April 2, 1940. A. C. THOMPSON 2,196,040

ELECTRIC DISCHARGE DEVICE

Filed March 14, 1936

FIG. 1

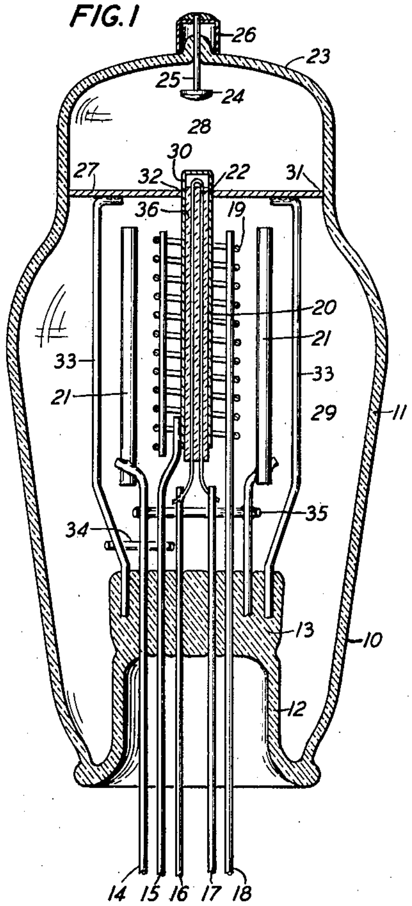


FIG. 2

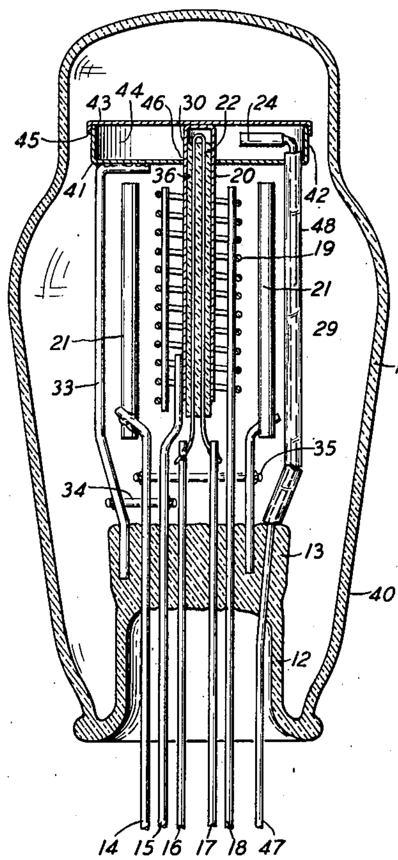
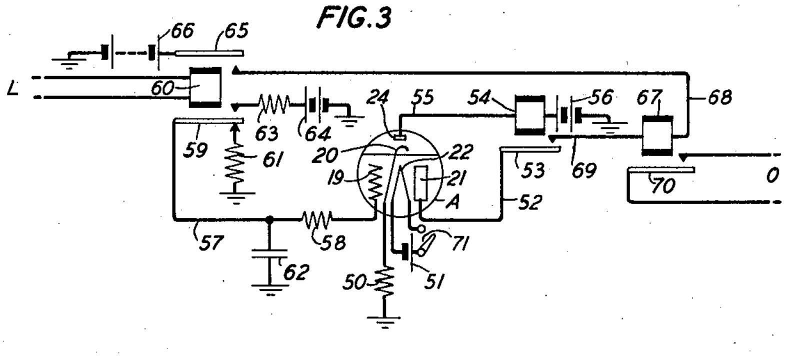


FIG. 3



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ELECTRIC DISCHARGE DEVICE

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3 Claims. (Cl. 250—27.5)

This invention relates to electric discharge devices, and, more particularly, to those of the gas-filled type.

One of the difficulties which has been encountered with gas-filled electric discharge devices or tubes is that the devices are irreparably damaged if the anode potential is applied before the cathode temperature has reached a sufficiently high value. Present practices for overcoming this condition consist of auxiliary circuits employing timing devices, such as thermal relays or condenser delay circuits, which delay the application of the anode potential for a predetermined time after cathode heating current has been applied. To afford complete protection, this interval must be long enough to safeguard a tube starting from normal or cold condition, and unless special arrangements are provided to reduce this period when only a momentary interruption of power occurs and the cathode does not cool to any great extent, considerable time is wasted. In addition, several relays are generally required and the whole control mechanism is relatively expensive.

An object of this invention is to overcome these difficulties by an improvement in the construction of the gas-filled tube itself.

A feature of this invention comprises a gas-filled tube having a thermionic cathode, an anode, an auxiliary electrode and means defining separate chambers for the anode and auxiliary electrode with the cathode in each.

Another feature comprises a gas-filled tube having a plurality of anodes in separate chambers.

A further feature comprises the combination of a gas-filled electric discharge device comprising a thermionic cathode and a plurality of anodes in separate chambers, and means in the circuit of the cathode and one anode for applying potential to another anode when the cathode has reached a predetermined temperature.

Still another feature comprises a gas-filled tube comprising a thermionic cathode and a plurality of anodes separated by a positive ion shield or partition.

Other and further features will be apparent from the descriptive matter which follows hereinafter.

A more complete understanding of the invention will be obtained from the detailed description which follows, taken in conjunction with the appended drawing, wherein:

Figure 1 is a cross-sectional view of an electric discharge device embodying the invention;

Fig. 2 is a cross-sectional view of another discharge device embodying this invention; and

Fig. 3 shows a circuit embodying the device of either Fig. 1 or Fig. 2.

Fig. 1 discloses an electric discharge device 10. It comprises an envelope, enclosure or vessel 11, preferably filled with an inert gas or vapor such as argon, neon, mercury or mixture thereof. The envelope may be of transparent vitreous material, having a reversely and inwardly projecting portion or stem 12 including a press 13. Within the vessel and supported on the press by sealed leading-in conductors 14, 15, 16, 17 and 18 are a control electrode or helical grid 19, an indirectly heated cathode or filament 20, a main anode or anodes 21 electrically connected by the conductor 35, and a heater filament 22 embedded in an insulating material 36 surrounded by the cathode, which may be cylindrical in shape. At the end 23 of the vessel opposite the stem is supported an auxiliary electrode or anode 24 having a supporting leading-in conductor 25 projecting through and sealed in the envelope, and terminated on a terminal cap or member 26. A partition, wall, disc or shield member 27, planar and circular in shape, preferably impervious to positive ions, and, for example, of metal, divides the vessel interior into two chambers 28, 29 and has a central aperture through which the upper end portion 30 of the cathode extends into the chamber containing the auxiliary electrode. The joints 31, 32 between the shield and the vessel or between the shield and the cathode need not be gas-tight but should be reasonably close fitting so as to prevent the passage of positive ions. Suitable supporting rods or struts 33 support the shield from the stem. A connection 34 between the shield and cathode obviates any need for terminating the shield support at a separate terminal, which arrangement would require insulation between the shield and the cathode, although, if desired, the shield support may be brought out to a separate terminal to be grounded or to be maintained at a desired potential.

Fig. 2 discloses an electric discharge device 40, preferably filled with an inert gas or vapor, such as argon, neon, mercury or a mixture thereof, similar to the device of Fig. 1, like parts being designated by like numerals. The positive ion shield, however, is provided by an enclosure, shell or box member 41, cylindrical in shape, comprising a casing 42 and a cover portion 43 which divides the vessel's interior into chambers 44, 29. The shell 41 is supported by the rod 33, and contains an aperture through which extends the end portion 30 of the cathode. The joints 45, 46 between the casing 42 and cover 43 and the cathode and the shell need not be gas-tight, but, preferably, are sufficiently close fitting to prevent the passage of positive ions. The auxiliary electrode or anode 24 is positioned within the chamber 44, and may be supported therein by the leading-in conductor 47, the portion of which between the press and the anode 24 is enclosed in suitable insulation 48, which may be glass or ceramic tubing.

The device of either Fig. 1 or Fig. 2 may be embodied in a signal or pulse transferring or transmitting circuit, as is shown in Fig. 3, in which a signal or pulse is to be transferred from incoming line L to outgoing line O, or line L is to control line O. The electric discharge device A is either the device 10 or 40. The cathode is connected through a resistance 50 to ground, and the heater element or filament is shown provided in circuit with a battery 51 as a source of heating current. The main anode is connected by conductor 52 with the armature 53 of relay 54, the winding of which is connected by conductor 55 in series with the auxiliary electrode and battery 56 to ground. The grid is connected through a protective resistance 58 and conductor 57 to the back armature 59 of line relay 60 and through the back contact of armature 59 and resistance 61 to ground. A condenser 62 is in shunt with the grid. The front contact of armature 59 is connected through a resistance 63 to battery 64 and ground, and the front armature 65 of relay 60 to battery 66 and ground. The winding of relay 67 is connected through conductors 68, 69 with the contacts associated with armatures 65, 53, respectively. The conductors comprising line O are connected with the armature 70 and its associated contact.

Energization of the heater element by closure of the switch 71 causes the cathode to begin to emit electrons with a resultant current flow in the cathode-auxiliary electrode circuit and through relay 54, the circuit being from ground, battery 56, winding of relay 54, conductor 55, anode 24, cathode 20, resistance 50 to ground. The constants of the circuit are so proportioned that the relay does not get sufficient current to operate until the cathode has reached its safe operating temperature. When this occurs, relay 54 operates, the armature 53 engaging with its associated contact and connecting the main anode through the winding of relay 67 to the contact associated with the armature 65. Of course, when relay 60 operates armature 65 engages with its contact to apply the normal operating potential to the main anode. To avoid the production of positive ions and the resultant deterioration of the cathode in the chamber 28 or 44, a much lower voltage is applied to the auxiliary anode than to the main anode. The auxiliary anode potential might be of the order of 24–48 volts, as compared with approximately 150 volts for the main anode in a typical device. If, after the circuit for application of main anode potential has been completed, there is a loss of cathode emission, resulting, for example, from a failure of the heater power, the current in the cathode-auxiliary electrode circuit will decrease to a point where relay 54 releases and the voltage on the main anode is removed before any damage to the cathode occurs. Upon the restoration of the heater power, the current in the auxiliary circuit rises as the temperature of the cathode rises, and, when the safe value is reached, the main anode potential is again applied, assuming relay 60 to be already operated. The time for the discharge device to again become operative is dependent on the amount the temperature has dropped, and is only the minimum required to protect the device under these conditions rather than a predetermined interval based on starting cold.

The purpose of the positive ion shield 27 or 41 is to keep the ions generated in the main portion 29 of the tube from entering the space around the auxiliary electrode, where their presence would prevent that electrode from maintaining close control of the current in the cathode-auxiliary electrode circuit. If ionization were allowed to take place in this portion of the device, to the same extent as in the main portion, the current in relay 54 would remain at a high value for too long a period and the relay would not release soon enough to protect the cathode.

Referring again to Fig. 3, and assuming that the cathode is at its predetermined or operating temperature and relay 54 operated with its armature in engagement with its associated contact, relay 67 will not operate because the voltage on the grid is too low to permit the device to ionize or fire, even though a signal or pulse arriving over line L has caused relay 60 to operate, thereby having caused armature 65 to engage with its associated contact. Operation of relay 60 causes armature 59 to engage with its associated front contact to apply potential from battery 64 through resistance 63 to the condenser 62 and thence to the grid through the protective resistance 58. At the moment relay 60 operates, the voltage across condenser 62 is essentially zero, but it rises as the charge on the condenser increases. The potential on the grid rises at the same time, and when the critical value is reached the device ionizes or fires, a conducting path between the cathode and main anode being established to complete the following circuit: ground, battery 66, armature 65, conductor 68, winding of relay 67, conductor 69, armature 53, conductor 52, anode 21, cathode 20, resistance 50 to ground. Relay 67 operates, causing armature 70 to engage with its associated contact to close a circuit through the outgoing line O, the circuit remaining closed so long as the relay 60 is energized and there is no failure of the device or tube A. The time required for the device to fire is that required for the voltage on the condenser and on the grid to rise to the critical value, and is determined by the potential of battery 64, the capacity of the condenser, and the value of the resistance 63. Resistance 50 supplies a biasing potential to the grid during the time the circuit is in non-operated condition, i. e., when relay 60 is deenergized, while resistance 61 serves the dual purpose of connecting this potential to the grid and of limiting the discharge current of the condenser upon the release of relay 60. The potential for the main anode is supplied through a contact under control of relay 60 so that when the latter releases, the potential is removed. This is necessary because of the fact that with gas-filled devices or tubes the grid loses control upon ionization, and the discharge will not stop unless the anode potential is reduced below the sustaining value which is much lower than the starting value.

While this invention has been disclosed with reference to various specific embodiments thereof, it is to be understood that it is not limited thereto, but by the scope of the appended claims only.

What is claimed is:

1. An electric discharge device comprising a

gas-filled enclosing vessel, a thermionic cathode, a control electrode, a main anode, an auxiliary anode opposite a relatively small portion of said cathode, and an enclosure within said vessel completely surrounding said auxiliary anode and said relatively small portion of said cathode.

2. An electric discharge device comprising a gas-filled enclosing vessel, a thermionic cathode, a control electrode, a main anode, an auxiliary anode, opposite one end portion of said cathode, and a solid walled housing within said vessel and supported in part by said cathode, said housing having an opening into which said end portion extends, and completely enclosing said auxiliary anode and said end portion.

3. An electric discharge device comprising an enclosing vessel having a filling of gas, a positive ion shield dividing said vessel into two chambers, a cathode having a large area electron emitting surface in one of said chambers and a restricted electron emitting portion in the other of said chambers, an auxiliary anode in said other chamber and in proximity to said portion whereby a small potential between said auxiliary anode and said portion suffices for ionization of the gap therebetween, and a main anode in cooperative relation with said surface and relatively remote therefrom.

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