Oct. 10, 1933. L. J. BUTTOLPH 1,930,084

STARTING APPARATUS FOR ELECTRIC DISCHARGE DEVICES

Original Filed April 29, 1929

Fig. 1

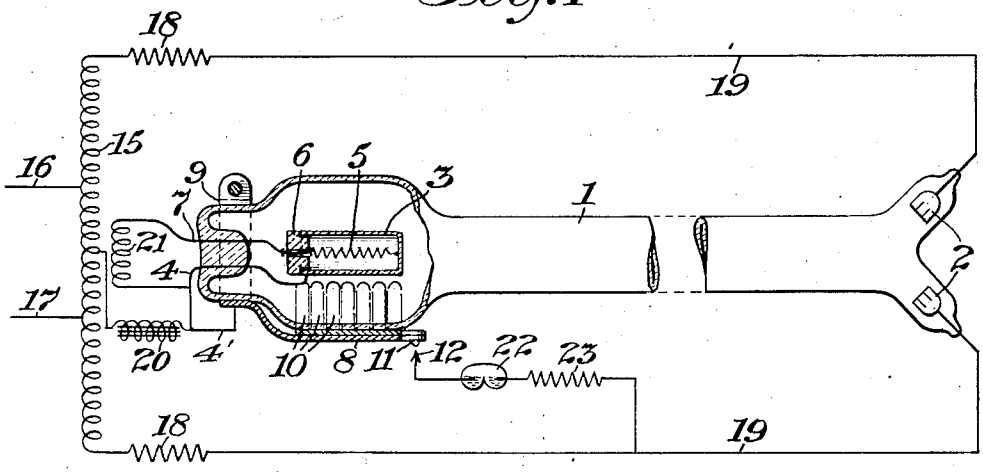


Fig. 2

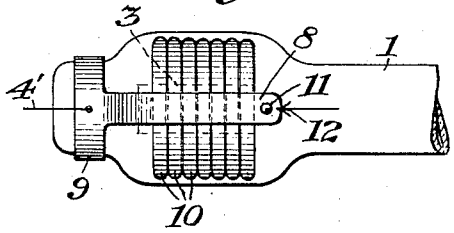


Fig. 3

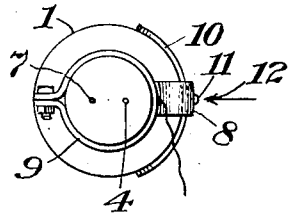


Fig. 4

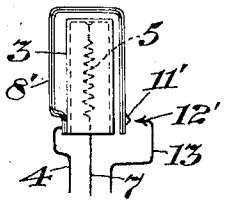
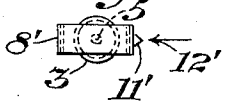


Fig. 5



INVENTOR
Leroy J. Buttolph
BY
Thos. H. Brown
HIS ATTORNEY

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STARTING APPARATUS FOR ELECTRIC DISCHARGE DEVICES

Leroy J. Buttolph, Grantwood, N. J., assignor to General Electric Vapor Lamp Company, Hoboken, N. J., a corporation of New Jersey

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7 Claims. (Cl. 176—124)

The present invention relates to gaseous discharge devices and particularly to devices of this type which operate with a hot cathode.

The particular object of the invention is to improve the starting and operation of such devices, but various other objects and advantages will be obvious from the following particular description of apparatus embodying the invention or from an inspection of the drawing. The invention consists in certain new and novel features of construction and combinations of parts hereinafter set forth and claimed.

Gas or vapor discharge devices designed for low voltage operation are commonly provided with means for impressing a high voltage surge of short duration upon one of the electrodes in order to initiate a discharge when starting, and also in some cases have means for heating the cathode in order to facilitate starting. In such cases the application of the high potential to the electrodes before the cathode has had time to heat up is injurious, since if a discharge is started before the cathode has reached the proper temperature for free emission of electrons the discharge is confined to one spot on the cathode and tends to disintegrate the electron emitting material. The present invention is for an apparatus to delay the initial application of the high potential until the cathode has reached the operating temperature. A thermal element energized by heat from the cathode furnishes a very simple and accurate means for limiting this interval to the exact time necessary, regardless of varying conditions under which the device may be operated.

In the accompanying drawing there are shown two forms of apparatus embodying my invention, in which

Fig. 1 is a schematic diagram of a gaseous discharge device partly in section, and its connection to the associated apparatus,

Fig. 2 is a side view of a portion of the gaseous discharge device of Fig. 1,

Fig. 3 is an end view of the gaseous discharge device of Fig. 1,

Fig. 4 is a detail of the cathode of Fig. 1 with a slightly different embodiment of my invention, and

Fig. 5 is a top view of the structure shown in Fig. 4.

In the device shown in Figs. 1–3 an envelope 1 of glass or other vitreous material, which contains any desired gas, such as neon, or source of vapor, such as mercury, or combinations thereof, has sealed into one end thereof the anodes 2 of iron or other suitable material. At the other end of said envelope 1 is a cylindrical cathode 3, of nickel or other suitable material, and preferably coated with an alkaline or alkaline earth oxide, said cathode being supported by a rigid inlead 4 which is welded thereto. Centrally disposed within said cathode 3 and welded thereto at one end, is a filament 5 of tungsten or other suitable material. The other end of said filament 5 passes through a porcelain bushing 6 fitted into the open end of said cathode 3, and is welded to an inlead 7 adjacent to said bushing 6. A bimetallic element 8, of any suitable metals extends longitudinally along the outside of the envelope 1 in proximity to the cathode 3, and is secured at one end to said envelope 1 by the collar 9. To increase the sensitivity of this bimetallic element 8 to temperature changes in the cathode 3 fins 10 are attached to said element 8 which extend circumferentially on either side thereof in close proximity to the envelope 1. These fins, which are of heat conducting metal, may also be blackened on the inside and polished on the outside to facilitate heat absorption and conduction to the element 8. At its free end said bimetallic element carries a contact 11, which is adapted to make contact with a contact point 12 when said strip 8 has curled to the position occupied by it when cathode 3 has reached operating temperature.

An autotransformer 15 is connected by leads 16 and 17 to a suitable source of alternating current. The end leads of said transformer 15 are each connected through a resistance 18 to one of the anodes 2 through the leads 19. A midpoint of the transformer 15 is connected through an iron cored inductance 20 to the inlead 4 of the gaseous discharge device. One terminal of a low voltage secondary coil 21 is likewise connected to the inlead 4, while the other terminal thereof is connected to the inlead 7. The same end of inductance 20 which is connected to the inlead 4 is also connected through the lead 4' to the bimetallic element 8. The contact point 12 is connected to one terminal of a mercury switch 22 of the type commonly called a shifter. The other terminal of said shifter 22 is connected through a resistance 23 to one of the leads 19. Said shifter 22 (which is only schematically shown) is normally in a circuit closing position, but has an armature in electromagnetic relation to the core of inductance 20, so that when current flows through said inductance 20 said armature is attracted to said core and rotates said shifter to an open circuit position.

In the operation of this device an alternating

current potential is applied to the leads 16 and 17, whereupon current immediately starts to flow from the secondary 21 through inlead 4 to cathode 3, thence through filament 5 and inlead 7 back to said secondary 21. Normal operating potential is likewise impressed between the electrodes of the discharge device, but is insufficient to initiate the discharge. The current passing through the filament 5 heats up the cathode 3, whereupon said cathode 3 increasingly radiates heat, a portion of which is intercepted by the fins 10 and conducted to the bimetallic element 8. When the cathode 3 reaches the operating temperature sufficient heat is received by the element 8 to cause it to curl to bring the point 11 into contact with the point 12. When this occurs current flows from the midpoint of transformer 15 through inductance 20, lead 4, bimetallic element 8, contact 11, contact 12, shifter 22, resistance 23, a lead 19, thence through a resistance 18 back to the transformer 15. This current builds up a magnetic field about the inductance 20, magnetizing the core thereof, which thereupon attracts the armature of the shifter 22, opening the circuit. As the magnetic field about said inductance 20 collapses a high voltage surge is impressed upon the cathode 3 which tends to initiate a discharge to one of said anodes 2. If, for any reason, a discharge is not started the shifter 22 again closes the circuit after the inductance 20 has become demagnetized and the cycle is repeated until a discharge occurs, whereupon the core of inductance 20 is maintained in a magnetized condition by passage of current through the discharge path, thus keeping shifter 22 in an open circuit position. Once a discharge is started it will be maintained by the potential difference existing between each of said anodes and the cathode. Since heat radiation from the cathode is depended upon to energize the discharge initiating circuit it is obvious that the starting of the discharge will always occur at substantially the same cathode temperature.

Where desired the thermostatic element may be located within the envelope 1, a suitable structure for this purpose being shown in Figs. 4 and 5. One end of the thermostatic element 8' may be welded to the cathode 3, the element being so shaped as to be exposed to the cathode 3 throughout its length in order to increase its sensitivity to the heat radiated from said cathode 3. At its free end the bimetallic element 8' carries a contact point 11' which cooperates with a contact 12', which is mounted on a third inlead 13, to complete the circuit through inductive circuit in the same manner as the contacts 11 and 12 of Fig. 1. This construction is advantageous under certain conditions, as where atmospheric conditions by wide variation tend to vary the temperature of an external thermostatic element with respect to the cathode.

While I have shown and described preferred forms of my invention, it is to be understood that my invention is not limited thereto, and that various substitutions, omissions, and changes in the form and details of the apparatus may be made without departing from the spirit thereof.

I claim:

1. In combination, a gaseous discharge device having a cathode of refractory solid material adapted to emit electrons when heated, means for preheating said cathode to its normal operating temperature, and a circuit closing device which is actuated by heat from said cathode at its operating temperature to initiate a discharge in said device.

2. In combination, a gaseous discharge device having a cathode of refractory solid material adapted to emit electrons when heated, means for preheating said cathode to its normal operating temperature, means to initiate a discharge through said device, and a circuit closing device actuated to a closed position by heat from said cathode when it reaches operating temperature, said means to initiate the discharge being inoperative while said circuit closing device is open.

3. In combination, a gaseous discharge device having an anode, a cathode of refractory solid material adapted to emit electrons when heated, means for preheating said cathode to its normal operating temperature, a circuit closing device actuated to a closed position by heat from said cathode when it reaches operating temperature, and means to impress a voltage surge between said cathode and said anode, last said means being inoperative while said circuit closing device is open.

4. In combination, a gaseous discharge device having electrodes separated by a fixed distance, one of said electrodes being a cathode of refractory solid material adapted to emit electrons when heated, means for preheating said cathode to its normal operating temperature, means to initiate a discharge through said device and a thermal element in series therewith, said thermal element being adjacent to said cathode and receiving heat therefrom, whereby said discharge initiating means is rendered inoperative until said cathode reaches operating temperature.

5. In combination, a gaseous discharge device having an anode, a cathode of refractory solid material adapted to emit electrons when heated, means for preheating said cathode to its normal operating temperature, an inductance in series with said cathode, a circuit connected between said cathode and said anode and including a thermal element actuated by heat from said cathode when it reaches operating temperature to energize said inductance, and means to open the aforesaid circuit through said inductance as soon as energized to impress a voltage surge between said cathode and said anode.

6. In combination, a gaseous discharge device having a cathode of refractory solid material adapted to emit electrons when heated, means to heat said cathode to an electron emitting temperature, means to initiate a discharge through said device, said last mentioned means being controlled by a thermal element actuated by heat from said cathode, said thermal element maintaining said discharge initiating means inoperative until said cathode has reached a temperature at which the free electron emission therefrom will support the normal discharge current.

7. In combination, a gaseous discharge device having a cathode of refractory solid material adapted to emit electrons when heated, means to heat said cathode to an electron emitting temperature, means to initiate a discharge through said device, said last mentioned means being controlled by a thermal element actuated by radiant heat from said cathode, said thermal element maintaining said discharge initiating means inoperative until said cathode has reached a temperature at which the free electron emission therefrom will support the normal discharge current.

LEROY J. BUTTOLPH.