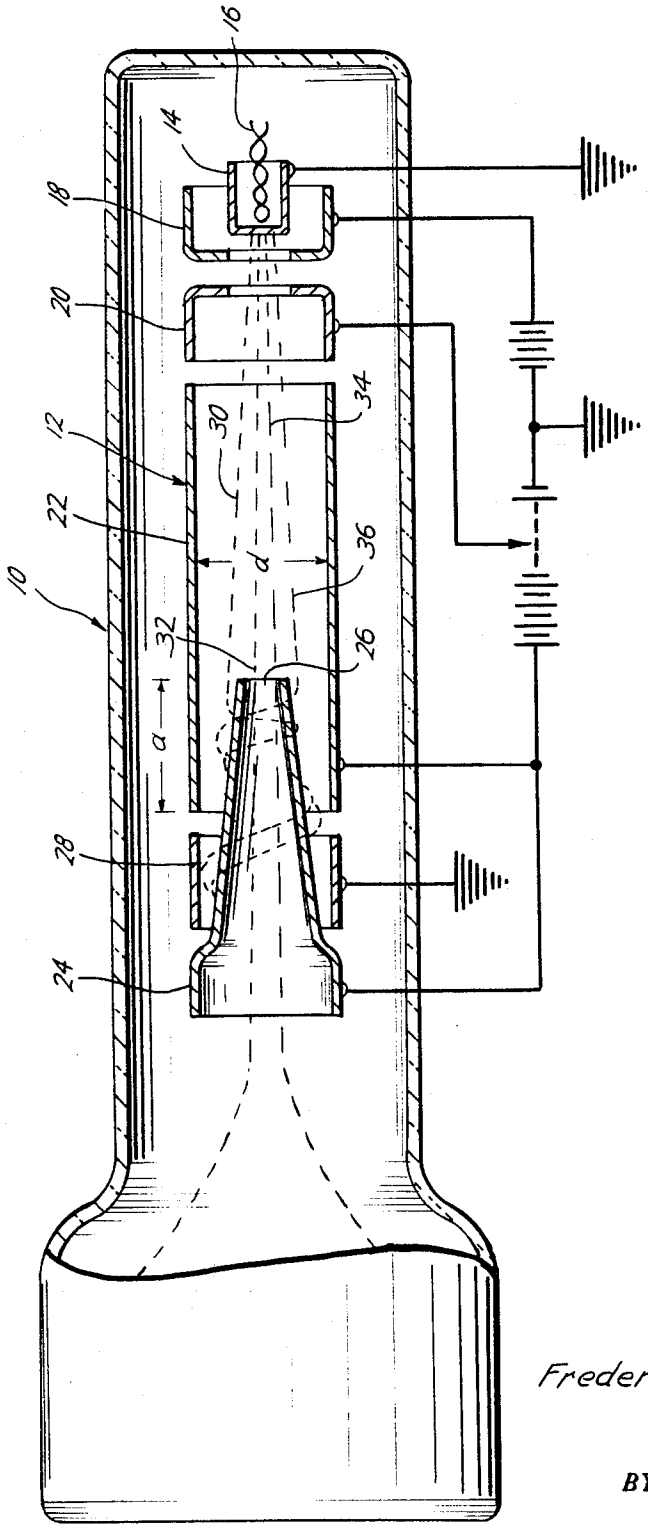
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ION PUMPING ELECTRON GUN

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ION PUMPING ELECTRON GUN

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ABSTRACT OF THE DISCLOSURE

An electron discharge tube having an electron gun therein and a target for impingement of electrons from the electron gun. The electron gun includes a conically shaped grid made of titanium with an aperture in the small end of the cone through which axially moving electrons may pass. The small end of the cone is in a field free space and divergent electrons are caused to move in a helical path around the cone. A cylindrical member at ground potential surrounds the cone. The divergent electrons collect on the cone and positive ions collect on the cylindrical member. The electrons cause sublimation of titanium which is deposited upon the cylindrical member to trap the positive ions. Negative ions impinge upon the titanium cone and cause sputtering of the titanium. Some of the sputtered material will be deposited upon the cylindrical member and assist in trapping positive ions falling thereon.

Background of the invention

Because of the difficulty of maintaining a high vacuum over a long period of time in electron discharge tubes, there are often ions of various elements present in such tubes. The presence of such ions causes a deterioration in the performance of the tubes when the ions strike the target at which the electron beam is directed. The ions cause what is known as "ion spot" on the target, and, in the case of television camera tubes for example, result in the appearance of spurious signals in the output of the tube. On television receiver vacuum tubes a discoloration is caused on the phosphor.

The problem is particularly severe in devices which involve charge storage as, for example, scan conversion tubes. However, ion spot is sufficiently vexatious in other applications that various steps have been taken in the past to avoid the problem. For example, as described on page 7–45 of Radio Engineering Handbook, by Henney, ion trap guns are sometimes used. Also, the use of getters utilizing zirconium to adsorb residual gas in a tube has been effective in some cases. However, such adsorption is selective at different temperatures for different gases so that the getters are not always effective for all the ions in the tube. Furthermore, these getters require a considerable power input for their operation and occupy space in addition to that of the electron gun within the tube.

Summary of the invention

According to the present invention the difficulties with ion spot are overcome by providing a continuous pumping action for residual gas in an electron discharge device. According to the present invention the ion pump is incorporated within the normal configuration of the electron gun itself and makes use of a part of the electron beam which is normally derived from the electron gun. A normally unused portion of the electron beam is utilized to ionize residual gas and to bombard an electrode made of a suitable material such as titanium so that the ions are trapped in sublimed or sputtered titanium. In a preferred embodiment the poriton of the electron beam which is utilized for ionization is allowed to enter a region of approximately radially disposed electric field so as to increase the travel path of the beam and thereby increase

the amount of ionziation and ion entrapment. The foregoing is accomplished without changing the configuration of the electron gun to an extent that the normal operation of the gun is impaired.

Brief description of the drawing

For a better understanding of the invention reference is made to the single figure of the accompanying drawing, which shows in somewhat schematic form a longitudinal sectional view of an electron tube incorporating a preferred embodiment of the invention.

Description of the preferred embodiment

The drawing shows a typical electron discharge tube **10**, many details of which have been omitted for the reason that they are conventional and well known in the art and form no part of the present invention. Suffice it to say that a target of some sort is provided at the left end of the tube, as shown in the drawing, upon which electrons from the electron gun indicated generally at **12** impinge.

In the embodiment shown the electron gun consists of the cathode **14** with its heater **16** and electrodes **18**, **20**, **22** and **24**. In this embodiment electrode **24** is a positively charged grid and is electrically connected to electrode **22** and is conical in shape with the small end of the cone extending a substantial distance into electrode **22**. An aperture **26** in the small end of the cone is axially aligned with the electrode **22** and the apertures in electrodes **18** and **20**. A cylindrical member **28** surrounds the cone of electrode **24** and is electrically insulated from electrodes **22** and **24**. In practice, the potential difference between the cone of electrode **24** and the cylindrical member **28** will lie between a few hundreds and a few thousands of volts. Potentials of the various electrodes are determined, as is well known in the art, by the required electron optical performance of the electron gun and the required velocity of the electron beam.

In the preferred embodiment of the invention electrode **24** is made of, or at least partially coated with, an active material capable of being sublimed upon being bombarded by electrons and capable of adsorbing residual gases. Titanium is by far the best material presently known for this purpose although zirconium and tantalum have some utility.

It will be observed that, in the embodiment shown, the aperture **26** of electrode **24** lies in a field free space, since electrodes **22** and **24** are at the same potential, and therefore the electron optical performance of the gun is unimpaired. Preferably the distance *a* that the cone extends into electrode **22** is approximately equal to or greater than the diameter *d* of the electrode **22** in order to insure a substantially field free space and to prevent focusing of the electron beam.

In operation, the electrons from the cathode **14** traverse the gun in a diverging beam illustrated in the drawing by electron paths **30**, **32**, **34** and **36**. Electrons following the substantially axial paths **32** and **34** pass through the aperture **26** of electrode **24** and may be focused on the target at the left end of the tube as shown on the drawing. However, electrons following, for example, the paths **30** and **36** are, in the normal tube, usually wasted, being collected on the surrounding electrode. According to this invention, however, as the electrons following these paths enter the space between the cone and the cylindrical member **28** they will be subjected to the approximately radial field between these elements and will therefore describe an approximately helical path therethrough. The electrons will eventually impinge on some part of the cone and the resulting energy transfer will cause sublimation of some of the active material from which the cone is made. The sublimed material will be either wholly or partially condensed on

the cylindrical member **28**. In addition to the effects of sublimation due to the impingement of electrons on the cone, there will also be some ionization of gases due to collision between electrons and residual gas surrounding the cone. Positive ions so formed will migrate toward the cylindrical member **28**, by virtue of the potential difference, where they will be discharged and also entrapped by the sublimed material from the cone. Negatively charged ions will impinge on the cone and, as is well known, will tend to sputter material from it. Some of this sputtered material will be deposited on the cylindrical member **28** and will assist in entrapping positive ions falling thereon.

Thus, it can be seen that a pumping action is provided which utilizes a member of low potential to collect ions created by impingement of electrons with residual gas, and which in a preferred embodiment utilizes sublimation and sputtering of an active material to trap ions of residual gas. The pumping action will continue at all times while the gun is energized providing electrons are being emitted. It is even possible, utilizing the structure of this invention, to pump residual gas without bombarding any electrode beyond the electrode **24** by connecting such other electrodes to the cathode. Thus, by suitable switching in an equipment continuous pumping is achieved.

The specific configuration of electrode **24** utilized herein is for the purpose of assuring that the entrance to the cone lies in a field free space so that the optical performance of the gun is unimpaired. However, it is contemplated that other configurations may be used in which the electron aperture is not in a field free space. This will of course require redesign of other electrodes in the gun to obtain the required electron optical performance.

Also it is not necessary that a cone be used but only that a member of generally circular configuration be used to utilize as much of the divergent portion of the beam as possible.

Thus, although a preferred embodiment of the invention has been shown and described, the invention is not limited to such embodiment, but also includes variations and modifications thereof which will occur to those skilled in the art and which are included within the scope of the following claims.

What is claimed is:

1. An ion pumping electron gun containing
- a positively charged grid of circular cross-section having an aperture axially aligned with the axis of the electron beam emitted by said gun, and
- a member of lower potential surrounding and spaced away from said grid;
- whereby electrons in the gun which do not pass through the aperture may ionize gas and ions will be collected on the grid and on the member.

2. An ion pumping electron gun as defined by claim **1** wherein the grid is made of titanium, zirconium or tantalum.

3. An ion pumping electron gun as defined by claim **1** wherein the aperture is in a substantially field free space.

4. An ion pumping electron gun as defined by claim **3** wherein the grid is made of titanium, zirconium or tantalum.

5. An ion pumping electron gun as defined by claim **4** wherein the grid is made of titanium.

6. An ion pumping electron gun containing
- a positively charged conically shaped grid having an aperture at its small end axially aligned with the electron beam emitted by the cathode of said gun and directed toward said cathode, and
- a cylindrical member of substantially lower potential surrounding and spaced away from said grid,
- whereby electrons from the cathode which do not pass through the aperture may ionize gas and ions will be collected on the grid and on the cylindrical member.

7. An ion pumping electron gun as defined by claim **6**, wherein the grid is made of titanium.

8. An ion pumping electron gun as defined by claim **6**, wherein the aperture is in a substantially field free space.

9. An ion pumping electron gun as defined by claim **8** wherein the grid is made of titanium.

10. In an electron discharge device comprising an envelope, an electron gun, and a target for an electron beam emitted by said electron gun, the improvement wherein said electron gun comprises
- a cathode,
- means for causing a divergent electron beam to be emitted from said cathode,
- a tubular positively charged grid surrounding and in axial alignment with the said electron beam,
- a conically shaped grid having titanium on its outer surface, and having an aperture at its small end axially aligned with the tubular grid, and having the small end extending into the end of the tubular grid a distance at least about equal to the diameter of the tubular grid,
- said tubular grid and said conical grid being at substantially the same potential so that the said aperture in the conical grid lies in a substantially field free space,
- and a cylindrical member of substantially lower potential than said grids spaced away from said conical grid and surrounding at least a portion of it.

References Cited

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