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(54) Electronic connection device for a lamp

Vorrichtung für eine elektronische Verbindung für eine Lampe

Dispositif de connexion électronique pour une lampe

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- **DOSHI M ET AL: "Low frequency architecture for multilamp CCFL systems with capacitive ignition" APPLIED POWER ELECTRONICS CONFERENCE AND EXPOSITION, 2005. APEC 2005. TWENTIETH ANNUAL IEEE AUSTIN, TX, USA 6-10 MARCH 2005, PISCATAWAY, NJ, USA, IEEE, US, vol. 2, 6 March 2005 (2005-03-06), pages 1072-1078Vol.2, XP010809429 ISBN: 978-0-7803-8975-5**

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Description

Field of the invention

[0001] Tubular fluorescent lamps and HID lamps (High Intensity Discharge) are connected by way of electronic connection devices with a supply of electric power, receiving therefrom the energy needed thereby for illumination while being switched to the ON state.

Prior art

[0002] The fluorescent tube of fluorescent lamps and HID lamps is filled with a gas, such as for example argon or krypton. The generation of light further requires "a drop" of mercury which gasifies in response to an electrical discharge which produces ultraviolet radiation as electricity discharges through the fluorescent lamp. The fluorescent lamp has its inner surface coated with a fluorescent material, converting the ultraviolet radiation, which has been generated by the electrical discharge taking place in mercury vapor, into visible light.

[0003] In addition to a fluorescent tube, the fluorescent lamp and the HID lamp comprise either an electronic connection device or a magnetic inductor. At present, magnetic inductors have been almost completely displaced by electronic connection devices. The current generated in electronic connection devices and flowing through a fluorescent lamp is generally 20-100 kHz in frequency, most typically 50-60 kHz.

[0004] Fig. 1 illustrates a lamp according to the prior art, comprising a fluorescent lamp 100 and an electronic connection device 101. The electronic connection device comprises an electronic circuit used for providing the fluorescent lamp with a current needed for illumination, for example at a frequency of 50 kHz. The physical size of a resonance coil L1 is determined by losses in a normal illumination state, but even more importantly by a saturation current produced at the ignition moment of a fluorescent lamp. As the in-coil ferrite becomes saturated, the coil has its inductance falling quite sharply at the ignition moment of a fluorescent lamp. At the same time, there occurs an intensification of the voltage working across a still not-ignited fluorescent lamp. The situation is not under control as the prior art technology only enables monitoring the current of what is a bottom switching transistor Q2 in a half-bridge Q1, Q2. In the circuitry of fig. 1, the current flowing through the transistors can only be regulated by measuring the switching transistor's Q2 current from a resistor R3. The flow of the transistor's Q1 current cannot be directly regulated or discontinued. Thus, the saturating coil L1 may result in the fluorescent lamp being supplied with an excessively high voltage causing the destruction of transistors or a safety hazard (e.g. a fire hazard).

[0005] In document D1, US patent US4873471, is presented a high frequency ballast for gaseous discharge lamps. Power switches 30, 31, in other words transistors 30, 31, are connected to the ground potential via junction 32 and current sensing resistor 33. A voltage at junction 32 is a signal representative of the current flowing in whichever of the transistors 30, 31. The voltage at junction 32 is measured by using a comparator circuit 42 (not 41, error in column 4, row 61) to generate an output signal when the measured value reaches a predetermined value. Document D1 is an example of prior art technology to measure current of the transistor(s) that are connected to ground potential.

Summary of the invention

[0006] An objective of the invention is to gain control over the current of a lamp coil at the ignition moment of a fluorescent lamp in a manner which ensures that the coil current is maintained at safe values. This is achieved with an electronic connection device of the invention according to claim 1. The electronic connection device provides an ignition voltage for the fluorescent lamp for activating the generation of illuminating radiation. The electronic connection device comprises at least two switching transistors and the associated current paths for feeding current to a coil and an ignition capacitor which develop an ignition voltage for the fluorescent lamp. The electronic connection device has integrated therewith a control circuit which measures the current of the at least two switching transistors. While measuring, the control circuit detects whether an excessively high current is flowing through one or more switching transistors, and limits the excessively high current to a lower current level by switching off the switching transistor, through which the excessively high current was detected to flow, for a predetermined inactivity period.

[0007] The invention is based on a continuous measurement of currents flowing through the switching transistors of a coil, and upon detecting that an excessively powerful current is flowing through one or more switching transistors, the flow of current is interrupted for the duration of an appropriate inactivity period to enable limiting the coil current to a lower level.

[0008] A benefit of the invention is that the lamp's coil current is maintained within an appropriate range regarding the lamp's functionality and regarding, for example, fire safety. Limiting the coil current also enables the use of smaller-size and hence economically more efficient coils.

List of figures

[0009]

Fig. 1 : shows a lamp according to the prior art.

Fig. 2 : shows a lamp according to the invention.

Fig. 3 : shows a measuring arrangement according to a preferred embodiment of the invention for the

current of an ignition capacitor with the same resistor as the one used for the half-bridge by using a diode couple Q3a and Q3b.

Fig. 4 : shows a preferred embodiment of the invention, which has been supplemented with a measuring feature for the cathode of a fluorescent lamp.

Detailed description of the invention

[0010] Fig. 2 shows a fluorescent lamp 100 and an electronic connection device 102 designed with a control circuit 104 according to the invention. The electronic connection device 102 of fig. 2 has the control circuit 104 integrated therewith in such a way that the connection device can be used for monitoring separately the current of both an upper switching transistor Q1 and a lower switching transistor Q2 and, if necessary, the current of a coil L1 can be limited to an appropriate level. The upper switching transistor's Q1 current can be monitored by measuring the current of a resistor R4 prior to the ignition of the fluorescent lamp 100. The same current can also be measured elsewhere along the current's path (Vbus - Q1 - L1 - C1) either by way of a resistor or with a current transformer, for example. Respectively, the current of the switching transistor Q2 is measured by way of a resistor R3.

[0011] The control circuit 104 is fitted with a current level limit value, which may not be exceeded by a current flowing through either one of the switching transistors Q1 and Q2. The installation of a current level limit value in the control circuit is performed for example programmatically.

[0012] Each switching transistor is measured at the time of ignition and, upon detecting that the current of either one of the switching transistors exceeds the accepted limit value, the flow of current is discontinued with a switch 106, 108 through this particular switching transistor. In preferred embodiments of the invention, which have been depicted for example in figures 2, 3 and 4, the switch 106, 108 refers to the actual switching transistor Q1, Q2 which functions the way of a relay in a current control process effected through the intermediary of the control circuit 104. The switching transistors Q1, Q2 presented in figures 2, 3 and 4 are MOSFET transistors. The switching transistors may also be transistors manufactured by other techniques, such as bipolar or IGBT transistors.

[0013] The control circuit 104 has also programmed therein a current flow inactivity period, after which the flow of current is re-activated by means of the switch 106, 108. By measuring the currents of both switching transistors Q1, Q2 pulse by pulse and by discontinuing the flow of a limit-value exceeding current through the switching transistor, in other words by deactivating the switching transistor immediately for the duration of a sufficiently long inactivity period, the current of a coil L can also be limited to a sufficiently low level. Consequently, this serves to ensure that the switching transistors do not sustain damage or that the fluorescent lamp's 100 maximum voltage values are not exceeded.

[0014] In a situation, in which a detection is made at the moment of ignition that both switching transistors Q1, Q2 have a limit-value-exceeding current flowing therethrough, the switching transistors Q1, Q2 will be deactivated for an inactivity period. This creates a condition in which the currents flowing through both switching transistors increase in frequency and since frequency is directly proportional to voltage, the fluorescent lamp's 100 ignition voltage increases towards its sufficient ignition value.

[0015] Fig. 3 shows a measuring process according to a preferred embodiment of the invention for the current of an ignition capacitor with the same resistor as the one used for the half-bridge Q1, Q2 by using a diode couple Q3a and Q3b. The embodiment of the invention shown in fig. 2 involves the use of two resistors for measuring a current and, if an IC (Integrated Circuit) is available, the measurement is performed at two separate measuring points. On the other hand, in the preferred embodiment of the invention shown in fig. 3, the diode couple Q3a and Q3b enables measuring the current of an ignition capacitor C1 and measuring the current of a half-bridge, comprising the switching transistors Q1 and Q2, by means of one and the same resistor R3. Respectively, the IC has just a single measuring point at which such measurements of currents are performed. In the preferred embodiment of the invention shown in fig. 3, it is possible to regulate at the moment of ignition the current of both switching transistors Q1 and Q2 from a single circuitry connected to the IC.

[0016] Fig. 4 shows a preferred embodiment of the invention, which has been supplemented with a measuring circuit 110 for the cathode of a fluorescent lamp 100, said circuit comprising resistors (R4, R5, R6), a diode Q5, and a capacitor C5. An operating voltage Vcc needed by a measuring circuit is supplied to the measuring circuit 110 by way of the resistor R5. In other respects, fig. 4 comprises an embodiment similar to the one shown in the context of fig. 3. Since the current of the ignition capacitor C1 is monitored continuously in the circuitries of figs. 3 and 4, the same measuring point on the IC can also be used for measuring the fluorescent lamp 100 for its voltage while the fluorescent lamp is in an illuminating state.

[0017] The ignition capacitor's C1 current is directly proportional to the frequency, the value of which is known. Correspondingly, the ignition capacitor's C1 current is directly proportional to the voltage of the fluorescent lamp 100. Accordingly, the deactivation or switch-off of the fluorescent lamp can also be detected from the same measuring point. It is also possible to utilize the same measuring point in the identification of a rectifying fluorescent lamp, based on unequal magnitudes of the currents of rectifying fluorescent lamps. Likewise, the absence of a fluorescent lamp, in other words the absence of the cathode of a fluorescent lamp, or its presence can

be confirmed by a measurement effected at the same measuring point.

[0018] Although the invention has been described in the above specification with reference to the circuit diagrams depicted in the figures, the invention is not limited to the specification and the circuit diagrams of figs. 2-4 but, instead, the invention can be varied within the scope defined in the appended claims. As one example, it can be noted that the order of a capacitor C2 and a fluorescent lamp 100 can be other than what is depicted without the change making any substantial functional difference in the embodiment of the invention. Similarly, other types of circuitry combinations and components within the scope defined by the claims can also be relevant as embodiments according to the invention. In embodiments of the invention, the lamp can be for example a fluorescent lamp or a HID (high intensity discharge) lamp.

Claims

1. An electronic connection device (102) for providing an ignition voltage for a fluorescent lamp (100) for activating the generation of illuminating radiation, the electronic connection device (102) comprising:

   - a first switching transistor (106) and a second switching transistor (108),
   - an ignition capacitor (C1) and a coil (L1) for developing the ignition voltage for the fluorescent lamp, and
   - a circuit (IC1) coupled to gate electrodes of said first (106) and second (108) switching transistors;

   characterised in that:

   - the electronic connection device comprises a first current path from a first input voltage node (Vbus) through the first switching transistor (106), the coil (L1), and the ignition capacitor (C1) and further to a second input voltage node, with a connection node between said coil (L1) and said ignition capacitor (C1) for connecting to said fluorescent lamp,
   - the electronic connection device (102) comprises a second current path from said connection node in the opposite direction to the first current path through said coil (L1) and through the second switching transistor (108),
   - the electronic connection device (102) comprises integrated therewith a control circuit (104), which is configured to measure electric current through the first switching transistor (106) on the first current path and through the second switching transistor (108) on the second current path,
   - the control circuit (104) is configured to respond to a detection of an excessively high current through each switching transistors by switching off the respective switching transistor, through which the excessively high current was detected to flow, for a predetermined inactivity period.

2. An electronic connection device according to claim 1, **characterised in that**:

   - the electronic connection device comprises a first resistor (R4) in series with the coil (L1) on the first current path,
   - for monitoring the current through the first switching transistor (106) at the time of ignition of the fluorescent lamp, the control circuit (104) is configured to measure the current through said resistor (R4),
   - the electronic connection device comprises a second resistor (R3) on said second current path, and
   - for monitoring the current through the second switching transistor (108), the control circuit (104) is configured to measure the current through said second resistor (R3).

3. An electronic connection device according to claim 1, **characterised in that**:

   - the electronic connection device comprises a first diode (Q3a), a second diode (Q3b), and a resistor (R3),
   - from said ignition capacitor (C1) the first current path continues through said first diode (Q3a) and said resistor (R3) to said second input voltage node,
   - from the second switching transistor (108) the second current path continues through said resistor (R3) to said second input voltage node,
   - said second diode (Q3b) is coupled from said second input voltage node to the opposite side of said ignition capacitor (C1) than said connection node, and
   - the control circuit (104) is configured to measure the current through the first switching transistor (106), the current through the second switching transistor (108), and the current of the ignition capacitor (C1) with said resistor (R3).

4. An electronic connection device according to claim 1, **characterised in that** it comprises a current transformer for measuring the current through one or both of said first (106) and second (108) switching transistors on said first and/or second current paths respectively.

5. An electronic connection device according to claim 1, **characterised in that**:

- a current limit value is set in the control circuit (104), and
- said detection of an excessively high current through one or both switching transistors means the detection of a current that is in excess of said current limit value.

6. An electronic connection device according to claim 1, **characterised in that**:

- the electronic connection device comprises integrated therewith a measuring circuit (110) for the cathode of the fluorescent lamp,
- through said measuring circuit (110), the electronic connection device is configured to measure or detect at least one of the following: the voltage of the fluorescent lamp (100) when the fluorescent lamp is in an illuminating state; deactivation of the fluorescent lamp (100); whether the fluorescent lamp (100) is in place; to identify a rectifying fluorescent lamp based on the unequal magnitudes of currents of rectifying fluorescent lamps.

Patentansprüche

1. Elektronische Verbindungseinrichtung (102) zum Bereitstellen einer Zündspannung für eine Fluoreszenzlampe (100) zum Aktivieren der Erzeugung von Beleuchtungsstrahlung, wobei die elektrische Verbindungseinrichtung (102) umfasst:

- einen ersten Schalttransistor (106) und einen zweiten Schalttransistor (108),
- einen Zündkondensator (C1) und eine Spule (L1) zum Entwickeln der Zündspannung für die Fluoreszenzlampe, und
- eine Schaltung (IC1), die zu Gate-Elektroden des ersten (106) und zweiten (108) Schalttransistors gekoppelt ist;

dadurch gekennzeichnet, dass:

- die elektrische Verbindungseinrichtung einen ersten Strompfad von einem ersten Eingangsspannungsknoten (Vbus) durch den ersten Schalttransistor (106), die Spule (L1), und den Zündkondensator (C1) und ferner zu einem zweiten Eingangsspannungsknoten, mit einem Verbindungsknoten zwischen der Spule (L1) und dem Zündkondensator (C1) zum Verbinden zu der Fluoreszenzlampe umfasst,
- die elektrische Verbindungseinrichtung (102) einen zweiten Strompfad von dem Verbindungsknoten in der entgegen gesetzten Richtung zu dem ersten Strompfad durch die Spule (L1) und durch den zweiten Schalttransistor (108) umfasst,
- die elektronische Verbindungseinrichtung (102) darin integriert eine Steuerschaltung (104) umfasst, welche konfiguriert ist, um elektrischen Strom durch den ersten Schalttransistor (106) auf dem ersten Strompfad und über den zweiten Schalttransistor (108) auf dem zweiten Strompfad zu messen,
- die Steuerschaltung (104) konfiguriert ist, um auf eine Erfassung eines übermäßig hohen Stromes durch jeden Schalttransistor durch Ausschalten des jeweiligen Schalttransistors, durch welchen erfasst wurde, dass der übermäßig hohe Strom fließt, für eine vorbestimmte Inaktivitätsperiode zu antworten.

2. Elektronische Verbindungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass**:

- die elektronische Verbindungseinrichtung einen ersten Widerstand (R4) in Serie mit der Spule (L1) auf dem ersten Strompfad umfasst,
- zum Überwachen des Stroms durch den ersten Schalttransistor (106) zu der Zündzeit der Fluoreszenzlampe, die Steuerschaltung (104) konfiguriert ist, um den Strom durch den Widerstand (R4) zu messen,
- die elektronische Verbindungseinrichtung einen zweiten Widerstand (R3) auf dem zweiten Strompfad umfasst, und
- zum Überwachen des Stroms durch den zweiten Schalttransistor (108) die Steuerschaltung (104) konfiguriert ist, um den Strom durch den zweiten Widerstand (R3) zu messen.

3. Elektronische Verbindungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass**:

- die elektronische Verbindungseinrichtung eine erste Diode (Q3a), eine zweite Diode (Q3b), und einen Widerstand (R3) umfasst,
- sich der erste Strompfad von dem Zündkondensator (C1) durch die erste Diode (Q3a) und den Widerstand (R3) zu dem zweiten Eingangsspannungsknoten fortsetzt,
- sich der zweite Strompfad von dem zweiten Schalttransistor (108) durch den Widerstand (R3) zu dem zweiten Eingangsspannungsknoten fortsetzt,
- die zweite Diode (Q3b) von dem zweiten Eingangsspannungsknoten zu der dem Verbindungsknoten gegenüberliegenden Seite des Zündkondensators (C1) gekoppelt ist, und
- die Steuerschaltung (104) konfiguriert ist, um den Strom über den ersten Schalttransistor (106), den Strom über den zweiten Schalttransistor (108), und den Strom des Zündkondensators (C1) mit dem Widerstand (R3) zu mes-

sen.

4. Elektronische Verbindungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** es einen Stromwandler zum Messen des Stroms über einen oder beide des ersten (106) und zweiten (108) Schalttransistors auf dem ersten und/oder zweiten Strompfad jeweils umfasst.

5. Elektronische Verbindungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass**:

- ein Stromgrenzwert in der Steuerschaltung (104) gesetzt ist, und
- die Erfassung des übermäßig hohen Stroms über einen oder beide Schalttransistoren die Erfassung eines Stroms bedeutet, der über den Stromgrenzwert hinausgeht.

6. Elektronische Verbindungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass**:

- die elektronische Verbindungseinrichtung damit integriert eine Messschaltung (110) für die Kathode der Fluoreszenzlampe aufweist,
- über die Messschaltung (110) die elektronische Verbindungseinrichtung konfiguriert ist, um mindestens eines der Folgenden zu messen oder zu erfassen: die Spannung der Fluoreszenzlampe (100), wenn die Fluoreszenzlampe in einem Beleuchtungszustand ist; Deaktivierung der Fluoreszenzlampe (100); ob die Fluoreszenzlampe (100) am Platz ist; um eine gleichrichtende Fluoreszenzlampe basierend auf der ungleichen Stromstärke von gleichrichtenden Fluoreszenzlampen zu identifizieren.

Revendications

1. Dispositif de connexion électronique (102) pour fournir une tension d'allumage pour une lampe fluorescente (100) pour activer la génération de radiation d'illumination, le dispositif de connexion électronique (102) comprenant :

- un premier transistor de commutation (106) et un second transistor de commutation (108),
- un condensateur d'allumage (cl) et une bobine (L1) pour développer la tension d'allumage pour la lampe fluorescente, et
- un circuit (IC1) couplé aux électrodes de grille desdits premier (106) et second (108) transistors de commutation ;

caractérisé en ce que :

- le dispositif de connexion électronique comprend un premier chemin de courant à partir d'un premier noeud de tension d'entrée (Vbus) à travers le premier transistor de commutation (106), la bobine (L1), et le condensateur d'allumage (C1) et en outre à un second noeud de tension d'entrée, avec un noeud de connexion entre ladite bobine (L1) et ledit condensateur d'allumage (C1) pour une connexion à ladite lampe fluorescente,
- le dispositif de connexion électronique (102) comprend un second chemin de courant à partir dudit noeud de connexion dans la direction opposée au premier chemin de courant à travers ladite bobine (L1) et à travers le second transistor de commutation (108),
- le dispositif de connexion électronique (102) comprend un circuit de commande (104) intégré à celui-ci, qui est configuré pour mesurer un courant électrique à travers le premier transistor de commutation (106) sur le premier chemin de courant et à travers le second transistor de commutation (108) sur le second chemin de courant,
- le circuit de commande (104) est configuré pour répondre à une détection d'un courant excessivement élevé à travers chacun des transistors de commutation en bloquant le transistor de commutation respectif, à travers lequel le courant excessivement élevé a été détecté de passer, pendant une période d'inactivité prédéterminée.

2. Dispositif de connexion électronique selon la revendication 1, **caractérisé en ce que** :

- le dispositif de connexion électronique comprend une première résistance (R4) en série avec la bobine (L1) sur le premier chemin de courant,
- pour surveiller le courant à travers le premier transistor de commutation (106) au moment de l'allumage de la lampe fluorescente, le circuit de commande (104) est configuré pour mesurer le courant à travers ladite résistance (R4),
- le dispositif de connexion électronique comprend une seconde résistance (R3) sur ledit second chemin de courant, et
- pour surveiller le courant à travers le second transistor de commutation (108), le circuit de commande (104) est configuré pour mesurer le courant à travers ladite seconde résistance (R3).

3. Dispositif de connexion électronique selon la revendication 1, **caractérisé en ce que** :

- le dispositif de connexion électronique comprend une première diode (Q3a), une seconde diode (Q3b), et une résistance (R3),

- à partir dudit condensateur d'allumage (C1), le premier chemin de courant continue de traverser ladite première diode (Q3a) et ladite résistance (R3) jusqu'audit second noeud de tension d'entrée,
- à partir du second transistor de commutation (108), le second chemin de courant continue de traverser ladite résistance (R3) jusqu'audit second noeud de tension d'entrée,
- ladite seconde diode (Q3b) est couplée à partir dudit second noeud de tension d'entrée au côté opposé dudit condensateur d'allumage (C1) par rapport audit second noeud, et
- le circuit de commande (104) est configuré pour mesurer le courant à travers le premier transistor de commutation (106), le courant à travers le second transistor de commutation (108), et le courant du condensateur d'allumage (C1) avec ladite résistance (R3).

4. Dispositif de connexion électronique selon la revendication 1, **caractérisé en ce qu'**il comprend un transformateur de courant pour mesurer le courant à travers un ou les deux desdits premier (106) et second (108) transistors de commutation sur lesdits premier et/ou second chemins de courant respectivement.

5. Dispositif de connexion électronique selon la revendication 1, **caractérisé en ce que** :

- une valeur limite de courant est réglée dans le circuit de commande (104), et
- ladite détection d'un courant excessivement élevé à travers un ou les deux transistors de commutation signifie la détection d'un courant qui est en excès de ladite valeur de limite de courant.

6. Dispositif de connexion électronique selon la revendication 1, **caractérisé en ce que** :

- le dispositif de connexion électronique comprend un circuit de mesure (110) intégré à celui-ci pour la cathode de la lampe fluorescente,
- à travers ledit circuit de mesure (110), le dispositif de connexion électronique est configuré pour mesurer ou détecter au moins un de ce qui suit : la tension de la lampe fluorescente (100) lorsque la lampe fluorescente est dans un état d'illumination ; désactivation de la lampe fluorescente (100) ; si la lampe fluorescente (100) est en place ; pour identifier une lampe fluorescente de redressement sur la base des amplitudes inégales de courant de lampes fluorescentes de redressement.

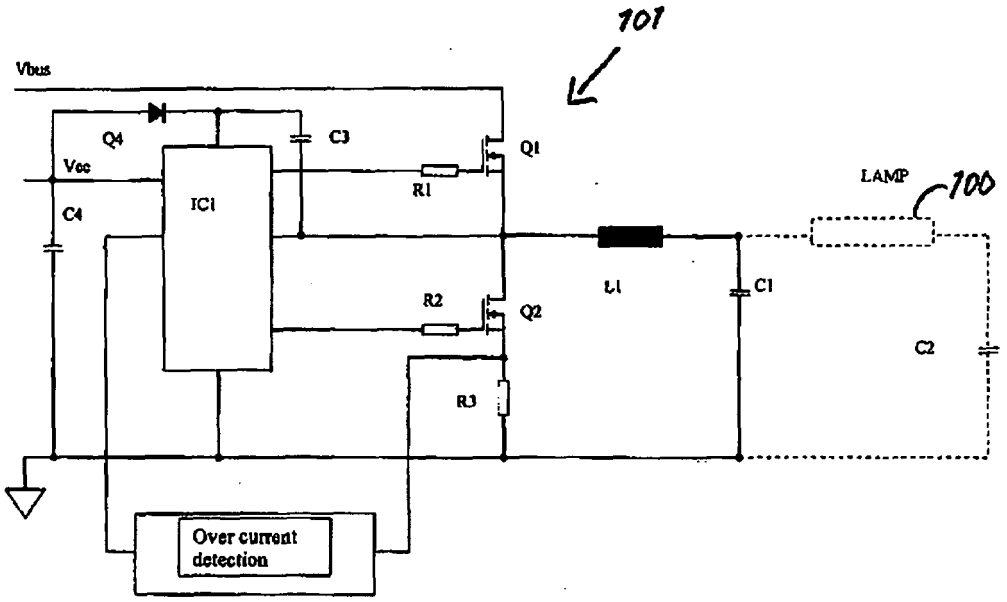
101
Vbus
Q4
C3
Vcc
IC1
R1
Q1
LAMP
100
C4
L1
C1
R2
Q2
C2
R3
Over current detection

Fig. 1

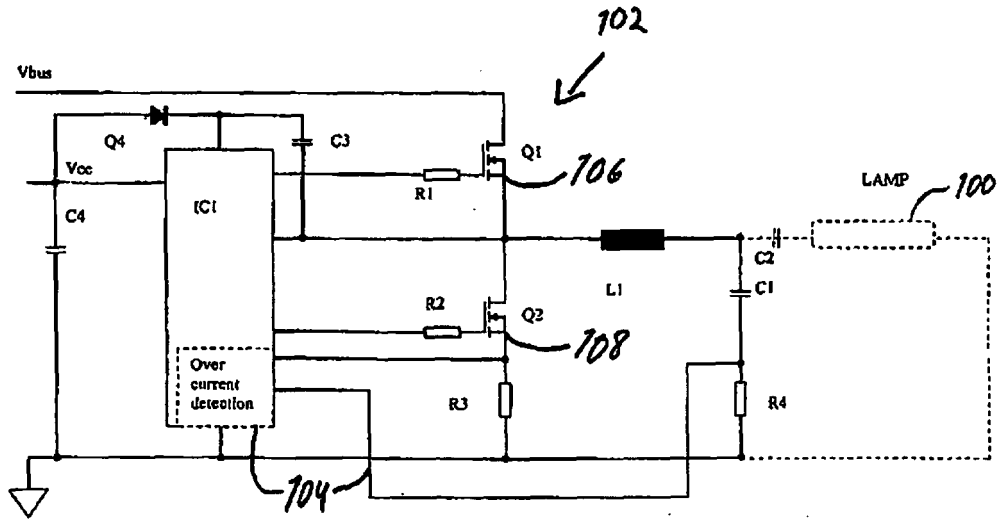
102
Vbus
Q4
C3
Q1
106
Vcc
R1
LAMP
100
C4
IC1
C2
L1
C1
R2
Q2
108
Over current detection
R3
R4
104

Fig. 2

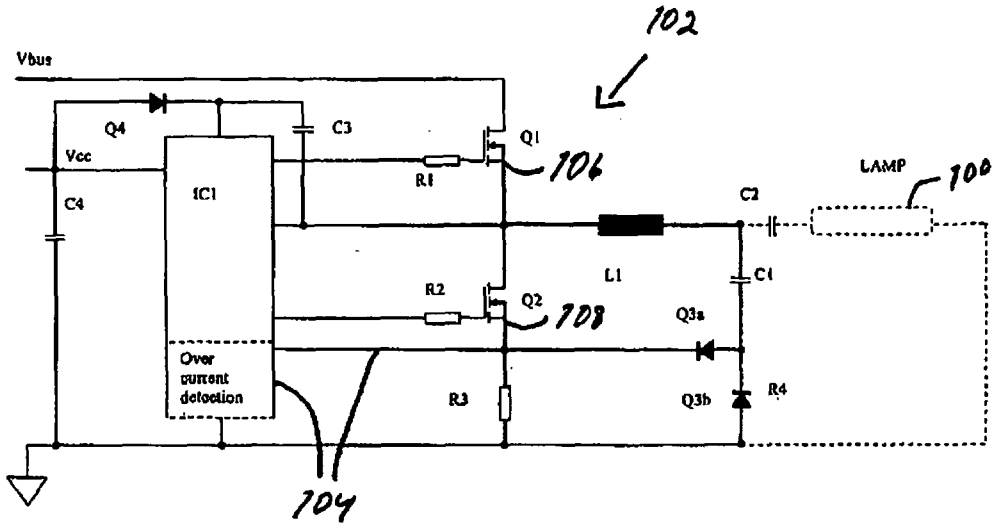
102
Vbus
Q4
Vcc
C4
IC1
C3
R1
Q1
106
LAMP
100
C2
L1
C1
R2
Q2
108
Q3a
Over current detection
R3
Q3b
R4
104

Fig. 3

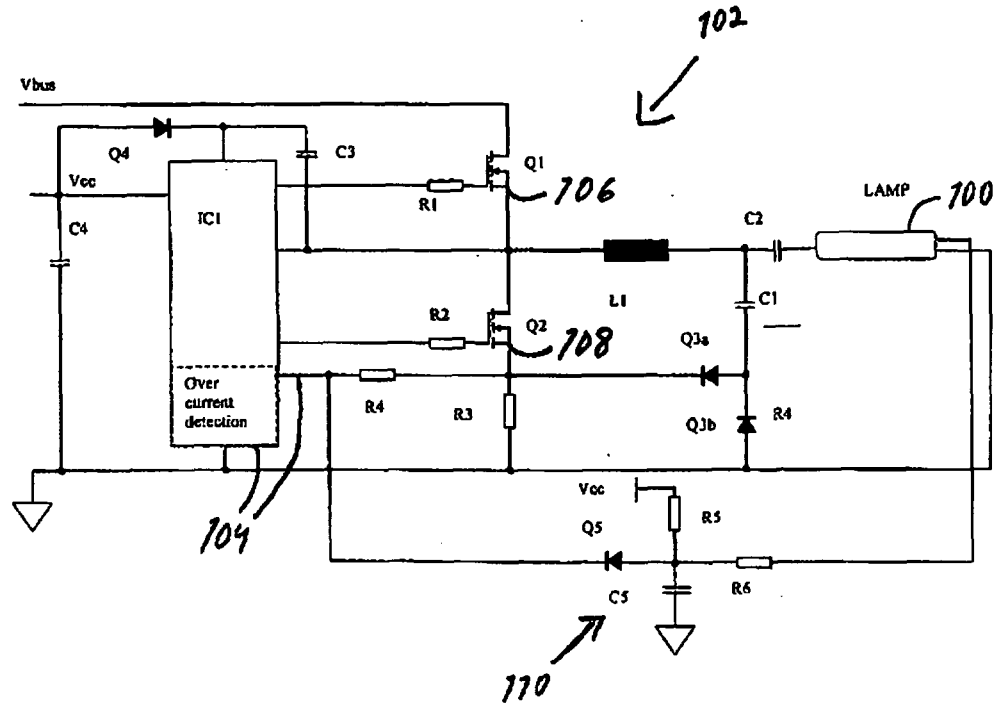
102
Vbus
Q4
Vcc
C4
IC1
C3
R1
Q1
106
LAMP
100
C2
L1
C1
R2
Q2
108
Q3a
Over current detection
R4
R3
Q3b
R4
Vcc
Q5
R5
C5
R6
104
110

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4873471 A **[0005]**