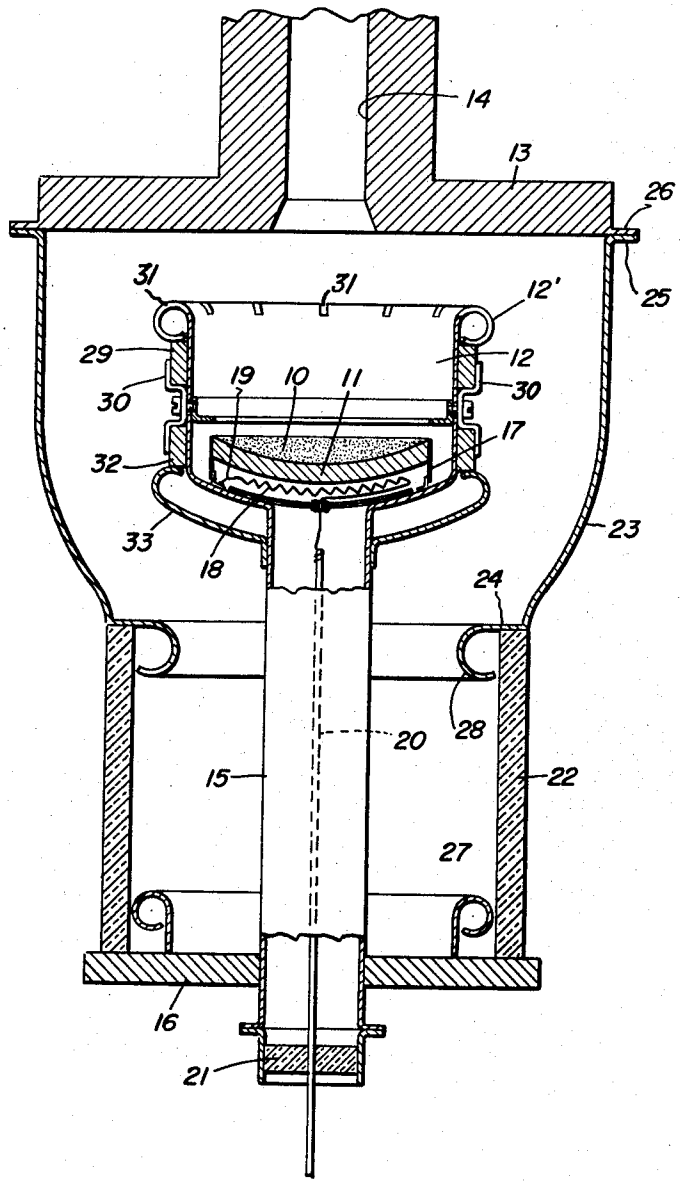
Nov. 22, 1960 R. A. DEHN 2,961,562

OSCILLATION SUPPRESSION IN HIGH VOLTAGE ELECTRON GUNS

Filed May 5, 1958



Inventor:
Rudolph A. Dehn,

by Richard R. Brainard
His Attorney.

United States Patent Office 2,961,562 Patented Nov. 22, 1960

2,961,562

OSCILLATION SUPPRESSION IN HIGH VOLTAGE ELECTRON GUNS

Rudolph A. Dehn, Schenectady, N.Y., assignor to General Electric Company, a corporation of New York

Filed May 5, 1958, Ser. No. 732,941

6 Claims. (Cl. 313—82)

The present invention relates to the suppression of unwanted oscillations in high voltage electron guns, particularly of the type used in beam tubes of the interaction gap or extended interaction types.

In electron guns for producing electron beams and particularly in guns operating at high voltages I have found that unwanted high frequency oscillations tend to occur. These oscillations occur particularly where the size of the elements of the gun structure produces resonance at a frequency of such a magnitude that the electron transit time is correct for the excitation of the circuit at that frequency. In accordance with an important aspect of my invention I provide for the suppression of these oscillations in such a manner that the normal direct current voltage accelerating field is not disturbed.

In the specific form of my invention illustrated in this application a volume of material capable of absorbing energy from the magnetic fields of such high frequency oscillations is placed in a region of high magnetic field with the result that the oscillations are suppressed while the direct current voltage accelerating field is essentially undisturbed.

My invention will be better understood and further objects and advantages thereof will become apparent from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims. In the drawing the single figure is an elevational view in section of an electron gun structure embodying my invention.

In the embodiment of my invention illustrated in the drawing electrons emitted from the coated surface **10** of a concave cathode member **11** are focused by a focusing cup **12** and accelerated by an apertured anode **13** to provide an electron beam directed through the central passage **14** of the anode. As will be readily appreciated by those skilled in the art the tube **14** may extend into the first or input resonator (not shown) of a klystron type device where it cooperates with a similar spaced tubular member to provide an interaction gap. In the particular construction illustrated the focusing cup is formed in one piece with a supporting hollow tubular member **15** which is bonded within an opening formed in a cathode supply terminal **16**. The cathode member **10** is supported centrally within the focusing cup by means of a suitable cylindrical foil support **17** secured to the bottom of the focusing cup. A suitable resistance heater element **18** is positioned between the bottom of the focusing cup and the cathode member **11** with one terminal **19** thereof connected with the focusing cup and the other terminal connected with a conductor **20** supported centrally within the tubular extension **15** and maintained in insulated relation with respect thereto by an insulating disk **21**. The enclosing structure for the cathode is completed by a hollow cylindrical ceramic insulator **22** and a somewhat flared cylindrical metal member **23**. As illustrated the member **23** is provided with an inwardly extending flange **24** at the lower end and an outwardly extending flange

25 at the upper end. The insulator **22** is bonded between the flange **24** and an upper surface of the disk-like cathode terminal **16**. The upper flange **25** of the metal member **23** is welded or brazed to a lip **26** formed as a peripheral extension of the anode member. In view of the high voltages contemplated in the operation of the gun described above corona shields are provided at the region of the joints between the ceramic member **22** and the terminal **16** and the metal member **23**. These corona shields **27** and **28** are rolled over to provide a smoothly curved surface exposed to the regions of high intensity electric fields. In a similar manner the upper edge of the focusing cup **12** is rolled over as shown at **12'**.

The internal parts of the gun structure may be formed of materials selected in accordance with well known considerations. For example, the cathode disk **11** may be of nickel. The focusing cup **12**, the corona shield **27** and the cylindrical enclosing member **23** may be formed of nickel, stainless steel or, as in the particular embodiment illustrated, of molybdenum. The accelerating anode itself is preferably made of stainless steel because of electrical considerations while in usual tube constructions for lower voltage applications this member is of copper since it is called upon to dissipate considerable amounts of heat.

In the operation of the gun structure thus far described voltage is applied between the conductor **20** and the terminal **19** to supply heating current to the heater element **18** and to provide a supply of electrons from the electron emitting coating **10**. These electrons are accelerated and focused into a beam which passes into cylindrical passage **14** by means of the anode **13** which is maintained at a high positive direct current voltage with respect to the cathode and the focusing cup **12** which is maintained at cathode potential.

With the structure thus far described I have found that oscillations tend to occur in the gun structure to an extent which is detrimental to the operation of the gun as a source of a focused beam of electrons of relatively uniform and stable density and I have further found that these undesirable oscillations may be eliminated without disturbing the accelerating electric fields produced by the direct current voltage applied between the anode **13** and the cathode terminal **16** by placing in regions of high magnetic field a material capable of dissipating energy from the high frequency magnetic fields in which it is placed. In accordance with a particular embodiment illustrated an annular ring **29** of such magnetic energy dissipating material surrounds the focusing cup just under the corona roll **12'** at the upper end thereof. The ring is held in position by suitable flanged clamping members **30** secured to the side walls of the focusing cup at suitable circumferentially spaced points. Also, the corona roll is slotted at a number of circumferentially spaced points as shown at **31** to improve the coupling between the ring **29** and the magnetic field associated with the unwanted mode of resonance in the enclosure **23**. While a variety of materials that will dissipate energy from the magnetic field may be used I have found that a class of materials known as ferrites may be used to particular advantage. These materials are a sintered mixture of iron oxide and one or more other metal oxides which yield a material having residual permeability at the frequency of the oscillations to be suppressed. A nickel ferrite of the form $NiFeO_4$ is particularly suitable because it may be used at temperatures as high as 590° C. before it reaches it Curie temperature. Other ferrite materials such as manganese-iron, cobalt-iron or manganese-aluminum-iron, for example, have the desired dissipative properties but the Curie point is reached at such a low temperature as to render them unsuitable for application in most

electron tube gun structures. In the drawing, I have shown a second dissipative ring **32** near the bottom of the focusing cup. This ring may be supported on a circular flange **33** secured to conductor **15** and having a rolled outer edge engaging the lower edge of the dissipative ring **32**. The upper edge of ring **32** is held in position by the same clamps **30** which hold the ferrite ring **29** in position. This ring is also in a position of high intensity magnetic fields associated with the unwanted high frequency oscillations that tend to occur between the metal parts of the gun structure which are operating at different direct current voltages. While either of the rings **29** or **32** may be effective in a given structure both may be used to advantage to obtain maximum dissipation of the energy of the unwanted oscillations.

In the particular embodiment of the invention illustrated the gun is electrostatically focused and no collimating magnetic fields are desired. In structures where it is desirable to do so the ferrite material may be subjected to a steady magnetic field suitably adjusted to provide ferromagnetic resonance. As will be readily appreciated this use of the magnetic field may be made effective to optimize the absorption of energy at the specified frequency of undesired oscillations.

While I have shown and described particular embodiments of my invention it will be apparent to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects and I aim, therefore, in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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 plurality of electrodes including a cathode, a focusing electrode and an apertured anode, and means for suppressing unwanted electrical oscillations in said gun structure when said anode is operated at a high direct current voltage with respect to the remaining electrodes comprising a member of ferrite material supported in said gun structure in a region of high intensity magnetic field.

2. An electron gun structure for producing a focused electron beam comprising a plurality of electrodes including a cathode, a focusing electrode and an apertured anode adapted to be operated at a large positive direct current accelerating voltage with respect to said cathode and said focusing electrode, and oscillation suppressing means including a body of material lossy in a high frequency magnetic field supported in a region of high intensity magnetic component of high frequency magnetic field produced between said anode and the remainder of said electrodes for dissipating magnetic energy and thereby suppressing unwanted electrical oscillations in said gun structure.

3. An electron gun for producing a focused electron beam comprising a plurality of electrodes including a cathode, a generally cylindrical focusing electrode and an apertured anode adapted to be operated at a large positive direct current voltage with respect to said cathode and said focusing electrode and oscillations suppressing means including a ring of ferrite material surrounding said focusing electrode for suppressing unwanted electrical oscillations in said gun structure.

4. An electron gun for producing a focused electron beam comprising a plurality of electrodes including a cathode, a generally cylindrical focusing electrode and an apertured anode adapted to be operated at a large positive direct current accelerating voltage with respect to said cathode and said focusing electrode, said focusing electrode having a rolled edge thereof facing said anode and a ring of ferrite material surrounding said focusing electrode on the side of said rolled edge remote from said anode and a plurality of coupling slots formed in the rolled edge and facing said anode.

5. An electron gun for producing a focused beam of electrons comprising a plurality of electrodes including a cathode, a focusing electrode and an apertured anode, and means for suppressing unwanted electromagnetic oscillations in said gun structure when said anode is operated at a high direct potential with respect to the remaining electrodes comprising a member of material lossy in a magnetic field supported in said gun structure in a region of high intensity magnetic component of high frequency electromagnetic field.

6. An electron gun for producing a focused beam of electrons comprising a plurality of electrodes including a cathode, a focusing electrode and an apertured anode enclosed in a conductive housing, means for suppressing unwanted electromagnetic oscillations in said gun structure when said anode is operated at a high direct potential with respect to the other electrodes comprising a member of material lossy in a magnetic field supported in said gun structure in a region of high intensity magnetic component of high frequency electromagnetic field.

References Cited in the file of this patent

UNITED STATES PATENTS

2,291,948	Cassen	Aug. 4, 1942
2,764,708	Beck	Sept. 25, 1956
2,797,353	Molnar et al.	June 25, 1957
2,811,667	Brewer	Oct. 29, 1957
2,844,750	Veith et al.	July 22, 1958
2,916,659	Sege	Dec. 8, 1959

FOREIGN PATENTS

690,438	Great Britain	Apr. 22, 1953