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AN ILLUMINATION UNIT EMPLOYING A LED OR A FLUORESCENT LAMP FOR NORMAL AND EMERGENCY OPERATION

Field of the Invention

The present invention is related to the field of lighting units. Specifically, the present invention is related to an illumination unit that illuminates upon user demand, under ordinary conditions, using the AC power supplied by the electricity network, or in an emergency situation when the electricity network fails to provide AC power, using DC power from an internal rechargeable element.

Background of the Invention

Several systems for providing emergency light in case of failure of the local electricity supply have been developed. For example, USP 5,426,347 discloses an arrangement consisting of a power supply for providing a high frequency current, a lamp holder including a lamp socket, and a fluorescent lamp capable of being screwed into the socket. An alternate embodiment of this USP includes a rechargeable battery and appropriate circuitry to allow the operation of the lamp in the case of failure of the power line voltage.

U.S. Patent No. 5,473,517 discloses an emergency light that is electrically and mechanically connected to a conventional light switch. The unit contains a power-interruption detector connected to a relay that supplies DC power from self contained batteries to power a 5, 7, or 9 Watt fluorescent lamp or an incandescent lamp as an emergency light source. However, none of the conventional illumination units disclosed in these patents have the capability of supplying light with the unit's lamp on demand, under normal conditions when provided with AC power supplied by the electricity network and of automatically continuing to supply light by the same lamp, if still required, when a power failure occurs. In addition, the disclosed units do not have the capability of supplying light with the unit's lamp on demand, when a power failure occurs,

and of automatically continuing to supply light by the same lamp, if still demanded, under normal conditions, when provided with AC power supplied by the electricity network. Furthermore, the conventional illumination units function as an additional lighting source to other common existing light sources, and therefore they usually needs additional means for placing them on walls or on ceilings.

US 2003/0141819 discloses an illumination unit, that comprises a lamp; an adapter for attaching the electrical contacts of the unit to contacts of a socket being connected to an electricity network that feeds the unit through a switch. The switch electrically connects/disconnects at least one contact of the unit to/from the electricity network, while being in its conductive/nonconductive state, respectively; a rechargeable element for supplying electrical power form to the lamp during emergency period, when the electricity network fails, and an electronic circuit for automatically detecting the state of the switch and failure of the electricity network and to operate the lamp, which is operative to disconnect the unit from the rechargeable element from the electricity network, if failure is detected whenever the switch being in its conductive state, or otherwise, to disconnect the unit from the electricity network and from the rechargeable element whenever the switch being in its nonconductive state. However, the operation of such unit involves sending signals over the electricity network which may cause distortions to other electronic devices or appliances.

It is therefore an object of the present invention to provide an illumination unit, having on demand illumination capability during both normal and emergency conditions, which will not generate any distortions to the surrounding electronic equipment.

It is another object of the present invention to provide an illumination unit which is capable of automatically detecting a demand for illumination, and in response, of providing such illumination under any condition.

It is still an object of the present invention to provide an illumination unit capable of being placed in any existing light source housing.

Further purposes and advantages of this invention will appear as the description proceeds.

Summary of the Invention

The present invention is directed to an illumination unit that operates normally by lighting a lamp when provided with AC power supplied by the electricity network and which is also capable of automatically detecting a power failure in that electricity network, and only if required, supplies light via said lamp when such a power failure occurs (i.e., is capable to operate in an emergency mode, only on demand). The illumination unit comprises: a) a controller for determining whether to supply power for lighting at least one lamp in a normal or an emergency mode, according to the presence of power from an electricity network and according to the state of a switch, normally used to turn on/off the light, provided by said lamp; b) at least one rechargeable element for supplying power to an ignition unit, for lighting said lamp whenever there is no presence of power from said electricity network and said switch is turned on; and c) a charger, for charging said rechargeable element whenever there is a presence of power from said electricity network.

According to an embodiment of the present invention the ignition unit is a ballast unit for stabilizing the power supplied to the lamp. Preferably, the ballast unit is comprised of standard elements required for normal operation of the lamp, such as an electronic choke, to serve as a starter and ballast during operati6on of the lamp and a converter section for DC operation.

According to another embodiment of the invention, the lamp is one or more Light Emitting Diodes (LED) and the ignition unit is a led card used for lighting said LEDs.

Preferably, the charger further comprises an adapter for converting the AC voltage of the electricity network to one or more DC voltage levels, required for charging and for operating the ignition unit and the controller, as well known by a person skilled in the art.

According to an embodiment of the invention, the illumination unit further comprises display means for displaying the current operation mode of said unit, whether it operates in a normal or an emergency mode.

Preferably, the illumination unit consists of a standard integral lamp, such as a compact fluorescent lamp, with an electronics section (i.e., the controller, charger and the rechargeable elements, such as batteries), integrally incorporated in the lower section of the device and a glass tube in the upper section. The unit has a standard mounting base which can be screwed into a standard Edison type lamp socket.

According to an embodiment of the invention, the controller comprises a microprocessor and associated electronic circuitry to allow DC operation, whenever a power failure occurs.

Preferably, the rechargeable element comprises a battery and/or capacitor(s), including circuitry for recharging said element, as known by a person skilled in the art.

When the illumination unit is electrically connected (e.g., screwed) into a standard lamp housing hat is connected to electrical network (e.g., the building electrical wiring circuit), and the lamp is switched on, the basic operation of the

illumination unit is as follows: after connecting the illumination unit to the electrical network, the power from the electricity network is received at the controller, which in turn checks the capacitance of the received voltage. The controller verifies that the frequency of the power voltage is about 40 to 60 Hz, as it should be in typical electricity networks. Whenever no power supply is received, either because the lamp is switched off or because there is a failure in the electricity network, the controller performs the steps of: a) generating a rising voltage signal (e.g., from 0 to 3.3 Volts), sending said rising signal to the electricity network and in turn receiving a first feedback signal from said network; b) after receiving said first feedback signal, generating a falling voltage signal (e.g., from 3.3 to 0 Volts), sending said falling signal to the electricity network and in turn receiving a second feedback signal from said network; and c) repeating steps (a) and (b) for one or more times and determining according to said received set of first and second feedback signals whether to turn on the lights.

According to a preferred embodiment of the invention, if the received feedback signal is indicating of an active load (i.e., the feedback signal is received from the network with no phase shift), then the controller instructs to turn on the lights.

The present invention is also directed to an illumination system for remote locations. As referred to herein, a "remote location" means a structure that is deployed at a geographical location which is generally, but not necessarily, significantly separated from a cable in communication with an AC electrical network.

The illumination system comprises a solar unit having an array of photovoltaic cells and mounted onto a roof of a structure that is to be illuminated, a rechargeable battery charged by said array of photovoltaic cells, at least one illumination unit, e.g. a LED-based illumination unit, in communication with said rechargeable battery, and an activating/deactivating device which may be

manually or automatically actuated- hereinafter referred to as a "switch"- adapted to electrically connect said battery and said at least one illumination unit upon demand in order to operate said at least one illumination unit, wherein said battery carries a charge for a sufficient period of time to operate said at least one illumination unit during the nighttime hours.

In one embodiment, the at least one illumination unit is at least one outdoor illumination unit and the switch is a movement detector, said movement detector adapted to connect the battery and the at least one illumination unit upon sensing the movement of a person at a predetermined distance from the entrance of the structure to operate the at least one illumination unit for a predetermined period.

In another embodiment, the at least one illumination unit is at least one indoor illumination unit and the switch is a manually actuated switch.

To prevent drain on the battery, the system may be provided with an optical detector for deactivating the at least one illumination unit upon sensing a sufficient level of light that is transmitted through windows of the structure.

Brief Description of the Drawings

The above and other characteristics and advantages of the invention will be better understood through the following illustrative and non-limitative detailed description of preferred embodiments thereof, with reference to the appended drawings, wherein:

- Fig. 1 is an external view of an illumination unit for normal and emergency operation, according to an embodiment of the invention;
- Fig. 2 schematically illustrates a cross-sectional view of the illumination unit of Fig. 1;

- Fig. 3 is a block diagram of the electronic unit used for operating the illumination unit of Fig. 1, according to an embodiment of the invention;
- Fig. 4 is a perspective view of an illumination system that includes a solar powered outdoor illumination unit that is automatically operated upon demand during the nighttime hours; and
- Fig. 5 is a perspective view of an indoor illumination unit in communication with the system of Fig. 4.

Detailed Description of Preferred Embodiments

For purposes of illustration, the invention will be described in an embodiment that comprises an integral array of LEDs. It should be clear however to the skilled person that the illumination unit proposed by the present invention can be used with other suitable type of lamps, such as Compact Fluorescent Lamp (CFL).

Fig. 1 is an external view of an illumination unit for normal and emergency operation, according to an embodiment of the invention. The illumination unit 1 consists of three parts: a lamp 2, which in this case is an array of LEDs, the main body 3, which contains the electronic unit 10 (Fig. 3) required for operating the illumination unit 1, and an adapter 4, for connecting the electrical contacts of the illumination unit 1 to contacts of a socket being connected to the electricity network.

The configuration of the illumination unit in this figure is an integral unit, in which all the components are combined into an inseparable unit. The device may be either a modular or a dedicated device. In a modular device, the lamp 2 is plugged into the main body 3 and can be replaced whenever required without discarding the whole unit. In a dedicated device, the electronic components are "hard wired" into the fixture and unlike the other two configurations, one must

initially purchase a lamp fixture in order to use the illumination unit (although one can then use standard lamps).

According to a preferred embodiment of the invention, adapter 4 is a screw-type made to conform to the standard Edison type sockets used in most lamp fixtures, such as the popular E-25 type. Therefore the illumination unit disclosed by the present invention is compatible with existing fixtures in most buildings, and the illumination unit can replace existing incandescent or fluorescent lamps.

Fig. 2 shows a cross-sectional view of the illumination unit 1. This figure shows the location of the electronic boards 5 and 6 and the rechargeable element 15 of the electronic unit 10 (Fig. 3) within the main body 3.

Fig. 3 is a block diagram of the electronic unit 10 for controlling the operation of the illumination unit 1, according to an embodiment of the invention. Electronic unit 10 comprises a controller 11, an ignition unit 12, a charger 13, a converter 14 and a rechargeable element 15.

The normal operation of the illumination unit 1 (Fig. 1) refers to an operation mode during which the electricity network provides the required electrical AC power, and the standard switch (which is typically, but not limitatively, manually controlled by a user) is closed when it electrically connects the required contact (or contacts) of the illumination unit 1 to the electricity network (i.e., the switch is in its conductive state). During normal operation, the electronic unit 10 (Fig. 3) functions as follows:

According to an embodiment of the invention, AC voltage from the electricity network reaches controller 11 and then converter 14 through adapter 4. Converter 14 converts the electrical power from the controller 11 to one or more different DC voltage levels, required for operating the ignition unit 12, which in turn lights up (activates) lamp 2. Controller 11 provides the required voltage to

the charger 13, which charges the rechargeable element 15. The rechargeable element 15 is preferably, but not limited to, a rechargeable battery, but it can also be another suitable power supply element or rechargeable element, such as a capacitor, an array of capacitors, etc. The rechargeable element 15, when charged, provides the required operating voltage to each element in the electronic unit 10 that needs it during a failure in the electricity network, such as controller 11. Electric power in AC form will be called hereinafter AC power.

According to an embodiment of the invention, whenever no AC power is received at the controller 11, either because illumination unit 1 is switched off manually by a user (e.g., a user is turned off the light switch) or because there is a failure in the electricity network, the controller 11 performs the steps of:

- generating a rising voltage signal (e.g., from 0 to 3.3volts) and sending it to the electricity network. In turn, controller 11 receives a first feedback signal from the electricity network. However, in order to receive a more accurate decision, controller 11 should repeat the previous step for more then one time. But, due to the fact that sending the rising signal causes a change in the state of the electricity network, it desired to return the network to its original condition, therefore it would be better that the next signal will be a falling signal, and vice versa; hence
- after receiving the first feedback signal, controller 11 generates a falling voltage signal (e.g., from 3.3 to 0 Volts) and it send that falling signal to the electricity network. In turn, controller 11 receives a second feedback signal from the electricity network; and
- preferably, but not imitatively, repeating the previous steps for additional times and determining according to the behavior of the received set of first and second feedback signals whether to turn on the lights.

According to an embodiment of the invention, if the received set of first and second feedback signals are indicating that an active load is detected (i.e., the feedback signal is received from the network with no phase shift) or an

inductive/capacitive load (i.e., is having a constant phase shift), then there is a failure in the supply of the required AC power to the illumination unit 1 (Fig. 1) and the switch is closed. Whenever the switch is closed, the controller 11 instructs the ignition unit 12 to turn on the lights. On the other hand, if the received set of first and second feedback signals are not showing repeated phase shift, but there is a noise (i.e., an undefined an random signal) then the switch is open and there is no need to turn on the light.

More specifically, whenever there is a failure in supplying the required AC power to the illumination unit 1 (Fig. 1) and the switch is closed, it is an emergency state. In such case, the controller 11 instructs the rechargeable element 15 to provide the required DC voltage to the ignition unit 12, which in turn lights up the lamp 2 (Fig. 1). The charger 13 then stops charging the rechargeable element 15. The rechargeable element 15 continues to provide the required operating voltage to each element in the electronic unit 10, that requires voltage.

Usually, the switch is open whenever it electrically disconnects the required contact (or contacts) of the illumination unit 1 from the electricity network (i.e., the switch is in its nonconductive state).

According to an embodiment of the present invention the ignition unit 12 can be a ballast unit for stabilizing the power supplied to the lamp 2. Preferably, the ballast unit is comprised of standard elements required for normal operation of the lamp, such as an electronic choke to serve as a starter and ballast during operation of the lamp and a converter section for DC operation. For example, lamp 2 is a CFL type lamp and the ignition unit 12 is a ballast circuit suitable to operate such a CFL lamp. In that case, whenever the controller 11 decides that the switch is closed during an AC power failure, it allows the rechargeable element 15 (i.e., DC power supply) to activate the lamp 2, by connecting the rechargeable element 15 to the ballast circuit. The ballast circuit turns on the CFL.

According to another embodiment of the invention, the lamp is one or more Light Emitting Diodes (LED) and the ignition unit 12 is a led card used for lighting said LEDs.

According to another embodiment, the illumination unit of the present invention may be operated upon demand at remote locations whereat AC power is generally not accessible. Exemplary remote locations include a warehouse, greenhouse, and a school building of undeveloped countries not equipped with AC power.

Fig. 4 illustrates an illumination system for remote locations generally designated by numeral 30, which restricts power consumption to the nighttime hours. Illumination system 30 comprises an outdoor LED-based illumination unit 35 that is automatically operated on demand only during the nighttime hours, rechargeable battery 38, solar unit 41 for providing the electrical load for system 30, and movement detector 44. As shown, illumination unit 35 is mounted above entrance 37 of warehouse 39. Illumination unit 35 and movement detector 44 are electrically connected by wire 51. Rechargeable battery 38 and movement detector 44 are electrically connected by wire 52. Battery 38 and illumination unit 35 are electrically connected by wire 53. When movement detector 44 senses the movement of a worker 47, or any other person, along path 48 at a predetermined distance, e.g. 12 m, from entrance 37, current flows through wires 51-53 and illumination unit 35 is operated for a predetermined period, e.g. 2 minutes. After this period of time, current ceases to flow through wire 52 and illumination unit 35 is deactivated. With this arrangement, path 48 is sufficiently illuminated to allow worker 47 to find his keys, while not imposing an excessive load on rechargeable battery 38 that powers illumination unit 35. It will be appreciated that illumination unit 35 may be any other source of DC-powered light.

Solar unit 41 having an array of photovoltaic cells 42 is supported by vertical rod 57 and base 58 which is mounted onto roof 49 of warehouse 39. Solar unit 41 is fixed at a predetermined angle with respect to roof 49 that allows for an optimal influx of solar radiation to photovoltaic cells 42. Photovoltaic cells 42 energize battery 38 as well known to those skilled in the art in such a way that battery 38 carries a charge for only approximately 12 hours so that illumination unit 35 may be automatically operated during the nighttime hours and not during the daytime hours.

Fig. 5 illustrates an indoor illumination unit 65 that is powered by battery 38 of system 30 charged by photovoltaic cells 42 (Fig. 4), so that illumination unit 65 is operated on demand only during the nighttime hours. When a worker is desirous of illuminating the interior of warehouse 39, manually actuated switch 67 in electrical communication with illumination unit 65 is depressed. During the daytime hours, illumination unit 65 is deactivated by means of switch 67, and windows 69 provide sufficient illumination for performing a desired operation within warehouse 39. If so desired, an optical detector (not shown) may be employed to deactivate illumination unit 65 upon sensing a sufficient level of light that is transmitted through windows 69.

Although embodiments of the invention have been described by way of illustration, it will be understood that the invention may be carried out with many variations, modifications, and adaptations, without departing from its spirit or exceeding the scope of the claims.

Claims

1. An illumination unit, comprising:
   a) a controller, for determining whether to supply power for lighting at least one lamp in a normal or emergency mode, according to the presence of power from an electricity network and to the state of a switch, normally used to turn on/off the light provided by said lamp;
   b) at least one rechargeable element for supplying power to an ignition unit for lighting said lamp whenever there is no presence of power from said electricity network and said switch is turned on; and
   c) a charger for charging said rechargeable element whenever there is a presence of power from said electricity network.

2. An illumination unit according to claim 1, in which the ignition unit is a ballast unit for stabilizing the power supplied to the lamp.

3. An illumination unit according to claim 1, in which the lamp is one or more Light Emitting Diodes (LED) and the ignition unit is a led card, being a suitable circuitry for lighting said LED.

4. An illumination unit according to claim 1, in which the charger further comprises an adapter for converting the AC voltage of the electricity network to one or more levels of DC voltage required for charging and for operating the ignition unit and the controller.

5. An illumination unit according to claim 1, in which the illumination unit further comprises display means for displaying the current operation mode of said unit, whether it operate in a normal or an emergency mode.

6. An illumination unit according to claim 5, in which the displaying means is a dye LED.

7. An illumination unit according to claim 1, further comprising a standard base which can be screwed into a standard Edison type lamp socket.

8. An illumination unit according to claim 1, in which the rechargeable element comprises a battery and/or capacitor(s), including appropriate circuit for recharging said element.

9. A method for operating the illumination unit of claim 1 whenever no power supply is received, either because the lamp is switched off or because there is a failure in the electricity network, comprising:
   a) generating a rising voltage signal, sending said rising signal to the electricity network and in turn receiving a first feedback signal from said network;
   b) after receiving said first feedback signal, generating a falling voltage signal, sending said falling signal to the electricity network and in turn receiving a second feedback signal from said network; and
   c) repeating steps (a) and (b) for one or more times and determining according to said received set of first and second feedback signals whether to turn on the light.

10. A method according to claim 9, wherein if the received feedback signal is indicating of an active or inductive/capacity load, then turning on the light.

11. A method for operating an illumination unit, comprising:
   a) attaching the electrical contacts of said illumination unit to contacts of a socket being connected to an electricity network feeding said unit through a switch, said switch electrically connects/disconnects at least one contact of said unit from said electricity network, while being in its conductive/nonconductive state, respectively;
   b) converting the electrical power from said electricity network into electrical power in DC form, said converter has one or more outputs that

provides different levels of electrical power in said DC form and supplying the required electrical power in DC form to components of said electronic circuit that required said electrical power in DC form;

c) charging a rechargeable element for supplying electrical power to the lamp of said unit during emergency period, when said electricity network fails;

d) automatically detecting the state of said switch during failure of said electricity network by performing the steps of:

d.1) producing signals and sending said produced signals to the electricity network;

d.2) waiting to receive, from said electricity network, a signal corresponding to said produced signals, and upon receiving said corresponding signals, manipulating them;

d.3) comparing said produced signals with said manipulated corresponding signals for automatically detecting whether a power failure occurs in said electronic circuit or not;

e) whenever a power failure occurs and said switch is in its conductive state, activating an ignition unit for turning on the light by said lamp.

12. An illumination system for remote locations, comprising a solar unit having an array of photovoltaic cells and mounted onto a roof of a structure that is to be illuminated, a rechargeable battery charged by said array of photovoltaic cells, at least one illumination unit in communication with said rechargeable battery, and a switch adapted to electrically connect said battery and said at least one illumination unit upon demand in order to operate said at least one illumination unit, wherein said battery carries a charge for a sufficient period of time to operate said at least one illumination unit during the nighttime hours.

13. An illumination system according to claim 12, wherein the at least one illumination unit is at least one outdoor illumination unit and the switch is

a movement detector, said movement detector adapted to connect the battery and the at least one illumination unit upon sensing the movement of a person at a predetermined distance from the entrance of the structure to operate the at least one illumination unit for a predetermined period.

14. An illumination system according to claim 12, wherein the at least one illumination unit is at least one indoor illumination unit and the switch is a manually actuated switch.

15. An illumination system according to claim 14, further comprising an optical detector for deactivating the at least one illumination unit upon sensing a sufficient level of light that is transmitted through windows of the structure.

16. An illumination system according to claim 12, wherein the at least one illumination unit is a LED-based illumination unit.

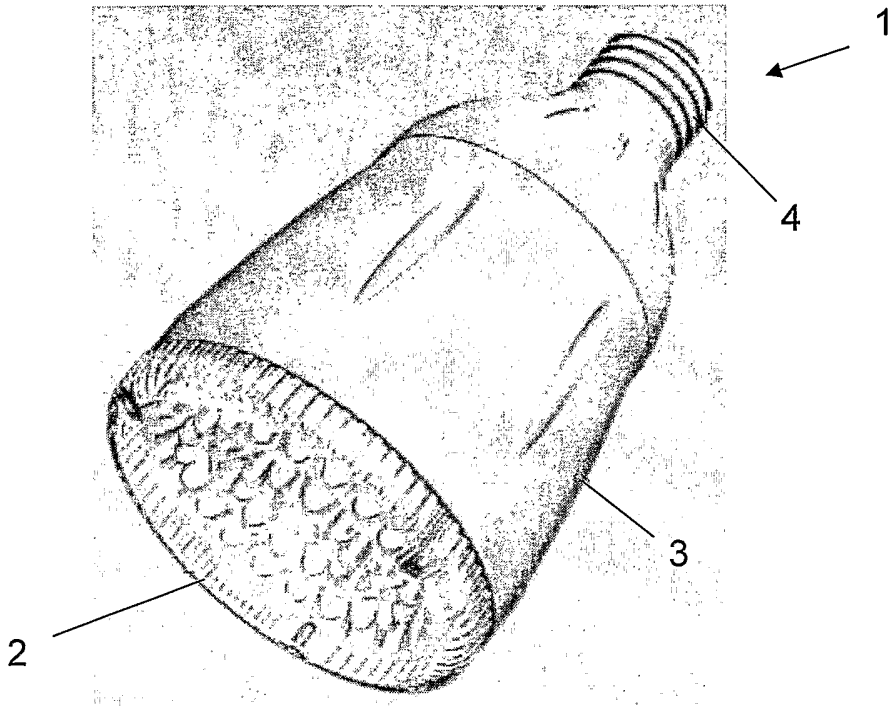

Fig. 1

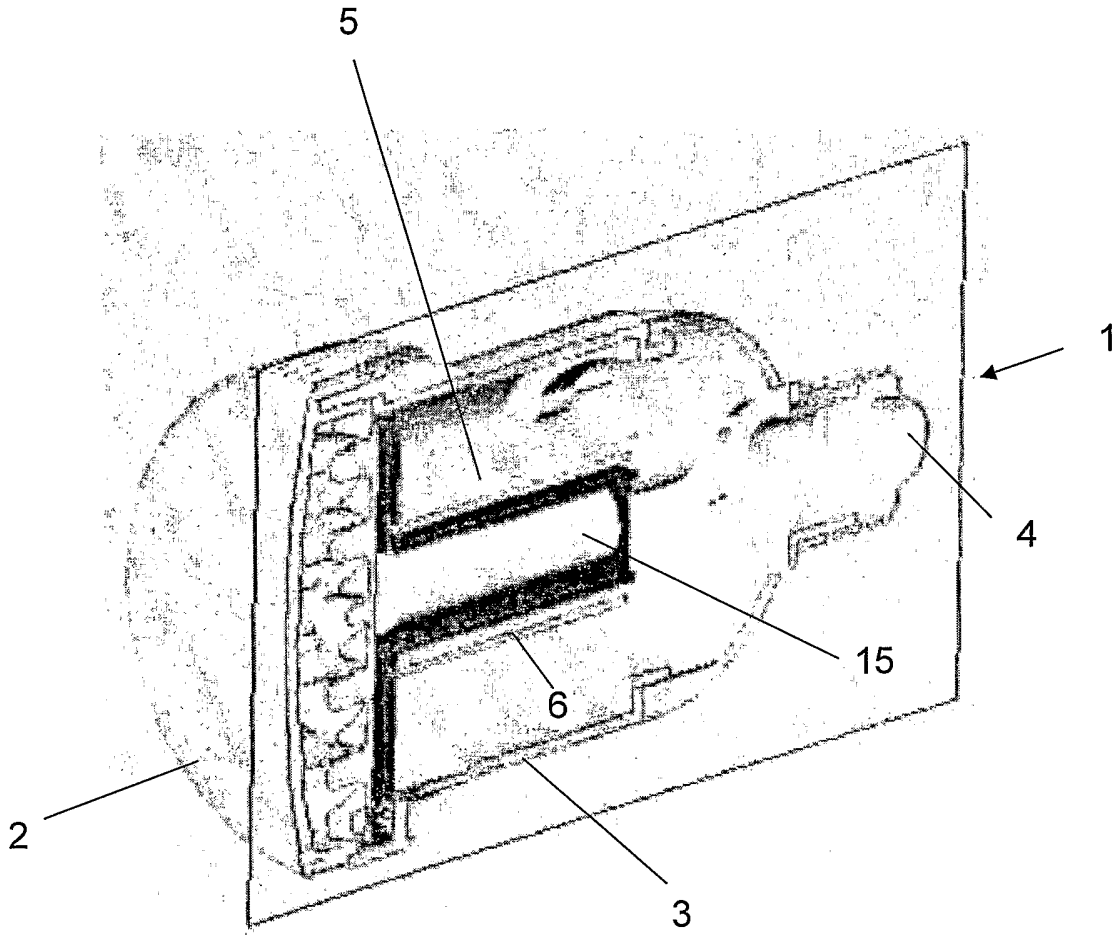

Fig. 2

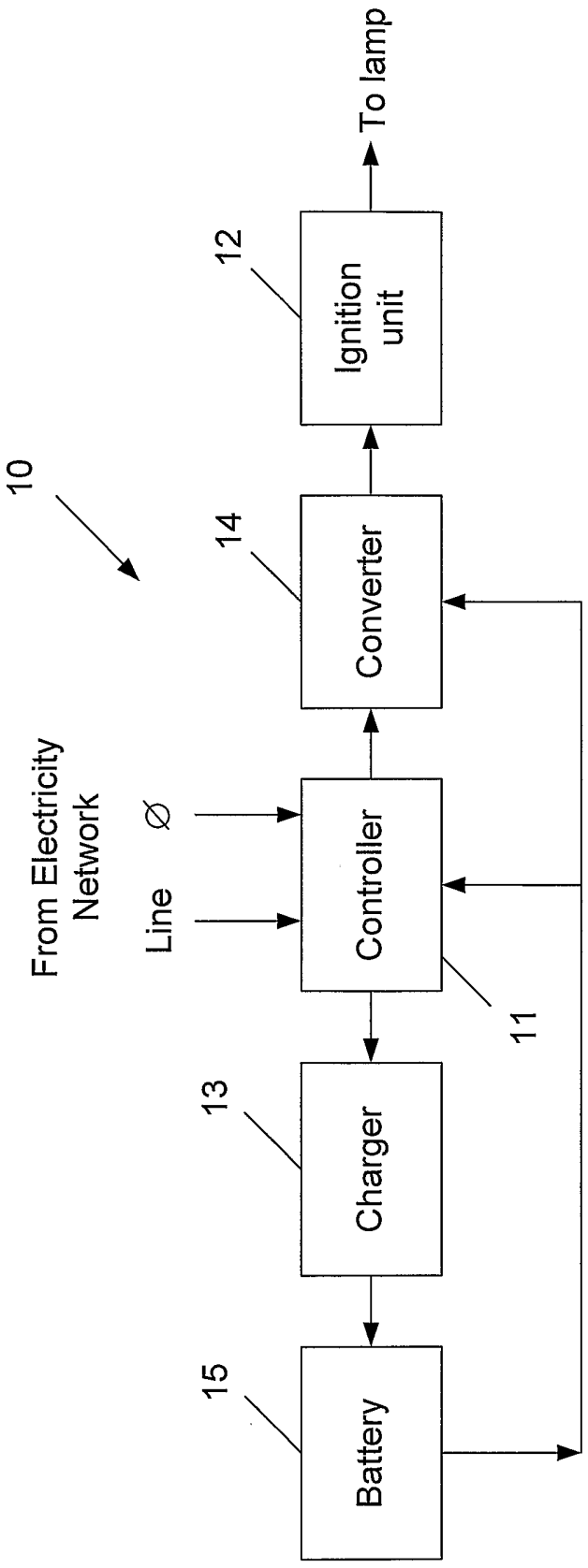
10
From Electricity Network
Line
∅
Controller
11
Converter
14
Ignition unit
12
To lamp
Charger
13
Battery
15

Fig. 3

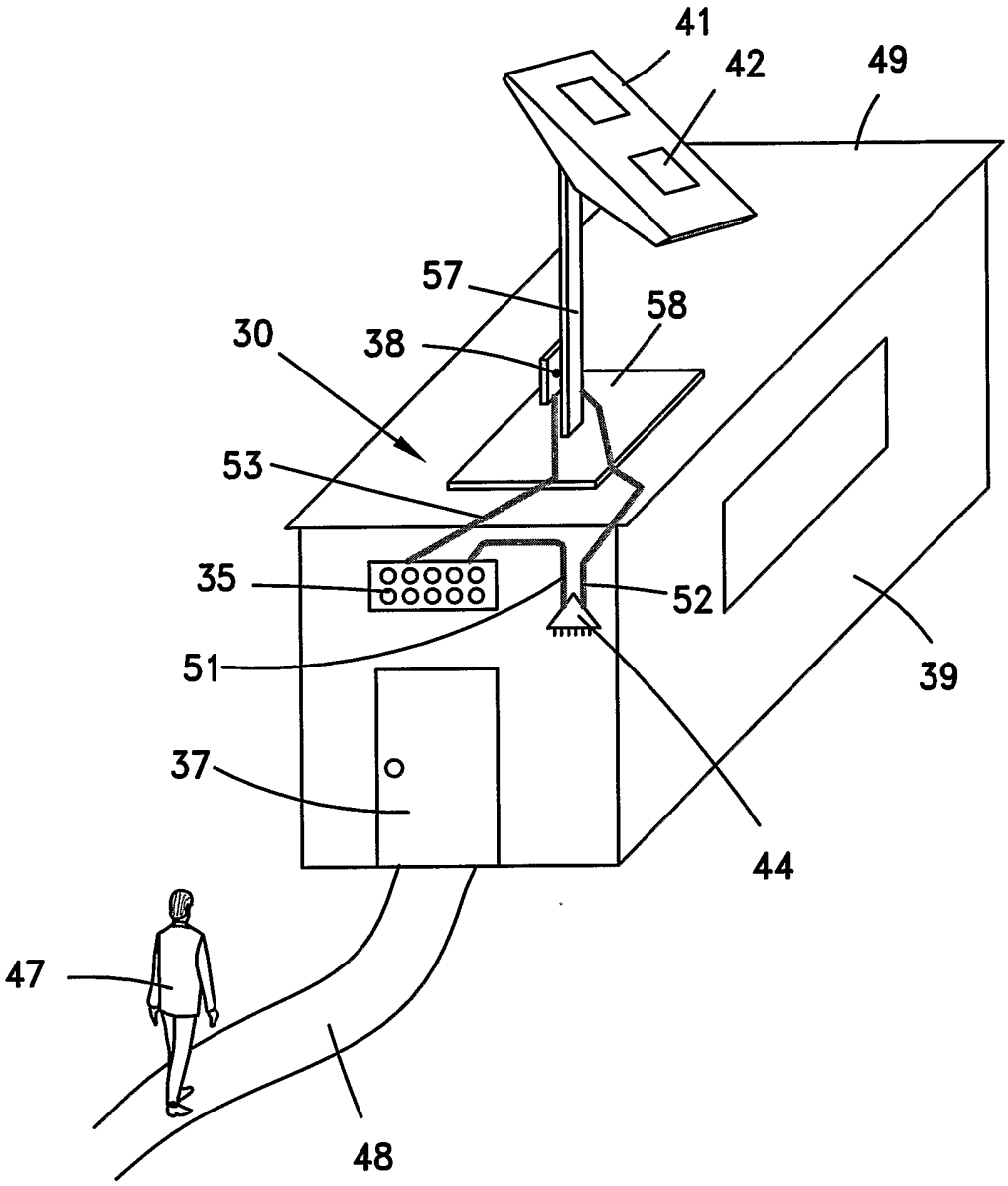

Fig. 4

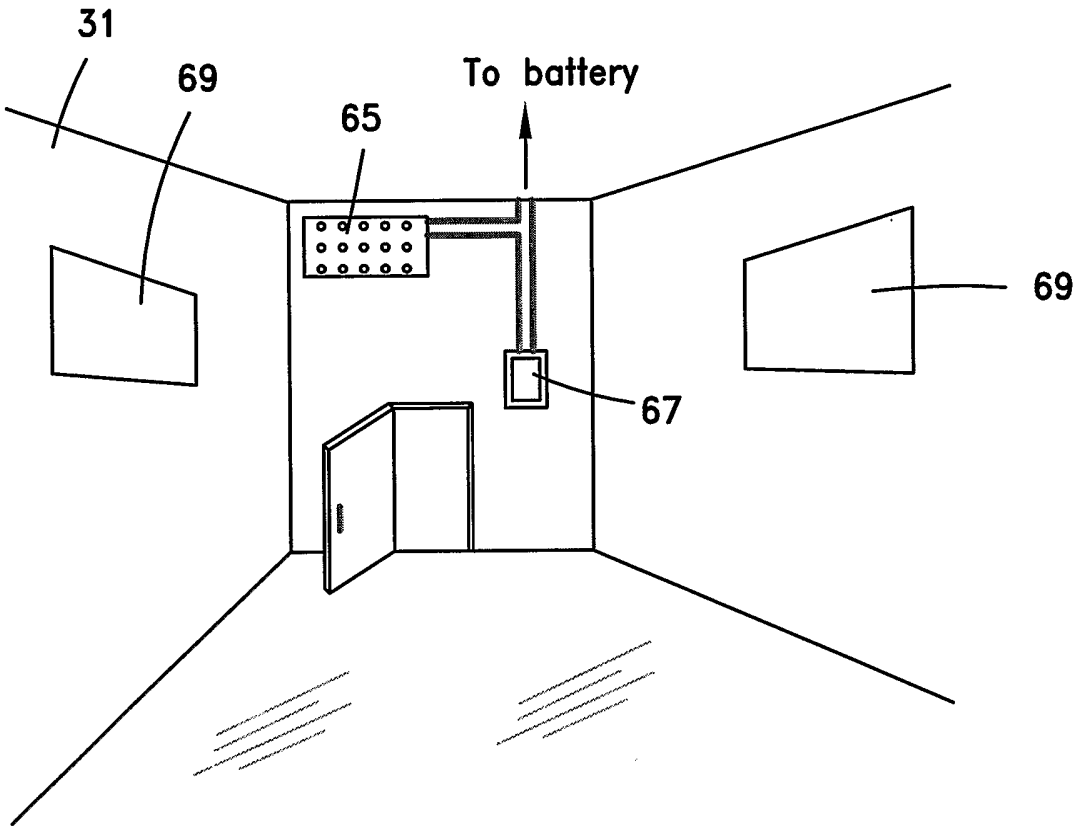

Fig. 5