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CATHODE RAY TUBE SYSTEM

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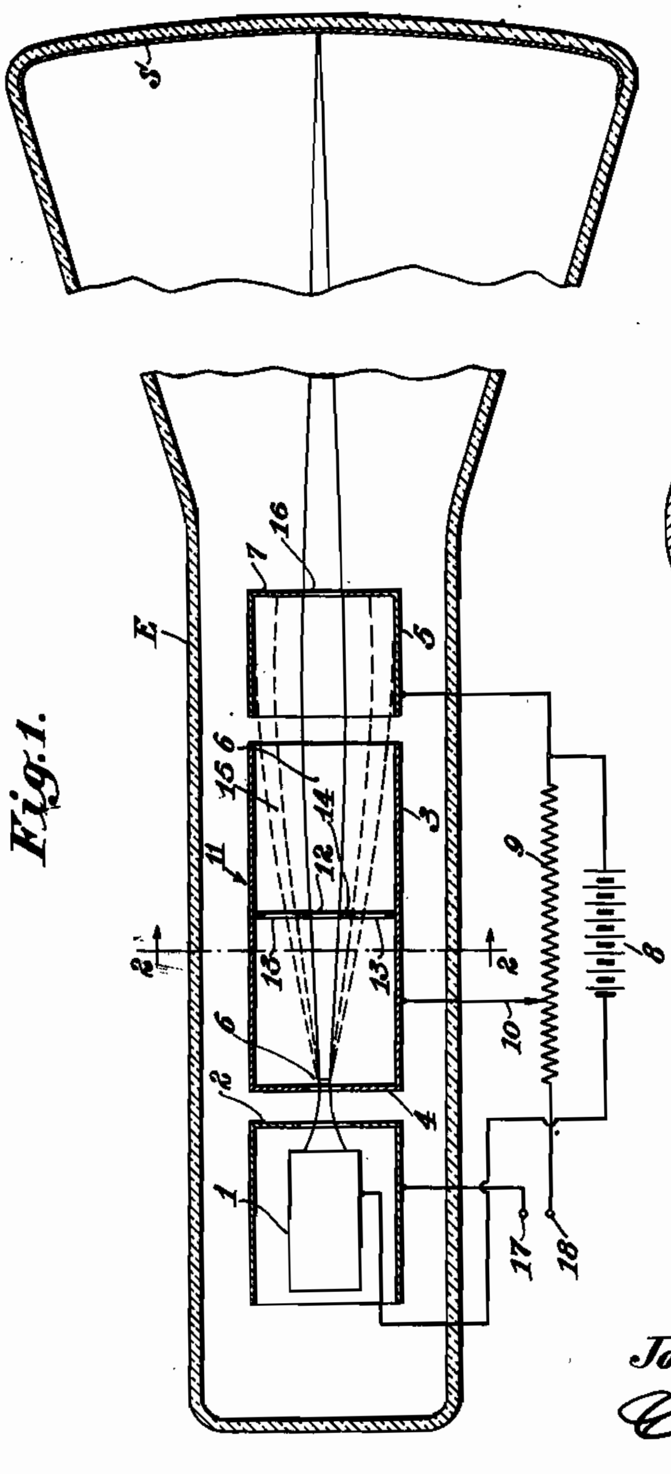

Fig.1.

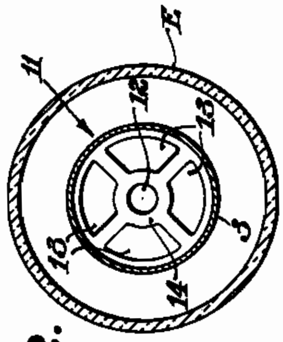

Fig.2.

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ALIEN PROPERTY CUSTODIAN

CATHODE RAY TUBE SYSTEM

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My invention relates to electron discharge tubes and systems of the cathode ray type and particularly to an improved electrode structure for use in such tubes and systems.

In cathode ray tubes of the types utilized for recreation of television images and for oscillograph purposes it is desirable to provide a structure capable of developing an electron beam of high electron density while at the same time limiting the cross sectional diameter at the target to a value as small as possible. High electron beam current may be obtained while retaining a small beam cross section at the target or fluorescent screen by focusing the electron streams from the cathode with the aid of a preconcentration system and by projecting a section of the beam thus formed on to the screen by means of an electrostatic lens system. In this case it is desirable to utilize an apertured diaphragm serving to limit the cross-sectional area of the beam of rays in order to avoid stray electrons impinging on the target or screen in the environment of the picture proper and producing additional light or halation over the target. Such a diaphragm has the disadvantage that the electrons which are intercepted produce secondary electron emission and if no particular provisions are made the secondary electrons thus liberated impinge not only on the target but also on other electrodes such as the deflecting plates and cause a variation of the potential of these plates if they are connected to a scanning circuit through a comparatively high resistance. This has the troublesome effect that the picture point on the screen varies its position with the current and the figure described by this point is deformed. The influence of the secondary emission is reduced if the apertured diaphragm is placed nearer to the cathode. Thus if it is secured to the first electrode or anode of the electrostatic projection system, then nearly all the electrons liberated by secondary emission are collected by the electrodes of the projection system, especially if the diaphragm is located in an electrostatic field free space. In this case, however, another difficulty is encountered in that the electrons which impinge on the diaphragm have the effect of reducing the potential of the associated anode which is usually connected across a comparatively high resistance to a source of potential. This results in a fluctuation of the anode potential and of the focal distance of the projection system and this causes defocusing of the image on the target screen. Consequently, with variation of the beam current, the voltage ratio between the electrodes varies, and must be adjusted subsequently, in order to keep the image sharp and in focus.

It is an object of my invention to provide a cathode ray tube and system wherein the electron beam may be maintained in a focused condition notwithstanding wide variations in beam current. It is another object to provide a cathode ray tube system utilizing an electron gun having a plurality of anodes wherein variation in the ratio of the potentials applied to the anodes is minimized, thereby minimizing variation in focus of the electron beam. A further object is to provide a tube of the type described wherein secondary electron emission is collected in such a manner as to minimize potential variation of the electrodes, and it is a still further object to control the variation of the focal distance of the electron beam in such a manner that the disadvantages referred to above are eliminated. These and other objects, features and advantages of my invention will become apparent when considered in view of the following description and the accompanying drawing, in which:

Figure 1 is a longitudinal view of a cathode ray tube system having electrode structure made and operated in accordance with my invention, and

Figure 2 is a cross sectional view of one of the electrodes shown in Figure 1 taken along the line 2—2.

I have found that it is almost exclusively those secondary electrons which emanate from the margin of a diaphragm in the end electrode which bring about troublesome phenomena, such as shift of the picture point and diffused screen light. Therefore, in accordance with my invention, I provide a structure wherein the electron beam is limited by an apertured diaphragm which is located at such a point that it does not emit harmful secondary and reflected electrons but transmits only those primary electrons which cannot generate any appreciable harmful secondary radiation from further electrodes of the structure. Further, in accordance with my invention I provide a diaphragm which collects only the stray electrons which directly adjoin the electron beam which is to be utilized to generate light on a target such as a fluorescent screen. Thus the stray electrons can no longer impinge on a further electrode at a position which might cause further secondary electron emission and therefore no serious trouble is encountered from secondary electrons emitted from this electrode. The potential of the apertured diaphragm, and associated anode limiting the rays and consequently the focal distance of the projection system are variable to a smaller degree since a great portion of the rays which are not used is not intercepted by the diaphragm and consequently does not contribute to the voltage variation of the diaphragm.

The invention will be more clearly understood with reference to Figure 1 wherein the highly evacuated envelope E is of elongated shape provided with a neck section enclosing an electron gun made in accordance with my invention and a frusto-conical section enclosing a target electrode such as the fluorescent screen S. The preconcentration system of the electron gun is constituted by the cathode 1 which may be of the directly heated type or indirectly heated type as shown, a control electrode 2, and a suction or first anode 3. This first anode 3 is of tubular shape and includes an apertured disc 4. The cathode 1, control electrode 2, first anode 3 and second anode 5 constitute the electron gun capable of developing and focusing a beam of electrons upon the target or fluorescent screen S.

Due to the electric field between the cathode 1 and the first anode 3, the electrons are accelerated through the control electrode 2 which has a negative voltage relative to the cathode causing the electron paths to converge toward the electron gun axis to form an electron beam 6. In the tube represented in Figure 1 the voltages applied to the electrodes have such values that the paths of the electrons emitted from any point of the emitting surface of the cathode intersect or cross over each other in the vicinity of the first anode apertured disc 4. Consequently, the intersection of the electron paths to form the beam 6 is not at a mathematical point but over a small surface at which the beam has a minimum cross section. After the electrons of the beam 6 pass the cross-over point they follow divergent paths and are subsequently directed by the electrostatic fields between the first and second anodes on to the fluorescent screen S. While I have shown a structure in which the electrons converge from the cathode at a cross-over point, the electrons may alternatively diverge from the cathode. The first anode 3 and second anode 5 are maintained at positive potentials with respect to the cathode 1, preferably by a single potential source 8. Since the first anode is operated at a lower potential with respect to the cathode than the potential of the second anode, I provide a bleeder or potentiometer 9 of high resistance shunted across the source 9 to derive the potential applied to the first anode 4 such as by the variable lead 10 from the source 6.

In accordance with the invention, and in order to prevent excessive variation of the ratio of potentials existing on the first and second anodes, I provide a multi-apertured diaphragm 11, which is so shaped as to intercept only part of the rays which are not used. As can be seen more clearly from Figure 2, the diaphragm 11 has a central aperture 12 which is aligned with the axis of the electron gun and a plurality of outer apertures 13 off the electron gun axis. The central portion 14 of the diaphragm is preferably of annular shape and intercepts the rays in a region which directly adjoins the beam, transmitting through the apertures 13 the rays running in a marginal region 15 which is still further away from the axis. The latter rays consequently reach the electrode 5 but do not produce any harmful secondary emission since they impinge on the electrode at points from which the secondary electrons cannot penetrate through the aperture 16 in the diaphragm 7. The secondary electrons which are produced at the central portion 14 of the diaphragm 11 do not bring about disadvantageous phenomena since the diaphragm is positioned in an almost field-free space so that the secondary electrons are not accelerated in the direction of the aperture 15.

While wide fluctuations of the potential of the first anode 3 with varying beam intensities are eliminated, due to the particular shape of the diaphragm 11, some residual variation in this potential due to the collection of electrons by the central annular portion is desirable. The intensity of the beam is controlled by setting up a voltage between points 17 and 18 in the connection between the control electrode 2 and the cathode 1, which voltage renders the electrode 2 negative with respect to the cathode. The greater this potential difference, the weaker is the beam current but also the more are compressed the rays emanating from the cathode. Consequently, the cross-over point of the beam electrons adjacent the apertured disc 4 will be located nearer to the cathode at comparatively high modulation voltages. However, the residual variation of the first anode potential compensates for any defocusing of the electron beam and the focal distance of the lens system is rendered substantially constant with variation of electron beam intensity. It is very desirable that the area of the central portion 14 and of the apertures 12 and 13 of the diaphragm 11 should be chosen to collect a portion of the electron flow thereby obtaining some slight variation of first anode potential with varying beam current. In conventional circuits this variation of the first anode potential and of focal distance is far too great with a diaphragm which intercepts all the marginal rays so that the displacement of the cross-over point of the electrons is overcompensated in this case. The ratio of the surface of the annular portion 14 to aperture 13 area may be determined by trial but in any case apertures to allow marginal electrons to pass to the second anode must be provided to obtain the benefits of my invention. The diaphragm 11 may also be constituted by a plurality of concentric rings or it may have a helical portion surrounding the annular central portion 14. The essential thing is that a central portion of the beam is transmitted and a portion of annular section about it is intercepted and outside the annular portion a quantity of rays is transmitted.

In the application of cathode ray tubes to oscillography it is often possible for the electrode voltage to be adjusted during use and thus to keep the beam in focus. In many cases, however, especially in recording of transient phenomena the short duration of the surges to be measured necessitates an automatic control which makes the use of my invention particularly desirable.

JOHANNES DE GIER.