April 25, 1933. J. D. FORNEY 1,905,840

SYSTEM FOR STARTING AND OPERATING GASEOUS ELECTRIC DISCHARGE DEVICES

Filed Nov. 29, 1929

Fig. 1

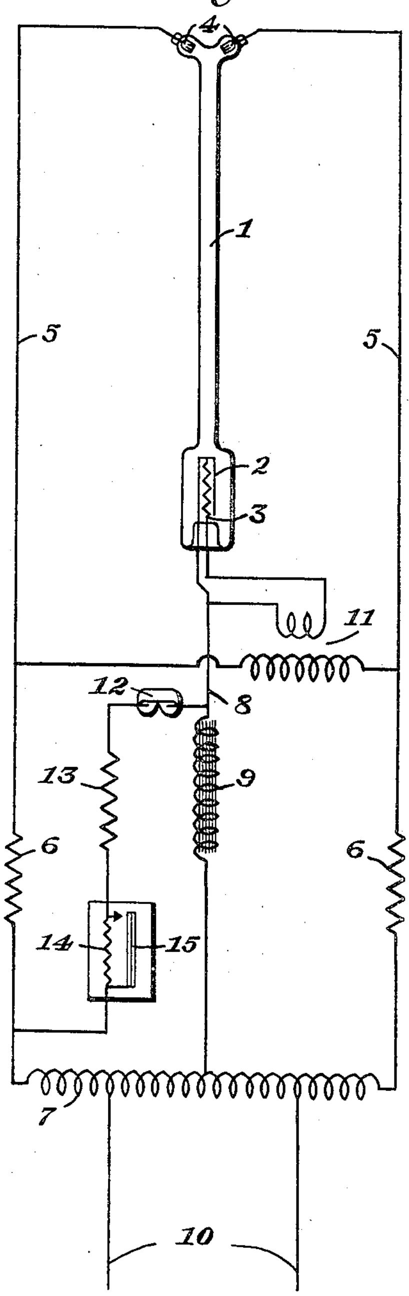
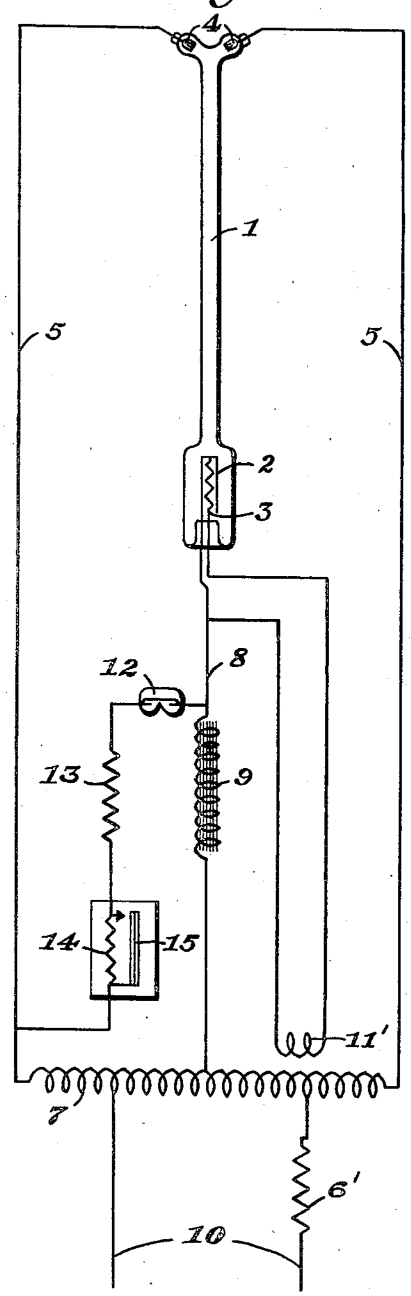


Fig. 2



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SYSTEM FOR STARTING AND OPERATING GASEOUS ELECTRIC DISCHARGE DEVICES

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The present invention relates to electric gaseous discharge devices, and particularly to method and means for the starting and operation of discharge devices having thermionic cathodes.

The invention consists in a new and novel method of operation and in a novel combination of elements as hereinafter set forth and claimed.

A particular object of the invention is to provide a method and means for automatically regulating the heat supplied to a thermionic cathode. Other objects and advantages of the invention will appear from the following detailed specification or from an inspection of the accompanying drawing.

A well known type of low voltage gaseous discharge device utilizes an oxide-coated cathode which is raised to an electron emitting temperature by means of a suitable filamentary heater which is operated at a potential lower than the ionizing potential of the gaseous atmosphere present in the device. This filamentary heater has heretofore been supplied with energy from a constant potential source, so that the heating of the cathode thereby is approximately constant at all times. This has not been entirely desirable, since the cathode of this type of device must be heated before a discharge is initiated, during which time the filamentary heater is the sole source of heat, whereas during operation the discharge contributes materially to the heating of said cathode. In order to shorten the time required to heat the cathode to an electron emitting condition, during which time the discharge cannot be safely started, it is highly desirable to operate the filamentary heater during this interval with a higher current input than is necessary or desirable after the discharge is started. I have discovered that this result may be automatically attained by so connecting the filamentary heater that it is subject to the voltage regulation provided to stabilize the discharge. When so connected a voltage considerably higher than normal will be impressed upon the filamentary heater during the starting period, which will be decreased to normal potential as soon as the discharge draws current through the stabilizing impedance. In this way the impedance is made to not only stabilize the arc, but to regulate the current passing through the filamentary heater.

For the purpose of illustrating my invention I have shown two embodiments thereof in the accompanying drawing, in which

Fig. 1 is a schematic diagram of the connections for an electric gaseous discharge device having a single thermionic cathode and designed for operation on alternating current, and

Fig. 2 is a schematic diagram of a variation of the circuit of Fig. 1.

As shown in the drawing, with particular reference to Fig. 1, an electric gaseous discharge device 1 has a cathode 2 of nickel or other suitable material which is preferably coated with an alkaline or alkaline earth oxide, and which is provided with a filamentary heater 3 of tungsten or the like, while spaced apart therefrom are the anodes 4 or iron, graphite or other suitable material. This device contains a suitable gaseous atmosphere, such as neon or mercury vapor. The anodes 4 are each connected through a lead 5 and a resistance 6 to opposite ends of an autotransformer 7, which may, if desired, supply energy to a plurality of discharge devices 1, while the cathode 2 is connected through a lead 8 and an inductance 9 to a mid-point of said autotransformer. Leads 10 connect said autotransformer to a suitable source of alternating current. Each end of the primary of the filament supply transformer 11 is connected to a lead 5 at a point between the anode 4 and resistance 6, while the secondary of said transformer has one end connected to the cathode lead 8 and the other to one end of the filamentary heater 3, the other end of said filamentary heater being connected to the cathode 2. For starting purposes a connection is made from the cathode lead 8 through a mercury switch or "shifter" 12, resistance 13 and resistance 14 to one end of the autotransformer 7. A bimetallic element 15 which is in thermal relation to said resistance 14 is connected thereto at one end and is adapted to short circuit said resistance after current has passed therethrough for a time interval which is made to equal the time required to heat the cathode 2 to a safe operating temperature. The shifter 12 is normally in a circuit closing position, but has an armature in magnetic relation to the inductance 9 whereby it is moved to an open circuit position when said inductance is energized, the resistance 14 being of such a value, however, that the current therethrough is insufficient to operate said shifter.

In the use and operation of this device, upon the application of a suitable alternating current potential to the leads 10 a potential difference is created between the anodes 4 and the cathode 2 which is, however, insufficient to initiate a discharge in said device. A potential is likewise applied to the primary of the transformer 11, the induced potential in the secondary thereof causing a flow of current through the circuit passing from one end of said secondary through the filamentary heater 3, cathode 2, and cathode lead 8 to the other end of said secondary. The resulting primary current of said transformer 11 is drawn through the resistances 6, in series, but since this current is small as compared to the discharge current, the potential drop therein is small, so that substantially the full voltage of the autotransformer 7 is impressed on the primary of the transformer 11. The heating of the cathode 2 therefore progresses at a rapid rate. At the same time a current flows from the mid-point of the autotransformer 7 through the inductance 9, shifter 12, resistance 13 and resistance 14 to one end of said auto-transformer. The heat generated by this current in the resistance 14 slowly warps the bimetallic element 15 until eventually it short circuits said resistance, the increased current which thereupon flows through the inductance 9 being then sufficient to actuate the shifter 12 to an open position. As the circuit is thus interrupted the collapsing magnetic field about said inductance 9 creates a voltage surge which initiates the discharge in the device 1, the discharge current thereupon maintaining the shifter 12 in the open circuit position. This discharge current, which passes alternately through the resistances 6 during alternate half cycles produces a considerable voltage drop therein. The potential applied to the transformer 11 is thereby reduced say 10–20% with the ensuing decrease in current flow through the filamentary heater 3 so that the heating effect thereof, and the wattage consumed, is materially reduced so long as the discharge is maintained.

With the connections shown in Fig. 2, in which a resistance 6′ in series with one of the leads 10 supplants the two resistances 6 of Fig. 1, it is possible to omit the separate filament supply transformer 11, a low voltage secondary 11′ on the auto-transformer 7 being utilized instead.

The operation of this circuit during the starting period is substantially the same as that of Fig. 1, the voltage drop in the resistance 6′ being small due to the relatively low wattage consumed by the filament 3 and the heating resistance 14. Upon initiation of the discharge in the device 1, however, the resistance 6′ consumes an appreciable portion of the line potential, say 20% or more, so that the excitation potential applied to the autotransformer 7 is decreased by that amount. This supplies the needed regulation for the discharge and likewise reduces the potential of the secondary 11′, thereby decreasing the wattage supplied to the filament 3 during maintenance of the discharge. This circuit has several advantages over that of Fig. 1. As will be evident, a greater degree of regulation of the filament current is obtainable with this circuit than is possible with the circuit of Fig. 1. The elimination of the separate filament transformer made possible by this circuit, is also desirable in many cases. Furthermore, this circuit reduces the potential supplied to the inactive anode and thereby tends to decrease the highly undesirable current from anode to anode.

While I have illustrated and described my invention by reference to particular embodiments thereof it is to be understood that it is not limited thereto, and that various additions, changes and substitutions, within the scope of the appended claims, may be made therein without departing from the spirit of my invention.

I claim:

1. In combination, an electric gaseous discharge device having a cathode adapted to emit electrons when heated, means comprising an electric heater to heat said cathode, and means to vary the energy supplied to said cathode heating means.

2. In combination, an electric gaseous discharge device having a cathode adapted to emit electrons when heated, means comprising an electric heater to heat said cathode at a given rate, and means to decrease said rate during maintenance of a discharge in said device.

3. In combination, an electric gaseous discharge device having a cathode adapted to emit electrons when heated, means comprising an electric heater to heat said cathode at a given rate, and means responsive to the flow of the discharge current to decrease the rate of heating by said heating means during maintenance of a discharge in said device.

4. In combination, an electric gaseous discharge device having a cathode adapted to emit electrons when heated, an electric heater for said cathode, and means responsive to the

flow of the discharge current to decrease the potential applied to said heater.

5. In combination, an electric gaseous discharge device having a cathode adapted to emit electrons when heated, an electric heater for said cathode, and an impedance in series with said discharge device and with said heater.

6. In combination, an electric gaseous discharge device having a cathode adapted to emit electrons when heated, means to heat said cathode, means to initiate a discharge in said device, means to delay the operation of said last mentioned means until said cathode is at operating temperature, and means for varying the energy supplied to said cathode heating means.

7. In combination, an electric gaseous discharge device having a cathode adapted to emit electrons when heated, an electric heater for said cathode, means to initiate a discharge in said device, means to delay the operation of said last mentioned means until said cathode is at operating temperature, and means responsive to the flow of the discharge current to decrease the potential applied to said heater.

8. In combination with an electric gaseous discharge device having a cathode adapted to emit electrons when heated and an electric heater for said cathode, a transformer supplying energy to said discharge device and to said heater, and an impedance in the primary circuit of said transformer.

9. The method of operating an electric gaseous discharge device having a thermionic cathode which comprises indirectly heating said cathode at a given rate before initiating a discharge in said device, and decreasing said rate of heating after the initiation of a discharge therein.

10. The method of operating an electric gaseous discharge device having a thermionic cathode which comprises indirectly heating said cathode at a given rate before initiating a discharge in said device, and availing of the voltage drop in an impedance due to the flow of the discharge current to reduce said rate of heating during maintenance of a discharge in said device.

Signed at Hoboken, in the county of Hudson and State of New Jersey, this 27th day of November, A. D. 1929.

JOHN D. FORNEY.