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ELECTRON DISCHARGE DEVICE HAVING CATHODE PROTECTIVE MEANS WITHIN THE ENVELOPE

Filed March 28, 1962

Fig. 1

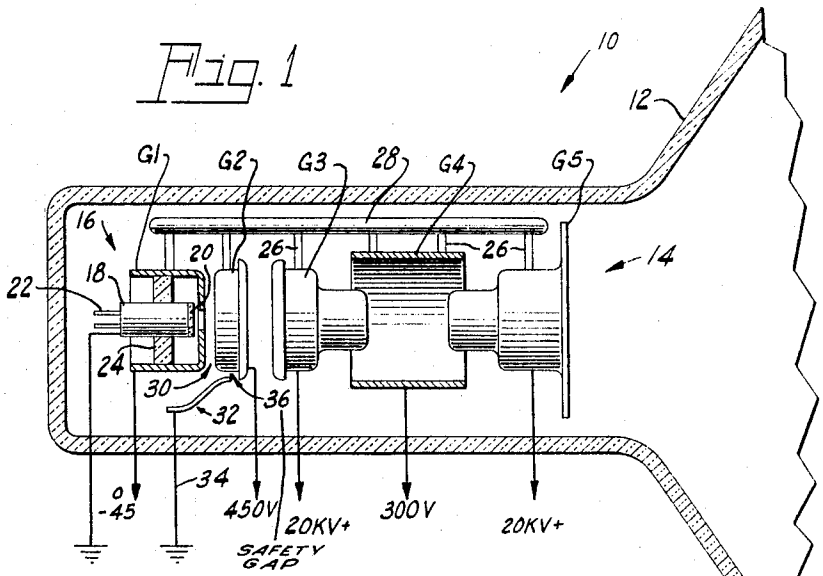


Fig. 2

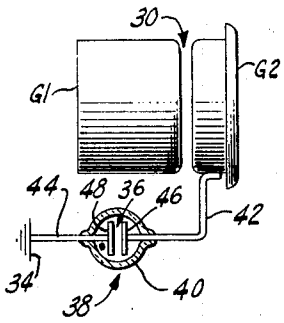


Fig. 3

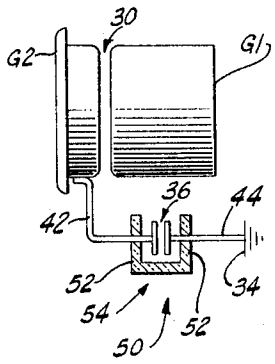
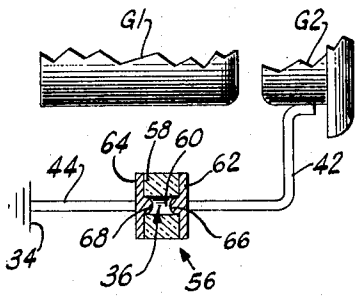


Fig. 4



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ELECTRON DISCHARGE DEVICE HAVING CATHODE PROTECTIVE MEANS WITHIN THE ENVELOPE

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This invention generally relates to cathode ray tubes, and more particularly to a device for protecting the emissive cathode coating of such a tube from damage caused by transient high voltage surges.

In a conventional form of cathode ray tube, such as that used in television receivers, there is provided an electron gun structure comprising a heated cathode having an electron emissive coating thereon and a plurality of axially aligned, closely spaced electrodes normally designated as G1, G2, G3, G4, and G5 formed to provide the modulation, focussing, and acceleration of the electron beam.

The spacing between adjacent ones of these electrodes can be considered inherently to define a given sparking potential in the evacuated tube which is higher than the normal operating potential gradient between these electrodes. However, it is not uncommon that transient high voltage surges originating with the high potential electrodes be imparted to the lower potential adjacent electrodes through disruptive discharges or arc-overs. This discharge often originates between the G3 and G2 electrodes because of the high potential difference normally existing therebetween. Once the discharge occurs, it will then progress to the G1 and then to the cathode, which is insulatingly mounted inside the G1. This disruptive discharge, when applied to the cathode, is often sufficient to destroy at least part of the emissive coating and thereby immediately cause or accelerate failure of the tube.

Heretofore, efforts have been made to protect the tube filament during arcing. The protecting devices used for this purpose consisted of spark gaps or shorting straps interconnecting a grounded heater filament lead and the cathode or control grid. Although some protection was afforded the filament, these arrangements have proven unsatisfactory since they do not provide any protection for the cathode.

There has also been suggested the provision of a high voltage surge suppression circuit generally employing a condenser grounded at one side and connected at the other side to a tube electrode which may be subjected to high voltage surges. Although some suppression occurs in these devices, the tube operation is disrupted for an undesirable period of time from its normal functioning. Further, the suppression circuit does not prevent internal arcing between many electrodes and does not protect the tube cathode.

It is, therefore, an object of this invention to protect the emissive coating of a cathode from high voltage surge damage.

It is another object of this invention to afford voltage surge protection for the tube and the operating circuit while minimizing the time period of disruption from normal tube operation.

In accordance with the foregoing objects there is provided by this invention a transient high voltage surge bypass device incorporated within a cathode ray tube. This device is fabricated, according to one aspect of the invention, from an electrically conductive material and has one terminal portion connected to ground potential, while the other terminal portion is connected to the G2 electrode and provides a sparking potential lower than the sparking potential existing between the G1 and G2 electrodes.

Accordingly, when a disruptive discharge occurs between the G2 and G3 electrodes, instead of progressing to the G1 and the cathode closely associated therewith, it will be conducted to ground by way of the by-pass device. By preventing these disruptive discharges from reaching the cathode, a substantial increase in the life of the emissive coating is achieved, thereby increasing the life of the tube. Also, because the discharge from the G2 to the by-pass device is in the form of an immediate arc, the time period of disruption from normal tube operation, caused by the abnormally high G2 potential, is minimized.

For purposes of this invention, the sparking potential between a given pair of electrodes in a gas is considered to depend upon the length of the spark gap and the pressure of the gas in such a way that it is directly proportional to the mass of gas between the two electrodes. Also, the work function of a given metal is referred to as the work per unit charge, expressed as a voltage, which is required to free an electron from the influence of the charges in the metal and thus to provide escapement from it.

Since the spaced electrodes described herein form an electron gun having prescribed parameters and since the low gas or air content and pressure within the evacuated tube are common to all electrodes, the sparking potential or work function potential can appropriately be referred to as being dependent upon the spacing between electrodes for comparison purposes.

For a better understanding of the present invention, together with other and further objects, advantages, and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the accompanying drawings in which:

FIG. 1 is a partial diagrammatic view of a cathode ray tube employing one aspect of the invention;

FIG. 2 illustrates two spaced electrodes embodying an alternate form of the invention; and

FIGS. 3 and 4 show additional embodiments of the invention.

In FIG. 1 there is shown generally a cathode ray tube **10** comprising an evacuated, hermetically sealed envelope **12** with an electron gun **14** mounted therein. Gun **14** employs a cathode assembly **16** having a sleeve **18** with emissive coating **20** on the end thereof and a heater **22** partially mounted within the sleeve.

Positioned forward of emissive material **20** are a plurality of axially aligned, spaced electrodes designated as **G1, G2, G3, G4,** and **G5**. The **G1** or control grid has the cathode assembly **16** insulatingly mounted within it by means of ceramic wafer **24**. For a grid driven tube, G1 may have a video drive range of about 45 volts relative to the cathode. The G2 serves as the screen grid and G4 is utilized as a focussing ring for the electron beam. These electrodes may be operated at about 450 and 300 volts respectively while the G3 and G5 electrodes, which serve as the accelerating electrodes and cooperate with G4 for focussing purposes, are maintained at a relatively high potential which may reach 20 kv. or higher. In order to maintain the proper alignment and spacing necessary for operation, these electrodes are provided with pins **26** for attachment to a plurality of insulating support rods **28**, only one of which is shown in the drawing.

While the spacing between any two adjacent electrodes in gun **14** determines the sparking potential therebetween as pointed out above, of primary interest here is the sparking potential across gap **30** which is defined as the spacing between the first electrode G1 and the second electrode G2. Gap **30** is of interest since it is the closest electrical isolating medium to the cathode to G1 sparking potential gap. It will be appreciated that under normal conditions,

if an arc occurs between the high voltage electrode G3 and low voltage electrode G2, there exists momentarily a potential difference between electrodes G1 and G2 which may be in the order of 20,000 volts. Since this voltage far exceeds the normal G1 to G2 sparking potential, an arc will occur therebetween, thus imparting the high voltage surge to G1. Almost instantly then the high voltage surge is transferred to cathode **18** because of its close proximity to G1. Of course, the surge voltage difference between the cathode and G1 vastly exceeds the normal sparking potential therebetween. Since electron emissive material **20** is on the surface of cathode **18** closest to G1, this material is inherently in the discharge zone and thereby becomes deleteriously disrupted and contaminated by the discharge.

In order to protect cathode **18**, an transient high voltage surge by-pass device **32** is contained within envelope **12** and is mounted, as by welding, to interconnect the second electrode G2 and a ground potential lead **34**. The by-pass device **32** is fabricated from an electrically conductive material preferably of ribbon stock or wire, and it is formed to provide a sparking potential across space **36** which is lower than the sparking potential across gap **30**. Accordingly, any arc to G2 will pass over space **36** to ground rather than to cathode **18**.

The material from which by-pass device **32** is fabricated may be the same as that used for electrodes G1 and G2, for instance a nickel alloy, or it may be chosen from one of the materials known as cold emitters. These include materials as for example titanium, magnesium, and barium-nickel alloy, which have in common a relatively low work function. When one of the above-mentioned materials is used, it should be chosen so that its work function potential is lower than the sparking potential across space **30**.

Referring now to FIG. 2, there is shown an alternate embodiment of the by-pass device. This transient high voltage surge by-pass device **38** comprises an encapsulating, hermetically sealed envelope **40** of insulating material surrounding a gaseous atmosphere, and a pair of electrically conductive members **42** and **44** fixedly mounted in the wall of encapsulating envelope **40**. Members **42** and **44** are affixed, as by welding, to electrode G2 and ground potential lead **34** respectively and project inwardly of encapsulating envelope **40** to terminate in spaced plates **46**, **48**. The nature of the gas content, together with the pressure and spacing, provide a predetermined sparking potential across gap **36** which is lower than the sparking potential across space **30**. Such a device has the advantage of isolating the discharge and ionization from the evacuated tube atmosphere.

In another embodiment shown in FIG. 3, members **42** and **44** of the by-pass device **50** are fixedly mounted in the upstanding walls **52** of a substantially U-shaped insulating block **54**. The sparking potential of this device is determined by space **36** and it is less than the sparking potential across space **30**. Device **50** may be separately constructed in an accurate manner prior to assembly with the gun electrode G2.

FIG. 4 illustrates another embodiment wherein a by-pass device **56** comprises a cylindrical block **58** of insulating material having a longitudinal bore **60** and opposed electrically conductive plates **62** and **64**, having spherical protuberances **66** and **68** bonded to block **58**. Plates **62** and **64** are affixed, as by welding, to conductive members **42** and **44** respectively. The protuberances **66** and **68** are formed to project into bore **60** to provide a space **36** therebetween which determines a sparking potential lower than the sparking potential across space **30**. Here again, this device may be separately constructed and it has the additional capability of confining the discharge and resulting ionization therewithin.

It will be apparent that a by-pass device electrode, preferably conductive member **44**, in any of the embodiments, may also be formed from a material having a low work function potential as above described.

While the preferred determinant for the appropriate sparking potential has been illustrated in conjunction with space or gap **30** between the G2 and G3 electrodes, it will be appreciated that other interelectrode gaps may serve as an appropriate determinant in the illustrated electron gun or in other types of guns so long as the cathode is properly protected.

The invention described herein provides a simple economical, rugged, device that will effectively protect the emissive coating on a cathode from transient high voltage surges, thereby enhancing the life characteristics of the tube in which it is employed.

While there has been shown and dscribed what are at present considered the preferred embodiments of the present invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. A cathode ray tube comprising an evacuated, hermetically sealed envelope, an electron gun positioned within said envelope, said electron gun having a cathode and at least first and second sequentially spaced low voltage electrodes, said second electrode being subject to transient high voltage surges, the spacing between said first and second electrodes defining a given sparking potential, at least one lead terminating interiorly of said evacuated envelope and projecting exteriorly for connection to ground potential, and a voltage surge by-pass device mounted within said envelope interconnecting said second electrode and said ground potential lead, said by-pass device being formed to provide a predetermined sparking potential lower than said given sparking potential.

2. A cathode ray tube comprising an evacuated, hermetically sealed envelope, an electron gun positioned within said envelope, said electron gun having a cathode and at least first and second sequentially spaced low voltage electrodes, said second electrode being subject to transient high voltage surges, the spacing between said first and second electrodes defining a given sparking potential, at least one lead terminating interiorly of said evacuated envelope and projecting exteriorly for connection to ground potential, and a voltage surge by-pass device mounted within said evacuated envelope comprising an encapsulating, hermetically sealed envelope of insulating material surrounding a gaseous atmosphere, a pair of electrically conductive members fixedly mounted in the wall of said encapsulating envelope and interconnecting said second electrodes and said ground potential lead, said pair of members being formed to project inwardly of said encapsulating envelope and terminating in a spaced relationship to provide a predetermined sparking potential therebetween lower than said given sparking potential.

3. A cathode ray tube comprising an evacuated, hermetically sealed envelope, an electron gun positioned within said envelope, said electron gun having a cathode and at least first and second sequentially spaced low voltage electrodes, said second electrode being subject to transient high voltage surges, the spacing between said first and second electrodes defining a given sparking potential, at least one lead terminating interiorly of said evacuated envelope and projecting exteriorly for connection to ground potential, and a voltage surge by-pass device mounted within said evacuated envelope comprising a substantially U-shaped block of insulating material having a base portion and a pair of upstanding walls projecting therefrom, a pair of electrically conductive members fixedly mounted in said upstanding walls and interconnecting said second electrode and said ground potential lead, said pair of members being formed to project

inwardly toward the center of said block and terminating in a spaced relationship to provide a predetermined sparking potential therebetween lower than said given sparking potential.

4. A cathode ray tube comprising an evacuated, hermetically sealed envelope, an electron gun positioned within said envelope, said electron gun having a cathode and at least first and second sequentially spaced low voltage electrodes, said second electrode being subject to transient high voltage surges, the spacing between said first and second electrodes defining a given sparking potential, at least one lead terminating exteriorly of said evacuated envelope and projecting exteriorly for connection to ground potential, and a voltage surge by-pass device employing a cold emitter mounted within said evacuated envelope and interconnecting said ground potential lead and said second electrode, said cold emitter having a work function potential lower than said given sparking potential.

5. A cathode ray tube comprising an evacuated, hermetically sealed envelope, an electron gun positioned within said envelope, said electron gun having a cathode and at least first and second sequentially spaced low voltage electrodes, said second electrode being subject to transient high voltage surges, the spacing between said first and second electrodes defining a given sparking potential, at least one lead terminating interiorly of said evacuated envelope and projecting exteriorly for connection to ground potential, and a voltage surge by-pass device mounted within said envelope interconnecting said ground potential lead and said second electrode comprising a cylindrical block of insulating material having a longitudinal bore therethrough, opposed electrically conductive plates having spherical protuberances thereon bonded to said block, said proturberances projecting into said bore to provide a space therebetween, said space defining a sparking potential lower than said given sparking potential.

6. A cathode ray tube comprising an evacuated, hermetically sealed envelope, an electron gun positioned within said envelope, said electron gun having a cathode and a plurality of intermediate spaced low voltage electrodes axially aligned with and sequentially arrayed from said cathode, at least one of said intermediate electrodes being subject to transient high voltage surges, the spacing between said one of said intermediate electrodes and an adjacent electrode defining a given sparking potential, at least one lead terminating interiorly of said evacuated envelope and projecting exteriorly for connection to ground potential, and a voltage surge by-pass device mounted within said envelope interconnecting said one of said intermediate electrodes and said ground potential lead, said by-pass device being formed to provide a predetermined sparking potential lower than said given sparking potential.

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