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OSCILLATION SUPPRESSOR FOR ELECTRON GUNS

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Fig. 1.

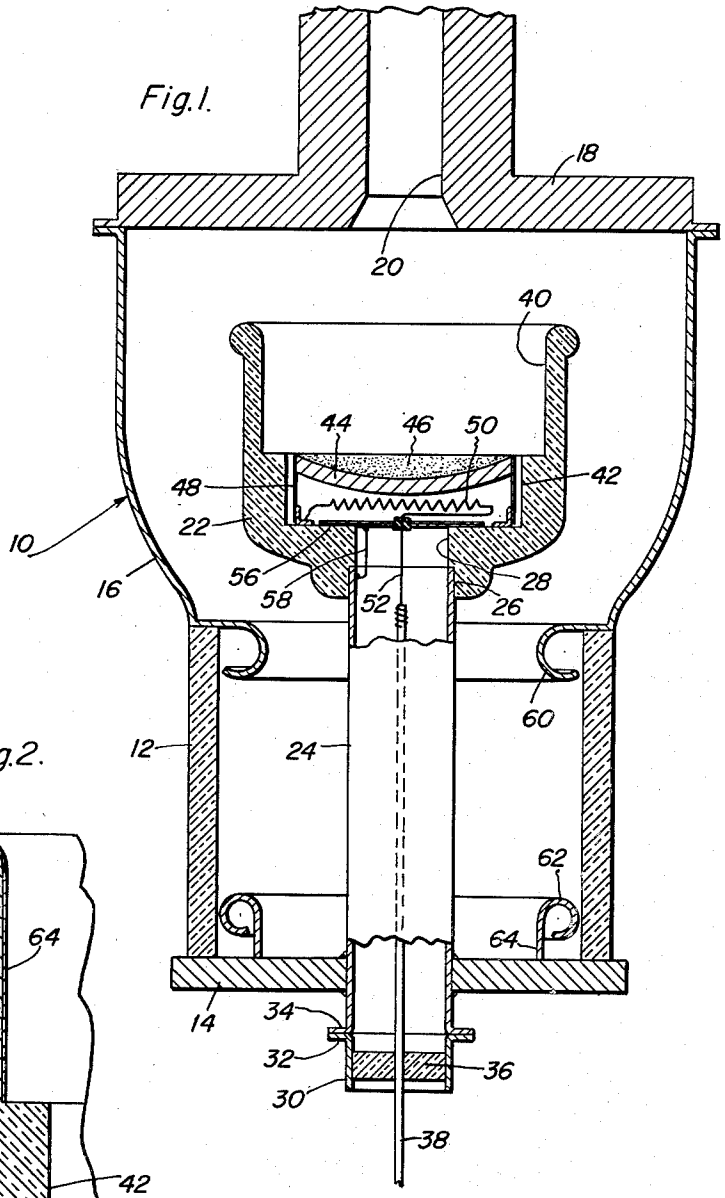
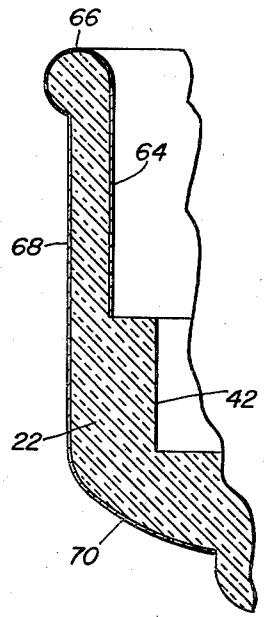


Fig. 2.



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OSCILLATION SUPPRESSOR FOR ELECTRON GUNS

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This invention relates to an electron gun of the type useful for producing an electron beam in an electron tube apparatus and more particularly to the focusing device of such a gun.

In certain electron tubes of more recent development, high energy electron beams are required for proper tube operation and to achieve such high energy, the electrons in the beam are accelerated from the cathode, from which they originate by emission, by high potentials applied to electrodes spaced from the cathode. In controlling the beam, it is frequently advantageous to provide a focusing cup or electrode about the cathode and having an open side in the direction of the accelerating electrodes. The effect of such electrodes is to confine or focus the electrons into a beam of relatively small radial dimension.

In the apparatus of the type described, the cup is contained in a sealed conductive housing which is spaced from the cup. It frequently occurs that the transit time of the high energy electrons in travelling from the cathode across a portion of the region within the housing is so interrelated with the size and volume within the housing, that it acts as a resonator so as to excite and establish modes of high frequency, spurious oscillations within the housing and including the region of the cathode and focusing cup. Such spurious oscillations are undesirable in that they interfere with the direct electric field in the space between the cathode and accelerating electrode and thus, interfere with formation of the proper electron beam. In the absence of such spurious oscillations, proper beam focusing may be readily achieved. Focusing cups made entirely of metal have no effect in suppressing or dissipating the oscillations of the generated field in that such cups present a too low resistance to fields of the spurious oscillations.

It is accordingly a principal object of my invention to facilitate high energy electron beam focusing without production of any spurious oscillations in the region of the beam focusing electrode.

It is another object of my invention to prevent the initiation or production of spurious high frequency electromagnetic energy waves in the region about an electron gun.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, the invention may be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a cross sectional elevation of an electron gun according to my invention, and

FIG. 2 is an enlarged, partial view showing in detail the film applied to portions of the focusing cup.

In accordance with my invention, the production and effect of spurious oscillations in the region of an electron gun are prevented or avoided by the provision of a thin coating of conductive material of predetermined resistivity over the surface portions of an insulating, focusing cup which are in regions tending to produce a relatively high intensity, high frequency, electromagnetic field. Such a film coating is preferably of a refractory metal and is of a resistance such as to generally match the wave impedance of the oscillations tending to be produced whereby currents tending to be established in the film due to the effect of high frequency oscillations are most effectively loaded in the production of heat in accordance with the product of the resistance of the path of the current and the square of the value of the current. Accordingly, the oscillations themselves are prevented from occurring.

Referring now more particularly to the drawings for a more detailed description of my invention, **10** represents generally the entire electron gun structure which embodies my invention which includes a housing comprising a hollow, cylindrical, ceramic member **12** sealingly closed at one end by a wall **14**, preferably of a suitable metal, and being in abutment with an end of a conductive cylindrical housing portion **16** at the other end.

To complete the housing, an apertured anode **18** is in abutment with the other end of metallic housing **16**. The anode section **18** is provided with an aperture **20** for accommodating the flow of electrons in the beam produced by the electron gun. Other apparatus of the electron tube beyond the anode **18**, for which the gun **10** provides the electron beam, is not shown, iasmuch as the same forms no essential part of the present invention.

Disposed within the housing **16** is a focusing cup **22** made of a suitable refractory ceramic and supported by a tubular member **24**, which in turn is rigidly secured in an aperture of end wall **14** as by suitable soldering or welding. The interior end of tubular member **24** is received in an enlarged portion **26** of an opening **28** in the base of the cup **22** and may be bonded thereto by any suitable means. The exterior end of tube **24** is sealed by a cap **30** which is flanged at **32** to abut a complementary flange **34** at the end of the tube **24** and is further provided with a supporting insulator **36** therewithin. For conducting electrical energy within the gun, insulator **36** is apertured to accommodate a conductive rod **38** extending along the interior of the tube.

For producing a beam of electrons, cup **22** is opened at **40** and is provided with a recess **42** for accommodating a cathode **44** having an outwardly concave surface. The cathode is coated with a suitable emission enhancing material **46** and is supported in the bottom of the recess **42** by a cylindrical foil support **48** extending from the periphery of the cathode to the bottom of the recess **42** and secured at each end. For raising the temperature of cathode **44** for copious thermionic emission, a heater **50** is mounted in close proximity to the side thereof remote from the concave, coated side and electrical power is supplied to the heater **50** through the rod **38** at the end of which is an electrical wire **52** extending from the rod end, to one end of the heater. A suitable insulating grommet **54** disposed in a conductive supporting member **56** spanning the aperture **28**, accommodates the wire **52**. The other end of heater **50** is connected to the supporting member **56** which in turn is in conductive contact with tube **24** through a wire **58** attached to the supporting member **56** and to the tube **24**.

In operating the electron gun, a high potential difference

is established between the housing **16** and the anode **18** on the one hand and the cup **22** and parts conductively connected therewith on the other hand. To minimize adverse effects of such high potentials at certain locations, a corona shield is formed at the end of housing **16** as shown at **60** and a complementary corona shield is formed at **62** by a cylindrical member **64** in contact with the end **14** and extending therefrom toward the housing **16**. These corona shields provide a smoothly curved surface exposed to the regions of high electric field, thus minimizing the concentration of such fields at sharply pointed conductive edges within the gun.

The region within the housing **16** is of a high electric field because housing **16** and the cup **22** are, respectively, at aceclerating anode and ground potentials. Electrons traveling between cathode **44** and anode **18** may be of such a velocity as to have a transit time interrelated with the dimensions of housing **16** so as to excite modes of high frequency oscillations as in a cavity resonator.

In accordance with a feature of my invention, to prevent or minimize such oscillations, the cup **22** is made of an insulating ceramic material such as alumina, beryllia, forsterite or steatite, for example, and is coated with a conductive material along portions of high electric field intensity to provide an effective load to such high frequency oscillations to completely suppress the high frequency electromagnetic field tending to be generated in the region. To this end, as shown more clearly in FIG. 2 of the drawing, the cup may be coated by a conductive material along portions **64**, **66**, **68**, and **70**. The material so utilized may be any material which in a thin coating is conductive but presents a resistance which effectively matches the wave impedance of the oscillations tending to be created and to dissipate the energy of such fields. This material further possesses required properties of compatibility with other tube components as to matters such as low vapor pressure and has adequate potential breakdown resistance. Materials producing particularly good results and considered preferable are molybdenum, tantalum and tungsten or any other suitable high refractory metal. The use of these metals facilitates operation of the gun at higher potentials because of higher breakdown potentials thereof and they are also possessed of qualities such as low vapor pressure at higher tube operating temperatures.

In accordance with my invention, film thicknesses for optimum loading, may be varied over a rather wide range in accordance with the demands of the particular tube structure and the particular modes and frequencies of oscillations tending to be produced therein. Film resistivities from 100 ohms per square to 1,000 ohms per square are contemplated as being optimum values in different situations and under some circumstances resistivities from 10 to 10,000 ohms per square may be utilized effectively.

As pointed out hereinabove, for most effective prevention of spurious oscillations the film would be of a thickness to most effectively match the wave impedance of the spurious oscillations tending to be generated. However, in a practical embodiment of the invention, certain portions of the film which are in portions of higher applied direct electric field, are preferably made somewhat thicker than is optimum for spurious oscillation prevention. Such thicker film portions are better able to withstand the destructive effects of occasional arcing that occurs at such regions by reason of the higher applied fields without being sufficiently mismatched as to materially lose their effectiveness in preventing spurious oscillations.

In the embodiment of my invention shown in the drawings, along the film portion **64**, extending from the bottom of the cup interior to the curved portion **66** and the film along portion **68**, extending along the exterior of the cup from portion **66** to curved portion **70**, the applied direct electric field intensity is not as great as that along portions **66** and **70**. Thus, the coatings of film along the portions **66** and **70** are preferably of lower resistivity than the coatings along portions **64** and **68**, so as to reduce high voltage arcing possibilities. The relatively higher resistivity of the film along portions **64** and **68** achieves damping of the high frequency oscillations.

While the present invention has been described by reference to particular embodiments thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the invention. I, therefore, aim in the appended claims to cover all such equivalent variations as come within the true spirit and scope of the foregoing disclosure.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electron gun for producing a focused beam of electrons comprising a cathode, a ceramic focusing cup enclosing the cathode and an apertured anode, and means for preventing spurious oscillations in said gun structure when said anode is operated at a high direct potential with respect to the remaining electrodes comprising a coating of high refractory metal along the portions of said focusing electrode in regions of high field intensity.

2. An electron gun for producing a focused beam of electrons comprising an apertured anode, a focusing electrode and a cathode disposed within said focusing electrode, said focusing electrode being a ceramic insulating member having a coating of refractory metal along portions thereof in regions of high field intensity.

3. A focusing cup for an electron gun comprising a hollow ceramic member open at one end for receiving a thermionically emissive cathode and portions of said member being coated with a high refractory conductive material.

4. An electron gun comprising a hollow, conductive member and an insulative focusing cup within said member and spaced therefrom and portions of said cup being coated with a thin film of conductive material.

5. An electron gun comprising a hollow, conductive member having an anode at one end and an insulative focusing cup within said member spaced therefrom, an electron emissive cathode within said cup for producing a beam of electrons in response to a potential applied to said anode positive with respect to said cathode, means for preventing the production of spurious oscillations within said member by electrons traversing the space between said cathode and anode and including a thin coating of refractory, conductive material along portions of said cup tending to be in electromagnetic fields of high intensity.

6. An electron gun comprising a hollow, conductive member having an anode at one end and an insulative focusing cup within said member spaced therefrom, an electron emissive cathode within said cup for producing a beam of electrons in response to a potential applied to said anode positive with respect to said cathode, means for preventing the production of spurious oscillations within said member by electrons traversing the space between said cathode and anode and including a thin coating of refractory, conductive material along portions of said cup tending to be in electromagnetic fields of high intensity, the resistance of said film being matched to the wave impedance of spurious oscillations tending to be produced in said member.

7. An electron gun for producing a focused beam of electrons comprising a ceramic focusing cup enclosing a thermionically emissive cathode, an anode spaced from said cup, said cup being contained in a conductive enclosure and means for suppressing spurious oscillations in said enclosure when said anode and enclosure are at a high direct potential with respect to said cup comprising a coating of high refractory conductive material along the portions of said focusing cup of high field intensity, the portions of said cup in fields of greater intensity having coatings of lower resistivity than portions thereof in the lower potential fields.

8. An electron gun comprising a hollow, conductive member having an anode at one end and an insulative focusing cup within said member spaced therefrom, an electron emissive cathode within said cup for producing a beam of electrons in response to a potential applied to said anode positive with respect to said cathode, means for preventing the production of spurious oscillations within said member by electrons traversing the space between said cathode and anode and including a thin coating of refractory, conductive material along portions of said cup tending to be in electromagnetic fields of high intensity, the resistance of said film being between 10 and 10,000 ohms per square to prevent the generation of spurious oscillations in said member.

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