Nov. 17, 1936. G. H. ROCKWOOD, JR 2,061,255

ELECTRIC DISCHARGE DEVICE

Filed Oct. 3, 1934 2 Sheets-Sheet 1

FIG. 1

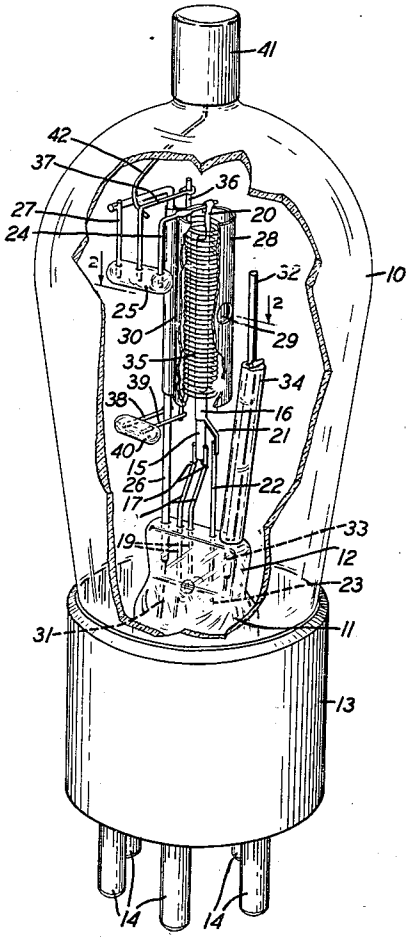

FIG. 3

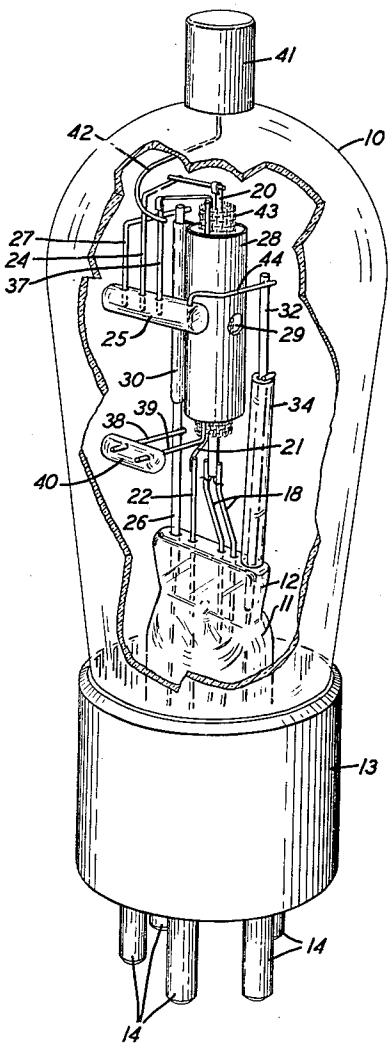

FIG. 2

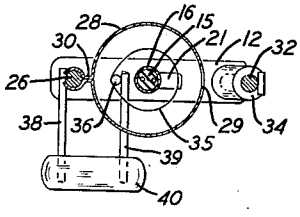

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FIG. 4

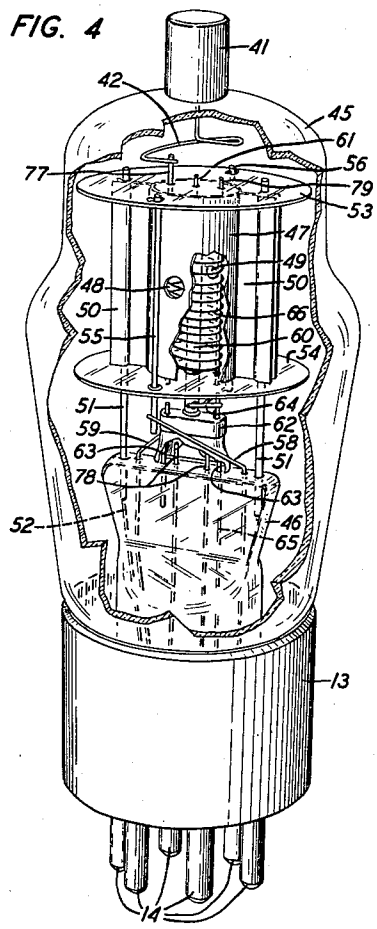
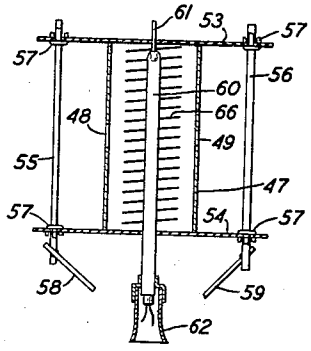


FIG. 5



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ELECTRIC DISCHARGE DEVICE

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Application October 3, 1934, Serial No. 746,631

8 Claims. (Cl. 250—27.5)

This invention relates to electric discharge devices and more particularly to such devices of the trigger type wherein the initiation of a discharge between a cathode and an anode is controllable by the potential of a third electrode.

One object of this invention is to decrease the deionization time in electric discharge devices of the trigger type.

In electric discharge devices comprising a cathode, an anode, and a grid electrode, such as disclosed in Patent 1,921,004, granted August 8, 1933 to A. L. Samuel, wherein the grid electrode is utilized as a trigger to control the initiation of a discharge between the cathode and the anode, the deionization time is dependent in a large measure upon the impedance of the circuit including the grid electrode and in general the greater the impedance of this circuit the longer is the deionization time. It is desirable frequently, however, to have in the same system a high impedance circuit including the grid electrode, and also a relatively short deionization time.

This desirable combination, that is of high impedance and short deionization time, may be attained in accordance with this invention by the provision of an auxiliary electrode, which may be operated with a momentary large negative bias from a low impedance source and used solely for deionization purposes. The grid electrode may be associated with a high impedance source and utilized solely to perform the usual control function.

In one embodiment illustrative of this invention, an electron discharge device comprises an enclosing vessel having an ionizable atmosphere therein, an incandescible cathode and a rod-like anode. A cylindrical shell, serving as the control electrode, encompasses the cathode and is provided with a lateral opening in juxtaposition to the anode, through which the cathode-anode discharge may occur. A deionization electrode, which may be a helical grid or a cylindrical mesh grid, encompasses the cathode and is disposed between the cathode and the control electrode. The deionization electrode preferably comprises closely spaced elements so that it will present a large surface for collecting positive ions during the deionization period.

The invention may be embodied also in devices, such as disclosed in my copending application, Serial No. 746,630, filed October 3, 1934, including a plurality of anodes and wherein the cathode, control electrode, and anodes are so constructed and arranged that the breakdown characteristics of the several anodes are different.

The invention and the features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of an electric discharge device illustrative of one embodiment of this invention, portions of the control electrode being broken away to show the inner electrodes more clearly;

Fig. 2 is a cross-sectional view along the line 2—2 of the electrodes in the device illustrated in Fig. 1, showing the configuration and relative disposition of the electrodes;

Fig. 3 is a perspective view of a modification of the device shown in Figs. 1 and 2, in which the deionization electrode is a cylindrical mesh grid;

Fig. 4 is another perspective view showing the invention embodied in an electric discharge device including a plurality of anodes having different breakdown characteristics; and

Fig. 5 is an elevational view in cross-section of the electrode assembly embodied in the device illustrated in Fig. 4.

Referring now to the drawings, the electric discharge device shown in Fig. 1 comprises an enclosing vessel 10 having a stem 11 terminating in a press 12 from which the electrodes of the device are supported. The vessel 10 is filled with an ionizable medium, such as argon at a pressure of the order of 0.25 millimeter of mercury. An insulating cap or base 13 is suitably secured to the enclosing vessel and carries a plurality of terminal prongs 14 for associating the electrodes of the device with an external circuit.

An equipotential heater type cathode is supported from the press 12 and includes an insulating core 15 having a heater filament, not shown, threaded therethrough and a metallic sleeve 16 encompassing the core 15 and having a coating of thermionic material, such as barium and strontium oxides, on its outer surface. The ends 17 of the heater filament are secured to rigid wires 18 embedded in the press 12 and electrically connected to two of the terminal prongs 14 by conductors 19. The cathode sleeve 16 is provided at opposite ends with integral extensions 20 and 21, the extension 20 serving as a leading-in conductor and being affixed to a metallic stub or wire 22 embedded in the press 12 and electrically associated with one of the terminal prongs 14 by a conductor 23. The other extension 21 is secured to a bent metallic stub 24 which is embedded in an insulating bead 25 supported from a metallic upright or rod 26 extending from the press, by a short wire 27.

Supported from the upright or rod 26 is a control electrode comprising a cylindrical portion 28 having a lateral opening 29 and coaxially disposed about the cathode, and a flange portion 30 suitably secured to the upright or rod 26, as by welding. The upright or rod 26 is electrically connected to one of the terminal prongs 14 by a conductor 31 and serves as the lead-in for the control electrode.

A metallic rod 32 is embedded at one end in the press 12 and extends in proximity to the opening 29, the rod serving as the anode of the device and being connected to one of the terminal prongs 14 by a conductor 33. In order to prevent discharges between the cathode and the anode through the lower end of the control electrode, the lower portion of the rod anode 32 is encased in an insulating sleeve 34, such as a glass tube.

As described in detail in the aforementioned Samuel patent, the electrode 28 may be utilized as a trigger to control the initiation of a discharge between the cathode 16 and the anode 32, the control characteristics of the electrode 28 being dependent upon the area of the opening 29. The deionization time of a device thus operated, that is the period required to reduce the number of positive ions in the cathode-anode field sufficiently to render the device non-conductive, is dependent in a large measure upon the impedance of the circuit including the control electrode, and in general the greater the impedance of this circuit, the longer the deionization time. It is frequently desirable, however, to have a relatively short deionization time in such devices included in systems wherein the impedance of the control electrode circuit is relatively great.

In accordance with this invention, the short deionization time is obtained by providing an auxiliary or deionization electrode, which may be operated with a momentary large negative bias from a low impedance source, serving to rapidly reduce the number of positive ions in the cathode-anode field.

In one form, as shown in Fig. 1, the auxiliary or deionization electrode may be a helical wire grid 35 disposed between the cathode 16 and control electrode 28 and coaxial therewith. The grid 35 is carried by a rigid metallic upright or rod 36, which is supported at one end by a rigid metallic stub or wire 37 embedded in the insulating bead 25 and is coupled to the upright or rod 26 through rigid wires or stubs 38 and 39 embedded in an insulating bead 40.

The auxiliary or deionization electrode is electrically connected to a terminal cap 41 affixed to the enclosing vessel 10, by a conductor 42 affixed to the cap 41 and to the wire or stub 37.

In order that the grid 35 will present a large surface for collecting positive ions during the deionization period, the turns thereof preferably are closely spaced. For example, if the ionizable medium is argon at a pressure of the order of 0.25 millimeter of mercury, the turns of the grid 35 may be spaced the order of 0.5 millimeter.

In the embodiment of the invention illustrated in Fig. 3, the auxiliary or deionization electrode is a cylindrical mesh grid 43 which is supported similarly to the helical grid 35 in the embodiment of the invention illustrated in Fig. 1. As shown in Fig. 3, to maintain the proper relative position of the several electrodes more positively, the insulating bead 25 may be coupled to the anode 32 by a rigid wire or stub 44.

The invention may be embodied also in electric discharge devices of the type disclosed in my copending application Serial No. 746,630, filed October 3, 1934, comprising a plurality of anodes having different breakdown characteristics. A device illustrative of this type is illustrated in Figs. 4 and 5 and comprises an enclosing vessel 45 having a stem terminating in a press 46 from which a unitary electrode assembly is supported. This assembly includes a control electrode having a cylindrical portion 47 provided with diametrically opposite apertures 48 and 49 of unequal areas, and supporting flanges 50 which are suitably secured, as by welding, to uprights or rods 51 embedded in and extending from the press 12, one of the uprights or rods being electrically connected to one of the terminal prongs 14 by a conductor 52. Insulating members 53 and 54, such as mica discs, extend across the ends of and are seated against the control electrode and carry a pair of metallic rods 55 and 56 which extend through the insulating discs and are secured thereto by eyelets 57. The rods 55 and 56, which constitute anodes of the device, are disposed in alignment with the apertures 48 and 49 and are electrically connected with two of the terminal prongs 14 by conductors 58 and 59 respectively sealed in the press 46.

Disposed within the cylindrical portion 47 of the control electrode and coaxial therewith is an equipotential cathode including a metallic sleeve 60 coated with a thermionic material and extending through a central aperture in the insulating disc 54. The sleeve 60 is affixed at its upper end to a short guide or wire 61 which extends through a central aperture in the upper insulating disc 53. Attached to the lower end of the metallic sleeve 60 is a flattened bell shaped shield 62 which encloses the leading-in conductors 78 for the cathode heater filament and is carried by two rigid metallic members or wires 63 embedded in the press, one of the metallic members or wires 61 being electrically connected to the metallic sleeve 60 by a tie wire 64 and to one of the terminal prongs 14 by a conductor 65. In some cases it is desirable to operate the heater filament positive with respect to the cathode, and in such cases the shield 62 serves to prevent the establishment of a discharge between the heater filament and the cathode.

A helical wire deionization electrode 66 encompasses the cathode 60 and is supported by two uprights or wires 77 which are fitted in apertures in the insulating discs 53 and 54. One of the uprights or wires 77 is electrically connected to a terminal cap 41 by a conductor 42.

Although specific embodiments of the invention have been shown and described it will be understood, of course, that modifications may be made therein without departing from the scope or spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electric trigger device comprising an enclosing vessel having an ionizable atmosphere therein, a cathode, a cylindrical control electrode encompassing said cathode and having a lateral discharge opening therein, an anode in juxtaposition to said opening, and a deionization electrode encompassing said cathode and disposed between said cathode and said control electrode, said deionization electrode being composed of a plurality of metallic elements spaced closely adjacent to provide a large area surface for the collection of positive ions.

2. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein, a linear incandescible cathode, a rod-like anode parallel to said cathode, a cylindrical control electrode between said cathode and anode and encompassing said cathode, and a helical deionization grid within said control electrode and encompassing said cathode, the turns of said grid being spaced of the order of 0.5 millimeter from each other.

3. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein, a linear cathode, a shell electrode encompassing said cathode and coaxial therewith, said shell electrode having a lateral discharge opening, a rod anode outside of said shell electrode and disposed in alignment with said cathode and said opening, and a cylindrical electrode between said cathode and said shell electrode and coaxial therewith, said cylindrical electrode being perforated to provide an unimpeded discharge path between said cathode and said anode through said lateral opening.

4. An electric discharge device comprising an enclosing vessel having a stem and having also an ionizable atmosphere therein, a support extending from said stem, a cylindrical shell electrode carried by said support, said shell electrode having a lateral opening, insulating members mounted on said support in spaced relation, a cathode within said shell electrode and coupled to one of said insulating members, an anode outside of said shell electrode and in alignment with said opening, and a cylindrical electrode supported from said insulating members, disposed within said shell electrode and encompassing said cathode, said cylindrical electrode being perforated to provide an unimpeded discharge path between said cathode and said anode through said lateral opening.

5. An electric discharge device comprising an enclosing vessel having a stem and having also an ionizable atmosphere therein, a support extending from said stem, a shell electrode carried by said support and having a lateral opening, a pair of insulating members carried by said support and disposed adjacent opposite ends of said shell electrode, a rigid member within said shell electrode and supported from said insulating members, a cylindrical grid carried by said rigid member and disposed within said shell electrode, a cathode within said grid and supported from one of said insulating members, and an anode outside of said shell electrode and in juxtaposition to said opening, said grid being perforated to provide an unimpeded discharge path between said cathode and said anode through said opening.

6. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein, a cathode, a plurality of anodes, a shell control electrode between said cathode and said anodes, said control electrode having a plurality of apertures of unequal areas disposed each in juxtaposition to a corresponding one of said anodes, and a deionization electrode between said cathode and said control electrode.

7. An electric discharge device comprising an enclosing vessel having an atmosphere of argon at a pressure of the order of 0.25 millimeter of mercury therein, a cylindrical shell control electrode having a lateral opening, insulating members extending across the ends of said control electrode, a cathode and a helical grid electrode disposed within said control electrode and positioned by said insulating members, the turns of said helical grid being spaced approximately 0.5 millimeter from each other, and an anode disposed in alignment with said opening, said anode extending between said insulating members and being supported thereby.

8. An electric discharge device comprisng an enclosing vessel having a stem, said vessel having an ionizable atmosphere therein, a plurality of supports extending from said stem, a rigid control electrode carried by said supports and including a cylindrical portion having lateral apertures of unequal areas, insulating discs extending across and seated against opposite ends of said cylindrical portion, a plurality of rod anodes extending between and carried by said insulating discs, each of said anodes being disposed in juxtaposition to a corresponding one of said apertures, a cathode within said cylindrical portion and having end portions fitted in said insulating discs, a plurality of rigid uprights disposed within said cylindrical portion and fitted at opposite ends in said insulating discs, and a helical deionization electrode carried by said uprights and encompassing said cathode.

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