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(54) Apparatus and process for adjusting alternating-current lighting devices

(57) Apparatus for adjusting alternating-current lighting devices (LD), which comprises at least one input connector (IC) for the electric connection to an alternating-current source and an output connector (OC) for the electric connection to one or more alternating-current lighting devices (LD), wherein the input connector (IC) and the output connector (OC) are electrically connected through at least one voltage regulator (VR), **characterized in that** the voltage regulator (VR) comprises a transformer (T) electrically connected to the input connector (IC) and a plurality of controlled switches (CS) connected in parallel between the taps of a winding of the transformer (T) and the output connector (OC), so that the output voltage (Vo) of the output connector (OC) can be varied with respect to the input voltage (Vi) of the input connector (IC) by closing at least one controlled switch (CS), wherein the control gates of the controlled switches (CS) are connected through at least one control line (CL) to an electronic control unit (CU) which is connected to one or more light sensors (LS) suitable for measuring the light intensity (LI) in the environment comprising the lighting devices (LD). The present invention also relates to a process which can be carried out through said apparatus.

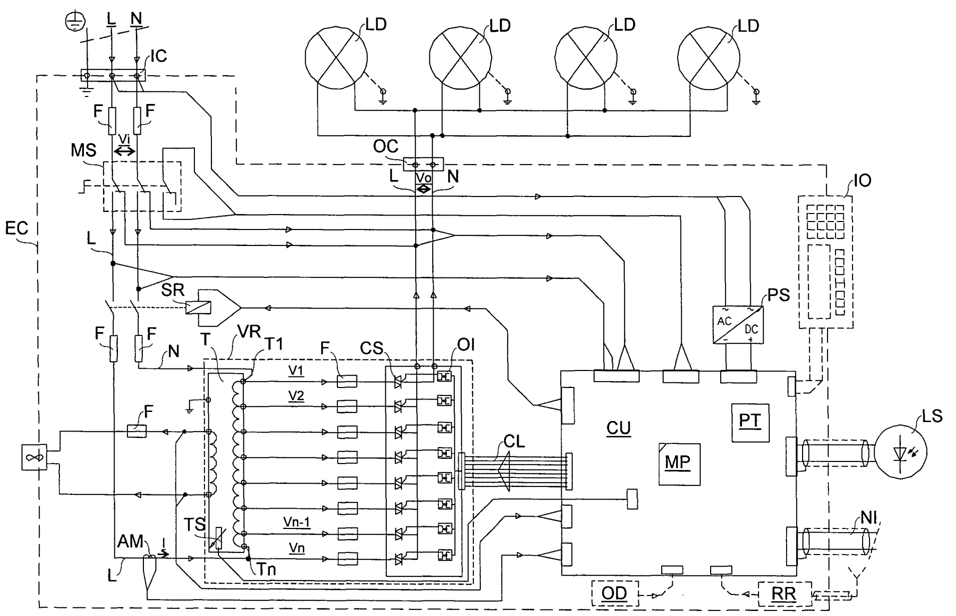

Fig.1

EP 2 146 554 A1

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Description

[0001] The present invention relates to an apparatus for adjusting alternating-current lighting devices, for example incandescent, fluorescent, mercury vapor, metal iodide lamps or the like. The present invention also relates to a process which can be carried out through said apparatus.

[0002] Known apparatuses for adjusting alternating-current lighting devices comprise an input connector and an output connector electrically connected through a voltage regulator. This voltage regulator generally comprises an inverter or a dimmer, which involve relatively high complexity and costs.

[0003] It is therefore an object of the present invention to provide an apparatus free from said disadvantages, namely an apparatus which is relatively simple and economical. Said object is achieved with an apparatus and a process, whose main features are disclosed in claims 1 and 5, while other features are disclosed in the remaining claims.

[0004] Thanks to the particular voltage regulator which is provided with, the apparatus according to the present invention allows to reduce the manufacturing and maintenance costs, as well as the electric energy consumed by the lighting devices, especially if the apparatus carries out the process according to the present invention.

[0005] Furthermore, by suitably selecting the voltages between the pairs of the adjacent taps of the transformer of the voltage regulator, the voltage of the lighting devices can be adjusted in an optimal manner with a reduced number of automatic switches.

[0006] Through the process according to the present invention the voltage of the lighting device can also be adjusted without annoying sudden variations and with an accurate control of turning-on, working and/or turning-off of the lighting devices.

[0007] Further advantages and features of the apparatus and the process according to the present invention will become clear to those skilled in the art from the following detailed and non-limiting description of an embodiment thereof with reference to the attached drawings, wherein:

- figure 1 shows a scheme of the apparatus; and
- figure 2 shows a flow-chart of the process.

[0008] Referring to figure 1, it is seen that the apparatus according to the present invention comprises in a known way an external casing EC provided with an input connector IC for the electric connection to an alternating-current source comprising a phase line L and a neutral line N, in particular at a voltage of 230 or 400 V. External casing EC is also provided with an output connector OC for the electric connection to one or more alternating-current lighting devices LD, always through a phase line L and a neutral line N. Input connector IC and output connector OC are electrically connected to each other through at least one phase line L and one neutral line N. A manual switch MS can connect directly, in a first position thereof, input connector IC to output connector OC. In a second position of manual switch MS, input connector IC and output connector OC are electrically connected through a voltage regulator VR.

[0009] Voltage regulator VR comprises a transformer T, in particular an autotransformer, which is electrically connected to input connector IC through phase line L and neutral line N. A plurality of controlled switches CS are connected in parallel between the taps of a winding of transformer T and output connector OC, so that output voltage Vo between phase line L and neutral line N of output connector OC can be varied with respect to input voltage Vi between phase line L and neutral line N of input connector IC. Said voltage variation is obtained by closing at least one controlled switch CS, so as to obtain an output voltage Vo equal to the difference of the voltages at the taps of transformer T connected to the closed controlled switches CS. In particular, first tap T1 and last tap Tn of the winding of transformer T are connected to neutral line N and phase line L, respectively, so that voltages V1 and Vn at these taps correspond to the voltage of neutral line N, namely 0 V, and to the voltage of phase line L, in particular 230 or 400 V. The voltage difference between tap T1 connected to neutral line N or tap Tn connected to phase line L and the intermediate tap T2 or Tn-1 adjacent to the latter tap is relatively low, for example 5 V, so as to obtain a fine adjustment of the voltage. For example, in the present embodiment there are eight taps T1...Tn with n=8 at an absolute voltage of 0, 5, 180, 190, 200, 210, 220, 230 V, respectively, so as to adjust output voltage Vo between 175 V and 230 V with 5 V steps. More precisely, the voltage difference between the pairs of adjacent taps Tn-1, Tn of the winding of transformer T is substantially equal to a nominal value Va, for example 10 V, apart from an extreme pair of adjacent taps, in particular pair T1, T2, where voltage difference Vb, for example 5 V, is lower than nominal value Va, and the pair of adjacent taps, in particular pair T2, T3, adjacent to this extreme pair T1, T2, where voltage difference Vc, for example 175 V, is greater than nominal value Va. In the present embodiment, controlled switches CS comprise TRIACs provided with opto-isolators OI, however in other embodiments controlled switches CS can comprise pairs of thyristors or SCRs connected in antiparallel, static relays or other equivalent devices.

[0010] Control gates of controlled switches CS are connected through at least one control line CL to an electronic control unit CU which is provided with a microprocessor MP for executing operating sequences, with a programmable timer PT for determining the on and off times of lighting devices LD and with one or more interfaces for the connection to electric or electronic devices, in particular to at least one light sensor LS provided with a photodiode suitable for measuring the light intensity in the environment comprising lighting devices LD. Control unit CU is powered by a power supply PS connected to input connector IC.

[0011] Control unit CU is also connected to input/output means IO, in particular comprising a keyboard and a display, for controlling the working of the apparatus, to a temperature sensor TS arranged close to transformer T for measuring the temperature of the latter, to manual switch MS for controlling the position of the latter, to neutral lines N and phase lines L of input connector IC and of output connector OC for measuring input voltage Vi and output voltage Vo, respectively, to a safety relay SR for disconnecting, if necessary, transformer T from input connector IC, to an ammeter AM arranged on phase line L for measuring phase current I, and/or to a network interface NI for connecting control unit CU to a computer network.

[0012] Control unit CU is further connected to two taps of a secondary winding of transformer T for controlling the phase of current I. Such taps are connected to a cooling fan CF and the voltage between them is low, in particular 18 V. Fuses F are arranged at different points of the apparatus, in particular on phase line L, on neutral line N and on the lines connecting transformer T to controlled switches CS.

[0013] Control unit CU can be connected to optional devices OD and/or to a radio receiver RR, in particular for receiving the signals of one or more light sensors LS suitable for measuring the light intensity in the same environment of light devices LD.

[0014] Referring to figure 2, it is seen that control unit CU is programmed for adjusting lighting devices LD through voltage regulator VR by means of the following adjustment process.

[0015] At the beginning (Start) of the adjustment process, control unit CU checks in programmable timer PT whether at that moment lighting devices LD must be on, namely if a light timer LT is in an ON position. In the negative (N), control unit CU turns off lighting devices LD by setting at zero output voltage Vo (Vo=0) and starts a cooling timer CT (CT=ON), after which it ends the adjustment process (End). In the affirmative (Y), namely if for programmable timer PT lighting devices LD must be on (LT=ON), control unit CU checks whether lighting devices LD are already on, namely Vo>0.

[0016] In the negative (N), namely if lighting devices LD are not on, control unit CU checks whether cooling timer CT is on (CT=ON?), in which case (Y) it ends the adjustment process (End), otherwise (N), if cooling timer CT is off (CT=OFF), control unit CU turns on lighting devices LD at a maximum voltage Vmax (Vo=Vmax), generally equal to input voltage Vi, and starts a stabilization timer ST (ST=ON).

[0017] In the affirmative (Y), namely if lighting devices LD are already on, control unit CU checks whether stabilization timer ST is on (ST=ON?), in which case (Y) it ends the adjustment process (End), otherwise (N), if stabilization timer ST is off (ST=OFF), control unit CU measures through ammeter AM phase current I and checks whether it is greater than a maximum value Imax.

[0018] In the affirmative (Y), namely I>Imax, control unit CU signals through input/output means IO the excessive current input, stores this fault in an error variable Ierr, namely Ierr=ON, after which it checks whether output voltage Vo is equal to a minimum maintenance value Vmin, in which case (Y), namely if Vo=Vmin, control unit CU ends the adjustment process (End), while in the negative (N), namely Vo>Vmin, control unit CU lowers by at least one step S, in particular equal to 5 V, output voltage Vo, namely Vo=Vo-S, thereby suitably driving voltage regulator VR, after which it ends the adjustment process (End).

[0019] If instead phase current I is not greater than maximum value Imax (I<=Imax), control unit CU turns off error variable Ierr (Ierr=OFF) and deactivates the fault signal in input/output means IO, after which it checks whether light intensity LI measured by at least one light sensor LS is comprised within a range Lmin-Lmax of programmed values of light intensity, namely if Lmax>LI>Lmin.

[0020] In the affirmative (Y), namely Lmax>LI>Lmin, control unit CU ends the adjustment process (End), while in the negative (N) control unit CU checks whether light intensity LI is greater than maximum value Lmax (otherwise lower than minimum value Lmin).

[0021] In the affirmative (Y), namely LI>Lmax, control unit CU checks in the above indicated manner output voltage Vo with the minimum maintenance value Vmin, lowers by at least one step S output voltage Vo, if possible, after which it ends the adjustment process (End), while in the negative (N), namely LI<Lmin, control unit CU checks whether output voltage Vo is already equal to maximum value Vmax (Vo=Vmax), in which case (Y) it ends the adjustment process (End), otherwise (N), if Vo<Vmax, control unit CU raises by at least one step S output voltage Vo, namely Vo=Vo+S, after which it ends the adjustment process (End). Control unit CU repeats periodically, for example every 10 ms, the adjustment process from Start to End.

[0022] Possible modifications and/or additions may be made by those skilled in the art to the hereinabove disclosed and illustrated embodiment while remaining within the scope of the following claims.

Claims

1. Apparatus for adjusting alternating-current lighting devices (LD), which comprises at least one input connector (IC) for the electric connection to an alternating-current source and an output connector (OC) for the electric connection to one or more alternating-current lighting devices (LD), wherein the input connector (IC) and the output connector (OC) are electrically connected through at least one voltage regulator (VR), **characterized in that** the voltage regulator (VR) comprises a transformer (T) electrically connected to the input connector (IC) and a plurality

of controlled switches (CS) connected in parallel between the taps of a winding of the transformer (T) and the output connector (OC), so that the output voltage (Vo) of the output connector (OC) can be varied with respect to the input voltage (Vi) of the input connector (IC) by closing at least one controlled switch (CS), wherein the control gates of the controlled switches (CS) are connected through at least one control line (CL) to an electronic control unit (CU) which is connected to one or more light sensors (LS) suitable for measuring the light intensity (LI) in the environment comprising the lighting devices (LD).

2. Apparatus according to the previous claim, **characterized in that** the voltage difference between the pairs of adjacent taps (Tn-1, Tn) of the winding of the transformer (T) is substantially equal to a nominal value (Va), apart from an extreme pair of adjacent taps (T1, T2), where the voltage difference (Vb) is lower than the nominal value (Va) and the pair of adjacent taps (T2, T3) adjacent to this extreme pair (T1, T2), where the voltage difference (Vc) is greater than the nominal value (Va).

3. Apparatus according to one of the previous claims, **characterized in that** the control unit (CU) is provided with a programmable timer (PT) for determining the on and off times of the lighting devices (LD).

4. Apparatus according to one of the previous claims, **characterized in that** the control unit (CU) is connected to the output connector (OC) for measuring the output voltage (Vo) and/or to an ammeter (AM) for measuring the phase current (I).

5. Process for adjusting alternating-current lighting devices (LD) through an apparatus according to one of the previous claims, **characterized by** the following operating steps:

- the control unit (CU) checks the light intensity (LI) measured by at least one light sensor (LS) in the environment comprising the lighting devices (LD);
- if the light intensity (LI) measured by the light sensor (LS) is greater than a programmed maximum value (Lmax) and if the output voltage (Vo) is not equal to a minimum value (Vmin) the control unit (CU) lowers the output voltage (Vo) by at least one step (S) of the voltage regulator (VR);
- if the light intensity (LI) measured by the light sensor (LS) is lower than a programmed minimum value (Lmin) and if the output voltage (Vo) is not equal to a maximum value (Vmax) the control unit (CU) raises the output voltage (Vo) by at least one step (S) of the voltage regulator (VR).

6. Process according to the previous claim, **characterized by** the following further operating steps:

- the control unit (CU) checks in the programmable timer (PT) whether the lighting devices (LD) must be on;
- in the negative (N) the control unit (CU) turns off the lighting devices (LD) and starts a cooling timer (CT);
- in the affirmative (Y) the control unit (CU) checks whether the lighting devices (LD) are already on.

7. Process according to the previous claim, **characterized by** the following further operating steps:

- if the lighting devices (LD) must be on and are not already on, the control unit (CU) checks whether the cooling timer (CT) is off;
- in the affirmative (Y), the control unit (CU) turns on the lighting devices (LD) at a maximum voltage (Vmax) and starts a stabilization timer (ST).

8. Process according to the previous claim, **characterized by** the following further operating steps:

- if the lighting devices (LD) are on the control unit (CU) checks whether the stabilization timer (ST) is on;
- in the negative (N), the control unit (CU) measures the phase current (I) and checks whether it is greater than a maximum value (Imax).

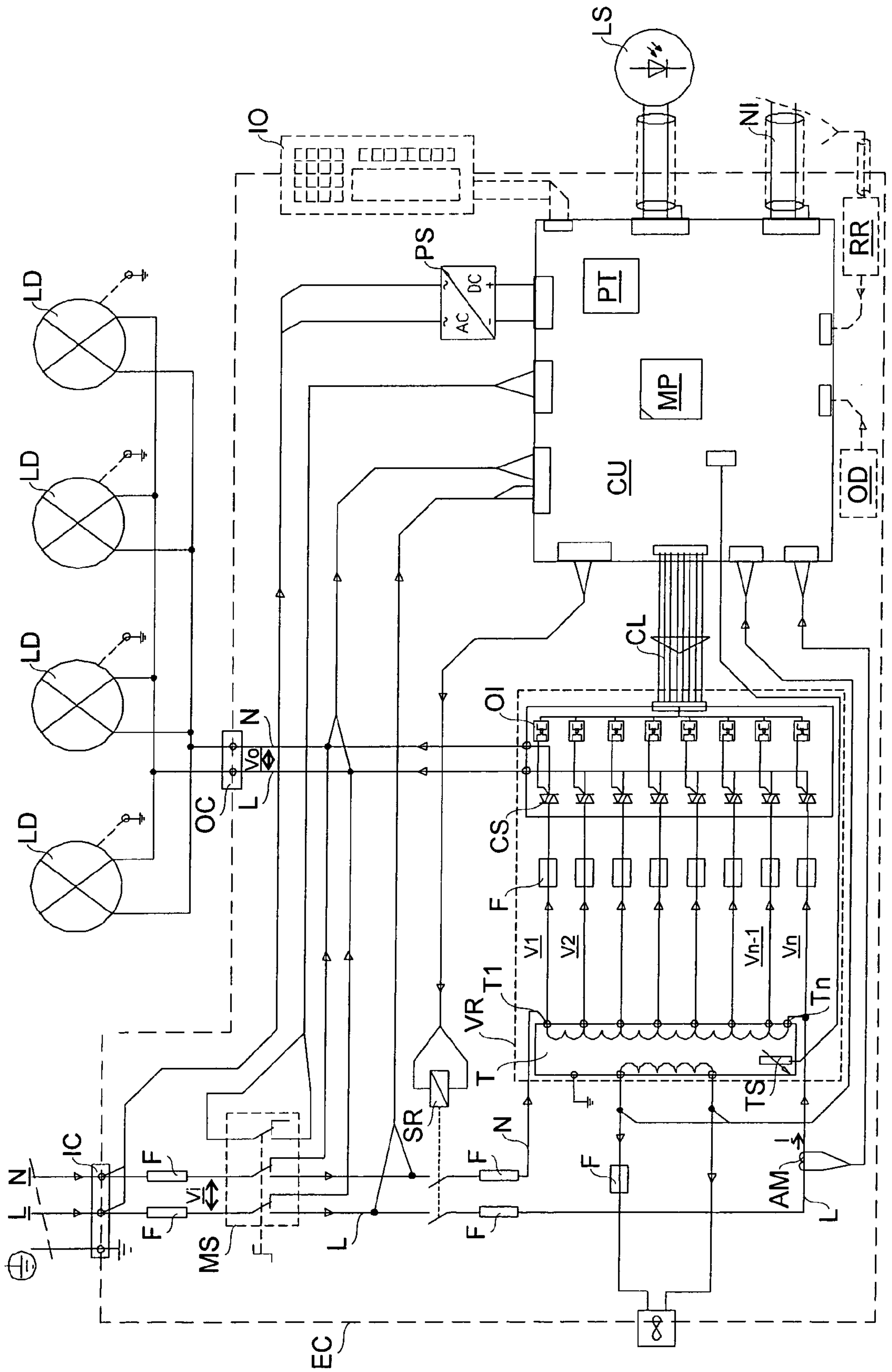
9. Process according to the previous claim, **characterized by** the following further operating step:

- if the current phase (I) is greater than the maximum value (Imax) the control unit (CU) signals through input/output means (IO) the excessive current input and stores this fault in an error variable (Ierr).

10. Process according to the claim 8 or 9, **characterized by** the following further operating step:

- if the current phase (I) is not greater than the maximum value (Imax) the control unit (CU) turns off the error variable (Ierr) and deactivates the fault signal in the input/output means (IO).
- se la corrente di fase (I) non è maggiore del valore massimo (Imax) l'unità di controllo (CU) azzera la variabile di errore (Ierr) e disattiva il segnale di anomalia nei mezzi di ingresso/uscita (IO).

11. Process according to one of claims 5 to 10, **characterized in that** the control unit (CU) repeats periodically this process.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Vo
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V1
V2
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T1
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Fig.1

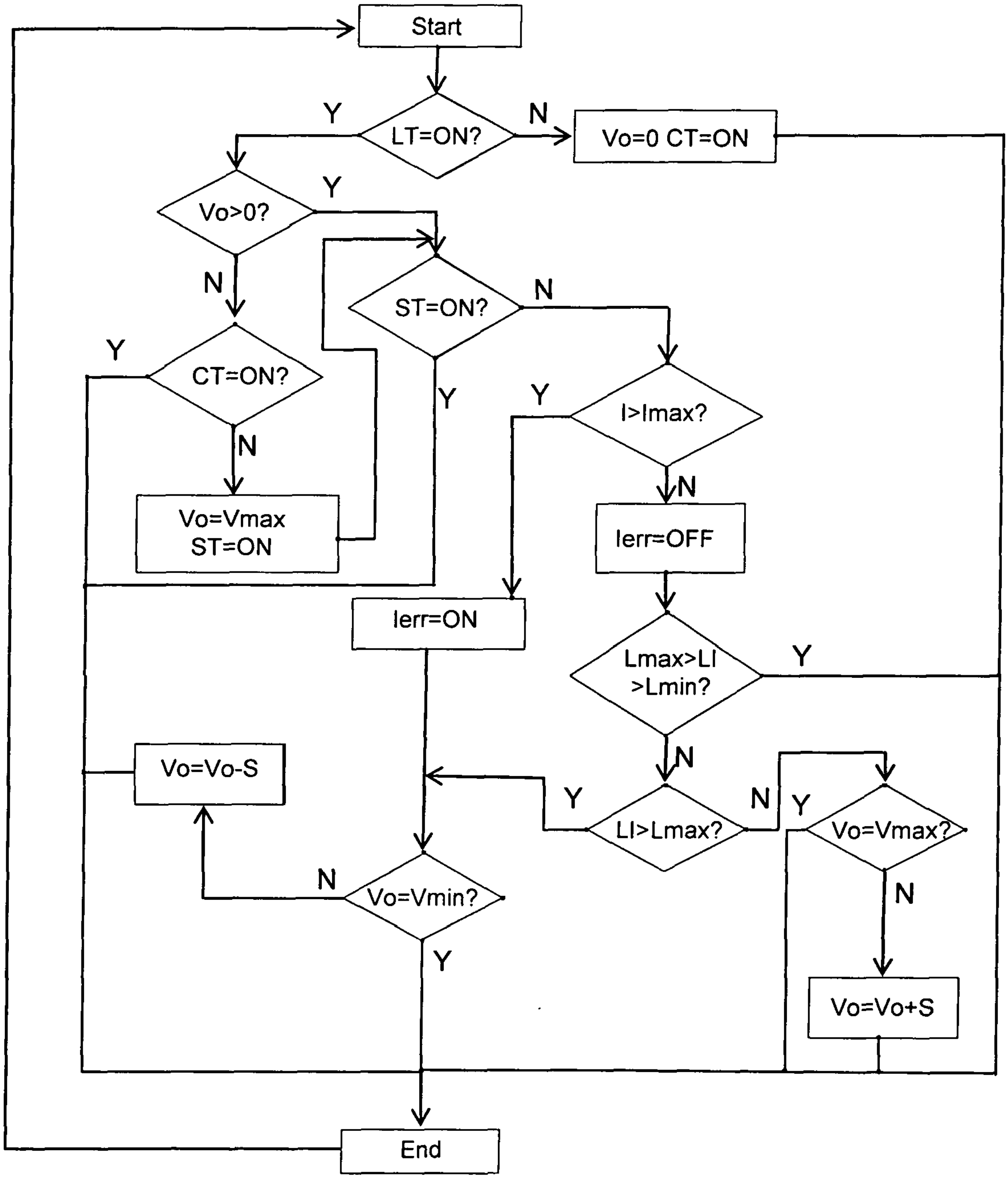
Start
LT=ON?
Y
N
Vo=0 CT=ON
Vo>0?
Y
N
ST=ON?
N
Y
CT=ON?
N
Vo=Vmax
ST=ON
Y
I>Imax?
N
Ierr=OFF
Ierr=ON
Lmax>Ll
>Lmin?
Y
N
Vo=Vo-S
Y
Ll>Lmax?
N
Y
Vo=Vmax?
N
Vo=Vmin?
Y
Vo=Vo+S
End

Fig.2

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EUROPEAN SEARCH REPORT

Application Number
EP 08 42 5482

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	EP 1 318 702 A (BOB HAMMER SYSTEMS SOLUTIONS S [CH]) 11 June 2003 (2003-06-11) * paragraphs [0001] - [0065] * * paragraphs [0116] - [0119]; figures 1,2 *	1-4 5-11	INV. H05B41/40
X Y	WO 02/065630 A (ENERGY SAVING 2000 S A [CH]; FORGHIERI ANTONIO [IT]) 22 August 2002 (2002-08-22) * the whole document *	1,3 5-11	
Y	US 2005/110416 A1 (VESKOVIC DRAGAN [US]) 26 May 2005 (2005-05-26) * paragraphs [0056] - [0086]; figures 1-5 * * paragraphs [0087] - [0099]; figures 6,7a-7c *	5-7,11	
Y	WO 2006/046264 A (VARESI SILVANO [IT]) 4 May 2006 (2006-05-04) * page 8, line 1 - page 9, line 2 *	8-10	TECHNICAL FIELDS SEARCHED (IPC)
A	US 6 191 568 B1 (POLETTI FRANCO [CA]) 20 February 2001 (2001-02-20) * column 1, lines 33-42 * * column 8, lines 20-47 *	7	H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 January 2009	Ferla, Monica

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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2

EPO FORM 1503 03.82 (P04C01)

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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13-01-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1318702 A	11-06-2003	AT 357838 T	15-04-2007
		AU 2002358624 A1	09-07-2003
		DE 60219066 T2	13-12-2007
		WO 03055283 A1	03-07-2003
WO 02065630 A	22-08-2002	CH 697215 A5	25-06-2008
		IT RM20010073 A1	13-08-2002
US 2005110416 A1	26-05-2005	US 2007211446 A1	13-09-2007
		US 2007211447 A1	13-09-2007
WO 2006046264 A	04-05-2006	EP 1897421 A1	12-03-2008
US 6191568 B1	20-02-2001	CA 2259055 A1	14-07-2000

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