Dec. 24, 1940. E. BRUCHE 2,225,901

ELECTRON DEVICE

Filed May 21, 1938

Fig. 1

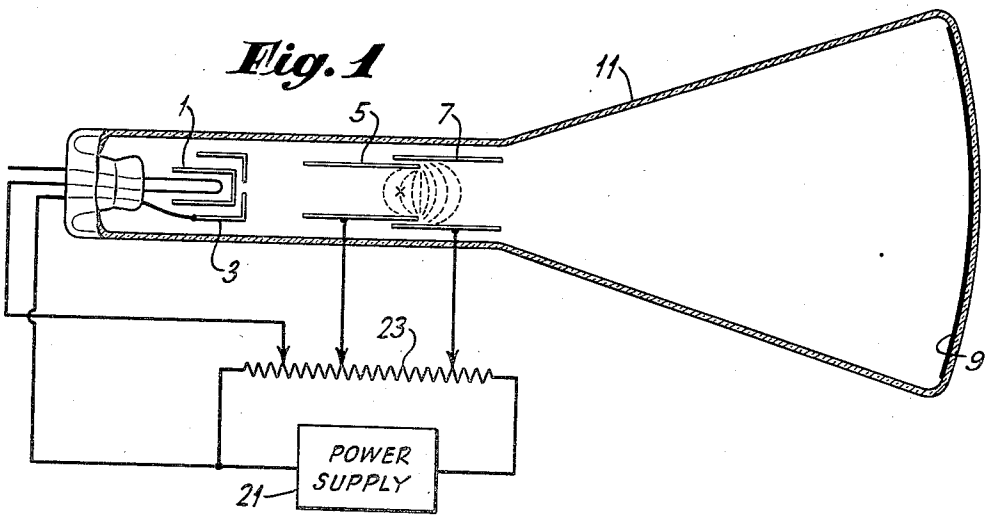


Fig. 2

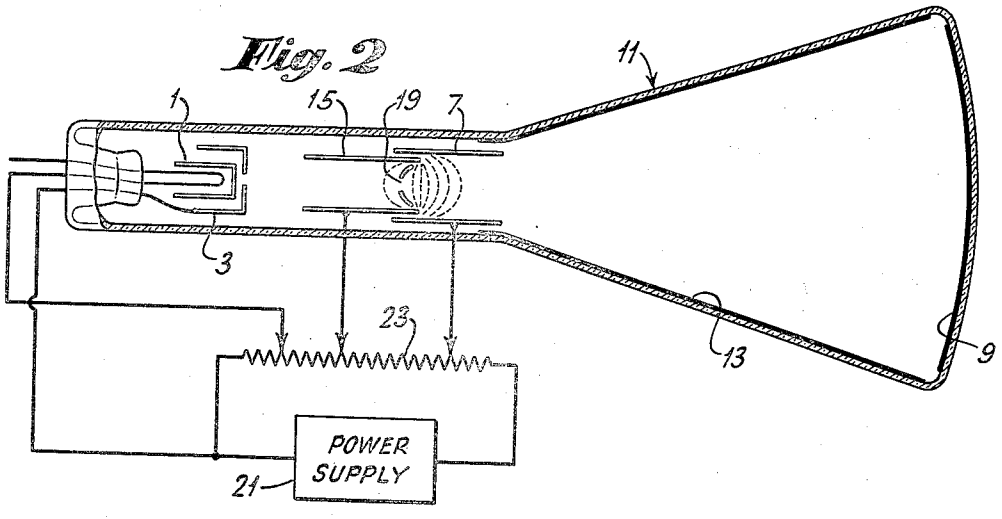
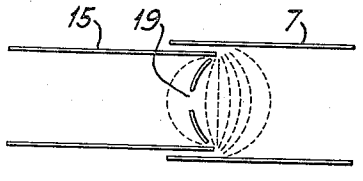


Fig. 3



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UNITED STATES PATENT OFFICE

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ELECTRON DEVICE

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In Germany May 31, 1937

2 Claims. (Cl. 250—162)

This invention relates to electron devices, and more particularly, to method and means of focusing electrons to overcome spherical aberration.

More particularly, the invention concerns itself with providing an electron lens system in which an apertured diaphragm is provided, which diaphragm is so shaped to avoid distorting the electrostatic fields comprising the electron lens.

In the prior art electrostatic electron lenses have made use of cylindrical electrodes in which one or more apertures might be provided. The apertures were provided in planar diaphragms and accordingly, where two such electrodes were placed in proximity to each other and had potentials applied thereto to provide the electrostatic field which serves as the electron lens, considerable distortion of the lines of force of this electrostatic field was produced. Accordingly, such an electrode system introduces distortions in the focusing of electrons which are analogous to spherical and chromatic aberrations, as well as coma in optical systems.

According to my invention, this is overcome by shaping the apertured diaphragms so that no distortion of the electrostatic fields is produced. To this end, the diaphragm is shaped to have the same form as the electrostatic field in which the diaphragm is immersed so that the lines of force of the electrostatic field are co-incident with the diaphragm itself. Under such circumstances no distortion is introduced, and accordingly, electrons may be focused free from the above named aberrations and distortion.

Accordingly, the main object of my invention is to provide an improved electron optical system.

A further object of my invention is to provide an electron optical system in which electrodes have non-planar diaphragms.

A still further object of my invention is to provide electrode structures for electron optical systems in which the diaphragms are shaped to coincide with the electrostatic fields which focus the electrons.

A still further object is to provide electrode structures having diaphragms in which the diaphragm has the same shape as an equi-potential electrostatic surface.

Other objects of my invention will become apparent from reading the description in conjunction with the drawing.

In describing my invention in detail, reference will be made to the drawing, in which Fig. 1 shows an electrode system for purposes of explaining the invention, while

Figs. 2 and 3 show one embodiment of my invention in which a non-planar apertured diaphragm coinciding with an equi-potential electrostatic surface is provided.

In Fig. 1 I have shown a cathode ray tube 11 in which is positioned an electron gun comprising an indirectly heated cathode, a focusing or control electrode 3, a first anode 5, a second anode 7, and a luminescent screen 9. A source of potential 21 supplies potentials to the various electrodes through a voltage divider 23. Due to the difference in potential supplied to the electrodes 5 and 7, electrostatic fields will be set up between these two electrodes which will result in equi-potential surfaces of approximately spherical form as shown by the dotted lines in Fig. 1. If, for example, it was desired to place a diaphragm at the end of the electrode 5 with an aperture therein in order to restrict the ray for producing finer focus, the introduction of a planar diaphragm would change the distribution of the electrostatic lines of force so that there would result instead of spherical equi-potential surfaces equi-potential surfaces having a distorted form different from those of a sphere. Accordingly, the electrons from the cathode 1 would not be focused upon the target electrode 9 properly. However, by making the diaphragm spherical in form such as shown in Fig. 2 where the diaphragm 19 is approximately spherical in shape, no distortion of the equi-potential surfaces takes place, and accordingly, the electrons pass through a plurality of substantially spherical equi-potential surfaces close to an axis of symmetry. Under such conditions, there is, in effect, provided a corrected electron optical lens which is free from spherical and chromatic aberrations, as well as coma.

In Fig. 2, I have shown a further electrode 13 provided in the form of an electrical conducting surface mounted on the wall of the envelope 11. Where it is desired to use a different configuration of the electrodes 15 and 7 such that the equi-potential surfaces would have a different form than those of spheres, then the diaphragm 19 may take on a different form. For example, if the equi-potential surfaces are parabolic in form, then the diaphragm 19 instead of being a spherical surface of revolution would be a parabolic surface. Or if elliptical equi-potential surfaces are provided, then the diaphragm 19 is made elliptical in shape. In other words, the diaphragm takes the shape of the electrostatic field which would be provided in the absence of the diaphragm. Under such conditions, there is no deformation of the potential field and the electrons are actually focused upon the luminescent screen.

Under such conditions where it is desirable that the aperture in 19 constitute the object plane, an image of which is to be focused upon a fluorescent screen or target electrode, then the potentials may be suitably varied such that the aperture shall lie in the object plane and further electrodes may be positioned intermediate the diaphragm 19 and the screen 9 to provide an optical system producing an image of the aperture in 19 on the screen 9.

Having described my invention, what I claim is:

1. An electron lens comprising a first cylindrical electrode, a second cylindrical electrode partially surrounding one end of the first cylindrical electrode, and a spherical apertured diaphragm substantially closing the surrounded end of the first cylindrical electrode said diaphragm extending within the surrounded end of said first cylindrical electrode.

2. In a cathode ray tube, an electron lens comprising a first cylindrical electrode, a second cylindrical electrode surrounding one end of the first cylindrical electrode, both of said electrodes being adapted to set up in the region of the surrounded electrode, an electrostatic field having a predetermined form of equi-potential surfaces, and a non-planar apertured diaphragm substantially closing the surrounded end of said first cylindrical electrode and extending within the first cylindrical electrode having its surface congruent with one of the said predetermined equi-potential surfaces whereby the aberrations of the lens are reduced.

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