United States Patent [19]

Grimmett et al.

[11] **3,909,655**

[45] **Sept. 30, 1975**

[54] **CATHODE RAY TUBE HAVING CYLINDER WITH INTERNAL RESISTIVE HELIX**

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[73] Assignee: **Thorn Electrical Industries Limited**, London, England

[22] Filed: **July 3, 1973**

[21] Appl. No.: **376,166**

[30] **Foreign Application Priority Data**

July 5, 1972 United Kingdom.............. 31514/72

[52] **U.S. Cl.**................................ **313/450**; 313/451

[51] **Int. Cl.²**..................... **H01J 29/56**; H01J 29/62

[58] **Field of Search**................................ 313/83 SP

[56] **References Cited**

UNITED STATES PATENTS

3,295,008 12/1966 Gallaro et al. 315/3

3,355,617 11/1967 Schwartz et al.................. 313/82 R

3,375,390 3/1968 Schlesinger..................... 313/83 SP

FOREIGN PATENTS OR APPLICATIONS

1,211,898 11/1970 United Kingdom............ 313/83 SP

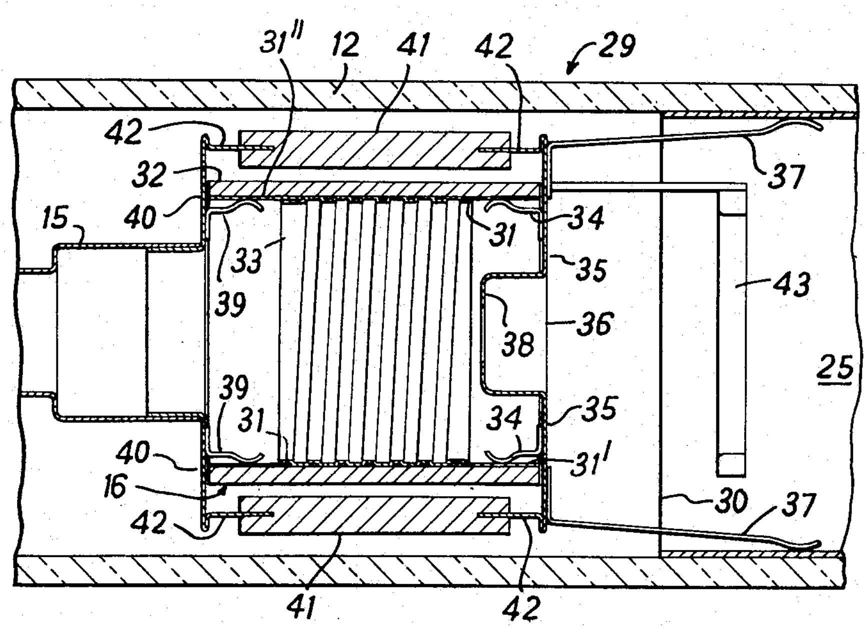
Primary Examiner—Robert Segal

Attorney, Agent, or Firm—Robert F. O'Connell

[57] **ABSTRACT**

A cathode ray tube housing an electron gun assembly mounted within a sealed evacuated envelope formed substantially of electrically insulating material has a first coating of electrically conductive material on part of its external surface and a second coating of electrically conductive material on part of its internal surface. The conductive coatings forming a capacitor. To minimize the effects of flashover, this capacitor is electrically connected to an electrode of the electron gun assembly by a resistor included in the electron gun assembly.

1 Claim, 2 Drawing Figures



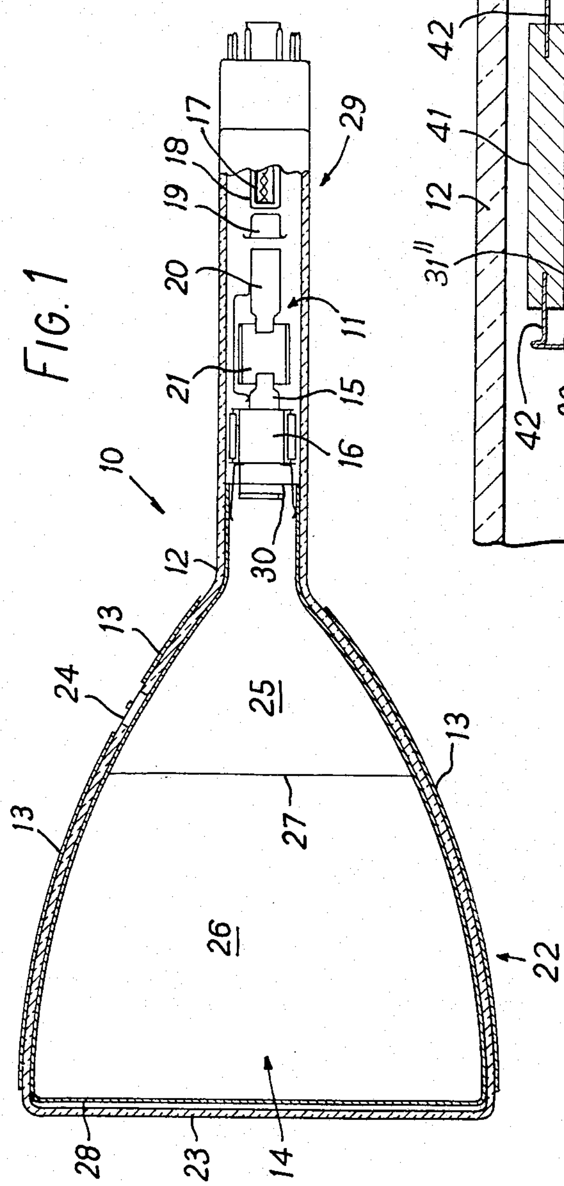

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FIG. 1

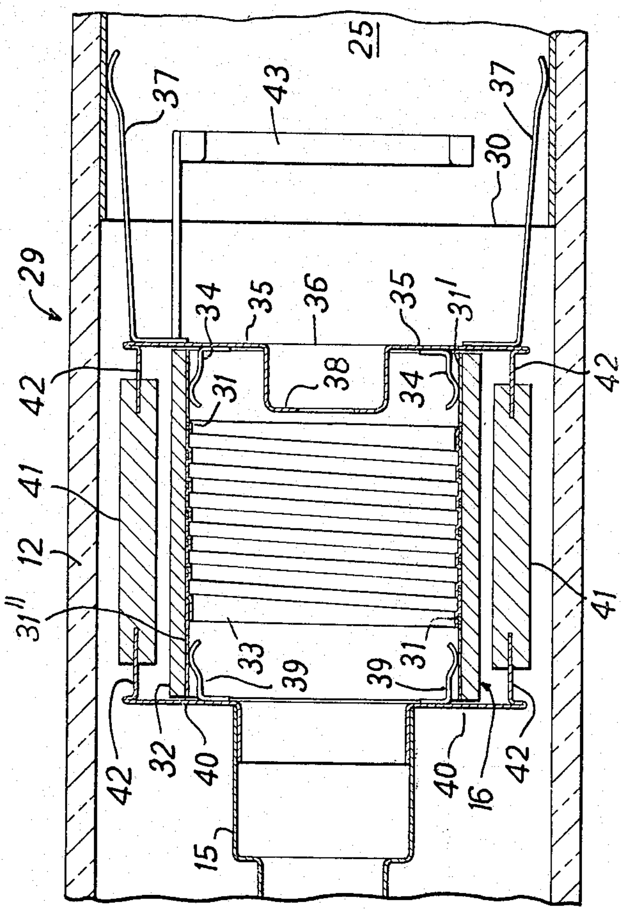
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FIG. 2

CATHODE RAY TUBE HAVING CYLINDER WITH INTERNAL RESISTIVE HELIX

BACKGROUND OF THE INVENTION

This invention relates to cathode ray tubes, and especially to cathode ray tubes including means for reducing the effects of internal flashover.

A cathode ray tube having an electron gun assembly mounted within a sealed evacuated envelope formed substantially of electrically insulating material is usually provided with a first coating of electrically conductive material on part of its external surface and a second coating of electrically conductive material on part of its internal surface. These coatings form a capacitor which can be used in a smoothing circuit for a high voltage supply circuit for use with the tube. This capacitor then contains a charge during operation of the tube, the internal coating being supplied with a positive voltage, and the external coating being connected to earth. Anodes are normally maintained at the same voltage as the internal coating in operation. A flashover from one of the anodes to one or more of the other electrodes, even the heater, having lower voltages may occur within the electron gun assembly.

The presence of a resistor between the internal coating of the bulb of a cathode ray tube and the final anode of its electron gun assembly reduces the quantity of energy which, on the occurrence of a flashover, can pass to circuits connected to the gun assembly. However, there exists a stray capacitance formed between the combination of the second and fourth anodes, the anodes in the tube and thier immediate surroundings. In a tube with magnetic deflection, the principal contributor in the intermediate surroundings to this stray capacitance is the deflector yoke. Before a flashover this stray capacitance is charged to the full voltage of the high voltage supply. When a flashover occurs, the charge from this stray capacitance flows unimpeded into circuits connected to the gun assembly and, if the stray capacitance is large enough, can deliver sufficient energy to damage semiconductor devices. We have found that the presence of a resistor between the internal coating and the final anode contributes to this stray capacitance in a manner which depends mainly upon the physical size of the electrically conductive material of the resistor. For example, we have found that in one example of a cathode ray tube having a resistor with a conductive element deposited on the inner face of the neck of the envelope, the said stray capacitance is 20 picofarads. A general description of this prior art cathode ray tube is given in United Kingdom patent specification No. 1,211,898.

It is accordingly an object of the present invention to provide a cathode ray tube in which the risk of damage to external circuitry by flashover within the tube is minimised.

SUMMARY OF THE INVENTION

According to the present invention there is provided a cathode ray tube housing an electron gun assembly mounted within a sealed evacuated envelope formed substantially of electrically insulated material and having a first coating of electrically conductive material on part of its external surface and a second coating of electrically conductive material on part of its internal surface, the said conductive coatings forming a capacitor

which is electrically connected to an electrode of the electron gun assembly by a resistor included in the said assembly.

Preferably the resistor has a conductive element which provides the resistance of the resistor and is supported by a rigid member formed of electrically insulating material.

In one preferred embodiment the said conductive element is in the form of a helix of resistive material, and the rigid member is a hollow cylinder of insulating material, the helix being coaxial with the cylinder and disposed on the internal or the external surface of the cylinder.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a cathode ray tube embodying the invention, and

FIG. 2 is a longitudinal sectional view of part of the cathode ray tube of FIG. 1 on a larger scale.

DESCRIPTION OF PREFERRED EMBODIMENT

In FIG. 1 there is shown a cathode ray tube **10** having an electron gun assembly **11** mounted within a sealed evacuated envelope **12** formed substantially of electrically insulating material and having a first coating **13** of electrically conductive material on part of its external surface and a second coating **14** of electrically conductive material on part of its internal surface. The coatings **13** and **14** form a capacitor which is electrically connected to an electrode, which is the final anode **15**, of the electron gun assembly **11** by a resistor **16** included in the assembly **11**.

The electron gun assembly includes a thermionic cathode **17** mounted over a heater, a modulation electrode **18**, and first, second and third anodes **19**, **20** and **21** respectively, the second anode **20** being connected directly to the final anode **15**.

In operation, a modulation signal circuit is connected to apply a modulation signal between the modulation electrode **18** and the cathode **17**, the modulation signal circuit supplying a voltage to the cathode **17** which voltage is varied to vary the intensity of the electron beam emitted by the cathode **17**, the electrode **18** being maintained at a constant bias voltage. Furthermore, the anodes **19**, **20** and **21** are connected to supply circuits which provide voltages enabling these anodes together with the final anode **15** to form and focus the electron beam to a point on the screen. Means, not shown, are also provided for deflecting the beam to desired positions, such means preferably being in the form of electromagnetic deflection coils located outside the envelope **12**.

The first coating **13** on the envelope **12** consists of a layer of conductive graphite and extends over substantially the whole of the curved surface of a bulbous portion **22** of the envelope **12** which terminates at its wider end in a substantially flat face plate **23**, one boundary of the coating **13** lying in a plane parallel to the face plate **23**. A small part of the bulbous portion **22** of the envelope **12** is formed by an electrically conductive connector **24**, and a clearance is left between the coating **13** and the connector **24** so that they are electrically insulated from one another.

The connector **24** makes electrical contact with a first portion **25** of the second coating **14** which portion **25** is in the form of a layer of conducting graphite, the coating **14** having a second portion **26** which is in the form of a layer of aluminium which makes electrical connection with the first portion **25** at a common boundary **27** lying in a plane parallel to the face plate **23.** The inner surface of the face plate **23** is coated with a layer **28** of electroluminescent material which is overlain by part of the second portion **26** of the coating **14.** The first portion **25** of the coating **14** extends from the common boundary **27** to the smaller end of the bulbous portion **22** of the envelope **12** and some distance into a cylindrical neck **29** which forms the remaining portion of the envelope **12,** the portion **25** ending in the neck **29** at a boundary **30** which lies in a plane parallel to the face plate **23** and is closer to the face plate **23** than is the resistor **16.**

Details of the resistor **16** and the manner in which it is mounted in the envelope **12** are shown in FIG. **2.**

The resistor **16** has a conductive element **31** which provides the resistance of the resistor **16** is supported by a rigid member **32** formed of electrically insulating material, for example, glass. The conductive element **31** is in the form of a helix of resistive material, for example a resistive material containing graphite as its primary constituent, and the rigid member **32** is a hollow cylinder, the helix being coaxial with the cylinder and disposed on the internal surface of the cylinder. A protective layer **33** of chromic oxide overlies the conductive element **31,** but may be omitted.

Although the element **31** is shown disposed on the internal surface of the member **32,** it may be disposed on the external surface of the member **32** with consequent rearrangement of the electrical contacts to be described below.

That end of the element **31** which is the nearer to the portion **25** of the coating **14** is electrically connected to it through a plurality of spring contacts **34,** an outwardly directed flange **35** of a flanged metal member **36,** and a further plurality of spring contacts **37,** the contacts **34** and **37** being welded to the flange **35** and having their respective free ends in electrical contact with the said end of the element **31** and the portion **25** of the coating **14** as shown in FIG. **2.** The conductive element **31** is terminated at each of its ends by respective short lengths **31'** and **31''** of low resistance graphite deposited around the internal circumference of the rigid member **32.**

The spring contacts **34** make electrical and physical contact with the length **31'**.

The flanged member **36** has an inwardly directed flange **38** which defines a circular aperture through which the electron beam passes in operation.

The other end of the element **31** is electrically connected to the final anode **15** through a plurality of spring contacts **39** welded to an outwardly directed flange **40** of the anode **15.** Thus the inner coating **14** is electrically connected to the anode **15** by the resistor **16.** The spring contacts **39** make electrical and physical contact with the length **31''**.

Alternatively, the lengths **31'** and **31''** may be omitted, and the spring contacts **34** and **39** make contact directly with the ends of the element **31.**

The flanged member **36** is secured to the flange **40** of the anode **15** by a plurality of insulating rods **41,** for example of glass, having short lengths **42** of stiff wire embedded coaxially in their ends and welded to the flanges **35** and **40.** Thus the resistor **16,** which is mechanically supported by the spring contacts **39** and **34** which hold the rigid member **32** coaxial with the trajectory of the electron beam, is mounted in the electron gun assembly **11.**

A tube getter **43** is also included in the electron gun assembly, being mounted on the flange **35** of the member **36.**

The coatings **13** and **14** form a capacitor which can be used in a smoothing circuit for a high voltage supply circuit for use with the tube **10.** This capacitor contains a charge during operation of the tube, the connector **24** being supplied with a positive voltage, and the external coating **13** being connected to earth. The anodes **15** and **20** are normally maintained at the same voltage as the internal coating **14** in operation, but may undergo a lowering of voltage if, as sometimes occurs when the electron beam constitutes a high emission current, the beam is partially intercepted by one or both of the anodes **15** and **20,** these electrodes being electrically connected to the connector **24** only by the resistor **16.**

A flashover from one of the anodes **15** and **20** to one or more of the other electrodes, even the heater, having lower voltages may occur within the electron gun assembly. When such a flashover does occur the resistance between the said capacitor formed by the coatings **13** and **14** and one or more of the electrodes **18** to **21** is reduced, but the resistance of the resistor **16** is chosen to be sufficient even in these circumstances to restrict the current flowing from the said capacitor to a value which will not damage any of the supply circuits or the modulation circuit, which may contain components such as solid state devices which are vulnerable to damage by high current levels, which are connected to the electrodes **18** to **21** in operation. For most circumstances the resistance provided by the element **31** should be at least **1000** ohms.

In another embodiment the said conductive element is in the form of a continuous film supported on an insulating base, and in a further embodiment the conductive element is in the form of a hollow cylinder of conductive material having sufficient rigidity to support itself and thus constituting the resistor.

The presence of a resistor between the internal coating of the bulb of a cathode ray tube and the final anode of its electron gun assembly reduces the quantity of energy which, on the occurrence of a flashover, can pass to circuits connected to the gun assembly. However, there exists a stray capacitance formed between the combination of the second and fourth anodes, the anodes **20** and **15** in the tube shown in FIG. **1,** and their immediate surroundings. In a tube with magnetic deflection, the principal contributor in the immediate surroundings to this stray capacitance is the deflector yoke. Before a flashover this stray capacitance is charged to the full voltage of the high voltage supply connected to the high voltage connector corresponding to the connector **24.** When a flashover occurs, the charge from this stray capacitance flows unimpeded into circuits connected to the gun assembly and, if the stray capacitance is large enough, can deliver sufficient energy to damage semiconductor devices. It has been found that the presence of a resistor between the internal coating and the final anode contributes to this stray capacitance in a manner which depends mainly upon the physical size of the electrically conductive material of the resistor. For example, it was found that in a cathode ray tube having a resistor with a conductive element which is of the form of the element **31** but does not embody the present invention, the conductive element being deposited on the inner face of the neck **29** of the envelope **12**, the said stray capacitance is **20** picofarads, whereas in a cathode ray tube differing only in that the resistor is constructed and arranged as described hereinbefore with reference to the resistor **16** the said stray capacitance is **3** picofarads.

We claim:

1. A cathode ray tube having an electron gun assembly mounted within a sealed evacuated envelope formed substantially of electrically insulating material and having a first coating of electrically conductive material on part of its external surface and a second coating of electrically conductive material on part of its internal surface, the coatings forming a capacitor which is electrically connected to the final anode of the electron gun assembly by a resistor included in the assembly, a small part of the envelope being formed by an electrically conductive connector, and a clearance being left between the external coating and the connector so that they are electrically insulated from one another, the connector making electrical contact with a first portion of the second coating which portion is in the form of a layer of conducting graphite, the internal coating having a second portion which is in the form of a layer of aluminium which makes electrical connection with the first portion at a common boundary lying in a plane, the said resistor having a conductive element which provides the resistance of the resistor and is supported by a rigid member formed of electrically insulating material and is in the form of a helix of resistive material, the rigid member being a hollow cylinder, the said helix being coaxial with the cylinder and disposed on the internal surface of the cylinder with a protective layer of chromic oxide overlying the conductive element, that end of the element which is nearer to the said first portion of the internal coating being electrically connected to it through a plurality of spring contacts, an outwardly directed flange of a flanged metal member, and a further plurality of spring contacts, the said contacts having their respective free ends in electrical contact with the said end of the element and the portion of the internal coating, and the other end of the element being electrically connected to the final anode through a further plurality of spring contacts.

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