United States Patent [19]

Dumas et al.

[11] **3,828,219**

[45] **Aug. 6, 1974**

[54] **VOLTAGE SURGE DISSIPATOR**

[75] Inventors: **Christ J. Dumas,** Forest View; **Stephen S. Simovits, Jr.,** Woodridge, both of Ill.

[73] Assignee: **American Plasticraft Company,** Chicago, Ill.

[22] Filed: **Sept. 7, 1972**

[21] Appl. No.: **286,967**

[52] **U.S. Cl.** **313/325,** 313/306, 313/326, 315/35, 328/8

[51] **Int. Cl.** **H01j 17/00,** H01j 21/00

[58] **Field of Search** 313/306, 307, 325, 326; 315/35, 36; 328/8

[56] **References Cited**

UNITED STATES PATENTS

3,372,341	3/1968	Eidecker	313/325 X
3,377,612	4/1968	Klier et al.	313/325
3,502,933	3/1970	Leimontas et al.	328/8 X

Primary Examiner—James W. Lawrence
Assistant Examiner—Saxfield Chatmon, Jr.
Attorney, Agent, or Firm—Roy E. Petherbridge; Robert L. Lindgren; Edward D. Gilhooly

[57] **ABSTRACT**

A transient voltage surge dissipating assembly for dissipating surges of high voltage electrical energy occuring at the terminal pins of an electron tube. The apparatus has a precisely formed air dielectric spark gap defined between an electrical connector coupled to a terminal pin of the electron tube and ground such that any over-voltage surges occurring at the terminal pins are precluded from arcing to an adjacent terminal pin, but are dissipated to ground through the spark gap assembly. The apparatus is adapted to be coupled to any individual terminal pin of an electron tube to provide protection to the tube and associated circuitry. Arcing between the terminal pins and any components is thereby eliminated preventing damage to the tube or associated electronic components.

27 Claims, 19 Drawing Figures

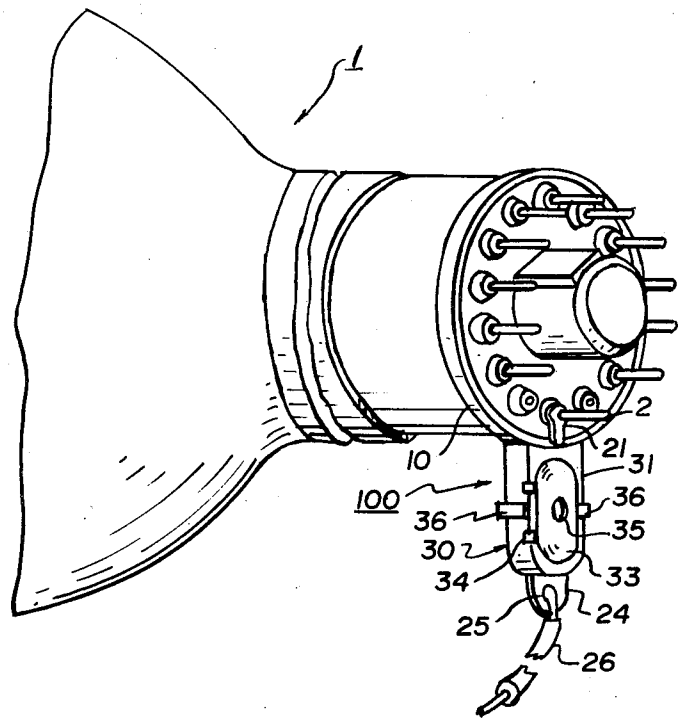


FIG.6

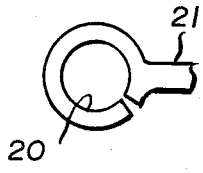


FIG.1

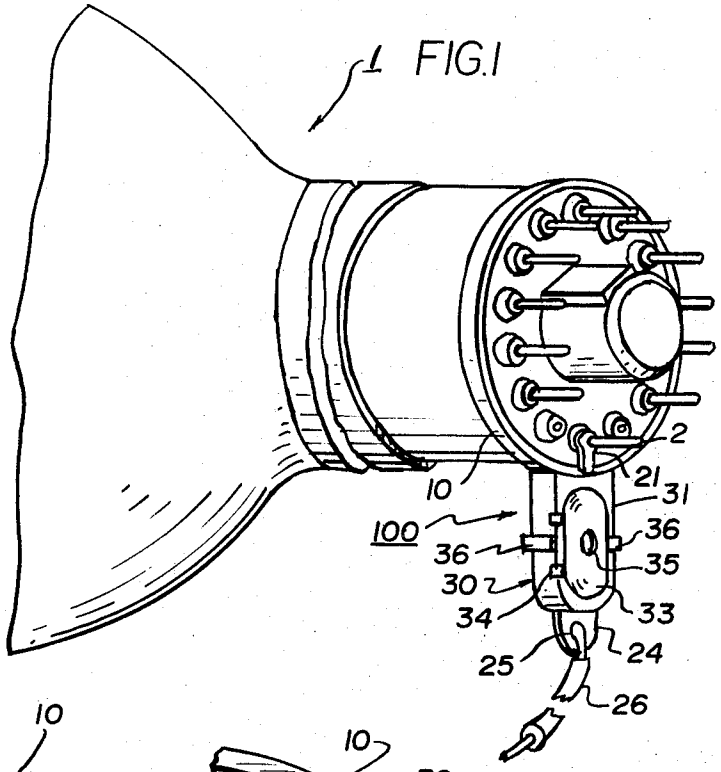


FIG.3

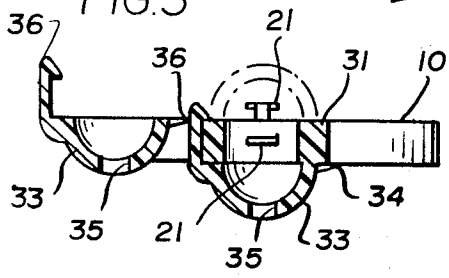
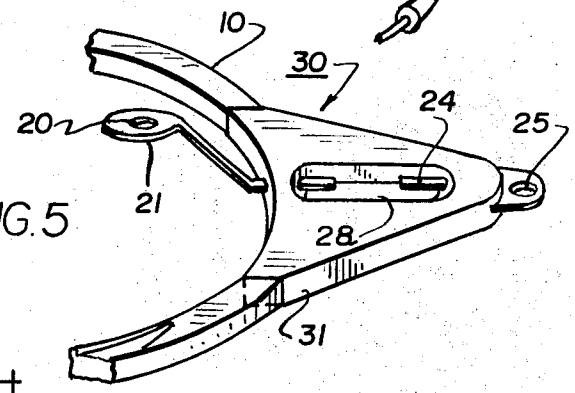


FIG.5



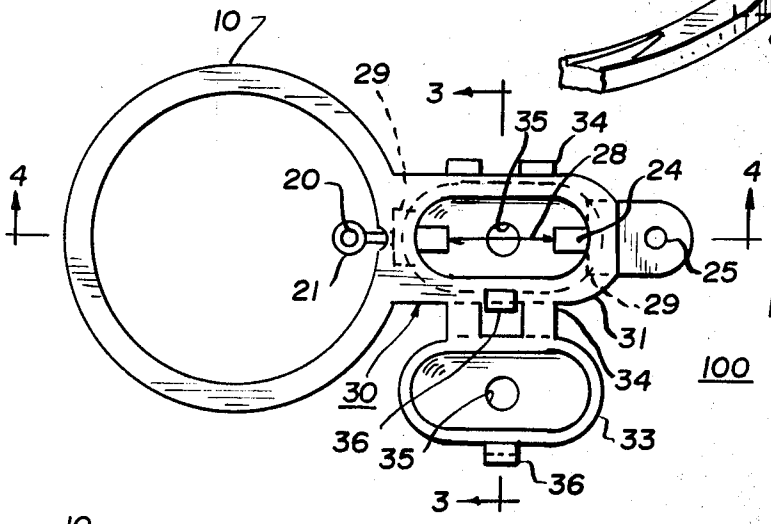


FIG.2

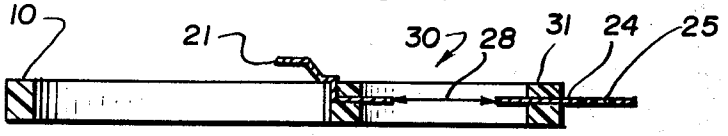


FIG.4

FIG.7

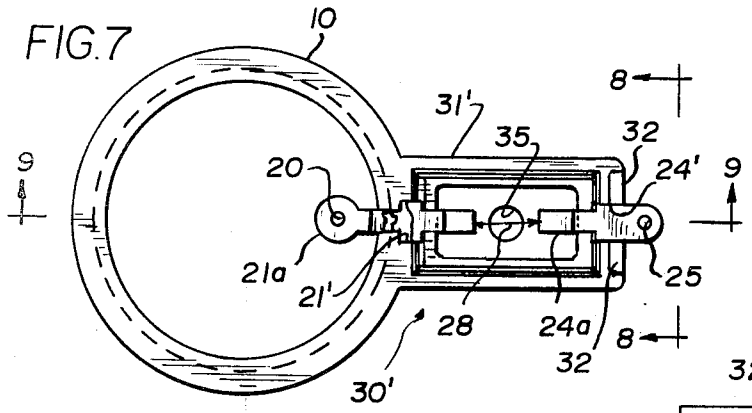


FIG.8

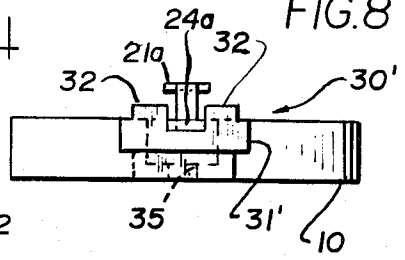


FIG.9

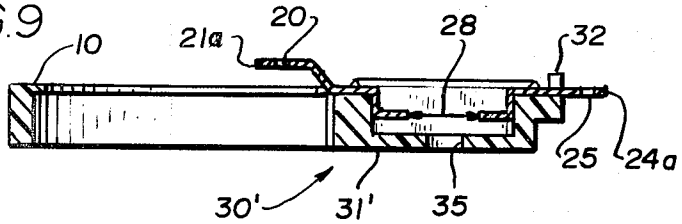
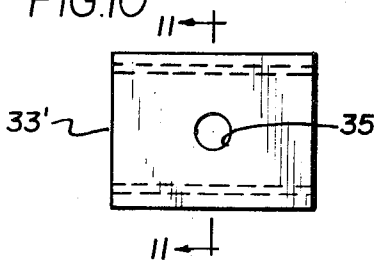


FIG.10



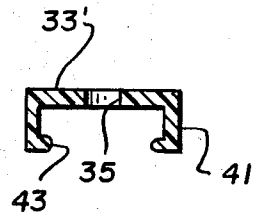


FIG.11

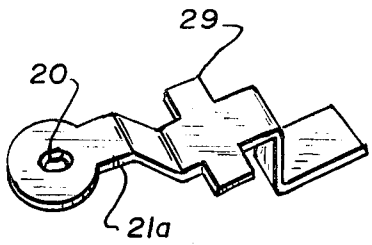


FIG.12

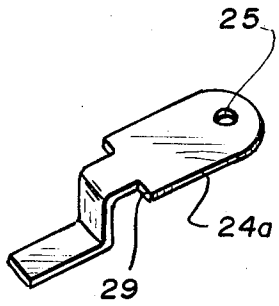


FIG.13

FIG.14

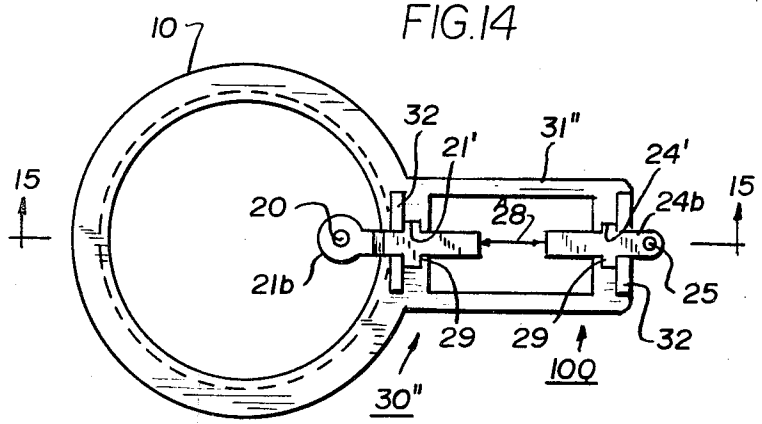


FIG.15

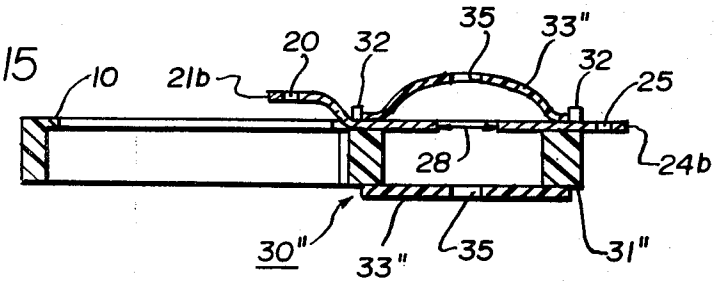
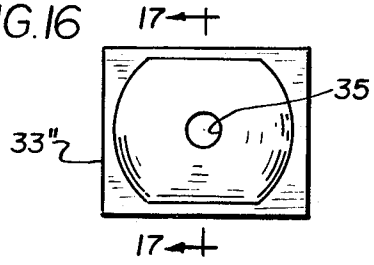


FIG.16



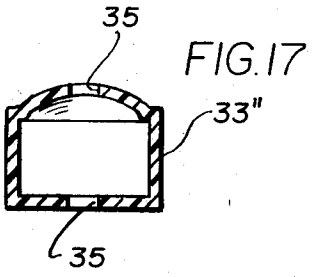


FIG.17

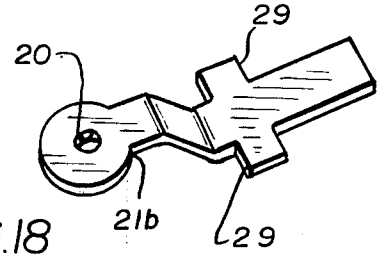


FIG.18

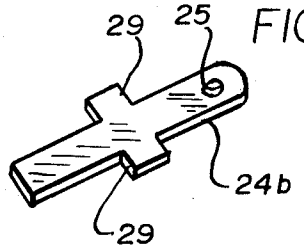


FIG.19

VOLTAGE SURGE DISSIPATOR

BACKGROUND OF THE INVENTION

This invention relates in general to electron tube protection and, in particular, to an externally mounted high voltage surge protection device for dissipating high voltage electrical energy transients.

More specifically this invention relates to an electron tube protective device having a spark gap formed between opposed electrical conductors, one of the conductors being coupled to a terminal pin of an electron tube and the other of the conductors being electrically connected to ground.

In electron tubes, for example television picture tubes, extremely high voltages in the order of 10,000 to 26,000 volts are used to accelerate cathode ray beams to the screen of the picture tube display device. These picture tubes have narrow neck portions with the terminal pins spaced circumferentially thereabout so closely that occasional arcing results regardless of all known attempts to provide an insulation barrier between the terminal pins or between the terminal sockets for the pins. When this arcing phenomenon occurs, the high voltage is conducted through the tube pins, terminal sockets, and lead wires to other components in the television set. These violent and incipient cathode ray tube arcs cause the television display tube (CRT) to destroy itself. Serious repetitious and violent cascaded arcing will cause a failure in the associated chassis circuitry and in certain cases can result in fires.

This arcing is a result of the ionization and breakdown of air, or other gas media, between two or more points of high potential difference. The arc occurs in the form of an electric current or plasma which is entirely dependent on the origin, mode and dwell period resulting from the high voltage energy stored in the picture tube and certain transformer circuits. Where arcing occurs, the stored energy is discharged through some low resistance path, causing the high voltage on the CRT to drop to a very low value. The loaded high voltage system will cause the high voltage regulator to lose control of this circuit varying the output impedance as much as two or three times its nominal level.

When arcing occurs the accelerating force from the cathode ray beams is removed resulting in a zero brightness on the display device during the arc event period. This eliminates the dynamic load for the high voltage supply which rises again to a very high value resulting in arc cascading. The high voltage rises, in the order of 50,000 to 65,000 volts, since the regulator circuit cannot recover quickly enough allowing the uncontrolled high voltage supply to rise to its maximum voltage level. This excessive high voltage transient energy over-stresses the picture tube, high voltage components, and wiring resulting in damage to the CRT and associated circuitry.

Electron beam tubes, such as a television picture tube, during initial operation (varying between one hour and one thousand hours for an individual tube) go through a normal maturing cycle before the picture tube stabilizes and remains fairly arc-free. In many television receivers today, the picture tube must be replaced after 2,000 to 10,000 hours of operation. When a new picture tube is introduced into the old chassis

and cabinet assembly, the tube will go through a new maturing cycle before it stabilizes and remains fairly arc-free. During this stabilization many arcing events occur which, if the tube is not equipped with a high voltage transient dissipating apparatus, will destroy the picture tube or the chassis itself will be damaged by over voltage arcing occurrences between terminal pins or the terminal pins and associated chassis. Therefore, it becomes very necessary to provide some protection against high voltage transients occurring in the picture tube.

While various types of spark gap tube sockets are available for use in protecting the picture tubes used in original equipment manufacture, if the original picture tube was not provided with a protective spark gap device, the replacement tube has heretofore been unprotected. Thus high voltage surges which frequently occur during the maturing cycle of the new tube frequently results in arcing between terminals or between a terminal and chassis causing damage to the tube and/or associated circuitry. Spark gap tube sockets of the type disclosed, for example, in U.S. Pat. Nos. 3,502,933 and 3,553,727 are not suited for use in the type of applications or the instant invention without disturbing the circuitry within the receiver or requiring complex re-wiring of the connector assembly. Such rewiring is extremely time consuming and, therefore, prohibitively expensive.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to improve apparatus for dissipating high voltage transients occurring in electron tubes.

Another object of this invention is to immediately dissipate to ground high voltage surges occurring in electron tubes thereby protecting the tube and associated circuiting.

A further object of this invention is to protect replacement electron beam tubes from the adverse effects of high voltage transients occurring during stabilization of the tube within a receiver.

Yet another object of this invention is to dissipate high voltage electrical surges occurring at certain specific individual terminal pins.

These and other objects are attained in accordance with the present invention wherein there is provided an apparatus electrically coupled to an individual terminal pin of an electron beam tube including a precisely formed spark gap which functions to control the arc-over voltage thereby dissipating the arc energy or plasma level occurring at a specific individual terminal pin.

DESCRIPTION OF THE DRAWINGS

Further objects of this invention, together with additional features contributing thereto and advantages accruing therefrom, will be apparent from the following description of several embodiments of the invention when read in conjunction with the accompanying drawings wherein:

FIG. 1 is a perspective view of a portion of a television picture tube having the high voltage transient protection device coupled to a specific individual terminal pin;

FIG. 2 is a horizontal planar view of the high voltage transient protection device with a coverplate opened to better illustrate the spark gap assembly;

FIG. 3 is a sectional view of FIG. 2 taken along lines 3—3 to better illustrate the insulative convering of the spark gap assembly;

FIG. 4 is a sectional view of the high voltage transient protection device with the cover plate removed taken along lines 4—4 of FIG. 2 to better illustrate the spark gap assembly and the electrical connection of the spark gap assembly to a terminal pin of the electron beam tube;

FIG. 5 illustrates a modified alternative embodiment of the high voltage transient protection device;

FIG. 6 is an enlarged planar view of a portion of a modified coupling electrode;

FIG. 7 is a horizontal planar view of an alternative embodiment of the high voltage transient protection device with the coverplate removed to better illustrate the spark gap assembly;

FIG. 8 is an end profile view of the apparatus shown in FIG. 7;

FIG. 9 is a sectional view of the high voltage transient protection device taken along lines 9—9 of FIG. 7 to better illustrate the spark gap assembly and the electrical connection of the spark gap assembly to a terminal pin of the electron beam tube;

FIG. 10 is a horizontal planar view of a cap used to enclose the spark gap chamber;

FIG. 11 is a cross sectional view of the cap illustrated in FIG. 10 taken along lines 11—11;

FIG. 12 is a perspective view of an electrode for coupling to a terminal pin of an electron beam tube and forming an element of the spark gap assembly;

FIG. 13 is a perspective view of an electrode for coupling to ground and forming an element of the spark gap assembly;

FIG. 14 is a horizontal planar view of another alternative embodiment of the high voltage transient protection device with the covering cap removed to illustrate the spark gap assembly;

FIG. 15 is a sectional view of the apparatus of FIG. 14 with the covering cap positioned taken along lines 15—15;

FIG. 16 is a horizontal planar view of the covering cap used to enclose the spark gap chamber;

FIG. 17 is a cross sectional view of the cap illustrated in FIG. 16 taken along lines 16—16;

FIG. 18 is a perspective view of an electrode for coupling to a terminal pin of an electron beam tube and forming an element of the spark gap assembly; and

FIG. 19 is a perspective view of an electrode for coupling to ground and forming an element of the spark gap assembly.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a cathode ray tube or, more commonly, a television picture tube 1 having the high voltage transient protection apparatus 100 connected to the picture tube to protect an individual terminal pin 2 of the picture tube from high voltage surges. In the application disclosed in FIG. 1, the dissipator 100 is shown electrically connected to the terminal pin connected to the focusing electrode within the picture tube. The dissipator 100 is mechanically connected to the base end of the picture tube by means of a support ring 10 which encircles the base of the neck portion and mechanically secures the dissipator to the picture tube. An electrically conductive coupling connector 21 which forms a portion of the spark gap assembly is formed with an opening 20 in one end thereof through which is inserted the terminal pin (shown at 2) of the display device for which high voltage surge protection is desired. Although the opening 20 is of a size to provide sufficient electrical contact with the terminal pin 2, the coupling may be soldered to insure a more secure connection. Also, the end may be split (FIG. 6) to facilitate placing the coupling electrode 21 onto the terminal pin.

The spark gap assembly includes the electrical connector 21, which is electrically connected to a terminal pin (2) of the picture tube, and a grounded electrode 24 electrically connected to ground. These elements are separated by a predetermined discrete spacing 28 which forms an air dielectric between the two electrodes. The ground electrode 24 is formed with an opening 25 at one end which is mechanically and electrically coupled to a ground connection or lead 26 for dissipating the high voltage to ground through the ground leaf for the chassis.

The dissipator 100 as best shown in FIGS. 2, 3 and 4 which illustrate an enlarged form of one embodiment of this device. The support ring 10 and arc chamber 30 depending therefrom are both formed of an electrical insulative material such as polyethylene or polypropelene. The connector electrode 21 and ground electrode 24 are molded into the body portion 31 of the arc chamber. Preferably, the discrete spacing 28 between the two electrodes during assembly. The electrodes 21 and 24 may be formed from a single piece of material, such as stamping or shearing a center section from an elongated member secured within the body section 31 thereby forming two electrodes. However, the electrodes may be fabricated separately and spaced a predetermined distance apart with the precise control of the spacing being accomplished through removal of a discrete portion from on or each electrode to control the spacing therebetween. As best seen in FIG. 2, both electrodes are formed with shoulders 29 to insure a positive fixed positioning within the body portion 31.

A pair of caps 33 are hinged (34) to the body portion to enclose the arc chamber. The caps are formed to encompass the opening in the body portion bearing the spaced electrodes 21 and 24 and the arc chamber for protection against accidental contact with the electrodes within the chamber. Each of the caps 33 is formed with a hole 35 which acts as a vent to exhaust any gases which are formed by the arc plasma during the arcing event. A latch portion 36 is formed on each cap, on the side opposite the hinge 34, to secure the cap to the body portion 31 insuring against accidental removal.

Referring now to FIG. 5 there is shown an alternative embodiment of the dissipator 100 with like reference numerals indicating parts corresponding to the embodiment illustrated in FIGS. 1–4. In this embodiment, the arc chamber 30 is open on both sides of the body portion 31 and the caps 33 are omitted. In certain types of application wherein heavy or cascaded arcing occurs the chamber with its open sides allows the gases generated during the arcing event to dissipate more rapidly. However, such applications must also include a sufficient electrical shielding in the area adjacent the dissipator to prevent accidental contact with the electrodes 21 and 24.

Referring now to the alternative embodiment of FIGS. 7–11, there is illustrated another form of dissipator **100** wherein like reference numerals indicate like parts. The dissipator is mechanically connected to the neck of a picture tube **1** by means of the support ring **10** which encircles the receiver and mechanically secures the dissipator to the picture tube. While each of the embodiments illustrated shown the support ring **10** formed as an endless circle, to facilitate placing the dissipator **100** onto the terminal pin of a picture tube without removing existing electrical connections, the support ring **10** may be split in a manner illustrated by the split end of the coupling electrode **21** (FIG. **6**) to allow the support ring to be mechanically secured to the base of the picture tube. The arc chamber **30'** and suppport ring **10** are both formed of an electrical insulative material such as polyethylene or polypropelene to insulate the connections from the electrical current passing through the terminal pin or the electrodes of the spark gap assembly. The connector electrode **21**(*a*) and ground electrode **24**(*a*) may be formed from a single piece of material through removing such as by stamping, cutting, or shearing, a center section from an elongated member after the member is positioned into the body portion **31'** of the arc chamber. The electrodes may also be fabricated separately and spaced a predetermined distance apart with the precise control of the spacing between the electrodes being effected through removal of a discrete portion from one or each electrode to obtain the controlled spacing therebetween.

FIGS. **12** and **13** illustrate a suitable connector electrode **21**(*a*) and ground electrode **24**(*a*) for use in the embodiments described, as well as illustrating the two separate electrodes created by removing a portion, or center section, from a single elongated member. While the embodiment disclosed in FIGS. **1–4** discloses that the electrodes **21** and **24** are molded or cast into the insulating body section **31** of the arc chamber **30,** the embodiment illustrated in FIGS. **7–11** is fabricated by placing the electrodes into suitable recesses **21'** and **24'** formed in the body section **31'** to receive the electrodes **21**(*a*) and **24**(*a*), respectively. As shown in FIGS. **12** and **13,** both electrodes are formed with shoulders **29** to insure a positive fixed positioning within the body section **31.** In this embodiment the electrodes **21**(*a*) and **24**(*a*) (FIGS. **12** and **13**) are formed with a downwardly bent portion which secures the electrodes against the inner walls of the body portion **31'** (FIG. **9**) such that the inner walls and the shoulders **29** securely retain the electrodes thereby fixing their position.

The arc chamber **30** is closed on one side (best shown in FIG. **9**) with a vent hole **35** which acts to exhaust any gases which are formed by the arc plasma during an arcing event between the two electrodes **21** and **24.** The open side of the arc chamber **30'** is covered by means of a snap-on cover **33'** illustrated in FIGS. **10** and **11.** An abutment **32** extends upwardly from the body section **31** of the arc chamber to protect the cap **33''** from accidental removal. The cover **33''** is formed of an electrically insulative material with depending legs **41** sufficiently resilient such that they can be expanded over the width of the arc chamber **30'** allowing the inwardly extending portions **43** to form a lock about the arc chamber securing the cap **33''** thereto. The cap **33''** is also formed with a vent hole **35** for the purpose hereinbefore described.

Referring now to the alternative embodiment of FIGS. **14–17,** there is illustrated another form of dissipator **100** wherein like reference numerals indicate like parts. The dissipator is mechanically connected to the neck of the picture tube by means of the support ring **10** which encircles the receiver and mechanically secures the dissipator to the picture tube. While the embodiment illustrated shows the support ring **10** formed as an endless circle, the support ring **10** may be split in the manner heretofore described to facilitate placing the dissipator **100** onto the picture tube. The arc chamber **30''** and support ring **10** are both formed of electrical insulative material to insulate the connections from the electrical current passing through the terminal pin or the electrodes of the spark gap assembly. The connector electrode **21**(*b*) and ground electrode **24**(*b*) may be formed from a single piece of material through removing a center section from an elongated member after the member is secured into the body portion **31''** of the arc chamber as by stamping, cutting, or shearing. The electrodes may also be fabricated separately and spaced a pre-determined distance apart with the precise control of the spacing between the electrodes being effected through removal of a discrete portion from one or each electrode to obtain the controlled spacing therebetween.

The arc chamber **30''** (FIG. **14**) is completely open as in the embodiment illustrated in FIG. **5,** with suitable recesses **21'** and **24'** being formed in the body section **31''** to receive the electrodes **21**(*b*) and **24**(*b*), respectively. The electrodes, shown in FIGS. **18** and **19,** are both formed with shoulders **29** to be placed in the recesses **21'** and **24'** to insure a positive fixed positioning within the body section **31''**.

The open arc chamber **30''** is covered by means of a cover cap **33''** illustrated in FIGS. **16** and **17.** Abutments **32** extend upwardly from the body section **31''** of the arc chamber to protect the cap **33''** from accidental removal. The cap **33''** is formed of an electrically insulative material sufficiently resilient to slideably engage the body section **31''** such that it may be expanded over the arc chamber **30''** with the ends of the cap **33''** being positioned against the abutments **32** to form a lock abaout the arc chamber securing the cap **33''** thereto. The cap **33''** is also formed with a vent hole **35** for the purposes hereintofore described.

While the invention has been described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is the intent that this invention not be limited to the particular embodiments disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. Apparatus for dissipating transient high voltage surges occurring at the terminal pins of an electron tube and adapted to be electrically coupled to a terminal pin without electrically modifying the circuitry associated therewith comprising

support means for positioning a spark gap assembly adjacent a terminal pin having electrical connections thereto,

said spark gap assembly including a coupling electrode for electrically coupling said spark gap assembly to a terminal pin of an electron tube without altering the electrical connections thereto and an electrically grounded electrode spaced a predetermined distance from said coupling electrode with a replenishable dielectric therebetween such that voltages occurring at said terminal pin exceeding a predetermined level will cause an arc to occur between said electrodes dissipating said voltage to ground, said spark gap assembly further including means for exhausting the dielectric after arcing to replenish the dielectric therebetween.

2. The apparatus of claim **1** wherein said spark gap assembly includes cover means enclosing a portion of said coupling electrode and said grounded electrode and the predetermined space therebetween.

3. The apparatus of claim **1** wherein said support means comprises a support ring encircling the base portion of the electron tube.

4. The apparatus of claim **1** wherein said coupling electrode includes an opening in one end thereof for receiving a terminal pin of an electron tube.

5. The apparatus of claim **4** wherein said opening in one end of said coupling electrode is completely encircled to coaxially receive a terminal pin in male-female relationship.

6. The apparatus of claim **4** wherein said opening in one end of said coupling electrode extends through the outer periphery thereof to facilitate connection of said electrode to a terminal pin.

7. The apparatus of claim **2** wherein said cover means is formed with a vent hole to exhaust gases formed during arcing between said electrodes.

8. The apparatus of claim **2** wherein said cover means includes a plurality of caps each having a latch for removably securing said caps in a position to enclose the spacial distance between said electrodes.

9. The apparatus of claim **1** wherein said grounded electrode includes an opening in one end thereof for connection to ground establishing means for dissipating voltage surges.

10. The apparatus of claim **3** wherein said support ring includes a depending portion carrying said electrodes in fixed spacial relationship.

11. The apparatus of claim **10** including a pair of caps hingedly supported from said depending portion, and each of said caps having latch means for removably securing said caps to said depending portion enclosing a portion of said electrodes and the space therebetween.

12. The apparatus of claim **11** wherein said caps are hingedly supported from opposed sides of said depending portion, and each of said caps is formed with a vent hole to exhaust gases formed during arcing.

13. The apparatus of claim **12** wherein said coupling electrode and said grounded electrode are coplanar and fixedly carried within said depending portion.

14. A high voltage surge dissipating apparatus for protecting electron tubes connected to an electrical system from voltage transients without electrically altering the electrical system to couple the surge dissipating apparatus to the electron tube comprising

a coupling electrode and a grounded electrode fixedly spaced a predetermined distance apart including a replenishable air dielectric insulator therebetween,

said coupling electrode having a portion forming an electrical contact with a terminal pin of an electron tube for electrically coupling said electrode to said terminal pin without electrically altering the electrical system connected thereto such that high voltage transients occurring at said terminal pin will cause an electrical arc between said electrodes across said air dielectric insulator dissipating said voltage transients to ground, and exhaust means in communication with the air dielectric to exhaust the air dielectric after arcing to replenish the air dielectric between the electrodes.

15. Apparatus for dissipating transient high voltage surges occurring at the terminal pins of an electron tube comprising

support means adapted to be carried by the base portion of an electron tube adjacent the terminal pins thereof,

arc chamber means carried by said support means and extending transversely to the terminal pins of the electron tube,

said arc chamber means including an electrode for coupling to a terminal of the electron tube and an electrode for coupling to ground, and

said electrodes carried by said arc chamber means being spaced apart and including a replenishable air dielectric having a predetermined break-over voltage to effect an arc therebetween, said arc chamber means further including means for exhausting the air dielectric after arcing to replenish the air dielectric therebetween.

16. The apparatus of claim **15** including a cap having resilient leg portions for receiving said arc chamber means and removably securing said cap thereto to enclose a portion of said electrodes.

17. The apparatus of claim **16** wherein said cap is formed with a vent hole to exhaust gases formed during arcing and the side of said arc chamber means opposite said cap is closed and formed with a vent hole.

18. The apparatus of claim **16** wherein securing said cap to said arc chamber means fixedly locates the spacial distance between said electrodes.

19. The apparatus of claim **16** wherein said arc chamber means includes a depending portion forming an abutment to prevent said cap from being accidentally removed.

20. The apparatus of claim **10** wherein said electrodes are fixedly secured within said depending portion of said support ring.

21. The apparatus of claim **10** wherein said electrodes are formed with shoulder portions for fixedly positioning said electrodes in spaced relationship.

22. The apparatus of claim **21** wherein said electrodes are formed with a downwardly extending portion operably connected to said depending portion of said support ring for fixedly positioning said electrodes.

23. The apparatus of claim **15** wherein a portion of each of said electrodes is molded within said arc chamber means.

24. The apparatus of claim **10** further including a cover cap slidably positionable about said depending

portion carrying said electrodes to enclose portion of said spark gap assembly.

25. The apparatus of claim **24** wherein said cap is formed with a vent to exhaust gases formed during arcing.

26. The apparatus of claim **24** wherein said depending portion includes abutment means for preventing said cover cap from being accidentally removed.

27. The apparatus of claim **24** wherein said cover cap is domed to prevent heat generated during an arcing event from burning said cap.

* * * * *