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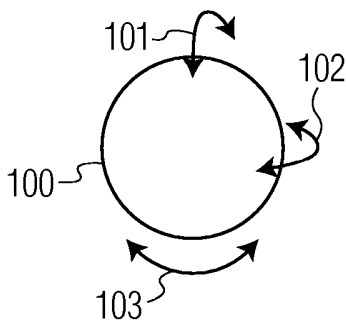
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

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(54) Title: MULTI-DIMENSIONAL CONTROL OF LIGHTING PARAMETERS



(57) Abstract: A multi-dimensional controller (150) controls the multiple parameters of a lighting system (250). A track-ball (100) that provides three axes of rotation (101-103), for example, is used to control each of three lighting parameters, such as chrominance, luminance, and saturation. In like manner, intensity, direction, and diffusion control may be controlled by a device with three degrees of freedom/control. Force-feedback (120) is optionally provided to indicate divergence from established presets (220) or recommended operating conditions. Switches (130) and other control elements are also provided to store or recall preset parameters (220), override scheduled lighting settings, and so on.

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MULTI-DIMENSIONAL CONTROL OF LIGHTING PARAMETERS

This invention relates to the field of lighting systems, and in particular to a multi-dimensional control system for varying lighting parameters.

5 The lighting of an environment has a significant effect on the ambiance associated with the environment. Environments conducive to reading are typically brightly lit; environments conducive to romance are typically dimly lit; and so on. In addition to the luminance level, the chromatic content also affects the ambiance of the environment. A yellow or red tinted light is generally considered to be "warmer" than a blue tinted light. Similarly, the saturation (white content) of the light and other
10 parameters, such as the degree of dispersion of the light, will affect the ambiance.

Conventional lighting systems use variable control switches to set the parameters for the desired lighting effect. In a home environment, different on/off switches or variable dimmers are used to control each light or set of lights to achieve the desired effect. In a theatre environment, a control panel containing numerous sliding or rotating controls knobs is typically used to achieve the desired
15 effect.

European Published Application 0192882, "LIGHT SOURCE HAVING AUTOMATICALLY VARIABLE HUE, SATURATION, AND BEAM DIVERGENCE", filed 30 October 1985, discloses a light fixture wherein different filters and lenses can be oriented relative to a source of white light to vary the hue, saturation, and divergence of the projected light, and is
20 incorporated by reference herein. As in typical embodiments of the era, the control panel for the variable light source includes sliding and rotating control knobs.

Increasingly, computers are being used to store sets of lighting parameters that can be recalled via a single command to achieve a desired effect.

U.S. Published Patent Application 2003/0057887, "SYSTEMS AND METHODS OF
25 CONTROLLING LIGHT SYSTEMS", filed 13 June 2002, discloses a multi-light system wherein the color and intensity of each light, or sets of lights, is controlled from a central controller via wireless communications, and is incorporated by reference herein. A graphic representation of the environment being controlled is preferably used to select and assign control parameters for each light or set of lights. These parameters are stored in a file, and "played back" (i.e. read from the file and
30 communicated to the lights) when desired. The playback may be initiated directly by a user, or programmed to occur according to a defined schedule.

It is an object of this invention to provide an interface for controlling multiple parameters of a light source. It is a further object of this invention to provide an interface for controlling multiple parameters of a light source that is compatible with both manual and computer controlled lighting
35 systems. It is a further object of this invention to provide an interface for controlling multiple

parameters of a light source that is easy and intuitive to use, and optionally provides feedback during use.

These objects and others are achieved by providing a multi-dimensional controller for controlling the multiple parameters of a lighting system. A track-ball that provides three axes of rotation, for example, is used to control each of three lighting parameters, such as chrominance, luminance, and saturation. In like manner, intensity, direction, and diffusion control may be controlled by a device with three degrees of freedom/control. Force-feedback is optionally provided to indicate divergence from established presets or recommended operating conditions. Switches and other control elements are also provided to store or recall preset parameters, override scheduled lighting settings, and so on.

The invention is explained in further detail, and by way of example, with reference to the accompanying drawings wherein:

FIGs. 1A-1E illustrate example embodiments of a three-dimensional track-ball for use in this invention.

FIG. 2 illustrates an example block diagram of a lighting control system in accordance with this invention.

FIG. 3 illustrates an example flow diagram of a lighting control system in accordance with this invention.

Throughout the drawings, the same reference numeral refers to the same element, or an element that performs substantially the same function. The drawings are included for illustrative purposes and are not intended to limit the scope of the invention.

The invention includes a multi-dimensional input device that is used to control multiple parameters in a lighting system. For ease of presentation and understanding, the invention is presented using a track-ball as a paradigm for a multi-dimensional input device. One of ordinary skill in the art will recognize that any of a variety of multi-dimensional input devices may be used, including, for example, a conventional joystick, mouse, and so on, as well as more advanced devices, such as virtual-reality (VR) gloves, suits, headgear, and so on. One of ordinary skill in the art will also realize that although a track-ball is a "relative location" or "motion-based" input device, like a mouse, the principles of this invention are equally applicable using an "absolute location" or "position-based" device, such as a graphics tablet wherein the absolute location of a pointing device on the surface of the tablet defines a two-dimensional coordinate. In like manner, the term "dimension" is used herein in the general sense, and includes any distinguishable aspect about which motion can be detected. For example, in a three-dimensional space, the dimensions may be up-down, left-right, and forward-back; in a spherical space, the dimensions may be roll, pitch, and yaw; in a fixed space, the dimensions may be stress and torque; and so on.

FIGS. 1A-1E illustrate example embodiments of a three-dimensional track-ball for use in this invention. FIG. 1A illustrates an example ball 100 that can rotate in any combination of directions 101, 102, 103. This ball 100 may contain internal inertial sensors that report movement of the ball 100, but in a more traditional embodiment, the ball 100 is mounted in a base 110 that includes sensors 111, 112, and 113 that are configured to report motion in each of the directions 101, 102, 103, respectively, as illustrated in FIG. 1B. The example sensors 111, 112, and 113 include rollers that are tangent to the ball 100, and rotate in each of three orthogonal directions, and sensing devices, such as optical pickups that communicate pulses or other signals corresponding to the rotation. A controller (150 of FIG. 2), discussed further below, receives these signals, from which a magnitude of movement of the ball 100 can be determined.

FIG. 1C illustrates another aspect of this invention, wherein a feedback element 120 is included in the multi-dimensional input device. For ease of understanding, the feedback element 120 is illustrated as being movable in a direction perpendicular to the surface of the ball 100, so as to exert a force that provides resistance to the rotation of the ball. One of ordinary skill in the art will recognize that other arrangements can be used to provide more selective feedback; for example, an arrangement that resists motion of the ball in a particular direction or combination of directions. In like manner, if a VR-glove is used as the multi-dimensional input device, the tension on elements of the glove can be selectively controlled to resist, or assist, motion in particular directions.

FIG. 1D illustrates another aspect of this invention, wherein a switch device 130 is included in the multi-dimensional input device. In this example, the switch device 130 may be a microswitch that is located beneath the ball 100, and reacts to vertical pressure being exerted on the ball by a user. Other switch arrangements will be obvious to one of ordinary skill in the art, including switches that are independent of the ball 100.

FIG. 1E illustrates another aspect of this invention, wherein a light element 140 is included in the multi-dimensional input device. In this example, the ball 100 is translucent, and the light element 140 is configured to project light to the ball 100 based on parameters determined by motion of the ball 100. Preferably, the projected light corresponds to the lighting effects that the multi-dimensional input device is producing, or will produce, in an actual environment.

FIG. 2 illustrates an example block diagram of a multi-dimensional light controller in accordance with this invention. A controller 150 receives signals from motion sensors 111, 112, etc. in a multi-dimensional input device. Note that although the reference numerals correspond to the motion sensors in the example track-ball of FIG. 1, for ease of understanding, these sensors in FIG. 2 correspond to any sensor in a multi-dimensional input device, such as inertial sensors, tension sensors, proximity sensors, and the like.

The controller 150 processes the signals from the sensors 111, 112, as well as from any switches 130, as discussed further below with respect to FIG. 3, to determine light-parameter values

corresponding to the signals from the input device. The controller 150 communicates these parameters to a light controller 250 that is configured to apply the appropriate control to one or more lights 211 corresponding to these parameters. For example, rotating the ball 100 of FIG. 1A in direction 101 may control the brightness or luminance of the lights, rotating the ball in direction 102 may control the
5 color or chrominance of the lights, and rotating the ball in direction 103 may control the whiteness or saturation of the lights. If there are more controllable features on the lights than dimensions available on the multi-dimensional input device, a switch 130 may be configured to reassign the mapping of the input signals to particular light-parameter values. For example, a set of inputs that control the flashing, blinking, or sequencing of the lights may be enabled by controlling a switch on the input
10 device.

The communication between the controller 150 and the controller 250 may be via any of a variety of wired or wireless means, including direct connection, radio, infrared, and so on. In a preferred embodiment of this system, the input device and the lighting system are each compatible with a home-networking protocol, and the controllers 150, 250 communicate via a corresponding
15 home-network. In a self-contained system, the controllers 150, 250 may be included within the same device, and, in some embodiments, the controllers 150, 250 are embodied as a single processing device, and the 'communication' of the parameters is via registers or memory elements within the processor as each functional block of software code is executed.

The controller 150 is also optionally configured to control a feedback device 120, as
20 discussed further below.

In a preferred embodiment of this invention, sets of defined parameter values are stored as presets 220, to allow a user to quickly set the lights 211 to achieve a predefined effect. This preset option may be provided within the multi-dimensional input device, or within the lighting control. In either embodiment, the multi-dimensional input device includes a control, typically a switch 130, that
25 allows the user to store the current parameters as a preset 220. If multiple presets 220 are provided, the switch 130 may be configured to enable one of the dimensions of the input device to 'scroll' through each preset. As noted above, the input device may include a light 140 that is also controlled by the light control 250. Optionally, the controller 250 can be configured to control the light 140 independently of the lights 211 while the user is scrolling through the presets, or otherwise searching
30 for a desired effect. When the user signals that the desired effect has been achieved, as shown by the light 140, the controller 150 enables the light controller 250 to apply the same settings to the lights 211. The controller 150, or the controller 250, also optionally includes a scheduler that is configured to activate a preset 220 at a given time, or a sequence of presets 220 at scheduled times.

FIG. 3 illustrates an example flow diagram for use in a controller 150 in accordance with this
35 invention. At 310, the controller detects activity from one or more sensors or switches on a multi-dimensional input device.

When an activity is detected, the controller executes the loop 320-335 for each dimension of the input device. In a preferred embodiment of this invention, the controller allows a user to selectively enable one or more of the input dimensions, so that, for example, the user can choose to only affect the luminance of the lighting system, and keep the other lighting effects fixed at their current setting. At 335, each dimension is checked to see if movements in that dimension are enabled to affect its corresponding parameter. If it is enabled, the lighting-parameter corresponding to the enabled direction is updated, based on any movement in the enabled direction.

After all of the input dimensions are processed, the controller processes each switch input, via the loop 340-355. Depending upon the current mode of the input device, some switches may be disabled from affecting the operation of the input device. At 345, each switch is checked to see if it is enabled, and if so, the operation controlled by the state of the switch is executed, at 350. As noted above, a switch may effect the storing or recall of preset parameters, thereby storing or overriding the lighting-parameter values set at 330.

After all of the switches, if any, are processed, each lighting-parameter is applied to the lighting system, via the loop 360-375. At 365, the lighting-effect corresponding to the parameter is controlled. As noted above, this control may affect the luminance, chrominance, saturation, etc. of the entire lighting system, or it may be limited to select lights, such as an optional light source in the input device, depending upon the current mode of the input device, or the current mode of the lighting system.

At 370, the controller optionally controls one or more feedback devices based on one or more of the lighting-parameters. For example, the failure rate of most lights is dependent upon the luminance level. A feedback device could be configured to provide increasing resistance to a continued increase in luminance, to discourage high luminance levels. In another example, the resistance could increase based on the difference from a selected preset. Similarly, using an 'expert systems' approach, the resistance could be based on sets of rules provided by the user, or provided by third-party experts in lighting effects. Such an expert system approach is particularly well suited for use in a professional lighting setting, such as a theatre, to reduce the likelihood of errors, and/or to reduce the amount of skill or training required to operate the system.

After all of the parameters are applied to the lighting system and optional feedback system, the controller returns to 310 to receive the next input from the input device and to repeat the above process.

The foregoing merely illustrates the principles of the invention. It will thus be appreciated that those skilled in the art will be able to devise various arrangements which, although not explicitly described or shown herein, embody the principles of the invention and are thus within the spirit and scope of the following claims.

In interpreting these claims, it should be understood that:

a) the word "comprising" does not exclude the presence of other elements or acts than those listed in a given claim;

b) the word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements;

5 c) any reference signs in the claims do not limit their scope;

d) several "means" may be represented by the same item or hardware or software implemented structure or function;

10 e) each of the disclosed elements may be comprised of hardware portions (e.g., including discrete and integrated electronic circuitry), software portions (e.g., computer programming), and any combination thereof;

f) hardware portions may be comprised of one or both of analog and digital portions;

g) any of the disclosed devices or portions thereof may be combined together or separated into further portions unless specifically stated otherwise;

h) no specific sequence of acts is intended to be required unless specifically indicated; and

15 i) the term "plurality of" an element includes two or more of the claimed element, and does not imply any particular range of number of elements; that is, a plurality of elements may merely include two elements.

CLAIMS:

1. A lighting control system comprising:

an input device (1A-1E) that is configured to detect motion in a plurality of dimensions (101-103), and

a controller (150) that is configured to:

map the motion in each of the plurality of dimensions (101-103) to corresponding lighting-parameters, and

communicate one or more of the lighting-parameters to a lighting system (250), to effect a change of lighting-effects at one or more lights (211, 212, 220), corresponding to the one or more lighting-parameters.

2. The system of claim 1, further comprising

the lighting system (250).

3. The system of claim 1, wherein

the input device (1A-1E) includes one or more feedback elements (120) that are configured to restrict the motion in one or more of the plurality of dimensions (101-103), and

the controller (150) is further configured to control the one or more feedback elements (120) based on the lighting-parameters.

4. The system of claim 3, wherein

the controller (150) is configured to control the one or more feedback elements (120) based on one or more of:

one or more rules associated with one or more of the lighting-parameters, and

a difference between one or more of the lighting-parameters and one or more predefined lighting-parameters (220).

5. The system of claim 1, further including:

one or more input switches (130), operably coupled to the controller (150).

6. The system of claim 5, further including
 - a memory that is configured to store one or more sets of lighting-parameters (220),
 - wherein
 - the controller (150) is configured to:
 - store the lighting-parameters to the memory based on a status of the one or more switches (130), and
 - recall the lighting-parameters from the memory based on the status of the one or more switches (130).
7. The system of claim 1, further including
 - one or more lights (211, 212, 220) that are controlled by the lighting system (250).
8. The system of claim 7, wherein
 - the input device (1A-1E) includes at least one (220) of the one or more lights (211, 212, 220).
9. The system of claim 1, wherein
 - the input device (1A-1E) includes a track-ball (100).
10. The system of claim 9, wherein
 - the track-ball (100) is configured to detect motion in three dimensions (101-103).
11. A method of controlling a lighting system (250) comprising:
 - receiving input (310) from an input device (1A-1E) that is configured to detect motion in a plurality of dimensions (101-103),
 - mapping (320-335) the motion in each of the plurality of dimensions (101-103) to corresponding lighting-parameters, and
 - communicating one or more of the lighting-parameters to the lighting system (250), to effect a change of lighting-effects at one or more lights (211, 212, 220), corresponding to the one or more lighting-parameters.
12. The method of claim 11, further comprising
 - receiving the one or more lighting-parameters at the lighting system (250), and
 - changing (365) the lighting-effects based on the one or more lighting-parameters.

13. The method of claim 1, further comprising
controlling (370) one or more feedback elements (120) that are configured to restrict the motion in one or more of the plurality of dimensions (101-103) in the input device (1A-1E) based on the lighting-parameters.
14. The method of claim 13, wherein
controlling (370) the one or more feedback elements (120) includes
applying one or more rules associated with one or more of the lighting-parameters to determine an amount of restriction of the motion.
15. The method of claim 13, wherein
controlling (370) the one or more feedback elements (120) includes
determining a difference between one or more of the lighting-parameters and one or more predefined lighting-parameters (220) to determine an amount of restriction of the motion.
16. The method of claim 13, further including
applying a force to the one or more feedback elements (120) to restrict the motion.
17. The method of claim 11, further including
receiving (340-355) an other input from the input device (1A-1E), and,
based on the other input, performing one of the following:
selectively storing the lighting-parameters, and
selectively retrieving the lighting-parameters.
18. The method of claim 11, further including
controlling (365) one or more lights (211, 212, 220) in the input device (1A-1E) based on the lighting-parameters.
19. The method of claim 11, wherein
the input device (1A-1E) includes a track-ball (100).
20. The method of claim 11, wherein
the input from the input device (1A-1E) includes an indication of the motion in three dimensions (101-103).

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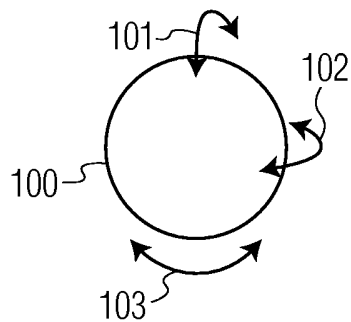


FIG. 1A

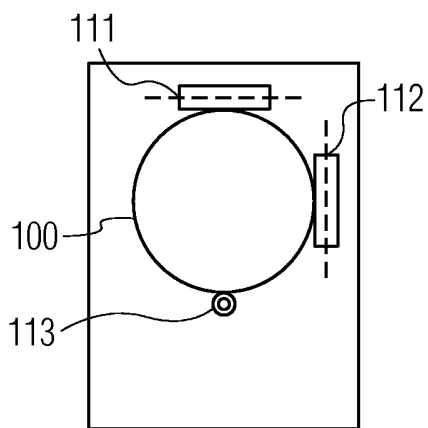


FIG. 1B

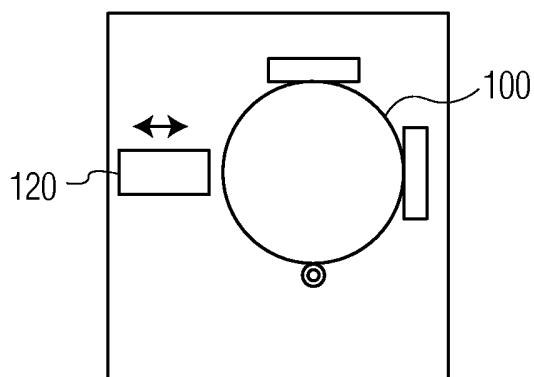


FIG. 1C

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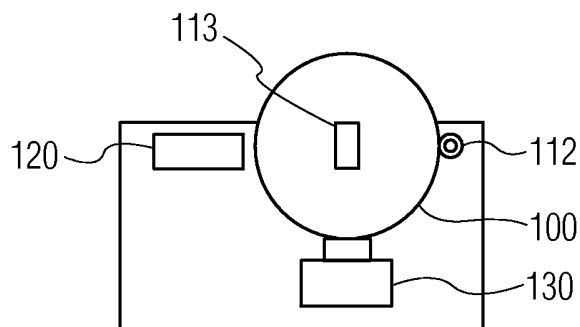


FIG. 1D

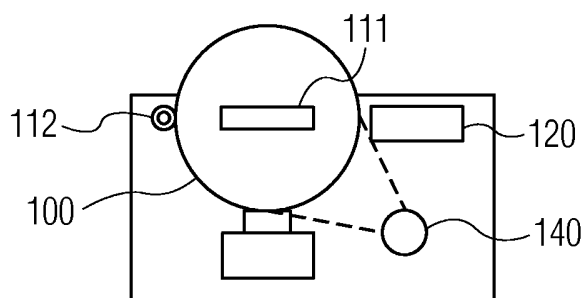


FIG. 1E

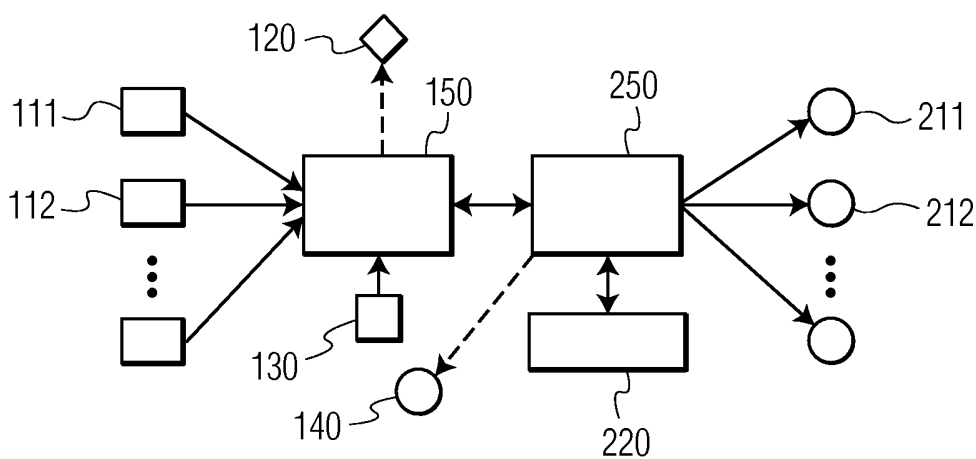


FIG. 2

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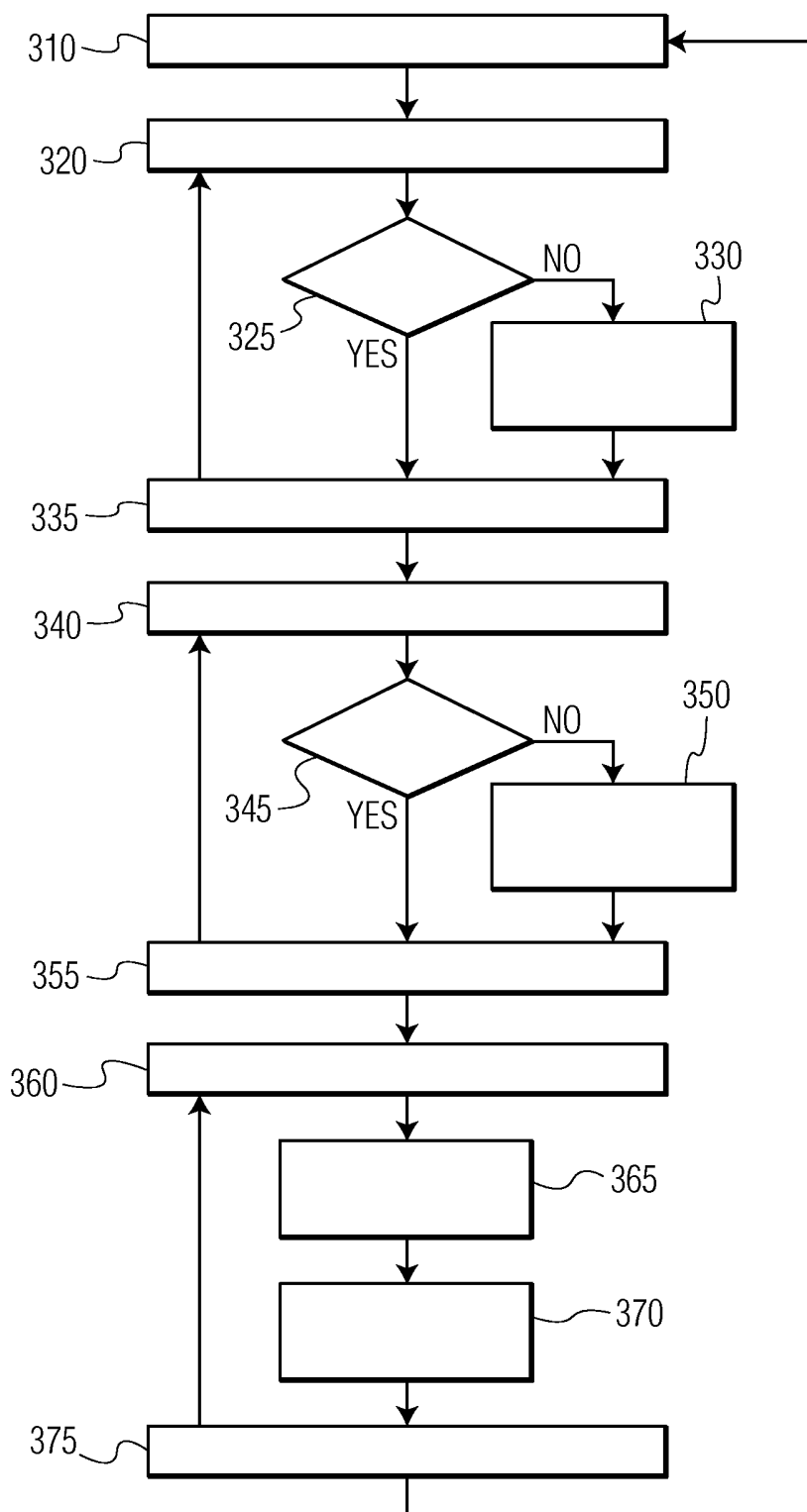


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2005/053816A. CLASSIFICATION OF SUBJECT MATTER
H05B33/08 H05B37/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 199 42 177 A1 (OSRAM OPTO SEMICONDUCTORS GMBH & CO. OHG) 22 March 2001 (2001-03-22) column 4, line 49 - column 5, line 3; figures 1A,1B	1,2, 5-12, 17-20
X	WO 2004/072840 A (KONINKLIJKE PHILIPS ELECTRONICS N.V; DIEDERIKS, ELMO, M., A; EGGEN, JO) 26 August 2004 (2004-08-26) page 5, line 5 - page 7, line 3; figures 1-8	1,2, 5-12, 17-20
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 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

14 February 2006

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21/02/2006

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Speiser, P

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2005/053816

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 2005/107338 A (KONINKLIJKE PHILIPS ELECTRONICS N.V; CORTENRAAD, HUBERTUS, M. R; BERGM) 10 November 2005 (2005-11-10) page 1, line 21 - page 2, line 6 page 4, line 1 - page 4, line 8 page 4, line 30 - page 5, line 13; figures 1-3	1,2, 5-12, 17-20
A	----- US 6 597 347 B1 (YASUTAKE TAIZO) 22 July 2003 (2003-07-22) figure w -----	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2005/053816

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19942177	A1	22-03-2001	NONE
WO 2004072840	A	26-08-2004	NONE
WO 2005107338	A	10-11-2005	NONE
US 6597347	B1	22-07-2003	NONE