantageous since it allows a compensation for a local temperature increase that would involve a different operation due to the relation between temperature, flux and needed current. The individual resistor allows to absorb the excess of power so that operation is compensated despite different local temperatures.

[0017] In some particular embodiments, each light unit consists of a solid-state light source and each control input is connected to each one of the group outputs by the interposition of a group resistor.

[0018] A global group resistor is also advantageous, since it provides compensation and reduces the power consumed by the driver element.

[0019] In some particular embodiments, the driver element is configured to operate as a current sink regulator.

[0020] The driver element may be located downstream of the solid-state light sources, so that it absorbs the voltage which is not consumed by the light branch groups.

[0021] In some particular embodiments, at least two light branch groups contribute for the same lighting function. This means that, when mounted on a vehicle and when the driver elements let current flow through them, the light branch groups emit light contributing to the fulfilment of an automotive signalling function.

[0022] This invention may also be used for animations: instead of performing each bit of information by a single light source, each bit of information may be performed by a light branch group.

[0023] In some particular embodiments, the device comprises more than ten light branches in total.

[0024] This number is relevant, since if each branch was controlled individually, for more than ten branches, more than one driver should be used. However, this is not the case of the present invention, where branches are grouped in branches groups, and each group (that may contain three, four, five or even ten branches) only requires one control input. A number of driver elements necessary for driving a given number of light branches is therefore greatly reduced, hence reducing the costs of a complex automotive luminous device.

[0025] In some particular embodiments, each light branch has the same number of light units and each branch has at least three light units.

[0026] In the present invention, within a group, every branch contains the same number of light units. But in a different group, the number of light units may be different. Where each branch of the device has the same number of light units, control is improved and power dissipation

in the driver is uniform across the different control inputs.

[0027] In some particular embodiments the solid-state light sources are configured to perform more than one different lighting functionality and the functionalities comprise at least two of daily running light, position light, stop light, tail light or direction indicator.

[0028] Unless otherwise defined, all terms (including technical and scientific terms) used herein are to be interpreted as is customary in the art. It will be further understood that terms in common usage should also be interpreted as is customary in the relevant art and not in an idealised or overly formal sense unless expressly so defined herein.

[0029] In this text, the term "comprises" and its derivations (such as "comprising", etc.) should not be understood in an excluding sense, that is, these terms should not be interpreted as excluding the possibility that what is described and defined may include further elements, steps, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] To complete the description and in order to provide for a better understanding of the invention, a set of drawings is provided. Said drawings form an integral part of the description and illustrate an embodiment of the invention, which should not be interpreted as restricting the scope of the invention, but just as an example of how the invention can be carried out. The drawings comprise the following figures:

Figure 1 shows a general electric scheme of a portion of an automotive luminous device according to the invention.

Figure 2 shows a general electric scheme of a portion of different embodiment of an automotive luminous device according to the invention.

[0031] Elements of the example embodiments are consistently denoted by the same reference numerals throughout the drawings and detailed description where appropriate:

- 1 Power supply
- 2 Branch group
- 3 Light branch
- 4 Group input
- 5 Group output
- 6 LED, light emitting diode
- 7 Driver element
- 8 Control input
- 9 Group resistor
- 10 Headlamp
- 11 First LED unit
- 12 Second LED unit
- 13 Third LED unit
- 14 Compensation resistor

DETAILED DESCRIPTION OF THE INVENTION

[0032] The example embodiments are described in sufficient detail to enable those of ordinary skill in the art to embody and implement the systems and processes herein described. It is important to understand that embodiments can be provided in many alternate forms and should not be construed as limited to the examples set forth herein.

[0033] Accordingly, while embodiment can be modified in various ways and take on various alternative forms, specific embodiments thereof are shown in the drawings and described in detail below as examples. There is no intent to limit to the particular forms disclosed. On the contrary, all modifications, equivalents, and alternatives falling within the scope of the appended claims should be included. Elements of the example embodiments are consistently denoted by the same reference numerals throughout the drawings and detailed description where appropriate.

[0034] Figure 1 shows a general electric scheme of a portion of an automotive luminous device according to the invention. This portion comprises a power supply 1, four light branch groups 2 and a driver element 7.

[0035] Each light branch group 2 contains a different number of light branches 3, but in any case, all of the light branches 3 of the same light branch group 2 are connected in parallel between a corresponding group input 4 and a corresponding group output 5.

[0036] In this case, the first light branch group contains six light branches 3, the second light branch group contains three light branches 3, the third light branch group contains seven branches 3 and the fourth light branch group contains five light branches 3.

[0037] Each light branch 3 comprises a plurality of LED units 11, 12, 13 being connected in series. In this case, all the branches of this device contain three LED units 11, 12, 13. Each LED unit contains a LED (light emitting diode) 6 and a compensation resistor 14. The resistance value of the resistors 14 are chosen to cause a known voltage drop in the resistor, since the resistor value is much higher than the resistance values of the LEDs 6.

[0038] In the present invention, within a group, every branch contains the same number of LED units. Further, in the present embodiment, every branch of every group contains the same number of LED units (in this case, three). But in a different embodiment, for a different group, the number of light units could be different. For example, in the first light branch group, all the light branches comprise three light units, but in the second light branch group, in a different embodiment, the light branches could comprise four light units. The fact is that, within the same light branch group, all the light branches contain the same number of light units, although this number may differ from the number of light units per branch of a different light branch group.

[0039] The driver element 7 comprises a plurality of control inputs 8, wherein each control input is connected

to a single corresponding group output 5. In this case, this connection is direct, although in other cases, this connection may be performed by the interposition of a group resistor. Hence, the driver element 7 is configured to operate as a current sink regulator.

[0040] The driver element 7 is configured to individually control the current flowing through each of the control inputs (8).

[0041] Hence, in this case, there are 24 light branches in total, and only four control inputs 8 are needed to manage the operation of these 72 LED units.

[0042] The LED units 11, 12, 13 are connected in a matrix way, as will be explained: each first LED unit 11 comprises an input connected to the power supply 1 and an output connected to the second LED unit 12, but also to the outputs of the first LED units 11 of the same light branch group. Hence, in the case of the first light branch group, the first LED unit of the first branch is connected to the second LED unit of the first branch (since there is a series connection within the branch) but also to the outputs of the first LED units of the rest of the branches of the first group.

[0043] This logic is repeated for each LED unit, and can be repeated regardless the number of light units comprised in the branch, and regardless the number of branches comprised in the group.

[0044] Finally, in the third LED unit 13, which also comprises an input and an output, the input is connected to the output of the second LED unit 12 but also to the inputs of the third LED units of the same light branch group. In turn, the output of this first LED unit is connected to the corresponding group output 5.

[0045] Provided this condition, the connection feature requires that each output of a light unit is connected, not only to the input of the next light unit of the same branch, but also with the output of the corresponding light unit of the rest of the branches of the same group: if the invention provides a first light branch group of four branches, with three light sources per branch, the output of the first light unit of the first branch is connected, not only to the second light unit of the first branch, but to the output of the first light unit of the other three branches of the same group. And successively with the rest of the light units. Hence, a matrix connection between all the light units of the same light branch group is achieved.

[0046] In this case, the four groups are intended to contribute to the same lighting function, which is rear position lamp. However, in other cases, each group may contribute to a different function, or a combination of both scenarios is also possible. The only limitation is provided by the fact that the whole group is controlled as a single light unit.

[0047] Figure 2 shows a general electric scheme of a portion of different embodiment of an automotive luminous device according to the invention.

[0048] In this case, the only difference with respect to the previous case is that in this case each LED unit only contains a solid-state light source 6 and each control in-

put 8 is connected to a single corresponding group outputs by the interposition of a group resistor 9.

[0049] This solution is cheaper, although temperature compensation is not as good as in the example of Figure 1.

Claims

1. Automotive luminous device (10) for an automotive vehicle, the luminous device comprising

a power supply (1);
a plurality of light branch groups (2), each light branch group comprising a group input, a group output and a plurality of light branches (3), each light branch in a group being connected between a respective group input (4) of the group and a respective group output (5) of the group, each light branch (3) comprising a plurality of light units (11, 12, 13) being connected in series; and a driver element (7) comprising a plurality of control inputs (8), wherein each control input is connected to a single corresponding group output (5), either directly or by the interposition of a group resistor (9);

wherein

each plurality of light units (3) consists of a first light unit (11), a last light unit (13), and a series arrangement of at least one intermediate light unit (12);

each light branch (3) in the light branch group comprising a same number of light sources;
each light unit comprises a series arrangement of a solid-state light source (6) connected between said light unit's respective light unit input and said light unit's respective light unit output, so that the light source emits light when current is flowing from the light unit input to the light unit output;

each first light unit (11) comprises a first input connected to the power supply (1) and a first output connected to the at least one intermediate light unit (12) and to the outputs of the first light units (11) of the same light branch group;
each intermediate light unit (12) comprises a second input and as second output, a second input and as second output, the first output of the first light unit of the same branch being connected to the second input of one intermediate light unit;

each last light unit (13) comprises a third input and a third output, the third input being connected both to a second output of one intermediate light unit (12) of the same light branch group and to the third inputs of the last light units of the

same light branch group, and the third output being connected to the corresponding group output (5);
the driver element (7) being configured to individually control the current flowing through each of the control inputs (8). 5

2. Automotive luminous device (10) according to claim 1, wherein each light unit comprises a solid-state light source (6) and a compensation resistor (14) connected in series between said light unit's respective light unit input and said light unit's respective light unit output. 10
3. Automotive luminous device (10) according to claim 1, wherein each light unit consists of a solid-state light source (6) and each control input is connected to a single corresponding group output by the interposition of a group resistor (9). 15
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4. Automotive luminous device (10) according to any of the preceding claims, wherein the driver element (7) is configured to operate as a current sink regulator. 25
5. Automotive luminous device (10) according to any of the preceding claims, wherein at least two light branch groups (2) are configured to contribute to a same lighting function. 30
6. Automotive luminous device (10) according to any of the preceding claims, wherein the device comprises more than ten light branches (3) in total.
7. Automotive luminous device (10) according to any of the preceding claims, wherein each light branch (3) has the same number of light units (11, 12, 13) and each branch has at least three light units (11, 12, 13). 35
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8. Automotive luminous device (10) according to any of the preceding claims, wherein the solid-state light sources (6) are configured to perform more than one different lighting functionality and the functionalities comprise at least two of daily running light, position light, stop light, tail light or direction indicator. 45

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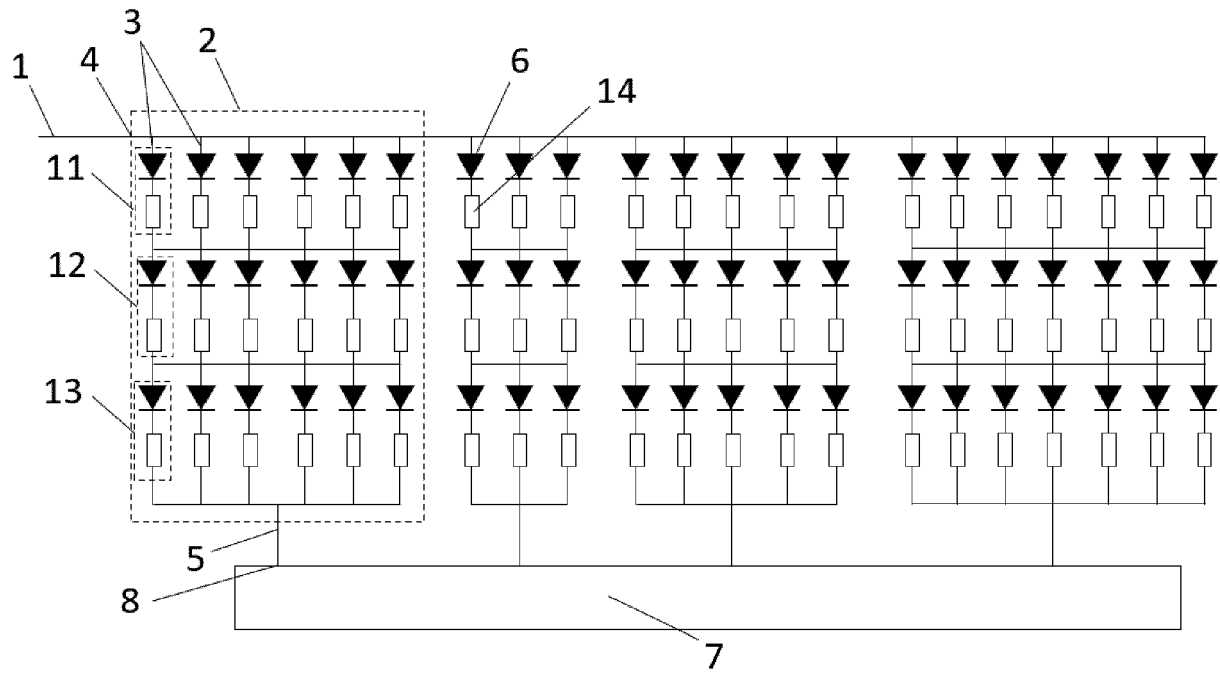


Fig. 1

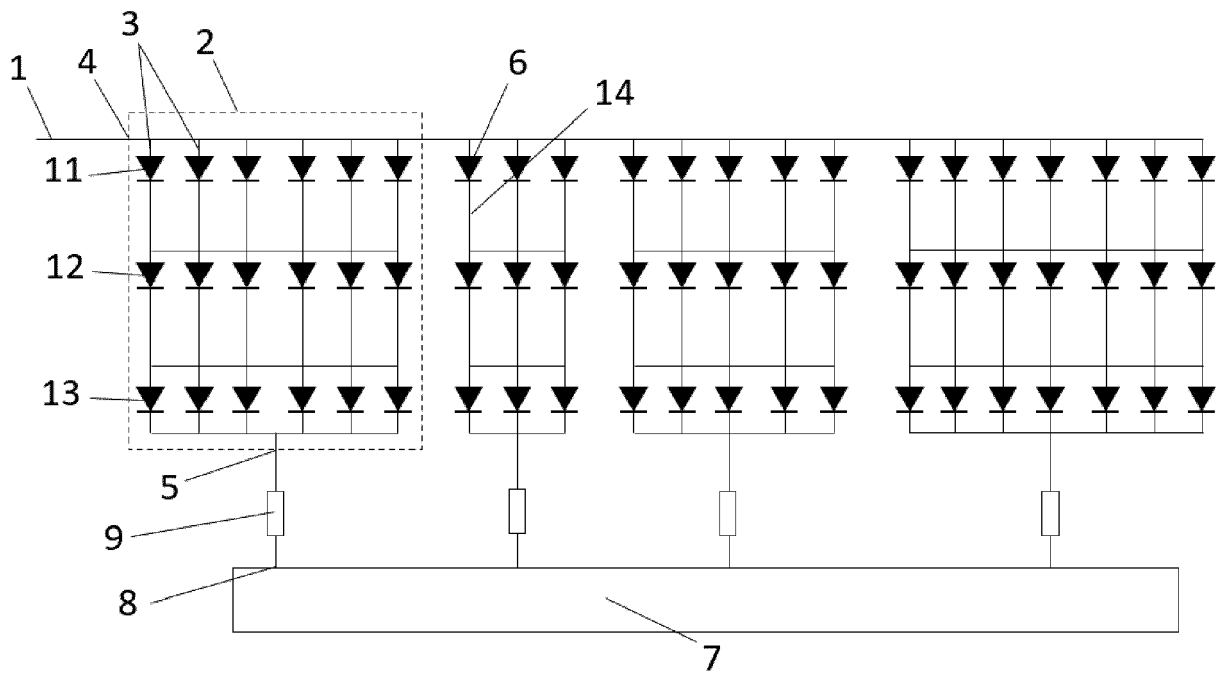


Fig. 2



EUROPEAN SEARCH REPORT

Application Number

EP 22 21 7446

DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 5 896 084 A (WEISS ACHIM [DE] ET AL) 20 April 1999 (1999-04-20)	1, 3-8	INV. H05B45/40
A	* column 1, line 21 - column 5, line 35; figures 1, 2, 5, 7 *	2	
A	EP 2 706 819 A1 (AUTOMOTIVE LIGHTING ITALIA SPA [IT]) 12 March 2014 (2014-03-12) * paragraph [0021] - paragraph [0073]; figures 2, 3, 5, 6 *	1-8	
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TECHNICAL FIELDS
SEARCHED (IPC)

H05B

The present search report has been drawn up for all claims

1

Place of search

Munich

Date of completion of the search

18 April 2023

Examiner

Henderson, Richard

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 22 21 7446

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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18-04-2023

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