(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 587 896 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.05.2013 Bulletin 2013/18

(51) Int Cl.:
H05B 37/02 *(2006.01)*

(21) Application number: **12189552.8**

(22) Date of filing: **23.10.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **25.10.2011 CN 201110327716**
25.10.2011 CN 201120411395 U

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(54) **Lighting system and method of operation thereof**

(57) There present invention is concerned with a lighting system. The system has at least one lighting module and a controller communicable with the lighting module via an electrical cable or infra red signal emitted from the controller. The lighting module is adapted to produce one of a number of predetermined performances selected from a group including but not limited to illumination, non-illumination, degree of illumination, pattern of illumination, movement of direction of illumination and positioning of lighting element.

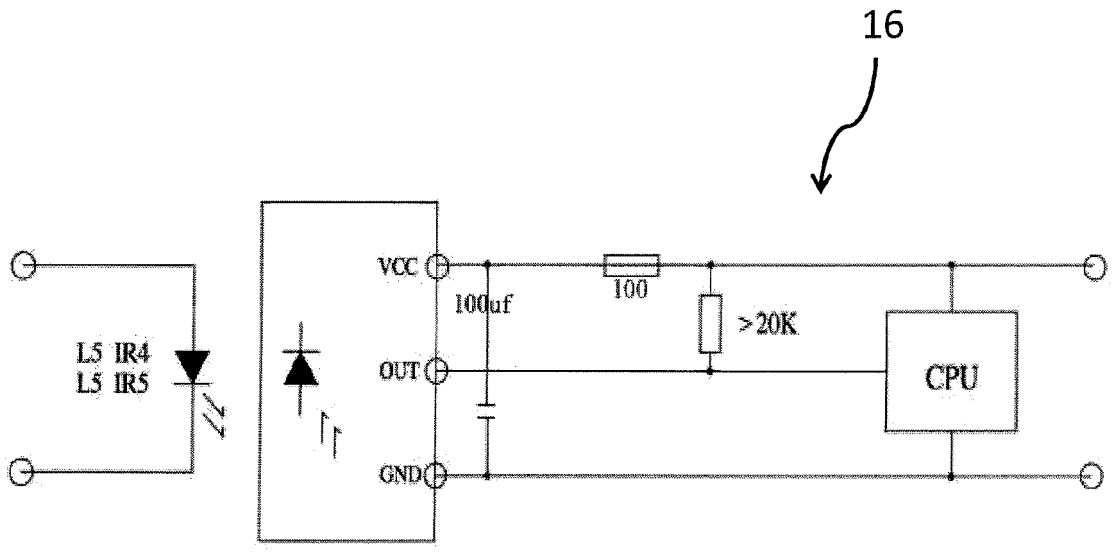

FIG. 1a

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Description

FIELD OF THE INVENTION

[0001] The present invention is concerned with a lighting system or a lighting apparatus and a method of operation thereof.

BACKGROUND OF THE INVENTION

[0002] Lighting systems are widely used in different settings and there are different lighting systems in the market to suit different needs. For example, in the entertainment industry or in concerts, sophisticated lighting systems are deployed to produce special visual effects. Lighting systems in concerts for example are often very advanced and complicated in that such systems often make use of tailor-made computer software to control specific performance of lighting during a show. While these systems are very powerful and versatile in their functionalities, they are not suitable for use in other settings such as domestic dwellings, small shops, offices, etc. Trained professionals are often needed to control such lighting systems.

[0003] Yet, before the filing date of this application the Inventors were aware that there would be a demand for smaller scale lighting systems for use in for example domestic dwellings. Such systems should have reasonable functionalities and yet they would be user friendly by layman and can realistically and economically be put to practice.

[0004] Accordingly, the present invention seeks to address the above issues and to allow users to more conveniently make use lighting effects in homes, offices, or smaller shops or department store, or at least to provide an alternative to the public.

SUMMARY OF THE INVENTION

[0005] According to a first aspect of the present invention, there is provided a lighting system comprising at least one lighting module and a controller communicable with the lighting module via an electrical cable or wireless infra red signal emitted from the controller, wherein the lighting module is adapted to produce one of a number of predetermined performances selected from a group including illumination, non-illumination, degree of illumination, pattern of illumination, movement of direction of illumination and positioning of the lighting module, wherein the controller is configured to be able to provide instructions to the lighting module for providing a desired electronic designation thereto or changing the electronic designation thereof, wherein the lighting module includes a programmable memory unit for storing the electronic designation, and wherein the electronic designation is representable by way of a visual indication shown on the lighting module. It can be appreciated with the lighting modules having their electronic designations, it will be convenient for a user to effect a certain predetermined performance of a particular lighting module or particular lighting modules remotely via the use of the controller. In a specific embodiment, the predetermined performance refers to one of the number of the preprogrammed performances with respect to the particular lighting module or itself, and not, for example, a particular predetermined configuration with respect to its surroundings.

[0006] Preferably, the lighting module and the controller may be adapted to communicate wirelessly within a distance of up to 15 meters. It can be appreciated that this range can cover the usage of the system in many indoor circumstances.

[0007] Conveniently, the lighting module may be configured to, when receiving wireless signals from the controller, act on infra red signals only.

[0008] In an embodiment, the lighting module may include a visual display via which, on activation thereof, the visual indication thereof is revealed visually by way of a two-digit alphanumerical representation such as a two-digit number.

[0009] In one embodiment, the lighting system may comprise two such lighting modules, or a first lighting module and a second lighting module, respectively, wherein the two lighting modules share the same electronic designation, whereby on instructions from the controller the two lighting modules deliver the same performance. In an alternative embodiment, the lighting system may comprise the two lighting modules, or a first lighting module and a second lighting module, respectively, wherein the first and second lighting modules are configured to carry different electronic designations, namely first and second electronic designations, respectively, whereby on instructions from the controller containing coding of the first electronic designation, only the first lighting module responds.

[0010] The lighting module may be configured to respond to or act on wireless instructions from the controller only when the wireless instructions contain a particular coding of the electronic designation of the lighting module or a global coding. By global coding, it means it codes for a blanket instructions receivable by and acted on by all lighting modules. When responding to or acting on the instructions containing the coding of the electronic designation of the lighting module, the instructions are intended for the lighting module only. When responding to the instructions containing the global coding, the global coding is intended to the lighting module as well as other lighting modules.

[0011] The lighting system may be free of means of using laser or narrow beam of light for effecting wireless communication between the controller and the lighting module. The lack of using laser or narrow beam of light is advantageous in at least two folds. First, the cost of manufacturing of the system would be lower. Second, a user would be able to operate the system without having to aim the controller or the laser or narrow beam thereof to the lighting module.

[0012] In a specific embodiment, the lighting system may comprise a rail-like member and a plurality of the lighting modules connected to and/or slidable on the rail-like member.

[0013] According to a second aspect of the present invention, there is provided a method of operating a lighting system as described above and comprise one or more of the steps of (a) assigning or changing the electronic designation(s) of the lighting module(s) via the electrical cable, (b) assigning or changing the electronic designations of the lighting modules such that the electronic designations become identical, or assigning or changing the electronic designations of the lighting modules such that the electronic designations are different, and (c) providing instructions to the lighting modules to effect the same performance or different performances thereof.

[0014] According to a third aspect of the present invention, there is provided a lighting apparatus comprising at least one lighting module and a remote controller, wherein the lighting apparatus comprises a mounting means for securing the lighting module on a wall or ceiling surface directly or indirectly, wherein the lighting apparatus module is adapted to produce one of a number of predetermined performances selected from a group including illumination, non-illumination, degree of illumination, pattern of illumination, movement of direction of illumination and positioning of lighting module, wherein the controller is communicable to the lighting module to assign or change a desired electronic designation of the lighting module, wherein the controller and the lighting module are, in a first configuration, communicable with each other via an electrical cable to assign or change the electronic designation of the lighting module, or in a second configuration, communicable via wireless infra red signals emitted from the controller to change the electronic designation of the lighting module, wherein the lighting module includes a programmable memory unit for recording the electronic designation thereof, and wherein the desired electronic designation is representable by way of a visual indication shown on a visual display of the lighting module.

[0015] Preferably, the lighting module may be configured to, when receiving wireless signals from the controller, act on infra red signals only.

[0016] Conveniently, the visual display may be adapted to display the visual indication by way of an alphanumerical representation or a two-digital number.

[0017] In one embodiment, the lighting system may comprise two such lighting modules, or a first lighting module and a second lighting module, respectively, wherein the two lighting modules share the same desired designation, whereby on instructions from the controller the two lighting modules deliver the same performance. In an alternative embodiment, the lighting system may comprise the two lighting modules, or a first lighting module and a second lighting module, respectively, wherein the first and second lighting modules are configured to carry different electronic designations, namely first and second electronic designations, respectively, whereby on instructions containing coding of the first electronic designation, only the first lighting module responds.

[0018] The lighting module may be configured to respond to instructions from the controller only when the instructions contain a coding of the desired electronic designation of the lighting module or a global coding.

[0019] The lighting system may be free of means of using laser or narrow beam of light for effecting wireless communication between the lighting module and the controller.

[0020] The lighting system may comprise a rail-like member and a plurality of the lighting modules connected to and/or slidable on the rail-like member.

[0021] The lighting system may comprise a motor means for effecting desired movement of direction of illumination, degree of illumination and/or positioning of illumination.

BRIEF DESCRIPTION OF DRAWINGS

[0022] Some embodiments of the present invention will now be explained, with reference to the accompanied drawings, in which:-

Fig. 1 a is a circuit diagram showing an exemplary circuit of a receiver of lighting system according to an embodiment of the present invention;

Fig. 1b is schematic circuit diagram illustrating an exemplary circuitry suitable for use in the receiver;

Fig. 2a is a side view showing a lighting module suitable for use in a lighting system according to an embodiment of the present invention;

Fig. 2b is another side view of the lighting module of Fig. 2a;

Fig. 2c is a bottom view of the lighting module of Fig. 2a;

Fig. 3a is a side view showing a lighting module suitable for use in a lighting system according to an embodiment of the present invention;

Fig. 3b is another side view of the lighting module of Fig. 3a;

Fig. 3c is a bottom view of the lighting module of Fig. 3a;

Fig. 3d is a perspective view showing the lighting module of Fig. 3a having assumed in a certain configuration;

Fig. 4a is a side view of a lighting module of a lighting system according to an embodiment of the present invention;

Fig. 4b is another side view of the lighting module of Fig. 4a;

Fig. 4c is a bottom view of the lighting module of Fig. 4a;

Fig. 5a is a top view of a remote control unit; and

Fig. 5b is a bottom view of the remote control unit of Fig. 5a.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0023] The present invention is concerned with a lighting system or a lighting apparatus suitable for use at smaller dwellings such as homes, retail shops, showrooms and display windows. Broadly, each lighting system of the present invention comprises at least one lighting module and a remote control unit or controller for controlling operation of the lighting module. The lighting module and the remote control unit are configured such that wireless infra red signals from the remote control unit are receivable by the lighting module within up to 15 meters of emission.

[0024] Referring to the drawings, Figs. 2a to 2c show different views of a lighting module of a lighting system according to a first embodiment of the present invention. The lighting module, generally designated 2, includes an illuminating portion 4. The illuminating portion 4 is in the form of an inverted cup member 6 in which an illuminator 13 is provided. In this embodiment, the illuminator 13 is a light-emitting diode (LED). The use of LED is advantageous because it can provide a relatively high luminous power and can operate at lower electric current. Further, different colours, intensities or epoxy colours of LEDs can be tailored made to suit a particular purpose. The lighting module 2 is provided with a base portion 8 from which two legs 10, 12 are extended. The illuminating portion 4 is attached to the base portion 8 via the legs 10, 12. The illuminating portion 4 is pivotably connected to the legs 10, 12 such that in use it is movable relative to the rest of the lighting module 2.

[0025] The lighting module 2 is provided with a mounting means 14 to which the base portion 8 is rotatably mounted to the mounting means 14. It can thus be understood that the base portion 8 is rotatably movable relative to the mounting means 14.

[0026] The mounting means 14 is configured such that it can be secured directly on the surface of a ceiling or wall. When mounted on the surface of a ceiling, for example, it is to be understood that the illuminating portion 4 is movable in two ways. In a first way, the illuminating portion 4 is movable relative to the base portion 8 such that lighting from the illuminating portion 4 is downwardly shining to the floor, as represented by "X" in Fig. 2b. The lighting may be downwardly shining or it may be downwardly shining at an angle to the floor or towards an adjacent wall. Alternatively or simultaneously, the illuminating portion 4 together with the base portion 8 may be rotatably moved relative to the mounting means 14.

[0027] The mounting means 14 can alternatively be mounted indirectly to a ceiling or wall surface via a rail-like member (not shown) attached to the ceiling or wall surface on which the lighting module 2 can slide. In this alternative, the illuminating portion 4 can move in a further dimension or in a manner such that lighting can be directed to an adjacent area by sliding the lighting module over. A desired lighting effecting can be achieved by adjusting the configuration and position of the lighting module 2.

[0028] The lighting system is configured such that the position of the lighting module 2 or the illuminating portion 4 can be adjusted remotely such that adjustment of the position of the illuminating portion 4 can be effected conveniently when the lighting module 2 is mounted on a ceiling out of normal reach by a user. Specifically, the base portion 8 is provided with electronics having a receiver for receiving infra red signals emitted from a remote control unit assigned to the lighting system 2. Fig. 1 a shows an electric circuit 16 of the receiver in this embodiment and Fig. 1b is a schematic diagram more broadly illustrating the logistics 18 of the working of the receiver. The base portion 8 is also provided with a motor means which acts on instructions from the electronics and can effect movement of the illuminating portion 4 such that lighting from the illuminator 13 can be directed downwardly or at an angle towards an adjacent wall surface. The motor means can also effect rotation of the lighting module 2 relative to the mounting means 14. The electronics and the parts in the base portion 8 can also effect other performances including illumination of the LED (to turn on the LED), non-illumination of the LED (to turn off the LED), degree of illumination of the LED (to control the brightness of the LED) and pattern of illumination (to control illumination pattern, eg flashing of lighting from the LED). It is to be understood that these other performances, together with the performances of different movements of the illuminating portion 4 or the lighting module 2, can create a variety of lighting effects in an environment. It is also to be understood that when the lighting system is provided with a plurality of lighting modules 2, the working of the lighting modules 2 together can create an even greater diversity or versatility of lighting effects. The following examples will explain the lighting system with respect to its hardware and its way of operation which allow setting up of designation(s) of the lighting module(s) 2 by a user.

Default setting of lighting module

[0029] In this embodiment, when the lighting system is being manufactured it is provided with a default electronic designation in the form of a two-digit numeral although in other embodiments other suitable forms of alphanumerical representations may be used. The default designation in this embodiment is "00" for the lighting module 2 shown in Figs. 2a-c. When only one lighting module 2 in the lighting system is used a user does not need to change the designation. In such scenario, after the lighting module is mounted to, for example, a ceiling surface, and connected to a power supply, a user can instruct the lighting module 2 to perform a desired performance remotely by using the remote control unit. Specifically, the user merely requires changing the channel of the remote control unit channel "00", thus matching the designation "00" of the lighting module 2. Once the

channel has been changed to "00", subsequent signals emitted from a transmitter of the remote control can be received by the receiver and acted on by the lighting module 2. The subsequent signals may contain instructions to, for example, increase the brightness of illumination from the illuminator.

Installation of lighting module

[0030] When the lighting module 2 is connected to a power supply, the display 20 will light up with the visual indication showing its electronic designation.

Checking the channel of lighting module

[0031] If a user would like to check the electronic designation of the lighting module 2, the user is merely required to instruct the remote control unit to send a relevant global signal for checking the electronic designation. This is achieved by pressing a relevant check button on the remote control unit. Once this is done, the lighting module 2 will indicate "00" on the visual display. A "global signal" refers to signals coding blanket instructions which are receivable, acceptable and acted on by all lighting modules within the system.

[0032] If there is a plurality of lighting modules 2 in the vicinity, the visual displays of all the lighting modules 2 will all light up, indicating their own electronic designations, which may be identical or different. It is to be noted that this particular global checking signal is receivable and acted on by all the lighting modules 2 in the vicinity.

Changing the channel of lighting module - before installation

[0033] Before installation on a ceiling surface, the electronic designation of a particular lighting module 2 can be changed by firstly connecting the remote control unit with the lighting module 2 with an electrical cable. Once they are connected, the existing electronic designation of the lighting module 2 can be revealed; and if it is to be changed a desired electronic designation can be input directly at the remote control unit and the new electronic designation is then transmitted to store at the memory of the lighting module 2 via the electrical cable.

[0034] When there is more than one lighting module 2, the same electronic designation or different electronic designations may be assigned to the modules 2 in a channel changing exercise for each lighting module accordingly.

Changing the channel of lighting module - after installation

[0035] After installation of the lighting module 2 on a ceiling surface, the electronic designation can also be changed remotely or wirelessly. This can be achieved by firstly checking the existing electronic designation assigned thereto as explained above. Then instructions by wireless signals for changing the existing electronic designation to a new electronic designation from the remote control unit are directed to the particular lighting module 2. This is achieved because the particular wireless signals contain coding with the existing electronic designation such that only the lighting module with this designation will respond to the signals, ie in this case to update its memory and record the new electronic designation.

Effecting desired performance of lighting module

[0036] Once the lighting module 2 with which a desired performance to be effected is identified, the remote control unit is set at a matching channel. For example, if the lighting module 2 with the electronic designation "01" is to be operated, then the remote control unit is to be set at the matching channel "01" such that operation signals from the remote control unit will contain coding for "01" and only upon receiving the operation signals containing the coding "01" would the particular lighting module 2 respond. In other words, in this scenario once the remote control unit is set at channel "01" the lighting module 2 with the electronic designation "01" is paired with the remote control unit such that the lighting module is in an operable state.

Effecting desired performance(s) of multiple lighting modules

[0037] When there are at least two lighting modules in the lighting system, namely a first lighting module 2A and a second lighting module 2B, and when they are expected to effect the same performance, it is important that they carry the same designation (eg "01 ") such that they will respond to operation signals with the same performance on instructions from the remote control unit. If not, their designations would have to be brought into consistency. (Changing of the channel can be achieved, as explained above.) In use, the channel of the remote control unit is then set to "01". Then subsequent operation signals containing coding with the electronic designation "01" will be received and acted on by all the lighting modules (ie 2A and 2B) having the electronic designation "01 ".

[0038] Of course if before installation on a ceiling or wall surface the lighting modules 2A and 2B are expected to effect the same performance, the designations of both the lighting modules 2A and 2B may for example be brought into consistency of eg "01" by connecting the lighting module 2B with the remote control unit with an electrical cable before the lighting module 2B is mounted on a surface. In other words, the designation is changed in a hard-wired manner. Once connected, the designation of the lighting module 2B is changed by the connected remote control unit as explained above. It is to be noted that the remote control unit is battery powered and the power is sufficient to effect the change and record the new designation "01" to the memory unit of the lighting

module 2B.

[0039] Alternatively, if both the lighting modules 2A and 2B have already been mounted on a ceiling surface out of reach by a user before the designation "02" of the lighting module 2B is changed to the designation "01", the designation "02" can still be changed wirelessly. This is achieved by firstly sending a remote infra red checking signal from the remote control unit to both the lighting modules 2A and 2B. This checking signal is globally read by the lighting modules. On receipt of this checking signal, visual indications showing the designations "01" and "02" will appear on the display screens of the lighting modules 2A and 2B, respectively. Since the designation "02" of the lighting module 2B is to be changed to "01", the relevant command on the remote control unit is provided, thus sending infra red signal corresponding to the command for changing and recording the designation of the lighting module 2B from "02" to "01" accordingly. Once the designations for the lighting modules 2A and 2B are both brought to "01", both the lighting modules 2A, 2B and the remote control unit can be considered as paired. In this configuration, since both the lighting modules 2A and 2B carry the same designation "01", the lighting modules 2A and 2B are both paired with the remote control unit via the designation (or channel) "01 ".

[0040] Once the lighting modules 2A and 2B carry the same designations, a user with the remote control unit can control them simultaneously. This is achieved by changing the channel of the remote control unit such that signals emitted therefrom are directed towards both the lighting modules 2A and 2B. On receipt of initial checking signal from the remote control unit, the visual displays of both the lighting modules 2A and 2B will indicate "01" flashing. The user can then set the channel of the remote control to "01" such that subsequent signals from the remote control unit will be recognizable and acted upon by both the lighting modules 2A and 2B.

[0041] If on the other hand different performances of the lighting modules are required, then designations "01" and "02" of the lighting modules need not be changed. Once the lighting modules 2A and 2B are mounted on, for example, a ceiling surface, each lighting module can be adjusted independently. When, for example, a specific performance of only the lighting module 2B is desired then the remote control unit is effected to emit an initial checking signal first. On receipt of the initial checking signal, the visual displays of both the lighting modules 2A and 2B will be flashing with their designations "01" and "02", respectively. Since a specific performance of only the lighting module 2B is desired, the user will, on identifying the designation "02" shown on the visual display, set the channel of the remote control to "02" such that subsequent signals from the remote control unit will be directed to and acted on by the lighting module 2B.

[0042] Then when the lighting module 2B has accomplished the specific performance, the user can change the channel of the remote control unit similarly as explained above in order to effect specific performance of the lighting module 2A.

[0043] It is envisaged that in other embodiments, different number of lighting modules may be provided, with some of the lighting modules sharing the same designations while some do not. For the lighting modules sharing the same designation as indicated by their visual displays, the same performance may be effected simultaneously. For the lighting modules with separate or unique designations, they may be controlled independently. It can be appreciated that when there are a plurality of lighting modules they are still be controlled in a similar manner. An embodiment of the lighting system according to the present invention is configured such that another global signal may be emitted by the remote control unit, and receivable and acted on by all the lighting modules. This other global signal contains instructions to turn off all lighting modules. It is to be noted that it will be within the grasp of a skilled person in the art to understand and arrive at the construction of the electronics required in this invention. It is thus to be understood that in this embodiment, there are two global signals, one for sending checking instructions, and the other for turning off the system, both are directed to all lighting modules. In a different embodiment of a lighting system according to the present invention, the system is configured to generate three global signals, in which the remote control unit can and is adapted to emit a third global signal providing a blanket instruction receivable and acted on by the receivers of all the lighting modules of the system in the vicinity for powering on the system or turning on illumination of all lighting modules in the system.

[0044] From the above, it is to be understood that a lighting system in accordance with the present invention is different from systems which for example require the use of two distinct types of radiation or frequencies for communication between the lighting module(s) and the remote control unit. The lighting system is also different in that when instructing a lighting module to effect a specific performance, a user is not required to hold onto the remote control unit and aim at a light detector or a small target of the lighting module for directing the signals or commands to the lighting module. Instead, designations of different lighting modules are firstly to be retrieved such that the user can conveniently identify the electronic designation of a particular lighting module or particular lighting modules to which performance is to be effected, and then set the channel of the remote control unit to enter into a relevant channel or pair with the lighting module (s) accordingly.

[0045] Figs. 3a-d illustrate a lighting module 30 of a lighting module according to another embodiment of the present invention. The lighting module 30 is different from the lighting module 2 in Figs. 2a-c in that an illuminating portion 32 is provided with an illuminator 34 which can be telescopically extended from or retracted into an illumination cup member 36 thereof, as shown by the arrows in Fig. 3d.

[0046] Figs. 4a-d illustrate a lighting module 40 of a

lighting module according to another embodiment of the present invention. The lighting module 40 is different from the lighting module 2 in Figs. 2a-c in that an illuminating portion 42 is provided with an illuminator which can be telescopically extended from or retracted into an illumination cup member 44 thereof such that lighting can be directed from downwardly and vertically to horizontally, as indicated by the arrows in Fig. 4b.

[0047] Fig. 5 shows a remote control unit 50 of a lighting system according to an embodiment of the present invention.

[0048] It should be understood that certain features of the invention, which are, for clarity, described in the content of separate embodiments, may be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the content of a single embodiment, may be provided separately or in any appropriate sub-combinations. It is to be noted that certain features of the embodiments are illustrated by way of non-limiting examples. For example, it is envisaged that an embodiment of a lighting system according to the present invention may be provided without the use of a rail or track. Lighting modules thereof can be embedded in or built into a ceiling or wall panel, as shown in Fig. 4. Also, a skilled person in the art will be aware of the prior art which is not explained in the above for brevity purpose.

Claims

1. A lighting system comprising at least one lighting module and a controller communicable with said lighting module via an electrical cable or wireless infra red signal emitted from said controller;
   wherein said lighting module is adapted to produce one of a number of predetermined performances selected from a group including illumination, non-illumination, degree of illumination, pattern of illumination, movement of direction of illumination and positioning of said lighting module;
   wherein said controller is configured to be able to provide instructions to said lighting module for providing a desired electronic designation to the lighting module or changing the electronic designation of the lighting module; wherein said lighting module includes a programmable memory unit for storing the electronic designation; and
   wherein the electronic designation is representable by way of a visual indication shown on said lighting module.

2. A lighting system as claimed in Claim 1, wherein said lighting module and said controller are adapted to communicate wirelessly within a distance of up to 15 meters.

3. A lighting system as claimed in Claim 1, wherein said lighting module is configured to, when receiving wireless signals from said controller, act on infra red signals only.

4. A lighting system as claimed in Claim 1, wherein said lighting module includes a visual display via which, on activation thereof, the visual indication thereof is revealed by way of a two-digital alphanumerical representation.

5. A lighting system as claimed in Claim 1, comprising two said lighting modules, or a first lighting module and a second lighting module, respectively, wherein said two lighting modules share the same electronic designation, whereby on instructions by wireless signals from said controller said two lighting modules deliver the same performance.

6. A lighting system as claimed in Claim 1, comprising two said lighting modules, or a first lighting module and a second lighting module, respectively, wherein said first and second lighting modules are configured to carry different electronic designations, namely first and second electronic designations, respectively, whereby on instructions by wireless signals from said controller containing coding of the first electronic designation, only said first lighting module responds.

7. A lighting system as claimed in Claim 1, wherein said lighting module is configured to respond to instructions by wireless signals from said controller only when the wireless instructions contain a coding of the electronic designation of said lighting module or a global coding.

8. A lighting system as claimed in Claim 1, wherein said system is free of means of using laser or narrow beam of light for effecting wireless communication between said controller and said lighting module.

9. A lighting system as claimed in Claim 1, comprising a rail-like member and a plurality of said lighting modules connected to and/or slidable on said rail-like member.

10. A method of operating a lighting system as claimed in any one of Claims 1 to 9, comprising one or more of the steps of:-

    - assigning or changing the electronic designation(s) of said lighting module(s) via the electrical cable;
    - assigning or changing the electronic designations of said lighting modules such that the electronic designations become identical, or assigning or changing the electronic designations of said lighting modules such that the electronic designations are different; and

- providing instructions to said lighting modules to effect the same performance or different performances thereof.

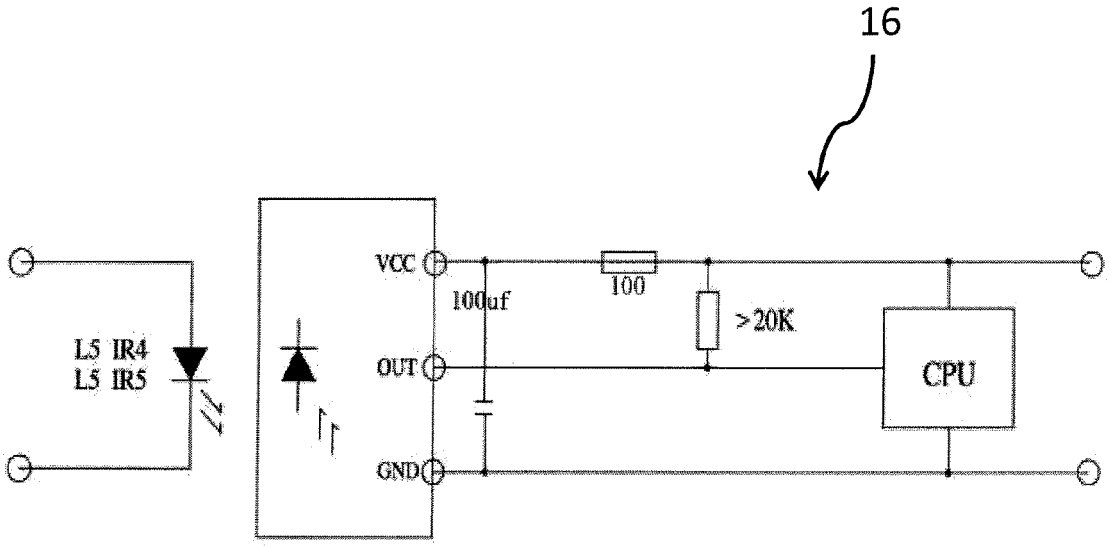
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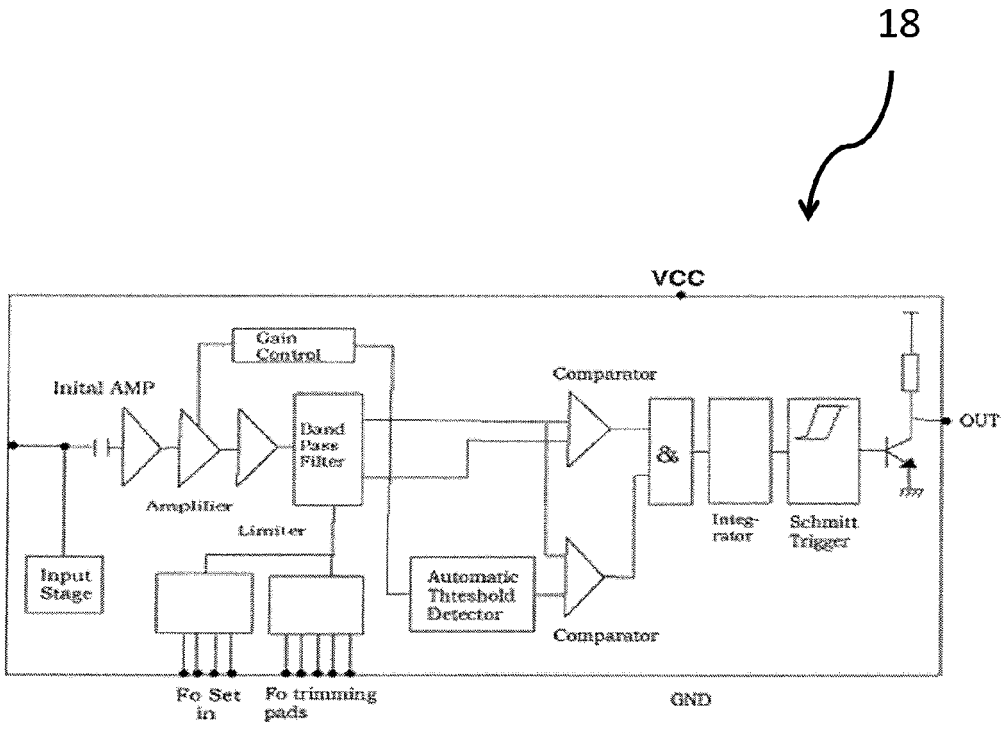
FIG. 1a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Inital AMP
Band Pass Filter
Amplifier
Limiter
Input Stage
Automatic Thteshold Detector
Comparator
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FIG. 1b

FIG.2a

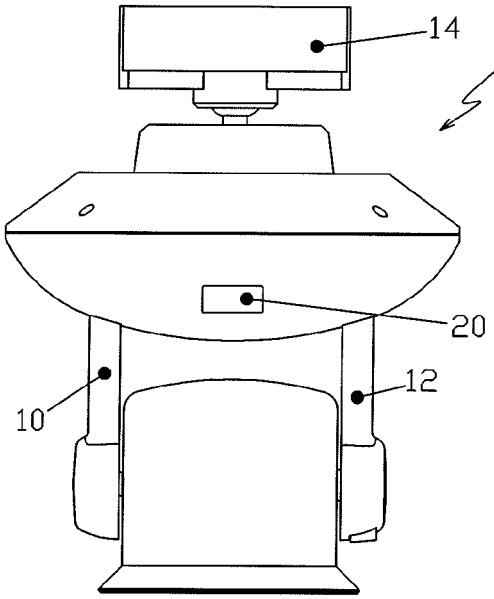
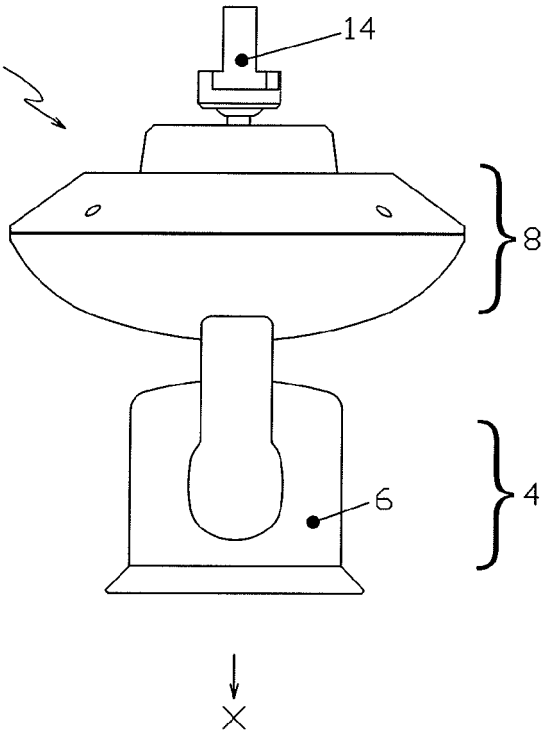


FIG.2b



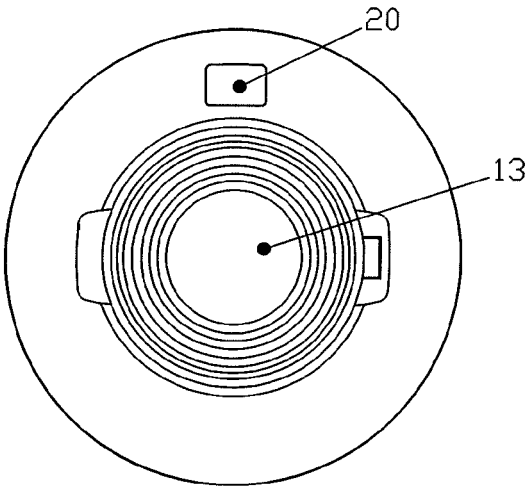


FIG.2c

FIG.3a

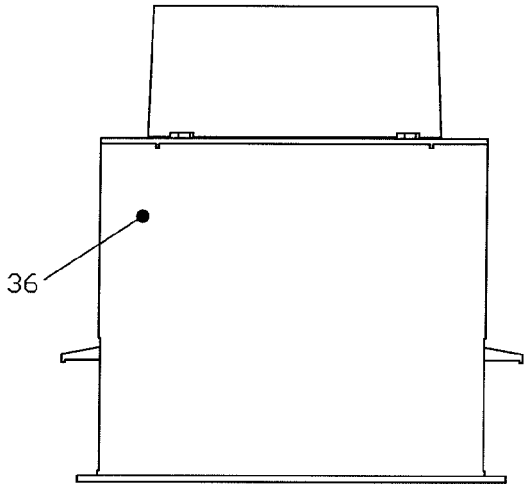
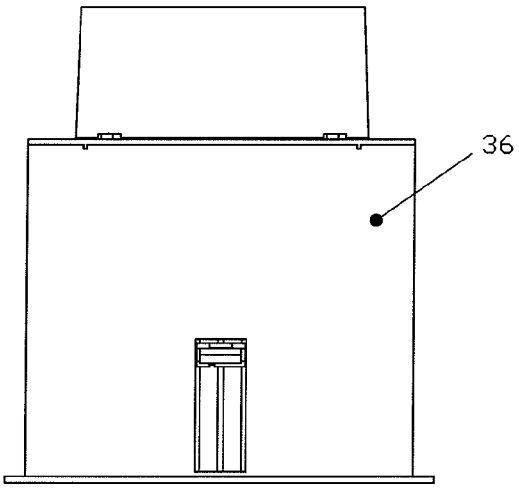
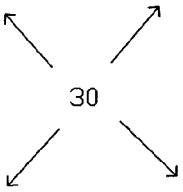


FIG.3b





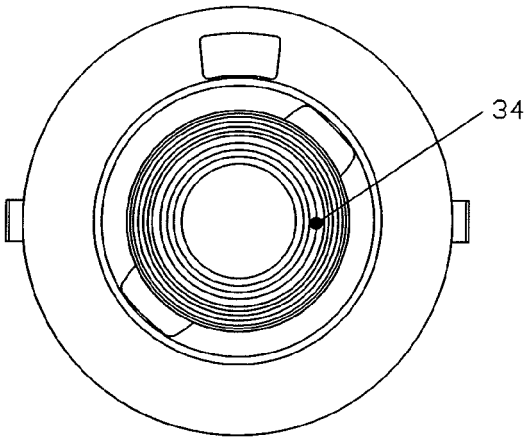


FIG.3c

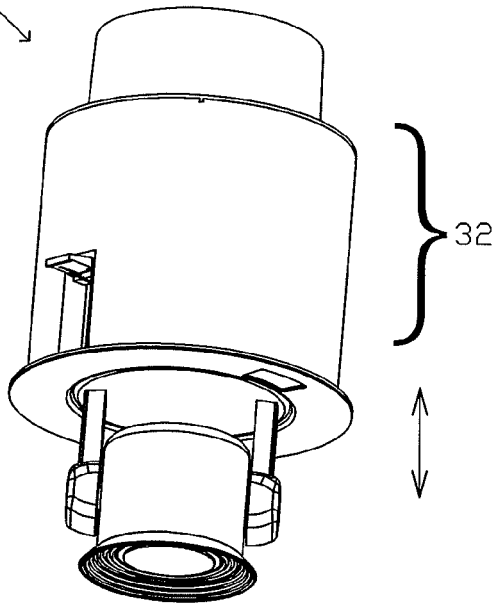


FIG.3d

FIG.4a

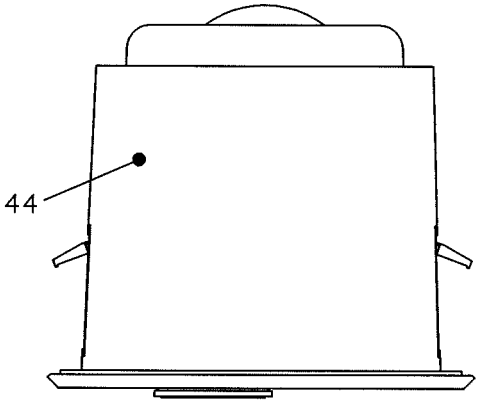
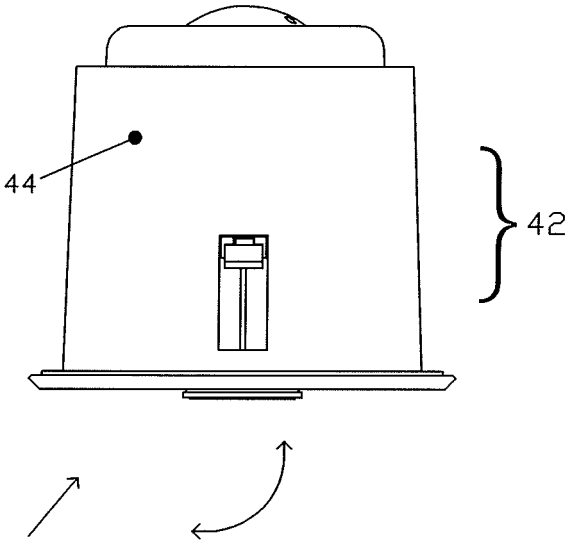


FIG.4b



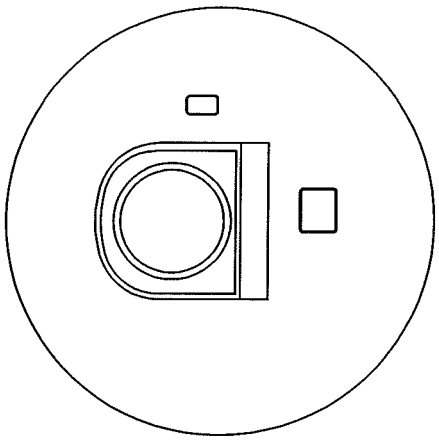


FIG.4c

FIG.5a

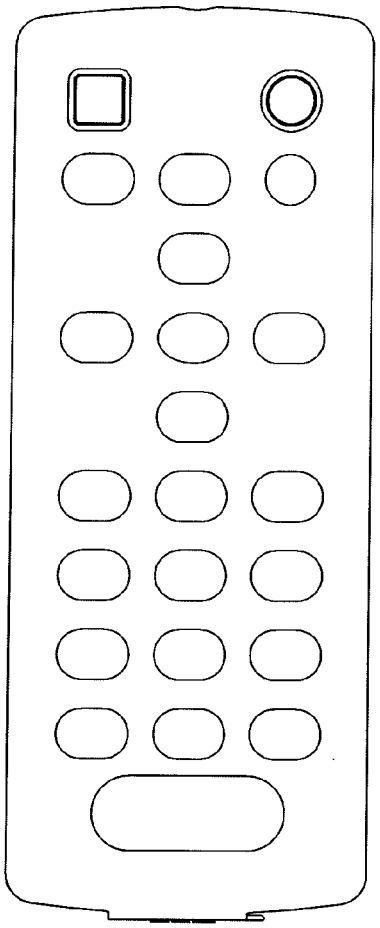


FIG.5b