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(71) Applicant: **Consorzio Terranuova**
52028 Terranuova Braccolini (AR) (IT)

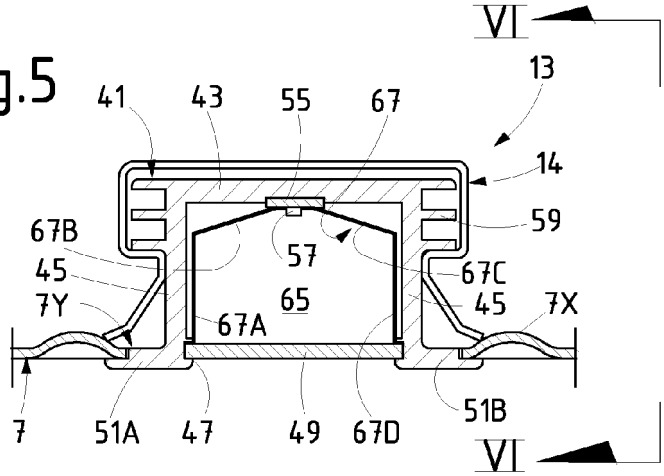
(72) Inventor: **Desideri, Valerio**
56124 Pisa (IT)

(74) Representative: **Mannucci, Michele et al**
Ufficio Tecnico Ing.A. Mannucci S.r.l.
Via della Scala 4
50123 Firenze (IT)

(54) **Lighting system and its components**

(57) There is described a lighting system that can use LED lighting bodies. A LED lighting body (13) can comprise a housing (41) of elongated form with a bottom wall (43) and an opposite opening extending along the longitudinal extension of the housing. Inside the housing there is arranged a electronic card (55) provided with a plurality of LEDs (57) distributed along the longitudinal extension of the housing (41) and facing the opening of the housing. In the opening there is housed a shield (49) that closes the opening and comprises a photoluminescent material, which modifies the spectrum of the radiation of the LEDs.

Fig.5



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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of lighting technology. More in particular, the invention relates to a new lighting system using LEDs as light sources.

STATE OF THE ART

[0002] The lighting technology sector is becoming increasingly oriented toward systems that are able to optimize energy consumption, increase reliability and improve the color rendering of the lighting bodies.

[0003] These objects are currently pursued with the use of LED (light emitting diode) technology. Recent developments in the LED lighting sector make it possible to obtain an approximately tenfold reduction in consumption with respect to conventional incandescent lamps and a reduction of approximately 50% with respect to gas discharge lamps (neon tubes). From the point of view of reliability, LEDs have a much longer useful life than conventional lighting bodies. Also from the point of view of the quality of light (CRI = Chromatic Rendering Index), LEDs guarantee the maximum performance obtainable in the lighting technology sector.

[0004] However, the use of LEDs has some drawbacks. In particular, these devices require control of the power supply with dedicated ballasts. Moreover, LEDs constitute point source lighting, which therefore tends to dazzle due to the high density of light emitted. Optical diffusion and reflection systems have been studied to overcome this problem. Remote phosphor systems have also been studied; these are materials that, when applied to a substrate placed at a distance from the LED, convert the radiation emitted by the LED into visible light not directly on the LED, but at a distance therefrom, so that the emitting surface is larger and the light emitted is less concentrated.

[0005] WO 2011/103204 describes a lighting system that utilizes strips of LEDs that excite a light emitting substance applied at a distance from the strip of LEDs, so as to obtain improved distribution of light radiation.

SUMMARY OF THE INVENTION

[0006] According to one aspect, the invention relates to an LED lighting body comprising a housing having an elongated shape with a bottom wall and an opposite opening extending along the longitudinal extension of the housing; wherein inside the housing there is arranged an electronic card provided with a plurality of LEDs distributed along the longitudinal extension of the housing and facing the opening of the housing; and wherein in said opening a foil shield is housed, which closes said opening and applied to which is a photoluminescent material, which modifies the spectrum of the radiation of the LEDs.

[0007] The lighting body in question can be sized so as to replace normal fluorescent tubes. For example the housing can be of elongated form, with transverse dimensions substantially equivalent to the dimensions of the diameter of a fluorescent tube. In this way the lighting body can be inserted in place of a fluorescent tube in an existing ceiling light fixture.

[0008] According to some embodiments, the invention provides for a lighting system with at least one ceiling light fixture including a support with a plurality of seats for respective lighting bodies. The system also comprises a plurality of LED lighting bodies each of which in turn comprises a housing of elongated form with a bottom wall and an opposite opening extending along the longitudinal extension of the housing. Inside the housing, which preferably has a generally upside-down U-shaped cross section, there is provided an electronic card provided with a plurality of LEDs distributed along the longitudinal extension of the housing and facing the opening of the housing. Moreover, each lighting body comprises a shield that closes the opening and comprises a photoluminescent material, or phosphor, which modifies the spectrum of the radiation of the LED. The system also comprises a mechanism for snap fastening the lighting bodies to the ceiling light fixture, so as to avoid the use of complex mounting devices, for example using screws or the like. Mounting is simplified and can be performed without the use of tools.

[0009] To obtain a reduction in production costs, in advantageous embodiments, each housing is made from a metal section bar, i.e. from an elongated component, with a constant cross section, for example obtained by extrusion.

[0010] In some embodiments, each housing can have at least one external finned surface for heat dissipation. The electronic card is advantageously in direct or indirect thermal contact with the housing to dissipate heat through the wall of the housing and the external finned surface.

[0011] The external finned surface can comprise one or more heat dissipation fins extending preferably for the whole of the longitudinal extension of the housing. In advantageous embodiments, the heat dissipation fins are placed on the outside of the bottom wall of the housing, so as to reduce the distance between fins and electronic card and thus increase thermal efficiency. In fact, the electronic card is advantageously placed in contact with the bottom inner surface of the housing, i.e. with the surface opposite the opening of the housing, through which the light radiation is diffused.

[0012] In other embodiments, the finned surface can comprise a plurality of heat dissipation fins that extend from the outer surfaces of the lateral walls of the housing, i.e. the walls that extend from the bottom of the housing toward the opening thereof.

[0013] In advantageous embodiments, in particular if the housing is made by extrusion, the finned surfaces for heat dissipation extend for the whole of the longitudinal extension of the housing.

[0014] In some embodiments, the heat dissipation fins can be used to anchor the lighting body to the respective ceiling light fixture. For example, by arranging the dissipation fins on the two opposite longitudinal walls of the housing, the system for snap fastening the lighting body to the ceiling light fixture can comprise at least one shaped elastic clip that is fitted along the housing of the lighting body and externally thereto, engaging with undercut with the heat dissipation fins, which can advantageously be "Ω" shaped. The ends of each clip can cooperate with longitudinal lips formed along the seat of the respective lighting body provided in the respective ceiling light fixture. The housing of the lighting body can in turn have longitudinal flanges that extend on both longitudinal sides of the opening and cooperate with the longitudinal lips on the opposite side with respect to the elastic clips.

[0015] In advantageous embodiments, the housing of each lighting body can be provided with a pair of end caps or covers, fixed to close the longitudinal ends of the housing of the lighting body.

[0016] When the lighting body is provided with closing caps, these can be used as part of the system or mechanism for snap fastening the lighting body to the ceiling light fixture. To this end, in some embodiments, each end cap can comprise a respective protuberance facing the outside of the housing of the respective lighting body. The protuberance cooperates with a retaining seat formed on the ceiling light fixture. In practical embodiments, at the opposite ends of the seat of the lighting body, produced in the ceiling light fixture, there can be provided tabs or appendages oriented at around 90° with respect to a surface, panel or plate of the ceiling light fixture, in which the seats for the lighting bodies are produced. The tabs can be provided with holes forming the retaining seats, into which the protuberances provided on the caps of the lighting body are inserted.

[0017] In practical embodiments, the lighting body therefore has two fastening elements in the form of projections or protuberances at the two opposite longitudinal ends, which are inserted in the retaining seats or holes produced in the two opposite tabs of the ceiling light fixture. These can have an elastic bending deformability, to allow insertion of the lighting body and to engage by snap fasting to the end closing caps of the housing.

[0018] The protuberances of the two caps can have a beveled surface to facilitate fastening to the tabs of the ceiling light fixture.

[0019] In advantageous embodiments, the ceiling light fixture can comprise a punched plate, advantageously made of metal, for example steel, aluminum or another suitable metal material. The punched plate can be provided with slots for mounting of the lighting bodies, formed by punching, laser cutting or similar machining operations of the plate, which form the seats for the lighting bodies. Advantageously, at opposite ends of the longitudinal extension of each slot the plate has tabs generally folded orthogonally to the main plane of the plate: The tabs have said retaining seats for the protuberances of the two end caps of the respective lighting body. The seats can also be made simply by punching or laser cutting of the plate. The elasticity of the material forming the plate provides the retaining effect of the lighting body.

[0020] The lighting body is positioned on one face of the plate forming the ceiling light fixture, from which the tabs forming the retaining seats project. When the ceiling light fixture is mounted, for example, on the ceiling, the lighting body and the retaining tabs are located above the ceiling light fixture, i.e. above the panel or plate in which the seats for mounting the lighting bodies are formed. This guarantees maximum safety against the lighting bodies accidentally falling from the ceiling light fixture.

[0021] In some embodiments, at least one of the end caps of each lighting body has an indentation for the electronic card to extend toward the outside of the housing, said electronic card being longer than the housing and carrying a connector arranged on a portion of the electronic card projecting from the housing of the respective lighting body.

[0022] In advantageous embodiments of the lighting bodies, inside the housing there can be arranged a mixing chamber, preferably extending for the whole longitudinal extension of the housing and comprising diffusing walls arranged in the housing and extending longitudinally therein. The LEDs can be arranged so as to radiate in the mixing chamber and the mixing chamber can be closed at the front by the foil shield, which receives electromagnetic radiation diffused in said mixing chamber and converts it into visible light. For example, the diffusing walls can be formed by a sheet material folded and inserted into the housing, or by a ceramic material. In some embodiments, along at least one of the diffusing walls of the mixing chamber there can be provided a plurality of holes in which the LEDs are inserted, advantageously the electronic card being placed outside the mixing chamber.

[0023] The LEDs can be arranged aligned with one another according to a linear array, although this is not indispensable. In some embodiments, the LEDs are arranged according to an arrangement generally parallel to the longitudinal extension of the lighting body, but not necessarily according to a rectilinear alignment.

[0024] To facilitate mounting of the electronic card, the housing of the lighting body can have a groove for housing the electronic card arranged in the bottom of the cavity formed by the housing. In some embodiments, to facilitate mounting and to retain the foil shield positioned in the opening of the housing, this can have, along said opening, retaining channels of the foil shield.

[0025] Advantageously, when end caps are provided, these can have tabs or appendages for retaining the foil shield, so as to prevent accidental extraction thereof from the end of the housing.

[0026] Moreover, in some embodiments, the end caps can comprise a protuberance that is inserted into the housing, for more effective fixing.

[0027] In some embodiments, the seats for the lighting bodies of a ceiling light fixture can be parallel to one another. However, to reduce the formation of shadows, in some preferred embodiments, the seats for the lighting bodies are arranged so that at least some of the lighting bodies of a single ceiling light fixture are arranged not parallel to one another. For example, the seats can be arranged along the diagonals of a rectangular or square panel, which forms the ceiling light fixture. In other embodiments, the seats of the lighting bodies can be arranged parallel to the sides of the ceiling light fixture. In some embodiments, the lighting bodies are arranged not orthogonal to one another, and in particular can be positioned so as to be neither parallel nor orthogonal to one another.

[0028] Each ceiling light fixture can comprise a circuit for powering and controlling the lighting bodies associated with said ceiling light fixture. In some embodiments, one or more ceiling light fixtures can be associated with a data transceiver device to communicate with other ceiling light fixtures. For example, the transceiver device can comprise a power line modem (PLM) interfaceable with an electrical power line.

[0029] One or more ceiling light fixtures can comprise one or more sensors selected from the group consisting of: presence sensors, motion sensors, infrared sensors, ambient light sensors, twilight sensors, photometric sensors, light sensors, temperature sensors, smoke sensors, fire detection sensors, or combinations thereof. In some embodiments, the system can comprise a sensor adapted to detect the level of ambient light, and the powering and control circuit is programmed to control a dimming function of at least one lighting body, such that the level of light emission of the lighting body is modulated as a function of the level of light of the space in which the sensor is installed. In some embodiments, there can be provided a single sensor through which several ceiling light fixtures are controlled. In other embodiments, there can be provided a sensor for each ceiling light fixture, or in any case which controls a single ceiling light fixture.

[0030] Adjustment of dimming as a function of ambient light can be aimed at using the work point with the best compromise between comfort, energy saving and efficiency of the LEDs.

[0031] The lighting system can comprise a plurality of ceiling light fixtures, which are connected through the electrical power distribution network to exchange data with one another, via a PLM system. A control unit of one of the ceiling light fixtures can be programmed to function as master and control units of a plurality of other ceiling light fixtures can be programmed to function as slaves.

[0032] According to a different aspect, the invention relates to a lighting system comprising:

a plurality of groups of lighting bodies, each of said groups of lighting bodies comprising one or more lighting bodies and each lighting body comprising one or more remote phosphor LEDs;

for each group of lighting bodies, a powering and control circuit and a PLM (Power Line Modem), or other communication system, for example wireless, such as Wi-Fi, to communicate with powering and control circuits of other groups of lighting bodies through an electrical power distribution network;

wherein at least one of said powering and control circuits is associated with at least one sensor that generates at least one signal used by the powering and control circuit to drive the lighting bodies. The lighting system can advantageously comprise LED lighting bodies of the type defined above. In other embodiments, lighting bodies of other form can be used.

[0033] In some embodiments, one of the powering and control circuits is programmed as master and the remaining powering and control circuits are programmed as slaves. One or more of said powering and control circuits can be associated with one or more sensors. For example, one powering and control circuit can be provided with all the sensors and the other powering and control circuits can be without sensors. Alternatively, several powering and control circuits of the system can be provided with sensors, all with the same configuration of sensors or also with different configurations of sensors. In some embodiments, each group of lighting bodies has a powering and control circuit and one or more sensors. The powering and control circuits can be programmed to function alternatively as master or as slave, also irrespective of the presence of sensors. In other words, powering and control circuits provided with sensors can also be programmed as slaves and, in this case, these sensors might not be used or might be used only in part.

[0034] In some embodiments a single powering and control circuit could function as master, sending through the transceiver device (for example the PLM) instructions, information or commands to the other powering and control circuits to drive or control the respective lighting bodies. It would be possible for the powering and control circuit operating as master to receive information only from sensors directly associated therewith. Nonetheless, it would also be possible for a single powering and control circuit programmed to operate as master to also (or exclusively) receive data from sensors associated or interfaced with other powering and control circuits, programmed to function as slaves. The number of sensors used and the their position can, for example, be modified through suitable programming of the single powering and control circuits, for example in order to adapt operation of the lighting system to a given space and/or to modify operation of the system based on the customer's needs, on the different intended use of the space, or the occurrence of requirements variable in time compared to those for which the system was originally programmed.

[0035] Further characteristics and embodiments of the invention are described hereunder with reference to examples of embodiment and defined in the appended

claims, which form an integral part of the present description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The invention will be better understood by following the description and accompanying drawings, which show non-limiting practical embodiments of the invention. More in particular, in the drawing:

Figs.1 and 2 show two diagrams of a lighting system according to the invention in two embodiments;
Fig.3 shows a schematic plan view of a room illuminated with ceiling light fixtures that produce a system according to the invention in a possible configuration;
Fig.4 shows a schematic front view of a ceiling light fixture in a possible embodiment;
- Fig.4A is a local cross section according to A-A of Fig.4;
Figs.5 and 6 show a lighting body, respectively in a cross section according to V-V of Fig.6 and in a side view according to VI-VI of Fig.5;
Fig.7 shows a cross section of the section bar constituting the housing of the lighting bodies;
Figs.8 and 9 show axonometric views of the end covers of the housing of the lighting bodies;
Fig. 10 shows a perspective view of a lighting body during assembly on a ceiling light fixture, in a different embodiment;
Fig.11 shows a perspective and sectional view of the lighting body and of the ceiling light fixture of Fig.10;
Fig. 12 shows a longitudinal section of the lighting body of Figs. 10 and 11;
Fig. 13 shows a cross sectional view of the lighting body of the Figs. 10 to 12;
Fig. 14 shows an axonometric view of the upper surface of a ceiling light fixture.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0037] The detailed description below of examples of embodiments refers to the accompanying drawings. The same reference numbers in different drawings identify identical or similar elements. Moreover, the drawings are not necessarily to scale. The detailed description below does not limit the invention. Rather, the scope of the invention is defined by the appended claims.

[0038] Reference in the description to "an embodiment" or "the embodiment" or "some embodiments" means that a particular characteristic, structure or element described in relation to an embodiment is included in at least one embodiment of the object described. Therefore, the phrase "in an embodiment" or "in the embodiment" or "in some embodiments" in various points throughout the description does not necessarily refer to the same embodiment or embodiments. Moreover, the particular characteristics, structures or elements can be combined in any suitable manner in one or more embodiments.

[0039] In the following there is described a lighting system comprising LED lighting bodies optionally combinable in groups, for example mountable in respective ceiling light fixtures. It would also be possible for each group, or for some of the groups, of lighting bodies to have only one lighting body and also optionally to have no ceiling light fixture. In the following there is also described a possible configuration of a ceiling light fixture and a possible configuration of a lighting body. It must be understood that the lighting system can also comprise ceiling light fixtures of different structure and/or different lighting bodies to those described and illustrated. It must also be understood that the lighting bodies described hereunder and illustrated in the drawings can be used advantageously in different lighting systems, or also individually, for example to replace single fluorescent tubes or other conventional lighting bodies.

[0040] Figs.1 to 3 schematically show a simplified embodiment of a lighting system that utilizes LED lighting bodies.

[0041] Fig.3 shows purely by way of example a plan view of a room 1 with windows 3 and a door 5. The room is provided with four ceiling light fixtures 7, indicated with 7A, 7B, 7C, 7D, containing lighting bodies produced with LEDs and combined with remote phosphors, for example according to a configuration described in greater detail hereunder.

[0042] The ceiling light fixtures 7A-7D are connected to an electrical power distribution network, indicated schematically with 9. The electrical power distribution network 9 can also be utilized for data exchange between the lighting bodies and/or the single ceiling light fixtures 7A-7D, via a carrier wave system and a PLM (Power Line Modem) on each ceiling light fixture 7A-7D or on each lighting body mounted on the ceiling light fixtures.

[0043] Fig.1 schematically shows a generic ceiling light fixture 7 connected to the electrical power distribution network 9. The ceiling light fixture 7 of Fig. 1 can be any one of the ceiling light fixtures 7A-7D of the system shown schematically in Fig.3.

[0044] In the diagram of Fig.1 inside the ceiling light fixture 7 there are mounted lighting bodies 13, each comprising a plurality of LEDs, for example arranged according to a linear array. Each lighting body comprises, in addition to the LEDs that constitute the electromagnetic radiation sources, also the electrical powering and control system.

[0045] As will be illustrated hereunder, the ceiling light fixture can have any number of lighting bodies 13, arranged according to suitable configurations. In the diagram of Fig.1 six adjacent lighting bodies 13 are provided. In other embodiments, a different number of lighting bodies can be provided, for example from 1 to 12. In Fig.3 four lighting bodies 13 are schematically illustrated for each ceiling light fixture 7A-7D. As can be understood by comparing Figs. 1 and 2, the geometrical arrangement

of the lighting bodies 13 in the ceiling light fixture 7, 7A-7D can vary, both according to the number and/or to the form or dimension of the lighting bodies and/or to the form and/or dimension of the ceiling light fixture, and also according to lighting technology considerations.

[0046] In the diagram of Fig.1 the generic ceiling light fixture 7 comprises a powering and control circuit 15 connected to the single LED lighting bodies 13 and forming a control unit. In practice, each lighting body 13 comprises an electronic card on which the single LEDs are mounted, for example aligned according to the longitudinal extension of the lighting body 13.

[0047] In the diagram of Fig.1, the number 17 schematically indicates a control line that connects the circuit 15 to the single electronic cards of the lighting bodies 13. The number 19 indicates a low voltage direct current supply line with which the LEDs mounted in the lighting bodies 13 are supplied with electricity. In some embodiments the line 17 can be omitted. The emission of the LEDs can be controlled by driving, by means of the supply voltage on the line 19.

[0048] In some embodiments a PLM (Power Line Modem), schematically indicated with 21, is associated with the powering and control circuit 15. The PLM 21 and the powering and control circuit 15 are connected through an electrical power line 23 to the electrical power distribution network 9. The PLM 21 can transmit and/or receive data via carrier waves transmitted along the line 23 and the electrical power distribution network 9, to communicate with the other ceiling light fixtures of the system and/or with units variously distributed, for example inside the building in which the room 1 is located.

[0049] Communication via carrier waves is particularly efficient, as it reduces the wiring required and avoids the need to use wireless transmission systems, which can involve problems of interference and/or electromagnetic pollution.

[0050] However, in other embodiments, it would also be possible for communication to take place using other systems. In some embodiments, a wired transmission system via RS-485 communication protocol can be used. In other embodiments, wireless transmission systems, for example with ZigBee, Bluetooth or Wifi protocols, or another proprietary system, can be used. In these embodiments, corresponding transceiver devices are associated with the single powering and control circuits.

[0051] The use of mixed systems would also be possible.

[0052] Purely by way of example, the diagram of Fig. 1 shows a controller 25 that can be connected via a line 27 to the electrical power distribution network 9. A PLM 29 enables the controller 25 to communicate, via the lines 27, 23 and the distribution network 9, with the ceiling light fixture 7 and/or with the other ceiling light fixtures 7A-7D of the lighting system.

[0053] In some embodiments, the lighting system comprising the components described above can be integrated in an existing home automation system. The number 31 schematically indicates a control unit of a standard home automation system. The connection between the controller 25 and the control unit 31 can take place via a dedicated line, for example a serial line 33, or via carrier waves using the same electrical power distribution network 9.

[0054] The controller 25 can be connectable extemporaneously or can be connected permanently to an optional programmer 34. The programmer 34 can be used to program the controller 25 and, via the connection existing between this latter and the single powering and control circuits 15, these latter, and therefore the functions of the single ceiling light fixtures 7, 7A-7D, can also be programmed.

[0055] In some embodiments, one or more sensors of various kinds can be connected to the powering and control circuit 15 of one or more ceiling light fixtures mounted in a given space. In the diagram of Fig.1, only three sensors 35A, 35B, 35C are indicated, but it must be understood that the number of sensors associated or interfaced with the powering and control circuit 15 can differ from the number represented, purely by way of example, in Fig.1.

[0056] In the simplest embodiments, the sensors could also be omitted, or a single sensor, for example a presence sensor, could be provided. The presence sensor can be used to automatically switch on/off the ceiling light fixture, as a function of the presence or absence of people in the space in which the ceiling light fixture is mounted.

[0057] According to other embodiments, alternatively to or in combination with the presence sensor, a twilight sensor, or preferably a photometric or light sensor, can be provided to detect the intensity and, optionally, one or more parameters, such as the color temperature, of the existing light in the space. In the simplest embodiments, this sensor can be a twilight sensor, which causes or allows the lighting bodies 13 of the ceiling light fixture 7 to be switched on and/or adjusted only when the light detected in the space is, for example, below a predetermined threshold.

[0058] The photometric sensor or light sensor can send a direct switch on/off command and thus control switch-on/off of the lighting bodies directly, according to the quantity of light detected in the space.

[0059] In other embodiments, the photometric sensor can be used to allow the lighting bodies present in the ceiling light fixture 7 to be switched on, said switching on taking place via the presence sensor, subject to the presence of people in the space. In this way, the lighting bodies 13 switch on only when two conditions occur: insufficient natural light and the presence of people in the space.

[0060] In other embodiments, the ceiling light fixture 7 can be switched on/off via a switch, indicated schematically with 37, in the absence of presence sensors. Also in this case, switching on can be subject to the level of light detected by the photometric sensor.

[0061] The light sensor or photometric sensor can be

used to control a simple switching on and off operation, or also to control a dimming function, with which the level of emission (i.e. the intensity of the light radiation generated) of the lighting bodies is modulated as a function of the level of light in the space in which they are installed.

[0062] When a more complex photometric sensor is used, this latter can give the lighting system further properties and functions, for example that of maintaining a given color temperature in the space to compensate for variations in the natural light in the various hours of the day, and/or allow the user to set and/or modify the color temperature according to preference.

[0063] According to one embodiment, the color temperature can be adjusted by using a mixture of phosphors with emission at different color temperatures and selectively excited by different wavelengths. In this case, the phosphors can be excited by groups of LEDs adjusted separately, each of which emits the radiation in the necessary excitation wavelength.

[0064] In some embodiments, the user can program the powering and control unit 15, i.e. drive it via a remote control or via the controller 25, so as to modify, in an automatic, programmed or manual way, the color temperature at all times of the day.

[0065] The ceiling light fixture 7 can be provided with other sensors, for example an infrared sensor which is part of an alarm system, or a smoke sensor, as an integral part of a fire detection system, or a temperature sensor both for the purpose of detecting fire and of controlling the temperature of the ceiling light fixture, and taking action by switching off the lighting bodies in the event of overheating.

[0066] Other sensors can also be associated with the powering and control circuit 15, to allow the lighting system to perform other functions with respect to those mentioned above, in combination with or alternatively to these.

[0067] Fig.2 shows a modified diagram of a lighting system. The same numbers indicate the same or equivalent parts to those described with reference to Fig. 1. The number 7 again indicates a generic ceiling light fixture in which there are housed LED lighting bodies 13. The number 15 indicates the powering and control circuit connected to the lighting bodies 13 via a data line 17 and via a supply line 19, to supply electrical current to the LEDs. The number 15A indicates a transmitter, for example Bluetooth, to communicate with a remote control 16. The number 37 indicates an on/off switch located on the line 23 that connects the ceiling light fixture 7, and therefore the powering and control circuit 15, to the electrical power distribution network 9.

[0068] The numbers 35A, 35B and 35C indicate by way of example some sensors that can be associated with the powering and control circuit 15.

[0069] In some advantageous embodiments, the lighting system can comprise a plurality of ceiling light fixtures, each provided with one or more lighting bodies and each provided with a powering and control circuit. The powering and control circuit 15 of a ceiling light fixture can be programmed to operate as master, while the other powering and control circuits 15 can be programmed to operate as slaves. In some embodiments, the powering and control circuit can be the only one provided with sensors and can send, via PLM, driving or control signals to the other groups of lighting bodies 13, based on data detected by the sensor or sensors. For example, a single ceiling light fixture can be provided with a presence sensor and with a photometric or light sensor, and control, via carrier wave signals, the remaining groups of lighting bodies mounted in the other ceiling light fixtures. The master unit can, for example, send a dimming command to the remaining slave units, so that the lighting bodies of the various ceiling light fixtures are controlled by a light signal generated by a single sensor.

[0070] In some embodiments, for example if programming of the powering and control circuit is carried out through a direct connection with a programmer (Fig.2), only the master circuit can be in communication with the programmer and, if necessary, said master circuit can send information, commands, instructions or the like to the remaining powering and control circuits, acting as slaves.

[0071] In some embodiments the master unit can be programmed to control timed switch-on of the lighting bodies interfaced with the master unit and the lighting bodies interfaced with the slave units.

[0072] The master unit can, for example, also be programmed to send a switch-on signal to all the slave units, based on a signal generated by a presence sensor.

[0073] In other embodiments, the powering and control circuits can constitute independent control units, i.e. without hierarchical order, each programmed to control only the lighting bodies associated with the same unit, for example the lighting bodies of a single ceiling light fixture.

[0074] It would also be possible for each powering and control circuit 15 to be programmed in a different or partly different way with respect to the others. For example, each powering and control circuit can be controlled by a its own presence sensor, so that at all times only the lighting bodies associated with the control unit or control circuits 15 that effectively detect the presence of people are switched on, while other functions can be controlled centrally, for example via a master unit.

[0075] In general, the system can have a flexible configuration, allowing both the number of ceiling light fixtures and/or lighting bodies to be increased, and the way in which each powering and control circuit 15 is programmed and, consequently, the way in which the various groups of lighting bodies are controlled or driven, to be modified.

[0076] In a possible configuration, in a space in which one or more ceiling light fixtures or groups of lighting bodies 13 are present, one of these can be programmed as master and the others as slaves. The system can, for example, function as follows. When the space is empty, the lighting bodies are switched off. When a user enters

the space, the presence sensor associated with the powering and control circuit programmed as master generates a signal that controls switching on of all the lighting bodies. The photometric sensor, light sensor or luminosity sensor, which can advantageously be associated with the same unit or powering and control circuit programmed as master, detects the degree of ambient light and generates a dimming signal that is used to drive all the lighting bodies, both associated with the master unit and with the slave units.

[0077] The commands between master unit and slave unit are transmitted via a power line.

[0078] Figs.4 to 9 show details of a possible embodiment of a ceiling light fixture and of the respective lighting bodies comprising the LEDs.

[0079] Fig.4 generically shows a ceiling light fixture 7 that can comprise a punched plate 7X provided with slots 7Y, for example formed by punching. Fig.4A shows a local section according to the line A-A in Fig.4 of one of the slots 7Y provided on the plate forming the ceiling light fixture 7. The slots 7Y have an elongated rectangular form. In the example illustrated the slots 7Y are arranged according to the diagonals of the plate 7X which, in the example illustrated, is square in form. Spatial arrangements differing from the one illustrated are also possible, as a function of the form and of the dimension of the lighting bodies to be housed in the slots and/or of the ceiling light fixture. A lighting body 13 can be housed inside each slot 7Y.

[0080] In the embodiment illustrated, the slots 7Y of the ceiling light fixture are arranged inclined to one another. Purely by way of example, in this case the slots 7Y are arranged in an X-fashion according to the diagonals of the ceiling light fixture. Different arrangements from the one illustrated are possible, also depending upon the number of lighting bodies to be mounted, their dimension and the form and/or dimension of the ceiling light fixture. In general, contrasting to the case of customary ceiling light fixtures with fluorescent tubes, it is advantageous for the lighting bodies 13 of elongated form to be arranged not parallel with one another. This reduces the formation of multiple shadows, which can be particularly bothersome to the eyes.

[0081] The powering and control circuit 15 of the single lighting bodies mounted on the ceiling light fixture can be mounted on the ceiling light fixture 7. In some embodiments, the sensor or the sensors (35A-35C) associated with the powering and control circuit 15 are also mounted on the ceiling light fixture 7. For example, these components can be integrated in a single block mounted on the upper face of the plate 7X forming the ceiling light fixture, i.e. the face that, when mounted, faces the ceiling. The plate 7X can have one or more holes for the sensors. In other embodiments, the sensors 35A-35C can be mounted separately from the powering and control circuit 15 and suitable wiring can be provided. In some embodiments, both the wiring and the sensors, and also the powering and control circuit, can be mounted preferably on the upper face of the ceiling light fixture 7, so as to remain hidden. In this case, specific holes can be provided for the sensors, so that they can "read" the magnitudes they are responsible for detecting. The sensors could also be arranged in a different position with respect to the ceiling light fixture and carry the signals to the powering and control circuit 15 via suitable wiring, for example in a false ceiling or in a duct. Less advantageously, the powering and control circuit can also be positioned at a distance from the ceiling light fixture.

[0082] In general, each ceiling light fixture can be provided both with a powering and control circuit and also with respective sensors. The ceiling light fixtures can differ from one another, for example, as far as the type and number of sensors are concerned. For example, also as a function of the point in which the ceiling light fixtures are installed, only one of these or only some of these can have a light sensor or a photometric sensor, and others can have a presence or movement sensor and/or some ceiling light fixtures can comprise both types of sensor.

[0083] In some embodiments, a single ceiling light fixture in a given space can be provided with sensors, while the others can be managed based on information detected by the sensors of the single ceiling light fixture. In this case, architectures of master-slave type can be obtained, where a ceiling light fixture forms, with its lighting bodies, the sensors and the powering and control circuit, a master unit. The other ceiling light fixtures form slave units. The powering and control circuit of these latter receives commands from the master unit. In some cases, several ceiling light fixtures can function as master units in relation to different functions. For example, a first ceiling light fixture can be used to detect, via its own sensors, the ambient light, while a second ceiling light fixture can be used to detect the presence of users. The signals of these two ceiling light fixtures are used also to manage other ceiling light fixtures functioning as slave units.

[0084] In some embodiments, all the ceiling light fixtures can be provided with temperature sensors, for reasons of safety.

[0085] Figs.5 and 6 shown in a partial side view and in a cross section a generic lighting body 13 mounted on the plate 7X forming a ceiling light fixture 7. In this embodiment, the lighting body 13 comprises a housing 41 of elongated form having a bottom wall 43 and two lateral walls 45. An opening 47 extends in front of the bottom wall 43 and is closed by a foil shield or window 49, for example formed by a transparent synthetic resin, on or in which there are deposited or incorporated one or more luminescent substances (phosphors). These substances receive the electromagnetic radiation generated by the LEDs at a given wavelength or interval of wavelengths and transform it into white light.

[0086] As is known to those skilled in the art, LEDs can emit, for example, in the ultraviolet or blue range. According to the emission wavelength of the LED, different luminescent substances can be used to obtain the desired spectrum of light delivered from the lighting body 13. Lu-

minescent materials or phosphors commonly used are, for example, YAG:Ce ($Y_3Al_5O_{12}:Ce^{3+}$, which converts blue light into yellow light. The combination of LEDs that emit in the blue region with YAG:Ce gives rise to a substantially white light emission. The emitted spectrum depends on the thickness of the shield containing phosphor and/or on the concentration of phosphor, i.e. of luminescent material, used. Other mixtures of phosphors commonly used can comprise $(Ba,Sr)2Si_5N_8:Eu^{2+}$, which convert blue light into amber light, in combination with YAG:Ce and with blue LEDs, or $Lu_3Al_5O_{12}:Ce^{3+}$ and $CaS:Eu^{2+}$ with LEDs emitting in the blue region. Other phosphors, such as $(Ba,Sr,Ca)_2Si_5N_8:Eu^{2+}$, (Sr, Ca)S:$Eu^{2+}$ and $(Ca,Sr)AlSiN_3:Eu^{2+}$, convert blue light into red light. Some phosphors, such as $Sr_2Si_2N_2O_2:Eu^{2+}$ and $SrGa_2S_4:Eu^{2+}$, convert blue light into green light. When the LED emits in the ultraviolet region, the phosphors can comprise, for example, a mixture of $BaMgAl_{10}O_{17}:Eu^{2+}$, $Ca_8Mg(SiO_4)_4Cl_2:Eu^{2+}$, Mn^{2+} and $Y_2O_3:Eu^{3+}$, Bi^{3+}.

[0087] The form of the housing 41 can be better understood from Fig.7, which shows a cross section of the housing without the remaining of the components forming the lighting body 13.

[0088] In substance, the main body of the housing 41 is formed by a section bar, for example made of aluminum, globally C- or U-shaped, the lateral walls 45 of which form the side members. The bottom wall 43 and the lateral walls 45 form a channel. A flange 51A, 51B extends along the edges of the channel thus formed there. The flange 51A, 51B is shaped to cooperate with the longitudinal edges of the respective slot 7X in which the lighting body 13 is inserted. Blocking of the single lighting body 13 on the ceiling light fixture 7 can be obtained as shown, for example, in Fig.5. One or more shaped elastic clips 14 are fitted along the housing 41 and externally thereto. The form of the elastic clips can be such that they engage with undercut with the finned surfaces 59, remaining fixed to the housing 41. The ends of each clip 14, which is approximately "omega" shaped, rest on or press against lips 7Z formed parallel to the slots 7Y, preventing the lighting bodies 13, inserted in the slots 7Y from below, from falling.

[0089] In some advantageous embodiments, along the inner surface of the bottom wall 43 a groove 53 is provided in approximately central position, extending according to a longitudinal extension of the section bar forming the housing 41. The groove 53 forms a seat for housing the electronic card, indicated with 55, to which LEDs 57 are applied (Fig.5). The LEDs 57 can be arranged aligned with one another to form a linear array. In other embodiments, the array can be two-dimensional, for example comprising two adjacent rows of LEDs. The elongated form of the lighting body 13, which requires a corresponding aligned arrangement of LEDs, is preferred when the lighting body 13 is replacing a normal fluorescent lamp (neon tube).

[0090] The electronic card 55, for example made of suitable heat conducting material, housed in the groove 53, is in thermal contact with a large surface of the bottom wall 43 of the housing 41 of the lighting body 13. In this way heat exchange is obtained by conduction between the electronic card 55, which is heated by thermal dissipation of the LEDs 57, and the bottom wall 43.

[0091] The heat generated by the electronic circuitry mounted on the electronic card 55 can be dissipated by natural convection from the surface of the section bar forming the housing 41. To improve heat dissipation, in some embodiments a cooling finned surface is provided. In the embodiment illustrated in the drawing, the housing 41 is provided with two finned surfaces 59 provided on both side members of the housing 41 and preferably along the lateral walls 45, in the vicinity of the bottom wall 43.

[0092] In other embodiments the finned surface can be provided on the surface facing the outside of the bottom wall 43 of the section bar forming the housing 41.

[0093] As shown in particular in the section of Fig.7, on the inner surfaces of the two lateral walls 45 two channels 61 are provided, extending parallel to the longitudinal extension of the section bar forming the housing 41. The channels 61 serve as seats for mounting and retaining the photoluminescent shield 49.

[0094] In some embodiments, the inner surfaces of the walls 43, 45 can be treated, for example painted, to form a mixing chamber of the electromagnetic radiation generated by the LEDs 57. In other embodiments, as shown for example in Fig.5, a mixing chamber 65 is formed through a folded sheet or foil material 67, for example made of plastic material. In the embodiment illustrated, the sheet material 67 has four portions 67A, 67B, 67C, 67D. The portions 67B, 67C converge toward an area in which the linear array of LEDs 57 is arranged projecting through the sheet material 67 at suitable holes made in the converging area of the portions 67B, 67C. In advantageous embodiments, the portions 67A, 67D are adjacent to the lateral walls 45 of the housing 41, while the portions 67B, 67C form inclined walls or inclined side members of the folded sheet material 67, behind which the bottom wall 43 of the housing 41 is located.

[0095] In other embodiments, the mixing chamber can be made of a monolithic material, for example ceramic, instead of a sheet material.

[0096] In the mixing chamber 65, both the electromagnetic radiation emitted by the LEDs 57 and the electromagnetic radiation reflected or diffused toward the inside by the photoluminescent shield 49 are reflected and/or diffused by the inner surface of the sheet material 67. Around 50% of the incident radiation on the photoluminescent shield 49 passes through this latter and is transformed into light radiation of the wavelength or with the spectrum of frequencies desired, which illuminates the space in which the ceiling light fixture on which the lighting bodies 13 are mounted is arranged.

[0097] In advantageous embodiments, the ends of the section bar forming the housing 41 are closed by respec-

tive covers or caps 71A, 71B (see Figs.8 and 9).

[0098] Each cover 71A, 71B has a tab 73 for retaining the photoluminescent shield 49 and a projection 75 or pad that is inserted inside the compartment defined between the bottom wall 43 and the lateral walls 45 of the section bar forming the housing 41. In some embodiments, the cover 71A also has a recess 77 through which the electronic card 55 housed inside the housing 41 projects, and on the end of which an integrated circuit to drive the LEDs, or more simply a connector, schematically indicated with 56, can be mounted for connection to the powering and control circuit 15 and/or to other lighting bodies 13 of the same group, i.e. mounted on a common ceiling light fixture 7. The component 56 is thus located outside the housing 41 (see Fig.6).

[0099] Figs.10 to 13 illustrate a further embodiment of a lighting body and of a respective ceiling light fixture according to the invention. The same numbers indicate the same or equivalent parts to those of the previous embodiments. The number 7 indicates a ceiling light fixture, for example made of punched metal plate 7X. In the ceiling light fixture, in the same way as illustrated in Fig. 4, slots 7Y can be provided, forming seats for mounting lighting bodies 13. Each slot 7Y can have a substantially elongated rectangular form, with edges or lips 7F, 7G. At the ends, i.e. along the short sides 7G of each slot 7Y, two appendages or tabs 7H are provided, preferably by punching and folding, folded along fold lines 7I so as to be generally orthogonal to the plate 7.

[0100] In advantageous embodiments, each appendage 7H can have an opening 7L, constituting a retaining seat for the lighting body 13. The two appendages 7H can be elastically deformable by bending according to the arrow f7H (Fig. 10), divaricating slightly to allow mounting or snap fastening of the respective lighting body. The snap fastening system can comprise, besides the two appendages 7H, respective projections or protuberances 72 obtained on the surfaces facing the outside of the caps 71A, 71B. The protuberances 72 can be obtained inside a lowered area 74 provided on the outer surface of the related cap, so that the protuberance does not project with respect to the maximum thickness of this cap. In advantageous embodiments, each protuberance 72 is provided with a beveled surface 72A, which during mounting (Fig. 10) cooperates with the edge of the corresponding appendage 7H.

[0101] With this arrangement, pushing the lighting body 13 between the appendages or tabs 7H causes elastic bending deformation (arrow f7H) thereof, allowing insertion and snap fastening of the protuberances 72 in the openings 7L. When the protuberances 72 are inserted in the retaining seats 7L, the appendages 7H tend to return to the initial non-deformed position, inserted in the lowered area 74 formed in the respective cap 71A or 71B (Fig. 11).

[0102] Advantageously, the footprint of the single lighting body 13 is preferably slightly larger than the slot 7Y. In this way, once the lighting body has been snap-fastened via the appendages 7H to the ceiling light fixture 7, it cannot fall downward through the respective slot 7Y. In other embodiments, to prevent the lighting body 13 from accidentally falling, for example in the event of breakage of one or both of the appendages 7H, projections 46 can optionally be provided on the outer surfaces of the longitudinal walls.

[0103] As can be seen in particular in the sections of Figs. 11, 12 and 13, the housing 41 of the lighting body 13 can be made using a section bar, for example made of extruded metal, typically aluminum or another suitable material. The body of the housing 41 can have an inner chamber delimited by the bottom wall 43 and by the two lateral walls 45 and closed at the ends by the caps 71A, 71B. At the front, the housing 41 has an opening housing the photoluminescent shield 65. This latter can be retained along the longitudinal edges by grooves or channels 47 formed by the section bar that constitutes the main part of the housing 41. At the ends thereof, the photoluminescent shield 49 can be retained by tabs 73 provided on the two caps 71A, 71B.

[0104] In the same manner as the previous embodiment, a mixing chamber 65 can be formed inside the housing 41. For this purpose, a diffusing foil, sheet or coating 67 can be provided to cover or coat the inner surface of the housing, in the same manner as the sheet 67 of the previous embodiment. The sheet or foil 67 can have an approximately parabolic cross section, as shown in Fig. 13. The sheet or coating 67 can have holes for the passage of or for housing the LEDs 57, which are advantageously mounted on an electronic card 55 arranged adjacent to, and in contact with, the bottom wall 43 of the housing 41, advantageously in thermal contact therewith.

[0105] To facilitate heat dissipation, the housing 41 can have one or more heat diffusing or cooling fins 59. Preferably, the fins are made in one piece with the remaining of the housing, for example they can be constituted by the same extruded section bar that forms the housing. For greater thermal efficiency, unlike those of the previously described embodiment, the fins 59 can be arranged approximately along the centerline of the bottom wall 43, on the opposite side with respect to the electronic card 55, so that this can more effectively dissipate heat generated by the electronic components, especially by the power components, mounted thereon.

[0106] Advantageously, the connector toward the electrical power supply and any connections for data transmission are preferably positioned outside the housing, as schematically shown in 56, on an extension of the electronic card 55, which extends from the respective end cap 71A, for example through a lowered area, recess or notch 77.

[0107] Fig.12 shows an axonometric view of the upper surface of a ceiling light fixture 7 with four lighting bodies 13 mounted thereon. The number 12 indicates the housing of the driver and of any further electronic components. The housing 12 can be fixed to the ceiling light fixture 7

with elastic tabs 14 similar to the tabs 7H used for fixing the lighting bodies 13.

[0108] The embodiments described above and illustrated in the drawings have been discussed in detail as examples of embodiment of the invention. Those skilled in the art will understand that many modifications, variants, additions and omissions are possible, without departing from the principles, concepts and teachings of the present invention as defined in the appended claims. Therefore, the scope of the invention must be determined purely on the basis of the broadest interpretation of the appended claims, comprising these modifications, variants, additions and omissions therein. The term "comprise" and derivatives thereof do not exclude the presence of further elements or steps besides those specifically indicated in a given claim. The term "a" or "an" preceding an element, means or characteristic of a claim does not exclude the presence of a plurality of these elements, means or characteristics. When a device claim lists a plurality of "means", some or all of these "means" can be implemented by a single component, member or structure. The stating of given elements, characteristics or means in distinct dependent claims does not exclude the possibility of said elements, characteristics or means being combined with one another. When a method claim lists a sequence of steps, the sequence in which these steps are listed is not binding, and can be modified, if the particular sequence is not indicated as binding. Any reference numbers in the appended claims are provided to facilitate reading of the claims with reference to the description and to the drawing, and do not limit the scope of protection represented by the claims.

Claims

1. A lighting system comprising:

- at least one ceiling light fixture comprised of a support with a plurality of seats for respective lighting bodies;
- a plurality of LED lighting bodies each comprising: a housing of elongated form with a bottom wall and an opposite opening extending along the longitudinal extension of the housing; inside the housing an electronic card provided with a plurality of LEDs distributed along the longitudinal extension of the housing and facing the opening of the housing; a shield that closes said opening and comprising a photoluminescent material, which modifies the spectrum of the radiation of the LEDs.
- a system for snap fastening the lighting bodies to the ceiling light fixture.

2. The system as claimed in claim 1, wherein each housing is formed by a metal section bar, preferably extruded.

3. The system as claimed in claim 1 or 2, wherein each housing has at least one external finned surface for heat dissipation and wherein said electronic card is in thermal contact with the housing to dissipate heat through the wall of said housing and said at least one external fin.

4. The lighting system as claimed in one or more of the preceding claims, wherein each housing comprises a plurality of heat dissipation fins on two opposite longitudinal walls of the housing, and wherein the snap fastening system comprises at least one shaped elastic clip which is fitted along the housing of the lighting body and externally thereto, engaging with undercut with said heat dissipation fins, and wherein the ends of each clip cooperate with longitudinal lips formed along the seat of the respective lighting body, the housing of the lighting body having longitudinal flanges, extending on both longitudinal sides of said opening and cooperating with said longitudinal lips on the opposite side with respect to the elastic clips.

5. The system as claimed in claim 1, 2 or 3, wherein each lighting body comprises a pair of end caps, fixed to the longitudinal ends of the housing of the lighting body.

6. The system as claimed in claim 5, wherein each end cap comprises a protuberance facing the outside of the housing of the respective lighting body, cooperating with a retaining seat formed on said ceiling light fixture.

7. The system as claimed in claim 6, wherein the ceiling light fixture comprises a plate, provided with slots for mounting said lighting bodies, which form the seats for the lighting bodies, and wherein at opposite ends of each slot the plate has protrusions bent generally orthogonally to the plate, which have the retaining seats for the protuberances of the two end caps of the respective lighting body.

8. The system as claimed in claim 5 or 6 or 7, wherein at least one of said end caps of each lighting body has an indentation through which the electronic card passes toward the outside of the housing, said electronic card having a greater length than the housing and carrying a connector arranged on a portion of the electronic card projecting from the housing of the respective lighting body.

9. The system as claimed in one or more of the preceding claims, wherein inside said housing there is arranged a mixing chamber comprising diffusing walls inserted in said housing and extending longitudinally in said housing, the LEDs being arranged to radiate in said mixing chamber and said mixing

chamber being closed by said foil shield, which receives electromagnetic radiation diffused in said mixing chamber and converts it into visible light.

10. The system as claimed in one or more of the preceding claims, wherein the seats for the lighting bodies of a ceiling light fixture are oriented so that said lighting bodies are arranged at least partly with an orientation not parallel to one another.

11. The system as claimed in one or more of the preceding claims, comprising a powering and control circuit of the lighting bodies associated with said ceiling light fixture.

12. The system as claimed in claim 11, comprising a data transceiver device to communicate with other ceiling light fixtures, wherein preferably said transceiver device comprises a power line modem (PLM) interfaceable with an electrical power line.

13. The system as claimed in claim 11 or 12, comprising at least one sensor selected from the group consistint of: presence sensors, motion sensors, infrared sensors, ambient light sensors, twilight sensors, photometric sensors, light sensors, temperature sensors, smoke sensors, fire detection sensors, or combinations thereof.

14. The system as claimed in one or more of claims 11, 12 or 13, comprising at least one sensor adapted to detect the level of lighting of the space, and wherein the powering and control circuit is programmed to control a dimming function of at least one lighting body, so that the level of light emitted by the lighting body is modulated as a function of the level of light in the space in which the sensor is installed.

15. The system as claimed in one or more of the preceding claims, comprising a plurality of ceiling light fixtures, wherein said ceiling light fixtures are connected by means of the electrical power distribution network to exchange data with one another.

16. The system as claimed in claim 15, wherein a control unit of one of said ceiling light fixtures is programmed to function as master and the control units of a plurality of said ceiling light fixtures are programmed to function as slaves.

Fig.1

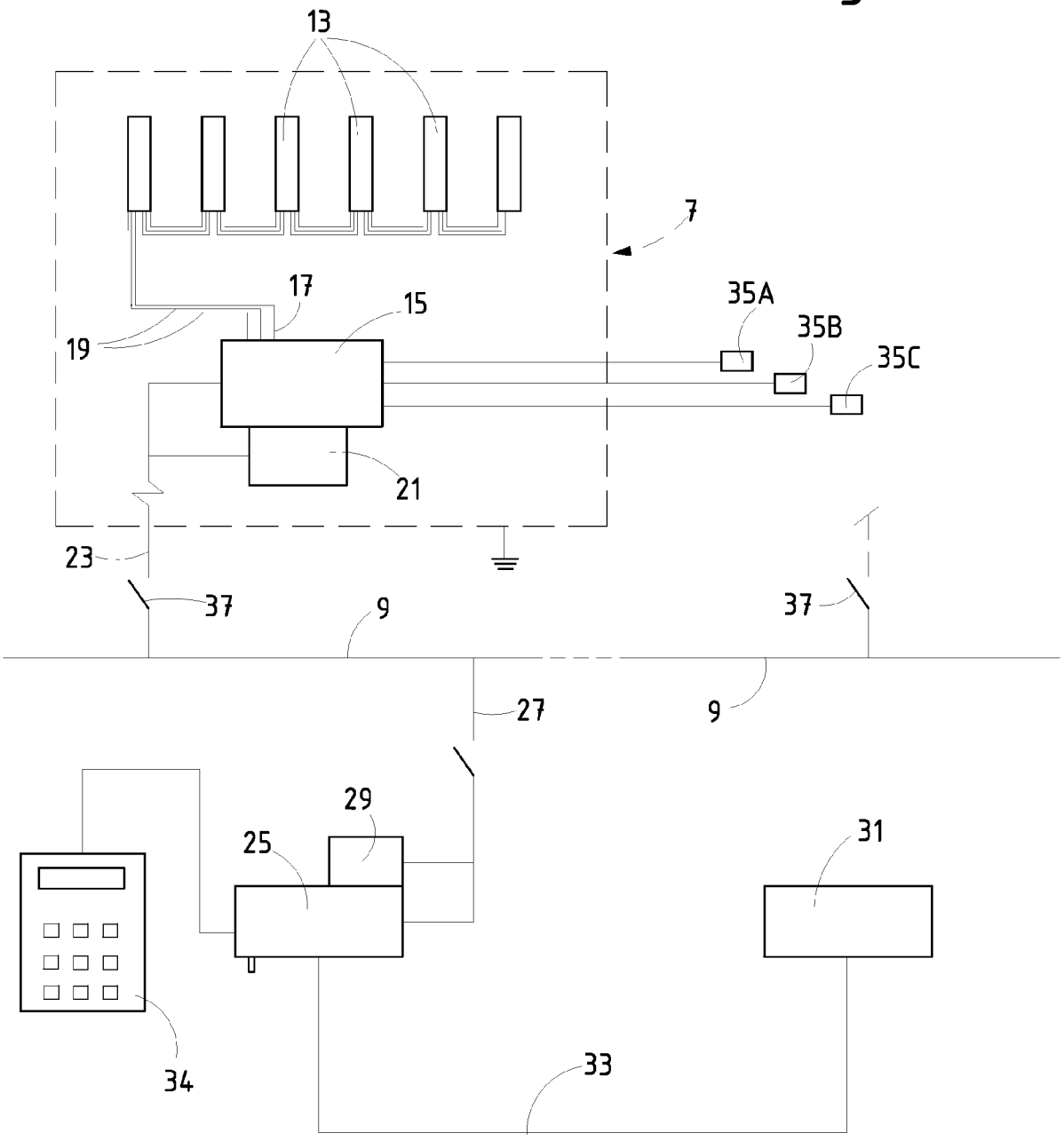


Fig.2

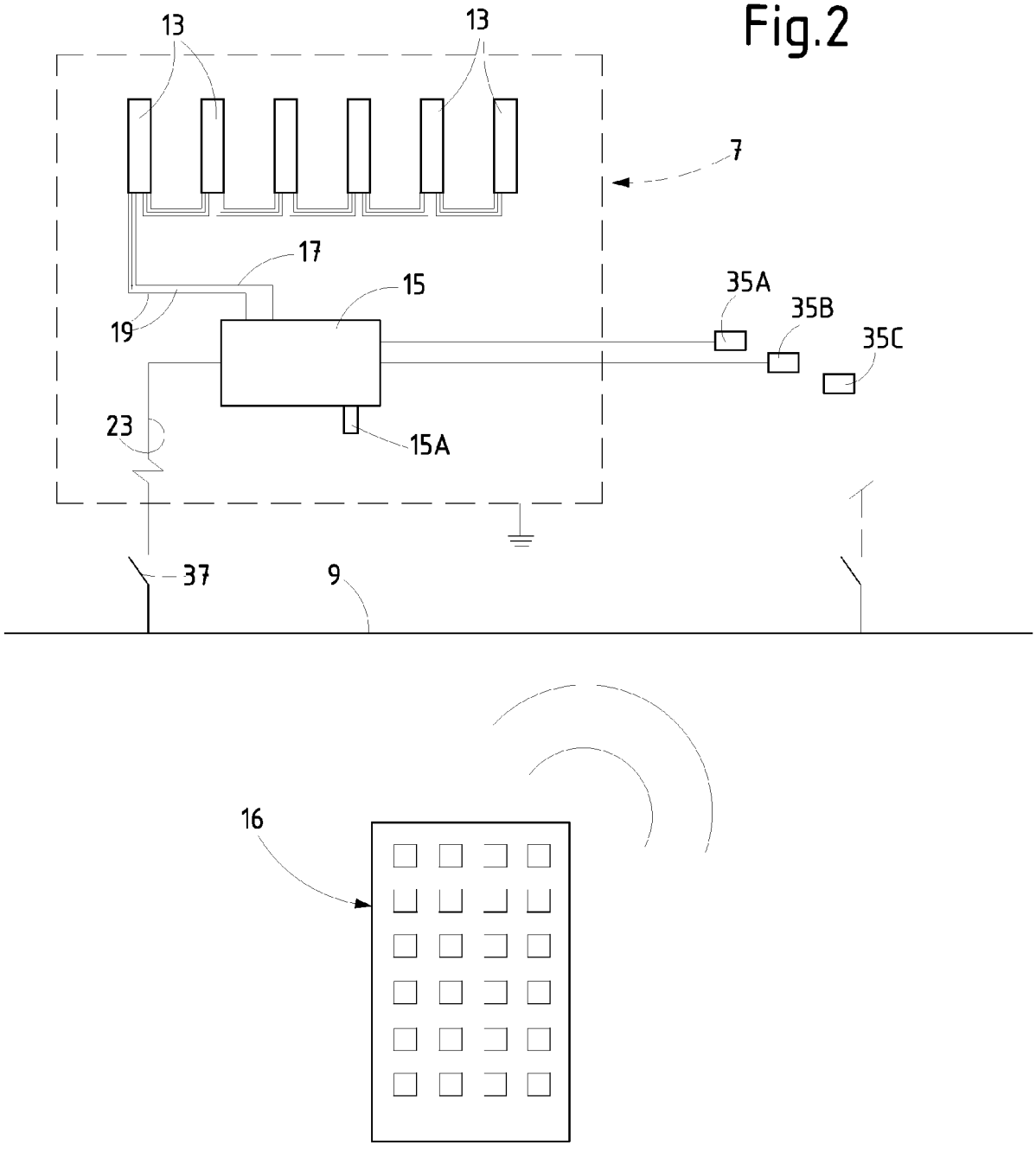


Fig.3

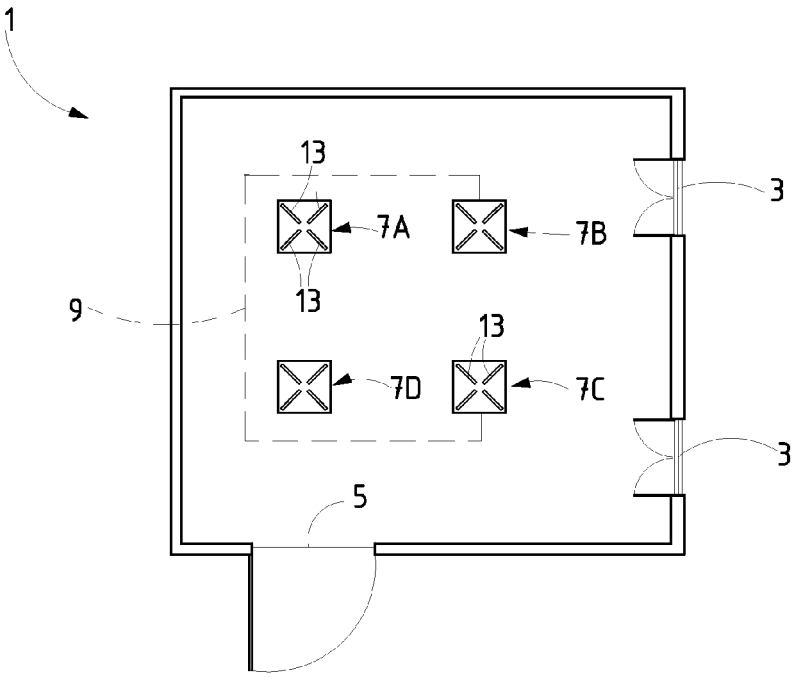
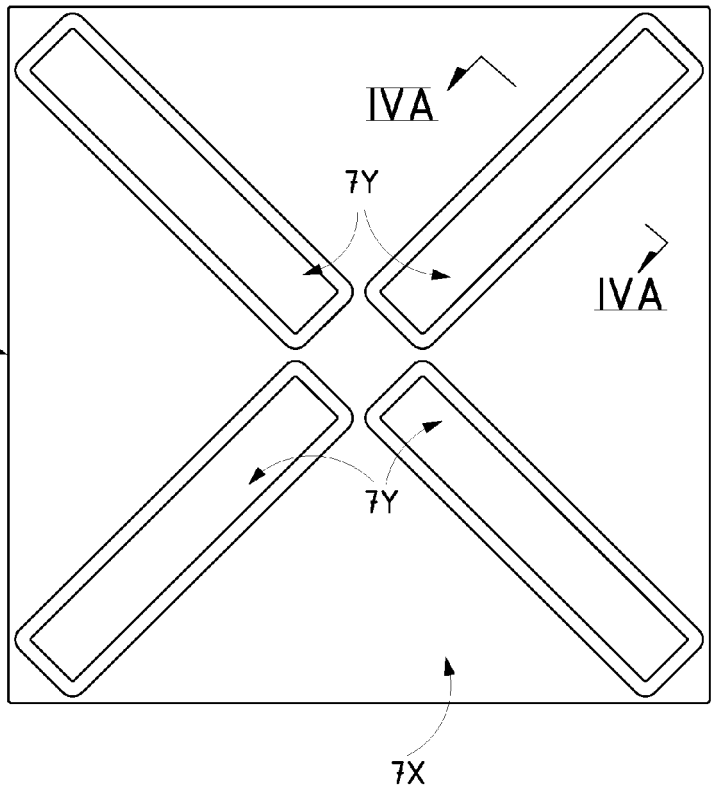


Fig.4



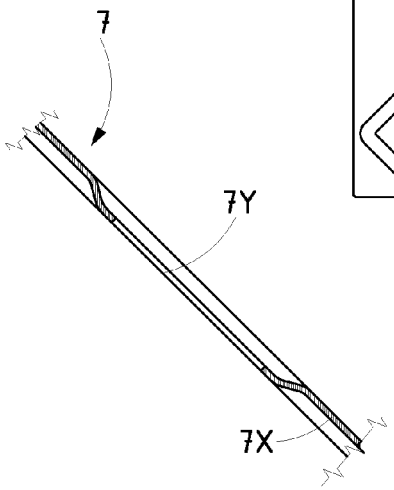


Fig.4A

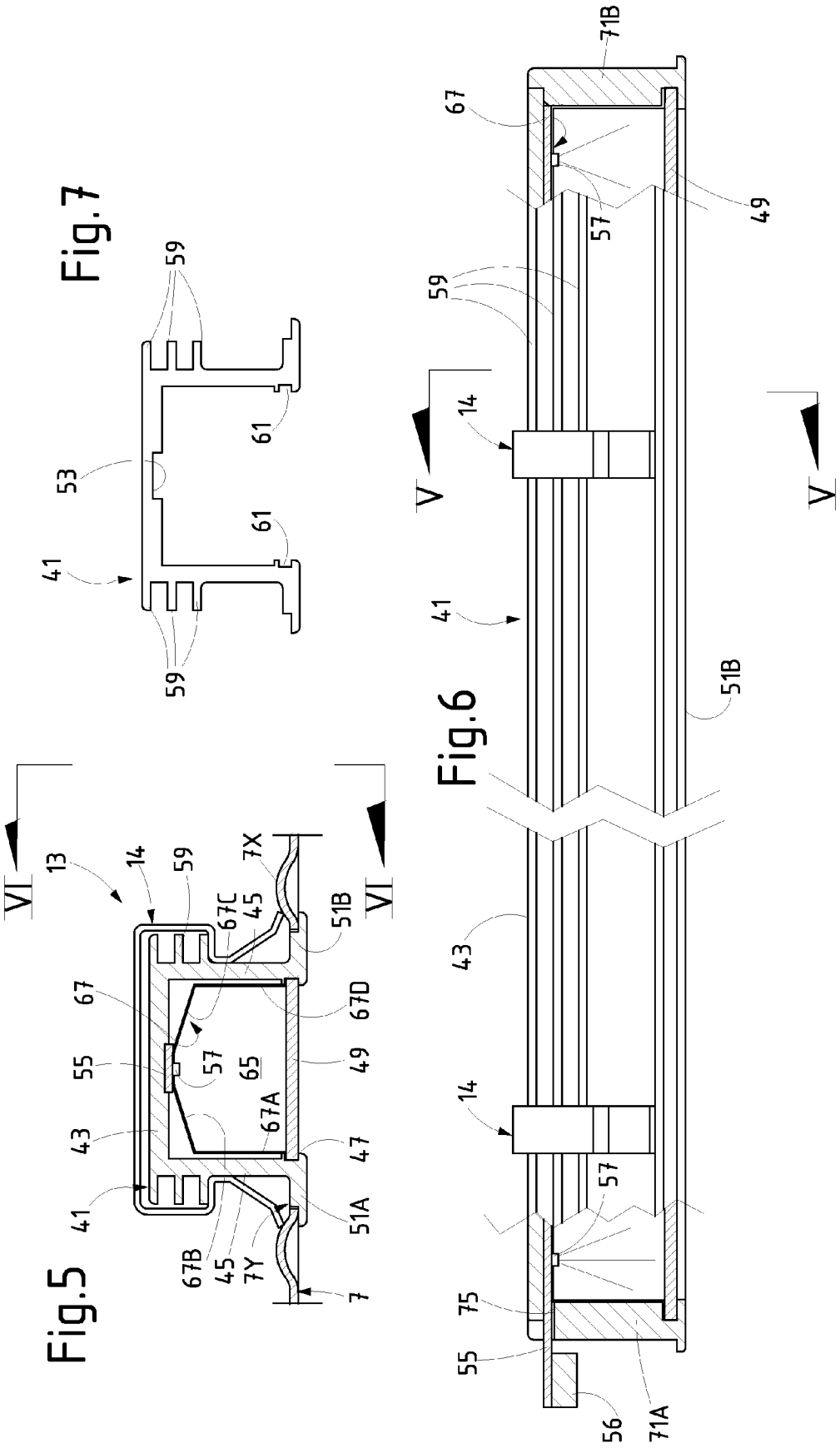

Fig.5
Fig.6
Fig.7
VI
V
13
14
59
7X
67C
45
51B
67
67D
55
57
65
49
43
67A
47
41
51A
67B
7Y
7
71B
75
56
71A
53
61

Fig.8

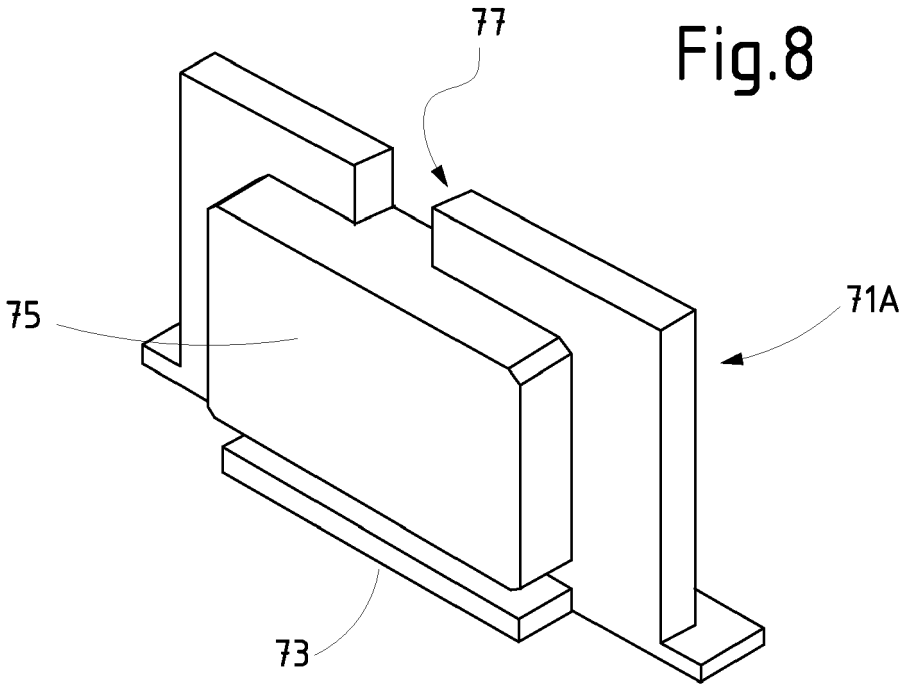
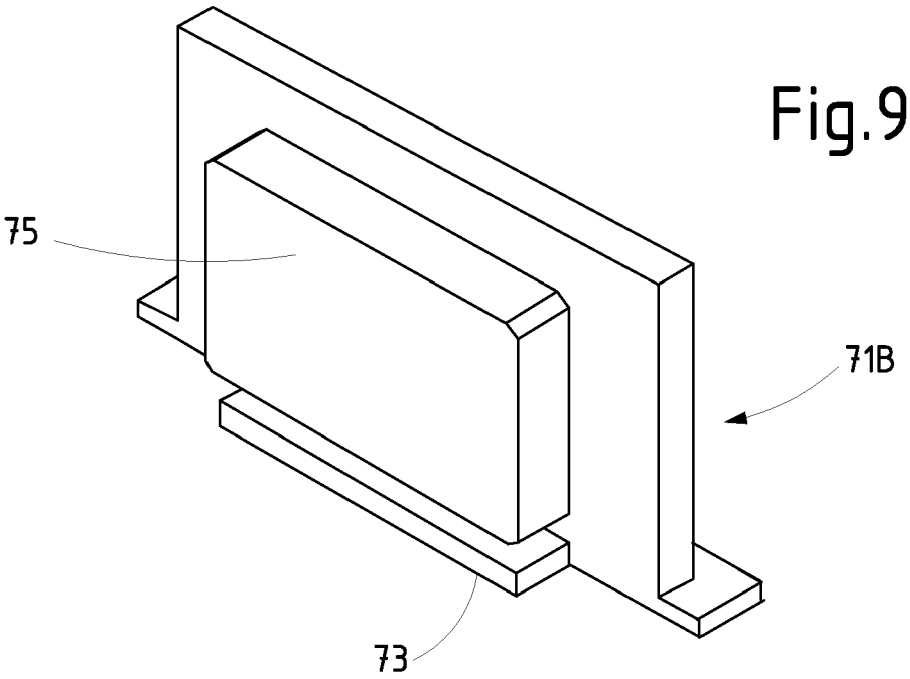


Fig.9



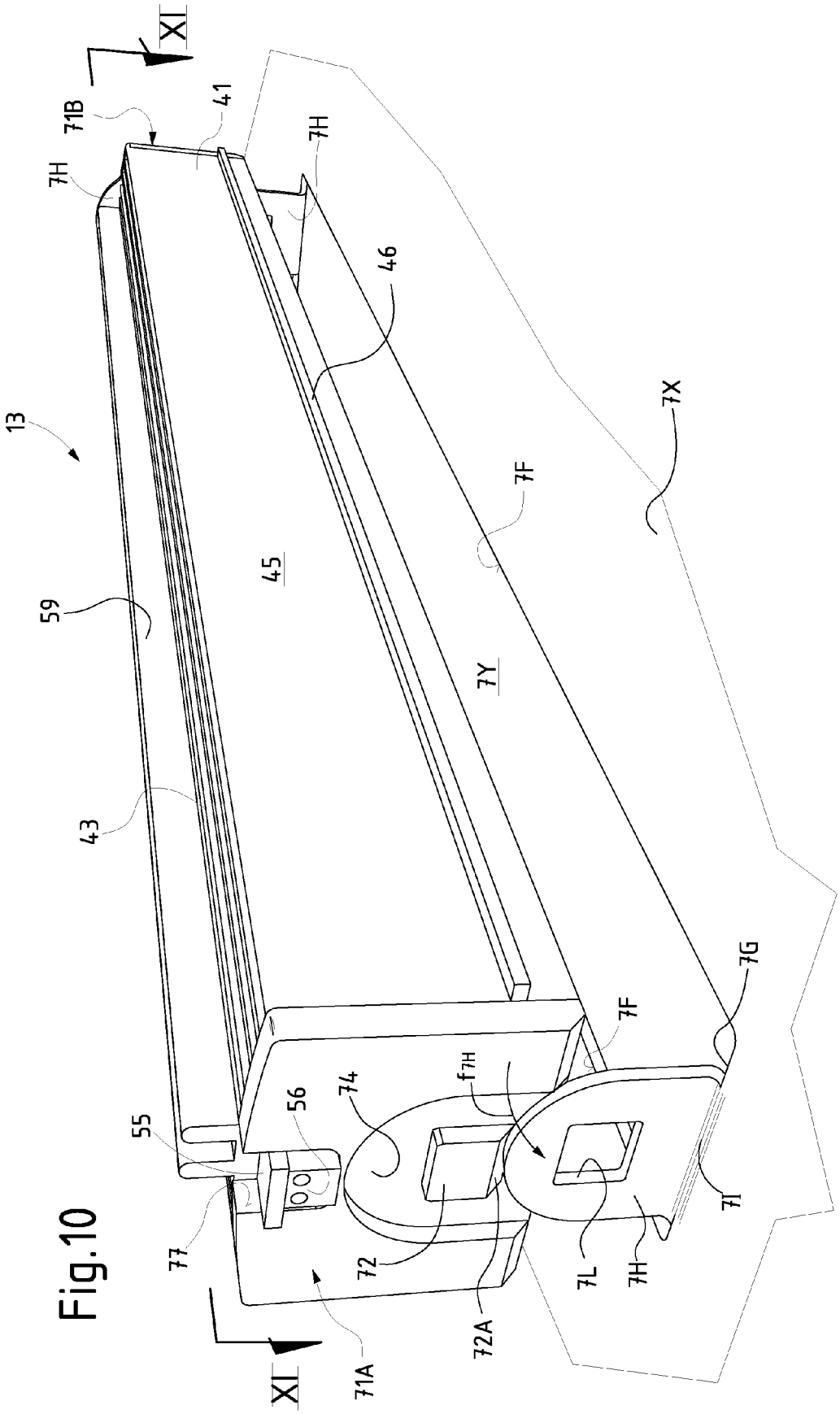

XI
71B
41
7H
7H
46
13
7X
7F
45
59
7Y
43
7G
7F
55
56
74
f7H
77
72
72A
7L
7H
7I
71A
XI

Fig.10

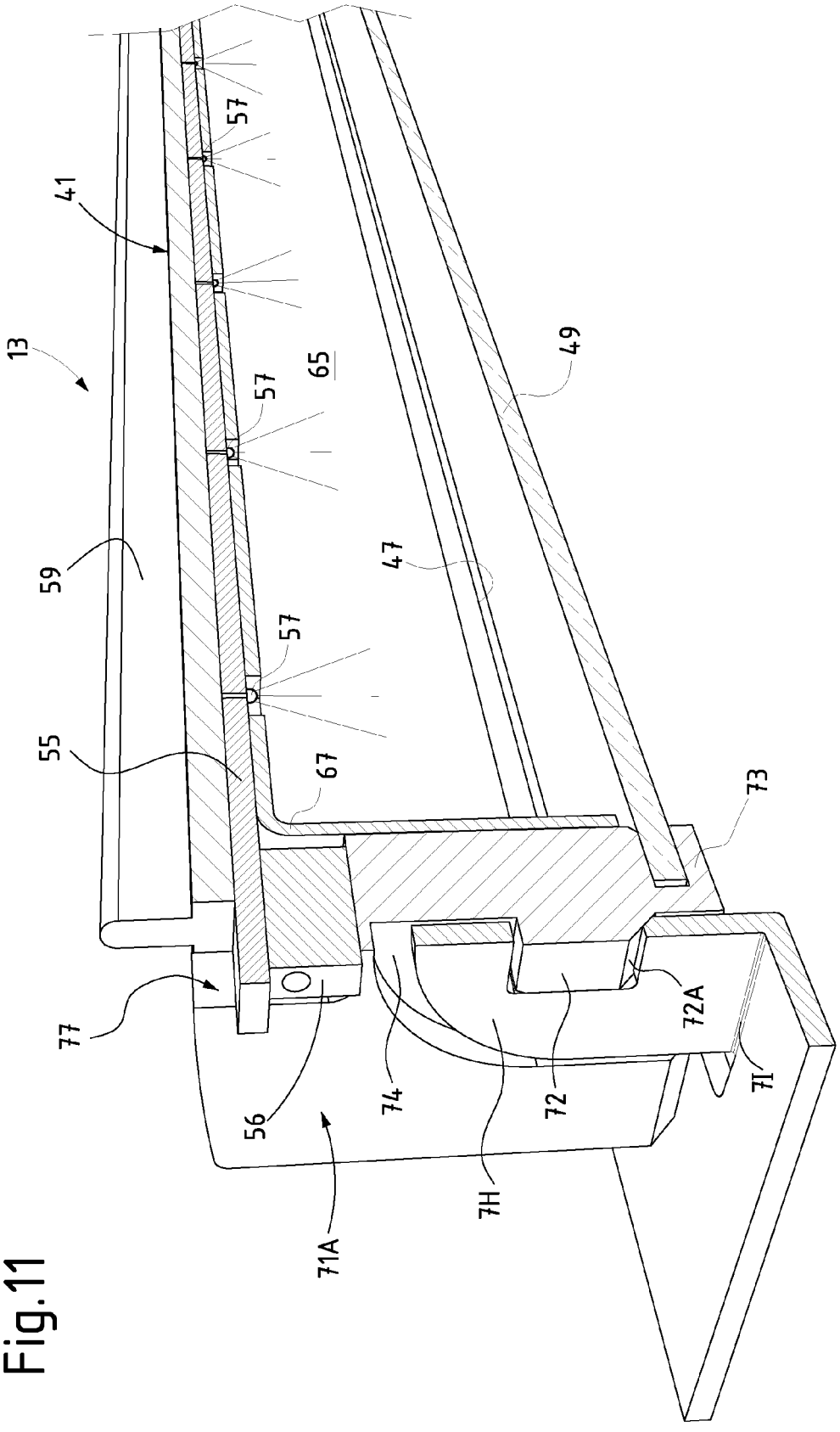


Fig.11

Fig.12

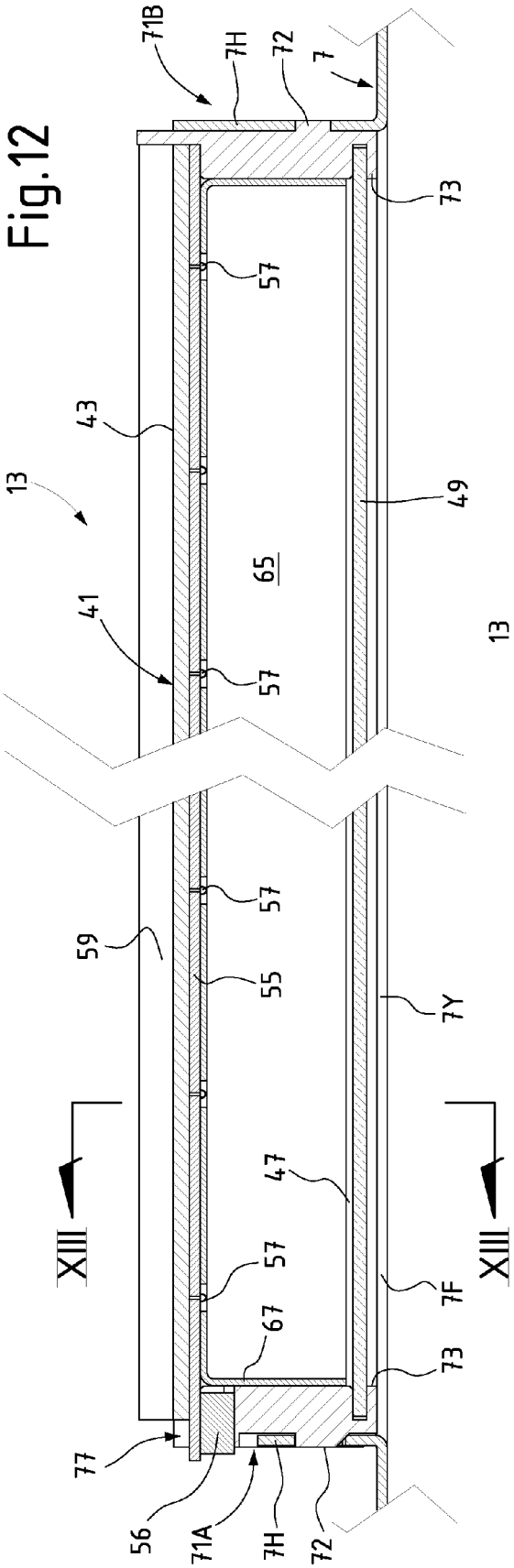

71B
7H
72
7
73
57
43
13
49
41
65
57
59
57
55
7Y
47
XIII
XIII
57
7F
67
73
77
56
71A
7H
72

Fig.13

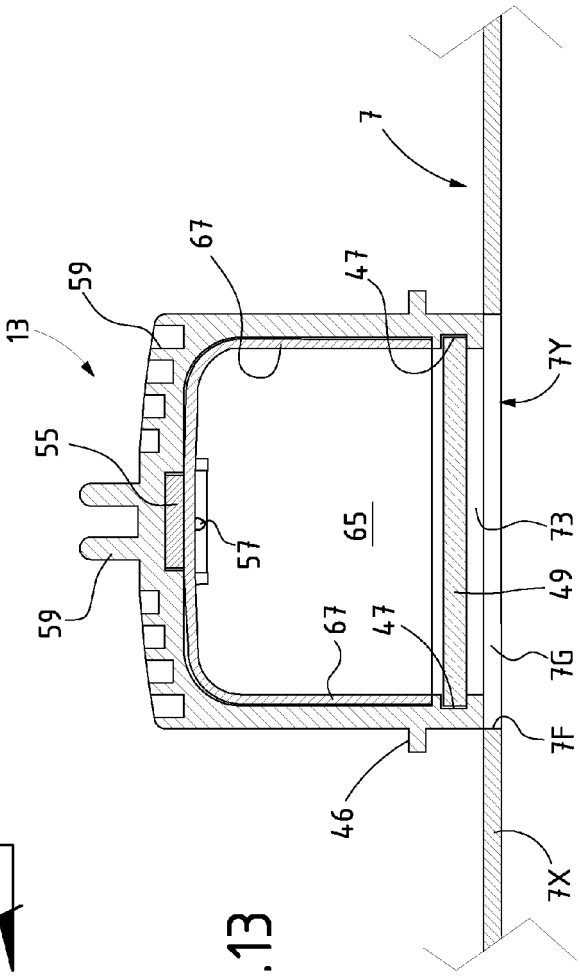
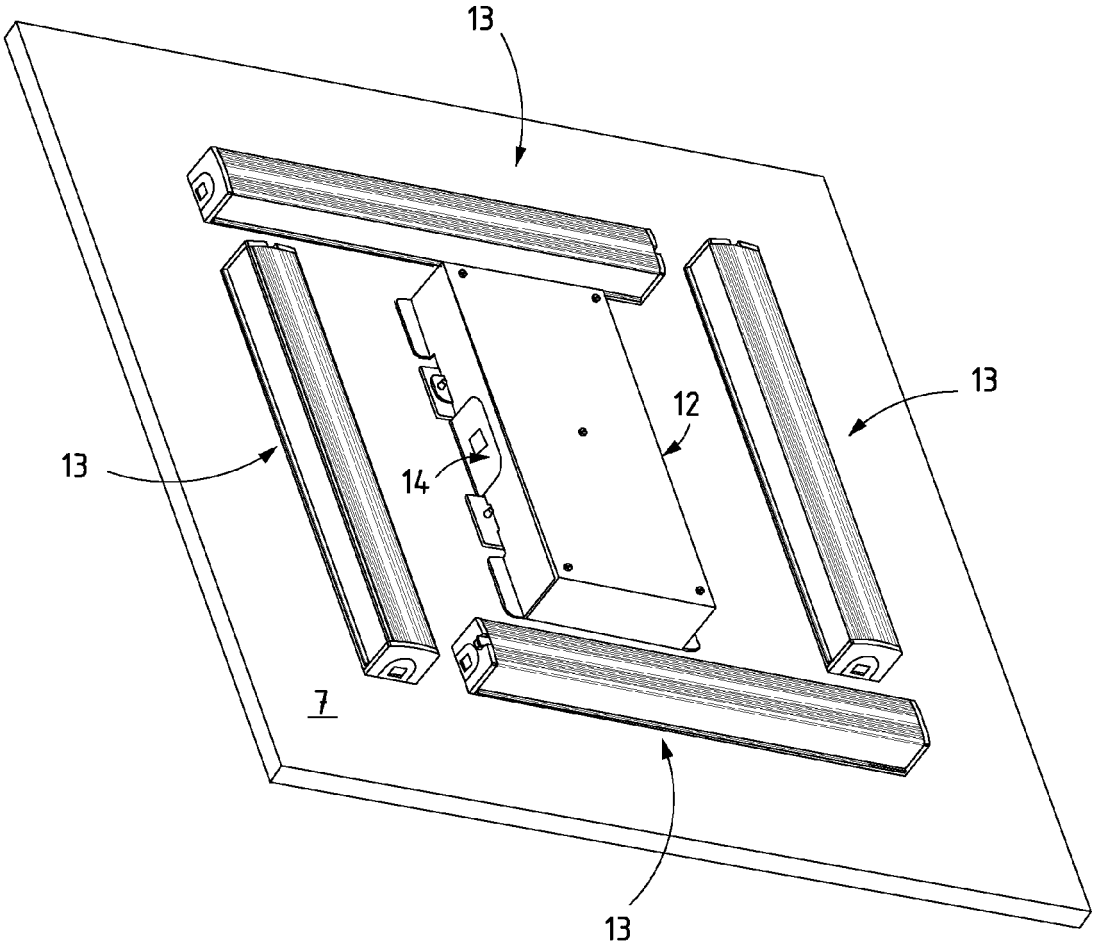

7
59
67
47
13
7Y
55
57
65
73
59
49
67
47
7G
7F
46
7X

Fig.14



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 19 2777

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 2011/139764 A2 (COOPER TECHNOLOGIES CO [US]; WALMA KENNETH [US]; CARNEY ANTHONY JAMES) 10 November 2011 (2011-11-10) * page 17, paragraph 3 - page 20, paragraph 1 * * figures 3A, 3B, 4, 8A-8C, 21, 22, 29, 30, 36 * -----	1-6,8-16	INV. F21K99/00 F21S2/00 F21S4/00 F21V15/01 F21V23/04 F21S8/04 F21V15/015
Y	US 2011/182068 A1 (HARBERS GERARD [US] ET AL) 28 July 2011 (2011-07-28) * paragraph [0031] - paragraph [0041] * * paragraph [0047] - paragraph [0049] * * figures 2, 3A, 4, 7B, 9 * -----	1-6,8-16	F21V21/03 ADD. F21Y101/02 F21Y103/00
A	WO 2011/139768 A2 (COOPER TECHNOLOGIES CO [US]; CHAN CHUN WAH [US]; CARNEY ANTHONY JAMES) 10 November 2011 (2011-11-10) * paragraph [0053] - paragraph [0055] * * figure 2 * -----	1-4	
A	WO 2011/032059 A1 (SPIRO DANIEL S [US]; WHITNEY LELAND R [US]) 17 March 2011 (2011-03-17) * paragraph [0037] - paragraph [0039] * * paragraph [0063] - paragraph [0069] * * paragraph [0090] - paragraph [0093] * * figures 17-19, 22, 23 * -----	13,14	TECHNICAL FIELDS SEARCHED (IPC) F21K F21S F21V F21Y
A	US 2010/214777 A1 (SUEHIRO YOSHINOBU [JP] ET AL) 26 August 2010 (2010-08-26) * paragraph [0114] - paragraph [0118] * * figures 17, 18 * -----	1,9	
A	US 2007/045524 A1 (RAINS JACK C JR [US] ET AL RAINS JR JACK C [US] ET AL) 1 March 2007 (2007-03-01) * paragraph [0155] - paragraph [0157] * * figures 6, 7 * -----	13,14	
	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	3 February 2014	Allen, Katie

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