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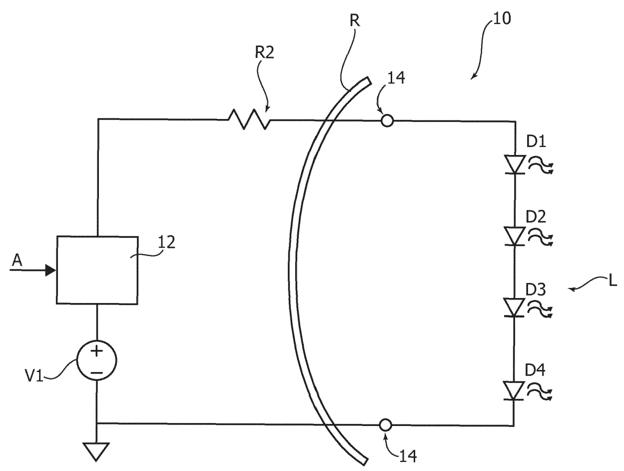
(54) A METHOD OF OPERATING LED LIGHTING SOURCES AND A LED LAMP FOR USE WITH SAID METHOD

(57) A LED lighting source (L) whose emission wavelength is a function of the current through the source (L) and the temperature of the source (L) is operated:
- in a first, e.g. direct current, lighting mode, wherein LED source (L) emits light radiation at a first wavelength, and
- in at least one second, e.g. pulsed, lighting mode, wherein the current through the source (L) and/or the temperature of the source (L) are varied with respect to said first lighting mode, whereby the LED source (L) emits light radiation at a second wavelength, said second wavelength being different from said first wavelength.

FIG. 1



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Description

Technical Field

[0001] The description relates to LED lighting sources.

[0002] One or more embodiments may find employment e.g. in the automotive sector, e.g. for emitting warning and/or alarm signals.

Technological Background

[0003] In various application fields, such as the automotive sector, it is possible to replace traditional light radiation sources with retrofit LED sources. To the purpose, compatibility features are offered as regards assembly and/or electrical connection, by using e.g. the same power line without disturbing the user and/or without the need to modify existing installations.

[0004] Thanks to the constant cost reduction of LED lighting sources, features and performances are currently available that traditional lamps are unable to achieve.

[0005] LED radiation sources may have the characteristic, which may be considered a drawback to be countered, of varying their emission wavelength, i.e. the colour of the emitted radiation, as a function of the temperature and/or of the supply current.

[0006] For example, US 2006/114201 A1 describes a method of correcting colour temperature change in a phosphor-converted LED by regulating the PWM cycle of the source.

[0007] Moreover, US 6 922 024 B2 describes the possibility of contrasting and suppressing the colour shift effect through the use of a filter.

[0008] Moreover, some documents have been published such as KR 20090097822 A, which describes the possibility of controlling the colour and the illuminance of a LED as a function of on an acceleration sensor, or such as CN 201566498 U, which describes a method of modifying the backlight colour of an instrument panel by varying the PWM as a function of a vehicle speed.

[0009] In addition, US 6 808 287 B2 describes the possibility of achieving a colour spectrum shift from blue to ultra-violet by sufficiently increasing the supply current.

Object and Summary

[0010] One or more embodiments aim at further developing the possibilities of employing LED light radiation sources as lighting sources.

[0011] According to one or more embodiments, said object may be achieved thanks to a method having the features specifically set forth in the claims that follow.

[0012] One or more embodiments may also concern a corresponding LED lamp.

[0013] The claims are an integral part of the technical teaching provided herein with reference to the embodiments.

[0014] One or more embodiments lead to the achievement of lighting devices, e.g. LED lamps, wherein the variation of the emission wavelength (colour shift) depending on current and/or temperature may be controlled and intentionally induced, e.g. in order to produce warning and/or alarm signals in sectors such as the automotive sector.

[0015] In one or more embodiments, such alarm signals may involve an intermitting and/or red light emission.

[0016] One or more embodiments achieve such operating modes via one LED lighting source (which may be either single or plural, i.e. comprising a LED string or cluster).

[0017] One or more embodiments achieve the above results while omitting colour selection filters, or a plurality of lamps of different kinds, or additional elements such as shutters or transparent screens of different colours.

Brief Description of the Figures

[0018] One or more embodiments will now be described, by way of non-limiting example only, with reference to the annexed Figure, which shows a possible circuit diagram of one or more embodiments.

Detailed Description

[0019] In the following description, numerous specific details are given to provide a thorough understanding of embodiments. One or more embodiments may be practiced without one or several of the specific details, or with other methods, components, materials, etc. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring the various aspects of the embodiments.

[0020] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the possible appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0021] The headings provided herein are for convenience only, and therefore do not interpret the extent of protection or the scope of the embodiments.

[0022] In the Figure, reference 10 denotes on the whole a LED lamp which may be employed, for instance, as a warning/alarm lamp in the automotive sector.

[0023] Lamp 10 includes a LED lighting source L, adapted to include one LED or a plurality of LEDs. For example, in the solution exemplified in the Figure source L includes four LEDs denoted as D1, D2, D3 and D4.

[0024] In one or more embodiments, light source L is adapted to be powered by a power source (which in the present case is exemplified as a voltage generator V1) which may be associated to a driver 12 adapted to operate e.g. as a function of a drive signal A, as better detailed in the following.

[0025] In one or more embodiments, signal A may be a warning or alarm signal.

[0026] Reference R2 denotes a shunt resistor adapted to be interposed between power source V1 and driver 12 and lighting source L.

[0027] Reference 14 schematically denotes clamps or terminals which may be employed for mounting source L, being adapted to establish both the electrical connection with the supply circuit V1, 12, R2 and the mechanical fixation of source L in a mounting housing thereof. Such a housing may comprise e.g. a reflector R of a headlamp, which may be mounted e.g. on board a vehicle (not visible in the drawings).

[0028] It will be appreciated that both the features of the supply circuit and the possible mounting conditions exemplified herein are in no way mandatory or limiting the scope of one or more embodiments.

[0029] For example (again by way of non-limiting example), in one or more embodiments the supply circuit may include the integration of source V1 and of driver 12 in one single circuit element, or a different arrangement of source V1 and circuit 12. In the same way, the use of shunt resistor R2 according to the ways better detailed in the following is by no way mandatory, because the corresponding function may be integrated in the functions of circuit 12. In the same way, reference to a possible mounting together with a reflector and/or in a vehicle headlamp is merely exemplary.

[0030] One or more embodiments may be based on the fact that, in lighting sources as the presently exemplified LED source, it is possible to take advantage of the colour shift of the emitted light radiation (i.e. of the wavelength around which, with a more or less clearly defined peak, light radiation is emitted), which may take place due to the variation of parameters such as the current (e.g. the average current) through lighting source L and/or the temperature (e.g. the junction temperature).

[0031] For example, in direct emission LED lighting sources, such as AlInGaP-based sources (which may be used e.g. in retrofit lamps in order to obtain a yellow light radiation emission around 595 nm), it is possible to observe:

- an increase of the wavelength of emitted radiation by approximately 10 nm when the current varies between a value slightly lower than 0.5 to a value of approximately 2.5 A,
- a wavelength shift in a range from approximately 6 nm to approximately +10 nm, when the temperature varies between approximately -20 and +120°C.

[0032] The above values refer to measurements taken at a temperature of 25°C for LEDs having a ceramic package which are marketed under the trademark OSLON SSL, LY CPDP by companies of the same group of the Applicants.

[0033] On such LED radiation sources, moreover, an increase of the luminous flux emitted with the current may be observed, up to a current value (e.g. 1.5 A) at which a peak of the corresponding flux takes place; afterwards a flux quenching occurs.

[0034] For example, measurements that have been carried out in the same conditions as above on the previously identified LEDs lead to the detection of a peak of flux increase by 250% with a pulsed current supply, the pulses having a length of 1 ms in the case of a rated current of 350 mA, with a maximum allowable direct current of approximately 1 A.

[0035] Moreover, it may be noticed that on the same components, thanks to the ability to operate with a direct supply up to the maximum current value, a pulsed operating mode may be employed by increasing the peak current and at the same time by reducing the pulse duty cycle down to a value of 2 A, i.e. approximately twice the current in direct current operation, while observing in this case too a clear variation of the emission wavelength.

[0036] In a possible embodiment, as shown in the Figure, lighting source L may include a plurality of LEDs (e.g. four) D1 - D4 with a ceramic package as described above, the power source V1 operating with direct voltage, e.g. with a voltage amounting to 13.5 Volt.

[0037] Referring to LEDs D1-D4 having, at a temperature of 25°C, a rated current of 350 mA with a voltage drop of 3 V across them, shunt resistor R2 (if present) may have a value of 10 Ohm. In this operating mode, the overall voltage drop across LEDs D1 to D4 may amount approximately to 11.4 V, the current flowing through the LEDs amounting approximately to 0.21 A and resistor R2 dissipating approximately 0.45 W.

[0038] As previously stated, circuit 12 may respond to a signal A adapted to indicate e.g. a warning/alarm condition, as detected e.g. by a vehicle control system (e.g. to signal that an airbag has been activated or any external control signal).

[0039] In one or more embodiments, at the reception of signal A circuit 12 may operate by switching the operating condition of source L from the previously described first lighting mode (e.g. with direct current supply) to a second lighting mode (e.g. with pulsed supply).

[0040] For example, circuit 12 may include a square (rectangular) wave oscillator, adapted to act by increasing the voltage and therefore the current applied to the LEDs, e.g. by applying on source L (on diodes D1 to D4, in the presently considered example) a pulsed voltage which meets the specifications of the LEDs constituting source L, so as to produce such a change of the LED current (and, at least indirectly, the temperature thereof) as to induce a shift in the emission wavelength.

[0041] For example, circuit 12 may be a square (rectangular) wave oscillator, adapted to supply a pulsed voltage of 35 Volt, with a current value of about 2 A, sot that the resistor R2 may dissipate around 2W. For example, current pulses may be produced having a value of 2 A and a duration of 1.5 ms, i.e. a duty cycle of D=0.05 referred to a period of 30 ms.

[0042] With such values (which of course are not to be construed as mandatory in the embodiments) a shift may be brought about, from a first lighting operating mode with a (direct) current of 200 mA, from a wavelength around 595 nm to a wavelength around 604 nm, i.e. a 9 nm-shift, between the first and the second lighting modes.

[0043] Such a shift may be perceived by an observer as a colour change of source L from yellow to a red, rapidly blinking light.

[0044] In one or more embodiments, the compliance with the specifications of the LEDs of the source (e.g. D1 to D4) enables a reversible operation, the possibility being given of switching operation from the first (e.g. direct current) operating mode to the second (e.g. pulsed) operating mode and then of returning to the first operating mode (e.g. when the alarm condition revealed by signal A has ceased) without jeopardizing the performance of source L.

[0045] In one or more embodiments, on the other hand, switching from the first operating mode to the second (alarm) operating mode may be irreversible.

[0046] For example, this may be envisaged if in the pulsed alarm operating mode the duty cycle and/or the current exceed maximum operating values allowable in the long term. In this way, it is possible to achieve even higher wavelength shifts, e.g. so that the colour of the light radiation emitted by lighting source L changes even more clearly, e.g. from yellow to a very bright green, by taking into account the thusly induced temperature variation.

[0047] For example, with reference to the previously exemplified quantitative values, a pulsed operation with current values up to 2.5 A may lead to a significant temperature change, so that the wavelength goes from 595 nm (first direct current operating mode) to around 615 nm, which corresponds to a quite bright red light.

[0048] In the case of ceramic LEDs, such an irreversible operating mode may moreover enable the emission of such a light radiation for a limited period of time, which however covers a sufficiently long time window, which may be chosen so that it corresponds to the duration of an alarm condition which varies from lamp to lamp.

[0049] One or more embodiments may find application together with LED lighting sources employing technologies other than previously quoted AlInGaP chips, with the consequent option to operate between wavelength values, and with wavelength value shifts, which are different from the above.

[0050] One or more embodiments may be applied both to direct emission LEDs and to non-direct emission LEDs, e.g. phosphor-converted LEDs.

[0051] One or more embodiments may find application in OLED (Organic LED) technology, because also these LEDs have features of emission wavelength variation which depend on current and temperature.

[0052] The reference to a first direct current operating mode and to a second pulsed operating mode is not to be construed as a limitation of the embodiments. In one or more embodiments it is possible to envisage e.g. either a direct current operation or a pulsed operation in both cases.

[0053] Moreover, in one or more embodiments, the presently considered operating modes may all be lighting modes, i.e. operating modes wherein source L actually performs a lighting action, e.g. of a vehicle headlamp.

[0054] In one or more embodiments, a pulsed operation (e.g. with PWM driving) may be used in order to compensate for undesirable wavelength shifts, which may be induced by room temperature. An example is the case, already discussed in the foregoing, of mounting light radiation source L in a vehicle headlamp, where significant temperature variations may take place e.g. because of a change of outdoor temperature (e.g. winter/summer).

[0055] In this case, a PWM driving may be used in order to cause the emission wavelength shift to correspond (only) to the desired shift, e.g. as a function of the reception of signal A.

[0056] As for the shape of the pulsed current which may be used to supply source L, it is possible to resort to waveforms other than rectangular, e.g. with Pulse Width Modulation (PWM). One or more embodiments may use regular shapes such as sinusoidal, triangular, sweep, gaussian, hypergaussian, or non-regular shapes deriving from the overlap, e.g., of several sinusoidal waveforms, or of waveforms of the same kind with different shape.

[0057] In one or more embodiments, switching from the first operating mode to (at least) one second operating mode may be brought about by acting on the waveform, the width, the frequency, the offset of the supply current applied to source L.

[0058] However, the possible applications of one or more embodiments are not limited to the emission of warning/alarm signals, as previously stated by way of example. One or more embodiments may be applied in order to obtain colour shifts (even in narrower variation ranges than previously exemplified), e.g. in order to adapt lighting to weather conditions: day/night, rain, snow etc.

[0059] Without prejudice to the basic principles, the implementation details and the embodiments may vary, even appreciably, with respect to what has been described herein by way of non-limiting example only, without departing from the extent of protection.

[0060] The extent of protection is defined by the annexed claims.

Claims

1. A method of operating a LED lighting source (L) whose emission wavelength is a function of the current through the source (L) and the temperature of the source (L),

the method including:

- powering the LED source (L) in a first lighting mode wherein the source (L) emits light radiation at a first wavelength, and
- powering the LED source (L) in at least one second lighting mode, wherein at least one of the current through the source (L) and the temperature of the source (L) is varied with respect to said first lighting mode, whereby the LED source (L) emits light radiation at a second wavelength, said second wavelength being different from said first wavelength.

2. The method of claims 1, including:

- switching operation of the LED source (L) from said first lighting mode to said at least one second lighting mode, and
- returning operation of the LED source (L) from said at least one second lighting mode to said first lighting mode.

3. The method of claim 1 or claim 2, including powering the LED source (L) with a DC current in said first lighting mode.

4. The method of any of the previous claims, including powering the LED source (L) with an alternate current in said at least one second lighting mode.

5. The method of claim 4, wherein said alternate current is a pulsed current, preferably a square-wave current.

6. The method of claim 4, wherein said alternate current is a pulsed current with pulses selected out of sinusoidal, triangular, sweep, gaussian, hypergaussian and combinations thereof.

7. The method of any of the previous claims, wherein powering the LED source (L) in said at least one second lighting mode includes varying at least one of a waveform shape, an amplitude, a frequency and an offset of said current with respect to said first lighting mode.

8. The method of any of the previous claims, including selectively controlling the duty-cycle of the current fed to the LED source (L) in at least one of said first lighting mode and said at least one second lighting mode.

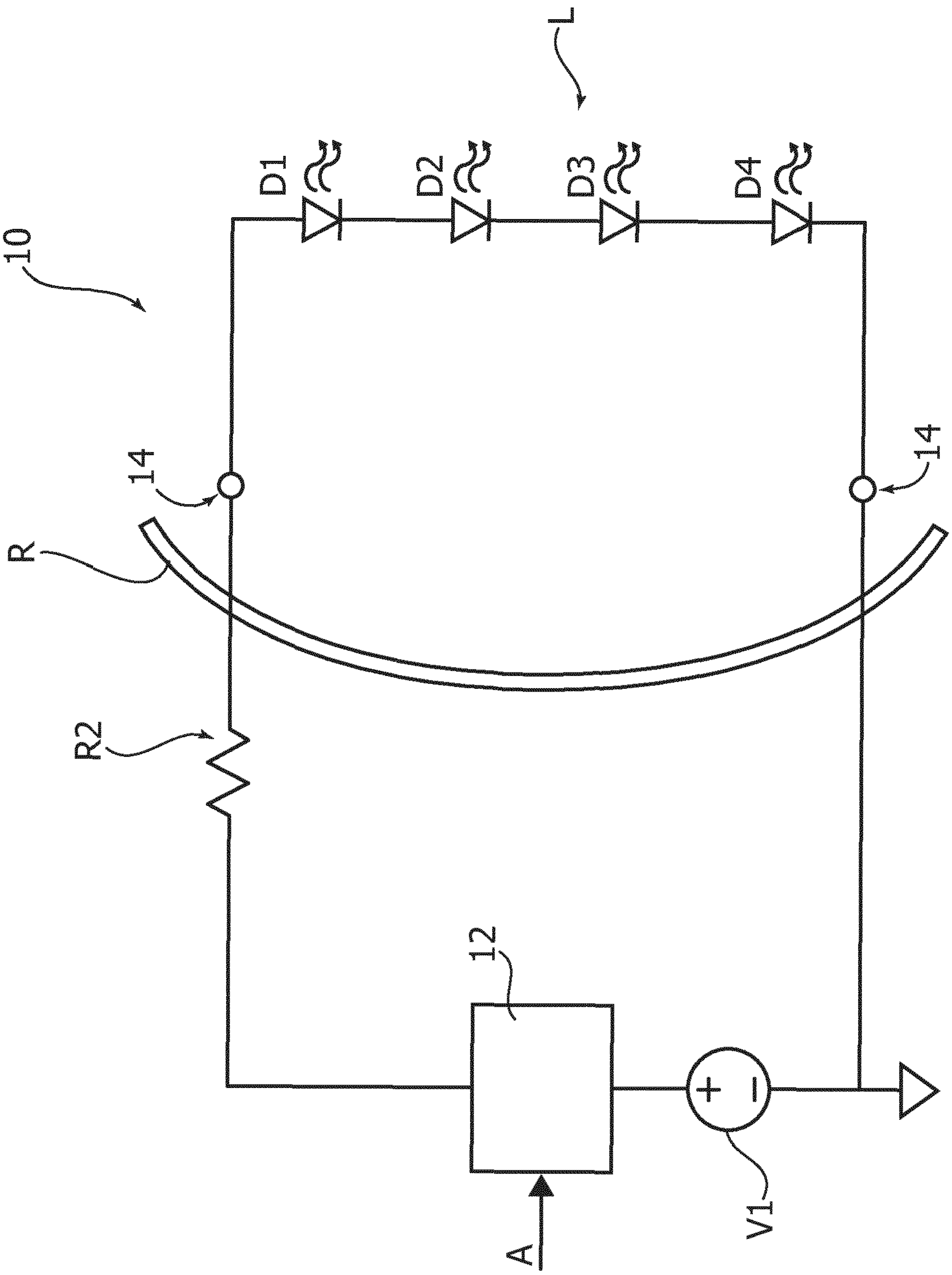
9. The method of any of the previous claims, including powering the LED source (L) in said at least one second lighting mode:

- to produce intermitting emission of light radiation at said second wavelength, and/or
- to produce emission of light radiation at said second wavelength as red light.

10. A LED lamp (10) operable with the method of any of claims 1 to 9, including:

- a LED lighting source (L), and
- an electrical power feed circuit (V1, 12, R2) for said LED source (L), the power feed circuit configured for:
- powering the LED source (L) in a first lighting mode, wherein the source (L) emits light radiation at a first wavelength, and
- powering the LED source (L) in at least one second lighting mode, wherein at least one of the current through the LED source (L) and the temperature of the LED source (L) is varied with respect to said first lighting mode, whereby the LED source (L) emits light radiation at a second wavelength, said second wavelength being different from said first wavelength.

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 16 18 3618

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2013/014568 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; PHILIPS INTELLECTUAL PROPERTY [DE]) 31 January 2013 (2013-01-31) * pages 8,16,17; figures 1, 4, 6 * -----	1-10	INV. H05B33/08
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TECHNICAL FIELDS SEARCHED (IPC)

H05B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	6 February 2017	Erskine, Andrew

CATEGORY OF CITED DOCUMENTS

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REFERENCES CITED IN THE DESCRIPTION

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