Nov. 28, 1961 V. L. RONCI ET AL 3,011,084

ELECTRON DISCHARGE DEVICES

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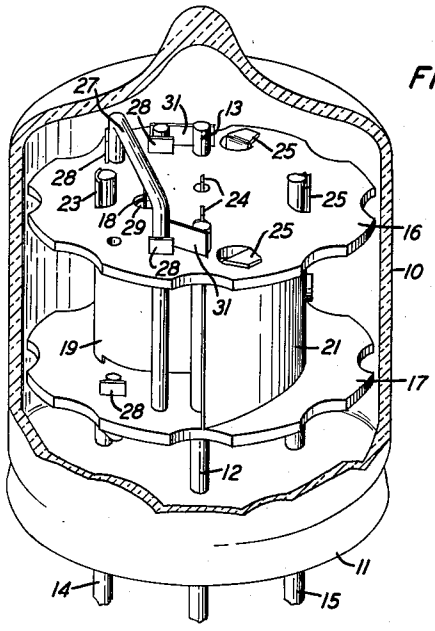

FIG. 1

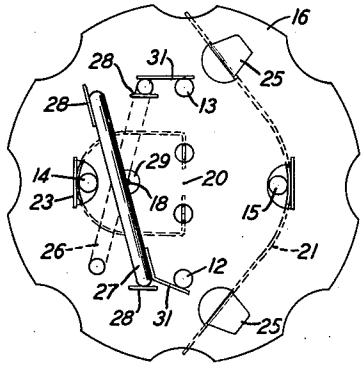

FIG. 2

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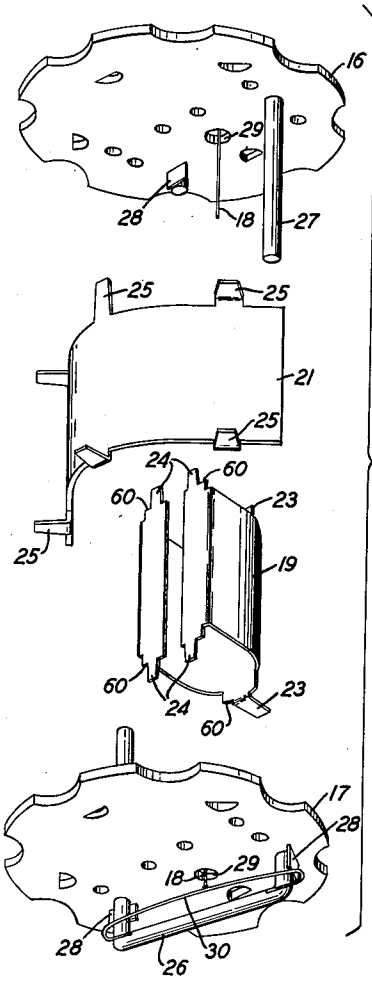
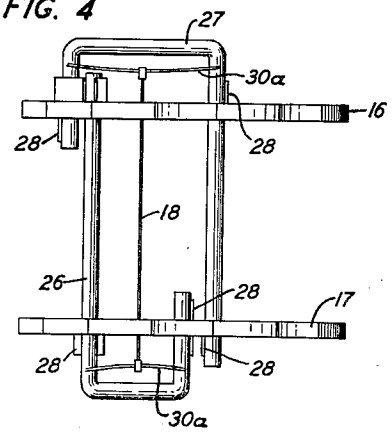


FIG. 3

FIG. 4



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ELECTRON DISCHARGE DEVICES

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This invention relates to electron discharge devices and more particularly to electrode assemblies including a filamentary cathode for such devices intended for use in projectiles.

The forces acting upon a body moving at high velocity are very great. Thus, in an electron discharge device mounted in a projectile, the electrodes and the supporting members of the device are subjected to tremendous axial and rotational acceleration and resultant forces during the flight of the projectile.

One object of this invention is to enable the attainment of an extremely rugged electrode assembly for electron discharge devices, capable of withstanding exceedingly great strains and stresses, whereby such devices, when utilized in projectiles, not only remain operable but retain the desired operating characteristics.

In one illustrative embodiment of this invention, an electron discharge device of the trigger control gas type comprises an enclosing vessel housing and on the base of which there is mounted a unitary electrode assembly including a cathode, a control electrode and an anode, the assembly including also insulating spacers between which the electrodes are mounted, and being supported by rigid metallic uprights extending from the base of the enclosing vessel, locked to the insulating spacers and serving as leading-in conductors for the electrodes.

In accordance with one feature of this invention, the cathode is a linear filament which projects through aligned apertures in the insulating spacers, and is supported between a pair of bridge members, each bridge member being secured at its ends to one of the insulating spacers and extending across the aperture therein and one of the bridge members mounting a resilient metallic strip having its ends secured to this bridge member adjacent the ends thereof. The filamentary cathode has one end affixed to the mid-point of the metallic strip and the other end affixed to the other bridge member.

In accordance with another feature of this invention, the control electrode is a formed sheet metal member encompassing the cathode and having spaced edges defining a discharge opening in parallel alignment with the cathode, the control electrode having integral tabs at opposite ends of the spaced edges which extend through and are fitted in apertures in the insulating spacers to thus fix and maintain accurately the width of the discharge opening.

In accordance with a further feature of this invention, two of the supporting uprights which serve as leading-in conductors for the cathode are mounted on opposite sides of the control electrode and between it and the anode. Being at substantially cathode potential, these uprights serve also as shields and screen the discharge path from extraneous fields.

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 a perspective view to a greatly enlarged scale of an electron discharge device illustrative of one embodiment of this invention, a portion of the enclosing vessel of the device being broken away to show the electrode assembly more clearly;

FIG. 2 is a plan view of the electrode assembly included in the device shown in FIG. 1;

FIG. 3 is an exploded perspective view of this electrode assembly; and

FIG. 4 is a detail view illustrating a modification of the filament and filament supporting system shown in FIGS. 1, 2 and 3.

The electron discharge device shown in FIG. 1 comprises an enclosing vessel **10**, for example of vitreous material, having therein a filling of gas, for example argon at a pressure of the order of 0.2 to 0.4 mm. of mercury. Sealed to and extending through the base wall **11** of the vessel are four rigid metallic supports **12**, **13**, **14** and **15** which, as shown clearly in FIG. 2, are mounted in space quadrature in circular relation. These supports extend through and are fitted in aligned apertures in parallel, preferably rigid, insulating spacers **16** and **17**, such as mica discs, having scalloped edges, as shown in FIG. 2, adjacent or engaging the inner wall of the enclosing vessel **10**.

Mounted between the insulating spacers **16** and **17** are a linear cathode **18**, which may be a tungsten filament coated with a thermionic material, a control electrode **19** substantially encompassing the cathode **18** and having juxtaposed edges defining a discharge opening **20** in parallel alignment with the cathode, and a dished anode **21**.

The control electrode **19** may be formed of sheet metal, such as nickel, and is provided with a plurality of integral tabs **23** and **24** extending from opposite edges thereof, the tabs being generally T-shaped, extending through apertures in the insulating spacers **16** and **17** and providing seating surfaces **60** upon which the insulating spacers bear. The control electrode **19** and one of the tabs **23** are secured, as by spot welding, to the support rod **14** and the other tab **23** is bent over and bears against the insulating spacer **17**. The stems of the several tabs **24** are tapered as shown and extend into and are tightly fitted in corresponding apertures in the insulating spacers **16** and **17**. These apertures are accurately located and spaced in the manufacture of the spacers so that when the stems of the tabs **24**, which it will be noted are adjacent the ends of the edges of the control electrode defining the discharge opening **20**, are fitted into these apertures the spacing of these edges and hence the width of the discharge opening are fixed accurately and, as will be apparent, are accurately maintained even when the device is subjected to great stresses.

The anode **21** also may be formed of sheet metal, such as nickel, and is provided with tapering integral tabs **25** which extend through apertures in the spacers **16** and **17** and all but one of which are bent over to lock the spacers against the opposite end edges of the anode. The remaining tab **25** and the anode **21** may be affixed, as by welding, to the metallic support **15**.

Carried by the insulating spacers **16** and **17** are a pair of rigid metallic J-shaped members **26** and **27** which extends through apertures in the spacers and are firmly locked thereto by metallic tabs **28** welded to the members **26** and **27**. As shown clearly in FIG. 2, the shorter arms of the J-shaped members **26** and **27** constitute bridge elements arranged in spaced crossed relation and having their mid-points opposite aligned apertures **29** in the insulating spacers **16** and **17**. Carried by the J-shaped member **26** is a resilient metallic support **30**, for example, of the fine tungsten wire, which has its ends secured to the bridge element portion of the member **26** and which has its mid-point opposite the aperture **29** in the insulating spacer **17**. The filament **18** extends through the apertures **29**, which are several times the diameter of the filament wire to maintain a clearance between the filament and the spacers, and is secured, as by welding, to the mid-points of the resilient support **30** and of the bridge element por-

tion of the metallic member 27. In the assembly of the device, the resilient member 30 is bowed slightly toward the insulating spacer 17 to place an initial tension upon the filamentary cathode 18.

The metallic members 26 and 27 constitute parts of the leading-in connections to the cathode and are connected electrically to the supports 12 and 13, respectively by wires or strips 31. These supports, being at cathode potential, screen the discharge path between the aperture 20 and the anode 21 from extraneous fields whereby stable operation is assured.

It will be appreciated that the electrode assembly constitutes a very rugged structure wherein the relation and form of the electrode is preserved even when the device is subjected to great strains and stresses. The filamentary cathode 18 is protected against rupture even when the device is propelled in a projectile due to the action of the resilient support 30 which greatly reduces the stresses produced in the filamentary cathode.

In a modification of the construction shown in FIGS. 1 to 3 and described hereinabove, the filamentary cathode 18 is supported resiliently at both ends. In this modification, as illustrated in FIG. 4, each of the bridge portions of the members 26 and 27 has extending thereacross a resilient member 30*a* such as a tungsten wire, which has its ends affixed to the corresponding bridge portion and has its mid-point opposite the aperture 29 in the adjacent insulating spacers 16 or 17. The cathode 18 is affixed as by welding, to the mid-points of the resilient wires 30*a*, each of which wires is bowed toward the adjacent insulating spacer, so that the filamentary cathode is placed under an initial tension and is floatingly supported.

Although specific embodiments of the invention have been shown and described, it will be understood that they are 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 electron discharge device comprising a pair of spacer members mounted in fixed spaced relation and having aligned apertures therein, a plurality of electrodes including a filiamentary cathode, and means supporting said cathode comprising a pair of rigid suports each having a bridge portion, each bridge portion being adjacent one of said spacer members, extending across the aperture therein and having its ends anchored thereto, and a resilient member extending across the bridge portion of one of said supports and having its ends affixed thereto, said cathode extending through said aligned apertures, having one end secured to an intermediate point on said resilient member and having its other end connected to the bridge portion of the other of said supports.

2. An electron discharge device comprising a plurality of electrodes one of which is a filamentary cathode, a pair of insulating spacers mounted in spaced relation and having aligned apertures, and means for supporting said cathode including a pair of rigid supports anchored to said spacers, and each having a portion extending between and through said spacers and having also a bridge portion, each bridge portion being adjacent one of said spacers and extending across the aperture therein, and a resilient member adjacent the bridge portion of one of said supports having its ends secured thereto and extending across the aperture there adjacent, said filamentary cathode having one end affixed to said resilient member, its other end connected to the bridge portion of the other of said supports, and extending through said apertures.

3. An electron discharge device comprising an enclosing vessel having a base, a plurality of rigid uprights extending from said base, a pair of insulating discs mounted in parallel relation within said vessel and fixed to said uprights, said discs having aligned apertures therein, a pair of substantially J-shaped supports each anchored at its ends to said discs, the stem of each support extending through both of said discs and the base of each support extending adjacent one of said discs and across the aperture therein, said discs being positioned between the base portions of said supports, a resilient strip member extending across the base of one of said supports and across the adjacent aperture and having its ends secured to said one support, and a pair of electrodes within said vessel one of which is a filamentary cathode extending between said discs and projecting through said apertures, said cathode having one end affixed to said resilient member and having its other end connected to the base portion of the other of said supports.

4. An electron discharge device comprising a pair of insulating spacers mounted in spaced relation and having aligned apertures therein, a pair of electrodes one of which is a filamentary cathode extending between said spacers and through said apertures, and means for supporting said cathode including a pair of rigid supports each having a bridge portion anchored to a corresponding one of said spacers and extending across the aperture therein, said spacers being between said bridge portions, and a pair of resilient members each between one of said bridge portions and the adjacent spacer and secured at its ends to the corresponding bridge portion, said filamentary cathode being secured at its ends to said resilient members.

5. An electron discharge device comprising a pair of spaced insulating spacers, and a plurality of electrodes including a cathode, a control electrode and an anode mounted between said spacers, said control electrode being a formed sheet metal member encompassing said cathode and having juxtaposed edges defining a discharge opening and having also integral tabs adjacent the ends of said edges and fitted in apertures in said spacers to fix the width of said opening.

6. An electron discharge device comprising a pair of spaced insulating discs, an anode and a cathode between said discs, a control electrode comprising a formed sheet metal member encompassing said cathode and having juxtaposed edges defining a discharge opening and having also integral tabs extending from the ends thereof, said tabs having shoulder portions against which said discs are seated, and two of the tabs at each end of said control electrode being adjacent said edges and fitted in apertures in said discs to fix the width of said opening, and means affixed to said discs mounting said cathode in fixed alignment with said opening.

7. An electron discharge device comprising an anode having a curviform surface, a cathode opposite said surface, a control electrode encompassing said cathode and having a discharge opening therein between said cathode and said surface, and leading-in means for said cathode including a pair of members substantially longitudinally coextensive therewith and mounted between said control electrode and said anode and on opposite sides of said opening.

8. An electron discharge device comprising an enclosing vessel having a base, four rigid metallic uprights in space quadrature extending from said base and longitudinally of said vessel, a pair of spaced insulating discs extending transversely within said vessel and mounted on said uprights, an anode mounted on one of said uprights, between said discs and having a curviform surface facing the diametrically opposite upright, a hollow control electrode between said discs, mounted on said diametrically opposite upright and positioned between the remaining two uprights, said control electrode having a discharge opening opposite said surface, a cathode within said control electrode, and means connecting said cathode electrically to said two remaining uprights.

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