

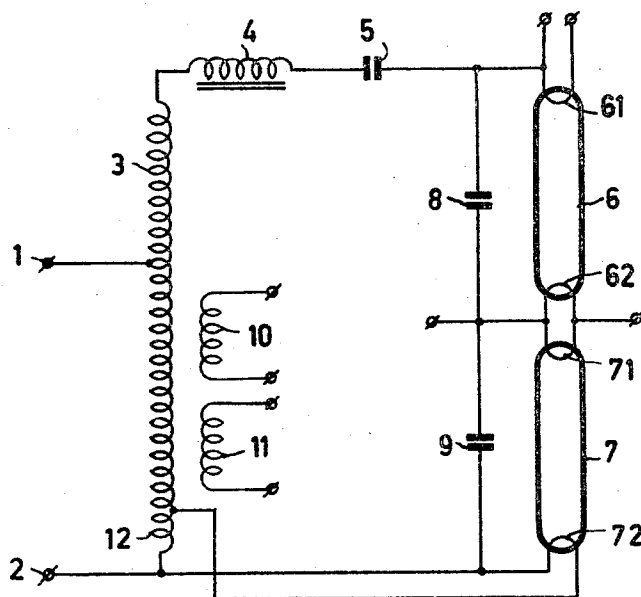
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DEVICE EMPLOYING TWO GAS- AND/OR VAPOUR-DISCHARGE TUBES

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DEVICE EMPLOYING TWO GAS- AND/OR VAPOUR-DISCHARGE TUBES

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The invention relates to a device employing two gas-and/or vapour-discharge tubes with activated thermionic electrodes which tubes are destined to be connected in series with one another and with a ballast impedance, to a source of alternating voltage one of the tubes being shunted by a capacitance.

When connecting the device into circuits, the full no-load voltage is supplied to the non-shunted tube through this shunting capacitance, which voltage causes its ignition, after which a voltage occurs across this capacitance which causes the shunted tube to ignite.

This circuit arrangement which is very attractive in itself has the drawback that the life of the non-shunted tube is shorter than that of the other tube.

It is an object of the invention to mitigate this drawback.

According to the invention both tubes are shunted by unequal capacitances of such a value that across the tube shunted by the smaller capacitance a voltage is set up for ignition purposes which is smaller than its cold ignition voltage.

It has been found that the shortened useful life of the non-shunted tube is due to the excessively high voltage which causes its ignition. The result hereof is that the activated electrodes of the tube which ignites first have not had time to reach their emission temperature. This excessively high voltage lies in a voltage range which will be termed the "cold-ignition voltage range."

By adding a shunting capacitance across the tube which ignites first, the voltage set up across this tube is reduced to such a value that the electrodes have sufficient time to reach at least locally the emission temperature. This voltage will be termed the "warm-ignition voltage."

The adjustment of the desired ignition voltage requires that a certain ratio be set up between the values of the shunting capacitances. Inside this ratio one of the capacitances may be freely chosen. In this case it should be observed that the capacitances discharge to produce current pulses across the tubes shunted by them. In order to render this as harmless as possible, it is normal to choose the impedance of the capacitance to be at least 280-fold of the operating impedance of the shunted tube.

According to a favourable embodiment of the invention, in which the device is destined for an operating frequency in the order of 40-60 c./s. and the ballast impedance consists of the series arrangement of an inductance and a capacitance, the impedance of this capacitance being larger than that of the inductance, the smaller shunting capacitance is proportioned so that the impedance of the larger capacitance is 30- to 50-fold of the operating impedance of the tube shunted by it and the apparent power of the inductance is 0.45- to 0.6-fold of the total apparent power of the two tubes.

This inductor which is too small in itself results in a comparatively long dark period of the two tubes caused by a rather long interruption of the lamp current. This gap in the current, however, is filled by the current pulses of

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the shunting capacitance which is too large in itself, so that the two influences substantially neutralise one another.

The advantage of this measure consists in that the elements of the ballast impedance become smaller and consequently cheaper.

In order that the invention may readily be carried into effect, it will now be described, more fully, by way of example, with reference to the accompanying drawing, which shows one embodiment.

In the drawing, reference numerals 1 and 2 denote the connection terminals of the device which are connected to a source of alternating current, not shown, the voltage of which will generally deviate from the desired supply voltage.

The terminals 1 and 2 are connected to the ends of the primary of a supply transformer 3, to the secondary of which, in series with one another, are connected an inductor 4, a capacitor 5 and two gas- and/or vapour-discharge tubes 6 and 7. The tubes are shunted by capacitors 8 and 9 respectively and are provided with thermionic electrodes 61, 62 and 71, 72 respectively which are connected in normal manner to the auxiliary windings 10, 11, 12 of the supply transformer 3, the parallel arranged electrodes 62 and 71 being supplied by the winding 11.

It is clear that in the absence of the shunting capacitor 9 the secondary voltage of the transformer 3, when connecting the device into circuit, is set up across the tube 7, via the elements 4, 5 and 8, after which the said tube can ignite. Its discharge current produces a voltage across the shunting capacitance 8 of the tube 6 which is sufficient to ignite the tube. In normal operation the tubes 6 and 7 operate in series with the inductor 4 and the capacitor 5.

In this device the tubes ignite one after the other which requires a considerably lower ignition voltage than when the tubes had to ignite simultaneously.

It has been found that the tube 7 (which is still considered not to be shunted by the capacitor 9) had a shorter life than the tube 6 and that this was due to the fact that an excessively high ignition voltage was set up across the tube 7 which ignites first. Too high a voltage has for its result that the tube ignites too soon, that is, at a time when the electrodes are still cold, which is harmful for its life.

In order to prevent this, according to the invention this tube 7 is shunted by the capacitor 9. By correct proportioning of the capacitors 8 and 9, the desired ignition voltage of the tube 7 which ignites first can be adjusted. The delay caused by the ignition of the first tube 7 has experimentally appeared to be sufficient to cause the second tube 6 to ignite always with warm electrodes.

In a particular embodiment the tubes 6 and 7 were low-pressure mercury vapour discharge tubes which, during normal operation, passed a discharge current of 455 ma. at a tube voltage of 103 volts. These tubes ignite with cold electrodes at voltages larger than approximately 275 volts. In the case where an ignition voltage larger than this value is employed, they show a shorter life than in the case where ignition voltages smaller than this value are employed.

For the operation of the tubes 6 and 7 a minimum supply voltage is required. In the case shown with a net capacitive stabilizing impedance consisting of the elements 4 and 5, it is at least 140% of the sum of the tube voltages. In the case of inductively stabilized tubes the supply voltage must then be at least 200% of the sum of the tube voltages.

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This means that in the present case the secondary of the transformer 3 must be at least $2 \times 103 \times 1.4 = 288$ volts, and in the case of inductive stabilization, the secondary voltage must be at least 412 volts. Both supply voltages exceed the smallest cold ignition voltage of the tube.

Without a capacitor 9 shunting the tube 7, the supply voltage of 288 volts set up across the tube 7 when connecting the device into the circuit is too high. By using the capacitor 9, an ignition voltage is set up across the tube 7 which is always smaller than the said value.

In a particular embodiment, with an alternating current frequency of 50 c./s., the capacitor 9 had a value of 18,000 pf. and the capacitor 8 a value of 0.4 μ f. At these values of capacitance, an ignition voltage of only 270 volts was set up across the tube 7.

Without the capacitor 9, the life of the tube 7 was approximately 16,000 switches, whereas with the capacitor 9 in the circuit, the tube life was approximately 22,000 switches. The tubes are connected into circuit each time for 20 seconds with time intervals of 40 seconds. It is noted that the life of the tube 6 was approximately 24,000 switches in both cases.

The shunting capacitors 8 and 9 form a potentiometer so that the voltage across capacitor 9 is equal to

$$\frac{C_8}{C_8 + C_9}$$

times the voltage across the series combination thereof, wherein C_8 and C_9 are the capacitance values of capacitors 8 and 9, respectively. The desired ignition voltage across the tube 7 can be achieved with an infinite number of capacitance ratios. In this case the impedance of the shunting capacitor may not be lower than a particular multiple of the impedance of the shunting tube, because otherwise the capacitor discharges across the tube with annoying current pulses.

The largest so far used capacitor 8 (without the use of the capacitor 9) was 50,000 pf., which means at 50 c./s. an impedance of approximately 64,000 ohms, which is approximately 280-fold of the impedance of the tube 6 which is approximately 225 ohms.

According to a favorable embodiment of the invention, the shunting capacitor 9 of the first-igniting tube 7 is given a value of 18,000 pf. and the value of the shunting capacitor 8 of the other tube is then 0.4 μ f. In this case the inductor 4 was given an abnormally low value so that during normal operation a voltage of only 100 volts was set up across it. As a result, a voltage of 320 volts must be set up across the series capacitor 5, which means a capacitance of 4.5 μ f.

At a frequency of the alternating voltage supply in the order of 40–60 c./s., wherein the ballast impedance, consisting of the inductor and the capacitor in series, exhibits a net capacitive reactance, it is normal to choose the apparent power of the series inductor to be at least 0.7 fold of the apparent power of the two tubes. In this case at least the 0.7-fold of the sum of the tube voltages it set up across the inductor.

In case of smaller values of the inductor, undesired long dark periods occur.

This would also be the case now, because only 100 volts instead of 145 volts is set up across the inductor 4, but the large shunting capacitor 8 causes current pulses of such a shape that the dark periods are shortened. In addition it appeared that by the above measure the form factor of the tubes (consumed power in watt divided by the multiplication of the tube voltage and the tube current) is 0.85 which approaches the in practice maximally achievable value of 0.9 (in case of rectangular tube voltage and sinusoidal tube current).

Without the use of the said values the operating voltages across the inductor 4 would have to be at least 145 volts and across the capacitor 5 at least 355 volts. In connection with the above it follows herefrom that the

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ballast impedances can now be manufactured considerably smaller and consequently cheaper.

In the present case the inductor 4 is shown as a separate element. However, in most of the cases it will be combined with the transformer 3 to a leakage transformer.

What is claimed is:

1. A lighting system comprising first and second serially connected electric discharge tubes each of which includes activated thermionic electrodes, said tubes having a given value of cold ignition voltage, a source of alternating voltage, ballast impedance means, means connecting said voltage source, said ballast means and said first and second tubes in series circuit, means for electrically heating said tube electrodes, a first capacitor having a given capacitance value C_1 connected in parallel with said first tube, said ballast means and voltage source in series normally producing a voltage across said second tube greater than the said cold ignition voltage, and means for reducing the ignition voltage across said second tube to a value less than the cold ignition voltage comprising a second capacitor connected in parallel with said second tube and having a given value of capacitance C_2 , the capacitance values of said capacitors being chosen so that

$$\frac{C_1}{C_1 + C_2}$$

combination of said first and second capacitors produces an ignition voltage across said second tube which is lower than said cold ignition voltage.

2. A system as described in claim 1 wherein the frequency of said alternating voltage source is in the range of 40 to 60 cycles per second, said ballast impedance means comprising an inductance element and a capacitance element in series which exhibit a net capacitive reactance at the frequency of said voltage source, the capacitance of said second capacitor being chosen smaller than the capacitance of said first capacitor and of a value such that the impedance of said first capacitor is 30 to 50 times the operating impedance of the tube in shunt therewith, and wherein said inductance element is chosen so that the apparent power thereof is 45% to 60% of the total apparent power of the two tubes.

3. A lighting system comprising first and second serially connected electric discharge tubes each of which includes activated thermionic electrodes, said tubes having a given value of cold ignition voltage, a source of alternating voltage of a given frequency, resistance heating means for preheating said tube electrodes prior to tube ignition, ballast impedance means, means connecting said voltage source, said ballast means and said first and second tubes in series circuit, a first capacitor connected in parallel with said first tube and having a given value of capacitance C_1 , said ballast means and voltage source in series normally producing a voltage across said second tube greater than the said cold ignition voltage, and means for reducing the ignition voltage across said second tube to a value less than the cold ignition voltage comprising a second capacitor connected in parallel with said second tube and having a given value of capacitance C_2 , said first capacitor having a greater value of capacitance than said second capacitor, the capacitive ratio of said capacitors being chosen so that

$$\frac{C_1}{C_1 + C_2}$$

times the voltage across the series combination of said first and second capacitors produces an ignition voltage across the second tube which is limited in amplitude to a range of values lower than the cold ignition voltage of said tube whereby the electrodes of said tube are preheated to a given temperature before said tube is ignited.

4. A system as described in claim 3 wherein said ballast impedance means comprises, in series, an inductance element and a capacitance element which together exhibit

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a net capacitive reactance at said given frequency, the capacitance value of said second capacitor being chosen so that the impedance of said first capacitor is 30 to 50 times the operating impedance of said first tube, and wherein said inductance element is chosen so that the apparent power thereof is 45% to 60% of the total apparent power of the two tubes.

5 5. A system as described in claim 3 wherein said tubes are gas discharge tubes and wherein the voltage of said source is greater than the cold ignition voltage of said tubes.

10 6. A system as described in claim 3 wherein said tubes are vapour discharge tubes and wherein the voltage of said source is greater than the cold ignition voltage of said tubes.

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