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## (54) Supply circuit for a gasdischarge lamp.

(57) Supply circuit for a gas-discharge lamp (6), comprising an oscillator (1) containing at least one first switching component (10, 11) which promotes the oscillation of the oscillator (1) and containing a feedback circuit (6, 7) comprising the lamp (6), suitable for generating and delivering to the lamp (6) an alternating supply voltage, and limiting means (25) connected to the switching component (11) which receive a derived voltage corresponding to the voltage delivered to the lamp (6) and which, for every cycle of the derived voltage, if the derived voltage reaches a predetermined value, drive the switching component (11) for the remainder of the cycle into a state other than the one before the predetermined value was reached.

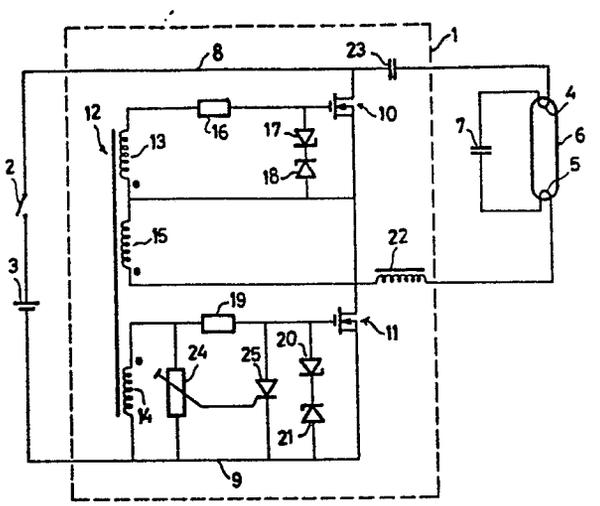


Fig.1.

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# Supply circuit for a gas-discharge lamp

The invention relates to a supply circuit for a gas-discharge lamp, comprising an oscillator containing at least one first switching component which promotes the oscillation of the oscillator and containing a feedback circuit comprising the lamp, suitable for generating and delivering to the lamp an alternating supply voltage.

A supply circuit of this type is known from Dutch Patent Application 84.03441. In the known supply circuit, the oscillator receives a direct voltage and the circuit delivers an alternating voltage having a frequency in the order of 30 kHz to 60 kHz across the lamp. The known supply circuit has the drawback that a high voltage, for example of 1.5 kV to 2 kV, may be delivered to the lamp during starting, or firing, or if the tube does not fire as a result of a fault although a current is in fact flowing through the filament thereof. This may present a dangerous situation for the user, for example during the installation of a lamp with supply circuit switched on. In addition, a so-called cold start may occur as a result of the high voltage during starting, in which process material is emitted from the cathodes, or filaments, of the lamp and deposits on the inside wall of the lamp, which shortens the service life of the lamp.

The object of the invention is to eliminate the drawbacks of the known supply circuit.

According to the invention, this object is achieved for a supply circuit of the type specified in the preamble by limiting means connected to the switching component which receive a derived voltage corresponding to the voltage delivered to the lamp and which, for every cycle of the derived voltage, if the derived voltage reaches a predetermined value, drive the switching component for the remainder of the cycle into a state other than the one before the predetermined value was reached. Consequently the maximum permissible voltage across the lamp can be set to a desired value, for example 900 V, with suitable dimensioning of the supply circuit and the possibility of the voltage across the lamp exceeding this maximum voltage is prevented and the occurrence of a cold start is prevented. Even if the lamp does not fire as the result of a fault, for example a leak, although oscillation occurs due to the presence of conducting filaments of the lamp, the possibility of the maximum voltage occurring across the lamp is prevented. Because the voltage across the lamp, and consequently the current in the output circuit of the oscillator containing the lamp, is limited, current-limiting capacitors parallel to the filaments of the lamp may be omitted. In addition, the limiting means may be provided in the oscillator instead of, for example, next to the lamp, as a result of which the limiting means may be common for a plurality of lamps connected to the oscillator, with the result that the cost price of the limiting means is relatively low for a plurality of lamps. In addition, the cost price is relatively low because the limiting means can be provided in a simple manner on a printed circuit board together with other components of the oscillator. In addition, the supply circuit according to the invention has the advantage that the voltage across the lamp, and consequently the light output of the lamp, can be controlled by suitably setting the predetermined value of the voltage derived from the voltage across the lamp.

The invention is explained with reference to the drawing. In the drawing:

Figure 1 shows a diagram of an embodiment of the supply circuit according to the invention; and

Figure 2 shows a diagram of the amplitude of the voltage across a good gas-discharge lamp and across a faulty gas-discharge lamp in the supply circuit of Figure 1 as a function of time.

The embodiment, shown in Figure 1, of the supply circuit according to the invention comprises an oscillator 1, indicated by a broken-line block, whose input side is connected to a direct voltage source 3 via a switch 2 and whose output side is connected to two filaments 4,5 of a gas-discharge lamp 6 and a capacitor 7 in series with the filaments 4,5. The capacitor 7 promotes the achievement of a positive feedback, with the result that the oscillator 1 is able to generate an alternating voltage having a frequency in the order of, for example, 30 kHz to 60 kHz across the lamp 6.

The oscillator 1 comprises two conductors 8,9 which are connected to the terminals of the direct voltage source 3. Connected in series with each other between the conductors 8 and 9 are two field-effect transistors 10 and 11. A transformer 12 has two control windings 13 and 14 and an output winding 15. A terminal of the controlwinding 13 is connected via a resistor 16 to the gate electrode of the field-effect transistor 10. The other terminal of the control winding 13 is connected to the source of the field-effect transistor 10. Two zener diodes 17 and 18 are connected in series with opposite polarity with respect to each other between the gate electrode and the source of the field-effect transistor 10.

A terminal of the control winding 14 having a polarity which is opposite to the polarity of the first terminal of the control winding 13 is connected to the gate electrode of the field-effect transistor 11 via a resistor 19. The other terminal of the control winding 14 is connected to the conductor 9. Two

zener diodes 20,21 are connected in series with opposite polarity with respect to each other between the gate electrode and the source of the field-effect transistor 11.

A terminal of the output winding 15 is connected to the source of the field-effect transistor 10 and the other terminal of the output winding 15 is connected to a terminal of the filament 5 of the lamp 6 via a choke coil 22. A direct voltage decoupling capacitor 23 is connected between the conductor 8 and a terminal of the other filament 4 of the lamp 6.

According to the invention, the oscillator 1 comprises limiting means which, in the embodiment of the supply circuit shown, are composed of a voltage divider, for example a potentiometer 24, connected in parallel with the control winding 14, and a thyristor 25 connected between the gate electrode and the source of the field-effect transistor 11, the gate electrode of which thyristor is connected to a tapping of the voltage divider, in the example the slider of the potentiometer 24.

The operation of the supply circuit shown in Figure 1 is as follows:

If the switch 2 is closed, the oscillator 1 will start to oscillate if the lamp 6 having conducting filaments 4 and 5 is fitted.

During oscillation, the gate electrodes of the field-effect transistors 10,11 receive, via the control windings 13,14 and the resistors 16 and 19 in series therewith, respective control voltages which, as a result of the magnetic coupling of the windings 13,14 and 15, are derived from the alternating voltage which is delivered to the lamp 6 and which is essentially sinusoidal. The amplitude of the control voltages is limited by the pairs of zener diodes 17,18 and 20,21 respectively. The control voltages delivered to the gate electrodes of the field-effect transistors 10 and 11 are consequently essentially square-wave voltages whose duty factor is 50% if the limiting means 24 and 25 are absent.

If the lamp 6 is not connected, no oscillation will occur. If a good lamp 6 is connected, the resistance thereof will have a relatively high value during starting and the resistance thereof will have a lower value after firing. If the limiting means 24 and 25 were absent, an alternating voltage having a relatively high amplitude, for example 2 kV, would be generated on starting the lamp 6. Such a high voltage may also occur if the lamp 6 is faulty, for example as a result of a leak. Such a high voltage is undesirable because it can create a dangerous situation and because a cold start may occur during starting, which limits the service life of the lamp 6.

If the limiting means 24 and 25 are present, the thyristor 25 will start to conduct if the voltage at the gate electrode of the thyristor 25 reaches a certain value, as a result of which the controlvoltage at the gate electrode of the field-effect transistor 11 becomes low, the field-effect transistor 11 blocks and the current through the series circuit containing the output winding 15 becomes smaller. After being rendered conducting during one of the two half cycles of the oscillator voltage, the thyristor 25 will remain conducting during essentially the remainder of said half cycle and will then block. Because the amplitude of the voltage across the control winding 14 varies as a function of time, the instant in time at which the thyristor will start to conduct with respect to the passages through zero in the oscillation cycle will depend on the dimensioning of the voltage divider. At the same time the duty factor of the square-wave voltages occurring at the gate electrode of the field-effect transistor 11 and at the connecting point of the two field-effect transistors 10 and 11 depends on the dimensioning of the voltage divider. Consequently, the energy content, and consequently the amplitude, of the sinusoidal alternating voltage across the lamp 6 depends correspondingly on the dimensioning of the voltage divider.

The voltage divider is preferably adjustable so that the instant in time with respect to the passages through zero of the oscillation cycle at which the thyristor 25 starts to conduct and therefore the quantity of energy delivered to the lamp 6 per oscillation cycle and therefore the desired maximum voltage across the lamp or lamps 6 can be set depending on the circumstances prior to installation of the supply circuit between a supply source such as 3, and one or more lamps 6.

If the voltage divider can be set from outside, a user can continually set the voltage divider after the installation in order to control the light output of the lamp or lamps 6 in doing so.

Figure 2 shows a diagram of the amplitude A of the alternating voltage delivered by the oscillator 1 to the lamp 6 as a function of time. Curve 26 relates to a faulty lamp 6 whose filaments 4 and 5 are in fact nevertheless able to conduct current. When the switch 2 is closed, the oscillator I will start to oscillate, during which process resonant rise of the output voltage occurs and after which a stabilization of the amplitude occurs after a short time, for example 10 ms, at a maximum permissible amplitude $A_{max}$ set by means of the limiting means 24 and 25.

The curve 27 shown in Figure 2 relates to a satisfactorily functioning lamp 6. If the switch 2 is closed, the still unfired lamp 6 between the oppositely situated filaments 4 and 5 represents a resistance having a relatively high value. For a short time after the oscillator 1 has started to oscillate, the output voltage across the lamp 6 will therefore have a relatively high value which is limited, how-

ever, to the maximum amplitude $A_{max}$ by the limiting means 24 and 25. When the lamp 6 has been fired after, for example, 200 ms, the lamp 6 represents a resistance having a relatively low value, as a result of which the amplitude of the voltage across the lamp 6 decreases to a value which depends on the voltage of the direct voltage source 3.

The invention thus offers a supply circuit for a gas-discharge lamp 6, in which the supply circuit has simple and cheap means for limiting the maximum permissible alternating voltage across the lamp 6.

It is pointed out that the invention can be used, in general, in oscillators having one or more switching components which promote the generation of an alternating voltage.

## Claims

1. Supply circuit for a gas-discharge lamp, comprising an oscillator containing at least one first switching component which promotes the oscillation of the oscillator and containing a feedback circuit comprising the lamp, suitable for generating and delivering to the lamp an alternating supply voltage, characterized by limiting means connected to the switching component which receive a derived voltage corresponding to the voltage delivered to the lamp and which, for every cycle of the derived voltage, if the derived voltage reaches a predetermined value, drive the switching component for the remainder of the cycle into a state other than the one before the predetermined value was reached.

2. Supply circuit according to Claim 2, characterized in that the limiting means comprise a second switching component connected to a gate electrode of the first switching component, a gate electrode of the second switching component receives a control voltage corresponding to the derived voltage and the second switching component drives the first switching component into the other state if the derived voltage reaches the predetermined value.

3. Supply circuit according to Claim 2, characterized in that the limiting means comprise a voltage divider which receives the derived voltage and a tapping of which delivers the control voltage.

4. Supply circuit according to Claim 3, characterized in that the voltage divider is adjustable.

5. Supply circuit according to one of Claims 2 to 4 inclusive, characterized in that the second switching component is a thyristor and the thyristor passes, during the conduction thereof, a current dependent on the derived voltage, the predetermined time essentially being limited by the passages through zero of the current passed.

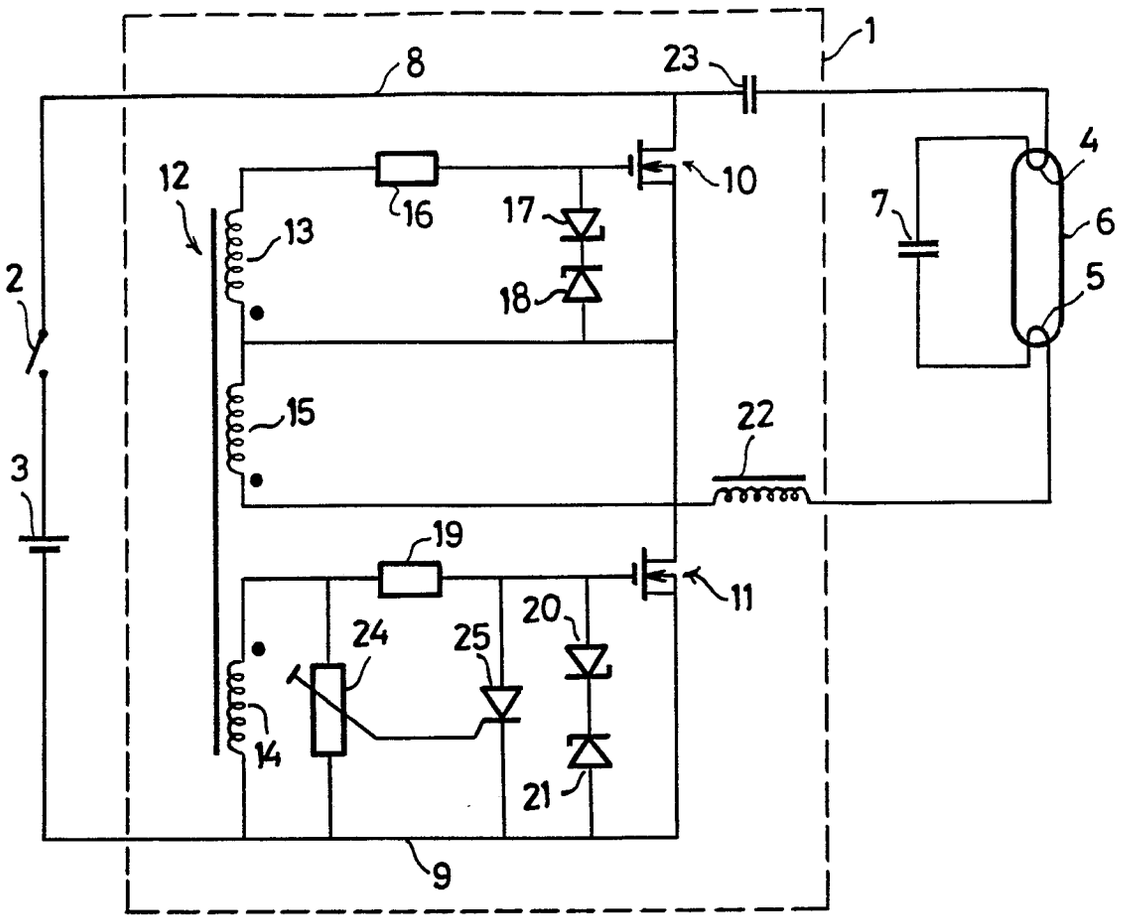
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Fig:1.

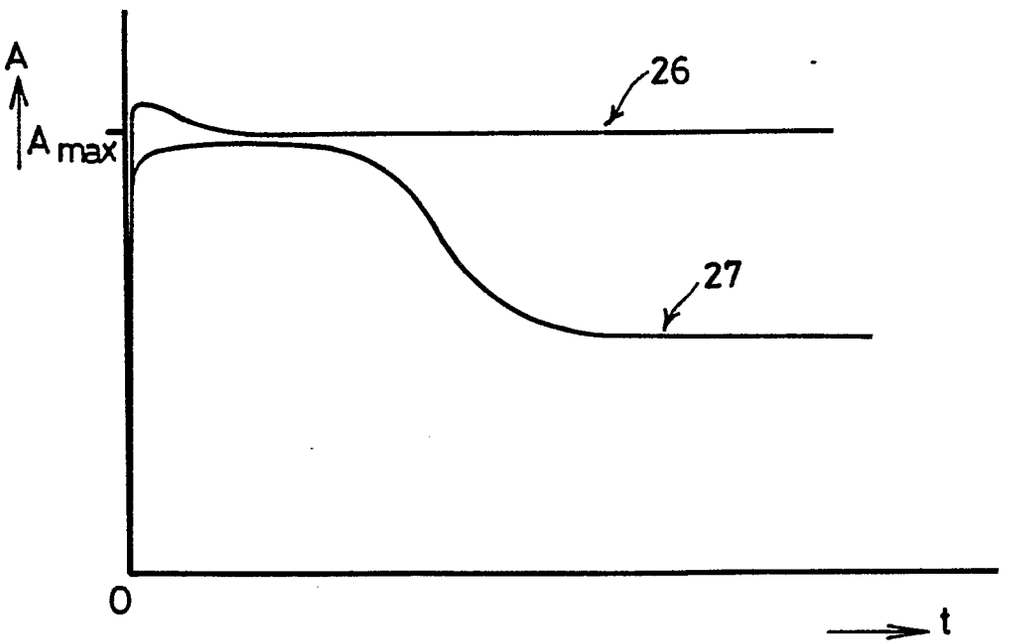
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Fig:2.

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# EUROPEAN SEARCH REPORT

Application Number

EP 89 20 3148

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5 ) |
|---|---|---|---|
| X | EP-A-239793 (PATENT TREUHAND)<br>* column 5, line 5 - column 6, line 15; figure 2 *<br>* abstract * | 1, 2 | H05B41/24 |
| X | US-A-4503363 (NILSSEN)<br>* the whole document * | 1, 2 | |
| A,D | NL-A-8403441 (MAARS)<br>* page 9, line 18 - page 9, line 30; figure 3 * | 1 | |
| A | WO-A-8800788 (SILVER GRUPPEN)<br>* page 12, line 26 - page 12, line 28; figure 1 * | 5 | |
| A | EP-A-189221 (PHILIPS) | | |

| TECHNICAL FIELDS SEARCHED (Int. Cl.5 ) |
|---|
| H05B |
| H02H |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 13 MARCH 1990 | SPEISER P. |

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