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M. S. GLASS

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ELECTRODE SYSTEM

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FIG. 1

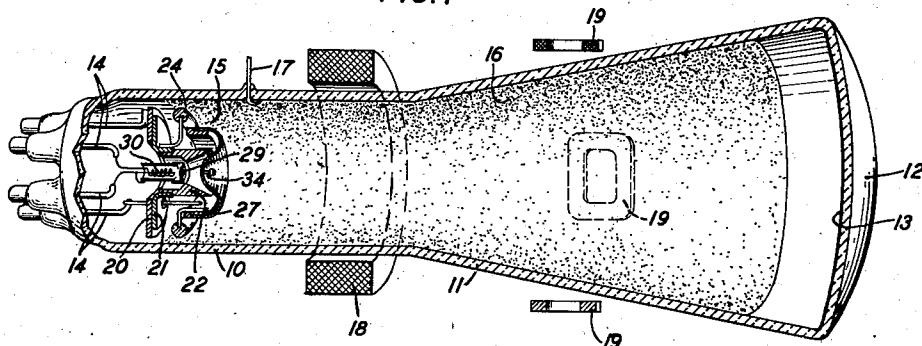
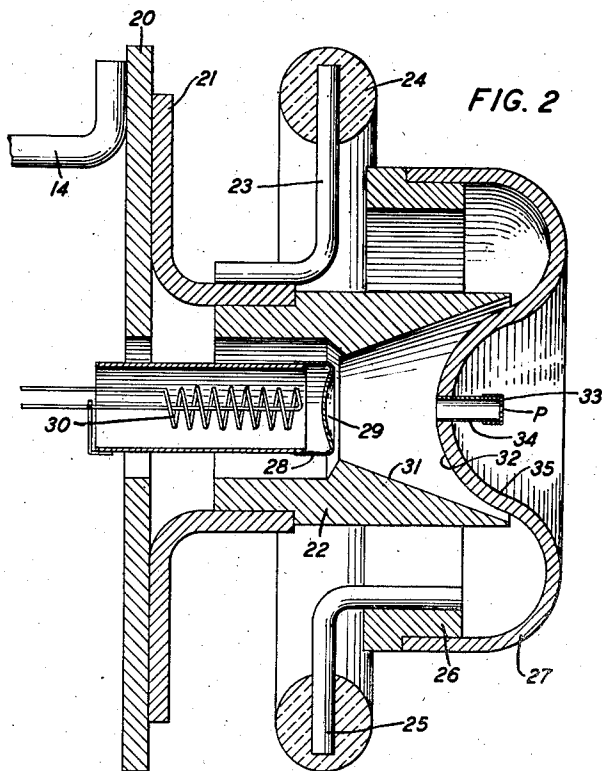


FIG. 2



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ELECTRODE SYSTEM

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5 Claims. (Cl. 250—162)

This invention relates to electrode systems, commonly referred to as electron guns, for electron discharge devices and more particularly to electron guns for cathode ray devices of the magnetic focussing type.

Electron guns of known construction, such as disclosed in my Patent 2,268,194, granted December 30, 1941, comprise, in general, a cathode and a pair of electrodes, such as a beam forming electrode and a first anode, in cooperative relation with the cathode for concentrating the electrons emanating from the cathode into a stream of restricted cross section. In cathode ray devices, the first anode is followed frequently by an accelerating electrode or second anode. As noted in my patent above identified, electrostatic focussing of the concentrated electron stream entails a fairly critical ratio of the potentials upon the first and second anodes. On the other hand, if magnetic focussing of the stream is utilized, because of the electric lens effect at the first anode due to the potential difference between the two anodes, the magnetic field and the potential of the second anode must be correlated and any substantial change in the potential necessitates adjustment of the magnetic field to realize the desired focussing. Hence, operation of the device is complicated.

One object of the invention is to obtain magnetic focussing of an electron stream in electron beam discharge devices, substantially independent of the potential of the second anode throughout a wide range of such potential. Stated in another way, one object of this invention is to construct an electron gun substantially free from electrostatic lens effects at the anode thereof, due to the action of this anode and the accelerating electrode in cooperative relation therewith.

In one illustrative embodiment of this invention, an electron gun comprises an axially symmetrical electrode system including a cathode, a centrally apertured anode, and a beam-forming or modulating electrode, the anode and beam-forming electrode having juxtaposed surfaces of predetermined configurations such that the electrons emanating from the cathode are concentrated into a beam converging upon a point on the axis of the system.

In accordance with one feature of this invention, the electrodes of the gun are so constructed and arranged that the point aforementioned lies beyond the surface of the anode farthest from the cathode, the anode is provided with a disc having a limiting aperture substantially at this point and the anode surface mentioned and the

supporting element for the disc are made such that the electric field in the vicinity of the limiting aperture is distorted so that at this aperture the electrons issue with relatively low velocity and are strongly accelerated by the electric field due to the second anode without any substantial electrostatic focussing thereof.

The invention and the aforementioned and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a perspective view mainly in section of an electron discharge device including an electron gun illustrative of one embodiment of this invention; and

Fig. 2 is an enlarged sectional view of the electron gun included in the device shown in Fig. 1.

Referring now to the drawing, the electron discharge device illustrated in Fig. 1 comprises an enclosing vessel having a cylindrical neck portion 10 and a flaring portion 11 terminating in an end wall 12 the inner surface of which has thereon a fluorescent screen or coating 13. Mounted within the neck portion 10 and supported by the leading in conductors 14 is an electron gun designated generally as 15, the gun comprising axially symmetrical electrodes, described hereinafter, and being in alignment with the screen 13.

The inner wall of the neck and flaring portions 10 and 11 of the enclosing vessel has thereon an electrically conductive coating 16, which may be formed, for example, by colloidal graphite, and to which electrical connection may be established by a wire 17 sealed to and extending through the wall of the neck portion 10. This coating, as shown in the drawing, extends from adjacent the electron gun 15 to adjacent the fluorescent screen 13 and serves as the second anode of the device.

Encompassing the neck portion 10 in the vicinity of the electron gun 15 is a magnetic coil 18 for focussing the electron stream produced by the gun, upon the fluorescent screen 13. Two pairs of deflecting coils 19, only three coils being shown, are mounted in space quadrature adjacent the wall of the flaring portion 11 and are utilized to deflect the electron stream thereby to produce a trace upon the screen 13.

The electron gun, as shown more clearly in Fig. 2, comprises an annular, metallic foundation member or plate 20 to which there is secured a flanged metallic support or collar 21. The support or collar 21 mounts a beam form-

ing or modulating electrode 22 and has affixed thereto a plurality, for example three, of rigid L-shaped wires 23 which are embedded in and support a vitreous ring 24. The vitreous ring has embedded therein also a plurality, for example three, of other rigid L-shaped wires 25 which mount an annular metallic member 26 on which an anode 27 is fitted and to which the anode is affixed. Extending into the beam-forming or modulating electrode 22 is an equipotential type cathode which includes a cathode member 28 having a concave electron emissive surface 29, and a heater filament 30.

The beam-forming or modulating electrode 22 is provided with a frusto-conical inner surface 31 and the surface 32 of the central portion of the anode 27 facing the surface 31 is convex. The surfaces 29, 31 and 32 are of such configuration and so arranged, for example, in accordance with my Patent 2,268,194 noted hereinabove, that they conform substantially to equipotential boundaries of an electric field such that the electrons emanating from the surface 29 are concentrated into a converging beam substantially focused upon a point P upon the axis of the electrode system. For example, these surfaces may conform to equipotential boundaries of field corresponding to a potential distribution of $E = Kx^2$ along the axis, where E is the potential on the axis at a distance x from the origin of the system and K is a constant.

Positioned in a plane passing through the point P is a metallic member or disc 33 having a central limiting aperture, this member being supported by a cylindrical metallic tube 34 fitted and secured in the central aperture in the anode 27. The surface 35 of the anode which encompasses the disc 33 and tube 34 corresponds substantially to the surface 32 and thus conforms substantially to an equipotential surface of the field between the surfaces 32 and 33.

As pointed out heretofore, the electrons emanating from the cathode surface 29 converge upon the point P. If the disc 33 and tube 34 were absent, because of the potential difference between the anode 27 and the second anode 16 the region adjacent the surface 35 would act as a strong electrostatic electron lens, the effect of which would be dependent largely upon the potentials of the anodes. However, the disc 33 and tube 34 distort the electric field in front of the surface 35 and adjacent the limiting aperture and this together with the fact that the limiting aperture in the disc 33 is at the region of beam crossover substantially eliminates electrostatic focussing effects upon the electrons issuing from the aperture. At the region of the aperture the electrons are subjected to a strong accelerating field and are projected at high velocity toward the screen 13.

Because of the absence of electrostatic lens effects in the region of the limiting aperture, the electrons are focussed readily by the magnetic field of the coil 18 and the focussing is substantially independent of the potential of the second anode 16 throughout a range of values for this potential. Thus, the device may be operated with a range of potentials upon the second anode without substantial alteration of the focussing and without adjustment of the magnetic field with changes in this potential. Hence, it will be appreciated that flexibility of operation and also high focussing efficiency are realized.

Although a specific embodiment of this inven-

tion has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electrode system for electron discharge devices comprising a cathode, a first anode opposite said cathode, a beam forming electrode between said cathode and said first anode, said electrode and anode having aligned apertures therein and having their facing surfaces of predetermined configurations to converge electrons emanating from said cathode substantially upon a point in front of the face of said anode facing away from said cathode, a second anode extending from the vicinity of said face of said first anode in the direction away from said cathode, and means for distorting the fields adjacent said face and said point, said means comprising a conductive member electrically integral with said first anode, extending transversely to the axis of alignment of said apertures and of smaller transverse dimensions than said face, said conductive member having a limiting aperture therein substantially at said point.

2. An electron gun comprising a cathode, a centrally apertured anode in alignment with said cathode and having a dished surface facing away from said cathode, a beam-forming electrode between said cathode and said anode, the facing surfaces of said anode and said electrode being of predetermined configurations to converge electrons emanating from said cathode substantially upon a point in front of said dished surface, and a conductive member having a restricted aperture therein mounted within the space bounded by said dished surface, in alignment with the aperture in said anode and substantially at said point, said conductive member being connected electrically to said anode.

3. An electron gun comprising a cathode, an anode having a centrally apertured dished portion in alignment with said cathode, the concave surface of said portion facing away from said cathode, a hollow beam-forming electrode having an inner wall flaring from said cathode toward said dished portion, the convex surface of said portion and said flaring wall being of predetermined configurations to converge electrons emanating from said cathode substantially upon a point in front of said concave surface and in alignment with the aperture in said dished portion, a conductive member having a restricted aperture therein at substantially said point, and a slender hollow conductive member within the region bounded by said concave surface, coaxial with said apertures and mounting said first conductive member from said anode.

4. An electron gun comprising an axially symmetrical electrode system including a cathode, an anode and a beam-forming electrode between said cathode and said anode, said anode and beam-forming electrode being centrally apertured and having opposed surfaces of predetermined configurations to converge electrons emanating from said cathode substantially upon a point on the axis of said system in front of the surface of said anode facing away from said cathode, said last-mentioned surface having a dished central portion, a disc member having a limiting aperture at substantially said point, and a tubular member of a diameter small in comparison to the diameter of said portion and co-

axial with said anode mounting said disc member from said anode.

5. An electron gun comprising an axially symmetrical electrode system including a cathode, a hollow beam-forming electrode adjacent said cathode and having therein a frusto-conical passageway flaring away from said cathode, an anode having a centrally apertured concavo-convex portion extending into the larger end of said passageway, the convex surface of said portion facing said cathode, said convex surface and

the bounding wall of said passageway being of predetermined configurations whereby electrons emanating from said cathode are substantially focussed upon a point on the axis of said system in front of the concave surface of said anode portion, a tubular metallic member within said portion and extending from the aperture therein to the region of said point, and a centrally apertured, metallic disc member mounted upon said tubular member substantially at said point.

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