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(54) **An apparatus, a method and an arrangement for driving a light element requiring constant current**

(57) An apparatus for driving a light element is provided. The apparatus comprises a driver circuit connectable to a power supply, the driver circuit configured to provide two or more supply lines, each exhibiting a predetermined level of electric current. The apparatus further comprises a selector circuit for controlling the level of electric current at an output of the driver apparatus, the selector circuit configured to receive a control signal for controlling an internal state of the selector circuit, and to connect a supply line exhibiting a level of electric cur-

rent corresponding to the current internal state of the selector circuit to the output of the driver apparatus. Furthermore, a corresponding method is provided. Moreover, an arrangement for driving a light element is provided, the arrangement comprising the driver apparatus connectable to a power supply, and a control circuit coupled to the driver apparatus, the control circuit comprising a user-operable switch, closing of which is configured to provide a control signal for controlling an internal state of the selector circuit.

600

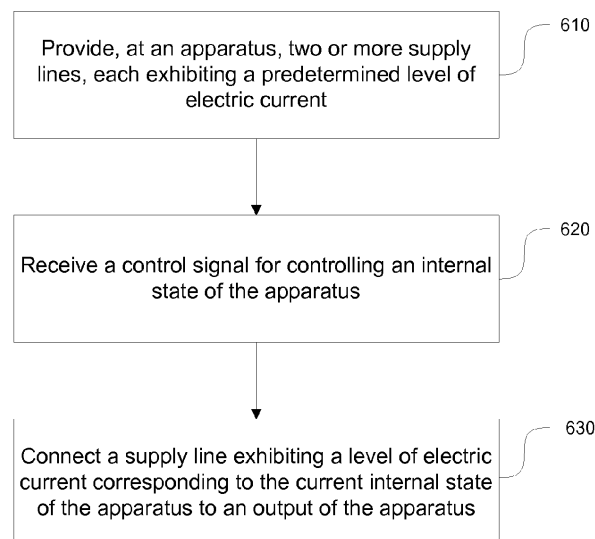


Figure 6

Description

FIELD OF THE INVENTION

[0001] The invention relates to a control of operation of a light element. In particular, the invention relates to an apparatus, a method and an arrangement for driving a light element requiring constant or essentially constant current, e.g. a light element comprising one or more light-emitting diodes (LED).

BACKGROUND OF THE INVENTION

[0002] Some light sources, for example light elements comprising one or more light-emitting diodes (LEDs) as light sources, typically require electric current that is constant or essentially constant in order to provide constant level of lighting. Consequently, for such a light source the power is typically supplied via a dedicated driver apparatus in order to ensure providing constant or essentially constant electric current at a desired level. However, different light sources may have different requirements for the level of constant or essentially constant electric current in order to provide the constant level of lighting at a desired lighting level, thereby calling for driver apparatuses of different type to cater for light sources of different characteristics. Moreover, selecting a lighting level may, in some applications or installations, be a desired feature of the lighting system, which may involve user-selection of the lighting level, e.g. setting a desired dimming level of a light source. Enabling adjustment or selection of the level of lighting provided by a light source as referred to hereinbefore may require a rather advanced driver apparatus and/or additional circuitry, possibly resulting in a relatively complex and/or relatively expensive solution

[0003] A driver apparatus may be configured to provide two or more output lines or output pins, each providing a different level of constant or essentially constant electric current. Consequently, a light source can be connected to the output line or output pin provided electric current at a desired level in view of the characteristics of the light source and/or the desired level of lighting during installation of the arrangement comprising the driver apparatus and the light source. While such a driver apparatus provides some flexibility in terms of being able to simultaneously provide multiple levels of electric current at different output lines, replacing the light source with one having different characteristics and/or changing the desired lighting level require changes to the installed arrangement or even re-installation of the arrangement. Moreover, such a driver apparatus does not enable user selection of the lighting level without an additional circuitry or apparatus.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide

an apparatus, a method and an arrangement for driving a light element requiring constant or essentially constant electric current for constant level of lighting, the apparatus, the method and the arrangement being simple in structure and inexpensive to manufacture, while at the same time enabling usage of light elements of different characteristics and convenient adjustment/selection of the lighting level.

[0005] The objects of the invention are reached by an apparatus, a method and an arrangement as defined by the respective independent claims.

[0006] According to a first aspect of the invention, an apparatus for driving a light element is provided. The apparatus comprises a driver circuit connectable to a power supply, the driver circuit configured to provide two or more supply lines, each exhibiting a predetermined level of electric current. The apparatus further comprises a selector circuit for controlling the level of electric current at an output of the driver apparatus, the selector circuit configured to receive a control signal for controlling an internal state of the selector circuit, and to connect a supply line exhibiting a level of electric current corresponding to the current internal state of the selector circuit to the output of the driver apparatus.

[0007] According to a second aspect of the invention a method for driving a light element is provided. The method comprises providing, at an apparatus, two or more supply lines, each exhibiting a predetermined level of electric current, receiving a control signal for controlling an internal state of the apparatus, and connecting a supply line exhibiting a level of electric current corresponding to the current internal state of the apparatus to an output line of the apparatus.

[0008] According to a third aspect of the invention, an arrangement for driving a light element is provided. The arrangement comprises a driver apparatus according to the first aspect of the invention, connectable to a power supply, and a control circuit coupled to the driver apparatus, the control circuit comprising a user-operable switch, closing of which is configured to provide a control signal for controlling an internal state of the selector circuit.

[0009] The exemplifying embodiments of the invention presented in this patent application are not to be interpreted to pose limitations to the applicability of the appended claims. The verb "to comprise" and its derivatives are used in this patent application as an open limitation that does not exclude the existence of also unrecited features. The features described hereinafter are mutually freely combinable unless explicitly stated otherwise.

[0010] The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Figure 1 schematically illustrates an exemplifying arrangement in accordance with an embodiment of the invention.

Figure 2 schematically illustrates an exemplifying driver apparatus in accordance with an embodiment of the invention.

Figure 3 schematically illustrates an exemplifying driver circuit in accordance with an embodiment of the invention.

Figure 4 schematically illustrates an exemplifying arrangement in accordance with an embodiment of the invention.

Figure 5 schematically illustrates an exemplifying driver apparatus in accordance with an embodiment of the invention.

Figure 6 illustrates a method in accordance with an embodiment of the invention.

DETAILED DESCRIPTION

[0012] Figure 1 schematically illustrates an exemplifying arrangement 100 comprising a power supply circuit 110, a driver device 120 and a light element 130. The power supply circuit 110 is configured to supply operating power to the driver device 120, which in turn is configured to drive the light element 130.

[0013] The power supply circuit 110 may be any power supply or a power converter that is able to provide suitable alternating current (AC) or direct current (DC) to the driver device 120. The driver device 120 is configured to make use of the input power supplied thereto from the power supply 110 into electric current exhibiting a desired - preferably constant or essentially constant - level to be provided for the light element 130 in order to enable provision of a constant level of lighting at a desired level. Moreover, the driver device 120 is preferably further configured to enable selecting the characteristics of the electric current provided to the light element 130 in accordance with the light element 130 (to be) coupled thereto. The selection can be made for example by a control signal issued at the driver device 120 via a control interface or by using a switch arranged in the driver device 120. The light element 130 may comprise for example one or more LED light sources, e.g. a string of LEDs.

[0014] Figure 2 schematically illustrates a driver apparatus 200 for driving a light element, such as the light element 130. The driver apparatus 200 may be configured to operate as the driver device 120 of the arrangement 100 or the driver device 120 may comprise the driv-

er apparatus 200. The driver apparatus 200 comprises a driver circuit 210 and a selector circuit 220, operatively coupled to the driver circuit 210.

[0015] The driver circuit 210 is connectable to a power source, for example to the power supply 110 of the arrangement 100. The driver circuit 210 is configured to provide two or more internal supply lines, each of the internal supply lines exhibiting a predetermined, constant or essentially constant level of electric current. As a non-limiting example, the driver circuit 210 may be configured to provide three supply lines, exhibiting constant or essentially constant levels of electric current at 700, 500 and 350 mA. Other levels of electric current within or outside this 'range' are equally applicable within the scope of the present invention.

[0016] The driver circuit 210 may be considered as a single logical entity, comprising one or more driver circuits 210 configured to provide the two or more internal supply lines configured to provide electric currents exhibiting respective predetermined levels. The driver circuit 210 may be further configured to provide further (internal) supply lines that provide electric currents having different characteristics, e.g. electric currents having variable level, etc.

[0017] Figure 3 schematically illustrates some details of an exemplifying driving circuit 310 that may be used as the driver circuit 210. The exemplifying driving circuit 310 provides three supply lines 312, 314 and 316, exhibiting constant or essentially constant levels of electric current at three different levels. The electric current provided to the supply lines 312, 314, 316 is based on constant or essentially constant current provided by a current setting portion 318. In particular, the electric current provided by the current setting portion 318 is directly provided to the supply line 312, whereas the electric current provided by the current setting portion 318 is provided to the supply line 314 via a resistor R1, and the electric current provided by the current setting portion 318 is provided to the supply line 316 via the resistor R1 and a resistor R2. The resistors R1 and R2 are selected such that they serve to limit the current provided to the supply lines 314 and 316 at the desired level. The supply lines 312, 314 and 316 may exhibit, for example, constant or essentially constant current at 700, 500 and 350 mA, respectively.

[0018] The driving circuit 310 serves merely as an example of a circuit for providing two or more supply lines exhibiting different levels of electric current and, consequently, a different circuit may be employed without departing from the scope of the present invention. As an example, a driver circuit comprising a dedicated current setting portion for each supply line to directly provide levels of electric current may be employed. Details of the current setting portion fall outside the scope of the present invention and are hence not described herein. Any current setting portion capable of providing electric current at constant or essentially constant level known in the art may be employed.

[0019] The selector circuit 220 is configured to control the level of electric current at an output line of the driver apparatus 200. The two or more internal supply lines provided by the driver circuit 210 may be coupled to the selector circuit 220, which in turn is configured to provide an output of the driver apparatus 200, or the selector circuit 220 may otherwise be arranged to control supply of the electric current from an internal supply line to the output of the driver apparatus 200.

[0020] The selector circuit 220 is configured to receive a control signal for controlling the internal state of the selector circuit 220. An internal state of the selector circuit 220, in turn, corresponds to a given level of electric current to be provided at the output of the driver apparatus 200, and the selector circuit 220 may be configured to couple or connect a supply line exhibiting electric current corresponding to the current internal state of the selector circuit 220 to the output of the driver apparatus 200.

[0021] As an example, an internal state of the selector circuit 220 may correspond to coupling or connecting one of the internal supply lines provided by the driver circuit 210 to the output of the driver apparatus 200. As another example, a further internal state of the selector circuit 220 may correspond to coupling or connecting none of the internal supply lines to the output of the driver apparatus 200. Coupling or connecting none of the internal supply lines to the output of the driver apparatus 200 may comprise for example providing electric current that is zero or essentially zero to the output of the driver apparatus 200 or coupling or connecting an external supply line - e.g. one not provided by the driver circuit 210 - to the output of the driver apparatus 200. Levels of electric current that the driver apparatus 200 may provide on basis of the internal supply lines and on basis of other sources, possibly including a zero current, may be referred to as available levels of electric current.

[0022] The selector circuit 220 may be considered as a multiplexing circuit controlling a switch that is configured to connect or couple one or none of the internal supply lines provided by the driver circuit 210 to the output of the apparatus 200. The selector circuit 220 may obtain the operating power it may require e.g. from/via the driver circuit 210 or directly from a power supply, e.g. the power supply 110 of the arrangement 100.

[0023] Reception of a control signal may comprise, for example, receiving a signal exhibiting a predetermined voltage and/or a predetermined electric current for at least a predetermined period of time. Such a control signal may originate e.g. from a control circuit including a switch, the control circuit being arranged to connect the selector circuit 220 to a power supply providing the predetermined voltage and/or the predetermined electric current, wherein upon closing the switch a control signal having a duration corresponding to the duration of the switch being in closed state is issued to the selector circuit 220. The switch may be operable by a user via a push button, pushing of which closes the switch and release of which opens the switch.

[0024] Figure 4 illustrates an arrangement 300 comprising the power supply 110, the driver apparatus 200, the light element 130 and the user-operable switch 340. The user-operable switch is coupled between the power supply 110 and the driver apparatus 220, thereby constituting a control circuit including a switch as described hereinbefore.

[0025] The user-operable switch 340 may be operable by a person who is installing the driver apparatus 200 or another component of the arrangement 300 in order to pre-select the internal state of the selector circuit 220 for subsequent use of a lighting system employing the driver apparatus 200 and/or the arrangement 300 by a common user. In other words, the switch 340 may be provided for professional use by a person installing the lighting system, while the user-operable switch 340 is not made available for a common user to operate after installation of the driver apparatus 200 and/or the arrangement 300. In such a scenario the pre-selected internal state of the selector circuit 220 may be chosen in accordance with the characteristics of the light element 130 and in view of the desired level of lighting, e.g. an internal state of the selector circuit 220 providing the highest available level of electric current tolerated by the light element may be selected to provide a maximum level of lighting under the circumstances.

[0026] Alternatively - or additionally - the user-operable switch 340 may be operable by a common user to enable selection of the internal state of the selector circuit 220. This may enable for example a discrete dimming function that makes use of the internal states of the selector circuit 220, each providing a different level of electric current to the light element, hence providing different levels of lighting in accordance with the currently employed internal state of the selector circuit 220. In such a scenario the light element 130 should be able to tolerate the maximum level of electric current provided by the driver apparatus 220.

[0027] The selector circuit 220 may be configured to change its internal state according to a predetermined rule in response to a control signal. As a first exemplifying rule, the predetermined rule may comprise a change towards a lower level of electric current such that in response to receiving a control signal the current internal state corresponding to a first level of electric current is changed into an internal state corresponding to a second level of electric current, which second level is the highest of the available levels that are smaller than the first level. The predetermined rule may further comprise, in case the first level is the lowest of the available levels of electric current, changing the internal state to the one corresponding to the highest one of the available levels. Alternatively, as a second exemplifying rule, the predetermined rule may comprise a change towards a higher level of electric current such that in response to receiving a control signal the change involves switching from a first level of electric current to a second level of electric current such that the second level is the lowest of the available

levels that are higher than the first level, with the further rule to switch from the highest of the available levels to the lowest one.

[0028] As an example, the selector circuit 220 applying the first exemplifying rule for controlling its internal state may be configured to provide electric current at one of the levels 700, 500, 350 and 0 mA, where the three first ones may be provided from the internal supply lines of the driver circuit 210 with the fourth one being provided independently of the driver circuit 210. These electric currents may be considered to correspond to the internal states 1, 2, 3 and 4, respectively. Hence, if currently in the internal state 3 corresponding to electric current at the level of 350 mA, the selector circuit 220 may be configured, in response to reception of a control signal, to change to the internal state 4 corresponding to electric current at level 0 mA e.g. by coupling the output of driver apparatus 200 to an internal reference line providing a zero current or by not coupling the output of the driver apparatus 200 to any of the supply lines. Moreover, if currently in the internal state 4 corresponding to electric current at level 0 mA, the selector circuit 220 may be configured, in response to reception of a control signal, to change to the internal state 1 corresponding to electric current at level 700 mA e.g. by coupling the output of the driver apparatus 200 to the internal supply line providing electric current at level 700 mA.

[0029] As a variation of the first or second exemplifying rule for controlling the internal state of the driver apparatus 200, the selector circuit may be configurable to exclude one or more of the internal states of the selector circuit 220 from the selection or setting the internal state. This may enable for example usage of a light element that is not able to operate at levels of electric current corresponding to said one or more internal states of the selector circuit 220. The excluded one or more internal states may be for example those corresponding to the highest levels of electric current available from the selector circuit 220.

[0030] Instead of applying a predetermined rule, the selector circuit 220 may be configured to directly select its internal state on basis of the characteristics of the control signal having predetermined characteristics with respect to electric current and/or voltage, as well as with respect to the (minimum and/or maximum) duration. Alternatively, the selector circuit 220 may be configured to directly select its internal state on basis of the characteristics of a sequence of such control signals received thereat. As an example, referring to the exemplifying internal states 1, 2, 3 and 4 described hereinbefore, the selector circuit 220 may be configured to switch to the internal state 1 in response to receiving a single control signal within a predetermined period of time, to switch to the internal state 2 in response to receiving two control signals within the predetermined period of time, etc. The predetermined period of time may be for example in the range from one second to three seconds, or other suitably short period of time.

[0031] Figure 5 schematically illustrates a driver apparatus 500 for driving a light element, such as the light element 130. The driver apparatus comprises the driver circuit 210, described in context of the driver apparatus 200, and a selector circuit 520, operatively coupled to the driver circuit 210. Figure 5 illustrates the driver apparatus 500 as a modification of the driver apparatus 220.

[0032] The selector circuit 520 is similar to the selector circuit 220, with the selector circuit 520 further being configured to receive a sensor signal and configured to change its internal state in response to the sensor signal.

[0033] In particular, the selector circuit 520 may be configured to change its internal state according to a second predetermined rule in response to receiving a sensor signal. As an example, the second predetermined rule may comprise a change towards a lower level of electric current such that the current internal state corresponding to a first level of electric current is changed into an internal state corresponding to a second level of electric current, which second level is the highest of the available levels that are smaller than the first level. Reception of a sensor signal may be considered as indication of an environmental condition in a location of interest, typically associated with the driver apparatus 500 or with a component or apparatus connected or coupled thereto, to have changed to extent requiring a change in the internal state of the selector circuit 520 in order to decrease the level of electric current provided from the driver apparatus 500.

[0034] As an example, the sensor signal may originate from a sensor apparatus comprising a temperature sensor, e.g. based on a negative temperature coefficient (NTC) thermistor. In such a scenario the sensor apparatus may be configured to provide a sensor signal in response to the current temperature in a location of interest, e.g. the temperature of the light element 130 or the temperature of the driver circuit 210, exceeding a predetermined threshold. Alternatively or additionally, a criterion different from a temperature exceeding a threshold may be applied to trigger the sensor apparatus to provide a sensor signal. The sensor apparatus may be configured e.g. to provide a sensor signal in response to the temperature in the location of interest exhibiting a rise exceeding a predetermined limit within a predetermined period of time.

[0035] As another example, alternatively or additionally, a sensor signal may originate from a sensor apparatus arranged to measure the level of ambient light in a location of interest. Such a sensor apparatus may comprise a photosensor, such as a photoresistor, a photodiode, a LED, etc. In such a scenario the sensor apparatus may be configured to provide a sensor signal in response to the measured level of ambient light in the location of interest exceeding a predetermined threshold.

[0036] In general, the selector circuit 520 may be configured to receive one or more sensor signals from one or more sensor apparatuses. The one or more sensor signals may originate from one or more sensor apparatuses configured to detect environmental conditions of

the same type or from one or more sensor apparatuses configured to detect environmental conditions of different type. Alternatively, the selector circuit 520 may be configured to receive a sensor signal comprising a value of a parameter that is indicative of an environmental condition in a location of interest. Consequently, the selector circuit 520 may be configured to change its internal state in accordance with the received value of the parameter. As an example, in an exemplifying case of the value of the parameter being indicative of the current temperature in the location of interest, the selector circuit 520 may be configured to change its internal state according to a (third) predetermined rule in response to the value of the parameter meeting a predetermined criterion. The selector circuit 520 may be, for example, configured to change to an internal state corresponding to a lower level of electric current in response to the value of the parameter indicating the current temperature in the location of interest exceeding a predetermined threshold and/or in response to the change in temperature within a predetermined period of time exceeding a predetermined threshold. As another example, in case the value of the parameter is indicative of the level of ambient light in the location of interest the selector circuit 520 may be configured to change its internal state according to a (fourth) predetermined rule in response to the value of the parameter meeting a predetermined criterion. For example, the selector circuit 520 may be configured to change to an internal state corresponding to a lower level of electric current in response to the value of the parameter indicating the level of ambient light in the location of interest exceeding a predetermined threshold.

[0037] The driver apparatus 200, 500 may be implemented as a dedicated apparatus or the driver apparatus 200, 500 may be implemented as a logical entity within another apparatus, for example the driver device 120.

[0038] Moreover, the operations, procedures and/or functions assigned to the structural units of the driver apparatus 200, 500, i.e. the driver circuit 210 and/or to the selector circuit 220, 520, as described hereinbefore may be divided between these units in a different manner, or the apparatus 200, 500 may comprise further units that may be configured to perform some of the operations, procedures and/or functions described hereinbefore for the driver circuit 210 and/or the selector circuit 220, 520.

[0039] On the other hand, the operations, procedures and/or functions the driver circuit 210 and to the selector circuit 220, 520 configured to perform may be assigned to a single processing unit within the apparatus 200, 500 instead. As an example, the apparatus 200, 500 for driving a light element may comprise means for providing two or more supply lines, each exhibiting a predetermined level of electric current, means for receiving a control signal for controlling an internal state of the selector circuit, and means for connecting a supply line exhibiting a level of electric current corresponding to the current internal state of the selector circuit.

[0040] The driver apparatus 200, 500 may be implemented as hardware alone, for example as an electric circuit, as an integrated circuit, as a programmable or non-programmable processor, as a microcontroller, etc.

[0041] Alternatively, the driver apparatus 200, 500 may have certain aspects implemented as software alone or implemented as a combination of hardware and software. In particular, certain aspects of the selector circuit 220, 520 may be implemented as software. The software may be stored in a memory of the driver apparatus 200, 500 or to a memory accessible by the driver apparatus 200, 500. The software may comprise a computer program comprising one or more sequences of one or more instructions that are configured to, when executed by one or more processors, cause an apparatus to implement operations, procedures and/or functions described hereinbefore in context of the driver apparatus 200, 500.

[0042] The operations, procedures and/or functions described hereinbefore in context of the driver apparatus 200, 500 may also be expressed as steps of a method implementing the corresponding operation, procedure and/or function. As an example, Figure 6 illustrates a method 600 in accordance with an embodiment of the invention. The method 600 may be arranged to driving a light element, the method 600 comprising providing, at an apparatus, two or more supply lines, each exhibiting a predetermined level of electric current, as indicated in step 610. The two or more supply lines may be provided for example by a driver circuit on basis of power supplied thereto by a power supply apparatus, as described hereinbefore in context of the driver circuit 210. The method 600 further comprises receiving a control signal for controlling an internal state of the apparatus, as indicated in step 620. Controlling the internal state of the apparatus may comprise controlling an internal state of a selector circuit by setting or changing the internal state of the selector circuit in response to receiving a control signal, as described hereinbefore in context of the selector circuits 220 and/or 520. The method 600 further comprises connecting a supply line exhibiting a level of electric current corresponding to the current internal state of the apparatus to an output of the apparatus, as indicated in step 630. Connecting may comprise connecting one of the provided two or more supply lines to an output line or to connecting none of the provided two or more supply lines to the output line in order to provide at the output line a level of electric current corresponding to the current internal state of the selector circuit, as described hereinbefore in context of the selector circuits 220 and/or 520.

[0043] The method 600 may further comprise receiving a sensor signal and changing the internal state of the selector circuit in response to the sensor signal, e.g. as described hereinbefore in context of the selector circuit 520.

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Claims

1. A driver apparatus for driving a light element, the apparatus comprising
a driver circuit connectable to a power supply, the driver circuit configured to provide two or more supply lines, each exhibiting a predetermined level of electric current,
characterized in that the driver apparatus comprises a selector circuit for controlling the level of electric current at an output of the driver apparatus, the selector circuit configured to
receive a control signal for controlling an internal state of the selector circuit, and
connect a supply line exhibiting a level of electric current corresponding to the current internal state of the selector circuit to the output of the driver apparatus.
2. An apparatus according to claim 1, wherein the selector circuit is configured to change its internal state according to a predetermined rule in response to receiving a control signal.
3. An apparatus according to claim 1 or 2, wherein an internal state of the selector circuit corresponds to connecting one of the two or more supply lines provided by the driver circuit to the output of the driver apparatus.
4. An apparatus according to claim 3, wherein an internal state of the selector circuit corresponds to connecting none of the two or more supply lines provided by the driver circuit to the output of the driver apparatus.
5. An apparatus according to any of claims 1 to 4, wherein the selector circuit is further configured to receive a sensor signal and configured to change its internal state in response to the sensor signal.
6. An apparatus according to claim 5, wherein the selector circuit is configured to change its internal state according to a second predetermined rule in response to receiving a sensor signal.
7. An apparatus according claim 6, wherein the sensor signal is indicative of a temperature of the driver circuit or the temperature of the light element exceeding a predetermined threshold, and wherein the second predetermined rule comprises changing the internal state to one corresponding to connecting a supply line exhibiting a level of electric current lower than that of the current internal state.
8. An apparatus according to claim 5, wherein the sensor signal indicates a value of a parameter indicative of an environmental condition and wherein the selector circuit is configured to change its internal state in accordance with said value.
9. A method for driving a light element, the method comprising
providing, at an apparatus, two or more supply lines, each exhibiting a predetermined level of electric current,
characterized in that the method further comprises receiving a control signal for controlling an internal state of the apparatus, and
connecting a supply line exhibiting a level of electric current corresponding to the current internal state of the apparatus to an output line of the apparatus.
10. An arrangement for driving a light element, the arrangement comprising
a driver apparatus according to any of claims 1 to 8, connectable to a power supply, and
a control circuit coupled to the driver apparatus, the control circuit comprising a user-operable switch, closing of which is configured to provide a control signal for controlling an internal state of the selector circuit.
11. An arrangement according to claim 10, further comprising a light element coupled to the output of the driver apparatus.

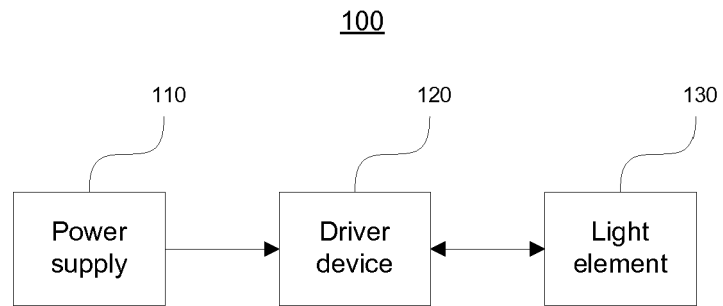


Figure 1

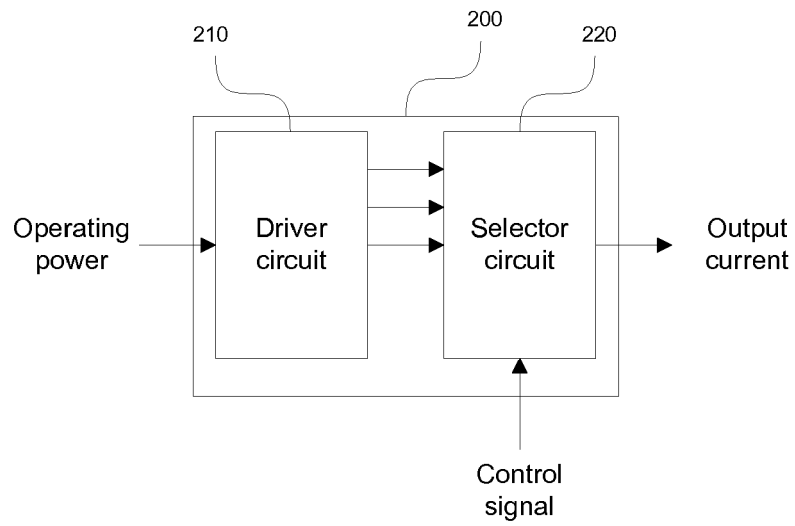


Figure 2

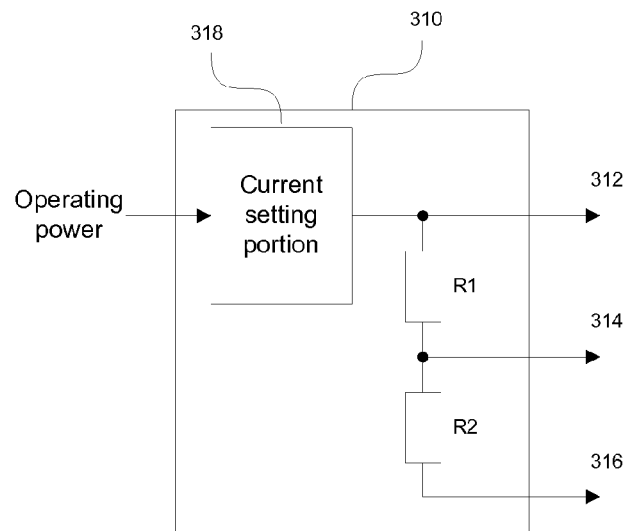


Figure 3

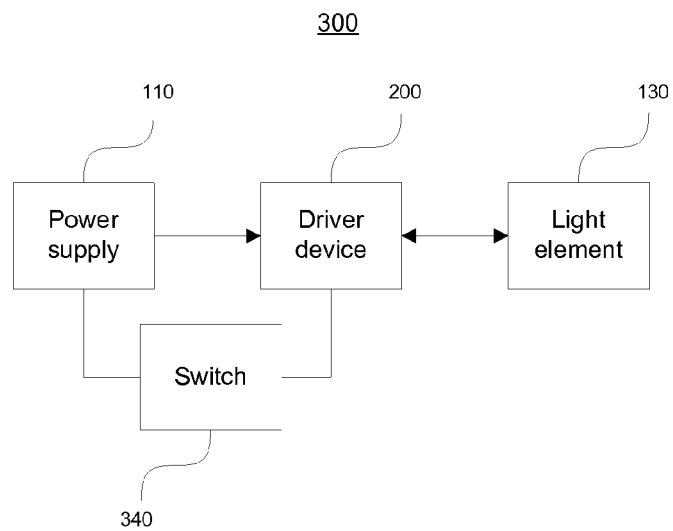


Figure 4

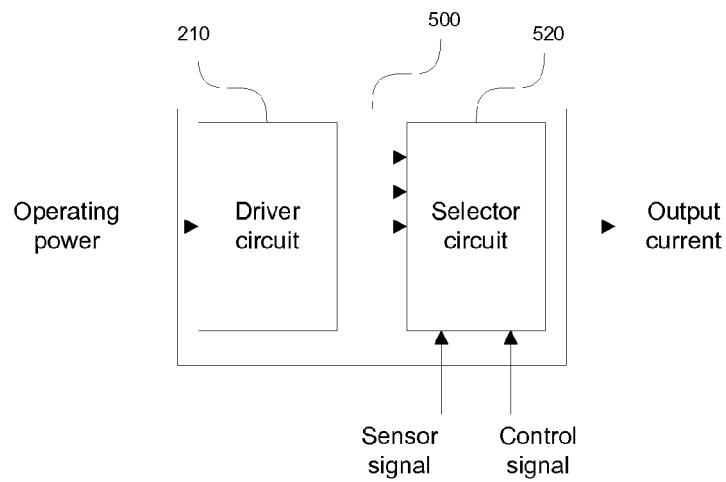


Figure 5

600

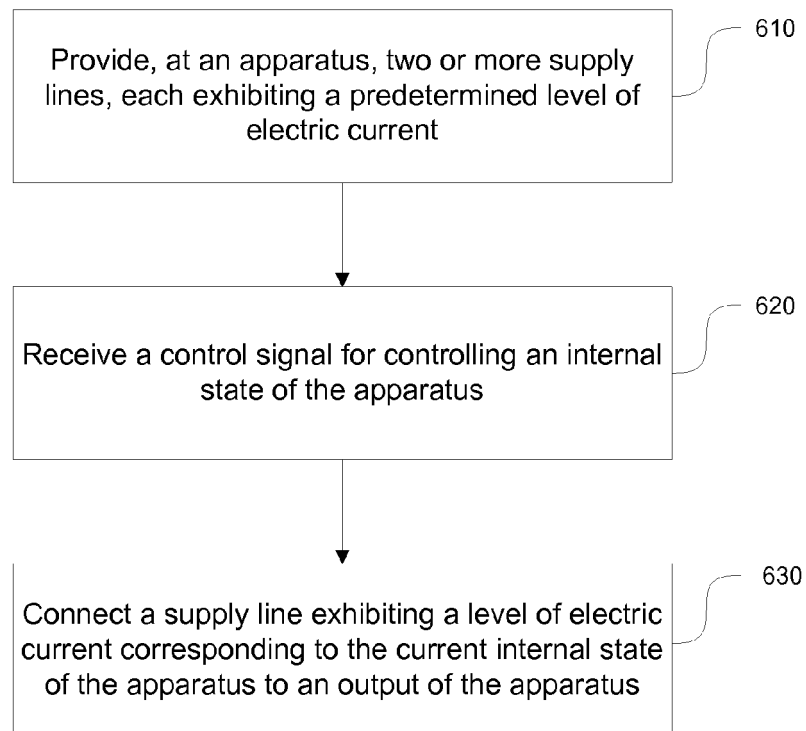


Figure 6



EUROPEAN SEARCH REPORT

Application Number
EP 12 17 0449

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	US 2006/274469 A1 (NIELSEN BRADLEY L [US] NIELSEN BRADLEY LYNN [US]) 7 December 2006 (2006-12-07) * the whole document *	1-11	INV. H05B33/08 G09G3/34
X	SUROSO ET AL: "Common-emitter topology of multilevel current-source pulse width modulation inverter with chopper-based DC current sources", THE INSTITUTION OF ENGINEERING AND TECHNOLOGY. JOURNAL,, vol. 4, no. 7, 2 August 2011 (2011-08-02), pages 759-766, XP006038683, ISSN: 1755-4543, DOI: 10.1049/IET-PEL:20100008 * the whole document *	1-11	
			TECHNICAL FIELDS SEARCHED (IPC)
			H05B G09G
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 July 2012	Examiner Bader, Arnaud
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EPO FORM 1503 03.02 (P04C01)

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

EP 12 17 0449

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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16-07-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006274469 A1	07-12-2006	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82