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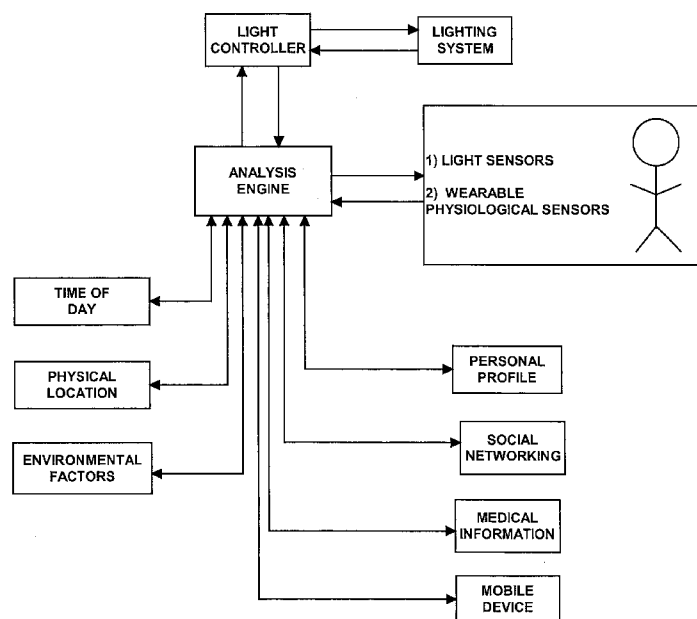
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(54) Title: COLOR ADAPTIVE THERAPEUTIC LIGHT CONTROL SYSTEM

FIG. 3



(57) Abstract: A system for influencing a state of a user includes a light source for emitting light influencing the state of the user. A light controller selectively controls the emission of the light including at least one of: (1) the spectrum of the light; (2) the duration of the light; (3) the distribution of the light; (4) the intensity of the light; and (5) the timing of the light. An analysis engine provides a signal to the light controller indicating a desired emission of the light, wherein the system selectively reflects a substantial portion of the emission of blue light from the light source of which a substantial portion is re-emitted as light different than blue light.

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GW, ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

DESCRIPTION

TITLE OF INVENTION:

COLOR ADAPTIVE THERAPEUTIC LIGHT CONTROL SYSTEM

5 TECHNICAL FIELD

The present invention relates generally to a therapeutic light control system.

BACKGROUND ART

10 The biological circadian rhythm in humans control important processes, such as the daily cycle of waking and sleeping. This biological rhythm tends to align its cycle to the external environment, such as the exposure of light modifying the hormone melatonin levels, which are associated
15 with sleep. The melatonin synthesis is reduced when light impacts the retina of the eye. It may be desirable to modify the circadian rhythm to increase the well being of the person.

Aarts et al., U.S. Patent Application Publication 2009/0326616 disclose a system that influences a
20 photobiological state of a person. The system includes a light source, a sensor that senses a first biophysical parameter of a person that is sent to a control circuit which sends a control signal to the light source so as to generate a predetermined photobiological state. The control signal provided by the

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control circuit is based upon the first biophysical parameter and another parameter, such as a biophysical parameter sensed at a different time.

Referring to FIG. 1, an exemplary LED based ceiling light allows the use of a remote controller to change the color of a white light with an adjustable color function and to adjust the brightness with the dimmer function. These functions combine to offer 110 different levels of color and brightness that match the mood or time of day. These lights also feature an eco-light rhythm function, a lighting program that automatically adjusts the color and brightness throughout the day.

The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

SUMMARY OF INVENTION

A system in accordance with an embodiment of the present invention includes the following features. In other words, a system for influencing a state of a user comprising:

(a) a light source for emitting light influencing the state of the user;

(b) a light controller selectively controlling said emission of said light including at least one of:

- (1) the spectrum of said light;
- (2) the duration of said light;
- 5 (3) the distribution of said light;
- (4) the intensity of said light; and
- (5) the timing of said light;

(c) an analysis engine which provides a signal to said light controller indicating a desired emission of said light, wherein said system selectively reflects a substantial portion of the emission of blue light from said light source of which a substantial portion is re-emitted as light different than blue light.

15 BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 illustrates a light source.

FIG. 2 illustrates a light controller and lighting system.

FIG. 3 illustrates a light control system.

FIG. 4 illustrates a spectral response of a light emitting diode.

FIG. 5 illustrates a filtering technique for converting blue light to yellow.

FIG. 6 illustrates spectral transmittance and reflectance of a dichroic filter.

FIG. 7 illustrates the use of a dichroic filter.

DESCRIPTION OF EMBODIMENTS

While a light system provides wellness benefits to a user,
5 different users tend to have different responses to the
application of light. With different users having different
responses to the application of light, it is desirable to include
a feedback to the system so that the system may be suitably
tuned to the particular user's characteristics. While many
10 users will tend to have similar characteristics, most users will
have somewhat different responses to the application of light
for therapeutic and wellness benefits. With a suitable
application of light, selected for the particular user based
upon their individual characteristics, the user may achieve
15 the improved health and wellness benefits.

By way of example, suitable exposure to light may
provide responses that are shorter term (such as 0-3 hours of
exposure) which are generally psychological in nature. For
example, the application of an appropriate amount of soothing
20 lights in a proper manner may calm the user and reduce their
heart rate. By way of example, suitable exposure to light
may provide responses that are longer term (such as several
hours to days) which is primarily circadian in nature as
controlled by melatonin levels.

25 Referring to FIG. 2, a lighting system may be controlled

by a light controller to manage a number of different attributes, each of which may individually or collectively contribute to the wellness and health of a user. The lighting system may include any suitable type of light source, such as for example, a luminaire, ceiling lights, a floor lamp, a desk lap, head worn goggles, a backlit display, or a combination thereof. The lighting system is preferably capable of generating light in the spectrum range of 420nm to 500nm for circadian system stimulation, although any spectrum may be used. A first aspect of the lighting system may be the color spectrum of the lights. For example, the lighting system may have multi-colored lights which may be selected to provide desired color or colors to the user. For example, the lighting system may provide a selected color spectrum to the user among a set of different selectable color spectrums including different color temperatures, i.e., warm or cold light. For example, the color spectrum may be modulated or otherwise temporally varied. A second aspect of the lighting system may be the duration of illumination of the lights. For example, the lighting system may provide illumination for one or more selectable durations to the user. A third aspect of the light system may be spatial distributions or positions of one or more of the lights. For example, the lighting system may have a one dimensional light arrangement, a two dimensional light arrangement, or a three dimensional light

arrangement where selected lights are illuminated. For example, the lighting system may have a plurality of light sources (or otherwise the distribution of illumination from a light source) that may be spatially and/or temporally selectable. A fourth aspect of the light system may be the brightness of the lights. For example, the lighting system may selectively provide a low illumination to the user, a medium illumination to the user, and/or a high illumination to the user in a manner to contribute to the wellness and the health of the user. For example, the lighting system may selectively have different brightness for different light sources illuminating the user. A fifth aspect of the light system may be the timing of the light or lights. For example, one or more selected lights may be turned on during different parts of the day in different manners.

By selectively modifying one or more of these five different lighting attributes, various wellness and health attributes for the user may be modified. In particular, these modifications should be based upon the particular user so that the most effective wellness and health benefits may be achieved. By way of example, suitable modification of one or more of these lighting attributes may manage sleep disorders, child hyperactivity learning disorders, elderly safety (e.g., fall avoidance), mental state, and concentration.

Referring to FIG. 3, an analysis engine may be used to

selectively control the light controller interconnected to the lighting system. The analysis engine may be operating on a local computer, a service on the Internet, or operating on a cloud computing platform, or otherwise. In some cases, a service provider may be provided to the user to which they may subscribe that provides suitable health services, customizable to the user. The service may be a subscription service to which the user subscribes. The light controller and analysis engine may be separate, or included as separate (or the same) processes on the same device. Also, the different components of the system may be interconnected using any suitable technique, such as wired or wireless communication. The analysis engine may receive input regarding the time of day. The time of day information may be any suitable time based information, such as for example, (1) the current time of the day; (2) morning, afternoon, evening, or night; (3) a weekday or a weekend; (4) a holiday; (5) a particular day of the week; and/or (6) a season of the year. For example, the user may have different requirements in the evening versus the morning. For example, the user may have different requirements during the work week rather than the weekend. For example, a holiday may be a stressful time for the user and thus have different requirements than a non-holiday. For example, a user may have different requirements during the winter than the summer.

The analysis engine may also receive input regarding the user's general physical location. For example, a user in Alaska may have different requirements than a user in Colorado, which may likewise be different than the requirements for a user in Hawaii. In addition, the combination of the user's location together with the time of year may have result in different requirements. For example, a user in Alaska during the winter may have different requirements than either a user in Hawaii during the winter or a user in Alaska during the summer. For example, a user being in their home or at the office may result in different requirements.

The analysis engine may also receive environmental factors regarding the user's current environment. Such environmental factors may include, for example, the current weather forecast; whether it is raining; whether it is foggy; whether it is sunny; whether it is overcast; whether it is hailing; whether it is lightening; whether it is flooding; whether it is cloudy; the current temperature; the anticipated temperature; the barometric pressure; and trends with all of the above. The environmental factors may likewise include current social conditions.

The analysis engine may also receive a personal profile of the user. The personal profile may include information

particularized to the user. In other words, the analysis engine may provide a signal based upon at least one of (a) a profile of the user and (b) an identification of a particular user to the light controller. Some of this particular information may include, for example, whether the user is a morning person or an evening person. The information may include an ophthalmologic characterization of the user, which is especially useful when the lighting system administers light using goggles worn close to the user's eyes. The profile may be specific to a particular user, a particular family, a group of people, or otherwise one or more users. The analysis engine may likewise base its processing on more than one profile, such as an average of a pair of profiles. In addition, the profile or profiles to be used by the analysis engine may be selected by a user or automatically selected by the system or otherwise selected based upon other input. Also, the profile may include health information for the user.

In many cases, users do not have the desire or motivation to manually create a profile. In this case, the user may link their profile to a social network account, such as for example, a Facebook account, a Twitter account, or a MySpace account. The analysis engine retrieves personal information from the social networking account, such as, relationship status, birthday, hometown name, hometown location, sex, employer, college, high school, interests, mood,

political views, religious views, activities, interests, music, books, movies, television, and/or occupation. In addition, the user may enter information about their current and/or previous status into the social networking service that may be indicative of their state of mind or otherwise. Since a user tends to have friends, acquaintances, or others linked to their social networking account that are similar to themselves, similar information from another's account may be likewise used by the analysis engine. In addition, the personal profile may include a medical profile of the user, or otherwise the personal profile may be linked to an account that includes medical information, preferably medical information that is otherwise periodically updated. Moreover, some of the information in the user profile may be provided by answers to a set of questions. Personal profile may contain information about the mental state of the individual where such state is determined by the answers that the individual provides to a set of questions indicative of individual's focus and alertness. These may include gender, age, activity and/or other profile information

The data obtained or otherwise determined as a result of the therapy, together with the results of the therapy, may be provided to the user's medical provider so that they can monitor the therapy. In general, the analysis engine may receive information from a variety of different sources, and

may likewise provide information to the sources, as desired.

In some cases, the user's profile may be periodically synchronized from the user's mobile device. By using wireless, Bluetooth, or other communication techniques, the user's mobile device may provide personal information to the analysis engine about the user.

In addition, sensors associated with the user may likewise provide data to the analysis engine. The sensors may include physiological sensors and light sensitive sensors in the environment of the user. Preferably, the light sensitive sensors and the physiological sensors are worn by the user. The physiological sensors may include, for example, heart rate sensors, time sensors, date sensors, location base sensor, acoustic sensor, body temperature sensor, respiration rate sensor, and/or motion sensor. The physiological sensor information accordingly provides information regarding the user's body. For example, if the user's heart rate is elevated then the analysis engine may be used to provide a light signal to reduce the heart rate. Likewise, the analysis engine may use the other information to provide health benefits. The light sensitive sensors, may be for example, a daysimeter device or a camera type sensor.

In some situations, the level or amount of exposure of light to a user in general, or a particular user, may be higher than a suitable level. In many cases, excessive exposure to

light may in fact decrease the user's health. In other cases, a sensor may sense the light exposure level to an individual's retina, and thus check and confirm that safety standards prevent toxicity by controlling light dosage. Accordingly, the analysis engine may use the light sensing information to determine safe lighting levels. In other words, the system may comprise limiting exposure to the light from the lighting system based upon a safety factor.

The system may further operate in a close-loop configuration, if desired. The analysis engine while receiving information from many sources, can likewise provide control or feedback signals (a signal indicating a desired emission of the light from the lighting system) to lighting controller, and control or feedback signals to the physiological or light sensors and sources of data. For example, the analysis engine could provide feedback for the configuration of the sensors so that they acquire data in a more suitable manner or other configuration data. For example, the analysis engine could provide feedback for goggles worn by the user to control the amount of light received by the user. For example, the analysis engine may update the personal profile with other information. The analysis engine may likewise receive feedback from the light controller and light sensors so that it may monitor the light that is actually provided to the user.

For example, the analysis engine may chose to invoke selected sensors to probe specific different characteristics, such as certain sensors placed at certain positions / locations in the house. In this manner, not all of the sensors need to be on at all times or otherwise configured in a particular. Also, the analysis engine also adjusts the sensitivity of individual sensors that are used to collect the data as needed to suitably control the lighting system.

One location that a user spends considerable time is driving a vehicle or a passenger in a vehicle, especially when driving long distances in the vehicle. Within a typical vehicle many different components include light sources, such as overhead lights, instrument panel lights, navigation system lights, and stereo lights. Also, the vehicle may include additional light sources, if desired. The vehicle may likewise include sensors that are provided within the vehicle, such as sensors in the seat, seatbelt, steering wheel, door, floor, pedals, on the driver's body, or otherwise. The analysis engine may use information from these sensors to adjust the lighting that is available in the vehicle though the windows in a manner to improve the health or alertness of the driver. In addition, the analysis engine may modify the sensors or otherwise select sensors. Also, the analysis engine may selectively reduce the external light or increase the external light by modifying the transmission of light into the vehicle.

This modification of external light may be achieved, for example, by changing the tint on the windows by an electrical signal, or otherwise raising and lowering a shade over the windows. In many cases, the user enters in a destination
5 into a navigation system that may be used as the basis to provide characteristics of the anticipated drive. Such characteristics may include the travel time, the traffic conditions, the average speed, the acceleration of the vehicle, and other information. The analysis engine may further use
10 this navigation information to modify the lighting to the user in a manner to improve their health or alertness level.

In many cases it is desirable to increase or otherwise decrease the amount of light from the light provided by the light source to modify the melatonin levels, such as to
15 increase or suppress the melatonin levels. In other cases, it is desirable to modify the spectral peaks or the spectral distribution from the light provided by the light source to modify the melatonin levels. In general, the blue spectrum has the greatest effect on the melatonin levels of the viewer,
20 so it is desirable to modify the blue spectrum of the light source.

Referring to FIG. 4, the spectrum of a white light emitting diode typically includes a blue primary peak spectra generally around 450 nm and a broad secondary peak spectra
25 as a result of a Stokes shift to a longer wavelength as a result

of a yellow phosphor within the diode. The 450 nm spectrum is near the peak of the human melatonin suppression wavelength. The substantially higher wavelengths of the spectrum typically have minor impact, if any, on the melatonin suppression.

Referring to FIG. 5, one technique to selectively increase the blue spectrum of the light emitting diode is to selectively include a blue / yellow dichroic filter in the path of the light from the light emitting diode. The dichroic filter tends to substantially transmit yellow light while substantially reflecting blue light. At least a part of the light, such as the blue light, is reflected back to the light emitting diode, which is then converted by a Stokes shift to a longer wavelength as a result of the yellow phosphor within the diode. Thus, the result of selectively using the additional dichroic filter is to decrease the amount of blue light output from the device, thus the system may selectively increase and decrease the amount of the blue output spectrum. In addition, selectively using the additional dichroic filter increases or decreases the amount of light output from other regions of the visible spectrum. The system selectively reflects a substantial portion of the emission of blue light from the lighting system of which a substantial portion is re-emitted as light different than blue light.

The amount of the conversion may be controlled by the amount of coverage the filter has over the light emitting areas. If all the LEDs are covered with the dichroic filter, then there will be comparatively little blue light from the LED. If all
5 the LEDs are not covered with the dichroic filter, then there will be comparatively more blue light from the LED. Also, if the dichroic filter is only in part of the optical path then the amount of blue light from the LEDs will be in between. The dichroic filter may be selectively moved into and out of the
10 optical path from the light emitting diodes. Other techniques may likewise be used to selectively include more or less of the dichroic filter in the optical path. The filter coverage may be implemented using any suitable technique, such as a manual slider in and out of the optical path, an automatic switch with
15 an electro-magnetic mechanism, and/or multiple electro-magnetic switches. Similarly, other filtering techniques may likewise be used to selectively reflect light back to the light emitting diode.

Referring to FIG. 6, an exemplary spectral transmittance and reflectance of a dichroic filter is illustrated. Other
20 spectral transmittance and reflectances may likewise be used, as desired. Other types of filters may likewise be used. FIG. 7 illustrates the spectra response of the light output as a function of wavelength selectively using a dichroic filter.

25 It is to be understood that the modification of the light

output as a result of selectively increasing or decreasing the blue light output, as a result of using a Stokes technique, may be likewise applicable to lighting sources apart from attempting to modify the circadian rhythm of the viewer.

5 Note that the present invention may also be expressed as below. Another aspect of the system may comprise (a) a light source for emitting light to a user, and (b) an adjusting mechanism (e.g. dichroic filter) for selectively reflecting a substantial portion of the emission of blue light from said
10 light source of which a substantial portion is re-emitted as light different than blue light.

 The terms and expressions which have been employed in the foregoing specification are used therein as terms of
15 description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.

CLAIMS

1. A system for influencing a state of a user comprising:

5 (a) a light source for emitting light influencing the state of the user;

(b) a light controller selectively controlling said emission of said light including at least one of:

(1) the spectrum of said light;

10 (2) the duration of said light;

(3) the distribution of said light;

(4) the intensity of said light; and

(5) the timing of said light;

15 (c) an analysis engine which provides a signal to said light controller indicating a desired emission of said light, wherein said system selectively reflects a substantial portion of the emission of blue light from said light source of which a substantial portion is re-emitted as light different than blue light.

20

2. The system of claim 1 wherein said selective reflection uses a dichroic filter.

25 3. The system of claim 2 wherein said dichroic filter is selectively moved with respect to an optical path of said light

source.

4. The system of claim 3 wherein said movement is automatic.

5

5. The system of claim 3 wherein said movement is manual.

10

6. The system of claim 1 further comprising said analysis engine obtaining information from a profile of said user.

15

7. A system of claim 1 wherein said signal indicates a desired emission of said light based upon at least one of (a) a profile of said user and (b) an identification of a particular said user.

20

8. The system of claim 7 further comprising said analysis engine obtaining information from said profile from a mobile device.

9. The system of claim 1 or 7 further comprising said analysis engine obtaining information regarding a time of day.

25

10. The system of claim 1 or 7 further comprising said

analysis engine obtaining information regarding a physical location of said user.

11. The system of claim 1 or 7 further comprising said
5 analysis engine obtaining information regarding environmental factors of said user.

12. The system of claim 1 or 7 further comprising said
10 analysis engine obtaining information regarding social networking.

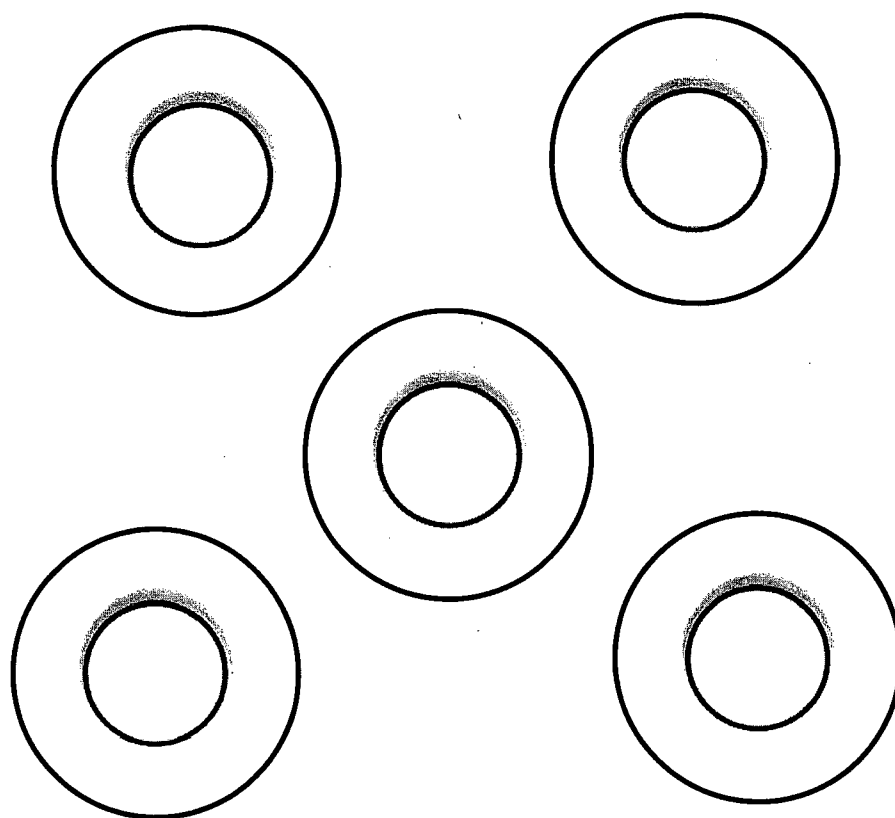
13. The system of claim 1 or 7 further comprising said
15 analysis engine obtaining information regarding medical information.

14. The system of claim 1 or 7 further comprising said
analysis engine obtaining information from a light sensor associated with said user.

20 15. The system of claim 1 or 7 further comprising said analysis engine obtaining information from a physiological sensor associated with said user.

25 16. The system of claim 7 further comprising limiting exposure to said light based upon a safety factor.

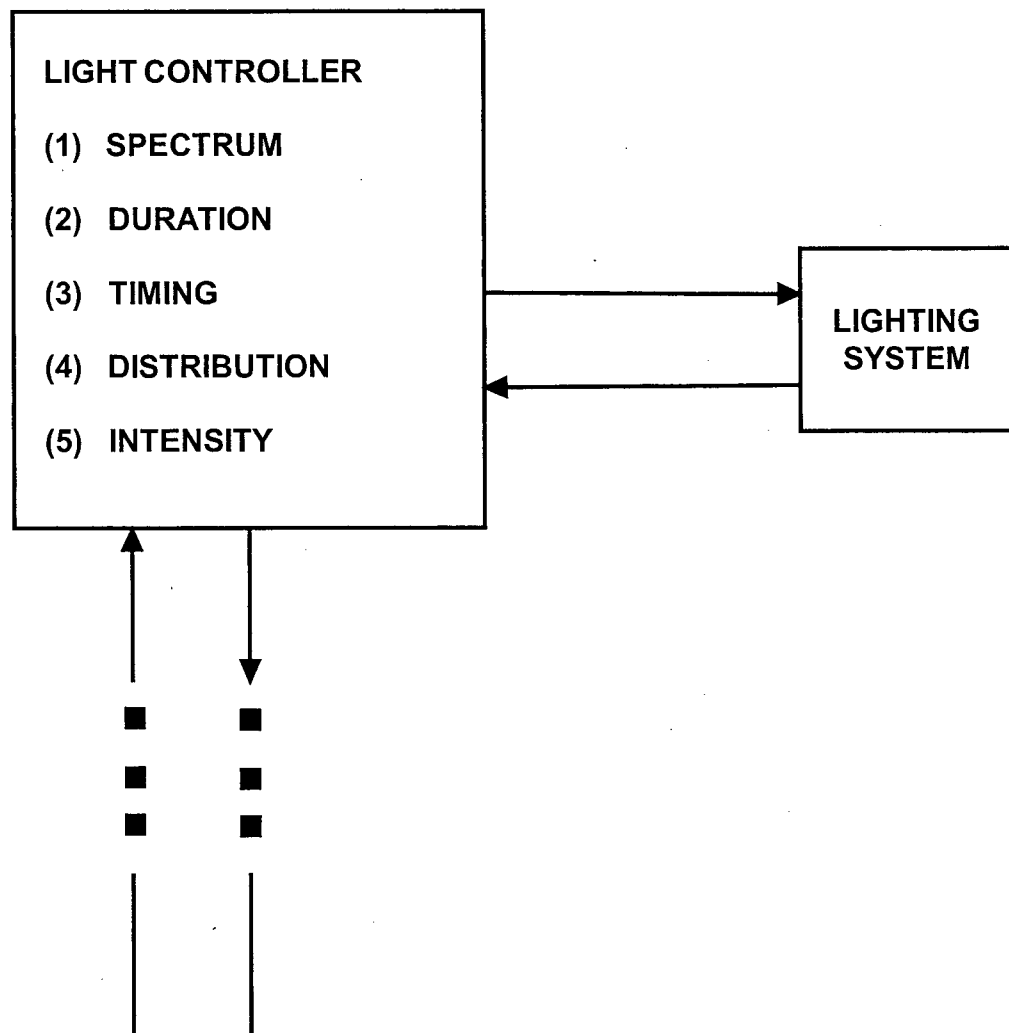
FIG. 1



LED CEILING LIGHTS

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FIG. 2



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FIG. 3

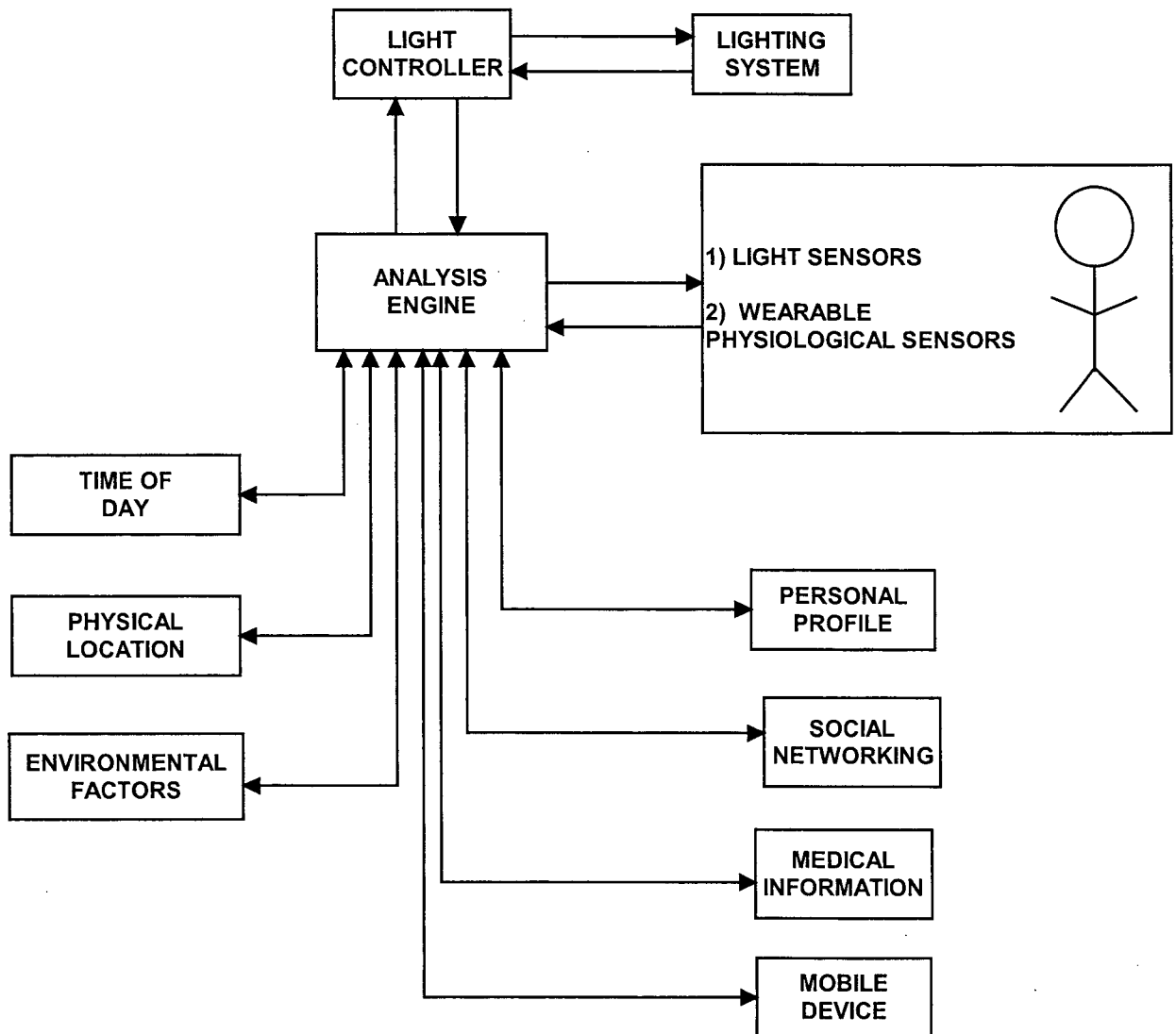


FIG. 4

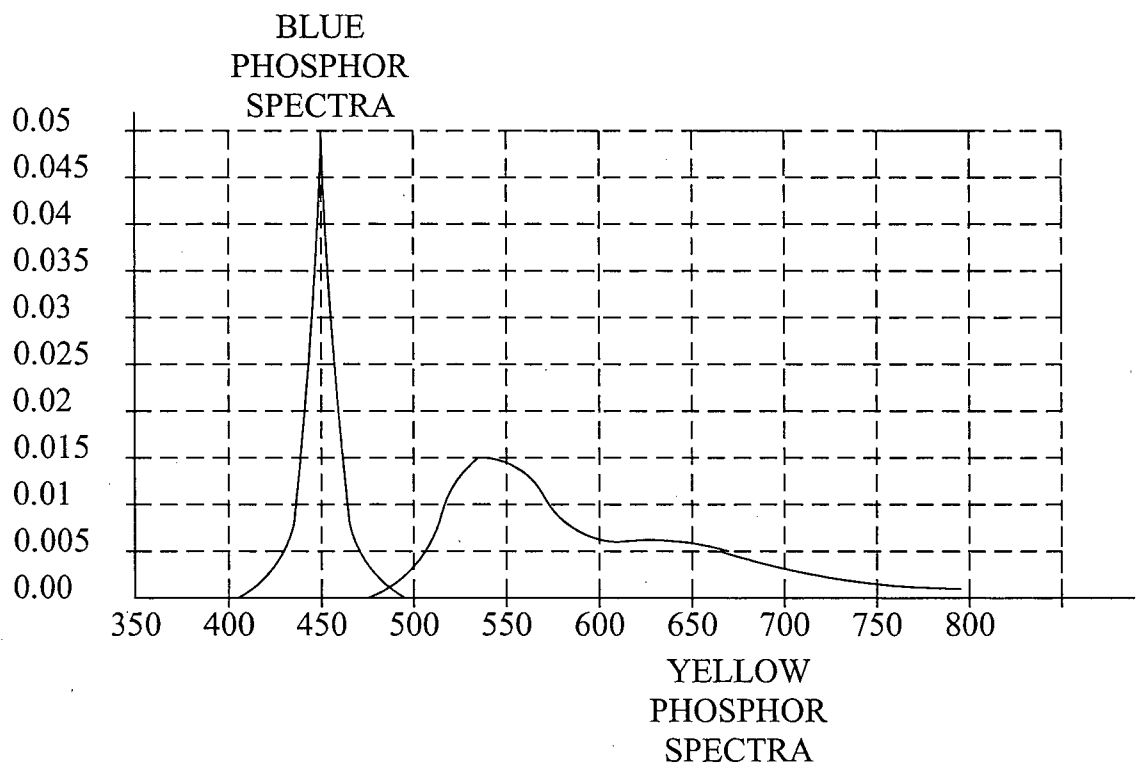
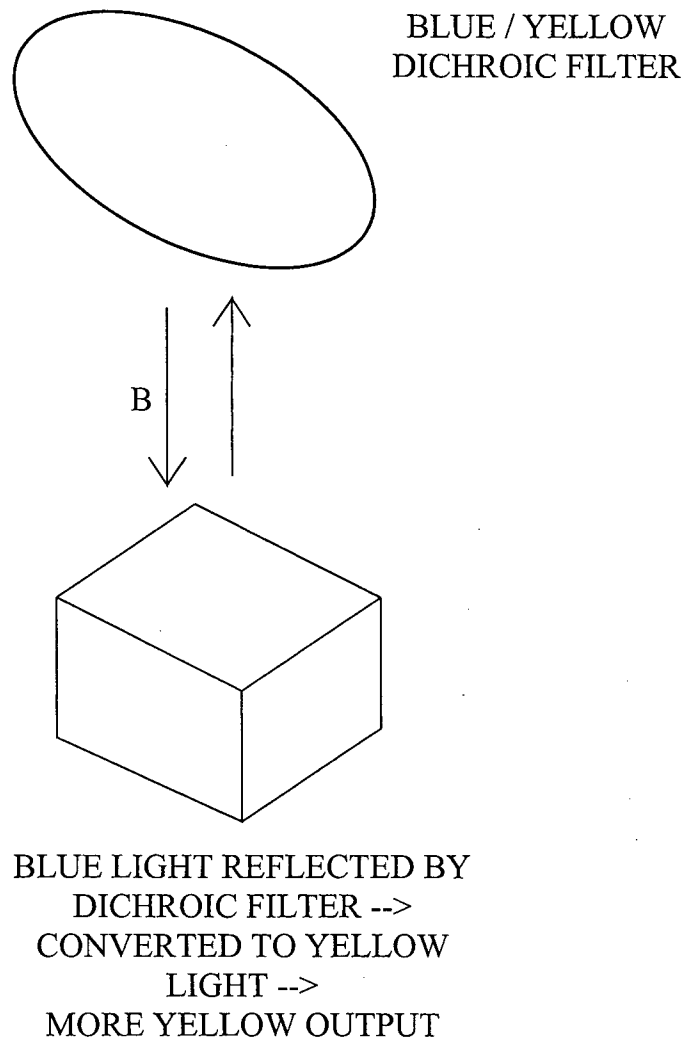
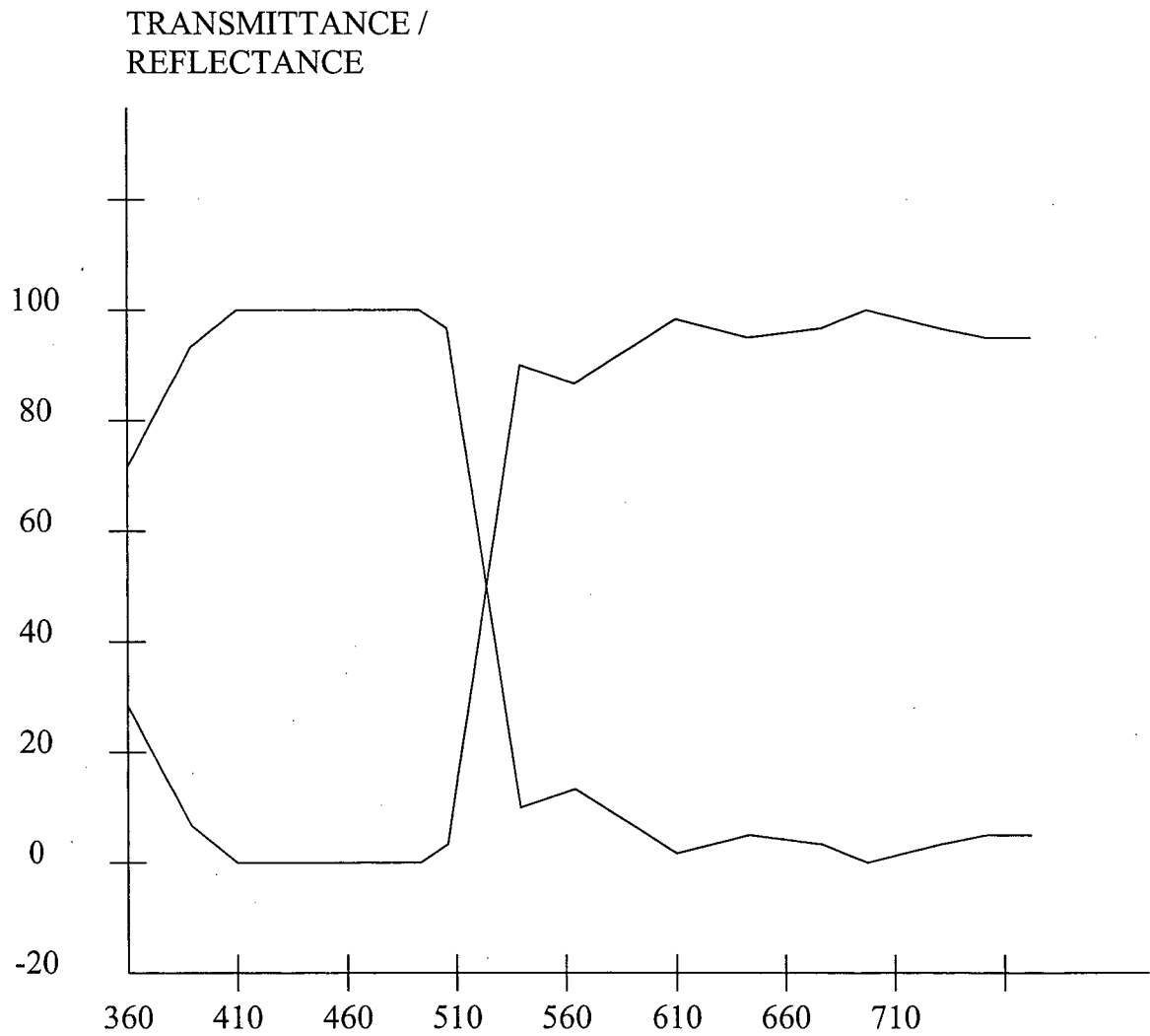


FIG. 5



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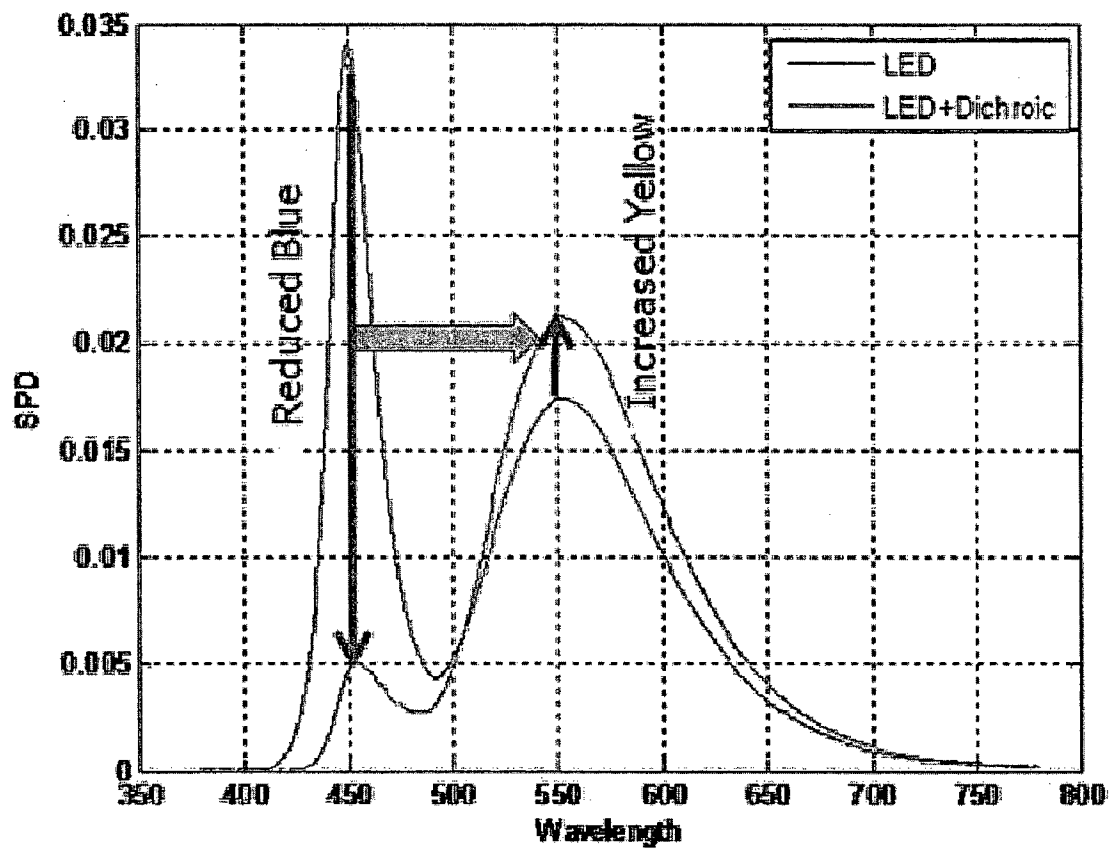
FIG. 6



WAVELENGTH IN NM

SPECTRAL TRANSMITTANCE AND REFLECTANCE F A DICHROIC FILTER

FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/053028

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. A61M21/02 (2006.01) i

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)

Int.Cl. A61M21/02

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2012
 Registered utility model specifications of Japan 1996-2012
 Published registered utility model applications of Japan 1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:

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“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search

19.04.2012

Date of mailing of the international search report

01.05.2012

Name and mailing address of the ISA/JP

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3E 5076

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/053028

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Y	WO 2008/069103 A1 (SHARP KABUSHIKI KAISHA) 2008.06.12, 【0048】 & US 2010/0060195 A1 [0072] & EP 2106198 A1 [0048] & CN 101589651 A 7-14 lines of page13	8