

Oct. 31, 1939.

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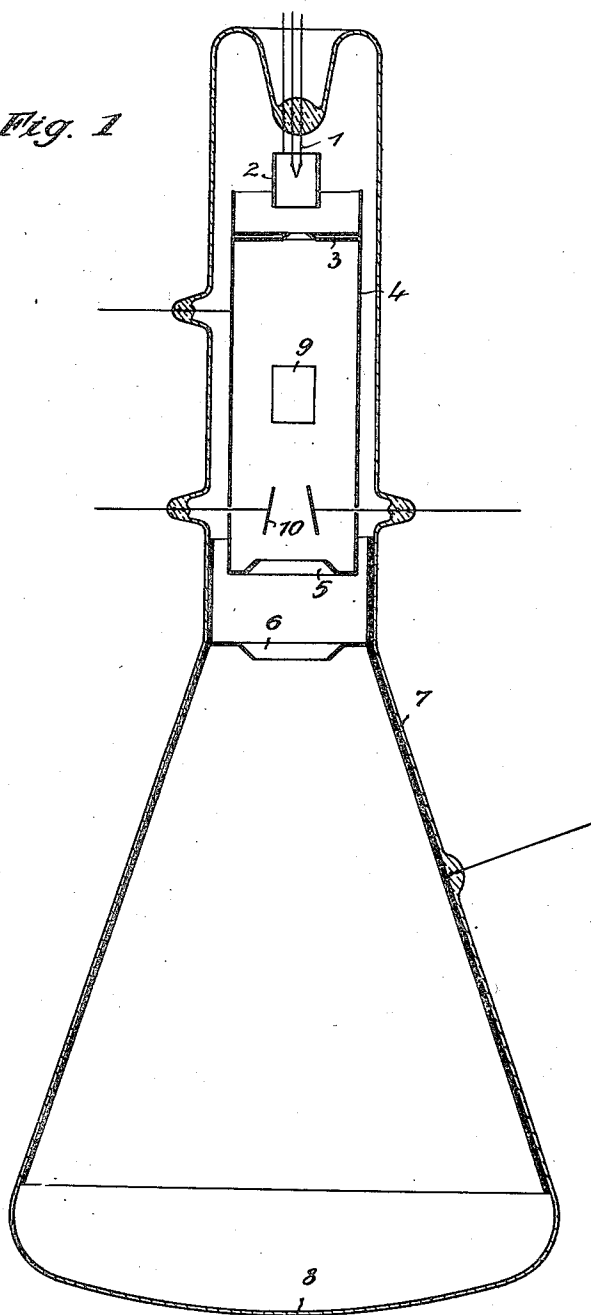
2,178,458

BRAUN TUBE

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2 Sheets-Sheet 1

Fig. 1



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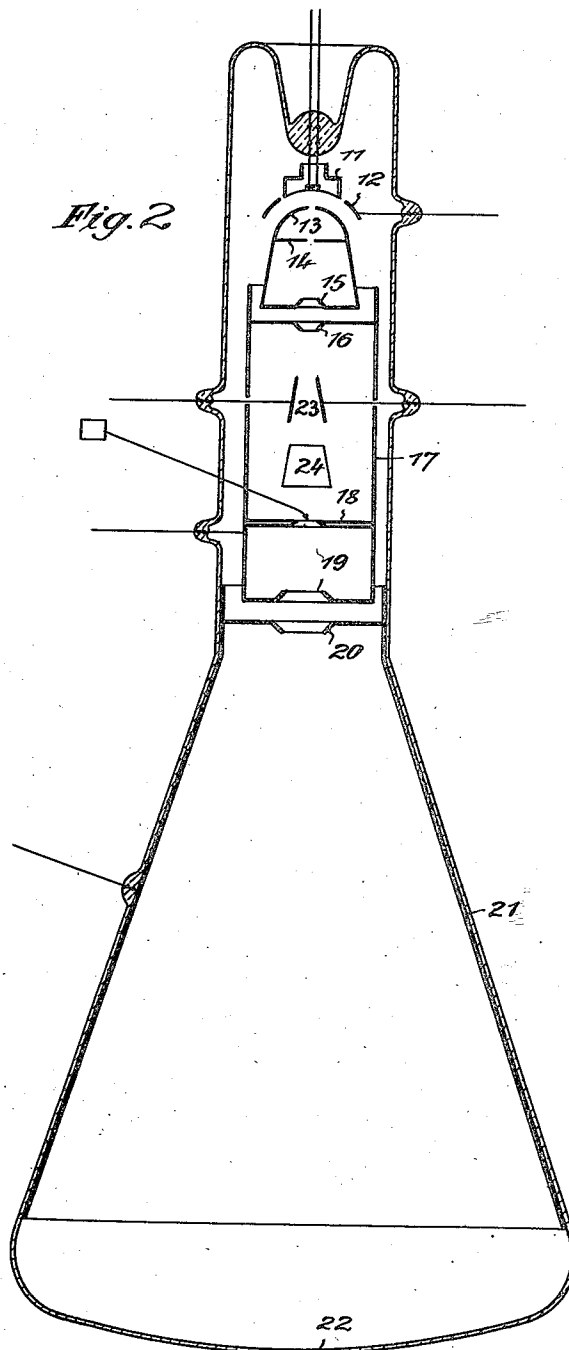
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UNITED STATES PATENT OFFICE

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BRAUN TUBE

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firm of Fernseh A. G., Zehlendorf, near Ber-
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In Germany January 26, 1934

1 Claim. (Cl. 250-162)

This invention relates to an improved Braun tube.

Braun tubes, particularly television and oscillograph tubes, should be sensitive to low voltages for modulating the ray, but the modulated image must nevertheless possess great intensity. This object can be attained by high current density of the ray and great screen sensitivity, and an additional expedient which is quite effective consists in increasing the speed of the electrons toward the screen after the deflecting fields are passed. It is known to provide for acceleration directly before the screen by applying thereto a strong positive voltage with respect to a fine-meshed wire netting positioned closely in front of it. Furthermore, it is possible to build up between the deflecting plates and the fluorescent screen a gradually rising potential field by a plurality of annular electrodes which may be arranged on the inside of the glass bulb on gradually rising potentials, or by a single spiral electrode subjected to the entire voltage. The first-mentioned method is open to the objection that part of the radiated energy is lost, absorbed by the wire netting, for the production of the image and that, owing to the irregularities of the electric field, distortions of the image points will appear at the meshes. Both methods suffer from the drawback of involving great difficulties in their technical application.

This invention proposes to eliminate these troubles by employing for the acceleration of the ray electrons to the screen an electric lens comprising two or more disc electrodes or net shaped electrodes and having a higher potential on the screen than on the cathode side. While accelerating the electrons, this lens reproduces, at a definite focal surface within the tube, such as the fluorescent screen, the image of a virtual or real primary image, i. e., of a virtual or real modulated cross section of an electronic ray at a defined cross section of the tube, so that the brightness of the image on the screen is increased by the lens according to the rise in potential, the modulation of the ray being effected, according to the invention, at low voltage and, correspondingly, at small deflecting voltages and currents.

As in all apparatus of this class the original source of the ray is an electron gun which determines the shape and, proportionally, the size of the image point or elementary area appearing on the fluorescent screen. The modulation of the image point as it is concurrently varied in intensity and deflected across the screen is in-

tegrated by the eye to give the appearance of an image. No actual electron image of a pictured object ever exists within the tube, but it is convenient to consider the ordered pattern of image points which are successively formed as if they were simultaneous, and to refer to them as an image. It will be apparent that where the proper electric field conditions obtain to form a complete and simultaneous image of a pictured object these same conditions will necessarily hold for individual points, and hence no errors are introduced by considering the aggregate of such points as an image.

Corresponding to the virtual or real object, two embodiments of the invention are illustrated in the accompanying schematic drawing, in which Figure 1 shows a tube for forming a virtual primary image of the object; and Figure 2, a tube for forming a real primary image, "virtual" and "real" having the same connotations as in optics.

In both instances, either the cathode itself or an irradiated diaphragm acting as electronic source defines an image point, the latter possibility, besides insuring the desired smallness of the point of image affords the advantage of choosing the form of the image point and permits the use of large-surfaced cathodes which yield more current, such as point-like, say, directly heated horse shoe cathodes, or large-surfaced cathodes such as indirectly heated oxide cathodes. The embodiment shown in Figure 1 employs a cathode-defined image point, while Figure 2 employs a diaphragm-defined image point.

According to Figure 1, the ray transversely modulated, i. e., deflected at a relatively low electronic speed is accelerated by an electric lens directly behind the deflecting plates. The fluorescent screen shows the real image of a virtual object found by extending the modulated beam back to the plane of the electronic source.

In the embodiment shown in Figure 1, the source of electrons is the conventional horseshoe or hairpin filamentary cathode 1, which is surrounded by a cylindrical control electrode 2 for varying the intensity of the electron stream. In front of the cathode an apertured diaphragm 3 is mounted in a shielding cylinder 4, to which is applied a potential positive to the cathode. Cathode, control electrode, and diaphragm combine to form an accelerating electron lens, which acts to decrease the divergence of the electron stream from the cathode as it passes through the shielding cylinder.

The opposite end of the shield supports a second diaphragm 5, shown as formed with an inwardly flared flange. Opposing the diaphragm 5 is a second diaphragm 6, formed with a symmetrically arranged flange, and connected to and forming part of a second anode 7, which lines the flaring portion and a part of the neck of the tube. The anode 7 is operated at a potential which is highly positive to the first anode structure comprising diaphragms 3 and 5 and the cylindrical shield 4. In other words, the electrons are given most of their acceleration between the diaphragms 5 and 6 which together form a second electron lens, and strike the fluorescent screen 8 at the end of the tube with this final high velocity to cause a correspondingly brilliant fluorescence thereon.

The usual pairs of electrostatic deflecting plates 9 and 10 are mounted within the shield 4. The pairs of plates are mounted perpendicularly to each other, and for television use one pair is excited by the picture or vertical deflection frequency, while the other pair is excited by the line or horizontal deflection frequency.

In operation, the electron stream as it passes the deflecting plates is weakly divergent and traveling at low velocity, and is hence easily deflected. The second accelerating lens 5, 6 not only greatly increases the velocity but causes the rays to converge, coming to a focus and forming a real image in the plane of the fluorescent screen 8. This image, considered in the aggregate as integrated by the eye, corresponds to a virtual image such as might be formed by a similarly deflected beam in a plane behind the first lens.

In the embodiment shown in Figure 2 an extended-surface, indirectly heated cathode 11 is shown with a control electrode 12 formed as an extension of the geometrical surface defining the cathode face. In front of the cathode is mounted a hollow anode 13, apertured to permit electrons from the cathodes to enter and reach a diaphragm 14 and to irradiate the small aperture formed therein with relatively high velocity electrons, the accelerating potential applied to the anode being comparatively high. In this manner a relatively large electron flow may be obtained through an exceedingly small aperture of any desired shape. The forward end of the anode shield is closed by a diaphragm 15 which is provided with an inwardly flaring flange and which forms the first element of an electron lens.

The second element of this lens is the diaphragm 16 which is mounted in a cylindrical shield 17, this shield, together with an intermediate diaphragm 18 and a closing diaphragm 19 being maintained at a potential negative to the anode, so that the lens 15, 16 is a retarding one. The potentials are so arranged as to form an image of the diaphragm 14 in the plane of the diaphragm 18, the converging electrons again diverging after they pass the plane of this diaphragm. The use of the diaphragm 18 is op-

tional, its purpose merely being to define the image field.

The diaphragm 20, opposed to the diaphragm 19 and connected to and continuous with the final anode 21 forms with diaphragm 19 a second electron lens, which imparts to the electron beam its final acceleration and forms the final image on the fluorescent screen 22. The deflecting plates 23 and 24 act in the same manner as the plates 9 and 10, in the embodiment first described, to deflect the beam over the area defined by the diaphragm 18. It will be noted that this area may be very small as compared to the size of the final image and hence little power will be needed to deflect the electron stream at the low velocity which it possesses as it passes between the deflecting plates. The primary difference between this embodiment and the first embodiment is that the primary aggregate image is a real image formed ahead of the first lens instead of a virtual one formed behind it.

It will be understood that the two embodiments shown in the drawings by no means exhaust the possibilities of the structures by which this invention may be carried out. The type of cathode shown in Figure 2 may be used with the virtual-image type of apparatus, and vice versa. Where the virtual-image system is used, the first pair of deflecting plates may be placed on one side of the first lens and the second pair of plates on the opposite side. Furthermore, the particular type of lens disclosed is only one form of several which are well known in the science of "electron optics", and any of these types of lenses may be used in the practice of the invention. With the lenses at the command of the designer, the actual combinations which may be used are almost unlimited. In the examples shown, the first lens in Figure 1, where the primary image is virtual, is an accelerating lens, whereas the first lens in Figure 2 is a retarding lens; if proper regard is had to the various velocities involved these conditions may be reversed. With such possibilities in mind, what I claim as new is the invention as expressed by the following claim.

I claim:

In a Braun tube, a source of electrons, a tubular shield positioned in the path of electrons emitted by said source, an apertured diaphragm positioned at each end of said tubular shield, each of said diaphragms being formed and positioned to form one element of an electron lens, means within the shield for deflecting electrons passing therethrough, a fluorescent screen positioned to receive electrons passing through said shield, and additional electron lens elements mounted adjacent said diaphragms without said shield and cooperating with said diaphragms to form a real image of successive points as the beam is deflected in the plane of said screen, and to form an additional primary image behind the closer of said diaphragms as viewed from said screen.

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