

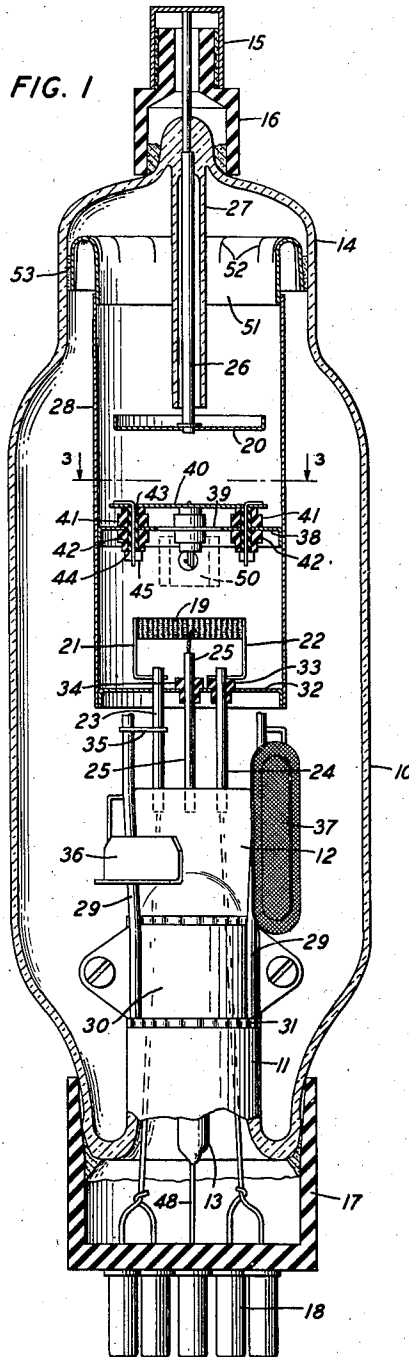
Aug. 22, 1944.

J. E. CLARK ET AL
ELECTRONIC DISCHARGE DEVICE

2,356,566

Filed June 5, 1942

2 Sheets-Sheet 1



J. E. CLARK
INVENTORS: J. V. DOMALESKI
V. L. RONCI
BY

Walter C. Kiesel
ATTORNEY

Aug. 22, 1944.

J. E. CLARK ET AL

2,356,566

ELECTRONIC DISCHARGE DEVICE

Filed June 5, 1942

2 Sheets-Sheet 2

FIG. 2

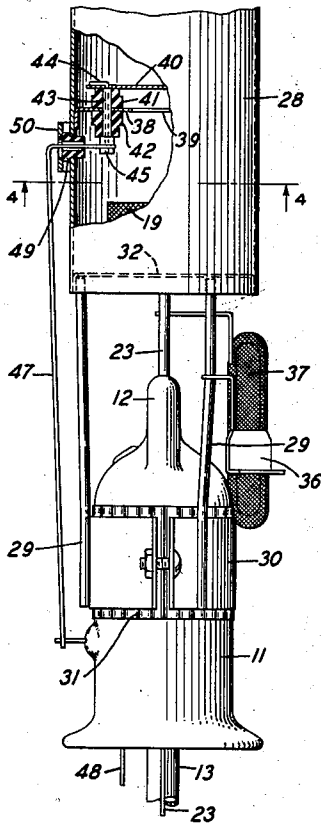


FIG. 3

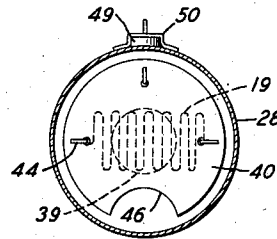


FIG. 4

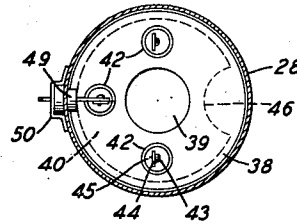


FIG. 5

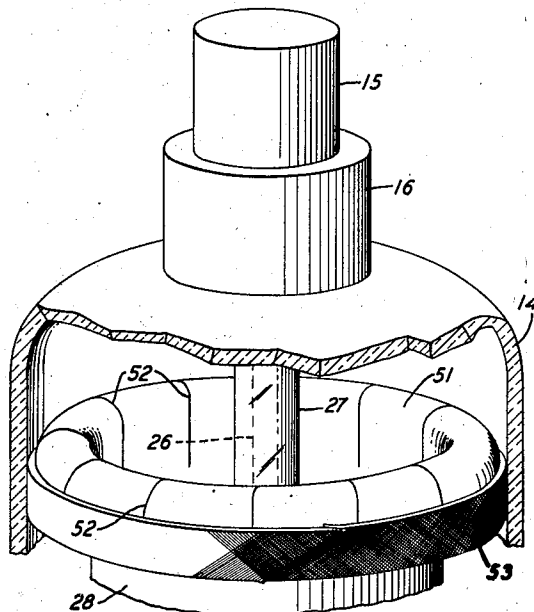
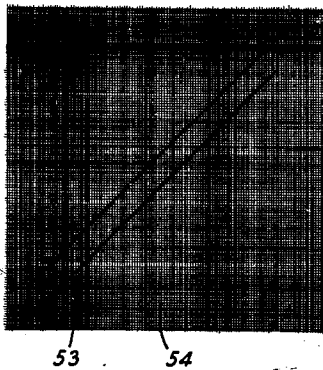


FIG. 6



J. E. CLARK
INVENTORS: J. V. DOMALESKI
V. L. RONCI

BY

Walter C. Kiesel

ATTORNEY

UNITED STATES PATENT OFFICE

2,356,566

ELECTRONIC DISCHARGE DEVICE

James E. Clark, Williston Park, N. Y., Joseph V. Domaleski, Wood Ridge, N. J., and Victor L. Ronci, Brooklyn, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 5, 1942, Serial No. 445,852

18 Claims. (Cl. 250—27.5)

This invention relates to electronic discharge devices and more particularly to such devices in which gaseous ionization contributes to the flow of current output in the device.

In gaseous discharge devices the power capable of being realized is limited by the inverse peak potential of the anode, particularly when the energizing electron source is a cathode of the oxide-coated type, since the active coating is liable to attack by anodic bombardment which destroys the coating and renders the device inactive or wholly inefficient. Furthermore, the cathode may be subjected to ionic bombardment by high voltage fields which follow circuitous paths in the gaseous atmosphere to attack the cathode, thereby vitiating the precautions taken to avoid direct attack of the cathode.

An object of this invention is to control the gaseous discharge so as to eliminate ionic bombardment of the electron emitting cathode of the discharge device.

Another object of the invention is to localize the discharge path to produce high efficiency in power output.

A further object of the invention is to facilitate the controlling action of the gaseous discharge path to effect sensitive operation.

In accordance with this invention the electronic discharge device includes an electron emitting cathode of the oxide-coated type and an anode with a gaseous atmosphere to create an ionizing discharge path between the cathode and the anode. This path is surrounded or localized by an electrostatic shield to confine the discharge between the electrodes and a control electrode is interposed between the cathode and anode to fire the discharge gap under definite control potentials.

A feature of the invention relates to a rugged construction capable of maintaining uniform characteristics under severe conditions of use in which the shield assembly is rigidly secured in position at one end of the device and resiliently positioned at the opposite end to substantially and completely enclose the main discharge path between the electrodes.

Another feature of the invention is concerned with a shield structure providing a complete electrostatic enclosure for the control electrode which is insulatingly supported at an intermediate position of the enclosure shield on a baffle partition. This construction produces a uniform electrostatic field and the grid and shield assembly presents a barrier between the cathode and anode so that there is no direct path therebetween.

A further feature of the invention relates to the prevention of stray discharge paths from the anode to the exterior of the electrostatic shield structure by a yieldable encircling member interposed between the resilient top shield portion and the wall of the vessel. This construction permits the shield to expand and contract with the adjacent wall of the vessel, yet eliminates the establishment of stray energizing paths containing ions with sufficient velocity to attack the cathode coating.

These and other features and advantages of the invention will be more clearly set forth in the following detailed description as applied to the accompanying drawings.

Fig. 1 is a cross-sectional view in elevation of a complete assembly of the device of this invention with the internal electrodes shown in relation to the enclosing vessel.

Fig. 2 shows a portion of the electrode assembly removed from the enclosing vessel of Fig. 1 with a portion broken away to illustrate the conductor connection of the control electrode enclosed within the assembly.

Fig. 3 is a plan view showing the relation of the control electrode and shield as viewed on the line 3—3 of Fig. 1;

Fig. 4 is another plan view from the opposite side taken on the line 4—4 of Fig. 2;

Fig. 5 is an enlarged perspective view of the top portion of the device of Fig. 1 and illustrating the relation of the shield and expansion band adjacent the anode; and

Fig. 6 shows the method of cutting the expansion band from a piece of woven wire material.

Referring to the drawings and Fig. 1 particularly, the electronic discharge device of this invention comprises a substantially cylindrical enclosing vessel 10, of vitreous material, having a reentrant stem 11 sealed to one end of the vessel and terminating in a press 12 which is provided with an outwardly extending tubulation 13 for evacuating and sealing the enclosing vessel. The other end of the vessel is provided with a dome portion 14 and carries a terminal cap 15 for one of the main electrodes, the cap being insulated from the enclosing vessel by a bushing 16 which is cemented to the vessel to isolate the terminal cap from corona effects and leakage paths along the wall of the vessel. The stem end of the vessel is provided with a cup-shaped base 17 carrying a plurality of terminals 18 for the remaining electrodes in the device. The main discharge electrodes of the device comprise an electron emitting cathode 19 and an anode 20 for generating a

desired power output in the operation of the device. The cathode comprises a metallic mesh ribbon folded in zigzag form and coated with electron emitting material, such as alkaline earth oxides of barium and strontium. The ends of the cathode ribbon are attached to L-shaped support wires 21 and 22 which are connected at the lower end to lead-in wires 23 and 24 respectively, sealed in the press 12 of the stem, these wires being connected in multiple to terminals 18 in the base 17, as shown in the drawings. The center portion of the cathode is secured to the stem by an anchor wire 25 carrying a hook engaging the mesh ribbon. The anode 20 is a metallic disc, preferably of carbonized nickel, to more readily dissipate the heat generated in the anode surface and this disc is supported in opposed relation to the cathode 19 by a central support wire 26 which extends through a glass tubulation 27 and is sealed in the top of the dome portion of the vessel to be attached to the terminal cap 15.

The main discharge path between the cathode and the anode is concentrated or localized by enclosing this path within a cylindrical electrostatic shield member 28 which is preferably carbonized to dissipate the heat energy generated in the area. The shield or housing is rigidly supported from the stem 11 by a plurality of rods 29 which are attached to a two-piece collar 30 rigidly clamped to the stem over a corrugated mica strip 31 employed to relieve unequal pressure against the glass stem and to provide frictional resistance against any tendency of the collar to slip. The support rods 29 are attached by welding to the inner periphery of a metallic disc closure 32 welded in the lower end of the shield 28, the disc 32 being provided with apertures to permit the passage of the conductors from the stem. The closure disc 32 is provided with a pair of insulating bushings 33 and 34 which are seated in apertures in the closure through which extend the conductors 24 and 25, respectively. The remaining conductor of the cathode extends through another aperture of the closure but is not insulated therefrom since this conductor is electrically connected to one of the support rods 29 of the shield by a strap wire 35 so that the shield is held at the same potential as the cathode and therefore does not function as an accelerating electrode in the progress of the electrons from the cathode through the ionized field between the cathode and the anode. A flag type getter support 36 is attached to one of the support rods 29 of the shield structure and carries a getter material which is vaporized in the final evacuation of the device to fix occluded foreign gases in an adsorbed film deposited on an adjacent wall of the vessel. An elongated capsule 37 is also attached to one of the support rods 29 of the shield structure to form a carrier for a supply of vaporizable material, such as mercury, the capsule being broken after the device is completely sealed to liberate the supply of mercury which forms the ionizing medium when brought to the proper state of vaporization.

The enclosure shield 28 is provided with a partition 38 intermediate the cathode and the anode, the partition having a central opening 39 to concentrate the flow of electron energy from the cathode. The partition also serves as a support for a control or trigger electrode 40 in the form of an imperforate metallic disc which is insulatingly supported on the partition by pairs of insulating bushings 41 and 42 arranged above and below the partition 38. An insulating sleeve 43

extends through the pair of bushings and the partition and a wire 44 extends through the sleeve to affix the control electrode to the partition, one end of the wire being bent over the top of the disc electrode 40 and welded thereto while the opposite end has a metallic tab 45 welded to the side of the wire to rigidly clamp the sleeve and bushings to the partition 38. The control electrode 40 has a cut-out recess 46 in the unsupported edge thereof, in the form of an arcuate opening which is located in offset relation with respect to the central aperture 39 in the partition 38, as shown in Figs. 3 and 4. This arrangement is provided to insure that the passage of the discharge follows a circuitous path to the anode or output electrode and there is no direct path from the anode to the cathode so that back-emission is eliminated. Controlling energy is supplied to the trigger electrode 40, as shown in Fig. 2, by a conductor 47 which is connected to a terminal lead-in wire 48 extending through the side of the stem 11 and the conductor 47 extends through the shield to be connected to one of the support wires 44 of the control electrode below the partition 38. The conductor 47 extending through the shield is insulated therefrom by a bushing 49 which is held in position by an angular strap 50 welded to the exterior of the shield. The lead-in wire 48 extending from the stem is attached to the remaining terminal 18 on the base so that a suitable controlling potential may be applied to the control electrode to transfer the discharge from the cathode to the anode in the operation of the device.

While the construction so far described renders the device highly efficient for certain types of service operation such as regulated rectifying and controlled relay action, and, furthermore, eliminates completely the deterioration of the cathode coating by inverse emission or back emission from the anode, it is necessary to go further in protecting the cathode against attack by extraneous fields and circuitous paths around the exterior of the shield and also to stabilize the characteristics of the device and obtain the highest power output therefrom. This is accomplished by segregating the anode field at the top of the shield by a resilient or flexible spacer ring 51 which is attached to the periphery of the upper end of the shield 28 and is provided with a reversely bent surrounding portion which engages the side wall of the dome portion 14 of the vessel. The ring member 51 is therefore in the form of a channel-shaped member which maintains the shield and the supported control electrode in uniform spatial relation with respect to the cathode and anode in which the reversely bent portion of the spacer ring is provided with a plurality of distributed slots 52 around the periphery which extend in a longitudinal direction to provide a plurality of resilient similarly shaped fingers which yieldably expand and contract with the wall of the vessel, thereby maintaining the shield in stable relation with respect to the main electrodes of the device. The main mechanical function of the flexible ring 51 is to cause a snug fit inside the glass dome even though the diameter of the latter varies within certain commercial limits and thereby positively supports the shield 28 in the vessel. For this reason the initial diameter of the ring is made to the maximum internal diameter of the dome. During assembly the ring is forced into the dome with sufficient pressure to deform the ring to the size of the dome portion 14.

Under low temperature operation the resilient spacer member is sufficient to prevent the escape of ionized particles from the anode of sufficient energy to attack the cathode from the bottom of the shield casing. However, when the device is functioning under peak operating conditions when the highest power output is attained, the expansion of the spacer ring 51 with respect to the vessel wall enlarges the slots adjacent the wall so that a discharge path of sufficient energy is established which might attack the cathode coating and thereby reduce the efficiency of the device. In order to cover the openings of the expanded slots or, in effect, break up the wide openings of the slots into minute perforations too small for the passage of the ionized particles in the discharge path and at the same time provide a yieldable covering which will mutually change in relation with the resilient fingers of the channel ring 51 and the wall of the vessel and thereby maintain abutting contact with the wall of the vessel, a perforated band 53 surrounds the periphery of the reversely bent portion of the ring 51 and is interposed between the ring and the wall of the dome portion 14 of the vessel. In a preferred aspect of the invention as applied to this feature the band 53 is formed of a mesh ribbon cut on the bias from a rectangular piece of mesh material 54 as shown in Fig. 6. This ribbon has the diagonal ends joined together to form a ring which is slipped over the reversely bent portion of the ring 51 and the ribbon is attached to alternate fingers of the spacer ring by spot welding. The diagonal arrangement of the warp and weft of the mesh material permits sufficient elongation and shrinkage of the ribbon 53 to compensate for the expansion and contraction of the spacer ring 51 and effectively inhibits the extension of the discharge from the anode area to the exterior of the shield thereby permitting higher power output to be obtained in the operation of the device without detrimental effects due to extraneous and injurious ionized fields which might attack the active cathode coating.

While the invention has been disclosed with respect to a particular arrangement of the structural assembly of the electrodes of the device and the cooperation of the individual parts thereof, it is, of course understood, that various modifications may be made in the detailed assembly and location of the elemental parts without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An electronic discharge device comprising an enclosing vessel, an electron emitting cathode and an anode mounted in opposed relation in said vessel, a metallic shield surrounding said cathode and anode and the discharge path therebetween, and an encircling spacer member carried by said shield and engaging the wall of said vessel, said member having a plurality of resilient portions adjacent said wall and capable of expanding with said wall to maintain said shield in uniform relation with respect to said cathode and said anode, said portions being joined at their free ends by expansible cushioning material.

2. An electronic discharge device comprising an enclosing vessel, an oxide coated cathode and an anode mounted in opposed relation in said vessel, a vaporizable material therein capable of producing an ionizing discharge between the cathode and anode, a cylindrical metallic shield surrounding said cathode and anode and the discharge path therebetween, and a resilient spacer ring

carried by said shield and engaging the wall of said vessel, said ring having a plurality of similar arched yieldable portions adjacent said wall and capable of expanding with said wall to maintain said shield in uniform relation with respect to said cathode and anode.

3. An electronic discharge device comprising an enclosing vessel, an oxide coated cathode and an anode mounted in opposed relation in said vessel, an ionizable atmosphere therein capable of producing a gaseous discharge between said cathode and anode, a metallic shield surrounding said cathode and anode and the discharge path therebetween, a metallic spacer member carried by said shield and engaging the wall of said vessel, said member having a plurality of resilient portions adjacent said wall and capable of expanding with said wall to maintain said shield in uniform relation with respect to said cathode and anode, and a foraminous ribbon encircling said resilient portions and masking the restricted gaps between said portions to prevent the extension of a high potential ionizing discharge from the anode area to the exterior of said shield.

4. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, said shield having a resilient portion adjacent the wall of said vessel, and a ring contact member transversely yieldable with respect to said resilient portion and interposed between said resilient portion and the wall of said vessel.

5. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, and a cylindrical resilient spacer member carried by one end of said shield, said member having a reversely bent slotted portion interposed between said member and the wall of said vessel.

6. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, and a cylindrical resilient spacer member carried by one end of said shield, said member having a reversely bent portion interposed between said member and the wall of said vessel, said reversely bent portion being slotted to form resilient fingers.

7. An electronic discharge device according to claim 6, in which the slots are arranged around the periphery and parallel to the axis of said shield.

8. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, a cylindrical resilient spacer member carried by one end of said shield, said member having a reversely bent portion interposed between said member and the wall of said vessel, said portion having longitudinal slots forming yieldable contacts with the vessel wall, said slots being enlarged during expansion of said member, and an intermediate perforate resilient band covering said slots to inhibit the ex-

tension of the high voltage ionized field to the exterior of said shield.

9. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, a cylindrical resilient spacer member carried by one end of said shield, said member having a reversely bent portion containing a plurality of slots interposed between said member and the wall of said vessel, and a yieldable band covering said slots.

10. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic metallic shield surrounding said cathode and anode and the discharge path therebetween, a cylindrical resilient spacer member carried by one end of said shield, said member having a reversely bent portion provided with a plurality of slots around the periphery and interposed between said member and the wall of said vessel, and a metallic mesh layer shielding said slots.

11. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield member surrounding said cathode and anode and the discharge path therebetween, a cylindrical resilient spacer member carried by one end of said shield, said member having a reversely bent portion provided with slots around the periphery thereof and interposed between said member and the wall of said vessel, and a woven mesh band surrounding said bent portion and slots and being in engaging relation with the wall of said vessel.

12. An electrode discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield member surrounding said cathode and anode and the discharge path therebetween, and a channel-shaped ring member having one end attached to said shield and the other end in contact with the wall of said vessel.

13. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, and a channel-shaped ring member having one end attached to said shield and the other end adjacent the wall of said vessel, said member having slots formed in a portion thereof extending along the wall of said vessel.

14. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, a channel-shaped ring member having one end attached to said shield and the other end in contact with the

wall of said vessel, said member having slots formed therein adjacent said wall, and yieldable means embracing the slotted portion to shield said slotted portion during expansion of said ring member.

15. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, an electron emitting cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, an apertured partition carried by said shield between said cathode and anode, and a control element spaced from and covering the opening in said partition, said element having a cut-out portion in offset relation to the aperture in said partition.

16. An electronic discharge device comprising an enclosing vessel containing an ionizable medium, an electron emitting cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, a partition having a central opening supported intermediate the ends of said shield and mounted between said cathode and anode, and a flat control electrode supported in spaced relation beyond said partition, said electrode having a segmental recess out of alignment with the central opening in said partition.

17. An electronic discharge device comprising an enclosing vessel containing an ionizing medium, an electron emitting cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween, a partition having a central opening mounted intermediate the ends of said shield between said cathode and anode, an impervious control electrode beyond said partition, said electrode having a segmental recess out of alignment with the central opening in said partition, an insulated conductor extending through said shield beyond said partition and connected to said control electrode through said partition, insulating bushings on opposite sides of said partition, and anchor wires extending through said bushings being rigidly secured to said control electrode.

18. An electronic discharge device comprising an enclosing vessel containing an ionizing medium, a cathode supported therein, an anode disposed opposite said cathode, an electrostatic shield surrounding said cathode and anode and the discharge path therebetween and supported from one end of said vessel, a resilient ring member carried by said shield and having a portion engaging the wall of said vessel, an apertured partition in said shield between said cathode and anode, a control electrode insulatingly supported by said partition within said shield, an insulator extending through said shield, and a conductor passing through said insulator and connected to said control electrode.

JAMES E. CLARK.
JOSEPH V. DOMALESKI.
VICTOR L. RONCI.