

Description

The invention relates to a circuit arrangement suitable for operating a low-pressure mercury discharge lamp by means of a high-frequency pulsatory current, comprising

- 5 - circuitry for generating the high-frequency pulsatory current with an amplitude A from a supply voltage,
- a modulator for modulation into a substantially square-wave shape of the high-frequency pulsatory current with a modulation frequency f and a duty cycle DC, and
- circuitry for adjusting the duty cycle DC.

10 A circuit arrangement as described in the opening paragraph is known from US-A- 4,219,760. In the known circuit arrangement, the luminous flux of the lamp can be adjusted through adjustment of the duty cycle DC while the modulation frequency f and amplitude A remain constant. The lamp operated in this way has a relatively high luminous efficacy also at a low value of the duty cycle DC.

A change in the duty cycle DC, however, not only influences the luminous flux but also the colour point of the light radiated by the lamp, which is regarded as unpleasant in many applications.

15 The invention has for its object to provide a circuit arrangement with which the colour point of the light radiated by the lamp is to a high degree independent of the value of the luminous flux of the lamp.

According to the invention, a circuit arrangement as described in the opening paragraph is for this purpose characterized in that the circuit arrangement is furthermore provided with circuitry for adjustment of the modulation frequency f.

20 It has been found that the colour point of the light radiated by the lamp is to a high degree independent of the value of the luminous flux through the adjustment of both the modulation frequency f and the duty cycle DC. A further advantage of the measure according to the invention is that the colour point of the light radiated by the lamp can be adjusted over a wide range, at a chosen value of the luminous flux, through the adjustment of both the modulation frequency f and the duty cycle DC.

25 In an advantageous embodiment of a circuit arrangement according to the invention, the circuit arrangement is provided with circuitry for adjusting the amplitude A of the substantially square-wave modulated high-frequency pulsatory current. This renders it possible to adjust besides the modulation frequency f and the duty cycle DC also the amplitude A of the substantially square-wave modulated high-frequency pulsatory current for a chosen value of the luminous flux of the lamp. The range over which the colour point can be adjusted for a chosen value of the luminous flux of the lamp is increased by this.

30 The substantially square-wave modulated high-frequency pulsatory current may be either unipolar or bipolar. In the former case it is usually desirable to commute the current through the lamp at a low frequency.

A circuit arrangement according to the invention is suitable for operating low-pressure mercury discharge lamps of various types, such as, for example, compact low-pressure mercury discharge lamps, conventional tubular low-pressure mercury discharge lamps and electrodeless low-pressure mercury discharge lamps.

35 The invention will be explained in more detail with reference to a drawing of an embodiment.

In the drawing

Fig. 1 shows a diagrammatic picture of the build-up of an embodiment of a circuit arrangement according to the invention and a lamp to be operated with it;

40 Fig. 2 shows the shape of a lamp voltage of a lamp operated with the circuit arrangement of Fig. 1;

Fig. 3 shows colour points of the lamp operated with the circuit arrangement of Fig. 1 for various luminous flux values, and

Fig. 4 shows various colour point settings of the lamp operated with the circuit arrangement of Fig. 1 at a given luminous flux.

45 The build-up of the circuit arrangement according to the invention shown in Fig. 1 is as follows.

P and Q are connection terminals suitable for being connected to a supply voltage source. I represents a current source which generates a high-frequency pulsatory current from the supply voltage. An output of the current source I is connected to an input of modulator II, which modulates the high-frequency pulsatory current into substantially a square-wave shape with a modulation frequency f and a duty cycle DC. An output of modulator II is connected to an input of circuit arrangement III with which an amplitude A of the substantially square-wave modulated current can be adjusted. A low-pressure mercury discharge lamp IV is connected between an output of the circuit arrangement III and an earth terminal.

55 V and VI are a circuit arrangement for adjusting the duty cycle DC and a circuit arrangement for adjusting the modulation frequency f, respectively. An output of the circuit arrangement V for adjusting the duty cycle DC is connected to an input of modulator II, while similarly an output of the circuit arrangement VI for adjusting the modulation frequency f is connected to a further input of modulator II.

The lamp voltage of the lamp IV is shown in Fig. 2 as a function of time.

The time dimension is plotted on a horizontal axis and the voltage dimension on a vertical axis. S is a high-

frequency substantially square-wave modulated pulsatory voltage which is present across the lamp when the lamp is operated by means of a high-frequency substantially square-wave modulated pulsatory current. B is the width of one square wave and C is a cycle of the substantially square-wave modulation. The cycle C is related to a modulation frequency f in the following way: $C = 1/f$. The duty cycle DC is related to the square wave width B and the cycle C in the following way: $DC = B/C$. The square wave width B, cycle C, duty cycle DC, and modulation frequency f of the high-frequency substantially square-wave modulated pulsatory current across the lamp are equal to the corresponding quantities of the high-frequency substantially square-wave modulated pulsatory current. An increased amplitude of the high-frequency voltage pulses D is the result of the ignition of the lamp at the beginning of each square wave. E and F are a rising and a trailing edge, respectively, of the substantially square-wave modulation.

Fig. 3 shows various colour point settings for various luminous flux values of the lamp IV, in this case an electrodeless low-pressure mercury lamp.

Fig. 3 represents part of the colour triangle in which curve G shows the drift of the colour point of the lamp when the luminous flux of the lamp is reduced at a modulation frequency f of 10 kHz by a reduction of the duty cycle DC of the substantially square-wave modulated high-frequency current pulses with which the lamp is operated. Point 1 is the colour point of the light radiated at a maximum luminous flux. Points 2 and 3 are the colour points of the light when the luminous flux is reduced to 50% and 10% of the maximum luminous flux of the lamp, respectively. In colour points 2' and 3' the luminous flux of the lamp is also 50% and 10% of the maximum luminous flux, respectively. However, the colour points 2' and 3' were realized by adjustment of not only the duty cycle DC but also the modulation frequency f : the modulation frequency is 200 kHz in colour point 2' and in point 3' the modulation frequency is 1 kHz.

The luminous flux was found to be approximately independent of the modulation frequency f and substantially directly proportional to the duty cycle DC. The distribution of the points in Fig. 3 clearly illustrates that the position of the colour point of the lamp, when the luminous flux is changed, is to a high degree independent of the value of the luminous flux owing to the adjustment of both the modulation frequency f and the duty cycle DC.

The lamp was provided with a spherical lamp vessel having a diameter of approximately 110 mm, into which argon was introduced with a filling pressure of 33 Pa (at 300 K). A quantity of amalgam consisting of mercury, bismuth and indium was also present in the lamp vessel. The wall of the lamp vessel was provided with a luminescent layer comprising a mixture of red luminescing yttrium oxide activated by Eu (3+), green luminescing cerium-magnesium aluminate activated by Tb (3+) and blue luminescing barium-magnesium aluminate activated by Eu (2+). The frequency of the high-frequency current pulses was 2,65 MHz. The results shown in Fig. 4 were obtained with the same lamp.

Fig. 4 shows various colour point settings of the lamp at the same luminous flux.

In Fig. 4, the points 6 to 18 are different colour points of the light radiated by the lamp realized at a constant luminous flux of 1000 lumens through adjustment of the duty cycle DC, the modulation frequency f , and the amplitude A of the substantially square-wave modulated high-frequency pulsatory current.

The curve H approximates the path over which the colour point was varied. In the present case such settings of the three parameters were chosen that each colour point on the curve H is experienced by the human eye as a pleasant colour, while following of the curve H from left to right corresponds to a transition from "cool white" to "warm white" light. The curve H illustrates the possibility of adjusting the colour point over a wide range for a given luminous flux of the lamp.

Table I below gives a few colour point settings for two different luminous fluxes of a low-pressure mercury lamp provided with electrodes.

The lamp was a conventional tubular fluorescent lamp with a power rating of 32 W and a rated luminous flux of 3200 lumens.

The Table clearly shows that the colour point of the lamp can be adjusted over a wide range by setting different values for the modulation frequency f and the duty cycle DC, given a chosen value of the luminous flux.

TABLE I

	luminous flux	modul. frequency f (kHz)	duty cycle (%)	colour point X-coord.	colour point Y-coord.
5					
10	1000	0.2	32	0.388	0.387
	1000	2	25	0.378	0.376
	2000	2	55	0.388	0.380
15	2000	10	44	0.393	0.385

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Claims

1. A circuit arrangement suitable for operating a low-pressure mercury discharge lamp by means of a high-frequency pulsatory current, comprising
- circuitry (I) for generating the high-frequency pulsatory current with an amplitude A from a supply voltage,
 - a modulator (II) for modulation into a substantially square-wave shape of the high-frequency pulsatory current with a modulation frequency f and a duty cycle DC, and
 - circuitry (V) for adjusting the duty cycle DC,
- characterized in that the circuit arrangement is further provided with
- circuitry (VI) for adjusting the modulation frequency f.

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Patentansprüche

1. Geeignete Schaltungsanordnung zum Betreiben einer Niederdruckquecksilberdampfentladungslampe mit Hilfe eines pulsierenden Hf-Stroms, mit folgenden Elementen:
- Schaltungen (I) zum Erzeugen des pulsierenden Hf-Stroms mit einer Amplitude A aus einer Speisespannung,
 - einem Modulator (II) zum Modulieren des pulsierenden Hf-Stroms in eine nahezu rechteckige Form mit einer Modulationsfrequenz f und einem Tastverhältnis DC, und
 - Schaltungen (V) zum Einstellen des Tastverhältnisses DC,
- dadurch gekennzeichnet, daß die Schaltungsanordnung außerdem versehen ist mit
- Schaltungen (VI) zum Einstellen der Modulationsfrequenz f.

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Revendications

1. Dispositif de commutation conçu pour le fonctionnement d'une lampe à décharge dans la vapeur de mercure à basse pression au moyen d'un courant impulsionnel à haute fréquence, comportant
- des circuits (I) pour engendrer à partir d'une tension d'alimentation un courant impulsionnel à haute fréquence présentant une amplitude A,
 - un modulateur (II) pour moduler le courant impulsionnel à haute fréquence en une forme sensiblement rectangulaire, présentant une fréquence de modulation f et un rapport cyclique DC, et
 - des circuits (V) pour ajuster le rapport cyclique DC,
- caractérisé en ce que le dispositif de commutation est encore muni
- de circuits (VI) pour ajuster la fréquence de modulation f.



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 - Schaltungen (I) zum Erzeugen des pulsierenden Hf-Stroms mit einer Amplitude A aus einer Speisenspannung,
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 - Schaltungen (V) zum Einstellen des Tastverhältnisses DC,dadurch gekennzeichnet, daß die Schaltungsanordnung außerdem versehen ist mit
 - Schaltungen (VI) zum Einstellen der Modulationsfrequenz f.

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 - de circuits (VI) pour ajuster la fréquence de modulation f.