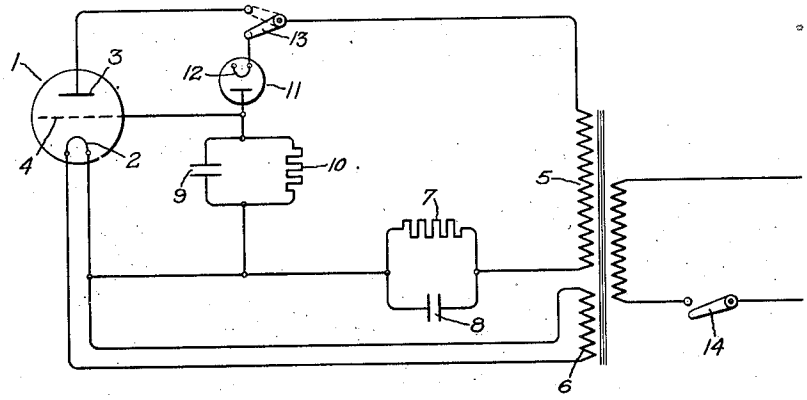
Dec. 12, 1933. H. T. RAMSAY 1,939,462

ELECTRIC DISCHARGE TUBE

Filed Jan. 28, 1931



Inventor:
Henry T. Ramsay,
by Charles E. Mullen
His Attorney.

Patented Dec. 12, 1933 1,939,462

UNITED STATES PATENT OFFICE

1,939,462

ELECTRIC DISCHARGE TUBE

Henry T. Ramsay, Gravesend, England, assignor to General Electric Company, a corporation of New York

Application January 28, 1931, Serial No. 511,884, and in Great Britain February 7, 1930

5 Claims. (Cl. 250—27)

This invention relates to electric discharge tubes, with a thermionic cathode and containing a small amount of gas or vapor in which the cathode is caused to emit electrons so copiously as to prevent destructive bombardment of the cathode by positive ions during normal operation.

In starting discharge tubes of this kind, the anode potential must not be applied until the emission from the cathode has reached a sufficiently high value, as otherwise, bombardment of the cathode takes place until the emission reaches the required value. This bombardment, which is repeated each time the tube is started, ultimately brings about the failure of the cathode.

An object of the present invention is to provide an arrangement for delaying the starting of a discharge tube until the cathode has reached a temperature high enough to cause electron emission, sufficient in quantity to preclude substantial positive ion bombardment of the cathode.

According to the present invention, the tube is provided with a control member or grid, shielding the anode from the cathode, which member is connected to the cathode through a capacity with a resistance shunted across its terminals. When it is desired to put the discharge tube into operation, the heating current is applied to the cathode, and at the same time the condenser is charged to give a suitable negative potential to the grid. The circuit including the condenser is then disconnected, and the charge begins to leak away through the high resistance shunt. The negative potential on the grid at first prevents the passage of current through the discharge tube; as the charge leaks away, however, a point is reached at which current commences to flow, and the discharge tube begins to operate. The value of the capacity and the resistance of the leak are so adjusted that the time which elapses before current begins to flow is sufficient to allow the cathode to become hot enough to emit sufficient electrons to protect itself from bombardment.

The initial negative charge on the grid conveniently may be obtained through a rectifier temporarily connected to the main current supply in such a manner that current flows to the grid during that part of the cycle in which the anode of the discharge tube normally would be negative. In order to accomplish this purpose the cathode of the rectifier which preferably constitutes a two electrode vacuum or gas filled tube, is connected to the supply mains, and the anode of the rectifier is connected to the grid of the discharge tube.

A circuit arrangement in accordance with the invention, suitable when the discharge tube is supplied with alternating current is shown, by way of example, in the accompanying drawing. The electric discharge tube is represented as a rectifier. The rectifier 1, the operation of which is to be delayed until the cathode 2 has time to heat up, has an anode 3 and a grid 4 shielding the cathode from the anode. The alternating current to be rectified is applied between cathode 2 and anode 3 by means of the transformer 5. The cathode is heated by another transformer 6. In the drawing, 7 is the load and 8 a smoothing condenser. The condenser 9 and resistance 10 are connected in accordance with the invention, between the grid 4 and the cathode 2. In order that the grid 4 may be charged negatively, it is also connected to the small gas discharge rectifier 11, the cathode 12 of which is connected through the switch 13 to the supply circuit of the main rectifier. Switch 13 may be interlocked with switch 14 in the primary of the transformer 5, so that when the power is applied by the closing of switch 14, switch 13 is also closed for a short period sufficient to allow the grid 4 to reach a negative potential high enough to stop the discharge in the rectifier 1. The switch 13 is then disconnected from the rectifier 11 and moved to connect the anode of the discharge tube with the current supply circuit. As soon as switch 13 is opened at the rectifier 11, the condenser 9 begins to discharge through the resistance 10 shunted across its terminals until finally the grid 4 assumes a potential which permits current flow to start in the main rectifier. The path through the tube, i. e. the anode circuit, is thus closed after the cathode circuit, i. e. the series path through the filamentary member, has been energized for an appreciable time. However, this feature of impressing a negative potential upon the grid of an electric discharge device for an interval of time sufficient to enable the cathode to reach a proper operating temperature broadly forms no part of my present invention, but is disclosed and claimed in the copending application of M. M. Morack, Serial No. 507,908, filed January 10, 1931, and assigned to the same assignee as the present application.

The values of the capacity of the condenser and of the resistance of the leak shunted across it are so adjusted that a sufficient time (half a

minute in some cases, this time being dependent of the size of the rectifier) elapses between the switching-on of the cathode heating current, and the starting of the main rectified current, to allow the cathode to be raised to an adequate temperature.

If t is this time V_o the negative potential to which the grid is charged initially, V the potential of the grid when the current begins to flow in the rectifier, then the requisite capacity C and resistance R are given approximately by

$$\frac{V}{V_o} = E\left(-\frac{t}{CR}\right)$$

This equation defines only the product CR, and there is therefore a wide choice permissible in the individual values. But C should be large compared with the capacities between the electrodes of the rectifiers and R small compared with the insulation resistance. For example, if V_o (which is the peak voltage of the transformer 5 less the potential drop in the rectifier 11) is 1500 volts, V is 60 volts, t/CR must be 3.2. If t is to be 30 seconds, CR must be 9.4 seconds; if C is 1 microfarad, R must be 9.4 megohms.

The arrangement in accordance with the present invention may, of course, be applied to luminous discharge tubes and gas-filled triodes (electrostatically controlled arc discharge devices) as well as to rectifiers, and may be used in all cases where it is desired to start a luminous discharge tube or a rectifier after a delay. In the case of a triode, it is apparent that the grid member which normally is provided for arc control purposes may also serve as the initial arc delay electrode, as described in the specification, although, if desired, an additional electrode may be employed for this purpose.

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

1. An electric discharge device comprising an envelope containing an electron emitting cathode, an anode and a gaseous atmosphere, circuits for said cathode and said anode, means for energizing the anode and cathode circuits, and means for delaying current flow in the anode circuit for a predetermined time interval after the cathode circuit has been energized, said delaying means comprising a negatively charged control member interposed between the cathode and anode.

2. An electric discharge device comprising an envelope containing an electron emitting cathode, an anode and a gaseous atmosphere, circuits for said cathode and said anode, means for energizing the anode and cathode circuits, and means for delaying current flow in the anode circuit for a predetermined time interval after the cathode circuit has been energized, said delaying means comprising a control member interposed between the cathode and anode and a reactive circuit for charging the control member negatively with respect to said cathode.

3. An electric discharge device comprising an envelope containing an electron emitting cathode, an anode and a gaseous atmosphere, circuits for said cathode and said anode, means for energizing the anode and cathode circuits, means for delaying current flow in the anode circuit for a predetermined time interval after the cathode circuit has been energized, said delaying means comprising a control member interposed between the cathode and anode and a circuit consisting of a condenser and a resistance in parallel connected between the control member and cathode, and means for energizing the last-mentioned circuit whereby the control member is charged negatively with respect to the cathode.

4. An electric discharge device comprising an envelope containing an electron emitting cathode, an anode and a gaseous atmosphere, circuits for said cathode and said anode, means for energizing the anode and cathode circuits, means for delaying current flow in the anode circuit for a predetermined time interval after the cathode circuit has been energized, said delaying means comprising a control member interposed between the cathode and anode and a circuit consisting of a condenser and a resistance in parallel connected between the control member and cathode, and means for energizing the last-mentioned circuit whereby the control member is charged negatively with respect to the cathode, said circuit energizing means consisting of a rectifier.

5. An electric discharge device comprising an envelope containing an electron emitting cathode, an anode and a gaseous atmosphere, circuits for said cathode and said anode, means for energizing the cathode and anode circuits, and means for delaying current flow in the anode circuit until after the cathode circuit has been energized, said last mentioned means including a means for maintaining a negative charge on the control member for a predetermined time interval whereby substantially no current flows between the anode and cathode, and means for dissipating the energy of the negative charge at a predetermined rate whereby current flows between the anode and cathode when the energy of the charge becomes less than a predetermined amount.

HENRY T. RAMSAY.