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- **MORIS GOMEZ, Juan**
23600 Martos (ES)
- **GONZALEZ RICO, ALBERTO**
23600 Martos (ES)
- **ILLAN CABEZA, Antonio Domingo**
23600 Martos (ES)

(71) Applicant: **Valeo Vision**
93012 Bobigny Cedex (FR)

(74) Representative: **Valeo Visibility**
IP department
34, rue Saint André
93012 Bobigny Cedex (FR)

(72) Inventors:
• **CANTUDO FRANCO, Miguel Angel**
23600 Martos (ES)

(54) **AUTOMOTIVE LUMINOUS DEVICE**

(57) The invention provides an automotive luminous device (10) for an automotive vehicle (100). It comprises a buck converter (1) configured to produce a voltage value in the voltage output (5) which is lower than the voltage value received at the voltage input (4). The buck converter (1) is also configured so that the voltage value at the voltage output (5) depends on the voltage value received at the control input (6). It also comprises a temperature compensation circuit (2) comprising a thermistor, the temperature compensation circuit having a circuit input (7) receiving the voltage output from the buck converter (1) and having a circuit output (8) connected to the control input (6) of the buck converter (1). Finally, it also comprises at least one light branch (3) connected in parallel between the voltage output and the ground connection, each light branch comprising at least one solid-state light source (9) and at least one passive component, such as a resistor (12), mounted in series with the at least one solid-state light source (9).

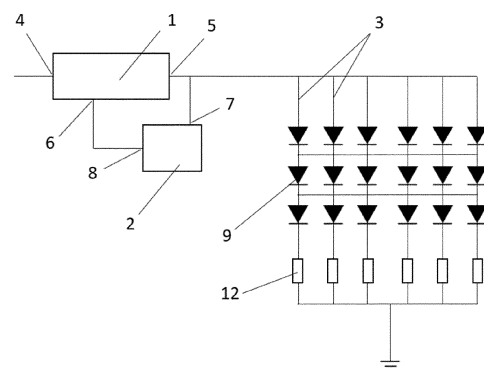


Fig. 1

Description**TECHNICAL FIELD**

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

STATE OF THE ART

[0002] Automotive luminous devices are designed to perform different functions. 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 electroluminescent 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] First issue is related to the fact that the output flux value depends on temperature. Since the operation of these devices produces heat, the temperature increase is a problem to be solved, since it has a big influence on the performance of these light sources.

[0005] 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 without animations. 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.

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

DESCRIPTION OF THE INVENTION

[0007] The invention provides a solution for the heat dissipation while keeping the flux continuous in the driver by means of an automotive luminous device for an automotive vehicle, the luminous device comprising

- a voltage regulator comprising a voltage input, a voltage output and a control output, the voltage regulator being also configured to provide a constant voltage value at the control output;
- a ground connection;
- a temperature compensation circuit temperature compensation circuit; and
- at least one light branch connected between the voltage output and the ground connection, each light branch comprising at least one electroluminescent light source and at least one passive component, such as a resistor, mounted in series with the at least one electroluminescent light source, wherein an in-

crease in operation temperature causes a voltage drop across the at least one electroluminescent light source;

5 wherein

- the temperature compensation circuit comprises a first portion and a second portion arranged in series;
- the first portion of the temperature compensation circuit has a circuit input connected to the voltage output of the voltage regulator, comprises a NTC thermistor and at least one compensation resistor and ends in an intermediate node;
- the second portion of the temperature compensation circuit is connected to the intermediate node and comprises a first connection branch which extends between the intermediate node and the control output and a second connection branch which comprises a bottom resistor and extends between the intermediate node and the ground connection; and
- the characteristic of the thermistor, the value of the compensation resistor and the value of the bottom resistor are configured to cause a compensation voltage decrease in the voltage drop across the first portion, such that the compensation voltage decrease is comprised between 0.5 times and 1.5 times the decrease in the voltage drop across the at least one electroluminescent light sources (9) of the light branches caused by the increase in operation temperature, and preferably between 0.8 times and 1.2 times the decrease in the voltage drop across the at least one electroluminescent light sources (9) of the light branches caused by the increase in operation temperature .

[0008] Voltage regulation as a function of the temperature is not a new feature as such. However, it can be obtained in many different ways. The present invention provides a way of varying the voltage value received by each light branch without using active components and keeping substantially the same current value in the light sources for all the temperature ranges. This reduces the cost of the luminous device and, at the same time, allows a temperature control of the light sources, thus achieving a homogeneous flux regardless the temperature.

[0009] A NTC thermistor is a Negative Coefficient thermistor. Its characteristic is usually defined by manufacturer-issued value tables. The resistor value of an NTC thermistor are characterized in that they decrease when temperature increases.

[0010] When the operation of the luminous device is started, the voltage regulator provides each light branch with a first voltage value higher than the branches' polarization value so that the electroluminescent light sources are powered on and consequently emit light. The voltage at the branches' resistors

[0011] The voltage regulator has a voltage regulated output (the control output) which keeps the voltage con-

stant between this control output and ground. As a consequence, voltage between the intermediate node and ground is constant. Hence, the current on this second connection branch is defined by this constant voltage value and the value of the bottom resistor.

[0012] When operation temperature increases, the voltage drop between the at least one electroluminescent light sources' anode and cathode decreases. If nothing changed upstream, the resistor associated to the at least one light source would have to absorb a voltage increase, and this would cause intensity to increase, which may lead to further power dissipation and, in turn, further temperature increase, resulting in overheating and possibly failure of the LEDs. To face this situation, the invention provides a temperature compensation circuit. First off, the current value in the temperature compensation circuit is defined by the voltage of the control output and the bottom resistance. Furthermore, the temperature compensation circuit comprises a thermistor which is configured to change its resistance value to a lower value when temperature increases, so that the voltage in the first portion of the temperature compensation circuit drops () to adapt to the change of the voltage drop across the electroluminescent light sources.

[0013] Hence, the voltage demanded from the voltage regulator is lower. Ideally, it should be the same as the voltage drop across the electroluminescent light sources, but in real terms is comprised between 0.5 times and 1.5 times this value, and more particularly, between 0.8 times and 1.2 times this value.

[0014] The term "electroluminescence" refers to light emitted by solid-state electroluminescence, which uses semiconductors to convert electricity into light. Compared to incandescent lighting, electroluminescent lighting creates visible light with reduced heat generation and less energy dissipation. The typically small mass of a solid-state electroluminescent 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. In a preferred embodiment of the invention, the electroluminescent light sources are LEDs.

[0015] In some particular embodiments, the voltage regulator is configured to provide a voltage value in the voltage output which is lower than the voltage value received at the voltage input.

[0016] A step-down voltage regulator is simpler and cheaper than a standard voltage regulator. When the forward voltage drop across the light sources branches is systematically lower than the power supply of the battery, it is an advantageous option.

[0017] In some particular embodiments, the voltage regulator is a buck converter.

[0018] A buck converter is a switching DC/DC converter, which is configured to drop the received voltage to a lower amount, so that this lower amount (the output voltage) is supplied to the light sources. When the DC/DC converter's input voltage is close to the output voltage, a buck converter is more efficient than other voltage regulator types. Control of the voltage is thus achieved with a more efficient, less bulky and less costly element. This is important to make the total device smaller, to fulfil efficiency requirements in particular for electric cars..

[0019] In some particular embodiments, the automotive luminous device comprises more than one light branch, and the light branches are connected in parallel between the voltage output and the ground connection.

[0020] The invention will be usually performed with a plurality of light branches connected in parallel. However, the invention may also work with a single light branch, so the invention is defined for "at least one light branch". In the event there are more than one light branch, they are connected in parallel, so that all of them receive the same voltage value.

[0021] In some particular embodiments, the passive component is a resistor.

[0022] In some particular embodiments, the temperature compensation circuit is integrated within the voltage regulator. In this document, the meaning of "integrated" is that the temperature compensation circuit is embedded within the same package of the buck converter.

[0023] In a preferred embodiment, several elements of the invention may be embedded in a single unit. The voltage regulator may for instance comprise the temperature compensation circuit, especially when this control circuit is simple.

[0024] In some particular embodiments, the voltage regulator is configured to produce a voltage output comprised between a low threshold and a high threshold, wherein the high threshold is comprised between 1.1 and 2 times the low threshold.

[0025] Although not the only one, this is an exemplary way of obtaining the purpose of the temperature compensation circuit.

[0026] In some particular embodiments, the thermistor and the at least one compensation resistor are mounted in series between the circuit input and the intermediate node.

[0027] In some particular embodiments, the first connection branch is constituted of a connection resistor and the second connection branch is constituted of a bottom resistor.

[0028] In some particular embodiments, the first portion of the temperature compensation circuit comprises two regulation branches in parallel, arranged between the circuit input and the intermediate node, wherein the first regulation branch comprises the thermistor and the compensation resistor, and the second regulation branch comprises a parallel connection of a capacitor and a resistor.

[0029] The capacitor helps for smooth transient proc-

esses, and the additional resistors help to adjust the voltage variation in the event of a temperature raise to fit the decrease in the voltage drop across the light sources.

[0030] In some particular embodiments, each light branch has the same number of light sources and each light branch has at least three light sources connected in series.

[0031] This allows a better control of the current. The specific value of three light sources is especially advantageous. Indeed, the equivalent voltage drop across a light branch comprising three electroluminescent light sources suits the voltage values that are managed by vehicle batteries.

[0032] Higher numbers of electroluminescent light sources connected in series per branch create a problem that the voltage needed to power all the LEDs so as to perform the desired function, which is typically close to 2V across each LED, as well as the voltage regulator, across which a voltage drop is typically of 1V. The voltage of the battery on vehicle start-up being commonly inferior to 9V, branches of 4 LEDs or more may flicker during vehicle start-up. A known solution to this problem is to use voltage regulators that may either step-up or step-down the voltage, such as SEPIC voltage regulators. Such regulators are more expensive.

[0033] On the other hand, for a constant total number of LEDs in the lighting device, a lower number of LEDs per branch usually implies correspondingly increasing the current at the voltage regulator's level, which lowers the regulator's efficiency and thereby increases its thermal requirements, thereby also increasing costs.

[0034] In some particular embodiments, the outputs of all the first light sources of each light branch are in electric connection and the inputs of all the second light sources of each light branch and the outputs of the second light sources are in electric connection with the inputs of all the third light sources of each light branch are in electric connection.

[0035] This allows that, in the event a light source fails open, the rest of the light sources keep operating. By "fails open", it is meant that there is a significant increase in the voltage drop across the failed light source, preventing it to emit light when powered at usual voltages ; in particular, when the outputs of all the first light sources of each light branch are in electric connection with the inputs of all the second light sources of each light branch and the outputs of the second light sources are in electric connection with the inputs of all the third light sources, a fail-open failure means it is impossible to light up the light source at a nominal voltage at which other light sources operate.

[0036] In some particular embodiments, the light sources are configured to perform more than one different lighting function.

[0037] In some cases, the same light sources may be in charge of different functions, to save the cost of additional light sources.

[0038] In some particular embodiments, the functions

are daytime running light and position light, stop light and tail light or turning indicator.

[0039] For instance, a same plurality of the light sources are configured to be powered on both for performing a tail light function, and for performing a Stop light function.

[0040] For instance, a plurality of the light sources are configured to be powered on both for performing a front Position Light function, and for performing a Stop light function.

[0041] In a second inventive aspect, the invention provides an automotive luminous vehicle comprising a battery and an automotive luminous device according to the first inventive aspect, wherein the battery is configured to directly power the voltage regulator with a voltage input comprised between 5 and 16 V.

[0042] The battery is configured to provide a battery voltage output. This battery voltage output is directly powered to the voltage regulator, i.e., the voltage regulator is powered by the battery through a certain number of switches, so the received voltage is the voltage input of the voltage regulator, which is comprised between 5 and 16 V.

[0043] 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.

[0044] 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

[0045] 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 detailed scheme of a portion of the temperature compensation circuit of a different automotive luminous device according to the invention.

Figure 3 shows an automotive luminous device according to the invention installed in an automotive

vehicle.

[0046] Elements of the example embodiments are consistently denoted by the same reference numerals throughout the drawings and detailed description where appropriate:

- 1 Buck converter
- 2 Temperature compensation circuit
- 3 Light branch
- 4 Voltage input
- 5 Voltage output
- 6 Control output
- 7 Circuit input
- 8 Circuit control pin
- 9 LED
- 10 Headlamp
- 11 Thermistor
- 12 LED Resistor
- 13 Compensation resistor
- 14 Capacitor
- 15 Resistor
- 16 Intermediate node
- 17 Connection resistor
- 18 Bottom resistor
- 100 Automotive vehicle

DETAILED DESCRIPTION OF THE INVENTION

[0047] 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.

[0048] 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.

[0049] Figure 1 shows a general electric scheme of a portion of an automotive luminous device according to the invention. This portion comprises

- a buck converter 1;
- a temperature compensation circuit 2 arranged in electric connection with the buck converter 1; and
- a plurality of light branches 3 arranged in parallel and receiving a voltage value from the buck converter 1.

[0050] The buck converter 1 comprises a voltage input 4, a voltage output 5 and a control output 6, the buck converter 1 being configured to provide a voltage value in the voltage output 5 which is lower than the voltage value received at the voltage input 4. The buck converter 1 is also configured to provide a constant voltage value at the control output 6.

[0051] The temperature control circuit 2, which comprises a thermistor as will be seen below, has a circuit input 7 receiving the voltage output 5 from the buck converter 1 and having a circuit control pin 8 connected to the control output 6 of the buck converter 1.

[0052] The plurality of light branches 3 are connected in parallel between the voltage output and the ground connection. Each light branch 3 comprises three LEDs 9 and a resistor 12 mounted in series with the LEDs 9.

[0053] The resistance value of the resistors 12 are chosen to cause a known voltage drop across the resistor, since the resistor value is much higher than the resistance values of the LEDs.

[0054] Figure 2 shows a detailed scheme of a portion of the temperature compensation circuit 2 of an automotive luminous device according to the invention.

[0055] The temperature compensation circuit 2 comprises a first portion and a second portion arranged in series.

[0056] The first portion of the temperature compensation circuit 2 has a circuit input connected to the voltage output 5 of the buck converter 1 and two regulation branches in parallel, arranged between the circuit input 7 and the intermediate node 16, wherein the first regulation branch comprises a thermistor 11 and an additional resistor 13, and the second regulation branch comprises a parallel connection of a capacitor 14 and a resistor 15.

[0057] The second portion of the temperature compensation circuit is connected to the intermediate node 16 and comprises a first connection branch connected to the circuit control pin 8 by the intermediation of a connection resistor 17, and a second connection branch, which comprises a bottom resistor 18 and is connected to the ground connection.

[0058] The values of the thermistor, the compensation resistor and the bottom resistor are configured to cause a voltage drop value in the first portion when an increase in operation temperature is produced, in such a way that the voltage drop value in the first portion is comprised between 0.8 times and 1.2 times the voltage drop caused in the electroluminescent light sources caused by the same increase in operation temperature.

[0059] Since the voltage drop across the LED is known for each LED as a function of the temperature, the voltage which is needed in each case to keep the voltage drop constant in the resistor is known. For example, at 25°C, for a given light flux required for a lighting function performed by the luminous device, the voltage drop across each LED 9 will be 2.1 V, and an intensity value of 50 mA is desired for the LEDs to perform the luminous function. To create a suitable total voltage drop value across

the light branch, a voltage drop of 1.5 V is desired across the resistor, so a resistor of $3\ \Omega$ is chosen. The required voltage drop across the light branch would be $3 \times 2.1 + 1.5 = 7.8\text{ V}$.

[0060] Hence, the characteristic of the thermistor 11, the value of the compensation resistor 13 and the value of the bottom resistor 18 are chosen so that the voltage drop across the temperature compensation circuit 2 is 7.8 V at 25°C. This voltage value is divided into the voltage value of the first portion and the voltage value of the second portion. The voltage value of the second portion is constant, so the values of the thermistor and the resistors of the first portion are chosen so that the total voltage value of the temperature compensation circuit 2 is 7.8 V.

[0061] When operation temperature increases, the forward voltage across LEDs 9 will decrease. For example, if temperature rises to 50°C, the voltage drop across each LED 9 will fall from 2.1 V to 1.7 V. If nothing changed upstream (i.e., if the temperature compensation circuit did not have any variable element and the voltage was fixed to 7.8 V), the resistor associated to the light branch would have to absorb this voltage variation, and this would cause the current value to increase, and this is not desired.

[0062] To face this situation, the invention provides a temperature compensation circuit with a thermistor configured to change its resistance value to a lower value when temperature increases, so that the voltage drop across the first portion of the temperature compensation circuit decreases to adapt to the voltage drop across the electroluminescent light sources. The current value remains constant, as it is defined by the constant voltage of the control output and the bottom resistance. In this case, the temperature compensation circuit should decrease by 1.2 V to adapt to the lower voltage value, which best fits to the new demand of the LEDs 9. This change is achieved by means of the change in the resistance value of the thermistor, which causes the first portion to change the equivalent impedance. Since the current in the temperature compensation circuit is constant and the equivalent impedance has decreased, the voltage drop across the first portion decreases, and, hence, the voltage drop across the entire compensation circuit decreases.

[0063] As may be seen in this figure, the outputs of all the first light sources of each light branch are in electric connection with the inputs of all the second light sources of each light branch and the outputs of the second light sources are in electric connection with the inputs of all the third light sources of each light branch are in electric connection. This matrix connection allows the operation of the remaining LEDs when one of them fails.

[0064] Figure 3 shows an automotive luminous device 10 according to the invention installed in an automotive vehicle 100.

[0065] This automotive luminous device 10 controls the operation of a great amount of LEDs 9 without an

overheating risk for the internal light driver. As a consequence, the performance of the LEDs 9 may be optimized without endangering the operation of the rest of the device.

Claims

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

- a voltage regulator (1) comprising a voltage input (4), a voltage output (5) and a control output (6), the voltage regulator (1) being also configured to provide a constant voltage value at the control output (6);
- a ground connection;
- a temperature compensation circuit (2); and
- at least one light branch (3) connected between the voltage output and the ground connection, each light branch comprising at least one electroluminescent light source (9) and at least one passive component, such as a resistor (12), mounted in series with the at least one electroluminescent light source (9), wherein an operation temperature increase causes a voltage drop decrease in the at least one electroluminescent light source (9);

wherein

- the temperature compensation circuit (2) comprises a first portion and a second portion arranged in series;
- the first portion of the temperature compensation circuit has a circuit input connected to the voltage output of the voltage regulator, comprises a NTC thermistor (11) arranged in series with at least one compensation resistor (13), and ends in an intermediate node (16);
- the second portion of the temperature compensation circuit (2) is connected to the intermediate node (16) and comprises a first connection branch which extends between the intermediate node (16) and the control output (6) and a second connection branch which comprises a bottom resistor (18) and extends between the intermediate node (16) and the ground connection; and
- the characteristic of the thermistor (11), the value of the compensation resistor (13) and the value of the bottom resistor (18) are configured to cause a compensation voltage decrease in the voltage drop across the first portion, such that the compensation voltage decrease is comprised between 0.5 times and 1.5 times the voltage drop decrease across the at least one electroluminescent light source (9) of the light

branches caused by the operation temperature increase.

2. Automotive luminous device (10) according to claim 1, wherein the voltage regulator (1) is configured to provide a voltage value in the voltage output (5) which is lower than the voltage value received at the voltage input (4). 5
3. Automotive luminous device (10) according to claim 2, wherein the voltage regulator is a buck converter. 10
4. Automotive luminous device (10) according to any of the preceding claims, wherein the automotive luminous device comprises more than one light branch (3), and the light branches (3) are connected in parallel between the voltage output (5) and the ground connection. 15
5. Automotive luminous device (10) according to any of the preceding claims, wherein the passive component is a resistor (12). 20
6. Automotive luminous device (10) according to any of the preceding claims, wherein the temperature compensation circuit (2) is integrated within the voltage regulator (1). 25
7. Automotive luminous device (10) according to any of the preceding claims, wherein the voltage regulator (1) is configured to produce a voltage output (5) comprised between a low threshold and a high threshold, wherein the high threshold is comprised between 1.1 and 2 times the low threshold. 30
8. Automotive luminous device (10) according to any of the preceding claims, wherein the thermistor (11) is a NTC or a PTC. 35
9. Automotive luminous device (10) according to any of the preceding claims, wherein the thermistor (11) and the at least one compensation resistor (13) are mounted in series between the circuit input (7) and the intermediate node (16). 40
10. Automotive luminous device (10) according to any of the preceding claims, wherein the first connection branch is constituted of a connection resistor (17) and the second connection branch is constituted of a bottom resistor (18). 45
11. Automotive luminous device (10) according to any of the preceding claims, wherein the first portion of the temperature compensation circuit comprises two regulation branches in parallel, arranged between the circuit input and the intermediate node, wherein the first regulation branch comprises the thermistor (11) and the compensation resistor (13), and the sec- 55

ond regulation branch comprises a parallel connection of a capacitor (14) and a resistor (15).

12. Automotive luminous device (10) according to any of the preceding claims, wherein each light branch (3) has the same number of electroluminescent light sources (9) and each branch has three light sources.
13. Automotive luminous device (10) according to claim 12, wherein each branch has an input and an output, and the three electroluminescent light sources are a first, a second and a third light source, each having an input and an output, all the inputs of the first light sources being electrically connected together, the outputs of all the first light sources of each light branch are in electric connection with the inputs of all the second light sources of each light branch, and the outputs of the second light sources are in electric connection with the inputs of all the third light sources of each light branch.
14. Automotive luminous device (10) according to any of the preceding claims, wherein the light sources (9) are configured to perform more than one different lighting function and the functions are dutytime running light and position light, or stop light and tail light.
15. Automotive luminous vehicle (100) comprising a battery and an automotive luminous device (10) according to any of the preceding claims, wherein the battery is configured to directly power the voltage regulator with a voltage input comprised between 5 and 16 V.

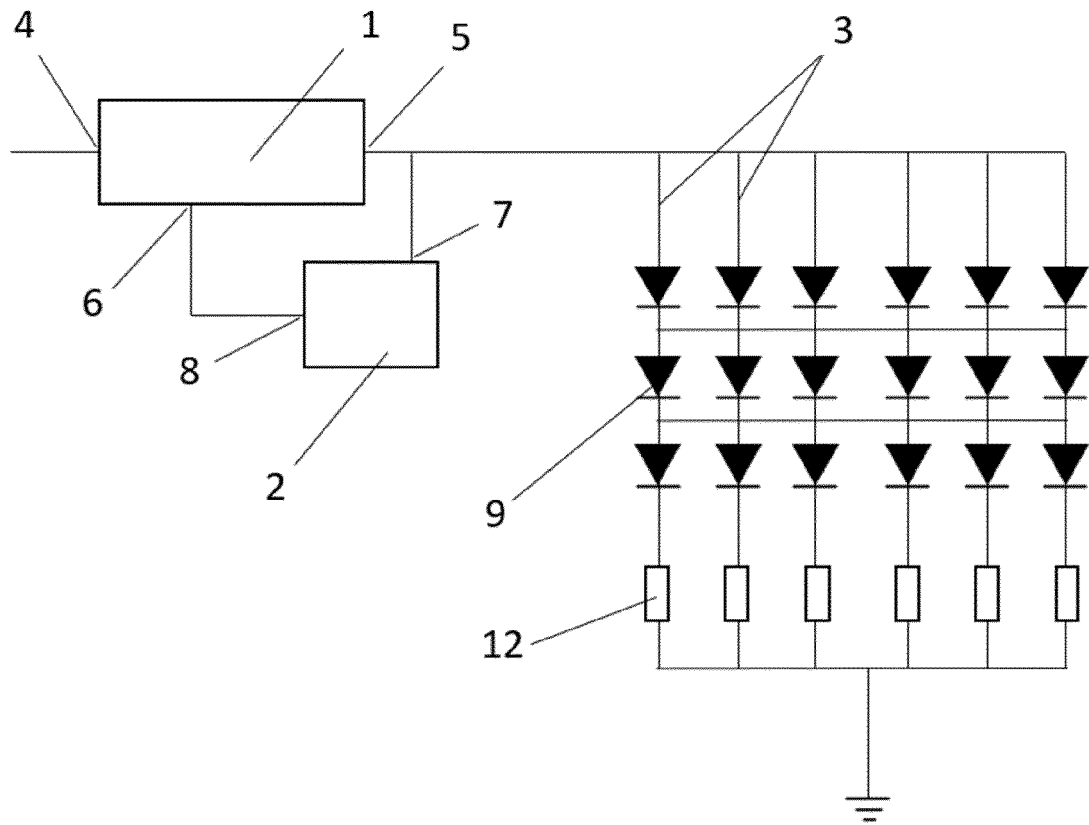


Fig. 1

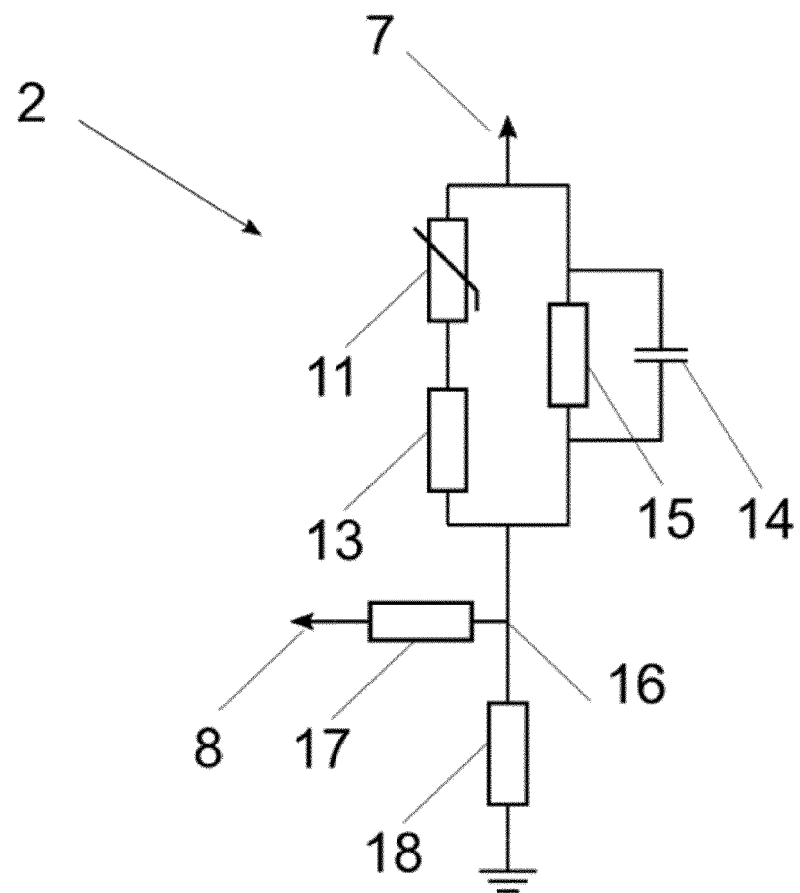


Fig. 2

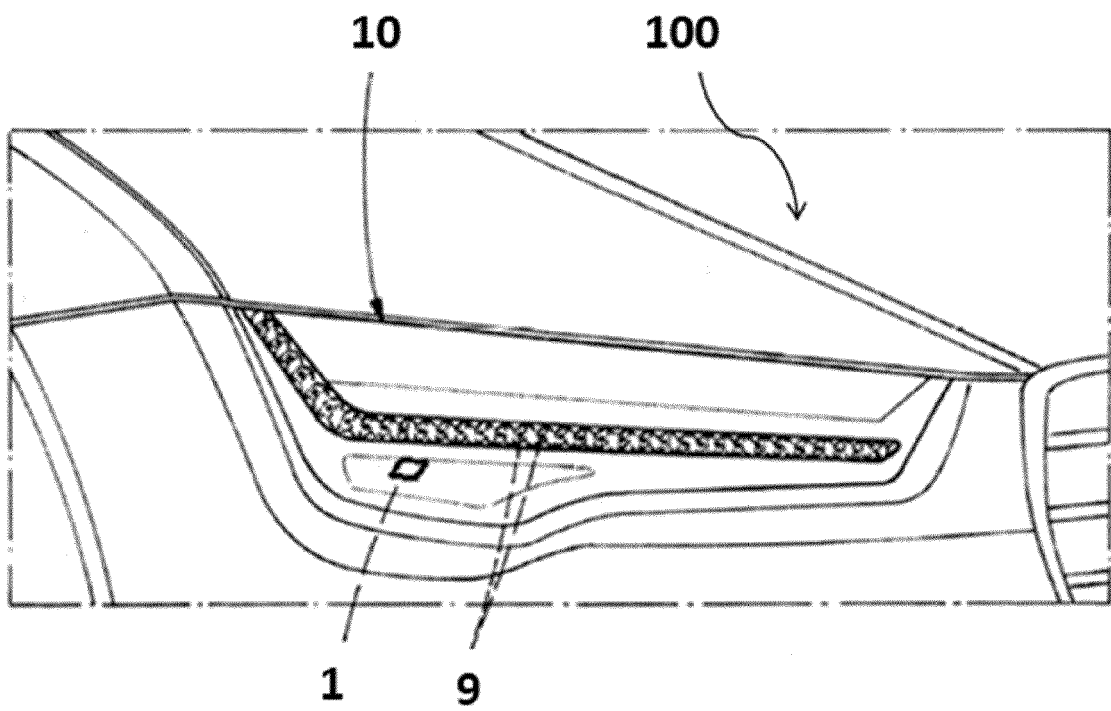


Fig. 3



EUROPEAN SEARCH REPORT

Application Number

EP 23 15 0048

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	* column 1, lines 18-20, 56-60 - column 6, lines 47-50; figures 1, 2 * * column 5, lines 17-22 - column 7, lines 5-15 * * column 9, lines 36-47 *	2-4, 6, 7, 11-13, 15	H05B45/375 H05B45/46
Y	EP 3 691 414 A1 (VALEO ILUMINACION SA [ES]) 5 August 2020 (2020-08-05) * claim 9; figures 1, 4 *	2-4, 6, 7, 9-12, 14, 15	
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The present search report has been drawn up for all claims			

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EPO FORM 1503 03.82 (P04C01)

Place of search

Munich

Date of completion of the search

16 May 2023

Examiner

Müller, Uta

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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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

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

EP 23 15 0048

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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 The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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