



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.06.2009 Bulletin 2009/23

(51) Int Cl.:
H05B 41/288 (2006.01)

(21) Application number: **08168253.6**

(22) Date of filing: **04.11.2008**

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

- **Pereira, Eduardo**
8050 Zürich (CH)
- **Huber, Martin**
8854 Siebnen (CH)
- **Horn, Frank**
8767 Elm (CH)

(30) Priority: **16.11.2007 DE 102007054806**

(71) Applicant: **TridonicAtco Schweiz AG**
8755 Ennenda (CH)

(72) Inventors:
• **Zimmermann, Michael**
8888 Heiligkreuz (CH)

(74) Representative: **Rupp, Christian et al**
Mitscherlich & Partner
Patent- und Rechtsanwälte
Sonnenstrasse 33
80331 München (DE)

(54) **Operating circuit for series-connected light-generating means, in particular for HID gas-discharge lamps**

(57) The invention relates to a circuit arrangement for operating at least two series-connected gas-discharge lamps (LA1, LA2), in particular HID lamps, which have the same operating current flowing through them. In order to even out differing brightness values and colours of the light emitted by the lamps, caused by power

consumptions of the lamps that differ from one another, it is proposed that for each pair of lamps (LA1, LA2) connected to one another, a balance unit (11) is provided which additionally supplies a current to a junction-point (P) between the two lamps (LA1, LA2) or draws off a partial current from this junction-point (P).

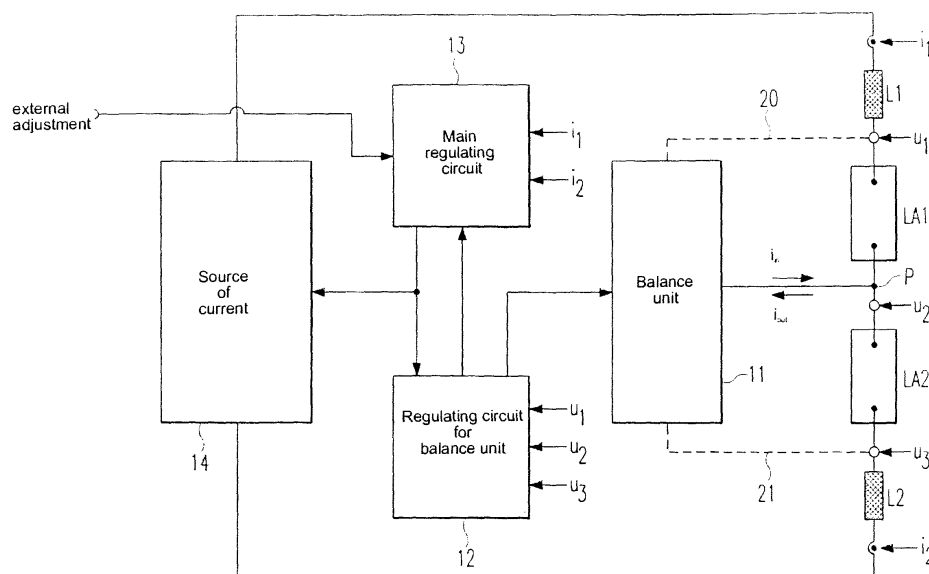


Fig. 1

Description

[0001] The invention relates to a circuit arrangement for operating at least two series-connected gas-discharge lamps or other light-generating means, in particular HID lamps, which have the same operating current flowing through them.

[0002] Normally several gas-discharge lamps, particularly when it is a question of HID lamps (HID = high-intensity discharge), are operated with an operating device only in parallel connection. Examples of this are described DE 198 16 815 C1, DE 39 25 654 C2 and US 7,164,237 B2.

[0003] Gas-discharge lamps, in particular HID lamps, frequently differ from one another in their power consumption, even when it is a question of lamps of the same type or of the same production batch. The causes are mostly differing rates of ageing or production tolerances. Whereas in the case of fluorescent lamps this is not normally a problem, in the case of HID lamps differing power consumptions have the effect that the light of these lamps differs perceptibly in brightness and colour.

[0004] The object underlying the invention is to create a circuit arrangement with which it is possible to balance also series-connected light-generating means - such as gas-discharge lamps, for example - that have the same operating current flowing through them.

[0005] In accordance with the invention, the object is achieved by a balance unit for series-connected light-generating means (lamps) being provided which in addition purposefully or in a directed manner supplies a current to a junction-point between the two lamps or draws off a partial current from this junction-point.

[0006] By virtue of the solution according to the invention, it is possible that to supply, to that one of two lamps connected to one another in series which has the lower power consumption, an additional current which increases the power consumption of this lamp and matches it to the power consumption of the other lamp. Conversely, it is also possible that the balance unit a fraction is branched off from the operating current flowing through the lamps jointly before the operating current flows through the lamp having the higher power consumption. As a result, the power consumption of this lamp is reduced and matched to the power consumption of the other lamp.

[0007] The present invention relates, according to one aspect, to a process for operating at least two series-connected light-generating means, in particular gas-discharge lamps, which are fed (after starting) with a low-frequency operating current (alternating current), wherein a current is purposefully supplied to a junction-point between the two lamps in addition to the AC operating current, or a partial current is drawn off from this junction-point.

[0008] "Low-frequency" in the sense of the invention presently being described is to be understood to mean significantly lower than the HF drive, within the kHz range

or even below, which is known from the state of the art. Preferably as low-frequency is below 1 kHz, still more preferred below 200 Hz or below 100 Hz.

[0009] The term "operating current" is to be understood to mean the lamp current flowing after starting.

[0010] A further development of the invention may consist in the fact that the operating current is an AC operating current which is generated by a DC/AC converter that is constructed as a bridge circuit with at least two switch elements, the one bridge diagonal of which is connected to a source of DC voltage, furthermore in the fact that the balance unit contains a series circuit consisting of at least two components, which is likewise connected to the source of DC voltage, in the fact that one of the components forming the series circuit of the balance unit is a further switch element, and in the fact that the nodal point of the components forming the series circuit of the balance unit and the nodal point of the two lamps in question are optionally connected to one another by means of a further component.

[0011] By way of DC/AC converter, a bridge circuit with four switch elements preferably finds application, wherein in each instance the two switch elements connected to the same pole of the source of DC voltage have an opposite-sense switching state. A bridge circuit that has these properties but that hitherto has been used only for the purpose of operating a single HID lamp is described in EP 1 114 571 B1.

[0012] Another further development may consist in the fact that information about deviations of the actual power consumption from the rated power consumption of the two lamps in question is supplied to each balance unit, which the balance unit evaluates for the purpose of dimensioning the supplied or diverted current. The information may be generated by measurement of the drops in voltage across the lamps.

[0013] A first embodiment of the balance unit may consist in the fact that the other component forming the series circuit of the balance unit is a diode which is switched in the reverse direction.

[0014] A further embodiment of the balance unit may consist in the fact that the other component of the series circuit contained in the balance unit is likewise a switch element.

[0015] The optionally present further component, which connects the nodal point of the series circuit in the balance unit and the nodal point of the lamps in question, may be an inductor.

[0016] For the purpose of configuring the balance unit, it is further proposed that the switch elements contained therein are clocked by continuous opening and closing for the purpose of dimensioning the supplied or diverted current, wherein the clock frequency and/or the clock ratio and/or the clock mode (opening or closing) is/are variable.

[0017] An additional advantage of the balance unit is that it can become active as a starting-aid in the starting-phase, wherein its inductor with capacitors contained in

the circuit arrangement, and optionally with further inductors, forms an oscillating circuit at which, given an appropriate clock frequency, an increase occurs in the resonance of the voltage of the oscillating circuit, bringing about starting.

[0018] Also in the warm-up phase the balance unit can become active in an assisting manner by supplying or diverting current in order to stabilise the lighting process.

[0019] Another further development of the invention may consist in the fact that the balance unit interacts with a main regulating circuit for adjusting and regulating the total power output of the lamps, in such a manner that, when required, the total power output is increased in order to guarantee that the balance unit can only divert current, which is the case when the series circuit of the balance unit - as specified above - consists of a switch element and a diode.

[0020] An advantage of the circuit arrangement according to the invention further consists in the fact that the balance unit has to be designed only for a relatively small fraction of the total power output of the lamps. If the total power output of the lamps is, for example, 140 watts, the balance unit needs to have, for example, a power of only 10 to 15 watts. As a result, in the case of the balance unit a loss-free switching is not necessary.

[0021] As a supplementary feature, an advantage of the series connection of HID lamps will also be pointed out. A bus voltage within the range of 400 V is frequently available by way of supply voltage for HID lamps. If each HID lamp has a rated voltage of 100 V, the voltage demand in the case of two series-connected lamps is approximately 200 V. In this case, the converter - which, if a low-frequency switching period is considered, preferably constitutes a buck converter - can be operated with an advantageous clock ratio of 50 %.

[0022] Exemplary embodiments of the invention will be described below with reference to the drawings.

Shown are:

[0023]

- Fig. 1 a system block diagram which represents the invention;
 Figs. 2a and 2b an embodiment, in concrete form, of the circuit according to the invention, in two consecutive operating phases;
 Fig. 3 an alternative embodiment of the balance unit.

[0024] The block diagram according to **Fig. 1** shows two light-generating means ('lamps') LA1 and LA2 which are connected in series together with, respectively, an inductor L1, L2. The series circuit is supplied with alternating current by a source of current 14. The source of current 14 may be, for example, a DC/AC converter. The DC voltage may be a rectified mains voltage or it may be

transferred to the converter 14 by a bus line from a central station.

[0025] The lamps LA1 and LA2 are preferably gas-discharge lamps, in particular so-called HID (high-pressure) lamps. The latter can also be operated with direct current. Preferably, however, a low-frequency alternating current is used by way of operating current, in order to guarantee that the electrodes do not burn out unevenly. A further advantage of low-frequency or high-frequency alternating current is that current limitation can be effected by means of chokes. The chokes are represented in the present case by the inductors L1 and L2.

[0026] The total power consumption of the lamps is determined by a main regulating circuit 13, the parameters of which can be adjusted externally. To this end, the main regulating circuit 13 receives information about the current flowing in the series circuit of the lamps LA1, LA2 from two current-measuring points. The currents measured by these measuring-points are i_1 and i_2 . The fact that two current-measuring points are provided has its origin in the function of the balance unit 11, which will be elucidated later.

[0027] The main regulating circuit 13 evaluates the measured signals concerning the current in the series circuit of the lamps LA1 and LA2 and generates a control signal that is supplied to the source of current 14. If the source of current 14 is a DC/AC converter, the current generated by the source of current 14 can be controlled by the clock frequency and/or the clock ratio for the switching of the converter being influenced.

[0028] If the two lamps LA1 and LA2 are of the same type but - owing to manufacturing tolerances or to a varying rate of ageing - display an unequal power consumptions, regardless of the fact that they have the same current flowing through them. The differing power consumption has the consequence that the drop in voltage across the two lamps LA1 and LA2 is unequal. For a matching of the power consumptions of the two lamps LA1 and LA2, advantage is taken of the last-named fact, i.e. the voltages are measured at three points in the series circuit and in this manner three voltage u_1 , u_2 and u_3 , measured against a reference potential, are obtained. The difference of u_2 and u_1 yields the drop in voltage across lamp LA1. The difference between the voltage u_3 and u_2 yields the drop in voltage across lamp LA2. The three measured voltages u_1 , u_2 and u_3 are supplied to a regulating circuit 12 for the balance unit 11. The regulating circuit 12 further receives from the main regulating circuit 13 an item of information about the clock pulse with which the source of current 14 switches over the polarity of the current supplied to the series circuit of the lamps LA1 and LA2.

[0029] From the information supplied to the regulating circuit 12 the regulating circuit generates a control signal for the balance unit 11. The balance unit 11 generates a current which is supplied to the nodal point P between the two lamps LA1 and LA2, or it draws off a partial current from this nodal point P.

[0030] The balance unit 11 accordingly acts either like

a source of current or like a current sink. The supply or the removal of current is indicated by the arrows in question, having the labels i_{in} and i_{out} .

[0031] The function of the balance unit 11 will now be elucidated as follows. In this connection let it be assumed that the power consumption of the lamp LA1 and hence the drop in voltage across this lamp are lower than the power consumption of the lamp LA2 and hence also the drop in voltage across this lamp. In order to match the lamps to one another, there are two possibilities. The first possibility is that an additional current is conducted through the lamp LA1. The second possibility consists in the fact that - if the operating current is flowing from LA1 in the direction towards LA2 - a fraction of the operating current is branched off at the nodal point P, so that a reduced operating current flows through the lamp LA2.

[0032] The further function of the balance unit 11 will be described in still more detail later with reference to Figs. 2a and 2b.

[0033] If the balance unit 11 is active in the manner previously described, the currents i_1 and i_2 at the two measuring-points of the series circuit of the lamps LA1 and LA2 differ. Since the main regulating circuit 13 regulates the total current, it is necessary that it measures the operating current after the supply of current if the balance unit 11 is working as a source of current. If, on the other hand, the balance unit is working as a current sink, the operating current has to be measured before a partial current is branched off from it. This may be in the one current direction i_1 and in the other current direction i_2 or conversely.

[0034] Figs. 2a and 2b show a circuit arrangement in concrete form with a DC/AC converter which converts a DC operating voltage into an alternating current. The circuit arrangement includes a bridge with four bridge arms 1 to 4 and with four diagonal points 5 - 8 as well as two bridge diagonals 9 and 10. Each bridge arm 1 to 4 contains a switch S1 - S4. Instead of one or both of the switches S3 and S4, however, capacitors can also be inserted into the bridge arms 3 and 4.

[0035] The positive pole of the DC voltage is situated at diagonal point 5, and the negative pole is situated at diagonal point 6. The switches S1 - S4 or only S1 and S2 are switched continuously, in each instance the switches connected to a pole of the source of DC voltage having an opposite-sense switching state. The switching frequency is relatively low and typically amounts to 100 Hz.

[0036] Fig. 2a shows a first of two operating phases caused by the switching, in which switches S1 and S4 are open and in which switches S2 and S3 are closed or clocked. In the following operating phase, which are represented in Fig. 2b, switches S1 and S4 are closed or clocked, whereas switches S2 and S3 are open.

[0037] In order to be able to control the alternating operating current that is generated, in the operating phase according to Fig. 2a in addition switch S2 is clocked with a frequency that is considerably higher than the switching

frequency, for example 50 kHz. In the following operating phase according to Fig. 2b, switch S1 is clocked. The clocking of the switches S1 and S2 is indicated by the curved double-headed arrow. During the clocking of one of the switches, in each instance the integrated free-wheeling diode ('body diode') of the other switch is utilised for the purpose of forming a freewheeling path during the phase in which the clocked switch is open.

[0038] The series circuit consisting of the lamps LA1 and LA2 and also the associated inductors L1 and L2 is situated in the bridge diagonal 10 between diagonal points 7 and 8.

[0039] The inductor L2 is provided with a tap which is connected to the terminals of two capacitors C2 and C3. The other terminal of the capacitor C2 is situated at the nodal point P between the two lamps LA1 and LA2. The other terminal of the capacitor C3 is situated at the diagonal point 6, i.e. at the negative pole of the source of DC voltage. The series circuit consisting of lamp LA2 and inductor L2 is, in addition, bridged by a capacitor C1.

[0040] As already mentioned, the two switches S3 and S4 which are switched at only low frequency may also be replaced by capacitors. These capacitors can enable both the desired blocking action and, upon activation of the corresponding diagonal, the transmission action. In advantageous manner the two switches S1 and S2 are interconnected with additional diodes, in order to block the integrated freewheeling diodes and to replace them with faster diodes.

[0041] As mentioned in the introduction, the basic principle of the bridge converter which is employed here according to EP 1 114 571 B1 is known. The content of this printed publication is intended to pertain to the disclosure of this application. Therefore it will not be explained more precisely what function the capacitors C1-C3 have. Let it be noted only that they, on the one hand, contribute to the formation of a resonant circuit for the starting and, on the other hand, have an interference-suppression function.

[0042] The capacitor C1 serves in this case for filtering and smoothing the current through the lamps LA1 and LA2, above all in order to enable an operation of the switches S1 and S2 that is as low-loss as possible. During the high-frequency clocking of a switch in each instance, the switch is switched on whenever the current through the inductor L1 attains its minimum, in order to be able to minimise the switching losses. The minimum in this case is preferably close to the zero level or a little below.

[0043] Since the current through the lamps LA1 and LA2 is to be kept as constant as possible, the capacitor is utilised as a filter element, in order to store energy for smoothing the current through the lamps LA1 and LA2. The capacitor C1 may also be arranged differently in the circuit; what is important is that it is able to smooth the current through the lamps LA1 and LA2.

[0044] The capacitors C2 and C3 serve, above all, for starting the lamps LA1 and LA2. Jointly with the inductor L2 they form one or more resonant circuits which, for

example, can be excited by high-frequency alternating clocking of switches S3 and S4 by utilising the step-up in resonance. But it is also possible to realise the starting of the lamps LA1 and LA2 by means of a different starting-circuit. For example, via a second winding on the inductor L2 the starting-voltage can be generated in this inductor by applying a voltage that is clocked at high frequency.

[0045] In this manner, operation of the lamps LA1 and LA2 with a low-frequency alternating voltage can be obtained, wherein the current through the lamps LA1 and LA2 during a low-frequency switching period can be kept very constant.

[0046] The balance unit 11 forms the bridge diagonal 9. It accordingly extends between diagonal points 5 and 6 and hence also between the poles of the source of DC voltage.

[0047] In the present case the balance unit 11 consists of two further switch elements S5 and S6 and also an inductor L3 which connects the nodal point of the two switch elements S5 and S6 to the nodal point P of the two lamps LA1 and LA2. In the operating phase according to Fig. 2a, switch S6 is closed and switch S5 is open. In the following operating phase according to Fig. 2b, switch S6 is open, whereas switch S5 is closed.

[0048] The regulating circuit for the balance unit 11, which is likewise represented in Figs. 2a and 2b, and the main regulating circuit 13 have already been elucidated in connection with Fig. 1. A further description will therefore be dispensed with. The same for a number of other details which likewise have already been described in connection with Fig. 1.

[0049] It remains to add that each switch S1-S6 can also be bridged additionally by a freewheeling diode, particularly when it is a question of field-effect transistors. For the sake of clarity, merely one freewheeling diode D1 is indicated, which bridges switch S1.

[0050] Now for the more detailed description of the function of the balance unit 11.

[0051] In Fig. 2a the balance unit 11 is acting as a current sink. The operating current i_0 flows here from the positive pole of the source of DC voltage, i.e. from diagonal point 5 through the closed switch S3, the inductor L2 and the lamp LA2. At the nodal point P between the two lamps LA1 and LA2 a partial current i_b is branched off by the balance unit 11, which flows off through the inductor L3 and the closed switch S6 to the negative pole of the source of DC voltage, that is to say, to the diagonal point 6. Accordingly, through the lamp LA1 there flows a differential current i_d , reduced by the branched-off partial current i_b , which passes through the lamp LA1 and flows through the inductor L1 and the closed switch S1 and the closed switch S2 onward to the negative pole of the source of DC voltage, and hence to the diagonal point 6. In this manner the current flowing through the lamp LA1 is lower than the current flowing through the lamp LA2, and in this manner it is possible to compensate a lower power consumption of the lamp LA2 in comparison with the lamp LA1.

[0052] After switching of the switches S1 - S6, the operating current changes its direction of flow. That in Fig. 2b represented. In order, here too, again to compensate a lower power output of the lamp LA2 in comparison with the lamp LA1, the balance unit 11 now acts as a source of current. To the operating current i_0 coming from the positive pole of the source of DC voltage - that is to say, from the diagonal point 5 - which flows through the closed switch S1, the inductor L1 and the lamp LA1, a balance current i_b is added at the nodal point P. This balance current i_b comes from the positive pole of the source of DC voltage, that is to say, from diagonal point 5, flows through the closed switch S5 and the inductor L3 to the nodal point P. To the lamp LA2 a sum current i_s is accordingly supplied which flows through this lamp and furthermore passes through the inductor L2 and also the closed switch S4, in order then to flow to the negative pole of the source of DC voltage, that is to say, to the diagonal point 6. The sum current i_s is accordingly greater by the balance current i_b than the original operating current i_0 . As a result, the power consumption of the lamp LA2 is increased.

[0053] The compensating function of the balance unit 11 is monitored and regulated - as has already been described in connection with Fig. 1 - by measurement of the three voltages u_1 , u_2 and u_3 .

[0054] The balance unit (11) may be capable of being switched selectively in parallel with at least one of the lamps (LA1, LA2), in order to bridge the lamp(s), for example in the event of a defect of a lamp.

[0055] It is not obligatory that the balance unit 11 consists of switch elements. **Fig. 3** shows the possibility that the switch element S5 is replaced by a diode DX which is polarised in the reverse direction. In this case the balance unit 11 acts as a current sink. Its action has to be assisted by the main regulating circuit 13, which has to increase the total power consumed by the lamps LA1 and LA2 correspondingly.

[0056] The starting of the lamps LA1 and LA2 can also be effected by means of one or more additional starting-circuits. For example, a starting-transformer can be used in order to achieve a sufficiently high voltage at the lamps LA1 and LA2. In a starting-circuit of such a type at least one further switch may be present, which more advantageously excites or at least activates the starting-circuit at a high frequency. For operation after starting, as already elucidated, above all the two switches S1 and S2 are necessary; moreover, the inductor L2 and capacitor C1 are required for low-frequency operation of the lamps LA1 and LA2.

Claims

1. A circuit arrangement for operating at least two series-connected light-generating means, in particular gas-discharge lamps (LA1, LA2), which are fed by a low-frequency AC operating current,

characterised in that

a balance unit (11) is provided which in addition to the operating current supplies a current (i_b) in a directed manner to a junction-point (P) between the two lamps (LA1, LA2) or draws off a partial current (i_b) from this junction-point (P).

2. A circuit arrangement according to Claim 1,

characterised in that

the operating current is an alternating operating current which is generated by a DC/AC converter constructed as a bridge circuit with at least two switch elements, the one bridge diagonal of which is connected to a source of DC voltage,

in that the balance unit (11) contains a series circuit consisting of at least two components, which is likewise connected to the source of DC voltage,

in that one of the components forming the series circuit of the balance unit (11) is a further switch element (S5 or S6),

and **in that** the nodal point of the components forming the series circuit of the balance unit (11) and the nodal point (P) of the two lamps (LA1, LA2) in question are optionally connected to one another via a further component.

3. A circuit arrangement according to Claim 2,

characterised in that

the bridge circuit contains four switch elements (S1-S4), and **in that** in each instance the two switch elements (S1, S3 and S2, S4) connected to the same pole of the source of DC voltage have an opposite-sense switching state.

4. A circuit arrangement according to one of the preceding claims,

characterised in that

information about deviations of the actual power consumption from the rated power consumption of the two lamps (LA1, LA2) in question is supplied to each balance unit (11), which the balance unit (11) evaluates for the purpose of dimensioning the supplied or diverted current (i_b).

5. A circuit arrangement according to Claim 4,

characterised in that

the information is generated by measurement of the drops in voltage (u_3-u_2 , u_2-u_1) across the lamps (LA1, LA2).

6. A circuit arrangement according to one of Claims 2 to 5,

characterised in that

the other component forming the series circuit of the balance unit (11) is a diode (DX) which is connected in the reverse direction (Fig. 3).

7. A circuit arrangement according to one of Claims 2

to 5,

characterised in that

the other component contained in the series circuit of the balance unit (11) is likewise switch element (S5 or S6).

8. A circuit arrangement according to one of Claims 2 to 7,

characterised in that

the optionally present further component, which connects the nodal point of the series circuit in the balance unit (11) and the nodal point (P) of the lamps (LA1, LA2) in question, is an inductor (L3).

9. A circuit arrangement according to one of Claims 2 to 8,

characterised in that

the switch element(s) (S5, S6) contained in the balance unit (11) is/are clocked by continuous opening and closing for the purpose of dimensioning the supplied or diverted current (i_b), the clock frequency and/or the clock ratio and/or the clock mode (opening and then closing or conversely) being variable.

10. A circuit arrangement according to Claims 8 and 9,

characterised in that

in the starting-phase the balance unit (11) is active as an starting-aid, its inductor (L3) forming, with capacitors (C1-C3) contained in the circuit arrangement and optionally with further inductors (L1, L2), an oscillating circuit at which, given an appropriate clock frequency, a step-up of the resonance of the voltage of the oscillating circuit occurs, bringing about starting.

11. A circuit arrangement according to one of the preceding claims,

characterised in that

in the warm-up phase the balance unit (11) is active in an assisting manner by supplying or diverting current in order to stabilise the lighting process.

12. A circuit arrangement according to Claim 6,

characterised in that

the balance unit (11) interacts with a main regulating circuit (13) for the purpose of adjusting and regulating the total power output of the lamps (LA1, LA2), in such a manner that, when required, the total power output is increased in order to guarantee that the balance unit (11) can only divert current.

13. A circuit arrangement according to one of the preceding claims,

characterised in that

the main regulating circuit (13) and the regulating circuit (12) take the form of an integrated circuit, in particular an ASIC or microcontroller or hybrid circuit formed therefrom.

14. A circuit arrangement according to one of the preceding claims,
wherein the balance unit (11) is capable of being
selectively switched in parallel with at least one of
the lamps (LA1, LA2) in order to bridge the lamp(s). 5
15. A process for operating at least two series-connect-
ed light-generating means, in particular gas-dis-
charge lamps (LA1, LA2), which are fed by a low-
frequency operating current, 10
characterised in that
in addition to the operating current a current (i_b) is
supplied in a directed manner to a junction-point (P)
between the two lamps (LA1, LA2) or a partial current
(i_b) is drawn off from this junction-point (P). 15
16. A process according to Claim 15,
characterised in that
the supplying or drawing-off of a current (i_b) is effect-
ed by a balance unit (11). 20

25

30

35

40

45

50

55

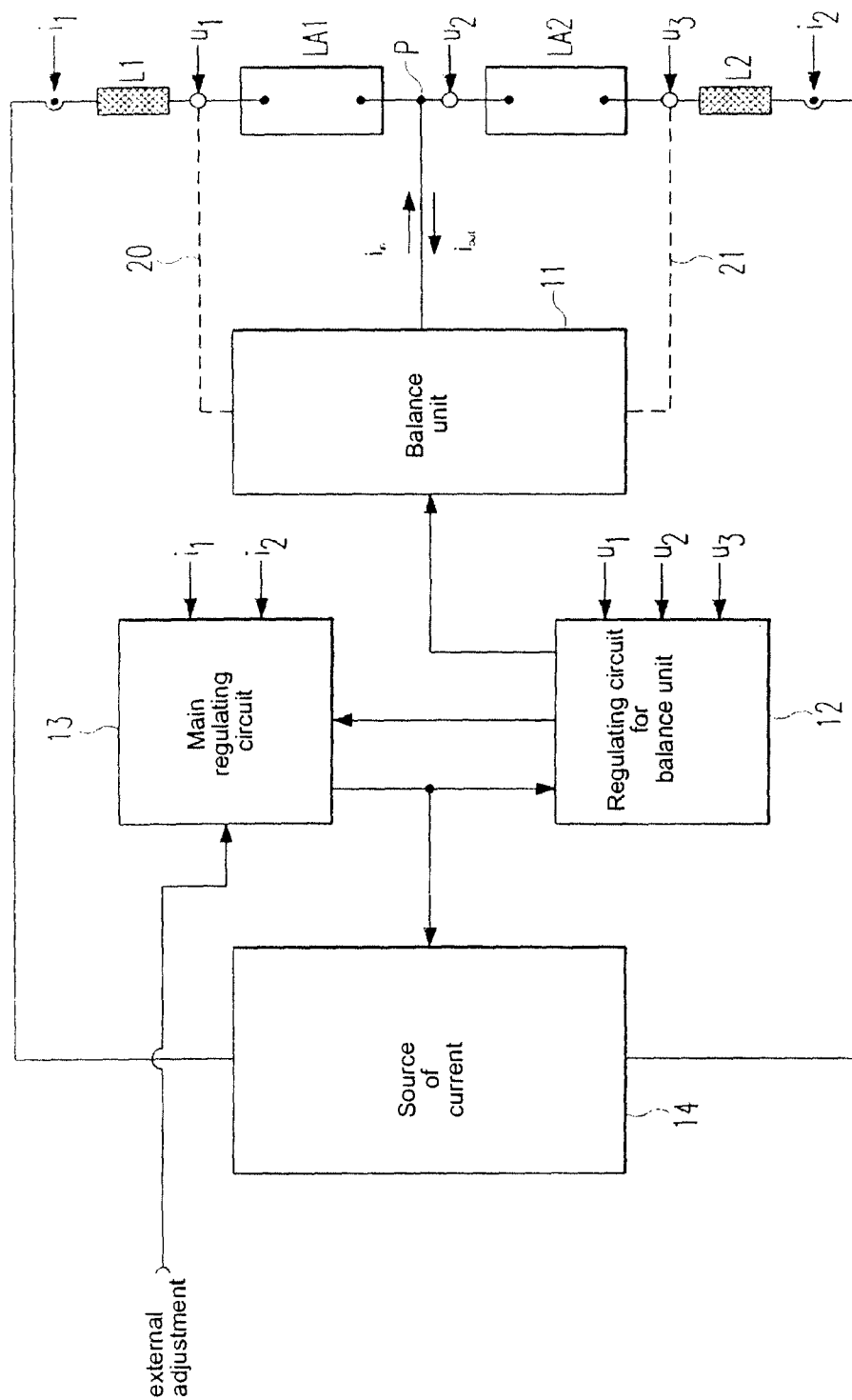


Fig. 1

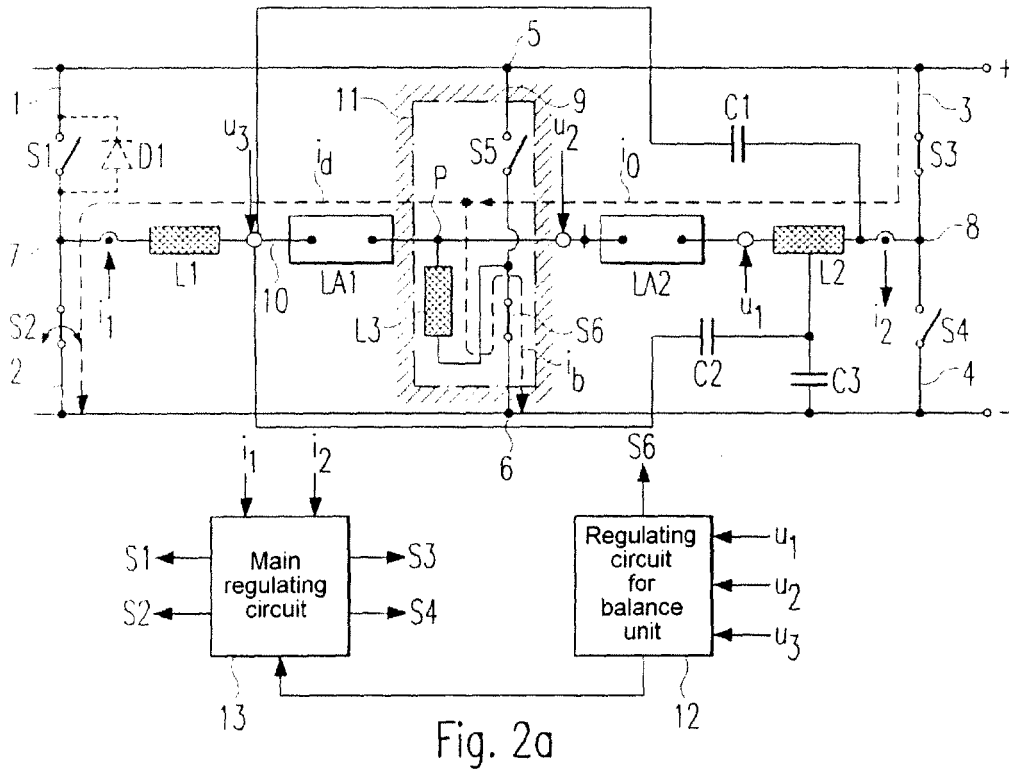


Fig. 2a

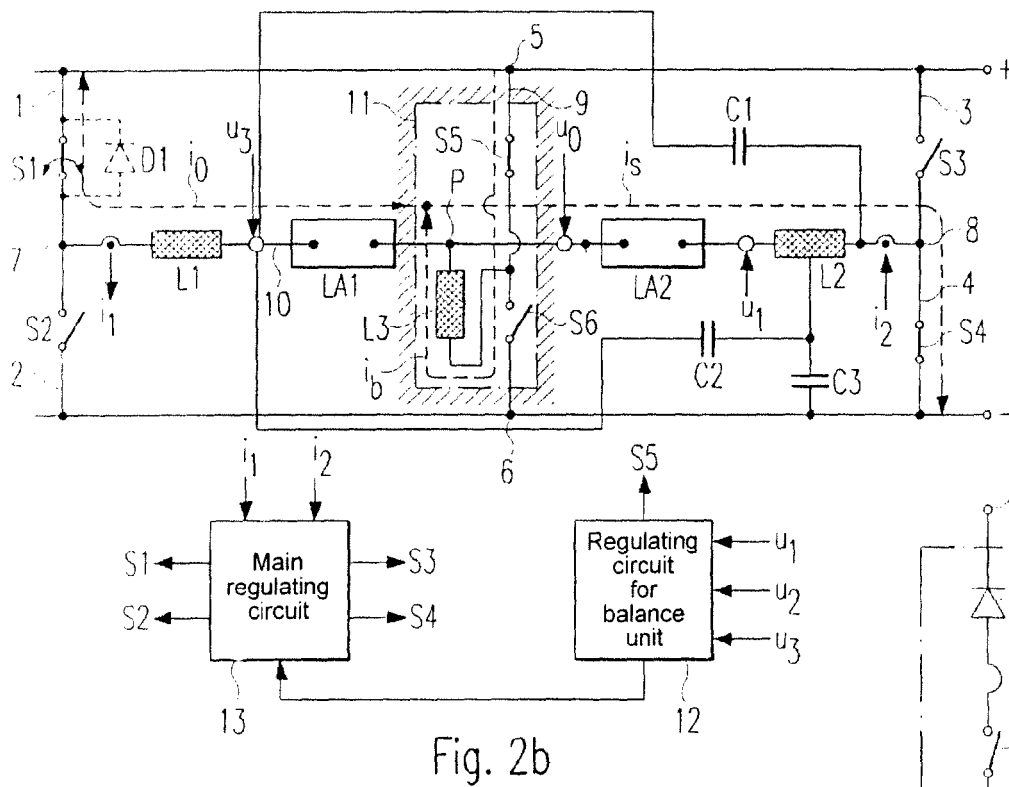


Fig. 2b

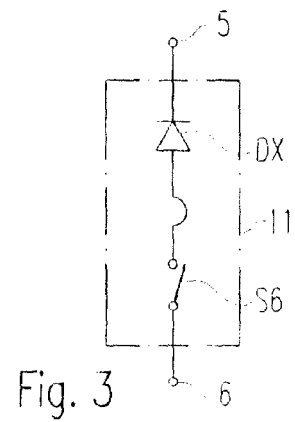


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 08 16 8253

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	GB 2 360 150 A (MICROLIGHTS LTD [GB]) 12 September 2001 (2001-09-12) * pages 16-18; figures 1,4 *	1,11,13, 15,16	INV. H05B41/288
X	WO 2004/057933 A (KONINKL PHILIPS ELECTRONICS NV [NL]; COUWENBERG WINSTON D [NL]; VAN CA) 8 July 2004 (2004-07-08) * pages 3-4; figure 1 *	1,15	
A	US 2002/125838 A1 (TSAI YING HSIEN [TW]) 12 September 2002 (2002-09-12) * pages 1-2; figure 5 *	1-16	
			TECHNICAL FIELDS SEARCHED (IPC)
			H05B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 March 2009	Examiner Morrish, Ian
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 16 8253

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-03-2009

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 2360150	A	12-09-2001	AU 3759601 A	17-09-2001
			EP 1262092 A1	04-12-2002
			WO 0167829 A1	13-09-2001
			US 2003117089 A1	26-06-2003

WO 2004057933	A	08-07-2004	AU 2003283736 A1	14-07-2004
			CN 1729729 A	01-02-2006
			JP 2006511051 T	30-03-2006
			US 2007007901 A1	11-01-2007

US 2002125838	A1	12-09-2002	NONE	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 19816815 C1 [0002]
- DE 3925654 C2 [0002]
- US 7164237 B2 [0002]
- EP 1114571 B1 [0011] [0041]