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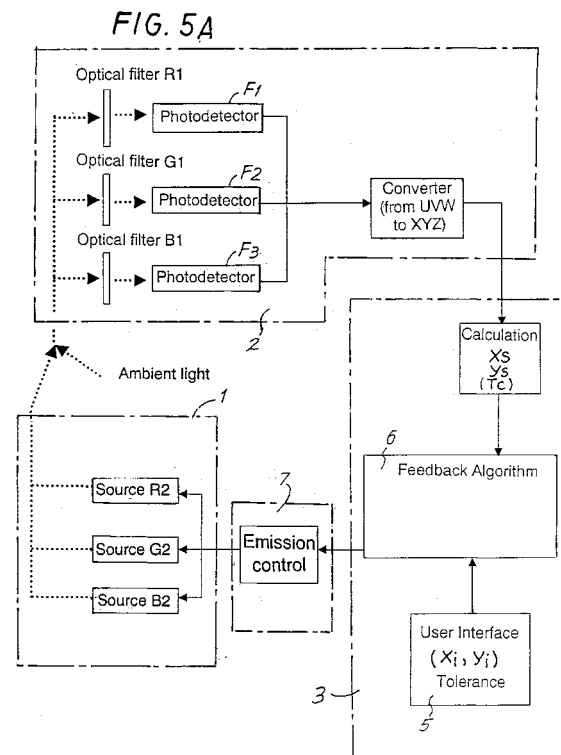
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(54) **Device and method for controlled-spectrum lighting**

(57) The lighting device comprises:

- a plurality of light sources with varied light-emission spectra;
- photodetection means which determine at least one characteristic of the ambient spectrum;
- feedback means which compare said at least one characteristic of the ambient spectrum with a corresponding characteristic of a preconfigured spectrum and modify the emission of at least one of said sources so as to minimize the difference between the characteristic of the ambient spectrum detected and the characteristic of the preconfigured spectrum.



Description

[0001] The present invention relates to a device and a method for controlled lighting of various types of environment.

[0002] In addition to the normal lighting systems which are activated manually, lighting systems currently exist where the level of light intensity is controlled according to the ambient light. A type of system which is widespread consists of so-called "twilight switches" which automatically switch on one or more light sources when the ambient lighting falls below a predetermined threshold. However, even with these known systems and installations it is possible to achieve only regulation of the light intensity according to the ambient light, but not control of the light spectrum.

[0003] The object of the present invention is to provide a device and a method which are able to achieve automatic control of the lighting conditions in terms of the light spectrum. In the description which follows and in the accompanying claims, the expressions "light" and "light spectrum" are not to be regarded as referring necessarily to only radiation in the visible range. On the contrary, the spectrum of interest for the present invention may also comprise the infrared and ultraviolet range. The expression "light sources" may also be understood as referring to sources which emit in this extensive range of electromagnetic radiation.

[0004] Essentially, the lighting device according to the invention comprises:

- a plurality of light sources with varied light-emission spectra;
- photodetection means which determine at least one characteristic of the ambient spectrum;
- feedback means which compare said at least one characteristic of the ambient spectrum with a corresponding characteristic of a preconfigured spectrum and modify the emission of at least one of said sources so as to minimize the difference between the characteristic of the ambient spectrum detected and the characteristic of the preconfigured spectrum.

[0005] The method according to the invention envisages the steps of:

- providing a plurality of light sources with varied light-emission spectra;
- determining at least one characteristic of the ambient spectrum;
- comparing said at least one characteristic of the ambient spectrum with a corresponding characteristic of a preconfigured spectrum;
- modifying the emission of said plurality of sources so as to minimize the difference between the characteristic of the ambient spectrum detected and the characteristic of the preconfigured spectrum.

[0006] With a system of this type, by means of a suitable interface, the user is able to define given characteristics of the preconfigured spectrum for the light required in the environment, the color temperature of the light in the environment, the correlated color temperature, or the like. For example, the predefined parameters may consist of desired chromatic coordinates or an indication of a point in the plane of the chromatic coordinates. The chromatic coordinates may be those of a standard system, for example the system XYZ CIE 1931, or also of another colorimetric system which may be chosen randomly.

[0007] The system is able to maintain these characteristics of the predefined spectrum, within predetermined tolerances, also when there is a variation in the natural lighting and/or artificial lighting conditions.

[0008] Using the photodetection means, which may be of any kind, the value of the characteristics of the ambient spectrum is determined by the control system and then compared with the corresponding characteristics of the preconfigured spectrum. The feedback system regulates the conditions for supplying power to the light sources by modifying, for example, the power supplied to one or other or several of the light sources, so as to adjust the conditions of the ambient spectrum to the desired value, i.e. to the value of the corresponding characteristics of the preconfigured spectrum.

[0009] Essentially, the environmental lighting obtained overall consists of the sum of the sources outside the system and the sources of the system. The latter vary the emission conditions so that the resultant lighting has the desired characteristics in terms of chromaticity, color temperature, or the like.

[0010] The feedback system performs a continuous controlling function over time, which is repeated at desired time intervals, having a duration chosen on the basis of the required speed of adaptation of the system to the variation in the lighting conditions.

[0011] In a particularly sophisticated embodiment, it may also be envisaged that the characteristics of the predefined spectrum are not constant, but variable, for example, during the course of the day. In this case the feedback means will adjust the emission conditions of the individual sources not only depending on the variation in the external lighting conditions, but also depending on the preset program on the basis of which the lighting conditions are to be varied over time.

[0012] According to a particularly advantageous embodiment of the invention, three or more photodetectors or sen-

sors are envisaged, being sensitive in different bands of the spectrum and consisting, for example, of photodiodes with passband filters, or other selective devices for the light spectrum, which are centered on different portions of the light spectrum. These sensors capture the signals reflected back from a suitable white object illuminated by the entire ambient light, with stability characteristics over time, or the signals from the group of sources, and send them to a control system which receives at its input also the parameters of the predefined spectrum. By means of a feedback algorithm the differences between the measured parameters and the predefined parameters are then minimized when the difference exceeds (in terms of absolute value) a threshold value. The system may also be used to correct automatically any deviations in the characteristics of the spectrum of the lighting produced by the light sources, due to aging of the lamps, a drop in the power supply voltage, or the like. In this sense, the system may also be used as a single lighting system in an environment which may also not receive any natural light.

[0013] For example, if the system is based on control of the chromaticity coordinates, the algorithm may carry out a check as to the difference between each of the two chromaticity coordinates of the ambient light detected and the corresponding coordinates predefined by the user. On the basis of the difference thus determined, it is possible, using a processor, to check the power supply conditions of the individual sources in order to reduce and minimize the difference.

[0014] A possible embodiment envisages at least three independent sources having different light-emission spectra, for example with an emission band centered on red, on green and on blue, respectively.

[0015] The light sources may consist, for example, of halogen lamps with respective passband filters. Alternatively, it is possible to envisage fluorescent lamps with emissions centered on the desired bands, discharge lamps or in any case light sources with the desired emission spectrum. Also, combined solutions are possible, i.e. in which incandescent lamps (of the halogen or equivalent type) are combined with fluorescent lamps.

[0016] It is also possible to envisage the use of several sources with varied spectra and, optionally, the use also of white sources in addition to colored sources. A greater number of sources with varied spectra amplifies the range of colors of the spectrum which can be obtained and therefore the range of lighting conditions which can be achieved by the system.

[0017] A particularly simple, low-cost and efficient device is obtained by using, as photodetection means, a plurality of photodetectors associated with corresponding optical filters. Basically at least three sensors or photodetectors are used, but it is also possible to use a greater number of photodetectors with respective filters centered on corresponding wavelength bands.

[0018] The feedback means may be realized by means of a suitable hardware circuit. However, according to a particularly advantageous embodiment of the invention, the feedback system is implemented by means of an algorithm performed, with the aid of software, by an electronic processor which receives at its input the data relating to the ambient spectrum (typically the chromaticity coordinates) and the corresponding data of the predefined spectrum. At its output the processor provides the signals controlling the programmable power supply units of the individual sources.

[0019] Further advantageous features and embodiments of the device and the method according to the invention will be described below and are indicated in the accompanying independent claims.

[0020] The device and the method according to the invention may have a plurality of uses, for example in the provision of lighting installations for domestic, industrial or professional use. A system of this type allows the user to define the desired lighting characteristics and maintain them in the event of a variation in the external conditions. A particularly interesting use of the system is in the museum and exhibition sector where the optimum lighting conditions - not only in terms of intensity but also and in particular as regards the color temperature of the light used - may be chosen and maintained using said system.

[0021] The invention will be understood more fully with reference to the description and the accompanying drawing which shows a practical non-limiting embodiment of the invention. More particularly, in the drawing:

Fig. 1 shows the color equality curves of the colorimetric system X,Y,Z CIE 1931;

Fig. 2 shows the x-y chromaticity diagram of the colorimetric system XYZ CIE 1931;

Fig. 3 shows the sum of two colors in an x-y chromaticity diagram;

Fig. 4 shows an example of compensation of the ambient light by means of the light produced by the device according to the invention in an x-y chromaticity diagram;

Fig. 5A shows a block diagram of the device according to the invention;

Fig. 5B shows a flow diagram of the feedback algorithm in a possible embodiment;

Figs. 6A and 6B show an emission spectrum of a halogen lamp with a dichroic reflector and red filter at various power supply levels of the lamp and the corresponding points in the x-y diagram;

Figs. 7A and 7B show an emission spectrum of a halogen lamp with dichroic reflector and green filter at various power supply levels and the corresponding points in the x-y diagram;

Figs. 8A and 8B show an emission spectrum of a halogen lamp with dichroic reflector and blue filter at various power supply levels and the corresponding points in the x-y diagram;

Figs. 9A and 9B show an emission spectrum of a red fluorescent lamp at various power supply levels and the corresponding points in the x-y diagram;

Figs. 10A and 10B show an emission spectrum of a green fluorescent lamp at various power supply levels and the corresponding points in the x-y diagram;

Figs. 11A and 11B show an emission spectrum of a blue fluorescent lamp at various power supply levels and the corresponding points in the x-y diagram;

Figs. 12A, 12B and 12C show the flux pattern of the red, green and blue fluorescent lamps respectively, depending on the power used by the lamp.

[0022] As is known from colorimetry, having defined three light sources with different spectral characteristics, many colors may be obtained by the summing together (i.e. by means of additive synthesis) of the three sources, suitably calibrating the light intensity of each of the three sources (called primary sources). According to the standard colorimetric system XYZ CIE 1931, a color Q may be obtained as the sum of three imaginary stimuli X, Y, Z, as follows:

$$Q = XX + YY + ZZ$$

where X, Y, Z are the tristimulus values defined by

$$X = k \int^{\lambda} P(\lambda) \bar{x}(\lambda) d\lambda$$

$$Y = k \int^{\lambda} P(\lambda) \bar{y}(\lambda) d\lambda$$

$$Z = k \int^{\lambda} P(\lambda) \bar{z}(\lambda) d\lambda$$

where $P(\lambda)$ is the monochromatic component at the wavelength λ of the stimulus with a spectral distribution SPD $\{P(\lambda)d\lambda\}$ and k is a standardization factor which may be assigned arbitrarily provided that it remains constant. The functions $\bar{x}(\lambda)$, $\bar{y}(\lambda)$ and $\bar{z}(\lambda)$ are color equality functions and their progression in the standard colorimetric system XYZ CIE 1931 is shown in Fig. 1.

[0023] From the values of X, Y and Z it is possible to obtain the so-called chromaticity coordinates x , y , z defined by:

$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

$$z = \frac{Z}{X + Y + Z}$$

using the relation

$$x + y + z = 1$$

[0024] According to this standard system, a given color is represented on an x-y diagram on which the abovementioned

tioned chromaticity coordinates are shown. The x-y diagram is shown in Fig. 2. In this diagram a few properties are useful in the description of the system according to the present invention. In particular, given two colors represented on the x-y chromaticity diagram by two points S1, S2, the sum of these colors is represented by a point S3 which is located on the straight line which joins together the points S1 and S2. Moreover, according to the standard system XYZ CIE 1931, the tristimulus value Y of a color corresponds to the luminosity of the signal and, therefore, knowing the tristimulus values Y1 and Y2 of the two colors S1 and S2, it is possible to obtain, by means of the law of additivity of the luminosity, the value of the luminosity Y3 of the sum of the two colors S1, S2: $Y_3 = Y_1 + Y_2$.

[0025] Fig. 3 shows how the position of the color S3 obtained from the sum of the colors S1 and S2 is determined.

[0026] The point S3 is positioned on the straight line which passes through the points S1 and S2 and -has chromatic coordinates x3, y3 defined by:

$$x_3 = \left(\frac{Y_1}{Y_1 + Y_2} \right) x_1 + \left(\frac{Y_2}{Y_1 + Y_2} \right) x_2$$

$$y_3 = \left(\frac{Y_1}{Y_1 + Y_2} \right) y_1 + \left(\frac{Y_2}{Y_1 + Y_2} \right) y_2$$

[0027] The abovementioned principles may be used in order to obtain a controlled-spectrum lighting system, in which the emission spectrum of the artificial light sources is controlled depending, for example, on the natural lighting, so as to obtain a color temperature of the lighting which is more or less constant and equal, within predefinable tolerance values, to a given value. The concept is schematically illustrated in Fig. 4: the x-y chromaticity diagram shows a first point SA which represents the color of the ambient light. SS, on the other hand, indicates the point in the x-y diagram representing the light emitted by the artificial lighting system. ST represents the chromaticity point which is to be obtained with the system. As regards the above, the point ST is obtained as the sum of the two points representing the natural light source (SA) and the artificial light source (SS) and is therefore located on the line joining together the two points SA, SS.

[0028] As a result of the device and the method according to the present invention it is possible to maintain an overall lighting, defined by the sum of the two sources SA, SS, at the point ST, by controlling the spectral emission characteristics of the source SS and therefore by basically displacing the point SS in the x-y diagram when there is a variation in the position of the point SA.

[0029] The device according to the invention is schematically shown, in the form of a block diagram, in Fig. 5A. In the embodiment illustrated here, the system has a first block 1 comprising a set of three sources R2, G2, B2 which emit red light, green light and blue light, respectively. The sources R2, G2 and B2 may be of a varied nature, for example halogen lamps or fluorescent lamps. Examples of lamps will be described below and characterized by means of the associated emission diagrams.

[0030] The sources R2, G2 and B2 emit a light which is added to the ambient light which may be produced by the natural light and/or by other artificial light sources. The resultant light is captured by a colorimeter, generally indicated by the block 2, comprising three photodetectors F1, F2, F3 in front of which three optical filters R1, G1, B1 are arranged.

[0031] The outputs of the three photodetectors F1, F2, F3 are sent to a converter block which will be described in greater detail below and from which the abovementioned tristimulus values X, Y, Z for the light captured by the photo-detection system, comprising the filters R1, G1, B1 and the photodetectors F1, F2, F3, are obtained. From the values of X, Y and Z, a control system, represented by the block 3, determines the values of the x-y coordinates in the chromaticity diagram. These values are indicated by xS and yS in the block diagram according to Fig. 5. The calculation of the chromaticity coordinates is performed, for example, with the aid of software, via a processor. The processor also receives at its input, via a user interface 5, a pair of values xi, yi representing the chromaticity coordinates of the point in the x-y chromaticity diagram to be obtained by means of the lighting device. In other words, the coordinates xi, yi indicate the position in which the point indicated in the diagram of Fig. 4 by ST must be located. If the coordinates xS and yS differ from the coordinates xi, yi, this means that the overall lighting (provided by the sum of the ambient light and the light generated by the sources R2, G2, B2) does not correspond to the desired color. If this occurs, the control

unit, by means of a feedback algorithm schematically represented by the block 6 and described in greater detail below, modifies the power supply conditions of the sources R2, G2, B2 so as to correct the lighting conditions and bring the chromaticity coordinates xS and yS towards the set value xi, yi. This is obtained by means of the control block 7 which modifies the power supply conditions of the sources R2, G2, B2.

[0032] The feedback algorithm may be configured in a varying manner. Generally, it is possible to use any algorithm which is able to generate a control parameter which, depending on the chromaticity coordinates detected, corrects the chromaticity coordinates of the source formed overall by the three sources R2, G2, B2 so as to obtain the predefined chromaticity coordinates.

[0033] Fig. 6 shows, in the form of a flow diagram, a particularly simple algorithm for obtaining this function.

[0034] On the basis of the set values xi, yi and a tolerance value (t), representing the maximum permissible error between the set chromaticity coordinates and the measured coordinates, the algorithm performs the following steps:

Check as to the coordinate x:

[0035] If the difference, in terms of absolute value, between xi and xS is greater than the tolerance t, a check is performed as to whether the value of xS is greater than the value of xi. If it is (and if the power with which the source R2 is supplied is not equal to the maximum value), the value of the power supply of the red light source R2 - and therefore the luminous flux provided by this source - is incremented by a predefined quantity ($\Delta R2$). On the other hand, if the value of the power supply of the red light source R2 is already at its maximum value, the power supply of the blue light source B2 - and therefore the luminous flux generated by this source - is reduced by a predefined quantity ($\Delta B2$).

[0036] If the value of xS is greater than or equal to xi, the power supply of the blue light source B2 is increased. If the latter is already at its maximum value, the power supply of the red light source R2 is reduced. Check as to the coordinate y

[0037] If the difference, in terms of absolute value, between the coordinates yS and yi is greater than the tolerance t, the power supply of the green lamp G2 is reduced if yS is greater than or equal to yi; the power supply of the green light source G2 is increased if yS is less than yi.

[0038] The feedback algorithm is performed at time intervals determined so that the emission characteristics of the sources R2, B2, G2 are constantly adapted so as to keep the chromaticity coordinates of the overall light in the region of the set value, with the tolerance t.

[0039] If the optical filters located in front of the photodetectors should have a transmittance $T_i(\lambda)$ (with $i=x, y, z$ for the three filters) and the photodetectors should have a spectral response $s(\lambda)$ such that

$$T_x(\lambda) = \frac{\bar{x}(\lambda)}{s(\lambda)}$$

$$T_y(\lambda) = \frac{\bar{y}(\lambda)}{s(\lambda)}$$

$$T_z(\lambda) = \frac{\bar{z}(\lambda)}{s(\lambda)}$$

at the output of the three photodetectors there would be the three abovementioned tristimulus values X, Y and Z. Since, however, the filters and the photodetectors which are commercially available do not satisfy the abovementioned conditions, the outputs of the three photodetectors F1, F2, F3 will correspond to tristimulus values in a system which is different from the standard system XYZ (and generically indicated by UVW in Fig. 5). By means of suitable calibration of the photodetectors it is possible to determine the matrix which converts the tristimulus values in the generic system UVW to the XYZ system.

[0040] Using the following components:

- three Texas photodetectors, model TSL 230;
- a Kodak Wratten No. 29 optical filter, as the filter R1,
- a Kodak Wratten No. 58 optical filter, as the filter G1 and
- a Kodak Wratten No. 46 optical filter, as the filter B2 the transformation matrix obtained is the following:

$$\underline{P} = \begin{pmatrix} 6.1598 & 1.2977 & 1.9314 \\ 3.1861 & 5.6998 & 0.1184 \\ -0.1403 & -0.0570 & 11.3130 \end{pmatrix}$$

[0041] The conversion block, indicated by the numeral 8 in Fig. 5, performs the conversion from the UVW system to the XYZ system by means of the abovementioned matrix. Obviously the coefficients of the matrix change depending on the filter/photodetector system used.

[0042] The block 3 may also be programmed so as to perform the calculation of the correlated color temperature (Tc) of the light obtained, for example by implementing, using software, one of the methods for determining the correlated color temperature, such as the Robertson method.

[0043] By varying the power supply of the individual sources, both the luminous flux of said sources and the chromatic characteristics of the light emitted are varied. The system takes this into account by means of the feedback algorithm. The effect of variation of the chromaticity coordinates of the light emitted by the individual sources as a function of the power used is illustrated by the diagrams of Figs. 6-12, where Figs. 6 to 8 refer to halogen lamps with a dichroic reflector and passband filter, while Figs. 9 to 12 refer to fluorescent lamps.

[0044] Fig. 6A shows the emission spectrum of a halogen lamp (model Osram Decostar Titan 46870FL made by OSRAM, Germany) equipped with a passband filter centered on red. The five graph curves refer to five different power consumption levels and, more particularly, to the power levels 28, 34, 40, 45 and 50 W (50 W being the rated power of the lamp). Fig. 6B shows the corresponding five points in the x-y chromaticity diagram of the standard system XYZ CIE 1931. It is obvious that, by varying the power supply of the lamp, the position of its chromaticity coordinates and essentially the color temperature of the emitted light change.

[0045] A similar behavior is noted for the same lamp equipped with a passband filter centered on green (Figs. 7A and 7B) and a passband filter centered on blue (Figs. 8A, 8B). The power levels corresponding to the various measurements performed are shown in the diagrams.

[0046] Figs. 9A and 9B show the emission spectrum and the x-y chromaticity diagram of a red, tubular, fluorescent lamp, model Osram L58W/60, with a rated power of 60 W. The graph and the points in the chromaticity diagram are obtained for power levels of 6, 11, 17, 23, 29, 35, 40, 46, 52 and 58 W.

[0047] Figs. 10A and 10B show the emission spectrum and the chromaticity diagram for a green, tubular, fluorescent lamp, model Osram L58W/66, for variable power supply levels of 17, 23, 29, 35, 40, 46, 52 and 58 W.

[0048] Figs. 11 A and 11B show the emission spectrum and the chromaticity diagram for a blue, tubular, fluorescent lamp, model Osram L58W/66, for power levels of 23, 29, 35, 40, 46, 52 and 58 W.

[0049] For the three fluorescent lamps, Figs. 12A, 12B and 12C show the progression of the luminous flux (% along the ordinate) as a function of the power used (W along the abscissa).

[0050] It can be clearly seen from the diagrams shown in Figs. 6 to 11 that, by varying the power supply of the individual lamps (be they filtered halogen lamps or colored fluorescent lamps), the chromaticity coordinates of the emitted light are varied. By suitably applying, in the manner described above, the feedback algorithm it is thus possible to displace the point of the ambient light spectrum in the x-y diagram so as to position it at the desired point taking into account the displacement of the emission point of the individual sources in the x-y diagram when there is a variation in the power used.

[0051] It is understood that the drawing shows only a practical non-limiting embodiment of the invention, the forms and arrangement of which may vary without thereby departing from the scope of the underlying idea of the said invention.

Claims

1. A lighting device including:

- a plurality of light sources with varied light-emission spectra;
- photodetection means which determine at least one characteristic of the ambient spectrum;
- feedback means which compare said at least one characteristic of the ambient spectrum with a corresponding characteristic of a preconfigured spectrum and modify the emission of at least one of said sources so as to minimize the difference between the characteristic of the ambient spectrum detected and the characteristic of the preconfigured spectrum.

2. Device as claimed in claim 1, wherein said photodetection means determine the chromaticity coordinates in a chromaticity diagram of said ambient spectrum.
- 5 3. Device as claimed in claim 2, wherein said feedback means cause a modification in the chromaticity coordinates of the light generated by said plurality of light sources, so as to minimize the difference between the chromaticity coordinates of the ambient spectrum and corresponding chromaticity coordinates of said preconfigured spectrum.
- 10 4. Device as claimed in claim 1, wherein said plurality of sources comprises at least three independent sources having different light-emission spectra.
- 5 5. Device as claimed in claim 4, wherein said three sources have emission spectra centered on red, on green and on blue, respectively.
- 15 6. Device as claimed in claim 4 or 5, wherein said plurality of sources comprises at least one fourth white light source.
7. Device as claimed in one or more of the preceding claims, wherein said plurality of sources comprises halogen lamps equipped with corresponding selective devices for the light spectrum, centered on varied spectral bands.
- 20 8. Device as claimed in one or more of the preceding claims, wherein said plurality of sources comprises fluorescent lamps centered on respective varied spectral bands.
9. Device as claimed in one or more of the preceding claims, wherein said photodetection means comprise a plurality of photodetectors associated with corresponding selective devices for the light spectrum.
- 25 10. Device as claimed in claim 9, comprising a plurality of selective devices for the light spectrum, consisting of a number equal to the number of sources simultaneously in operation.
- 30 11. Device as claimed in claim 10, wherein said selective devices for the light spectrum which are associated with said photodetectors are centered on the emission bands of said sources.
- 35 12. Device as claimed in claim 2, wherein said photodetection means determine the chromaticity coordinates of the ambient spectrum in the XYZ CIE 1931 system.
13. Device as claimed in claim 11 and 12, wherein the product of the sensitivity of said photodetectors and the transmittance of the respective selective devices for the light spectrum define color equality functions of an imaginary set of three tristimulus values and wherein means are provided for converting the tristimulus values of said imaginary set of three values into tristimulus values of the XYZ CIE 1931 system.
- 40 14. Device as claimed in one or more of the preceding claims, wherein said feedback means comprise an algorithm implemented by means of a program in a processor.
- 45 15. Device as claimed in claim 14, wherein said algorithm determines the difference between each chromaticity coordinate of the ambient spectrum and the corresponding chromaticity coordinate of said preconfigured spectrum and, on the basis of said difference, modifies the power supply conditions of one or more of said sources so as to minimize said difference.
16. Device as claimed in at least claim 1, wherein said characteristic of the ambient spectrum and said characteristic of the preconfigured spectrum consist of respective color temperatures or correlated color temperatures.
- 50 17. A method for controlling at least one characteristic of an ambient light spectrum including the steps of:
 - providing a plurality of light sources with varied light-emission spectra;
 - determining at least one characteristic of the ambient spectrum;
 - comparing said at least one characteristic of the ambient spectrum with a corresponding characteristic of a preconfigured spectrum;
 - 55 - modifying the emission of one or more of said sources so as to minimize the difference between the characteristic of the detected ambient spectrum and the characteristic of the preconfigured spectrum.

18. Method as claimed in claim 17, wherein said characteristic of the ambient spectrum and said characteristic of the configured spectrum consist of the respective coordinates in a chromaticity diagram.

19. Method as claimed in claim 17 or 18, wherein said sources are at least three in number.

20. Method as claimed in claim 17, 18 or 19, including the steps of:

- determining the two chromaticity coordinates of the ambient spectrum, in a chromaticity diagram;
- checking whether the difference between each of said chromaticity coordinates of the ambient spectrum and a corresponding coordinate of said preconfigured spectrum exceeds a predefined threshold value;
- if at least one of said differences exceeds said threshold value, modifying the emission conditions of at least one of the sources so as to minimize said difference.

21. Method as claimed in one or more of claims 17 to 20, wherein at least three light sources with varied spectral bands are used.

22. Method as claimed in claim 21, wherein said light sources have spectral bands centered on red, on blue and on green, respectively.

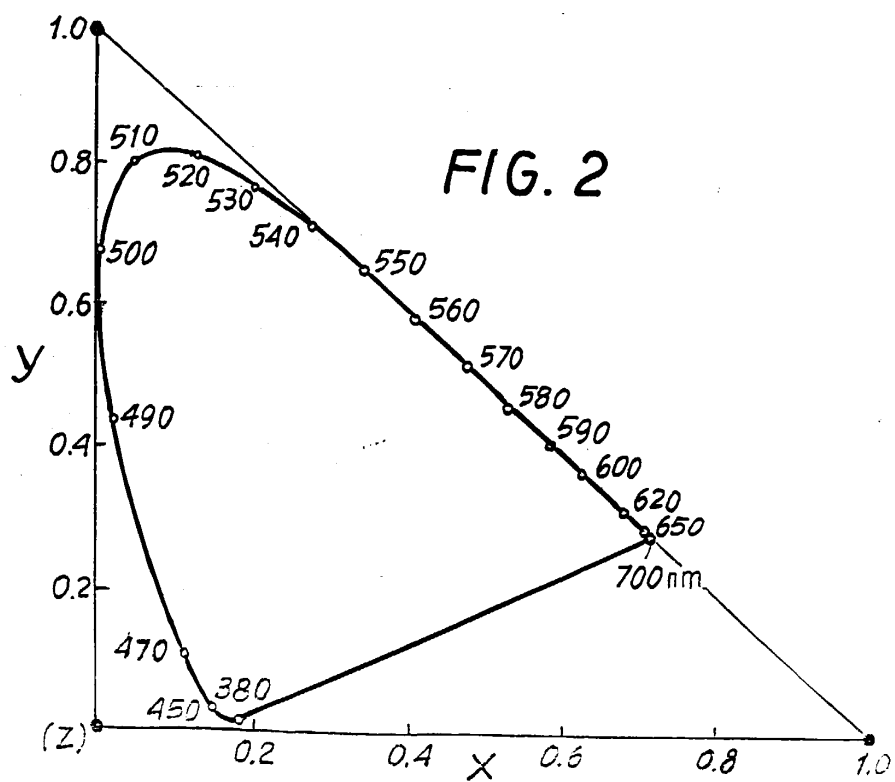
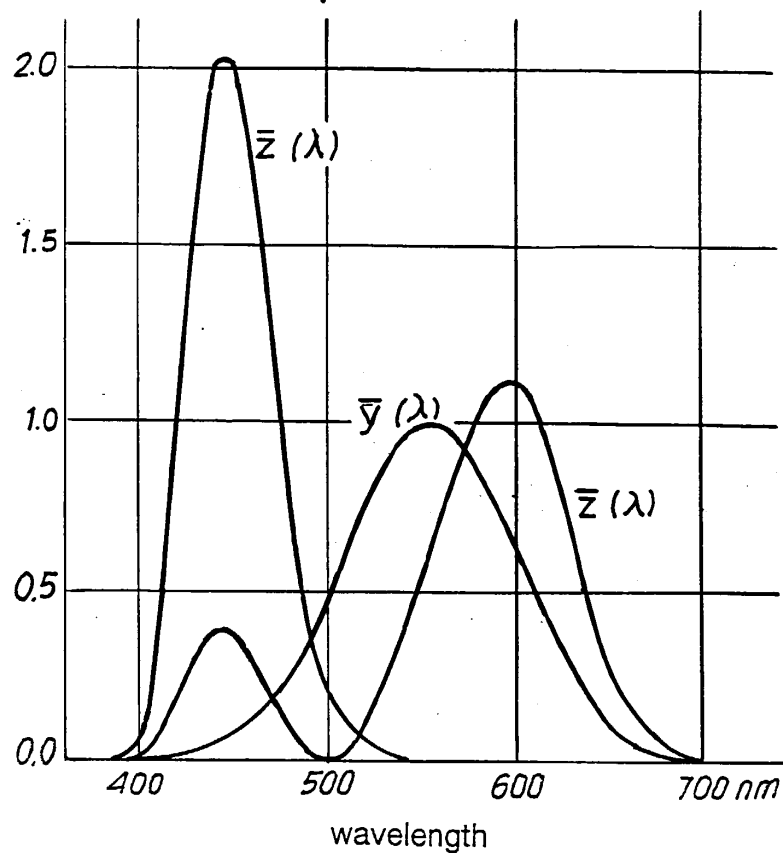
23. Method as claimed in one or more of claims 17 to 22, wherein an auxiliary white source is used, the emission intensity thereof being modified depending on the overall luminosity required.

24. Method as claimed in one or more of claims 18 to 23, wherein said chromaticity coordinates are the chromaticity coordinates of the XYZ CIE 1931 colorimetric system.

25. Method as claimed in claim 24, wherein the chromaticity coordinates of the ambient spectrum are determined by means of a set of three photodetectors associated with respective selective devices for the light spectrum, each photodetector having a sensitivity and the respective optical filter having a transmittance such that the three products of the sensitivity of the photodetector for the transmittance of the associated selective device for the light spectrum define a set of three color equality functions of an imaginary set of three tristimulus values, and wherein the tristimulus values determined by said photodetectors in said imaginary set of three tristimulus values are converted into corresponding tristimulus values in the XYZ CIE 1931 system so as to calculate the chromaticity coordinates.

26. Method as claimed in at least claim 17, wherein said characteristic of the ambient spectrum and said characteristic of the preconfigured spectrum are represented by the color temperature or by a correlated color temperature.

FIG. 1



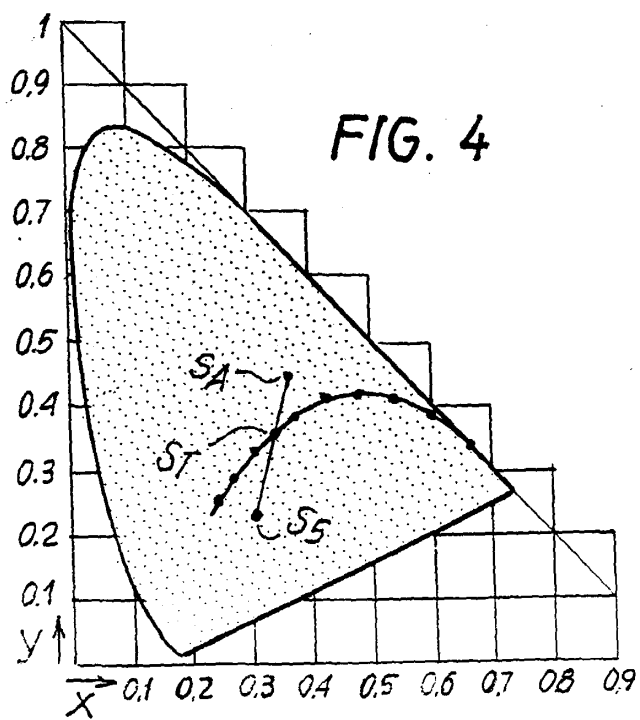
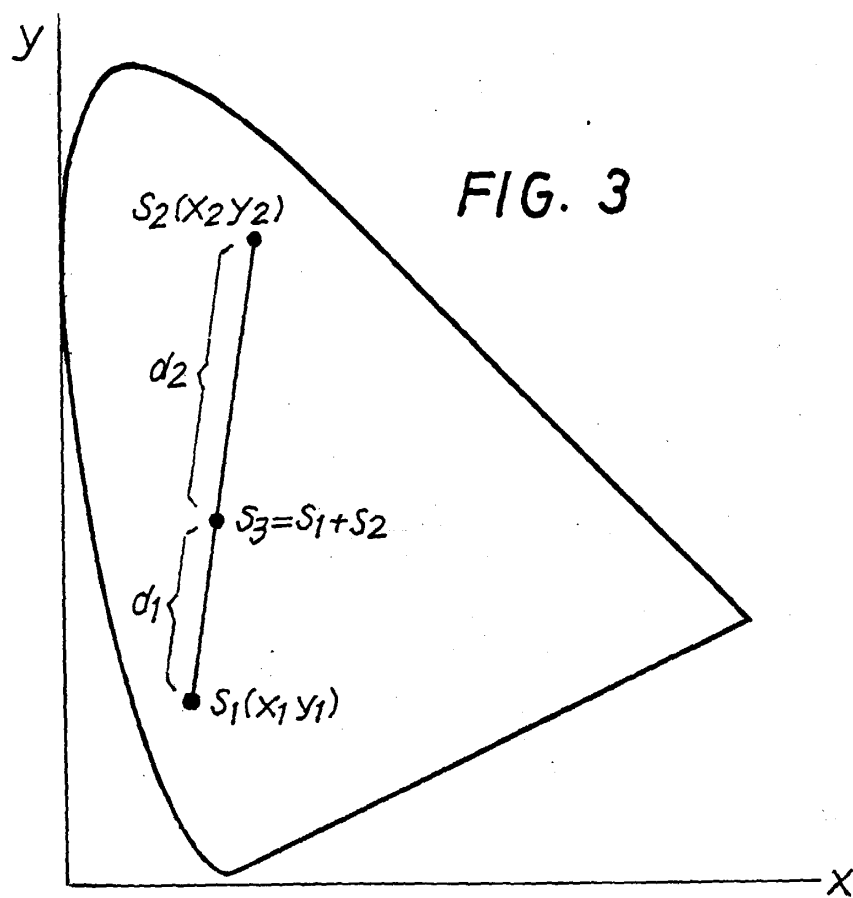


FIG. 5A

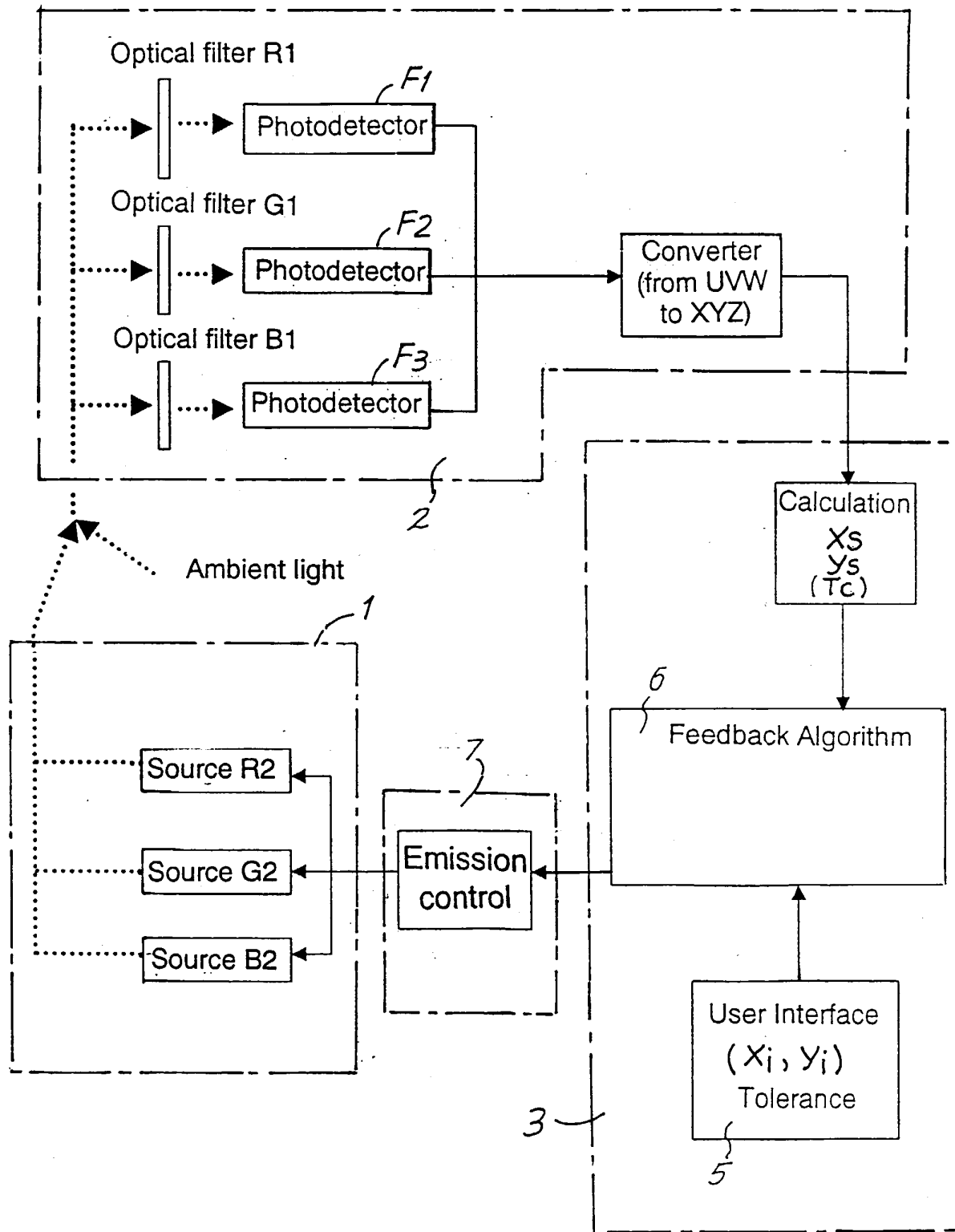


FIG. 5B

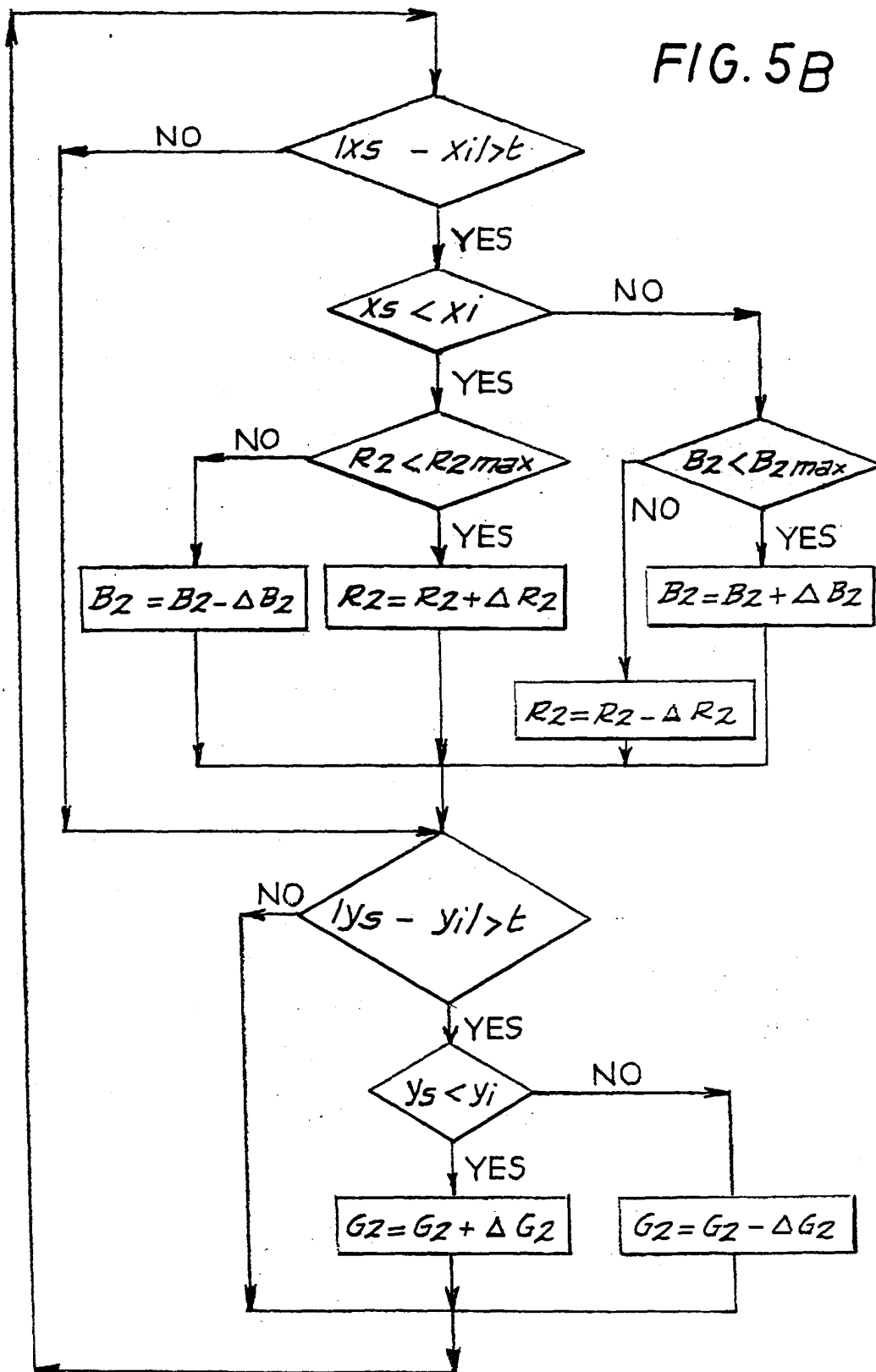


FIG. 6A

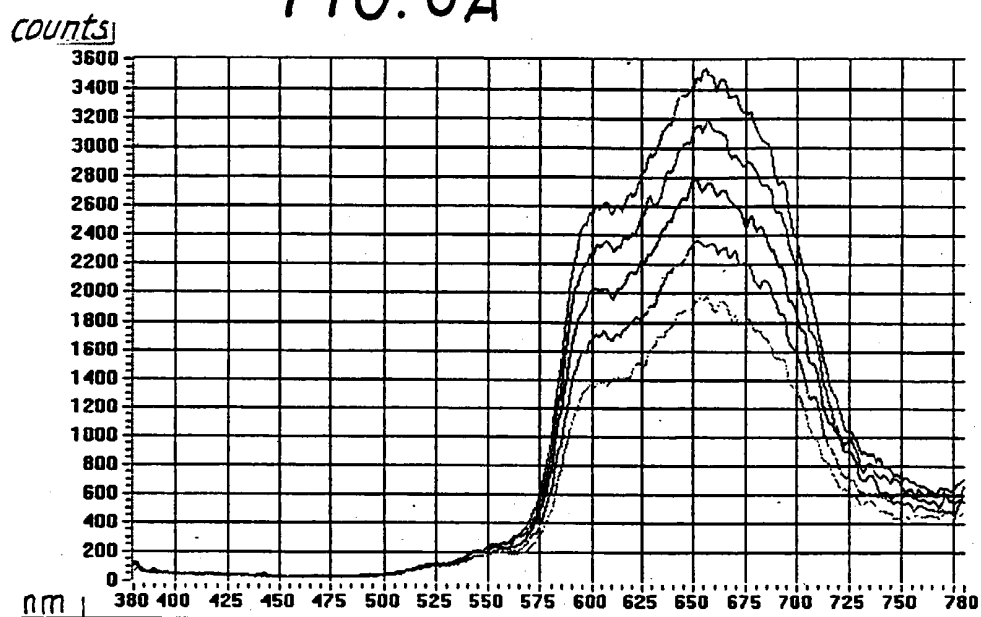


FIG. 6B

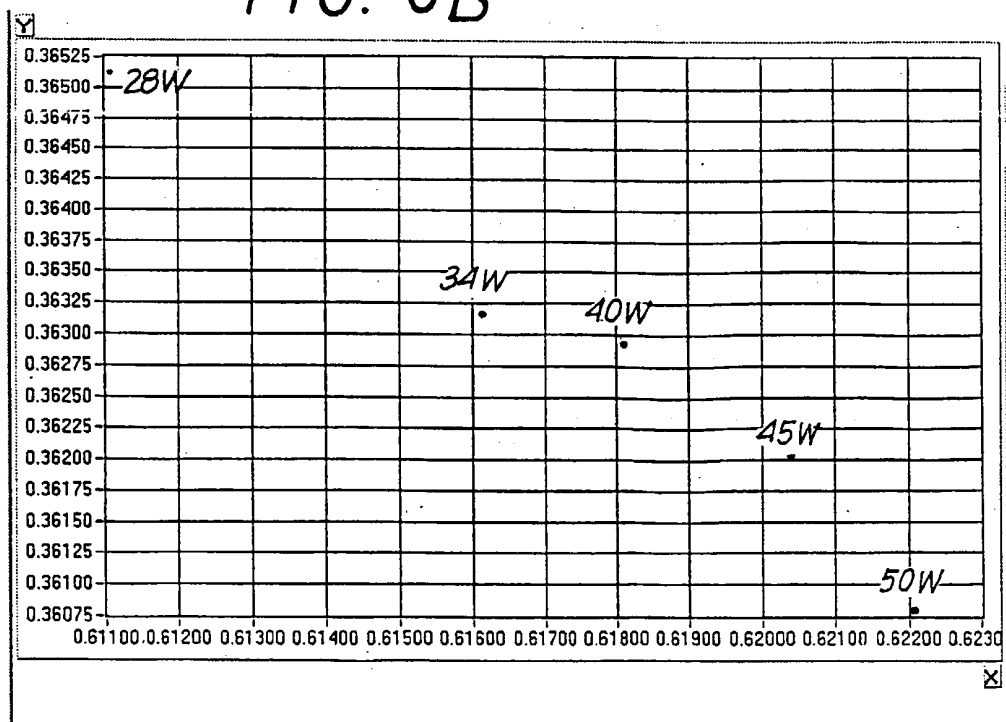


FIG. 7A

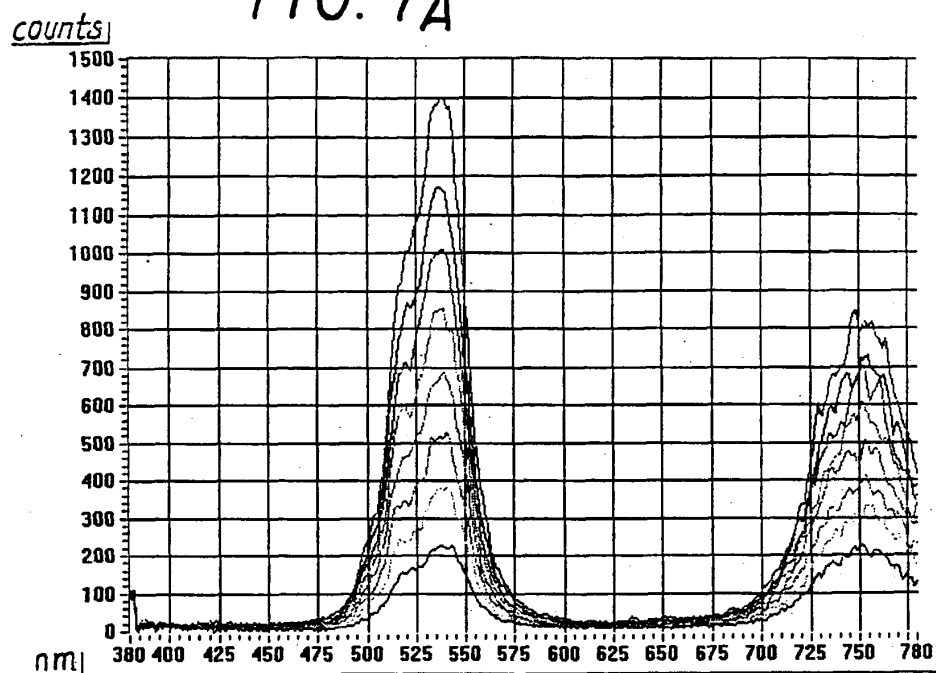
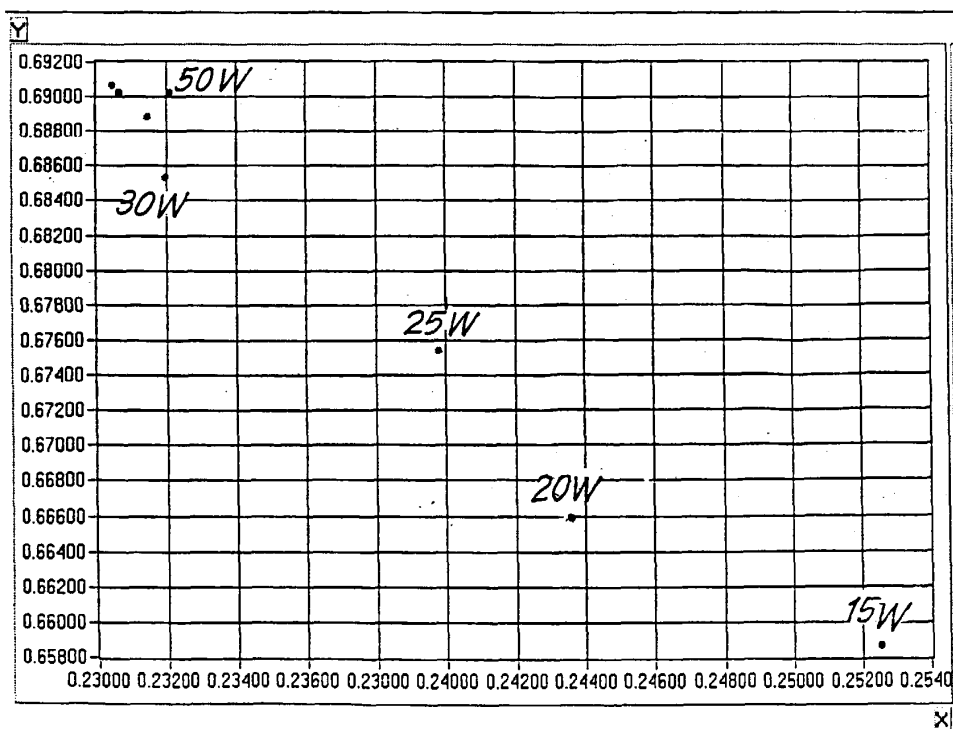


FIG. 7B



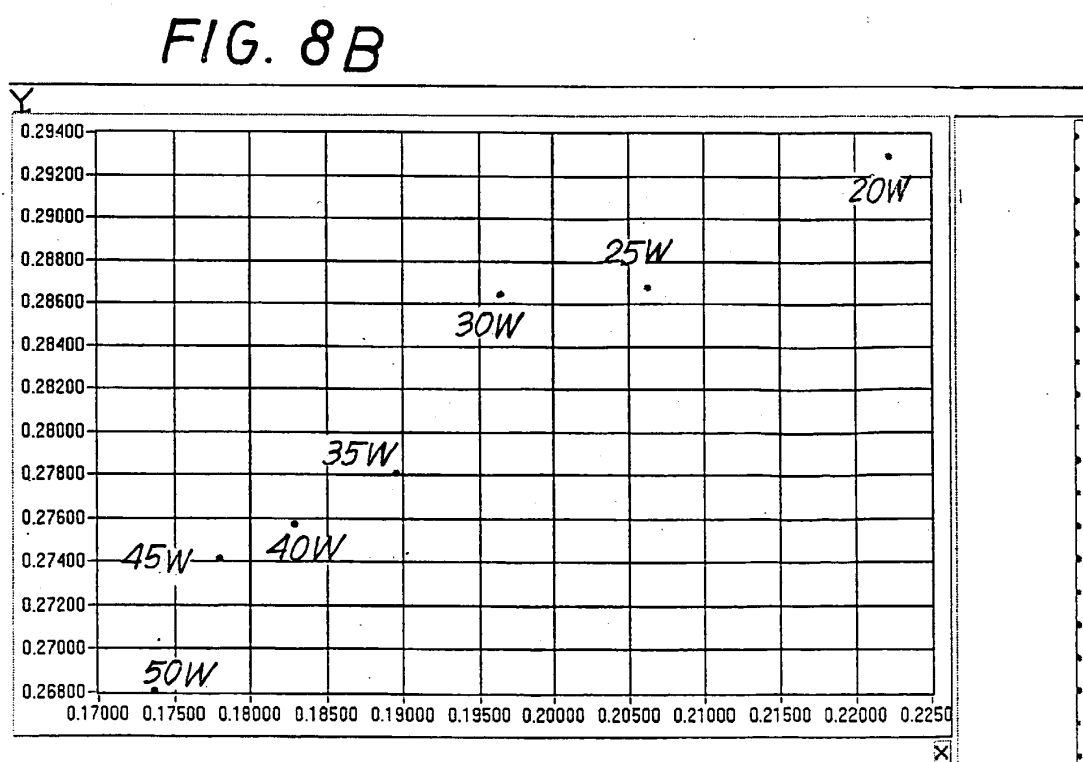
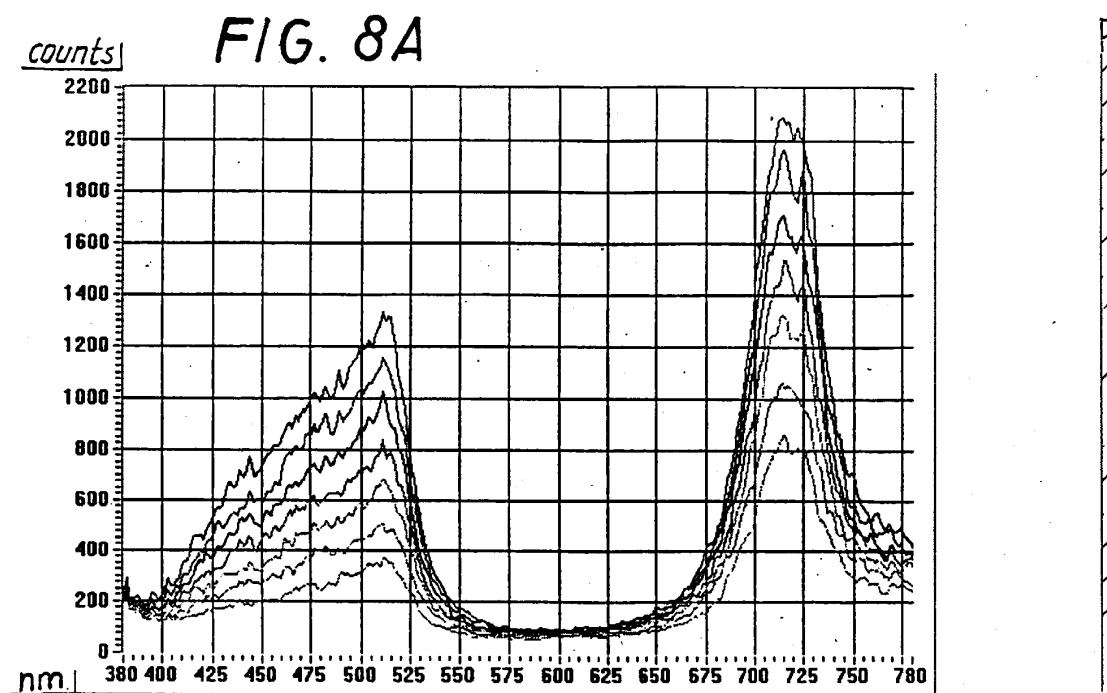


FIG. 9A

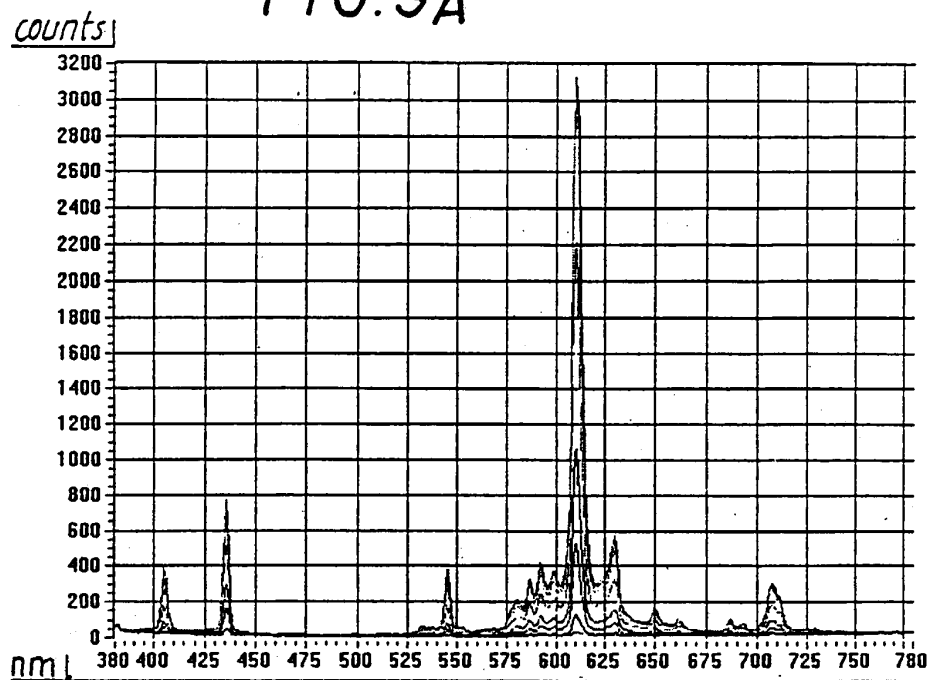


FIG. 9B

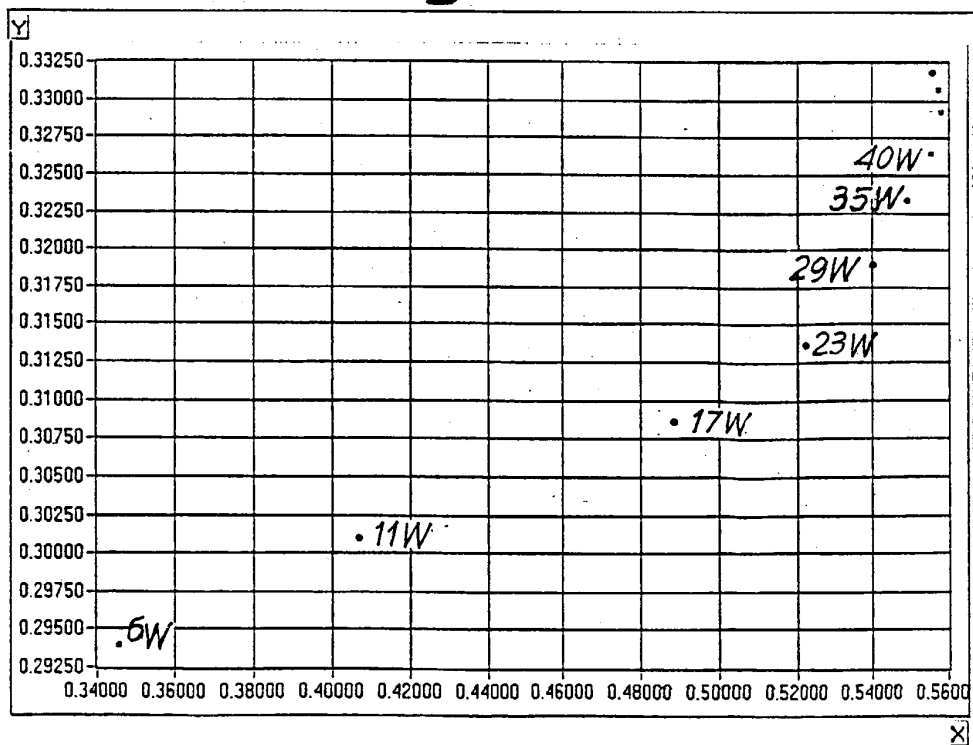


FIG. 10A

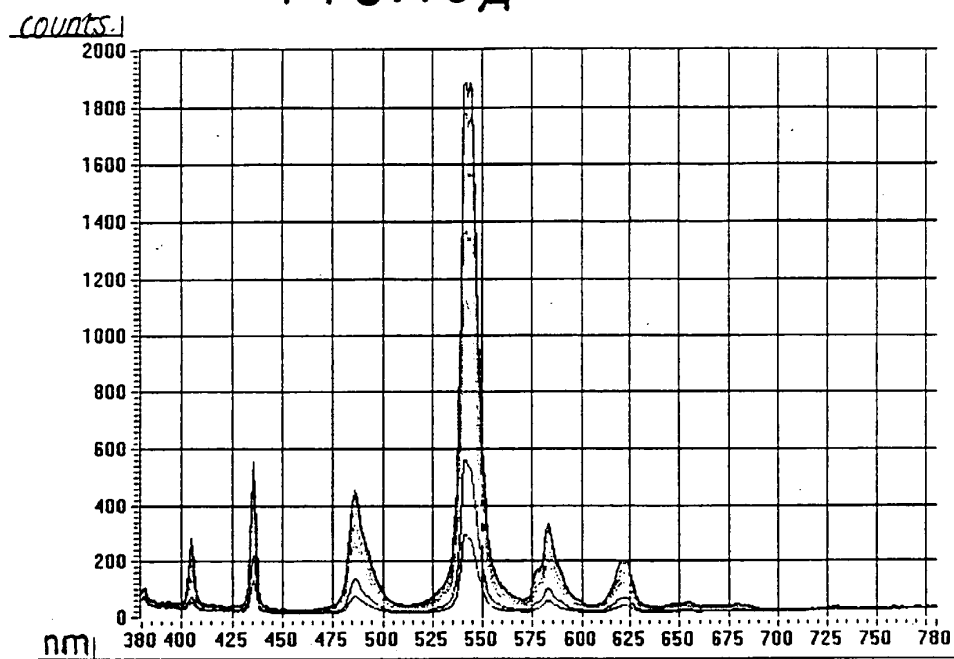


FIG. 10B

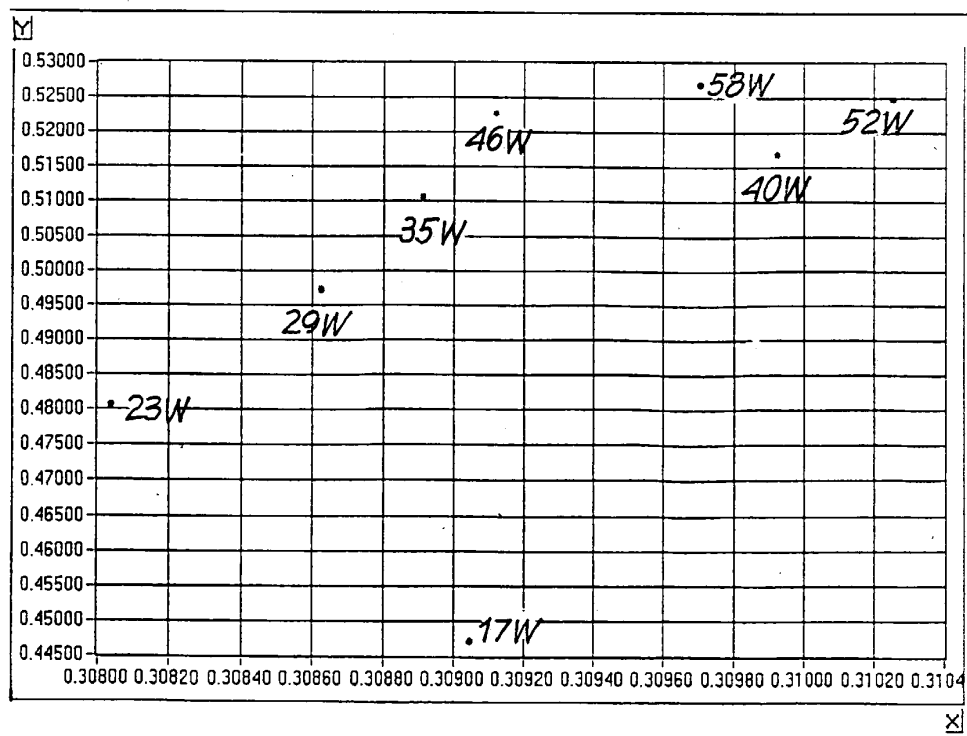


FIG. 11A

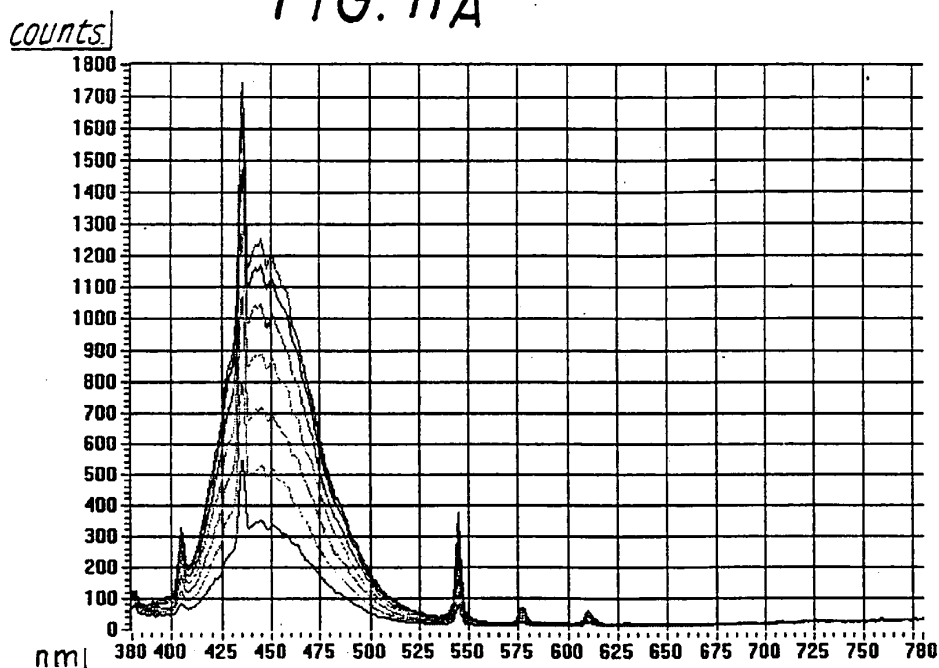


FIG. 11B

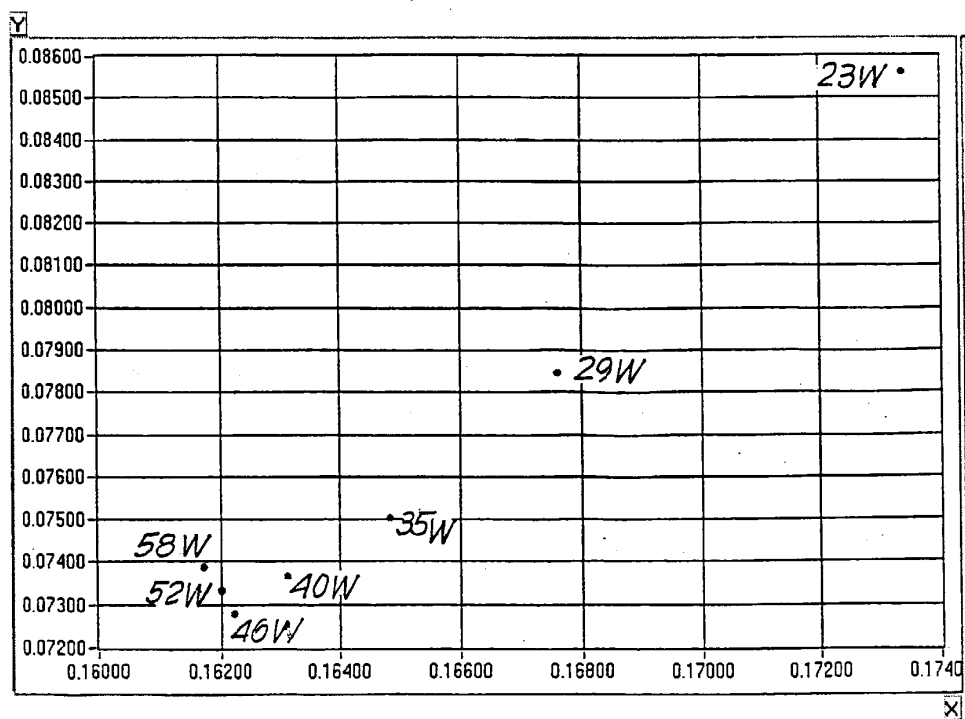


FIG. 12

