Title: OUTPUT CIRCUIT OF AN ELECTRONIC BALLAST FOR A FLUORESCENT LAMP

Abstract: A modified output circuit of the electronic ballast for a fluorescent lamp comprises lamp tubes, a capacitor (C1), an inductor (L), a thermistor (RT) and a second capacitor (C3), the two leads of the capacitor (C1) and inductor (L) are respectively connected to the two output ends of the frequency converter of the electronic ballast and one of the pins (A, C) of the electrode at one side of the lamp tube (21), the two leads of the thermistor (RT) are respectively connected to the electrode pins (B, D) at the other side of the lamp tube, which can decrease the current flowing through the filament and eliminate the irregular peak voltage wave-form generated on the filament, and can make the phosphor powder consumed slower.
Description

Output Circuit of an Electronic Ballast for a Fluorescent Lamp

The present invention relates to an output circuit of an electronic ballast for a fluorescent lamp.

The electronic ballast for a fluorescent lamp available on the market consists of a filter, a rectifier, a frequency converter and a general output circuit 1, as shown in Fig. 1. The output circuit 1, in addition to tubes 11, includes a resonance circuit composed of capacitors C1, C2 and an inductor L, a pair of lamp tubes which serve as a preheater and a starter and are connected in parallel to a thermistor RT and a capacitor C2. The resonance circuit provides an operation voltage approximate to sine wave for the lamp tube, and the inductor L in this circuit also serves as a ballast. Two filaments or electrodes r1 and r2 of the tube 11 are made of twin-screw tungsten wire, the middle portion of the lamp tube is coated with phosphor powder G, both ends of the lamp tube are supported and fixed by side bars M, as shown in Fig. 2 (Fig. 2 is an amplified diagram for the structure of one of the two electrodes). Tungsten filament H has a resistance property and the phosphor powder G is capable of transmitting electrons under certain temperature.

When the above output circuit is working, transient high frequency current i1, after passing through capacitor C1 and when entering electrode r1 of the lamp tube, is divided into three paths of current i2, i3 and i4, and then is converged to pass a circuit formed by inductor L. Current i2 flows through lamp tube 11 and is the maximum sub-current necessary for keeping the lamp tube 11 to discharge; current i3 flows through capacitor C2, its function is to constantly heat electrodes r1 and r2 auxiliarily; current i4 has a relatively small current value at normal lighting and generally can be ignored for analysis. The lamp tube 11, when lighted, will generate a voltage drop at both ends
since the current flows through electrodes r1 and r2, at the point E of the tungsten filament H, there exists a maximum positive potential or negative potential, point E is likely to be bombed by both positive and negative ions existing quantitatively in the discharge space, thus forming a substantially fixed heat point; point F is at the edge of phosphor powder G and closest to point E. Thus, in the entire coating layer of phosphor powder, point F has a highest temperature, thus forming an electronic transmission point. When the heat of the heat point (point E) raises the temperature of point F high enough to make the electrodes of the lamp tube capable of transmitting, the space in vicinity of the electrode transmitting point of normal activity will form an electron cloud layer. At this time, the electrode has the lowest potential drop, if the temperature is not high enough, there is no electronic cloud layer, and the electrode potential drop rises, making the bombard energy of the ions grater, thus resulting in the temperature rise of the heat point until the transmitting point forms an electronic cloud layer, this is a process of automatic balancing. After the transmitting point forms an electronic cloud and the heat point stabilizes, if the capacitance of capacitor C2 is relatively large, the current flowing through the filament is also large, thus making the temperature of the transmitting point rising too high. It is shown by experiments that the current i3 flowing through capacitor C2 is an important reason to accelerate the consumption of phosphor powder G. When the tube is lit, current i3 forms a voltage drop on electrodes r1 and r2, making to form a potential difference between the transmitting point and the heat point. Along with the removal of the transmitting point, this potential difference becomes greater, so does the bombard energy of the ions, thus making the temperature of the filament rising and hence accelerating the evaporation and sputtering consumption of the phosphor powder. In addition, unnecessary power consumption is also increased and the emitting efficiency of the lamp is lowered. What is more serious is that current i3 is a multi-peak wave-form, as shown in Fig. 3. When this current flows through electrodes r1 and r2, it brings about a multi-peak voltage fluctuation, thus making the transmitting point bombarded more strongly by the ions, the phosphor powder seriously sputtering and further accelerating the consumption of the phosphor powder, and hence shortens the life time of the lamp tube.
The phosphor powder is continuously consumed because the powder G at the transmitting point of the filament is frequently sputtered and evaporated due to bombardment when the lamp tube is lit, the position of the transmitting point also moves gradually away from the heat point along with the consumption of the phosphor powder. When the phosphor powder on the filament is exhausted, the lamp tube will stop working and its life terminates. So, the consumption speed of the phosphor powder is directly related to the life time and emitting efficiency of the lamp tube.

An object of the present invention is to overcome the above defects and to provide an output circuit of the electronic ballast for a fluorescent lamp for controlling the consumption speed of the phosphor powder and for increasing the life time and emitting efficiency of the lamp tube.

To realize the above object, the output circuit of the electronic ballast for a fluorescent lamp according to this invention comprises lamp tubes, a capacitor, inductor and a thermistor, two leads of said capacitor and inductor are respectively connected to the two output terminals of the frequency converter of the electronic ballast and one of the pins of the two electrodes at one side of the lamp tube, two leads of said thermistor are connected to pins of two electrodes at the other side of the tube and in that said output circuit further comprising a second capacitor, its two leads are each connected to the two electrode pins of the tube in a manner of connection to capacitor and inductor.

In the output circuit of the electronic ballast for fluorescent lamp according to this invention, said second capacitor has a capacitance of 1000 to 30000 pF.

The output circuit of the electronic ballast for fluorescent lamp according to this invention further comprises a third capacitor, which is connected to the two electrode pins of the lamp tube in a manner of connection in parallel to the thermistor, its capacitance is equal to or less than 2000 pF.

The output circuit of the electronic ballast for fluorescent lamp according to this invention, due to the addition of a second capacitor at the electrode pins on the bases of lamp
tube, capacitor, inductor and thermistor, can decrease the current flowing through the filament and eliminate irregular peak voltage wave form generated on the filament, making the phosphor powder consumed more slowly and hence serving to increase the lifetime and emitting efficiency of the lamp tube.

In order to comprehend the object, features and advantages of this invention more clearly, the preferred embodiments of this invention will be explained in detail in conjunction with the accompanying drawings.

Fig. 1 is a diagram showing the prior art output circuit of an electronic ballast for a fluorescent lamp;

Fig. 2 is an amplified view of a structure of an electrode of a lamp tube of one of the filaments;

Fig. 3 is a diagram of the current wave-form of the current flowing through a resonant capacitor and the tube when the fluorescent lamp of Fig. 1 is lit;

Fig. 4 is a diagram showing the circuit of a preferred embodiment of this invention;

Fig. 5 is a diagram showing the circuit of another preferred embodiment of this invention.

Referring to Fig. 3, there is shown an oscillogram of the current passing through the electrodes r1 and r2 of the tube 11 of the circuit according to Fig. 1. This current of the tube 11 when lighted shows a multi-peak wave form.

Please refer to Fig. 4, this diagram shows a preferred embodiment of a modified output circuit 2 of the electronic ballast for a fluorescent lamp, comprising lamp tube 21, capacitor C1, inductor L, thermistor RT and second capacitor C3. Two leads of said capacitor C1 are respectively connected to the frequency converter of the electronic ballast, i.e., an output end of the frequency converter after the filter and rectifier and pin A of an electrode r1 at the side of the lamp tube 21, two leads of said inductor L are respectively connected to the other output end of the frequency converter of the electronic ballast and to pin C of an electrode r2 at the side of the lamp tube 21, two leads of said
thermistor RT are respectively connected to pins B, D of two electrodes r1, r2 at the
other side of the tube 21, said second capacitor C3 has a capacitance of 1000 - 30000
pF, its two leads are respectively connected to the two electrode pins A, C of the tube in
a manner of connection to capacitor C1 and inductor L. The second capacitor C3 is
established for forming a resonance circuit, which will avoid producing an irregular
voltage wave-form with peaks on electrodes r1 and r2 (this is because that the original
capacitor C2 is cancelled, so current i3 in the output circuit 1 of the prior art will not
exist), at the same time, the voltage drop on r1, r2 of tube 21 will also decrease, thus,
the consumption of the phosphor powder will be decreased when the lamp tube 21 is
working, and the consumption of energy will also be decreased so that the life time and
emitting efficiency will be increased. Capacitor C3 is a polyester medium capacitor
which is adopted to withstand 1000 V.

When the above output circuit 2 is used, an energy-saving lamp is taken as the lamp
tube 21, after the lamp tube is lit for 2000 hours, observation and test show that the
phosphor powder is consumed very little, the transmitting point moves very little, the
glass wall of the fluorescent lamp blackens slightly, and the maximum value of the tem-
perature rise for the heat point is only about 80 °C.

When output circuit 1 of the prior art as shown in Fig. 1 is used, under the same lamp
tube power and lighting condition, observation and test show that the phosphor powder
has been consumed seriously, the transmitting point moves greater relatively, the glass
wall near the electrode is deposited with the phosphor powder sputtered and blackens
seriously, the temperature of the heat point on the cathodes raises by about 200 °C.

According to the observation and test of the above two output circuits and the compari-
son of the life time and emitting efficiency of the lamp, the differences lies in that the
output circuit 2 of the electronic ballast for the fluorescent lamp according to this in-
vention can increase more than 20 % of life time over the output circuit 1 of the prior
art, and the emitting efficiency of the lamp tube can increase 5 %.
Please refer to Fig. 5, which shows output circuit 3 of the electronic ballast for the modified fluorescent lamp of another preferred embodiment according to this invention. In addition to all the modules and connection modes of output circuit 2 for the above embodiment, this output circuit also includes a third capacitor C2’, which is connected to the two cathode pins B, D lamp tube 21 in a manner of connection in parallel to thermistor RT, its capacitance is equal to or less than 2000 pF. The third capacitor C2’ used here is different from that in the output circuit of the prior art, the capacitance of the original capacitor C2 having been greatly decreased, thus, the value of current i3 flowing through the filament does not work, so the irregular peak voltage wave form will not be generated on the filament, thus serving to increase the life time and emitting efficiency of the lamp.
Claims

Output Circuit of an Electronic Ballast for a Fluorescent Lamp

1. An output circuit of an electronic ballast for a fluorescent lamp (21), comprising a lamp tube (21), a capacitor (C1), an inductor (L) and a thermistor (RT), wherein two leads of said capacitor (C1) and inductor (L) each are connected to one of the two output terminals of the frequency converter for the electronic ballast and one of the pins (A, C) of the two electrodes on one side of the lamp tube (21), two leads of said thermistor (RT) are connected to the pins (B, D) of the two electrodes on the other side of the lamp tube (21), and further comprising a second capacitor (C3), whose two leads each are connected to the pins (A, C) of the two electrodes of the lamp tube (21) in a manner of connection to the capacitor (C1) and inductor (L).

2. The output circuit of an electronic ballast for a fluorescent lamp according to claim 1, characterized in that: said second capacitor (C3) has a capacitance of 1000-30000pF.

3. The output circuit of an electronic ballast for a fluorescent lamp according to claim 1 or 2, characterized in that: it further comprises a third capacitor (C2'), which is connected to the pins (B, D) of the two electrodes for the lamp tube in a manner of parallel connection to the thermistor, its capacitance is equal to or less than 2000pF.
Fig. 3
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 H05B41/298 H05B41/295

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)

IPC 7 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**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 4 647 820 A (CHERMIN HUBERTUS M J ET AL) 3 March 1987 (1987-03-03) abstract; figure 1 column 1, line 42 -column 1, line 60 column 4, line 30 -column 6, line 46</td>
<td>1-3</td>
</tr>
<tr>
<td>A</td>
<td>DE 30 14 419 A (SIEMENS AG) 22 October 1981 (1981-10-22) page 16, line 23 -page 16, line 35; figure 4</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>US 5 880 564 A (FRANCK FELIX) 9 March 1999 (1999-03-09) column 1, line 7 -column 1, line 34; figure 1 column 4, line 13 -column 4, line 17</td>
<td>1</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents:
  *A* document defining the general state of the art which is not considered to be of particular relevance
  *E* earlier document but published on or after the international filing date
  *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  *O* document referring to an oral disclosure, use, exhibition or other means
  *P* document published prior to the international filing date but later than the priority date claimed
  *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
  *&* document member of the same patent family

Date of the actual completion of the international search: 26 August 2002

Date of mailing of the international search report: 03/09/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5618 Patentlaan 2 NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3010

Authorized officer: Ferla, M
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
</table>
| A        | US 5 502 423 A (OKUDE AKIO ET AL)  
26 March 1996 (1996-03-26)  
column 4, line 55 - column 4, line 59;  
figure 1 | 1 |
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 4647820</td>
<td>03-03-1987</td>
<td>NL 8400923 A</td>
<td>16-10-1985</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 54237 T</td>
<td>15-07-1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 1235455 A1</td>
<td>19-04-1988</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 3578495 D1</td>
<td>02-08-1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0156439 A1</td>
<td>02-10-1985</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 541408 D0</td>
<td>16-05-1986</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 8607664 A1</td>
<td>01-11-1986</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2073704 C</td>
<td>25-07-1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 7093198 B</td>
<td>09-10-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 60218799 A</td>
<td>01-11-1985</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 8316 T</td>
<td>15-07-1984</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BE 888412 A1</td>
<td>31-07-1981</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 8103102 A1</td>
<td>29-10-1981</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FI 811179 A,B</td>
<td>16-10-1981</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IT 1137447 B</td>
<td>10-09-1986</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZA 8102504 A</td>
<td>28-04-1982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2205344 A1</td>
<td>15-11-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 59705440 D1</td>
<td>03-01-2002</td>
</tr>
<tr>
<td>US 5502423</td>
<td>26-03-1996</td>
<td>JP 7057887 A</td>
<td>03-03-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1099216 A,B</td>
<td>22-02-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 4413946 A1</td>
<td>27-10-1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 2277415 A,B</td>
<td>26-10-1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 7006889 A</td>
<td>10-01-1995</td>
</tr>
</tbody>
</table>