April 21, 1964 R. KOZIAK 3,130,340

ELECTRON GUN FOR GENERATING A HOLLOW BEAM

Filed Oct. 5, 1960

Fig. 1

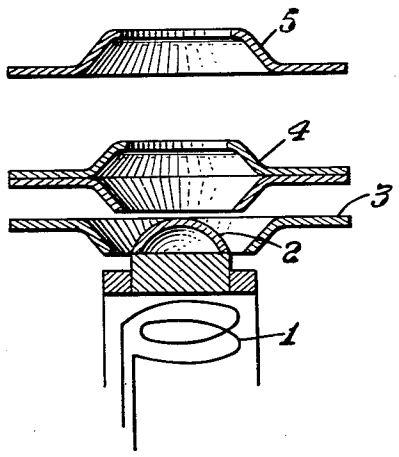



Fig. 2

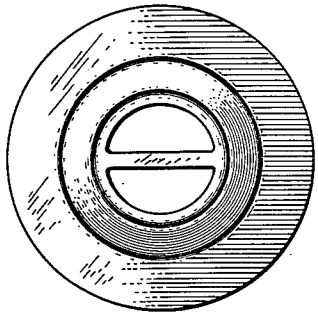
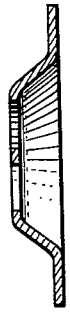


Fig. 3



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# ELECTRON GUN FOR GENERATING A HOLLOW BEAM

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The present invention relates to an electron gun for generating a hollow beam, said gun consisting of a cathode, a Wehnelt-cylinder and further electrodes, these electrodes being provided with central openings.

For some types of tubes for centimeter and millimeter waves a hollow beam construction is used which allows improvement of electrical parameters as well as higher efficiency. The density of these hollow beams is frequently very high. The design of electron-optics for obtaining hollow beams is very difficult both from the theoretical as well as from constructional point of view, and the difficulties are particularly pronounced in the case of the construction of tubes for millimeter waves.

Hitherto known electron guns comprise a cathode, a Wehnelt-cylinder and further electrodes with annular openings, the dimensions of the openings being approximately of the same size as the electron beam to pass therethrough. These types of electrodes are made either of one piece of material or the annular opening is defined by two separate pieces of material. In the first case the annular opening is interrupted at some places by bridges (usually three in number) which join the center to the perimeter. The disadvantage of this solution is the undesirable influence of the interrupted parts of the annular opening upon the shape and the quality of the resulting hollow beam, this being especially apparent in electron guns for hollow beams of smaller dimensions, as it is technically impossible to reduce the thickness of the joining bridges in proportion to the reduction of the diameter of the electrodes. Another disadvantage resides in sensitivity to overloading, as the current loss limits the maximum current density attained and increases the noise level in the tube. The other solution is very intricate in construction and troubles arise in fastening the solid central part of the electrode as well as the leads-out of this part, because it is necessary to keep the assembly tolerances. With respect to the aforesaid disadvantages the employment of such construction is not suitable for electron guns of smaller diameter.

The disadvantages briefly mentioned in the foregoing paragraphs are overcome by a new construction of an electron gun containing a cathode, a Wehnelt-cylinder and at least one additional electrode, with the cathode and Wehnelt-cylinder being both cup-shaped and the cavity of the Wehnelt-cylinder being directed with respect to the cathode in the opposite direction and provided with an opening, in which the cavity of the cathode is positioned, and with the additional electrodes being each provided with a central opening. The shape as well as the dimensions of the electron hollow beam is determined by the shape of both cathode and Wehnelt-cylinder and by their mutual positions. The control electrode usually consists of two parts having different forms. Such arrangement of the control electrode secures low values of the grid bias, and, at the same time, screens the cathode region from the influence of the electrodes following the control grid. Another advantage of this arrangement of the control grid resides in improved focusing conditions in the crossing parts of the electron gun, namely in the region between the cathode and control grid where the velocity of electrons is very low, and the influence of the electrode opening is reduced. The influence of the opening of the electrode may be reduced a great deal by the shape of the cathode. The other electrodes provided with central openings may have these openings furnished with a partition. These electrodes may be made of one piece, or they may consist of two differently shaped parts. The electrodes, or parts of them, may be made of one piece of material, with the partitions added thereto. The second part of the electrode which is remote from the cathode may likewise be furnished with such a partition. The electrodes are generally formed differently, but in a special case all electrodes may be formed in the same way. The sizes of the central openings of the individual electrodes or of their parts may be different, but in a special case the central openings may have the same size. The central openings may have any desired form, but in a special case it is a circle. The axis of the central opening usually passes through the center of the electrodes. The distances between the control electrode and the cathode as well as between the control electrode and the following electrode are chosen so as to reduce the harmful influence of the central opening in the electrodes to a minimum (lens effect).



The specification is accompanied by a drawing in which:

FIG. 1 is a section through an electron gun embodying features of the invention;

FIG. 2 is a plan view of an electrode of an electron gun; and

FIG. 3 is a section through the electrode of FIG. 2.

Referring to the drawing in greater detail now, and more particularly to FIG. 1, there are a filament 1, a cathode 2, a Wehnelt-cylinder 3, a control electrode 4, and an accelerating electrode 5. It will be seen that the cathode 2 has a hollow concave-convex or dome-shaped central portion extending into the central opening of the Wehnelt cylinder 3, which opening is formed at the bottom of a central cup-shaped portion. The member 3 is disposed so that the convex side of its cup-shaped portion faces in the opposite direction from the convex surface of the central portion of cathode 2. Further, the control electrode 4 is shown formed of two, superposed annular parts defining a central space having openings at the opposite sides directed toward the Wehnelt cylinder 3 and the accelerating electrode 5, respectively. It is also apparent that the peripheral portion of cathode 2 extends radially beyond the axial projection of the opening of control electrode 4 facing toward Wehnelt cylinder 3 and cathode 2.

The electron gun according to the invention works under normal conditions of the magnetic field passing through the cathode. The current efficiency of this electron gun is much better than in electron guns with annularly shaped electrodes. The electron gun according to the invention is highly resistant to overloading due to the fact that no elements can be easily damaged by burning through as for instance the joining bridges and full centers of the electrodes. With regard to their low current losses, they can be employed even in low-noise tubes. In comparison with hitherto known types of electron guns, the construction of the electron gun according to the invention is by far more simple, the respective parts being easy to construct and consequently less expensive. For covering of a certain frequency band, it is often necessary to employ more tubes. These tubes may now be advantageously provided with electron guns with very similar shapes. Consequently, it becomes possible to produce cheaper electron guns with slight modification of electrodes for many types of tubes.

FIG. 2 shows an electron gun electrode provided with a partition, and FIG. 3 shows the same electrode in a cross-sectional view.

The electron gun according to the invention may be

employed in tubes for centimeter and millimeter waves intended in particular for generators of measuring instruments, amplifiers, radiolocators, etc.

What I claim is:

1. An electron gun for generating a hollow beam of electrons comprising

(A) a cathode having a hollow central portion with a convex outer surface,

(B) a Wehnelt cylinder having a cup-shaped portion with a central opening at the bottom thereof,

(1) said Wehnelt cylinder being disposed with said cup-shaped portion directed toward said cathode and with said central portion of the latter projecting into said opening at the bottom of the cup-shaped portion, and

(C) at least one additional electrode arranged at the side of said Wehnelt cylinder remote from said cathode and having a central opening which is smaller than the outer periphery of said cathode.



2. An electron gun is in claim 1; wherein said additional electrode is a control electrode formed of two concave annular parts arranged with their concavities facing each other and forming, with said convex outer surface of the hollow central portion of the cathode, the compensation system of an electronic lens.

3. An electron gun as in claim 1; wherein at least one of the additional electrodes has a partition extending diametrically across said central opening thereof.

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