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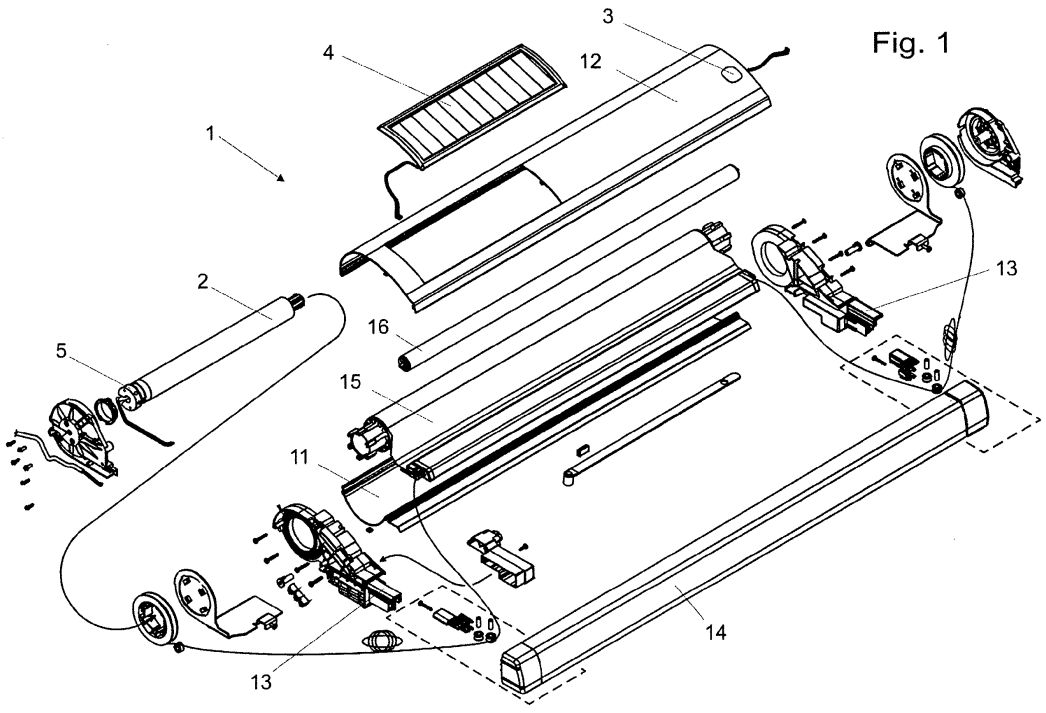
(54) **Automatic roller blind for roof windows and a method of controlling thereof**

(57) The invention relates to an automatic roller blind (1), in particular for roof windows, comprising a curtain (15), a motor (2) driving the curtain (15), a rechargeable battery (6) to store energy required to operate the motor (2), a photovoltaic panel (4) charging said rechargeable battery (6), and a microcontroller (7) to control an operation of the blind in response to control signals including at least a control signal representing a sunlight level. The invention also relates to a method of controlling such an automatic roller blind. In order to make the blind virtually and fully autonomous, i.e. capable of continuous automatic operation for a relatively long period of time without an auxiliary power supply or frequent battery (6) recharge sessions, said control signal representing a sunlight level is an output electrical power of the photovoltaic panel (4), and the microcontroller (7) controls the operation of the blind also on the basis of the output voltage of said rechargeable battery (6).

Fig. 1



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Description

Technical Field

[0001] The present invention relates to an automatic roller blind, in particular for roof windows, comprising a curtain, a motor driving the curtain, a rechargeable battery to store energy required to operate the motor, a photovoltaic panel charging said rechargeable battery and a microcontroller to control operation of the blind in response to control signals including at least a control signal representing a sunlight level. The invention also relates to a method of controlling such an automatic roller blind.

Background of the Invention

[0002] Automatic roller blinds or shutters of the kind mentioned in the outset are used for various purposes.

[0003] For example they may be employed to control the heat transfer between the inside and outside of the building. During summertime the blind may cover the window during daytime to prevent room overheating. Research shows that during the summertime roller blind installed over the roof window is capable of lowering temperature inside the room up to 7 °C as compared to the same room with a roof window devoid of the blind. On the other hand during wintertime the blind may uncover the window during daytime to allow the sunlight to warm the inside of the building or contrarily cover the window if there is no sunlight to improve thermal isolation coefficient of the window.

[0004] Automatic roller blinds of this kind may also be employed to improve the comfort of the inhabitants, for example by uncovering the window at the morning while sun exposition increases in order to allow access of the sunlight to room, by covering the window at the sunset to improve intimacy of inhabitants, etc.

[0005] Automatic roller blinds known from the state of art employ sensors providing sunlight level signals that are usually energized from an external power sources. Furthermore in case of a rechargeable battery discharge and a sunlight level insufficient for recharging the battery to a minimal voltage level enabling for operating a motor driving a curtain, the functionality of automatic positioning of the curtain disappears instantly usually at a random position of the curtain what in certain situations may be disadvantageous or at least inaesthetic.

[0006] Therefore there is a need to provide an automatic roller blind that would be virtually and fully autonomous, i.e. capable of continuous automatic operation for a relatively long period of time without an auxiliary power supply or frequent battery recharge sessions.

Summary of the Invention

[0007] The invention provides an automatic roller blind as described in the outset, which is **characterised in that**, said control signal representing the sunlight level is an output electrical power of the photovoltaic panel and the microcontroller controls the operation of the blind also on the basis of the output voltage of said rechargeable battery.

[0008] Therefore the photovoltaic panel serves not only to charge the battery of the blind but most importantly to control its operation. Furthermore it is now possible to differentiate the working mode of the blind on the basis of the available power supply. In order to measure the output electrical power of the photovoltaic panel it may be dissipated into a reference resistor and determined in a simple manner by a measurement of a voltage drop induced on the reference resistor by the current produced by the panel.

[0009] In this context it is preferable if said microcontroller works in at least two working modes including a manual working mode, where automatic control of a blind is disabled, and an automatic working mode, where position of the curtain is set as often as necessary in response to said control signals, wherein the microcontroller works in said automatic working mode if the output voltage of said rechargeable battery is higher than a predefined automatic working mode voltage threshold.

[0010] Preferably said working modes further include a semi-automatic working mode, where position of the curtain is maintained after it is set.

[0011] The microcontroller may work in the semi-automatic working mode, for example, if the output voltage of said rechargeable battery is higher than a predefined semi-automatic working mode voltage threshold and lower than said predefined automatic working mode voltage threshold.

[0012] Preferably the roller blind according to the invention additionally comprises a module providing user control signal for the microcontroller.

[0013] Said switch/indicator module may also indicate the working mode of the blind and preferably comprises low battery voltage indicator which is turned on if the output voltage of said rechargeable battery is lower than said predefined manual working mode voltage threshold.

[0014] The indicator informs the user that battery recharge is required which may takes place after e.g. in during a winter after prolonged period of low sunlight level and the blind working in said automatic working mode.

[0015] Preferably the blind additionally comprises at least one component providing additional control signal for the microcontroller chosen among: outside temperature sensor, curtain state sensor, timer, and inside temperature sensor.

[0016] In some embodiments said microcontroller may be a part of a larger home automation system.

[0017] The invention also provides a method of controlling an automatic roller blind as described in the outset that involves the steps of:

measuring an output electrical power of the photovoltaic panel as a said control signal representing

sunlight level,
measuring the output voltage of said rechargeable battery, and
controlling position of a curtain using the microcontroller working in at least two working modes including a manual working mode, where automatic control of the blind is disabled, and an automatic working mode, where position of the curtain is set as often as necessary in response to said control signals, wherein said automatic working mode is set if the output voltage of said rechargeable battery is higher than a predefined automatic working mode voltage threshold.

Brief Description of the Drawings

[0018] The invention is presented below in exemplary embodiment and in connection with the attached drawings on which:

Fig. 1 is a schematic perspective view of a part of an automatic roller blind according to the present invention;
Fig. 2 is a simplified diagram of functional elements of an automatic roller blind according to the present invention; and
Fig. 3 is a simplified block scheme of an automatic roller blind according to the present invention.

[0019] A roller blind 1 shown partially in Fig. 1 comprises a case 11, 12 attached to two side guides 13 (shown in part) connected with a cross beam 14. A curtain 15 is slidably disposed in elongated channels of side guides 13 and rolled over a shaft 16 rotationally disposed inside the case 11, 12 and driven by a drive system including an electric motor 2. Furthermore, Fig. 1 shows a digital outside temperature sensor 3 (thermometer) and a photovoltaic panel 4. These and remaining elements of the blind 1 are illustrated on a simplified diagram of Fig. 2.

[0020] In this embodiment position of the curtain 15 (open, closed or intermediate) is determined by measuring the current energizing the motor 2. Alternatively the blind 1 may obviously comprise an electromechanical sensor or a sensor integrated with a motor 2. This and other options are known to those skilled in the art.

[0021] As shown in Fig. 2, the blind further comprises a schematically illustrated rechargeable 12 Volt battery 6 and a schematically illustrated microcontroller 7 comprising a working mode (manual, semi-automatic and automatic) switch/indicator module 8, an internal timer 9 and a control logic 10. Actual implementation, design, construction and mechanical location of the battery 6, the microcontroller 7, the switch/indicator module 8, the internal timer 9 and the control logic 10 and other components of the blind 1 are arbitrary. For example the microcontroller 7 may be wirelessly connected or may have a form of an element of a larger home automation system including all possible particular software implementations thereof or may be implemented as an integrated electronic control unit (ECU) along with the switch/indicator module 8, and the control logic 10.

[0022] Connections of the functional elements of the blind 1 with the control logic 10 are depicted with arrows, wherein directions of arrows also indicate directions of current or signal transfer, so that for example the battery 6 not only supplies the power required for operation of the microcontroller 7 and the motor 2 but is also charged by the photovoltaic panel 4 in a manner controlled by the control logic 10.

[0023] The block scheme of Fig. 3 schematically illustrates an exemplary arrangement of interconnections between particular functional components of the roller blind 1 according to the present invention. As shown a two position switch 17 is installed on a supply line led out from the schematically shown photovoltaic panel 4, wherein the rechargeable battery 6 is connected to the first output contact of the switch 17 and a reference resistor 18 is connected to the second output contact of the switch 17. A first output current measuring arrangement 19 is installed on the line connecting the switch 17 with the resistor 18 and measures current supplied to the resistor 18 from the panel 4. The position of the switch 17 is controlled by the microcontroller 7 or more precisely by the control logic 10 of the microcontroller 7. The control logic 10 periodically probes a value of the photovoltaic panel 4 output power via the current measuring arrangement 19, turning the switch 17 into state in which it connects the photovoltaic panel 4 with the resistor 18. Therefore the output signals of the output current measuring arrangement 18, representing directly an output current generated by the panel 4 and determined on the basis of a measurement of a voltage drop on the resistor 18, indirectly represent an output electrical power of the photovoltaic panel 4 dissipated into the resistor 18. The normal default position of the switch 17 is the position in which the switch 17 connects the photovoltaic panel 4 with the rechargeable battery 6. The switch may be any arbitrary known switch in particular an electronic key switch. An output voltage measuring arrangement 20 and a second output current measuring arrangement 21 are installed on the output supply line of the rechargeable battery 6 connecting the battery 6 with the electric motor 2. The output signal of the output voltage measuring arrangement 20 represents the battery 6 output voltage and is used for choosing between semi-automatic and automatic working modes as described below. In a preferred embodiment said output voltage may be a no-load output voltage of the battery 6. The output signal of the second output current measuring arrangement 21 represents the battery 6 output current which is drawn by the motor 2 and which may be used by the control logic 10 to determine the position (open, closed or intermediate) of the curtain 15.

[0024] All components the blind 1, in particular the components of the microcontroller 7, sensors 3, 5 and the measuring arrangements 19, 20 are energized by the

rechargeable battery 6 which in turn is charged by the photovoltaic panel 4 thus the roller blind 1 may work autonomously, if only the sunlight during a daytime enables the photovoltaic panel 4 to maintain a sufficient charge of the battery 6.

[0025] In the presented embodiment the blind 1 operates in one of three independent working modes: manual, semi-automatic and automatic. Given working mode is set by the user if only the battery voltage enables to choose this mode. To this end the switch/indicator module 8 shown in Fig. 2 is provided with schematically illustrated switches 81 to set the given mode and indicators 82 displaying the current working mode along with a low battery indicator. Indicators 82 may be implemented as Light-emitting diodes (LED), Liquid Crystal Display(s) (LCD), or various others. Similarly switches 81 (and 83c) may be independent units, regions of a LCD touchscreen, or various others known to those skilled in the art.

[0026] Three predefined voltage thresholds are stored within microcontroller 7 memory: a manual working mode voltage threshold (a first voltage threshold) set to e.g. 11.1 Volt, a semi-automatic working mode voltage threshold (a second voltage threshold) set to e.g. 11.8 Volt and an automatic working mode voltage threshold (a third voltage threshold) set to e.g. 12.3 Volt. In case the battery 6 voltage is lower than the first voltage threshold, low battery indicator 82d is on and all switches 81 are disabled. In this case user is required to recharge the battery 6 from an auxiliary source to increase its voltage at least above the first voltage threshold. In case the battery 6 voltage is above the first voltage threshold but lower than the second voltage threshold the blind operates in manual working mode i.e. all switches 81 are disabled and indicator 82c signals working in manual mode. In case the battery 6 voltage is above the second voltage threshold but lower than the third voltage threshold the blind may operate in manual or semi-automatic working mode i.e. only switches 81 b and 81c are enabled and indicator 82b or 82c signals the working mode chosen by the user using the switch 81 b or 81 c. Eventually if the battery 6 voltage is above the third voltage threshold the blind may operate in any chosen working mode so that all switches 81 are enabled. In a situation depicted in Fig. 2 the blind 1 operates in the automatic working mode.

[0027] Furthermore the microcontroller 7 utilizes the following control signals:

1. sunlight level - determined on the basis of an output electrical power provided by the photovoltaic panel 4;

2. outside temperature - determined by the outside temperature sensor 3;

3. state of the curtain 15 (open, closed or intermediate) - determined by sensor 5;

4. time (usually day or night time) - determined on the basis of an output electrical power provided by the photovoltaic panel 4, that is by sunlight level and/or by the internal timer 9;

5. (optional) inside temperature - determined by the outside temperature sensor (not shown).

[0028] Predefined thresholds may be stored within microcontroller 7 memory and correspond to the control signals: sunlight threshold (SLTHR, e.g. 70% of output electrical power rating of the photovoltaic panel 4) corresponding to the sunlight level, dawn/dusk sunlight threshold (DDSLTHR, e.g. 4% of output electrical power rating of the photovoltaic panel 4) to indicate the day (measured sunlight level above DDSLTHR) or night (measured sunlight level below DDSLTHR), temperature threshold (TPTHR, e.g. 5 °C) to distinguish between winter- and summertime functionality (as explained below), etc. All these thresholds may be user set or hardwired in the microcontroller 7 or control logic 10 memory.

[0029] Obviously the shutter may also utilize time thresholds, such as a dawn threshold (e.g. 6 AM) to indicate the sunrise time and a dusk threshold (e.g. 8 PM) to indicate the sunset time. Time thresholds in turn may obviously also depend on the day of the year e.g. to correspond to sunrise and sunset times in a given day, so that they may be set differently in May than in December.

[0030] Operation of the blind according to an exemplary embodiment of the invention in these three independent working modes is explained in detail below.

Manual working mode (8c)

[0031] The motor 2 may be activated to open or close the curtain 15 only by user using the switch 83c.

Semi-automatic working mode (8b)

[0032] The microcontroller 7 controls the motor 2 to set or maintain the curtain 15 in the opened position if all the following conditions simultaneously hold true:

Outside temperature is lower than TPTHR (wintertime functionality),

Output electrical power of the photovoltaic panel is higher than or equal to DDSLTHR (daytime).

[0033] Furthermore the microcontroller 7 controls the motor 2 to set or maintain the curtain 15 in the closed position if all the following conditions simultaneously holds true:

Outside temperature is higher than TPTHR (summertime functionality),

Sunlight is higher than SLTHR.

[0034] Therefore in the semi-automatic working mode 8b the opened (or closed) position of the curtain 15 shall not be changed once it has been set, providing the outside temperature remains below (or above) the season of the year temperature threshold TPTHR. Battery 6 power consumption is thus substantially limited.

Automatic working mode (8a)

[0035] The microcontroller 7 controls the motor 2 to set or maintain the curtain 15 in the opened position if all the following conditions simultaneously hold true:

Outside temperature is higher than TPTHR (summertime functionality),

Sunlight is lower than SLTHR (e.g. sky is overcast)

[0036] OR if all the following conditions simultaneously holds true:

Outside temperature is lower than TPTHR (wintertime functionality),
Output electrical power of the photovoltaic panel is higher than or equal to DDSLTHR (daytime).

[0037] Furthermore the microcontroller 7 controls the motor 2 to set or maintain the curtain 15 in the closed position if all the following conditions simultaneously hold true:

Outside temperature is higher than TPTHR (summertime functionality),

Output electrical power of the photovoltaic panel is lower than DDSLTHR (night).

[0038] or if all the following conditions simultaneously holds true:

Outside temperature is lower than TPTHR (wintertime functionality),

Output electrical power of the photovoltaic panel is lower than DDSLTHR (night).

[0039] In the automatic working mode 8a the opened or closed position of the curtain 15 is changed by the microcontroller 7 as often as necessary to reflect the changes in measured sunlight or time. Obviously some predetermined or user set (by the control panel 8) time delays (e.g. 3 min) may be provided between subsequent orders to open or close the curtain to avoid unnecessary battery 6 power consumption, which in this mode is obviously higher than in semi-automatic mode 8b.

[0040] The above disclosed embodiments of the present invention are merely exemplary. Figures are not necessarily to scale, and some features may be exaggerated or minimized. These and other factors however should not be considered as limiting the spirit of the invention, the intended scope of protection of which is indicated in the appended claims.

Claims

1. An automatic roller blind (1), in particular for roof windows, comprising a curtain (15), a motor (2) driving the curtain (15), a rechargeable battery (6) to store energy required to operate the motor (2), a photovoltaic panel (4) charging said rechargeable battery (6) and a microcontroller (7) to control an operation of the blind in response to control signals including at least a control signal representing a sunlight level, **characterised in that,**
said control signal representing the sunlight level is an output electrical power of the photovoltaic panel (4) and
the microcontroller (7) controls the operation of the blind (1) also on the basis of the output voltage of said rechargeable battery (6).

2. The roller blind according to Claim 1, **characterised in that** said microcontroller (7) works in at least two working modes including a manual working mode (8c), where automatic control of a blind is disabled, and an automatic working mode (8a), where position of the curtain (15) is set as often as necessary in response to said control signals, wherein the microcontroller (7) works in said automatic working mode (8a) if the output voltage of said rechargeable battery (6) is higher than a predefined automatic working mode voltage threshold.

3. The roller blind according to Claim 2, **characterised in that** said working modes further include a semi-automatic working mode (8b), where position of the curtain (15) is maintained after it is set.

4. The roller blind according to Claim 2 or 3, **characterised in that** it additionally comprises a module (8) providing user control signal for the microcontroller (7).

5. The roller blind according to Claim 4, **characterised in that** said module (8) indicates the working mode of the blind,

6. The roller blind according to Claim 5, **characterised in that** said switch/indicator module (8) comprises low battery (6) voltage indicator which is turned on if the output voltage of said rechargeable battery (6) is lower than said predefined manual working mode voltage threshold.

7. The roller blind according to any of Claims 1 to 6,

characterised in that it additionally comprises at least one component providing additional control signal for the microcontroller (7) chosen among: outside temperature sensor (3), curtain (15) state sensor (5), timer (9), and inside temperature sensor.

8. The roller blind according to any of Claims 1 to 7, **characterised in that** said microcontroller (7) is a part of a home automation system.

9. A method of controlling an automatic roller blind (1), in particular for roof windows, comprising a curtain (15), a motor (2) driving the curtain (15), a rechargeable battery (6) to store energy required to operate the motor (2), a photovoltaic panel (4) charging said rechargeable battery (6) and a microcontroller (7) to control operation of the blind in response to control signals including at least a control signal representing a sunlight level, **characterised in that,** it involves the steps of:

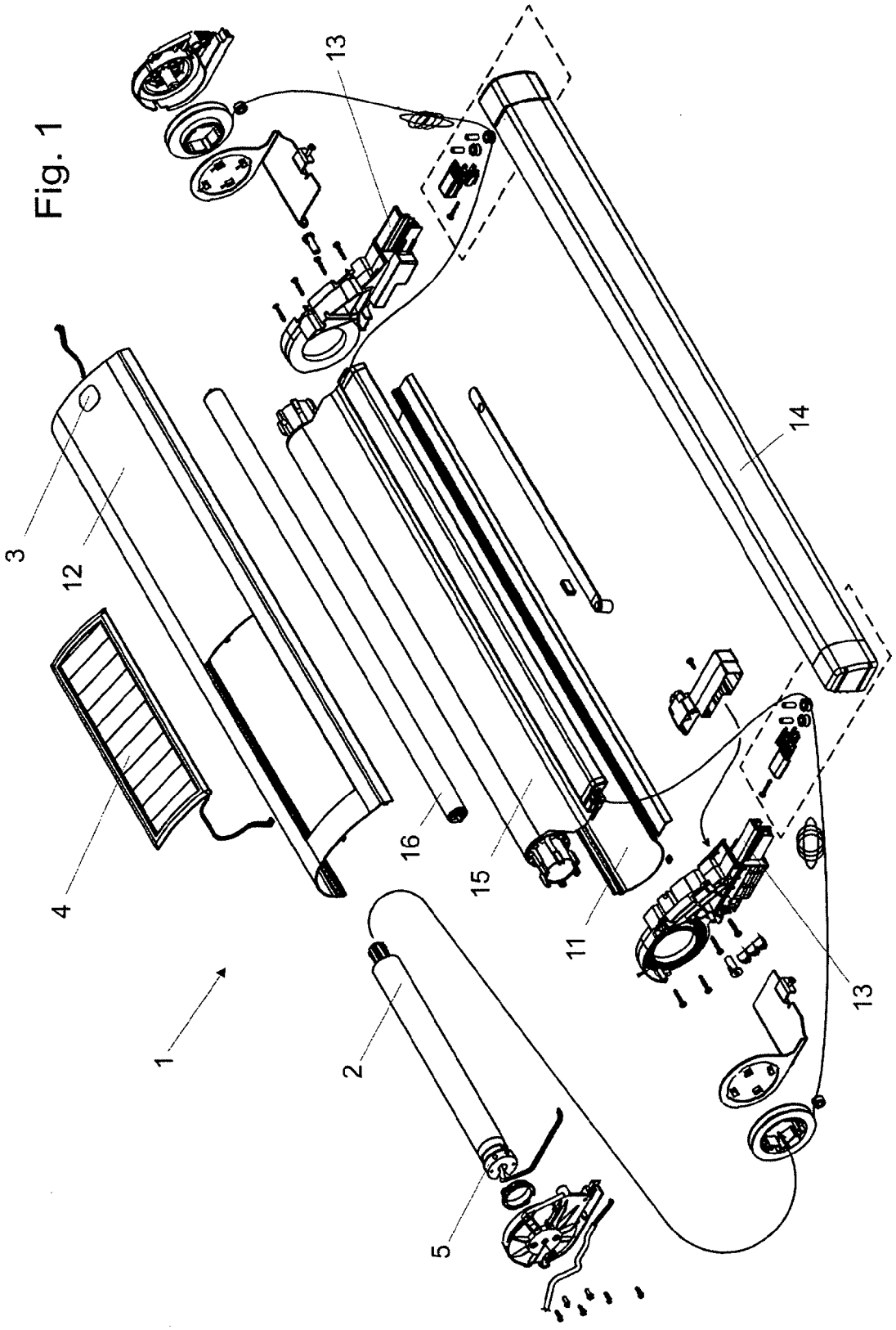
measuring an output electrical power of the photovoltaic panel (4) as a said control signal representing sunlight level,
measuring the output voltage of said rechargeable battery (6), and controlling position of a curtain (15) using the microcontroller (7) in at least two working modes including a manual working mode (8c), where automatic control of the blind is disabled, and an automatic working mode (8a), where position of the curtain (15) is set as often as necessary in response to said control signals, wherein said automatic working mode (8a) is set if the output voltage of said rechargeable battery (6) is higher than a predefined automatic working mode voltage threshold.

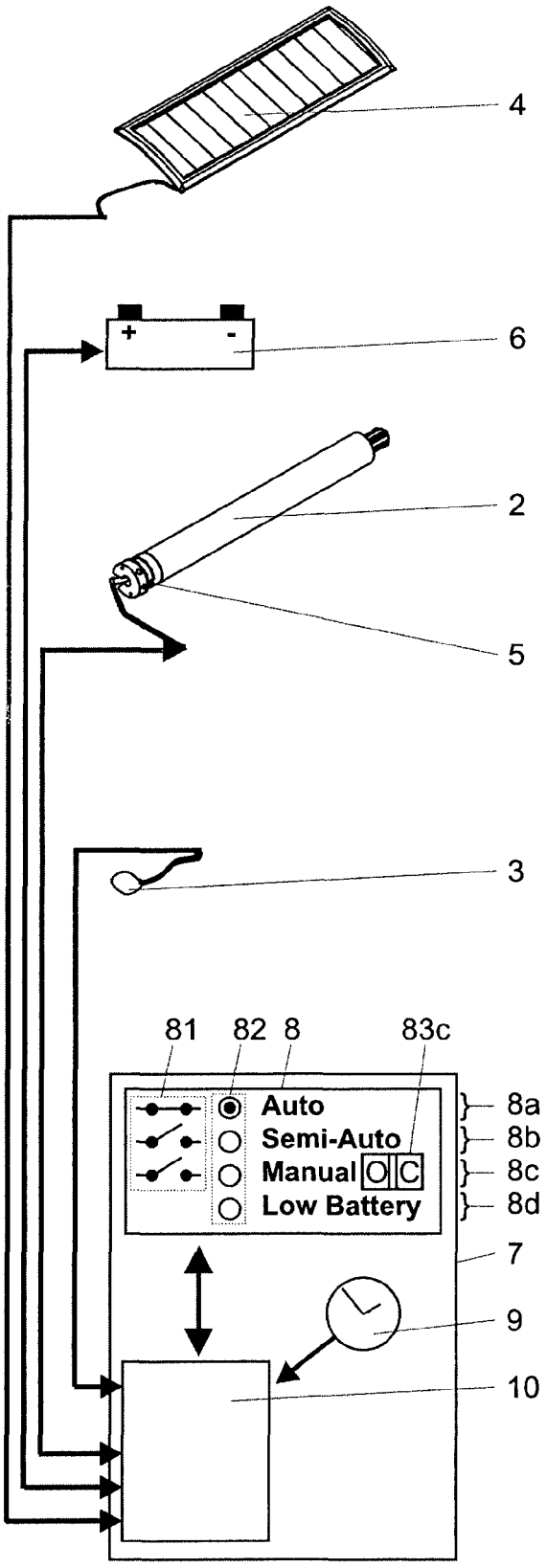
10. The method according to Claim 9, **characterised in that** said step of controlling position of the curtain (15) using the microcontroller (7) takes place also in an additional semi-automatic working mode (8b), where position of the shutter curtain (15) is maintained after it is set.

11. The method according to Claim 9 or 10, **characterised in that** user input is employed as a control signal in said step of controlling position of the curtain (15) using the microcontroller (7).

12. The method according to Claim 9 or 10 or 11, **characterised in that** additional control signals chosen among: outside temperature, curtain (15) state, time, and inside temperature are employed in said step of controlling position of the curtain (15) using the microcontroller (7).

Fig. 1

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83c
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Low Battery
8a
8b
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Fig. 2

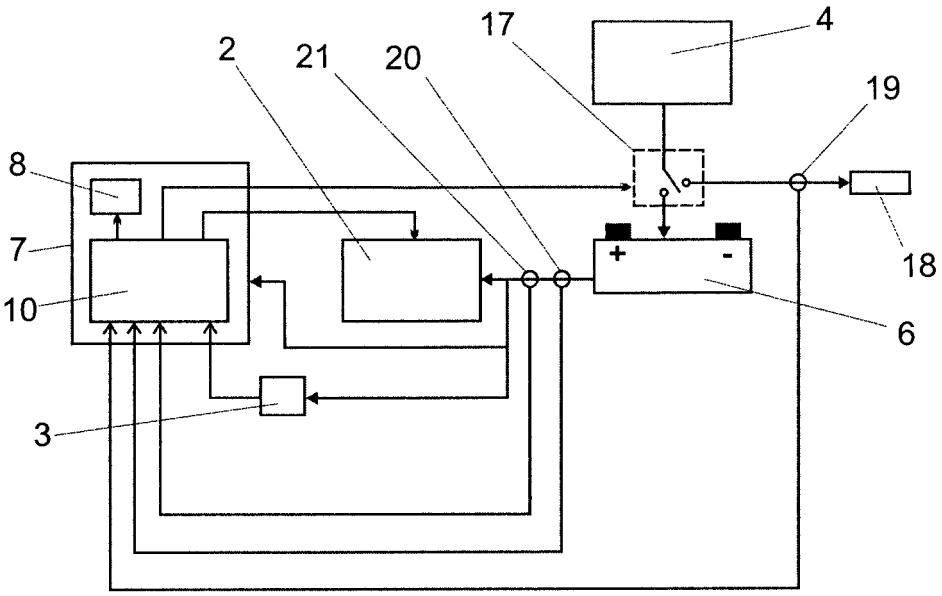

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 12 00 8299

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 May 2013	Weißbach, Mark

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 00 8299

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