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FLUORESCENT DISCHARGE LAMP STARTING AND OPERATING CIRCUIT

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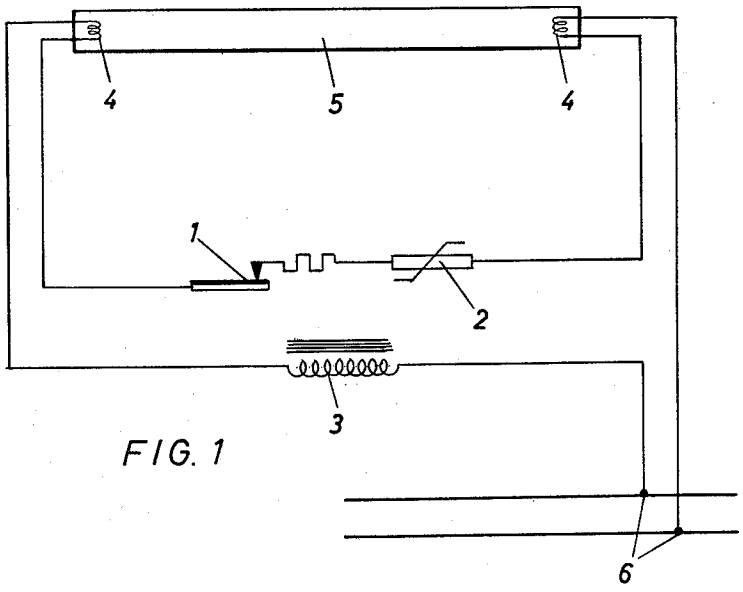


FIG. 1

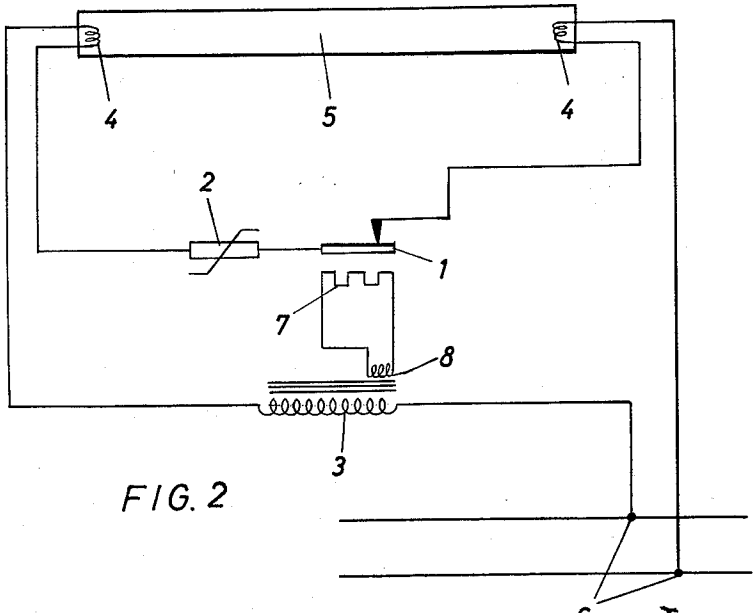


FIG. 2

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FLUORESCENT DISCHARGE LAMP STARTING AND OPERATING CIRCUIT

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The present invention relates to a device for starting the discharge of electric fluorescent lamps, which device uses, in the preheating circuit for the cathodes of the lamp, a resistance having a non-linear current-voltage characteristic and a switch acting as a function of the current or of the temperature, said two elements being connected in series with said filaments and with an additional impedance.

Many attempts have already been made to use non-linear resistances in the preheating circuit of electric fluorescent lamps. The current-voltage characteristic of these resistances may be explained by the approximate mathematical formula $I=CU^k$, I being the current, U the voltage, C and k constants of the material. These resistances increase and decrease inversely with the voltage applied to their terminals. As a result of this property, such a resistance, connected between the two cathodes, could, in principle, be sufficient to start the discharge. Under the influence of the voltage in the local supply circuit, the resistance is relatively low and permits the passage of a heavy preheating current of the order of from 0.6 to 1.2 a. After the starting of the lamp, the voltage drops at the terminals of the nonlinear resistance substantially to half its preceding value, the resistance increases and during the operation of the lamp is only traversed by a low current of the order of 10 to 20 ma. which is negligible in relation to the consumption of the lamp.

But the practical embodiment of this principle involves difficulties. The orders of magnitude of the voltages and currents of the most common lamps necessitates a value of the exponent k equal to or greater than 5, which value is difficult to obtain in resistors manufactured on an industrial scale.

On the other hand, it is difficult to obtain the optimum values for the elements of the preheating circuit, particularly for those lamps in which the operating voltage is substantially half the voltage of the local supply circuit, as for example the standard lamp of 40 watts 220 volts. Here, the ballast must also have a non-linear characteristic, that is to say its impedance should be a function of the current.

Furthermore, the fluctuations in the voltage of the local supply circuit or the changes in the humidity and the temperature of the air may cause uncertainty in starting or starting with an insufficiently preheated cathode, which shortens the life of the lamps.

The device according to the invention eliminates these disadvantages and thus renders possible the exploitation of the properties of non-linear resistances for all types of hot-cathode fluorescent lamps.

The operation of the device will be explained with reference to the figures, given by way of non-limiting example.

FIG. 1 shows a diagram of the device using a bimetal contact or flexion wire with direct heating, and

FIG. 2 is a diagram using indirect heating of the switch.

In FIG. 1, the bimetal contact **1** and the non-linear resistance **2** are connected between and in series with the two filamentary electrodes **3** and **4** of the lamp **5** and with an additional impedance connected between the local supply circuit and one of the electrodes.

In FIG. 2, only the bimetal contact is connected in series with the electrodes, the heating of the bimetal being effected by a heating element **7** and a current taken from a secondary coil **8** of the ballast **3**.

The operation of these devices is explained thus: at the moment when the voltage is applied, the bimetal contact is closed. The greater part of the voltage of the local supply circuit appears across the resistance **2**. Under this high voltage, the value of this resistance is low and the filaments and the bimetal contact are traversed by a heavy current which raises the filaments to a high temperature. After a short time, for example one or two seconds, the bimetal contact opens and at this moment, as a result of the impedance of the ballast **3** of the circuit, an excess voltage appears between the electrodes **4**. Since the filaments are at a high temperature, this excess voltage starts the discharge under optimum conditions.

At the moment of starting, in FIG. 1 the heating circuit containing the bimetal contact is open, and in FIG. 2 the current through the bimetal contact is reduced, hence, after starting, the bimetal contact re-closes. But at this moment, the voltage between the electrodes **4** is only substantially half the previous voltage, the value of the resistance **2** is high and the current is insufficient to cause the bimetal contact to function. The bimetal contact therefore remains closed, ready for a fresh start.

The advantages of the device of the present invention are the following:

If the coefficient k of known non-linear resistances is slightly inadequate, the preheating current is a little low and the voltage between the electrodes **4** may be insufficient for starting. By using the device according to the invention, it is only the time of lighting which becomes slightly longer. Since the bimetal contact is traversed by the same current as the filaments it always opens after adequate preheating and at this moment it causes a sufficient rise in voltage for starting.

The same inadequacy of the starting voltage may be caused by a slightly high value of the ballast **3** as well as by the temporary inadequacy of the voltage in the local supply circuit or by the humidity and the temperature of the air. The presence of the bimetal contact always ensures a voltage rise at the moment it opens.

Apart from these advantages in comparison with the circuits which only comprise a variable resistance without a switch, the device of the present invention represents a major advantage in comparison with the preheating circuits which only comprise a switch without a non-linear resistance. This advantage is afforded by the presence of the non-linear resistance which permits the closing of the bimetal contact immediately after the starting of the lamp. Thus after an interruption in the operation of the lamp, a starting procedure takes place immediately without having to await the cooling of the thermal members of the apparatus.

In comparison with the glow-discharge starters, the device of the present invention also has additional advantages: on the one hand the starting is a direct function of the preheating current and not of the voltage and on the other hand the interruption takes place in air and it is more abrupt, hence ensuring certain starting even under unfavourable conditions.

FIGS. 1 or 2 are only examples of an embodiment of the device of the present invention. The additional impedance **3** may, for example, be another type of ohmic impedance and may be inductive and/or capacitative. It may also be a transformer connected between the local supply circuit and the preheating circuit. At least some of this impedance can be connected between the two filaments in series with the switch **1** and the non-linear resistance **2**. In order to increase the slope of the non-linear resistance, it is also possible to use a resistance which is a

function of the temperature with a negative characteristic provided that it is less inert than the bimetal contact.

None of these modifications to the details of the preheating circuit can cause a device to leave the scope of the present invention, the essence of which is the simultaneous presence of the two elements: a switch and a non-linear resistance, between the two filaments of the lamp.

I claim:

1. In combination, a fluorescent discharge lamp having two spaced heater electrodes, a pair of alternating current supply conductors, and a series circuit connecting said supply conductors and electrodes and including a voltage-responsive non-linear resistor, said resistor having a current voltage characteristic given by $I=CU^k$, where I is the current therethrough, C is a constant of its material, U is the voltage thereacross, and k is a constant value at least of the order of 5, a temperature-responsive switch, and a ballast reactor, said reactor being connected between a terminal of one of said electrodes and one supply conductor, a terminal of the other electrode being connected to the other supply conductor, and the non-linear resistor and the temperature-responsive switch being connected between the remaining terminals of the electrodes, said switch having a heating winding, and means energizing said heating winding in accordance with the current flowing in the series circuit, the voltage across the resistor being initially high and its resistance low, whereby initially a large current flows in the series circuit, thereby energizing said heating winding, causing the switch to open and discharge to start in the lamp, after which the voltage across the resistor is relatively low and its resistance high, reducing the current in the series circuit sufficiently to allow the switch to close while the lamp discharge continues, whereby the lamp can be immediately restarted following an interruption in its operation.

2. The structure of claim 1, wherein said temperature-responsive switch includes a bimetallic arm.

3. The structure of claim 1, wherein said ballast reactor is an inductance.

4. The structure of claim 3, wherein said inductance is the primary of a transformer, and wherein said means energizing the heating winding comprises the secondary of said transformer, said heating winding being connected across said secondary.

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