March 2, 1937. G. DOBKE 2,072,733

ELECTRICAL DISCHARGE DEVICE

Filed Dec. 16, 1931

Fig. 1.

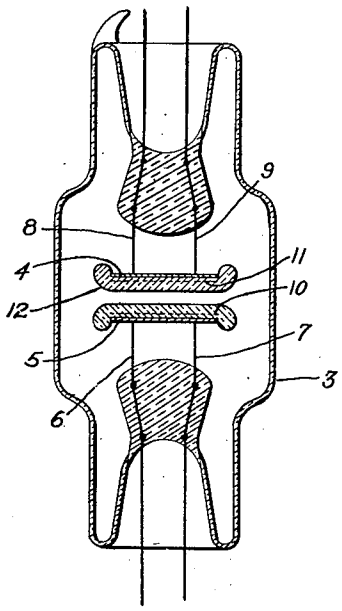
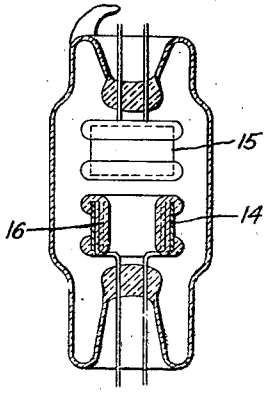


Fig. 2.



Inventor:
Günther Dobke,
by Charles V. Mullen
His Attorney.

Patented Mar. 2, 1937 2,072,733

UNITED STATES PATENT OFFICE

2,072,733

ELECTRICAL DISCHARGE DEVICE

Günther Dobke, Berlin-Reinickendorf, Germany, assignor to General Electric Company, a corporation of New York

Application December 16, 1931, Serial No. 581,385
In Germany December 24, 1930

6 Claims. (Cl. 250—27.5)

The present invention relates to electrical protective devices, or vacuum tubes so-called, whereby an electrical circuit may be relieved of excess voltages or surges.

It has been proposed to employ as a protective device for this purpose electrical discharge tubes containing juxtaposed electrodes and an attenuated gas. Such discharge tubes must be so dimensioned that the initial glow discharge which occurs therein immediately changes to an arc discharge in order that a considerable amount of energy may be quickly dissipated through the device. The difficulty here encountered is to so construct the device that during the discharge process the extinguishing voltage of the arc does not fall below the operating voltage. If this were the case the arc would not be extinguished, but on the contrary would continue to flow through the discharge device at the working voltage of the circuit to be protected.

According to the present invention this difficulty is overcome by covering at least one of the electrodes with a coating of high electron emissivity. This coating possesses the property of reducing the fall of potential in the tube to a very low value. Consequently even with relatively large currents flowing through the tube the quantity of energy dissipated in the tube will be relatively small and the heat evolved at the electrodes will be so small that the electrodes are not heated to a temperature of thermionic emission and therefore will not continue to pass current after the excess voltage has been discharged.

My invention will be described in greater detail in connection with the accompanying drawing which illustrates two embodiments of discharge devices made in accordance with my invention.

Fig. 1 is a side elevation partly in section of a device having substantially plane electrodes and Fig. 2 is a side elevation partly in section of a device having ring-shaped electrodes.

The device shown in Fig. 1 comprises an envelope 3 consisting of glass, quartz, or other suitable material, contains electrodes 4, 5 arranged in close proximity to one another. These electrodes may consist of metal plates joined to and supported by wires 8, 9 and 6, 7, respectively. To the respective juxtaposed faces of the electrodes 4, 5, wire grid or mesh members 10, 11 are secured by welding or otherwise. These grids serve as a support for a coating 12 of high electron emissivity. The coating 12 may consist for example of an oxide of high electron emissivity such as the oxides of thorium, cerium, beryllium, or other rare metal or of an oxide of the alkaline earth group such as barium oxide. Admixed with this oxide is a compound of an alkali metal as for example potassium carbonate or potassium chloride.

This mixture of oxides is applied as a paste and is dried in an oven at a temperature of about 50 to 60° C. Notwithstanding the appreciable hygroscopic property of an alkali salt this coating retains its activity for a long time, even in air. After the insertion of the electrodes with the emissive coating into the envelope the device is evacuated in the usual manner, including baking out to remove water vapor and is then filled with a desired gaseous filling as for example a filling of argon or other rare gas at a pressure of about one to thirty millimeters of mercury. Forming of the electrodes prior to the use of the device is not required. In the construction shown in Fig. 2 the electrodes 14, 15 are made cylindrical or ring-shaped. In this case, likewise, the electrodes are provided with metal grids, such a grid being indicated by dotted lines at 16 at the surface of the electrode 14, this grid being attached by welding or otherwise to the electrode.

When a voltage device as above described is connected in the usual manner in a suitable discharge circuit, for example, between a line to be protected and ground, under normal conditions no current flows through the device as its working voltage is below the critical voltage at which a discharge is ignited. On the occurrence of an excess voltage in the circuit a discharge occurs through the device. Within a very short time, which may be less than 10^{-7} second the glow discharge will change to an arc discharge. This period of time suffices to reduce surges to such an extent that there will be no danger of their continuation. When the arc discharge passes, some of the alkali compound is reduced to the metallic state which in turn reduces the electron emitting metal such as thorium to the metallic state at the starting points of the arc on the electrodes. The work function of the electrodes will be so far reduced thereby that the drop of potential in the tube will fall to a low value which may be less than five volts. Consequently even with relatively large discharge currents the heat generated in the tube will be so small that the characteristic igniting and extinguishing voltage of the device will not change appreciably. When the described device is employed in a discharge circuit for a line carrying alternating current a

discharge is extinguished as soon as the current passes through zero, and the returning voltage peak can not cause re-ignition. On account of the fact that the emissive coating is subjected to the above described changes only when the arc starts the tube can be used for a very long period of time. It has been found by experience that the arc is not likely to be set up a second time at the points at which it has once been formed. It is advisable to arrange the emissive coating in such a way that it covers all sharp corners of the electrodes and especially so the corners of the electrodes which are opposite one another. This will reduce the tendency of the arc starting at sharp points which might easily become too hot, and in consequence the resulting thermionic emission might give rise to re-ignition of the arc under the action of the working voltage. It is also advantageous to give the emissive coating a smooth surface so that the arc can travel very quickly under the influence of its own magnetic field over the surface of the electrodes, thus preventing the heating the individual points. This counteracts the tendency of the arc current to increase. If, as shown in Fig. 2, only the inner surface and the corners of the electrodes opposite one another are covered with the emissive coating, the starting points of the arc will be confined to the free metal surface and consequently the arc will be extinguished more easily.

Owing to the appreciable energy that the above described discharge tube is able to dissipate, the resistance of a discharge current connected in series with it may be small, even less than the wave resistance of the line to be protected. It is well known that under these conditions a discharge arrester exercises a more favorable protective effect.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electrical discharge device comprising an envelope containing gas and a plurality of flat cooperating electrodes presenting their flat surfaces to one another in parallel relation, a flat metal mesh member secured to one of said electrodes, said one electrode and said mesh member being coated with a material of high electron emissivity.

2. An electrical discharge device comprising an envelope containing gas and a plurality of cylindrical electrodes arranged end-to-end, cylindrical metal mesh members secured respectively to each of said electrodes and being coated with material of high electron emissivity.

3. A electrical discharge device comprising an envelope containing gas and a plurality of cooperating electrodes, at least two of said electrodes being coated with material containing a compound of alkaline earth metal, and a metal member embedded in the coating, said coated electrodes being of the non-filamentary type.

4. An electrical discharge device of the cold cathode type comprising an envelope containing gas and a plurality of cooperating electrodes, one of said electrodes coated with material containing a compound of alkaline earth metal and an alkali metal compound, and a metal member embedded in the coating and leading-in conductors for the electrodes, said conductors being adapted to be connected only to a load circuit.

5. An electrical discharge device comprising an envelope containing gas and a plurality of cooperating electrodes, at least two of said electrodes being coated with material containing a rare metal compound and an alkali metal compound, and a metal member embedded in the coating, said coated electrodes being of the non-filamentary type.

6. A protective device of the cold cathode type comprising an envelope containing gas and a plurality of cooperating electrodes, at least two of said electrodes being coated with material of high electron emissivity, and a metal member embedded in the respective coatings.

GÜNTHER DOBKE.