



(51) International Patent Classification:
H05B 41/285 (2006.01)

(21) International Application Number:

PCT/EP2011/065118

(22) International Filing Date:

1 September 2011 (01.09.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

201010298458.1

21 September 2010 (21.09.2010)

CN

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: BALLAST AND ILLUMINATION SYSTEM INCLUDING THE SAME

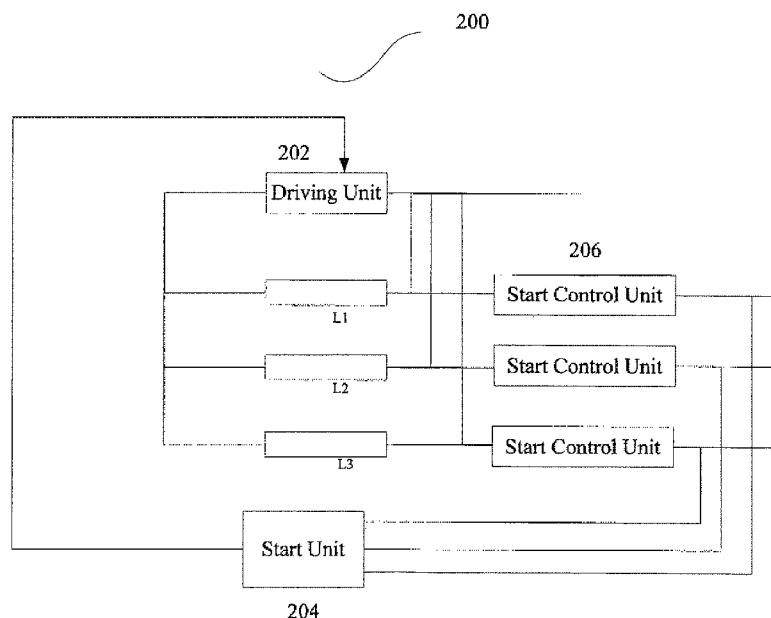


Figure 2

(57) Abstract: The present application provides a ballast and an illumination system including the same. The ballast includes at least two start control units, each configured to be connected with a corresponding lamp and output a start signal according to a state of the lamp; a start unit, configured to provide start signals from the at least two start control units to a driving unit; and the driving unit, configured to drive lamps according to the start signals from the start unit. Thus, the determination of whether each lamp in a plurality of lamps connected in parallel is normally working and an auto reset of each lamp after an impact protection are realized with a low cost.



Published:

— *with international search report (Art. 21(3))*

BALLAST AND ILLUMINATION SYSTEM INCLUDING THE SAME

Field of the Invention

5 [0001] The present invention relates to the field of electronics, in particularly, relates to a ballast and an illumination system including the ballast.

Background of the Invention

[0002] The ballast is a commonly used device and is widely used in various illumination systems.

10 [0003] In an illumination system including a plurality of lamps connected in parallel, the ballast typically can stabilize the voltage and limit the current. However, it is desired that the ballast can provide more additional functions, for example, determining whether a lamp is normally working and whether a driving voltage is to be provided, and implementing an auto-reset for each lamp after an impact protection.

15 [0004] Figure 1 shows a diagram of a ballast for an illumination system including a plurality of lamps connected in parallel in the prior art.

[0005] As shown in Figure 1, the ballast 100 includes a plurality of lamps L, a capacitor C connected with at least one of the lamps and a driving unit for driving the lamps.

20 [0006] As can be seen from Figure 1, when the lamp L connected with the capacitor C is not normally working (for example, the lamp is not correctly connected or the filament of the lamp is fused), the voltage across the capacitor is low because no current flow through the capacitor for charging. In this case, it can be determined that the lamp connected with the capacitor is not normally working.

[0007] In the illumination system including a plurality of lamps connected in parallel, it has been proposed that an application-specific integrated circuit (ASIC) is added to judging whether each lamp is normally working.

25 [0008] Moreover, in the case that an impact protection occurs, a protection circuit provides a high-level protection signal to the driving unit of the illumination system to make the driving unit stop the driving of the lamps. In this way, each lamp stops work and thus, the protection for each lamp is realized.

[0009] However, when an impact to the illumination system ends, a manual operation is required to reset the protection signal or the start signal to reset the illumination system.

Summary of the Invention

[0010] The following summary is a brief description of the present application so as to provide basic understanding of some aspects of the present application. It shall be understood that, the summary is not exhaustive and does not intend to limit key concepts or important aspects of the present application or define the scope of the present application. The summary only intends to provide some concept in a simple manner as a preamble of detailed embodiments as below.

[0011] An object of the present application is to provide a ballast which can judge whether each lamp in a plurality of lamps connected in parallel in an illumination system is normally working and can implement an auto reset after an impact protection with a low cost.

[0012] Another object of the present application is to provide an illumination system which includes a plurality of lamps and the above ballast. With the ballast in the illumination system, the determination of whether each lamp in a plurality of lamps connected in parallel is normally working and an auto reset of each lamp are realized with a low cost.

[0013] An aspect of the present application provides a ballast, including at least two start control units, each configured to be connected with a corresponding lamp and output a start signal according to a state of the lamp; a start unit, configured to provide start signals from the at least two start control units to a driving unit; and the driving unit, configured to drive lamps according to the start signals from the start unit.

[0014] Another aspect of the present application provides an illumination system, including at least two lamps connected in parallel and the above ballast.

[0015] With reference to the following detailed description of the embodiments and the drawings, the above and other benefits will be better understood.

Brief Description of the Drawings

[0016] The present invention may be better understood by referring to the description hereinafter in combination with the drawings, wherein in the drawings, the same or similar reference signs are used to indicate the same or similar components. All the drawings and the detailed description are included in the specification and constitute a part of the specification, and are used to further present examples to illustrate the preferred embodiments of the invention and explain the principles and advantages of the invention. Wherein:

[0017] Figure 1 shows a diagram of a ballast for an illumination system including a plurality of lamps connected in parallel in the prior art;

[0018] Figure 2 shows a diagram of a ballast for an illumination system according to an embodiment of the present application;

[0019] Figure 3 shows a diagram of an illumination system including the ballast according to an embodiment of the present application;

[0020] Figure 4 shows a diagram of a voltage comparing unit according to an embodiment of the

present application;

[0021] Figure 5 shows a diagram of a voltage comparing unit according to another embodiment of the present application; and

5 **[0022]** Figure 6 shows a connection of a voltage comparing unit according to an embodiment of the present application.

Detailed Description of the Embodiments

10 **[0023]** Hereinafter, the embodiments of the present invention will be described in combination with the drawings. In view of clearness and conciseness, not all the features of the practical embodiments are described in the description. However, it should be understood that many decisions specific to the embodiments need to be made during the development of any practical embodiments, so as to achieve the specific objects of the developer, and these decisions may vary to some extent according to different embodiments. Further, it should be understood that although the developing work may be rather complicated and time-consuming, it is only a routine job for those skilled in the art who benefit from the disclosure of the present invention.

[0024] It should be further pointed out here that in the drawings, only the device structure closely related to the solution of the present invention is illustrated in the drawings, and other details having little relation with the present invention is omitted, so as to avoid making the present invention unclear due to unnecessary details.

20 **[0025]** Figure 2 shows a diagram of a ballast for an illumination system according to an embodiment of the present application.

[0026] As shown in Figure 2, the ballast 200 according to the embodiment of the present application includes: three start control units 206, a start unit 204 and a driving unit 202. In Figure 2, reference signs L1-L3 represent lamps.

25 **[0027]** Particularly, lamps L1-L3 may be of the same type or different type. Each lamp may be any suitable light-emitting device such as fluorescent lamp, incandescent lamp and LED lamp.

[0028] As shown in Figure 2, each start control unit 206 may correspond to a lamp. The start control unit 206 may be connected with corresponding lamp and provide a signal in connection with the electrical potential of the lamp to the start unit 204.

30 **[0029]** Meanwhile, the signal in connection with the electrical potential of the lamp may be a signal indicating the electrical potential of one side of the lamp. For example, as shown in Figure 2, the signal in connection with the electrical potential of the lamp may be a signal indicating the electrical potential of side of the lamp L1 which is connected with the start control unit 206.

[0030] The start control unit 206 may judge whether the lamp is normally working according to the signal in connection with the electrical potential of the lamp.

[0031] For example, when the lamp L1 is not normally working (such as the lamp is not correctly connected or the filament of the lamp is fused), the electrical potential at the side of the lamp L1 which is connected with the start control unit 206 is kept to 0 because no current flow in the loop including the lamp L1 and the driving unit 202.

[0032] On the other hand, for example, when the lamp L1 is normally working, in the loop including the lamp L1 and the driving unit 202, the electrical potential at the side of the lamp L1 which is connected with the start control unit 206 is not kept to 0. Thus, the start control unit 206 may determine that the lamp L1 is normally working according to the signal in connection with the electrical potential of the lamp L1 (i.e. according to the electrical potential at the side of the lamp L1 which is connected with the start control unit 206) and provide the start signal of high level to the start unit 204.

[0033] The start unit 204 may provides the start signals respectively corresponding to the lamps to the driving unit 202.

[0034] As an example, the driving unit 202 may be a transmission gate which is adapted to provide the start signals corresponding to the lamps from the start control units to the driving unit.

[0035] The driving unit 202 may drive the lamps according to the start signals corresponding to the lamps, respectively.

[0036] As an example, the driving unit 202 may be a known voltage source which is controlled by control signal and provides a driving voltage according to the control signal. For example, when a high level start signal is received, the driving voltage is provided and when a low level start signal is received, the driving voltage is not provided.

[0037] In an embodiment of the present application, when the start signal corresponding to the lamp is at low level, the driving unit stops to provide the driving voltage to the lamp; when the start signal corresponding to the lamp is at high level, the driving unit provides the driving voltage to the lamp.

[0038] As can be seen, the ballast according to the embodiment can judge whether each of the lamps connected in parallel is normally working, and stop to provide the driving voltage to the lamp when it is determined that the lamp is not normally working (for example, the filament of the lamp is disconnected, the lamp is not correctly connected).

[0039] Moreover, the embodiment as show in Figure 2 is merely an example and the present application is not limited thereto. For example, the number of lamps is not limited to 3 as shown in Figure 2 and may be any other number such as 2, 4, 5 and 6.

[0040] Additionally, in the ballast according to above embodiment, the start control unit may be
5 implemented as any suitable device.

[0041] For example, in an embodiment of the present application, the start control unit may be capacitor.

[0042] Figure 3 shows a diagram of an illumination system including the ballast according to an embodiment of the present application.

10 **[0043]** As shown in Figure 3, the ballast according to the embodiment of the present application includes: three capacitors C1-C3 connected with the three lamps L1-L3 respectively, a start unit 304 and a driving unit 302.

[0044] Particularly, the start unit 304 and the driving unit 302 are similar to the start unit 204 and the driving unit 202 as mentioned above and repeated descriptions thereof are omitted herein for concision.

15 **[0045]** As shown in Figure 3, in the embodiment, each capacitor is connected with corresponding lamp and the side of the lamp connecting with the capacitor is further connected to the start unit 304. The other side of each capacitor is grounded and the other side of each start unit 304 is connected to the driving unit 302.

[0046] As shown in Figure 3, with lamp L1 as an example, when the lamp L1 connecting with the
20 capacitor C1 is normally working, the potential at the side of the lamp L1 connecting with the capacitor C1 is not kept to 0 and is maintained at a high level. Thus, when the lamp L1 is normally working, the capacitor C1 provides a high level signal to the start unit 304 as the start signal.

[0047] The start unit 304 may provide the high level signal (i.e. the start signal of high level) to the driving unit to drive lamp L1.

25 **[0048]** On the other hand, when the lamp L1 connecting with the capacitor is not normally working (for example, the filament is fused, the lamp is not correctly connected), the side of the lamp L1 connecting with capacitor C1 is kept to 0. Thus, the side of the lamp L1 connecting with the capacitor C1 is kept to a low level and the capacitor provides the low level signal (i.e. the start signal of low level) to the driving unit.

[0049] Thus, the start unit 304 may provide the low level signal (i.e. the start signal of low level) to the driving unit to stop the driving of the lamp L1.

[0050] In this embodiment, due to the low cost of capacitor, whether each lamp in a plurality of lamps connected in parallel is normally working is judged with a low cost. Further, when it is determined that a lamp is not normally working (for example, the filament is fused, the lamp is not correctly connected), the driving voltage is not provided to the lamp.

[0051] Moreover, the embodiment as show in Figure 3 is merely an example and the present application is not limited thereto. For example, the number of lamps is not limited to 3 as shown in Figure 2 and may be any other number such as 2, 4, 5 and 6. Moreover, the start control unit (implemented as a capacitor in figure 3) may also be implemented in other manner.

[0052] For example, in another embodiment of the present application, the start control unit may be a voltage comparing unit. The voltage comparing unit may set the start signal to high level or low level according to the signal in connection with the electrical potential of the lamp (for example, the potential at the side of the lamp connecting to the voltage comparing unit).

[0053] Figure 4 shows a diagram of the voltage comparing unit according to the embodiment of the present application.

[0054] As shown in Figure 4, the voltage comparing unit may include a first resistor R1, a second resistor R2 and a PNP transistor.

[0055] The first resistor R1 and the second resistor R2 may be any type of resistor such as wire wound resistor and film resistor.

[0056] Moreover, the first resistor R1 and the second resistor R2 realize a voltage dividing processing.

[0057] As shown in Figure 4, one terminal of the first resistor R1 is provided with the signal in connection with the electrical potential of lamp (for example, the potential at the side of the lamp connecting to the voltage comparing unit) and other terminal of the first resistor R1 is connected to the second resistor R2.

[0058] As for the second resistor R2, one terminal is connected with the first resistor R1 and the other terminal is grounded.

[0059] In addition, the base of the PNP transistor is connected to the connecting point of the first

resistor R1 and the second resistor R2, the collector of the PNP transistor is grounded and the emitter of the PNP transistor is provided with the start signal.

[0060] As can be seen, when the lamp is normally working, the electrical potential at the side of the lamp connecting to the voltage comparing unit is not kept to 0, and the potential at the base of the PNP transistor after the voltage dividing by the first resistor R1 and the second resistor R2 is not equal to 0. Preferably, the potential at the base of the PNP transistor can be kept to a level higher than the level of the start signal by adjusting the resistances of the first resistor and the second resistor.

[0061] Thus, when the lamp is normally working, the PNP transistor is not turned on. Thus, the emitter of the PNP transistor is kept to a high level, i.e. outputting a high level start signal.

[0062] On the other hand, when the lamp is not normally working (for example, the filament of the lamp is fused, the lamp is not correctly connected), no current flows through the first resistor and the second resistor. Accordingly, the potential at the base of the PNP transistor is kept to 0. Thus, the high level start signal is changed to low level by discharging via the PNP transistor. In this way, the emitter of the PNP transistor is changed to a low level and the start signal is changed to low level.

[0063] In the embodiment, the resistor, the transistor and the capacitor are all low-cost devices, thus, whether each lamp in a plurality of lamps connected in parallel is normally working can be determined with a low cost. Further, when it is determined that a lamp is not normally working (for example, the filament is fused, the lamp is not correctly connected), the driving voltage is not provided to the lamp.

[0064] Moreover, the embodiment as shown in Figure 4 is merely an example and the present application is not limited thereto. For example, in another embodiment of the present application, only the second resistor R2 may be used so as to further reduce the cost of the ballast.

[0065] Furthermore, in the voltage comparing unit used as the start control unit, a device for enhancing performance may be included.

[0066] For example, in an embodiment of the present application, a leak-current suppression unit may be included in the voltage comparing unit so as to suppress the leak current in the PNP transistor.

[0067] In a detailed embodiment of the present application, the leak suppression unit may be a unilateral electric device. Figure 5 shows a diagram of a voltage comparing unit including a diode as the leak-current suppression unit according to another embodiment of the present application.

[0068] As shown in Figure 5, the diode D is connected to the emitter of the PNP transistor in the

same direction.

[0069] As can be seen, the diode can suppress the leak current in the PNP transistor and improve the reliability of the voltage comparing unit.

5 **[0070]** Additionally, the embodiment as shown in Figure 5 is merely an example and the present application is not limited thereto.

[0071] For example, in the voltage comparing unit according to an embodiment of the present application, the start signal and the protection signal may be provide to the emitter of the PNP transistor in parallel so as to realize an auto reset of the illumination system after the impact protection.

10 **[0072]** As known in the art, in order to prevent the illumination system from being damaged, a protection unit (not shown) may be included in the illumination system. The protection unit may protect the illumination system from being damaged in the case that an impact occurs because one or more lamp fails.

[0073] The protection unit may be any known suitable protection device such as over-voltage protection circuit and over-current protection circuit.

15 **[0074]** Particularly, when the protection unit finds an impact to the illumination system, the protection unit may provide a high level protection signal to the driving unit. When the driving unit receives the high level protection signal, the driving unit stops the driving of the lamp and thus the protection of the lamp is realized. However, when the impact ends, the protection signal needs to be reset manually so as to reset the lamp.

20 **[0075]** Figure 6 shows a connection of a start control unit according to an embodiment of the present application. By using the start control unit according to the embodiment, the auto reset of the lamp after the impact may be implemented.

[0076] As shown in Figure 6, the start control unit includes a voltage comparing unit including PNP transistor.

25 **[0077]** At the emitter of the PNP transistor included in the start control unit, a start signal and a protection signal are provided in parallel.

[0078] Particularly, the level of the protection signal is higher than that of the start signal. Preferably, the start signal and the protection signal are so configured that a high level which is able to make the start signal valid is an invalid low level for the protection signal.

[0079] The structure and components of the start control unit are the same as those described above and repeated descriptions thereof are omitted herein.

[0080] Particularly, when the lamp corresponding to the start control unit is normally working, the start signal keeps at a high level. In addition, when the protection unit does not find an impact to the illumination system, the protection signal output from the protection unit is kept to a low level.

[0081] When the illumination system suffers an impact, the protection unit finds the impact and provides a high level protection signal to the driving circuit. In this case, though the start signal is kept to a high level, the driving unit stops the driving of the lamp because the priority of the protection signal is higher than that of the start signal.

[0082] During the impact, the protection unit keeps the protection signal at a high level and the lamp is not driven though the start signal is kept at a high level.

[0083] When the impact ends, the protection unit does not output the high level protection signal and the level of the protection signal is lowered by discharging through the PNP transistor.

[0084] When the level of the protection signal is lowered to the level of the start signal, the protection signal becomes invalid and the start signal is valid. Thus, the driving unit drives the lamp according to the start signal.

[0085] When the lamp is normally working again, the PNP transistor is turned off. In this case, the start signal is valid and the protection signal becomes invalid.

[0086] Thus, by providing the start signal and the protection signal in parallel to the emitter of the PNP transistor in the start control unit as shown in Figure 6 and utilizing the discharging of the high level protection signal via PNP transistor, an auto reset of the illumination system is implemented.

[0087] In above embodiments, the start control unit may be implemented as capacitor or be implemented as voltage comparing unit, however, the above embodiments are merely examples and can be modified or combined in any suitable manner.

[0088] For example, in practice application, a part of the start control units may be capacitor while the other part of the start control units may be the voltage comparing unit including PNP transistor.

[0089] With an illumination system including 4 lamps connected in parallel as an example, two start control units corresponding to two lamps respectively may be capacitors while the other two start control units corresponding to the other two lamps respectively may be voltage comparing units.

[0090] Alternatively, in the above illumination system including 4 lamps connected in parallel, one start control unit corresponding to one lamp may be capacitor while the other three start control units corresponding to the other three lamps respectively may be voltage comparing units.

[0091] Additionally, embodiments of the present application also provide an illumination system which includes at least two lamps connected in parallel and a ballast according to any of the above embodiment.

[0092] With the ballast in the illumination system, the determination of whether each lamp in a plurality of lamps connected in parallel is normally working and an auto reset of each lamp are realized with a low cost.

[0093] Additionally, it should be understood that the above descriptions are all examples and the present application is not limited thereto. The embodiments may be combined with each other. Thus, the above embodiments do not construct any limit to the present application.

[0094] Finally, it should be noted that the term “include”, “comprise” or any other variations means a non-exclusive inclusion, so that the process, method, article or device that includes a series of elements includes not only these elements but also other elements that are not explicitly listed, or further includes inherent elements of the process, method, article or device. Moreover, when there is no further limitation, the element defined by the wording “include(s) a ...” does not exclude the case that in the process, method, article or device that includes the element there are other same elements.

[0095] The embodiments of the invention are described in detail in combination with drawings. However, it should be understood that the embodiments described above are only used for illustrating the invention, and do not constitute a limitation of the invention. Various modifications and variations may be made to the above embodiments by those skilled in the art, without departing from the essential and scope of the present invention. Therefore, the scope of the present invention is only defined by the appended claims and the equivalent meanings thereof.

CLAIMS

What is claimed is:

1. A ballast, comprising
at least two start control units, each configured to be connected with a corresponding lamp and output a start signal according to a state of the lamp;
a start unit, configured to provide start signals from the at least two start control units to a driving unit;
and
the driving unit, configured to drive lamps according to the start signals from the start unit.
2. The ballast according to claim 1, wherein, each start control unit comprises a voltage comparing unit.
3. The ballast according to claim 1, wherein, each start control unit comprises a capacitor.
4. The ballast according to claim 1, wherein, the at least two star control units comprise at least one voltage comparing unit and at least one capacitor.
5. The ballast according to any one of claims 1, 2 and 4, wherein, the voltage comparing unit comprises: a resistor and a PNP transistor, wherein, a terminal of the resistor is connected with a base of the PNP transistor and is provided with a signal in connection with a lamp potential, an emitter of the PNP transistor is provided with the start signal, and the other terminal of the resistor is connected with a collector of the PNP transistor.
6. The ballast according to claim 5, wherein, the voltage comparing unit further comprises a leak-current suppression unit configured to suppress a leak current of a transistor.
7. The ballast according to claim 6, wherein, the leak-current suppression unit comprises a diode connected with the emitter of the PNP transistor in the same direction.
8. The ballast according to claim 5, wherein, the emitter of the PNP transistor is provided with the start signal and the protection signal in parallel.
9. An illumination system, comprising at least two lamps connected in parallel and a ballast,
wherein, the ballast is the ballast according to any one of claims 1-8.

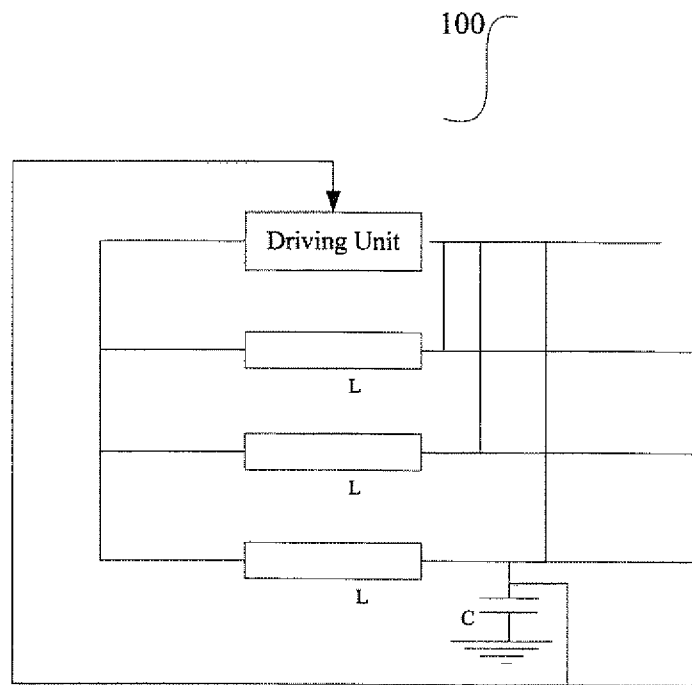


Figure 1

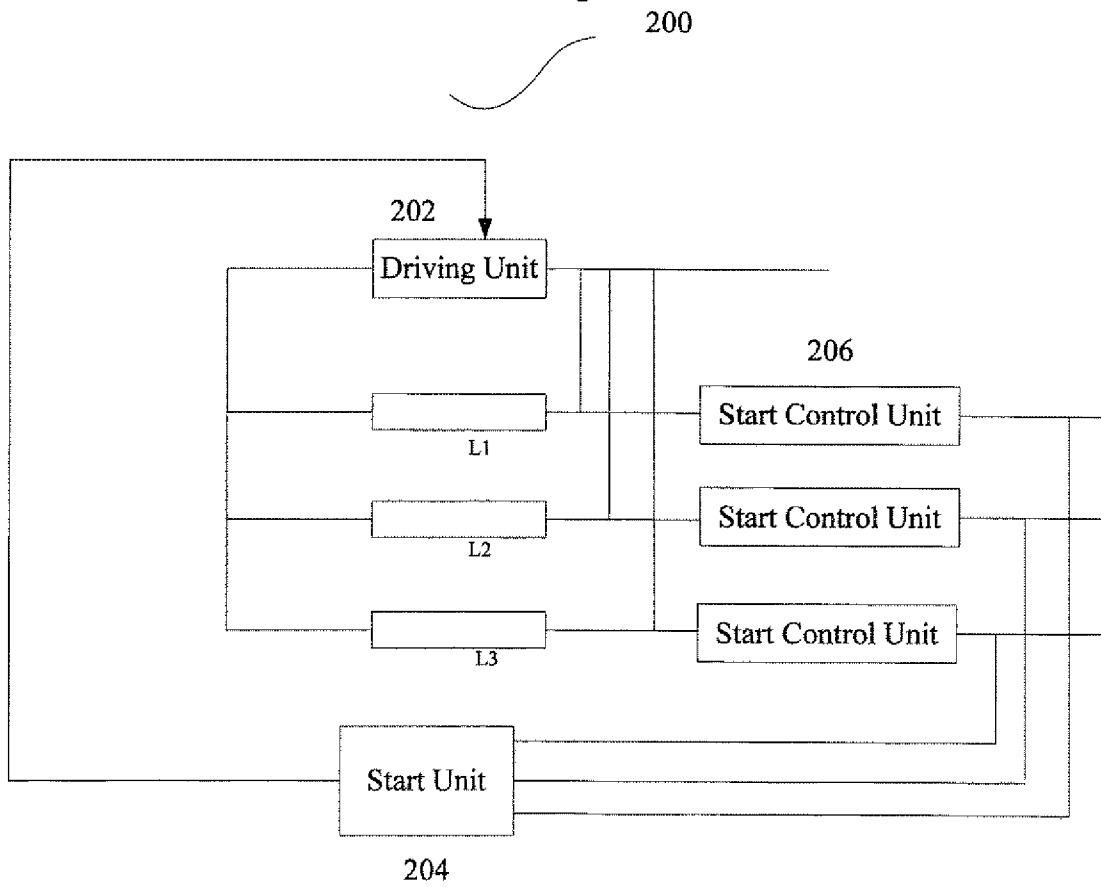


Figure 2

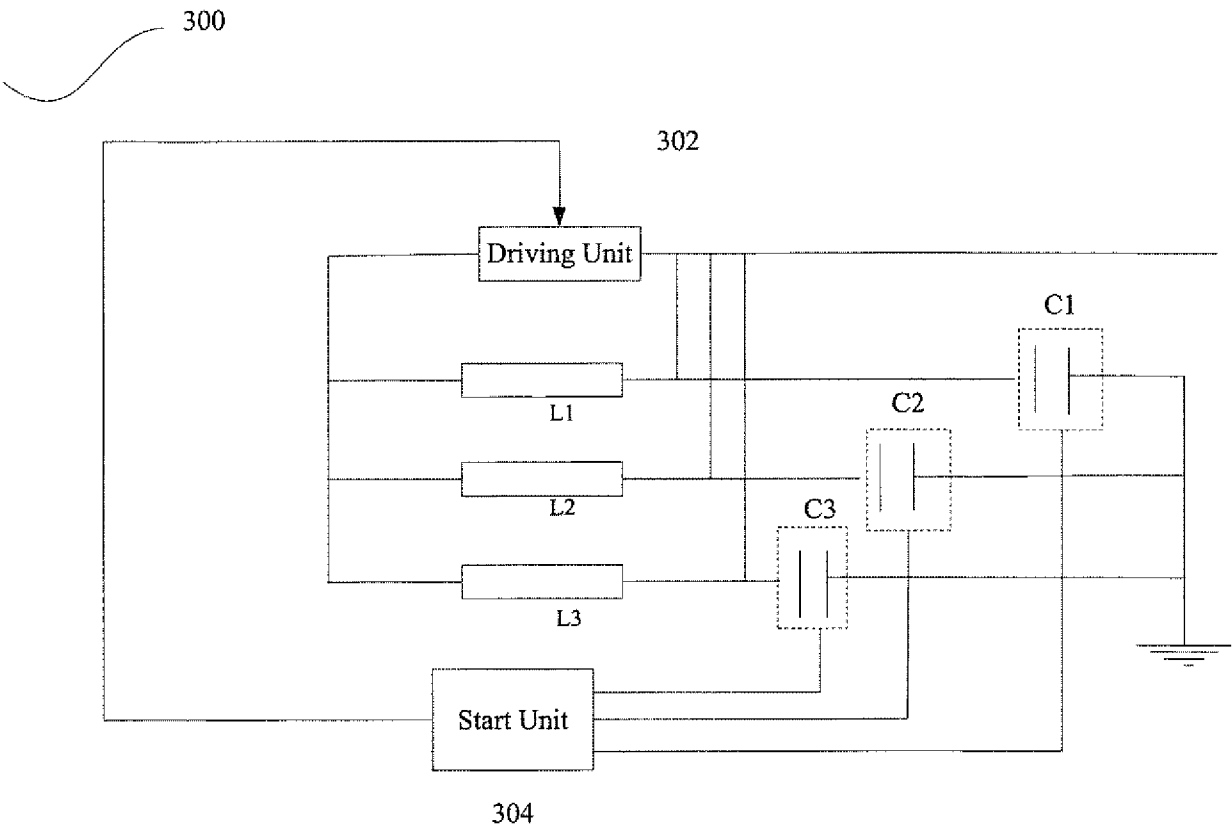


Figure 3

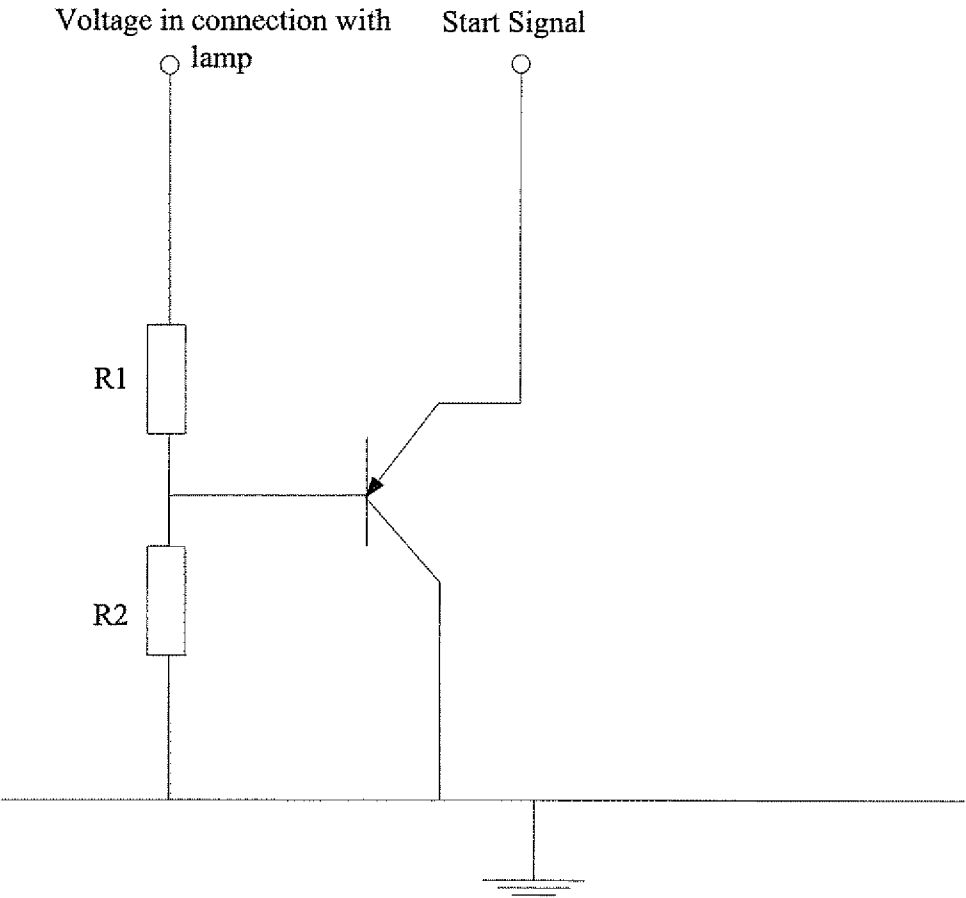


Figure 4

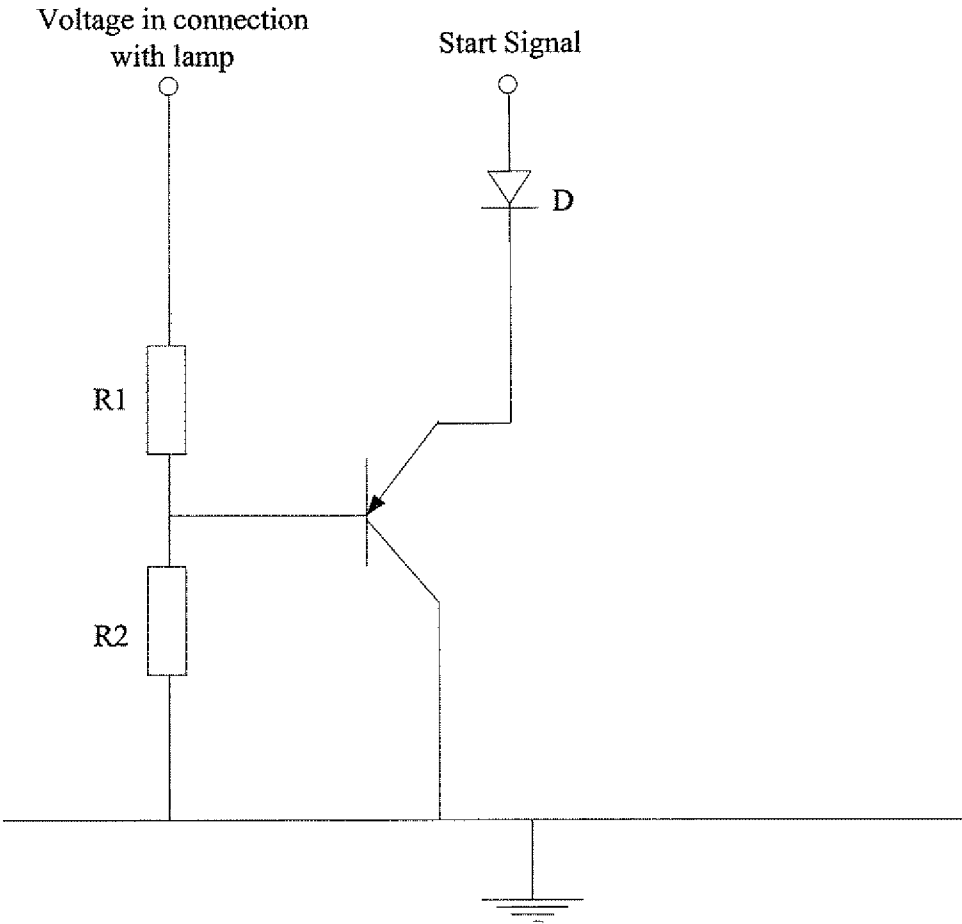
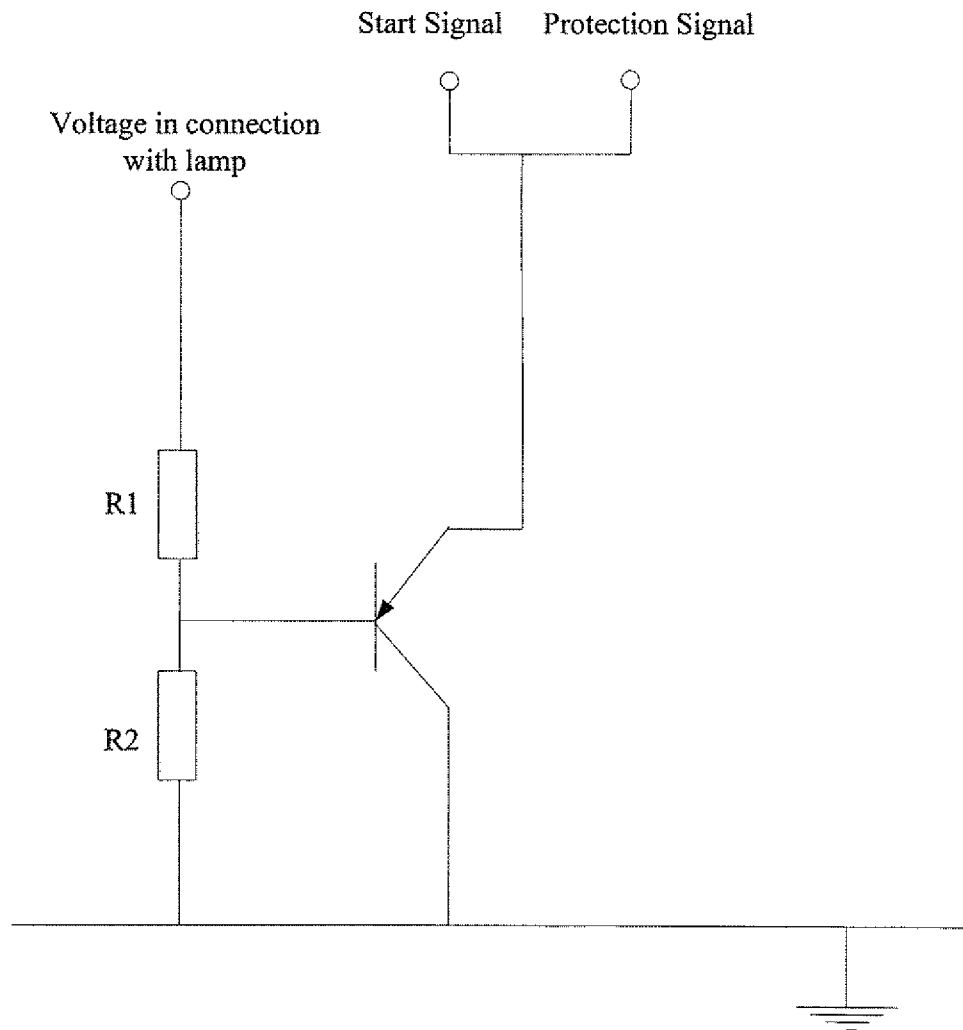


Figure 5

**Figure 6**

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/065118

A. CLASSIFICATION OF SUBJECT MATTER INV. H05B41/285 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H05B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 434 044 A (CHUNTEX ELECTRONIC CO LTD [TW]) 11 July 2007 (2007-07-11) the whole document	1-9
X	US 2005/269972 A1 (TRESTMAN GRIGORIY A [US] ET AL) 8 December 2005 (2005-12-08) the whole document	1-9
A	EP 1 718 132 A1 (SUMIDA CORP [JP]) 2 November 2006 (2006-11-02) the whole document	1-9
A	US 2007/120503 A1 (ZHOU TONG [CN] ET AL) 31 May 2007 (2007-05-31) the whole document	1-9
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Date of the actual completion of the international search	Date of mailing of the international search report	
14 December 2011	23/12/2011	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Hunckler, José	

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/184685 A1 (SEKINE MASASHI [US] ET AL) 25 August 2005 (2005-08-25) the whole document -----	1-9
A	US 5 770 925 A (KONOPKA JOHN G [US] ET AL) 23 June 1998 (1998-06-23) the whole document -----	1-9
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/065118

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