EUROPEAN PATENT SPECIFICATION

Date of publication and mention of the grant of the patent: 23.08.2000 Bulletin 2000/34

Application number: 97830185.1

Date of filing: 23.04.1997

Supply circuit for discharge lamps with overvoltage protection

Stromversorgung für Entladungslampen mit Ueberspannungsschutz

Alimentation pour une lampe à décharge avec protection de survoltage

Designated Contracting States: AT BE CH DE DK ES FR GB IT LI LU NL SE


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Description

Field of the invention

[0001] The present invention relates to a supply circuit with inverter for discharge lamps. More particularly the present invention relates to a supply circuit for discharge lamps with heated electrodes, in which an inverter comprising controlled breakers, turned on and off alternately, supply a load circuit having at least one lamp and an LC resonant circuit in series with the lamp.

State of the art

[0002] Systems for controlling the voltage on the electrodes of the lamp and which have the objective of modifying the behaviour of the load circuit or of turning off the supply thereto in case of defective operation of the lamp, are often used in supply circuits of the type mentioned above, with the objective of preventing excessively high voltages from arising between the electrodes.

[0003] From EP-A-0 610 642 there is known a supply circuit with inverter for discharge lamps, in which associated with the load circuit is a control circuit comprising a voltage-dependent resistor (VDR) in series with a dissipative element. When the voltage at one terminal of the VDR exceeds a threshold value (which occurs for example in the case of failure of the lamp to light following a defect therein), the VDR becomes conducting with the consequence that the resonant circuit in series with the lamp receives an additional dissipative element. This modifies the quality factor of the circuit and hence reduces the voltage at the terminals of the lamp. Provision is further made for a timer circuit which turns off the supply to the load circuit should the overvoltage condition last for a time greater than a preset threshold value.

[0004] From EP-A-0 113 451 there is known a different overvoltage control system, in which a voltage-dependent resistor (VDR) in series with a capacitor are inserted in parallel with a branch of the load circuit. In this case when a voltage difference greater than a specified threshold value is generated between the terminals of the VDR, it becomes conducting and inserts an auxiliary capacitor into the load circuit, modifying the frequency of resonance of the resonant circuit in series with the lamp.

[0005] Traditional circuits for protection from overvoltages come into operation when the voltage between the electrodes of the lamp exceeds a threshold value. In the case of a defective lamp, and hence of the failure of this lamp to light, the voltage between the electrodes of the lamp reaches values of the order of 1000 V. Conversely, when the lamp is removed from the load circuit the potential difference between the electrodes is of the order of 700 V. The circuits currently available are unable to discriminate between these two voltage values, which may moreover vary from one instance to another of the circuit. Consequently they cut in anyway, turning off the supply, a prespecified time (of the order of 300 ms) having elapsed from the onset of the establishment of a situation of overvoltage between the electrodes of the lamp and are unable to distinguish between the two conditions of fault and lamp absent.

[0006] It would, on the other hand, be appropriate to make provision for a circuit which is able to discriminate between a situation of actual defective operation and a situation of lamp absent in the load circuit, in such a way that the substitution of the lamp does not entail the disabling of the supply inverter of the load circuit. Thus, in currently known circuits the disabling of the supply inverter is permanent and hence requires the intervention of the operator in order to reactivate the supply for the lamp, even when the disabling has occurred through simple substitution of the lamp rather than through a defect in operation thereof. On the other hand, in case of overvoltage due to a defect in the operation of the lamp in the load circuit there flows a high current, which passes through the capacitor in parallel with the lamp. This anomalous condition may lead to the overstressing of the inverter and hence to damage thereto. Protection from overvoltage has the objective of preventing this consequence. When, conversely, the voltage in the load circuit increases on account of the lamp being absent, the current which flows in the circuit is practically zero and hence the inverter does not experience the dangerous stresses which occur under conditions of faulty lamp. Disabling of the inverter is therefore superfluous.

[0007] From US-A-5,332,951 a ballast circuit for driving gas discharge lamps is known, which is provided with a band pass filter centred on the operating frequency of the inverter. The band pass filter is coupled between the output of the inverter and the inverter control. Its purpose is to provide protection against the diode operation of the gas discharge lamps, and thus to avoid cross conduction of the transistors. This known device is not concerned with the problem of overvoltage protection.

Summary of the invention

[0008] The objective of the present invention is the construction of a supply circuit for discharge lamps, with an overvoltage protection system, not exhibiting the drawbacks of the traditional circuits briefly described above.

[0009] More particularly the objective of the present invention is the construction of a supply circuit for discharge lamps with an overvoltage protection circuit which is able to discriminate between the conditions of failure to light on account of defective lamp and the conditions of lamp absent, and which cut off the supply only when necessary, i.e. in the case of defective lamp.

[0010] Essentially, starting from a supply circuit of the type defined above, the objectives indicated above, and other objectives and advantages which will become
clear to those skilled in the art by reading the text which follows, are achieved by making provision for the over-voltage control circuit to comprise a band-pass filter centred on the switching frequency of the inverter, the input signal of which is dependent on the voltage at a specified point of the load circuit and the output signal from which is sent to control means associated with the inverter so as to turn off the supply for the load circuit in the case of defective operation.

The invention is based on the observation that, although the amplitude of the voltage between the electrodes of the lamp is of the same order of magnitude both in the case of defective operation and in the case of lamp absent, the waveform of the voltage signal is, conversely, qualitatively different in the two cases. In case of failure to light through a defect in the lamp, the voltage between its electrodes has a substantially sinusoidal profile with a frequency corresponding to the switching frequency of the inverter. In case of lamp absent, conversely, the waveform of the voltage signal at the terminals of the lamp exhibits, as well as a relatively limited component at the switching frequency, a strong signal content at the higher harmonics.

By detecting this voltage signal and filtering it through a band-pass filter centred on the switching frequency, a signal, which will be a high signal when the overvoltage established between the electrodes is due to defective operation of the lamp inserted into the load circuit, is therefore obtained at the output of the band-pass filter. This signal will, conversely, be low when the overvoltage established between the electrodes is due to lamp absent. In this last case, in fact, the signal component at the switching frequency is of modest strength with respect to the components at the higher harmonics, which are blocked by the band-pass filter.

The control circuit thereby becomes capable of discriminating between the conditions of defective operation and the conditions of lamp absent and will be able, with suitable logic, to intervene on the supply inverter, selectively disabling the operation thereof.

Further and advantageous characteristics and embodiments of the circuit according to the invention are indicated in the appended claims and will be described in greater detail below.

In particular, a voltage divider, to which the band-pass filter is linked, can be arranged in parallel with a branch containing at least one component of the load circuit (for example the inductive component). More particularly the voltage divider can be placed in parallel with a branch comprising one of the controlled breakers of the inverter and the inductive component of the resonant circuit in series with the electrodes of the lamp.

The band-pass filter can consist, in a particularly simple embodiment, of an LC cell in parallel, with a resonant frequency corresponding to the switching frequency of the inverter.

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The band-pass filter can consist, in a particularly simple embodiment, of an LC cell in parallel, with a resonant frequency corresponding to the switching frequency of the inverter.
stressing of the inverter 3 and hence it is necessary to provide a control circuit which, depending on the voltage at the point P of the load circuit, makes provision for disabling the supply circuit in the case in which the overvoltage condition persists beyond a preset time threshold.

[0022] When the lamp L is absent from the load circuit, a high voltage, of the order of 700 V, is again established at the point P. However, under these conditions the current through the load circuit is minimal and corresponds merely to the current through the stray capacitances of the circuit. Hence, in this case the supply circuit for the inverter 3 need not be disabled. The control circuit according to the invention, which will be described below, makes it possible to discriminate between these two conditions of overvoltage on the electrodes of the lamp and hence makes it possible to turn off the supply in the case of defective operation only and not in the case of lamp absent.

[0023] Represented in Figs. 2 and 3 is the waveform of the voltage signal at the point P of the load circuit. Represented in Fig. 2 is a substantially sinusoidal waveform with a frequency corresponding to the frequency f_c of switching of the inverter 3. This is the waveform of the voltage signal detectable at the point P in the case of a defect in the operation of the lamp L. The amplitude of the signal is around 1000 V. Conversely, in the case of lamp absent, the voltage signal at the point P takes the profile of Fig. 3 with an amplitude of around the same order of magnitude as the previous case (in the example around 700 V), but with a more complex harmonic content. Figs. 4 and 5 show the frequency spectrum of the two signals. As may be seen in Fig. 4, the waveform of Fig. 2 is practically a sinusoidal wave with a frequency f_c, whereas the waveform of Fig. 3, to which the spectrum of Fig. 5 refers, has a modest harmonic content at the switching frequency f_c and a large harmonic content at the higher harmonics.

[0024] The control circuit according to the invention exploits this differing harmonic content of the voltage signals at the point P under the two conditions of defective lamp and absent lamp so as to discriminate the two cases of overvoltage and turn off the supply in the first case only. With this objective, a voltage divider 31, 33, at the intermediate point of which is linked a band-pass filter 35 centred on the switching frequency f_c of the inverter 3, is connected to the point P of the load circuit.

[0025] On account of the different harmonic content of the voltage signal in the case of defective lamp and of absent lamp, the output from the filter 35 centred on the frequency f_c will be a sinusoidal signal of frequency f_c with a large amplitude in the case of defective lamp and a very small amplitude in the case of lamp absent. This is represented qualitatively in the graph at the bottom of Fig. 1, where time is plotted along the abscissa and the output voltage from the filter 35 along the ordinate and in which the labels V_1 and V_2 indicate the amplitudes of the signal output by the filter respectively in the case of defective lamp and in the case of absent lamp.

[0026] The signal output by the filter 35 is sent to a level discriminator 37, which dispatches a high signal to a logic unit 39 when the amplitude of the signal output by the filter 35 is equal to V_1, and a low signal when the amplitude of the signal output by the filter 35 is equal to V_2. The logic unit 39 is therefore able to discriminate between the two situations of absent lamp or of defective lamp and depending thereon will make provision to maintain the inverter 3 under supply conditions, when the lamp L is absent from the load circuit, whereas it will make provision to disable the inverter 3 when the overvoltage at the point P is due to a defect in the lamp.

[0027] Shown in Fig. 6 is a practical embodiment of the control circuit represented at a functional level in Fig. 1 and generically labelled 41 therein.

[0028] In Fig. 6 elements which are identical to or correspond to those of Fig. 1 are indicated with the same reference numerals and will not be described again. In this embodiment the band-pass filter 35 consists of an LC cell comprising a capacitor 51 and an inductor 53 in parallel which form a resonant circuit at the switching frequency f_c of the inverter 3. The filter 35 is linked via a diode 55 to a capacitor 57, the latter being charged at the voltage corresponding to the peak voltage of the signal output by the filter 35. The capacitor 57 is linked to the logic unit 39 via a Zener diode 59, at the output of which will be present a low signal when the input voltage is less than the conduction voltage of the Zener diode and a high signal when the input voltage is greater than the conduction voltage. The conduction voltage of the Zener diode 59 lies between the values V_1 and V_2 indicated in the graph at the bottom of Fig. 1.

[0029] In short, the signal at the output of the Zener diode 59 will be high only in the case of defective lamp and will remain low in the case of lamp absent or of normal operation of the load circuit. This signal is sent to the logic unit 39 which consists of a latch circuit with two inverting gates 61 and 63 in series with positive feedback. With this arrangement the output from the inverting gate 63 will remain at low level in the case of normal operation or of lamp absent whereas it will rise to high level and remain steady at this level, until the operator intervenes on the circuit, in the case of defective operation of the lamp. The signal output by the latch circuit is used to disable the inverter 3.

[0030] With the objective of avoiding the intervention of the protection circuit with each attempted ignition of the lamp (even under conditions of lamp intact), there is provided a delay circuit 71 with a delay time of the order of 100-200 ms. In this way the voltage peak which occurs for very brief instants at the moment of ignition of the lamp L even when the latter is not damaged, does not prompt any disabling of the supply circuit.

[0031] To achieve the disabling of the supply inverter of the lamp L via the signal output by the logic unit 39, this signal can be employed for example to short-circuit
the base of a transistor. This can be the typical solution for a supply circuit of the self-oscillating type. When the supply to the lamp L is achieved via an integrated control circuit, the signal generated by the logic unit 39 can be applied to an enabling/disabling pin of the integrated circuit.

[0032] It should be understood that the drawing shows merely one example given solely as a practical illustration of the invention, it being possible for this invention to vary in its forms and arrangements without however departing from the scope of the concept underlying the invention. The possible presence of reference numerals in the enclosed claims has the objective of facilitating the reading of the claims with reference to the description and drawing, and does not limit the scope of the protection represented by the claims.

Claims

1. A supply circuit for discharge lamps (L) comprising an inverter (3) with controlled breakers (5, 7) which are turned on and off alternately at a switching frequency (f_s) so as to generate a supply voltage at the said switching frequency (f_s) for a load circuit (15) arranged in parallel with one of the said controlled breakers and comprising at least one lamp (L) and a resonant circuit (23, 25) in series with the electrodes (17, 19) of the said lamp, there being associated with the said load circuit a control circuit (41) for turning off the supply to the said load circuit in case of defective operation of the lamp (L), characterized in that the said control circuit (41) comprises a band-pass filter (35) centred on the switching frequency (f_s) of the said inverter and whose input signal is dependent on the voltage at a point (P) of the load circuit, the output signal from the said filter being sent to control means (37, 39) associated with the said inverter (3) so as to turn off the supply to the load circuit in case of defective operation.

2. Supply circuit according to Claim 1 characterized in that a voltage divider (31, 33), to which the said band-pass filter (35) is linked, is arranged in parallel with a branch containing at least one component (23) of the load circuit (15).

3. Supply circuit according to Claim 2, characterized in that the said voltage divider is placed in parallel with a branch comprising one (7) of the said controlled breakers (5, 7) and the inductive component (23) of the resonant circuit in series with the electrodes of the lamp (L).

4. Supply circuit according to one or more of the preceding claims, characterized in that the said band-pass filter (35) comprises an L-C cell in parallel, the frequency of resonance of which is substantially corresponding to the switching frequency (f_s) of the said inverter.

5. Supply circuit according to one or more of the preceding claims, characterized in that the said control means comprise a level discriminator (37) and a latch circuit (39) whose output signal takes a high value in case of defective operation of the lamp, the said output signal turning off the supply to the load circuit.

6. Supply circuit according to Claim 5, characterized in that the said level discriminator comprises a Zener diode (59) interposed between the said filter (35) and the said latch circuit (39), in such a way that the voltage input to the said latch circuit (39) is high if the voltage output by the band-pass filter (35) exceeds the conduction voltage of the Zener diode.

7. Supply circuit according to Claim 5 or 6, characterized in that the said latch circuit comprises two inverting gates in series (61, 63) with positive feedback.

8. Supply circuit according to one or more of Claims 5 to 7, characterized in that the said level discriminator (37) furthermore comprises a capacitor (57) which is charged by the voltage output by the band-pass filter (35).

9. Supply circuit according to one or more of the preceding claims, characterized in that it comprises, downstream of the said band-pass filter (35), a delay timer circuit (71).

Patentansprüche

1. Versorgungsschaltung für Entladungslampen (L) mit einem Inverter (3) mit gesteuerten Unterbrechern (5, 7), die mit einer Schaltfrequenz (f_s) abwechselnd ein- und ausgeschaltet werden, um eine Versorgungsspannung mit der Schaltfrequenz (f_s) für einen Lastkreis (15) zu erzeugen, der parallel zu einem der gesteuerten Unterbrecher angeordnet ist und mindestens eine Lampe (L) und einen Resonanzkreis (23, 25) in Serie mit den Elektroden (17, 19) der Lampe umfaßt, wobei dem Lastkreise eine Steuerschaltung (41) zugeordnet ist zum Abschalten der Stromzufuhr zu dem Lastkreis im Fall eines schadhaften Verhaltens der Lampe (L), dadurch gekennzeichnet, daß die Steuerschaltung (41) ein Bandpaßfilter (35) umfaßt, das auf die Schaltfrequenz (f_s) des Inverters zentriert ist und dessen Eingangssignal von der Spannung an einen Punkt (P) des Lastkreises abhängt, wobei das Ausgangssignal von dem Filter ei-
ner dem Inverter (3) zugeordneten Steuereinrich-
tung (37, 39) zugeführt wird, um die Stromversor-
gung zu dem Lastkreis im Fall eines schadhaften
Verhaltens abzuschalten.

2. Versorgungsschaltung nach Anspruch 1, dadurch gekennzeichnet, daß ein Spannungstei-
ler (31, 33), an den das Bandpaßfilter (35) ange-
schlossen ist, parallel zu einem Zweig angeordnet
ist, der mindestens eine Komponente (23) des Last-
kreises (15) enthält.

3. Versorgungsschaltung nach Anspruch 2, dadurch gekennzeichnet, daß der Spannungstei-
ler parallel zu einem Zweig angeordnet ist, der ei-
en (7) der gesteuerten Unterbrecher (5, 7) und die
induktive Komponente (23) des Resonanzkreises
in Serie mit den Elektroden der Lampe (L) enthält.

4. Versorgungsschaltung nach einem oder mehreren
der vorangehenden Ansprüche, dadurch gekennzeichnet,
das das Bandpaßfilter (35) ein paralleles LC-Glied enthält, dessen Reso-
nanzfrequenz im wesentlichen der Schaltfrequenz
(f_s) des Inverters entspricht.

5. Versorgungsschaltung nach einem oder mehreren
der vorangehenden Ansprüche, dadurch gekennzeichnet,
das die Steuereinrich-
tung einen Amplitudendiskriminator (37) und eine
Verriegelungsschaltung (39) umfaßt, deren Aus-
gangssignal bei schadhaftem Verhalten der Lampe
einen hohen Wert annimmt, wobei das Ausgangs-
signal die Stromversorgung zu der Lastschaltung
abschaltet.

6. Versorgungsschaltung nach Anspruch 5, dadurch gekennzeichnet, daß der Amplitudendis-
kriminator eine Zener-Diode (59) umfaßt, die zwi-
schen dem Filter (35) und der Verriegelungsschal-
tung (39) angeordnet ist derart, daß die Eingangs-
spannung der Verriegelungsschaltung (39) hoch
ist, wenn die Ausgangsspannung des Bandpaßfil-
ters (35) größer ist als die Durchlaßspannung der
Zener-Diode.

7. Versorgungsschaltung nach Anspruch 5 oder 6, dadurch gekennzeichnet, daß die Verriegelungsschaltung zwei in Serie geschaltete inverternde Gatter (61, 63) mit positiver Rückkopplung auf-
weist.

8. Versorgungsschaltung nach einem oder mehreren
der Ansprüche 5 bis 7, dadurch gekennzeichnet, daß der Amplitudendis-
kriminator (37) ferner einen Kondensator (57) ent-
hält, der von der Ausgangsspannung des Bandpaßfilters (35) aufgeladen wird.

9. Versorgungsschaltung nach einem oder mehreren
der vorangehenden Ansprüche, dadurch gekennzeichnet, daß sie eine dem Band-
paßfilter (35) nachgeschaltete Zeitverzögerungs-
schaltung (71) aufweist.

Reivendications

1. Circuit d'alimentation pour lampe à décharge (L) comprenant un onduleur (3) avec des rupteurs commandés (5, 7) qui sont ouverts et coupés en alter-
nance à une fréquence de commutation (f_c) de fa-
çon à générer une tension d'alimentation à ladite
fréquence de commutation (f_c) pour un circuit de
charge (15) disposé en parallèle avec l'un desdits
rupteurs commandés et comprenant au moins une
lampe (L) et un circuit à résonance (23, 25) en série
avec les électrodes (17,19) de ladite lampe, un cir-
cuit de commande (41) étant associé audit circuit de
charge pour couper l'alimentation à destination
dudit circuit de charge en cas de fonctionnement
défectueux de la lampe (L), caractérisé en ce que
ledit circuit de commande (41) comprend un filtre
passe-bande (35) centré sur la fréquence de com-
mutation (f_c) dudit onduleur et dont le signal d'en-
trée est fonction de la tension en un point (P) du
circuit de charge, le signal de sortie à partir dudit
filtre étant envoyé à des moyens de commande
(37,39) associés audit onduleur (3) de façon à cou-
per l'alimentation à destination du circuit de charge
en cas de fonctionnement défectueux.

2. Circuit d'alimentation selon la revendication 1, ca-
ractérisé en ce qu'un diviseur de tension (31,33)
auprès du circuit passe-bande (35), est disposé
parallèlement avec un embranchement conté-
nant au moins un composant (23) du circuit de
charge (15).

3. Circuit d'alimentation selon la revendication 2, ca-
ractérisé en ce que le diviseur de tension est
monté en parallèle avec un embranchement com-
prénant l'un (7) desdits rupteurs commandés (5,7)
et le composant inductif (23) du circuit à résonance
est monté en série avec les électrodes de la lampe
(L).

4. Circuit d'alimentation selon une ou plusieurs des re-
vendications précédentes, caractérisé en ce que le-
dit filtre passe-bande (35) comprend une cellule L -
C en parallèle et dont la fréquence de résonance
est sensiblement correspondante à la fréquence de
commutation (f_c) dudit onduleur.

5. Circuit d'alimentation selon une ou plusieurs des re-
vendications précédentes, caractérisé en ce que
lesdits moyens de commande comprennent un discriminateur de niveau (37) et un circuit d'accrochage (39) dont le signal de sortie prend une valeur élevée en cas de fonctionnement défectueux de la lampe, ledit signal de sortie coupant l'alimentation à destination du circuit de charge.

6. Circuit d'alimentation selon la revendication 5, caractérisé en ce que le dit discriminateur de niveau comprend une diode Zener intercalée entre ledit filtre passe-bande (35) et ledit circuit d'accrochage (39), de telle sorte que l'entrée de tension dans le circuit d'accrochage (39) est élevée ai la sortie de tension par le filtre passe-bande (35) dépasse la tension de conduction de la diode Zener.

7. Circuit d'alimentation selon la revendication 5 ou 6, caractérisé en ce que ledit circuit d'accrochage comprend deux portes d'inversion en série (61,63) avec une rétroaction ou signal en retour positif.

8. Circuit d'alimentation selon une ou plusieurs des revendications 5 à 7, caractérisé en ce que ledit discriminateur de niveau (37) comprend de plus un condensateur (57) qui est chargé par la sortie de tension par le filtre passe-bande (35).

9. Circuit d'alimentation selon une ou plusieurs des revendications précédentes, caractérisé en ce qu'il comprend, en aval dudit filtre passe-bande (35), un circuit temporisateur - retardateur (71).