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(54) Preheat start-up device for fluorescent lamps.

(57) A fluorescent lamp preheating start-up device to be used in the preheating start-up of fluorescent lamp. It consists of hot bonded temperature sensitive resistance layer (sheet) and voltage sensitive switching resistance layer (sheet), a silver conductive layer is coated between the two layers, and the periphery thereof is sealed with a sealing film. A lead is led out from each of the surface electrodes of said two resistance layers (sheets) of different characteristics, respectively. In operation, it is serially connected in the loop of the filament after the parallel connection of the present device with the resonant capacitor C in the electronic ballast. The device has both the characteristic of temperature resistance and the function of voltage switch. In normal operation of the light tube, the power consumption of the present device is only 0.4 to 5% of that of an ordinary PTC device. In addition, the self-temperature-rise is low and the starting time is appropriate.

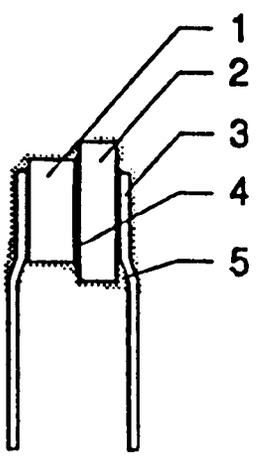

Fig.3

EP 0 663 789 A1

This invention relates to the start-up technique applied to gas filled lamps, and particularly to the start-up technique employed with electronic ballast fluorescent lamps. The invention may also be applicable to other types of discharge lamps.

More particularly, the invention relates to a preheating start-up device for electronic ballast fluorescent lamps and a method of producing same.

Fluorescent lamps have been widely used as an efficient lighting device and require, during normal operation, accessories such as current limiting means and start-up means. Current limiting means (ballast) frequently used are electronic and lamps using such current limiting means are known as high frequency lamps. These have the advantage of a low voltage start-up. The start-up means used as the operating switch in such lamps are the so-called "jumping bulb" glow starter. This is a monodirectional glow heat sensitive switch having a pair of head closing metallic electrodes sealed into a glass shell filled with an inert gas. The normal operative gas discharging voltage of the filament at the two ends of the fluorescent tube can be reached to cause glow of the light tube. This method of starting glow is known as high voltage quick cold start-up under normal temperature and does not involve any apparent preheating process of the filaments of the light tube during the starting procedure. Accordingly the light tube can only be started under high voltage conditions together with an impulse of high current (approximately 2.5 times the operating current of the lamp). Such high voltage quick cold starting may cause direct damage of the filament and the electron powder and may also cause the "rectifying effect" of asymmetric electron emitting, both affecting the life of the light tube.

More recently, fluorescent lamps have been developed which are gas charging lamps of the cathode preheating type, which are hot starting lamps. In order to prolong the life of a light tube it is important to "hot start" the light tube in preheating conditions, that is, the tube is lit at a relatively low open line voltage (such as at 300 to 400 volts instantaneous peak starting voltage) after a period of preheating the filaments. This is advantageous to prevent the filament and its superficial electron emitting material from "spurting out", whereby, the life of the light tube can be prolonged.

Heat sensitive resistors are relatively commonly adopted in making preheating type glow starters. This is a device having a positive temperature coefficient (PTC), which has been described in detail in US patent number 3,444,399. PTC thermistors have temperature sensitive characteristics and are directly used in electronic circuits to compensate for voltage change and to provide a stable current passing through the circuit load. Chinese Utility Model Patent number 92219487 discloses utilising a PTC in fluorescent lamp glow preheating. The fluorescent lamp starting preheater disclosed therein is a thermistor having a positive temperature coefficient and Curie point or switching temperature. The two terminals of the preheater are coupled to the two thermals of the main oscillatory circuit of the electronic ballast serially connected to the two filaments of the fluorescent lamp, respectively, as shown in Fig 1 hereof. It is necessary to match the parameters and volume of the PTC with the electronic parameters of the light tube when the PTC is utilised as a preheating device and this is difficult to achieve. In addition, the PTC itself also consumes power, its temperature rise is high and its starting time is relatively long (about three seconds).

It is an object of the present invention to provide a fluorescent lamp preheating starter having both the characteristics of positive temperature resistance and the function of a voltage switch and/or to provide a fluorescent lamp preheating starter having suitable start-up time and easy matching with the electric parameters of the light tube; and/or to provide a fluorescent lamp preheating starter having low power consumption per se and low temperature rise; and/or to provide improvements generally.

According to the invention there is provided a preheating starter-up device for electronic ballast fluorescent lamps and a method of producing same as claimed in the accompanying claims.

In an embodiment of the invention there is provided a preheating start-up device for electronic ballast fluorescent lamps constructed in the following manner. Two materials are used. One (referred-to below as the "V" layer) of which comprises more than 80% zinc oxide with minor additions of oxides of bismuth, antimony, cobalt and manganese. The other one (referred-to below as the "T" layer) of which comprises a mixture of oxides comprising more than 70% by weight of a barium and strontium and titanium complex oxide. These materials are mixed, respectively, and compressed to form circular sheets of 4-7mm diameter, and shaped by sintering. Each of the two surfaces of each sheet is then coated with a conductive layer of silver, thereafter, the two sheets obtained are hot bonded into an integrated body to form a chip. In the chip, the portion comprising a complex oxide of (inter-alia) barium is designated the "T" layer, while the portion mainly comprising zinc oxide is designated the "V" layer. Connecting leads are led out from the surfaces of the two layers, respectively, and together they form a fluorescent lamp automatic preheating/switch device, referred to as a VT device. The VT device is serially connected into the fluorescent lighting circuit. The above-men-

tioned chip of the VT device is then sealed into a coating of burn - resistant epoxy powder with is integrated by heating to form a complete device. The fluorescent lamp automatic preheating/switching device thus formed is serially connected in the loop of the filament of the fluorescent lamp after the parallel connection of the two leads with a resonant capacitor.

The "V" layer in the VT device behaves as a voltage sensitive switching resistor, it operates as a voltage sensitive switch and increases the initial current, speeds up the variation of resistance of the "T" layer and improves the starting speed of the light tube. The "T" layer in the VT device behaves as a PTC, which functions to delay the rise of the voltage in the light tubes circuit and prevents the exceeded current from passing through the "V" layer.

The selection of materials constituting the VT device and the ranges of its electric parameters can be varied accordingly depending on the features of the lamps with which they are used.

In use, voltage is applied to the two terminals of a fluorescent lamp. As the cold state conducting voltage of the light tube is higher than 600V, when the conducting voltage of said VT device is only approximately 150V, the VT device is first made conductive at a relatively low voltage, thus, the two terminals of the VT device lower the peak voltage.

Since the voltage at the two terminals of the light tube is maintained only at the voltage value of the voltage sensitive switch of the VT device, that is approximately 180V, therefore the lamp is not conductive. During this period, the current in the whole circuit passing through the VT device (approximately 80 mA) and the charging and discharging currents of the resonant capacitor C heat the filaments, and at the same time, the VT device is also heated.

The resistance of the temperature sensitive device in the VT device increases with the rise of temperature, that is, the voltage of the two terminals of the light tube increases continuously (V = IR), finally, when this voltage reaches the heat conducting voltage of the tube, ie 300 to 400V, the light tube becomes conductive and the gas inside the tube discharges, subsequently the voltage at the two terminals of the light tube or the two terminals of the VT device lowers to the normal working voltage of the light tube, ie approximately 70-90V, and at this stage the VT device converts to an "off" state.

Thus, in spite of the fact that there is a capacitance of about 350 PF in the VT device together with an internal resistance of about 1kW, there will still be a weak current under the high frequency power supply. During the passing through of these currents in the VT device, there will be a power consumption of about 0.015 Watt, but as compared with the self-power-consumption of ordinary PTC (approximately 0.4 Watt), it has been greatly reduced.

When the fluorescent lamp preheating starter of the embodiments is utilised, in addition to the fact that the temperature controlled impedance feature of ordinary PCT is maintained, there is also the function of a voltage switch, thereby, the power consumption of the preheating starter of the present invention during the normal working period of the fluorescent lamp is only 0.4 to 5% of that of the PTC.

The consequent advantages are that the rise of temperature of said device is low, it is easy to realise parameter matching with the light tube and the starting time is also appropriate. The reliability of the operation of the light tube can be improved, and the life of the light tube can be prolonged.

Embodiments of the invention will now be described by way of example only with reference to the accompanying illustrative drawings in which :

Fig 1 shows a circuit diagram showing a fluorescent lamp utilizing the prior art PTC preheating starting device;

Fig 2 shows a circuit diagram showing a fluorescent lamp utilising the VT preheating starting device of the present invention;

Fig 3 is a schematic drawing showing the structure of the VT preheating starting device of the present invention; and

Fig 4 is a schematic drawing showing a modification of the VT preheating starting device of the present invention.

As shown in Fig 2, the device indicated by the symbol VT is a fluorescent lamp preheating starting device or automatic glow starter/switch device of the present invention, which constitutes a serial circuit with the electronic ballast and the filaments and is connected in parallel with the resonant capacitor C.

Fig 3 shows a schematic diagram illustrating the structure of a fluorescent lamp preheating starting device, wherein the temperature sensitive resistance layer or "T" layer or sheet 1 comprises a mixture of oxides comprising more than 70% by weight of a barium and strontium and titanium complex oxide. In this embodiment the complex oxide has the molecular formula (0.878 Ba + 0.122 Sr + Ti) 0_3. The mixture contains oxides in the proportions given by one mole of this latter oxide mixed with the mole percentages now indicated of the following additional oxides : 0.05-0.3mol% NB_2O_5 and 0.8-3mol% SiO2 and 0.2-0.8mol% Al203 and 0.4-1.5mol% TiO2 and 0.03-0.08mol%CaO and 0.005 (or 0.05) - 0.01mol% MnO2 and 0.04-0.8mol%MgO.

The resistance layer has the properties of a heat sensitive resistor and is coated with a conductive layer, the Curie Point of which is 65^{0}C to 100^{0}C, and its resistance at normal temperature is 700 to 1200 . It corresponds to an MZ11PTC heat sensitive resistor.

The voltage sensitive switching resistance V layer or sheet 2 comprises a mixture comprising more than 80% zinc oxide with minor additions of oxides of bismuth, antimony, cobalt and manganese. In this embodiment the molecular percentages are as follows : 95-98mol% ZnO plus 0.1-5mol% of each of Bi2O, Sb2O3, CoO and MnO.

The V layer or sheet is a voltage sensitive structure, the voltage value of the voltage sensitivity is 120-160 volts, and the mean features of which are similar to that of an MYD-07K95 voltage sensitive resistor.

One surface of this voltage sensitive switching resistance layer (sheet) 2 is hot bonded with the above-mentioned temperature sensitive resistance layer (sheet) 1 by solder 4. Said solder is a tin plated brass wire solder attached with D4D-87 silver epoxy conductive glue. The thickness of the silver layer is 0.06 mm and being able to withstand temperatures of 300^{0}C, it is in fact a conductive layer. Leads 3 are connected to the temperature sensitive resistance layer (sheet) 1 and the voltage sensitive switching resistance layer (sheet) 2 respectively. The two layers 1 and 2 are hot bonded together to form an integrated body.

The above apparatus is sealed by a coating film 5 comprising epoxy powder to form an automatic starter/switch VT device having both temperature controlled impedance characteristics and voltage switching characteristics.

The main parameters of the automatic starter/switch VT device are as follows :

Switching voltage : 120 to 160 Volt

Curie point : 65^{0}C to 100^{0}C

Internal resistance (normal temperature) : 700 Ω to 1200 Ω.

Temperature resistance coefficient : >(R-700)-10%/1^{0}C (positive characteristic)

Power consumption : <0.03 Watt (during normal operation of the light tube)

Starting time : 0.6 to 1.5 sec (under normal temperature)

Life of switch : 100,000 times (under normal temperature)

Withstand voltage : >1000 Volt

Static capacitance : <350 PF

The above-mentioned materials constitute a fluorescent lamp starting device having both the function of a voltage switch and the characteristic of self-overload-current-protection, which is capable of automatic preheating, automatic switching, and self-protection. The lamp starting time of this automatic preheating/switching device (VT) is appropriate, ie 0.6 to 1.5 second, the life of the switch can be controlled in 20,000 to 100,00 times.

Fig 4 illustrates an embodiment of another structure of the fluorescent lamp preheating starter of the present invention as a modification of the above-mentioned structure. Therein, a current limiting resistance film 6 in parallel with the temperature sensitive device is coated on the peripheral (one or more peripheral surfaces) thereof. On the basis of the basic structure of the above-mentioned VT device, the resistance of this film is 12K Ohms to 20K Ohms. A current limiting resistor having the same resistance range may also be connected in parallel with the temperature sensitive device.

A further embodiment of the VT device of the present invention is one in which the voltage sensitive resistance layer (sheet) 2 and the temperature sensitive resistance layer (sheet) 1 in the above-mentioned structure are made separated, and the same effect is achieved merely by connecting them in series with a conductor and then mounting them in the location indicated by VT as shown in Fig 2.

Claims

1. A fluorescent lamp preheating start-up device comprising a temperature sensitive resistor, characterised in that, hot bonded into an integrated body with a voltage-sensitive switching resistance layer or sheet (2) comprising a major proportion of zinc oxide together with a temperature-sensitive resistance layer or sheet (1) comprising a major proportion of an oxide comprising barium, there is provided a silver-coated conductive layer between said two resistance layers (2 and 1), the diameter of said two resistance layers or sheets (2 and 1) being approximately in the range from 4 to 7 mm, and said device having leads (3), and said layers or sheets being sealed into a coating film (5) to form an automatic preheating/switching device.

2. A start-up device according to claim 1, characterised in that said start-up device, providing a voltage-sensitive switching resistance layer or sheet (2) and a temperature-sensitive resistance layer or sheet (1), said voltage- sensitive switching resistance sheet and said temperature-sensitive resistance sheet are separate devices connected in series by a conductor.

3. A start-up device according to claim 1 or claim 2 characterised in that the periphery of said temperature-sensitive layer or sheet (1) is coated with a current-limiting resistance film (6)

coupled in parallel therewith.

4. A start-up device according to claim 1 or claim 2 characterised in that a current-limiting resistor is connected in parallel with said temperature-sensitive layer or sheet (1).

5. A start-up device according to any one of claims 1 to 4 characterised in that the ratio of zinc oxide contained in said voltage-sensitive switching resistance layer or sheet (2) is more than 80%, and the voltage-sensitive resistance value lies in the range from 120 to 160 Volts.

6. A start-up device according to any preceding claim characterised in that said temperature-sensitive resistance layer or sheet comprises a mixture comprising titanium oxide, the Curie point thereof lying in the range from 65^0C to 100^0C, and the resistance under normal temperatures being from 700 Ohms to 1200 Ohms.

7. A start-up device according to any one of the preceding claims characterised in that said oxide comprising barium is a complex oxide of barium, strontium and titanium.

8. A fluorescent lamp preheating start-up device characterised by comprising a voltage-sensitive switching resistance and a temperature-sensitive resistance interconnected to reduce the start-up time of said lamp.

9. A fluorescent lamp preheating start-up device comprising a V layer functioning as a voltage sensitive switching resistor, and a T layer having a positive temperature co-efficient, said V and T layers being interconnected.

10. A fluorescent lamp preheating start-up device comprising a temperature sensitive resistor, characterised in that hot bonded into an integrated body with a voltage sensitive switching resistance layer (sheet) (2) mainly composed of zinc oxide and other materials, and a temperature sensitive resistance layer (sheet) (1) comprising a major proportion of barium carbonate, there is a silver conductive layer coated between said two resistance layers (2) and (1), the diameter of said two resistance layers (sheets) (2) and (1) is approximately 4-7 mm, and they are provided with leads (3), respectively, and are sealed into a coating film (5) to form an automatic preheating/switching device.

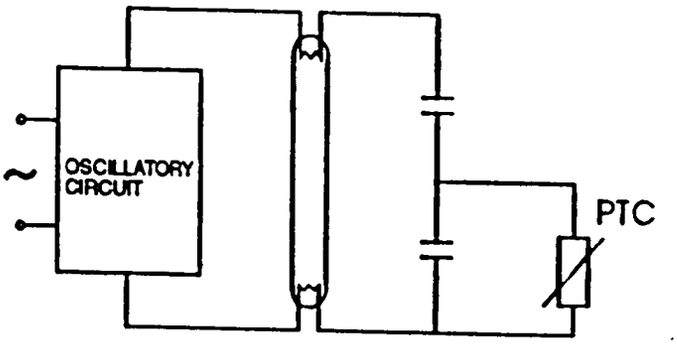

Fig.1

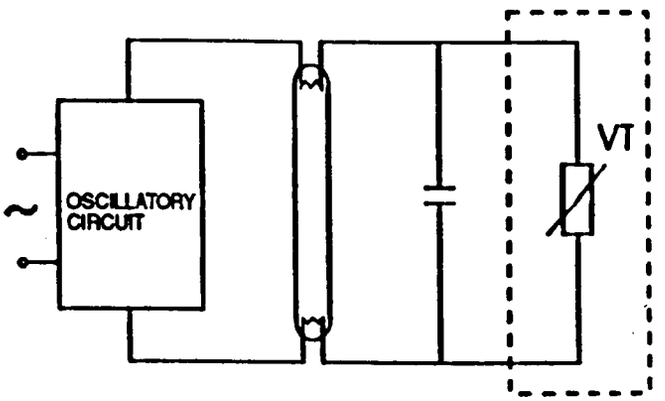

Fig.2

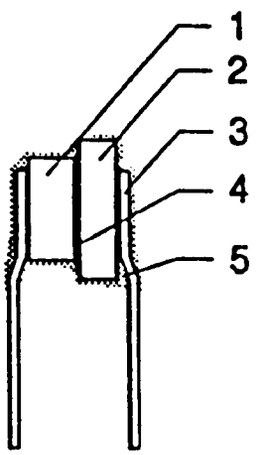

Fig.3

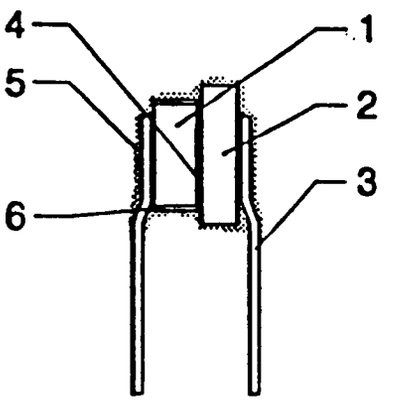

Fig.4

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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 5456

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.6)
A	WO-A-93 00784 (PROLUX) * page 7, line 6 - page 8, line 12 * * page 9, line 4 - page 9, line 9; figure 1 * -----	1,2,5-11	H05B41/29
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) H05B H05P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 November 1994	Speiser, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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