Nov. 15, 1927. 1,649,391

R. L. DAVIS

PROTECTIVE SYSTEM FOR HOT CATHODE DEVICES

Filed Jan. 23, 1925

Fig. 1

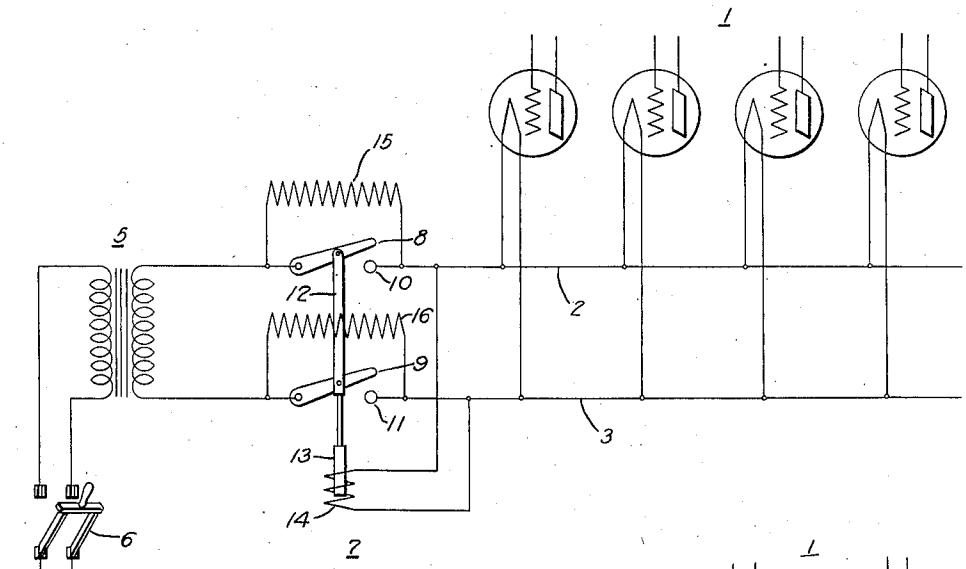
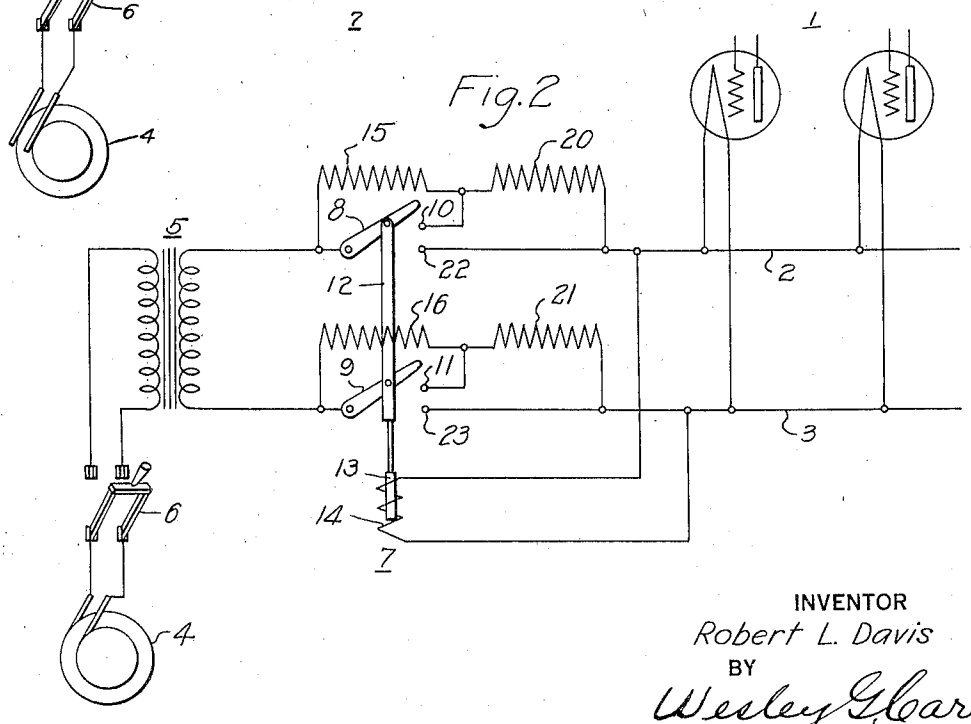


Fig. 2



INVENTOR
Robert L. Davis
BY
Wesley G. Carr
ATTORNEY

Patented Nov. 15, 1927. 1,649,391

UNITED STATES PATENT OFFICE.

ROBERT L. DAVIS, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MAUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

PROTECTIVE SYSTEM FOR HOT-CATHODE DEVICES.

Application filed January 23, 1925. Serial No. 4,278.

My invention relates to protective systems for hot cathode devices, and particularly to means for limiting current flow therethrough upon the first application thereof.

Another object of my invention is to construct a protective system for use in connection with hot cathode devices whereby a rush of current through the filaments thereof is prevented.

Another object of my invention is to prevent the development of high electromagnetic stresses upon the filamentary cathodes of vacuum tubes.

Another object of my invention is to construct an automatically actuated current-limiting resistor means for use with vacuum tube devices.

In the prior operation of large power hot cathode devices having filamentary cathodes, difficulty has been experienced in the starting operation due to the heavy rush of current through the cold cathodes when current was first applied thereto. These devices customarily have tungsten wire filament structures which are designed to operate at a temperature of high incandescence. Tungsten has a positive temperature coefficient of resistance of a fairly large value and, therefore, the resistance of the metal at the high temperature at which it is desired to be operated is very much greater than the resistance when the tungsten is cold. The cold resistance has been found to be only from 7 to 10% of the resistance at operating temperature. In consequence of this fact, if current at the normal operating voltage is applied to the cold filaments, the first rush of current may be very large; large enough to impose very severe strains on the filament itself because of electromagnetic effects.

My invention provides means for limiting the starting current to a lower value when heating of the cathode is first begun. Other objects and structural details of my invention will be apparent from the following description when read in connection with the accompanying drawings, wherein—

Figure 1 is a diagrammatic view of a preferred form of my invention, and

Fig. 2 is a diagrammatic view of an alternative form.

Referring to the drawing, a plurality of hot cathode devices have filamentary cathodes, the terminals of which are connected to supply mains 2 and 3. A generator 4 is provided and a transformer 5 connected thereto through a switch 6. This combination of generator, transformer and switch serves to supply current at a suitable voltage, and to control the supply. An automatic contactor device 7 is provided having movable contact members 8 and 9 that coact respectively with stationary contact members 10 and 11 and that are coupled together by an insulating member 12. The contactor 7 is controlled by an electromagnet comprising a core member 13 and a coil 14. The contact members 8 and 10 are shunted by a resistor 15 and the contact members 9 and 11 are shunted by a resistor 16. The terminals of the transformer 5 are connected to the contact members 8 and 9, and the leads 2 and 3 are connected to the contact members 10 and 11. The coil 14 is connected to the leads 2 and 3 as indicated.

In the operation of my device, current is generated by generator 4, and supplied under the control of switch 6, and transformer 5 to the contactor device 7. When the switch 6 is closed, transformer 5 will be energized and current will flow through resistors 15 and 16 to leads 2 and 3 and to the filaments of vacuum tubes 1. The current is, however, limited by the presence of resistors 15 and 16 to a value only slightly in excess of the normal current flow. While the filaments are cold and, therefore, at a relatively low resistance point, a relatively small amount of electromagnetic stress is produced in them. Likewise, the voltage across the filaments is small and insufficient to energize the coil 14 and to close the contactor members. The amount of current flowing is, however, sufficiently great to produce a substantial heating of the filaments which causes their resistance to rise and the voltage drop thereacross to increase until, when they have reached about one half the normal operating temperature, the voltage drop is sufficiently great to cause such an amount of current to flow through the coil 14 that the contact members 8 and 9 are closed, thereby imposing the normal operating voltage across the filaments and again allowing a current slightly in excess of normal operating current to flow until the full operating temperature is attained. At this point, the voltage drop becomes normal and coil 14 is energized to such extent

as to hold the contactors closed, during the operating period of the system.

This system limits the current flow to a suitably low value but does not necessarily limit it to a value not greater than normal operating current. If the excess current is found to be greater than desired, a contactor may be duplicated by a second device connected in series with the first and operating similarly by which means a still more strict limitation upon the starting current is imposed.

Referring particularly to Fig. 2, in which elements analogous to those illustrated in Fig. 1 are similarly numbered, an additional resistor 20 is inserted in series with the resistor 15, and an additional resistor 21 is inserted in series with resistor 16. The end of the resistor 20 nearest the load 1 is connected to a contact 22, while the corresponding end of resistor 21 is connected to a contact 23.

In the operation of my system, modified as shown in Fig. 2, the starting current through the tubes is limited by resistors 15, 16, 20 and 21. As the resistance of the tube filaments increases, the rise in current through the operating coil 14 causes contact to be made between members 8—9 and contacts 10—11, short-circuiting resistors 15 and 16. A further increase in filament resistance causes an increased current in the operating coil 14, resulting in a movement of the members 8—9 away from contacts 10—11, and into engagement with contacts 22—23, short-circuiting resistors 20 and 21.

It is thus apparent that, in the operation of my device as modified according to Fig. 2, a progressively increasing voltage is applied to the cathodes of the thermionic devices, the voltage corresponding to the progressive rise in temperature of such cathodes.

While I have shown but one embodiment of my invention in the accompanying drawing, it is capable of various changes and modifications therefrom without departing from the spirit thereof, and it is desired, therefore that only such limitations shall be placed thereon as are imposed by the prior art or indicated in the appended claims.

I claim as my invention:

1. An electrical system comprising a thermionic device having a cathode, means for generating a voltage, and means controlled by resistance changes in said cathode for automatically supplying said voltage to the cathode in progressively increasing steps.

2. An electrical system comprising a thermionic discharge device having a cathode, a source of electrical heating energy therefor, and current-limiting means connected therebetween comprising resistances and short-circuiting means therefor operative by change in voltage drop across said cathode.

3. An electrical system comprising radio, signalling apparatus having hot cathode devices therein, and means for protecting said cathodes against excess currents therethrough, comprising current-limiting resistors in circuit therewith, and resistor shunting means therefor actuated by the voltage drop across said cathodes.

4. An electrical system comprising hot cathode devices having filamentary cathodes, characterized by the fact that the resistance thereof when cold is a small fraction of the resistance when heated to an operating temperature, and means controlled by the voltage drop thereacross for limiting the current flow therethrough.

5. An electrical system comprising hot cathode devices having filamentary cathodes, characterized by the fact that the resistance thereof has a large positive temperature coefficient, electrical heating means therefor, current limiting means comprising a resistor arranged to carry the initial heating current, and short-circuiting means controlled by resistance changes in said cathodes cooperating therewith, whereby the current flow therethrough when cold is limited to a value only slightly greater than when hot.

6. In combination, a thermionic device having a cathode, a source of heating current for said cathode, means for limiting the initial potential applied to the cathode, and means responsive to increased cathode resistance for applying progressively higher voltages thereto.

7. In combination, a thermionic device having a cathode, a source of heating current for said cathode, a plurality of resistors in circuit between said cathode and said source, and means responsive to an increase in the resistance of said cathode for progressively short-circuiting said resistors.

8. In combination, a thermionic device having a cathode, a source of heating current for said cathode, means comprising a resistor for limiting the initial current passing through said cathode and the initial voltage applied thereto, and means responsive to a rise in resistance in said cathode for short-circuiting said resistor.

In testimony whereof, I have hereunto subscribed my name this 10th day of January, 1925.

ROBERT L. DAVIS.