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ELECTRODE STRUCTURE FOR GASEOUS DISCHARGE DEVICES

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FIG. 1

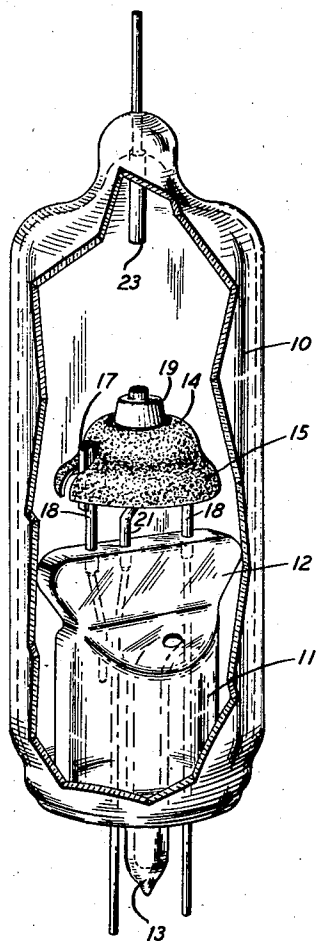
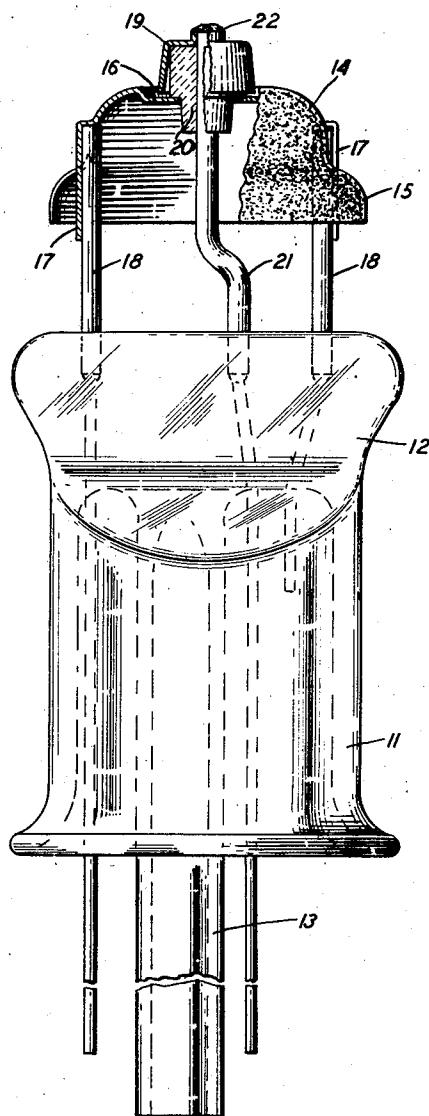


FIG. 2



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ELECTRODE STRUCTURE FOR GASEOUS DISCHARGE DEVICES

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1

This invention relates to electric discharge devices and more particularly to gaseous discharge devices of the trigger control type and especially suitable for use in equipment subject to shocks and high accelerations.

One general object of this invention is to improve the performance of electric discharge devices such as gaseous discharge devices having a cold type cathode, a control anode and a work anode.

More specifically, objects of this invention are to:

Obtain a low control gap breakdown voltage in gaseous discharge devices of the trigger control type;

Reduce the transfer current in such devices;

Realize and maintain a high control anode to cathode resistance in such devices;

Improve the stability of gaseous discharge devices;

Minimize variations in the operating conditions of such discharge devices as the result of shocks;

Facilitate the attainment of accurate cathode to control anode spacings; and

Increase the ruggedness of electric discharge devices whereby the devices may be utilized in equipment subject to high accelerations.

In one illustrative embodiment of this invention, a gaseous discharge device comprises an enclosing vessel having an ionizable atmosphere therein and housing a cathode of the cold type, a control anode in cooperative relation with the cathode and a work anode opposite the cathode.

In accordance with one feature of this invention, the cathode and the control anode are constructed and arranged to provide a relatively large cathode emissive area in juxtaposition to the control anode whereby a low and stable control gap breakdown voltage is realized.

In accordance with another feature of this invention, the cathode, control anode and work anode are of such configuration and are so correlated that the control anode to cathode glow discharge is confined to a limited region and is exposed to a strong work anode field whereby low transfer currents are obtained.

In accordance with a further feature of this invention, the cathode and control anode are spaced by an interposed insulating member whereby the interelectrode spacing is accurately fixed at a preassigned value in the construction of the device, and further, is maintained during the operating life of the device.

In accordance with still another feature of the invention, the insulator, control anode and cath-

2

ode geometry and relation are such that the leakage path over the insulating member is protected from sputtered cathode material whereby a high control anode to cathode insulation resistance obtains throughout the operating life of the device.

Additional features of devices constructed in accordance with this invention reside in a cathode having a large emissive surface all areas of which are accessible to the work anode field and the field for the major portion of which areas is quite uniform, the association of the several electrodes so that the control area of the cathode emissive surface is at a region of the most intense work anode field, and the cathode construction such that a small discontinuity in the work anode field at the cathode obtains whereby tendency to instability is reduced.

The invention and the above noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing, in which:

Fig. 1 is an elevational view in perspective of an electric discharge device illustrative of one embodiment of this invention, a portion of the enclosing vessel being broken away to show internal elements more clearly; and

Fig. 2 is an enlarged elevational view, partly in section, of the cathode and control anode assembly included in the device shown in Fig. 1.

Referring now to the drawing, the device therein disclosed comprises a vitreous enclosing vessel 10 having a stem 11 terminating in a press 12, the stem being provided with a tubulature 13 through which the vessel 10 may be exhausted and by way of which a gaseous filling, for example a mixture of 98 per cent neon and 2 per cent argon at a pressure of 60 millimeters of mercury, may be introduced.

Mounted from the stem 11 is a generally bell or dome shaped cathode, for example of nickel which may have a calorized inner surface, having a portion 14 of an approximately spherical contour, a skirt portion 15 and a central recessed portion 16. The outer surface of the cathode is coated with efficient electron emissive material.

Diametrically opposite portions of the cathode are slit to form mounting straps 17 affixed, as by welding, to rigid metallic supports 18 embedded in the press 12, one of the supports 18 serving as the leading in conductor for the cathode.

Axially aligned with the cathode is an inverted cup-shaped control anode 19 which is seated upon a cylindrical insulating, e. g., ceramic, spacer or

stud 20 fitted in a central aperture in the cathode and seated upon the cathode. The control anode is fixed in position against the insulating spacer by a rigid leading-in conductor 21 embedded in the press 12, the control anode being welded to the conductor 21 as indicated at 22. As shown in Fig. 2, in a particularly advantageous construction, the control anode extends into the central recess in the cathode so that the edge of the anode is in immediate proximity to the base wall of the recessed portion 16 of the cathode. In an illustrative construction, the clearance between the edge and base wall noted may be of the order of 5 to 20 mils. Thus, the change in effective control gap with variations in anode and insulator dimensions due to manufacturing tolerances is minimized.

A linear rod work anode 23 is sealed in the enclosing vessel 10 and axially aligned with the cathode and control anode.

It will be noted that the spacing between the cathode and control anode is determined by the dimension of the insulating stud 20 between the surfaces thereof against which the control anode and the base wall of the recessed portion of the cathode abut. This dimension may be fixed accurately in the fabrication of the stud so that upon assembly of the cathode and control anode the spacing therebetween is fixed automatically at a preassigned value. The control anode base fits the end of the stud so that the control anode is located coaxially with the cathode. Further, inasmuch as the cathode, control anode and spacer are locked together, the desired cathode control anode spacing is maintained even though, as in use of the device, the assembly is subjected to severe shocks and high acceleration.

From electrical and operating standpoints, several other features of the construction illustrated and described are to be noted especially. Substantial areas of the cathode and control anode are in juxtaposition and this, together with the close spacing of these electrodes, assures a strong control field over a large cathode area and, hence, a low and stable control gap breakdown voltage. Even small control anode currents produce a generally spherical volume of ionized gas in the region between the side of the control anode and the adjacent portion of the cathode so that low transfer currents are obtained. Ionization within the inverted cup-shaped control anode is prevented inasmuch as the insulating stud substantially fills this anode and limits the electron paths. Hence, the ionized gas volume aforementioned is always exposed to the main or work anode field and is at a region where this field is a maximum.

It is to be noted also that the side of the portion of the spacer 20 between the cathode and control anode is shielded by the control anode from sputtered cathode material so that the establishment of conducting films on the spacer is prevented and a high control anode-to-cathode resistance is maintained throughout the operating life of the device.

Further, the recessed portion in the cathode results in a substantially constant effective cathode to control anode spacing despite variations in the control anode, cathode and insulator dimensions due to manufacturing tolerances. The recess assures a concentrated and uniform control anode-to-cathode field whereby a low and stable control gap breakdown voltage is obtained.

Finally, it will be observed that the cathode construction provides a large electron emissive

surface substantially all of which is exposed to the work anode field. Also the configuration of the emissive surface tends to prevent shifting of the cathode glow with changing work currents so that stable operation is realized.

Although a specific embodiment of the invention has been shown and described, it will be understood, of course, that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electric discharge device comprising a cathode having an extended electron emissive surface provided with a shallow recess, a control anode overlying said recess and having a portion extending into said recess and having an edge substantially conforming to and immediately adjacent the lateral wall thereof, and a work anode opposite said surface.
2. An electric discharge device comprising a cathode having an extended electron emissive surface provided with a shallow circular recess, a control anode having an annular portion coaxial with said recess and in immediate proximity to the base and side wall of said recess, and a work anode opposite said surface.
3. An electric discharge device comprising a cathode having an extended electron emissive surface provided with a central cylindrical wall portion, said surface extending laterally outward beyond said portion, a control anode having a cylindrical wall extending within and in proximity to said wall portion and coaxial therewith, and a work anode opposite said surface.
4. An electric discharge device comprising a cathode having a dome-shaped convex electron emissive surface, said surface having a central shallow recess therein, a control anode extending into said recess, and a work anode opposite said surface.
5. An electric discharge device comprising a cathode having a dome-shaped convex electron emissive surface, said surface having a central, shallow cylindrical recess therein, a control anode having a cylindrical portion in immediate proximity to the side wall of said recess and coaxial therewith, and a work anode opposite said surface.
6. An electric discharge device comprising a cathode having an extended electron emissive surface, an insulating spacer seated upon said surface, a control anode mounted upon said spacer and having a hollow shielding portion adjacent and encompassing said spacer, and a work anode opposite said surface.
7. An electric discharge device comprising an insulating stud, a cathode abutting said stud and having an electron emissive surface extending laterally therebeyond, a control anode seated on said stud and having a hollow portion closely encompassing said stud and extending into proximity to said surface, and a work anode opposite said surface.
8. An electric discharge device comprising a cathode having an extended emissive surface provided with a recess, an insulating spacer seated in said recess, a control anode seated upon said spacer and having a hollow portion closely encompassing said spacer and extending into proximity to said surface, and a work anode opposite said surface.
9. An electric discharge device comprising a cathode having an extended electron emissive sur-

5

face provided with a central, circular recess, a cylindrical insulating stud seated in said recess, a control anode having a cylindrical portion closely encompassing said stud, coaxial with said recess and extending thereinto, and a work anode opposite said surface.

10. A unitary mount for electric discharge devices, comprising a mounting member, a pair of rigid supports extending from said mounting member, a cathode mounted by said supports and having a disc portion, an insulating stud abutting said disc portion, a control anode seated upon said insulating stud, and means locking said cathode, stud and anode together.

11. A unitary mount for electric discharge devices, comprising a stem, a pair of laterally spaced rigid supports extending from said stem, a cathode extending between said supports and fixed thereto, said cathode having a central disc portion, an insulating stud abutting said disc portion, a control anode seated upon said stud, and a rigid leading-in conductor for said control anode extending through said stud, said conductor being secured to said anode and locking it against said stud.

12. A unitary mount for electric discharge devices, comprising a stem, a pair of parallel, rigid supports embedded in said stem, a dome-shaped cathode between said supports and affixed thereto with its axis substantially parallel to said supports, a coating of electron emissive material upon the face of said cathode away from said stem, said cathode having a central planar portion provided with a central aperture, a cylindrical insulating stud seated upon said planar portion and having a portion fitted in said aperture, a control anode seated upon said stud and positioned thereby in coaxial relation with said cathode, said anode having a cylindrical portion encompassing said stud and extending into proximity to said

6

control cathode face, and a rigid leading-in conductor for said anode, embedded in said stem and extending through said stud, said conductor being fixed to said anode and locking it and said stud against said planar portion of said cathode.

13. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein, a cathode having a convex dome-shaped surface provided with a central, circular recessed portion, an electron emissive coating upon said surface, a control anode having a cylindrical portion coaxial with and in proximity to said recessed portion, and a linear rod work anode in axial alignment with said recessed portion and opposite the end of said control anode remote from said recessed portion.

14. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein, a cathode having an outer dome-shaped surface coated with electron emissive material, said surface having a shallow, central, circular recess therein, an inverted cup-shaped control anode coaxial with said recess and having its edge in juxtaposition thereto, an insulating spacer member seated in said recess and extending within and abutting said control anode, and a linear rod work anode coaxial with said control anode and opposite the base thereof.

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