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CATHODE RAY TUBE OPTICAL SYSTEM

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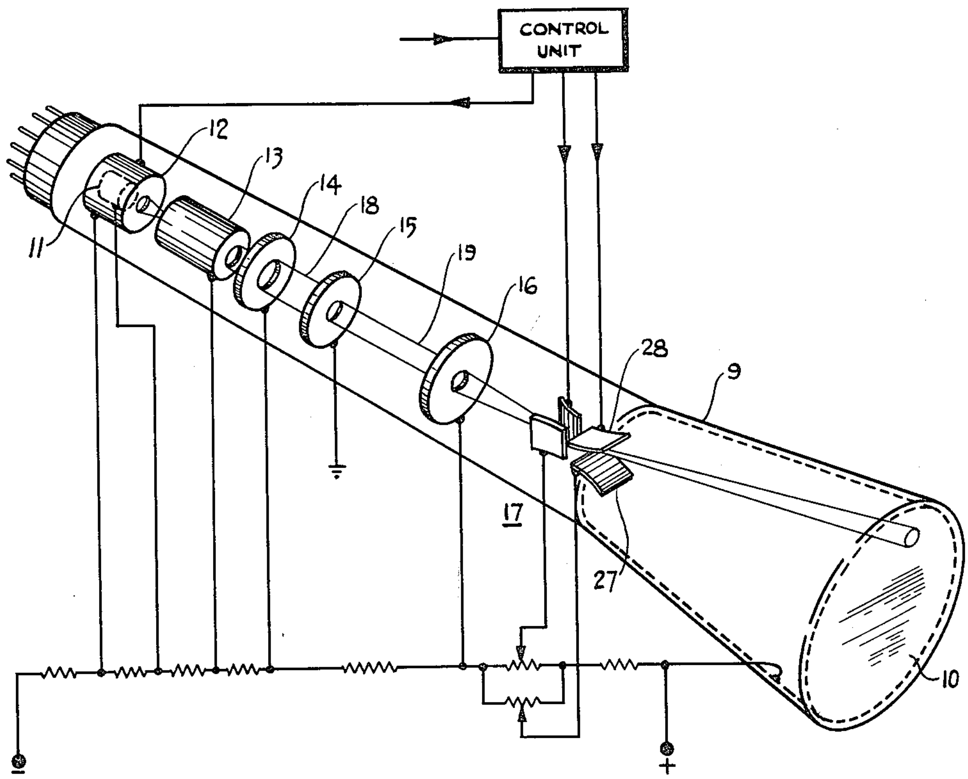
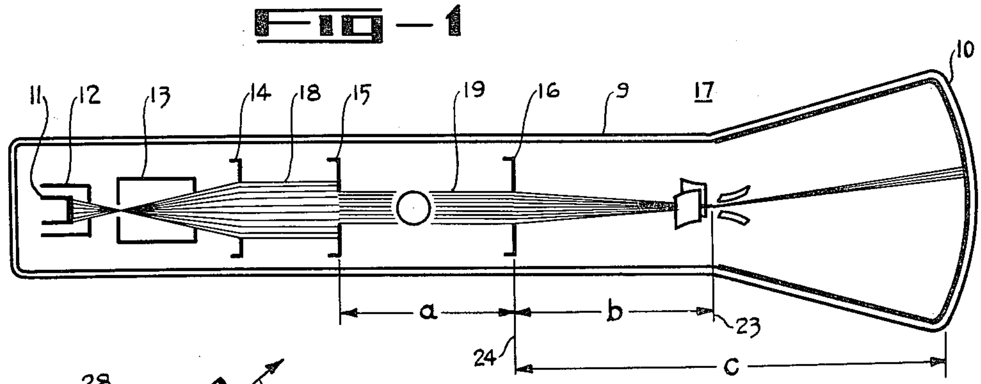
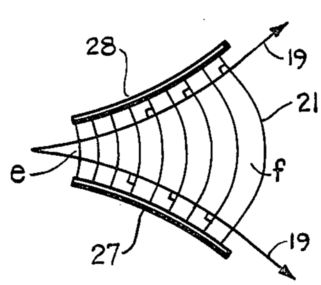


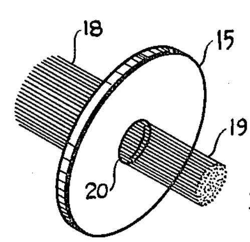

FIG—1



FIG—2



FIG—4



FIG—3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# CATHODE RAY TUBE OPTICAL SYSTEM

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4 Claims. (Cl. 313—85)

The present invention relates to a cathode ray tube optical system and more particularly, to a cathode ray tube optical system which utilizes electron optical components in a cathode ray tube in a manner giving a high resolution and uniform shaped spot over the entire face of a cathode ray tube screen.

In the past to obtain a spot on the screen of a cathode ray tube, the general procedure has been to generate a beam, pass it through a convergence lens to reduce its cross sectional area, and hinge this small cross sectional area on the screen of the tube. Somewhere along the path of the beam, the beam is deflected to a desired position on the screen. This prior art method has the disadvantage of being unable to provide a high resolution spot on the screen. The electron beam after leaving the grid of the tube generally passes through two or more cylindrical anode focusing plates which converges the individual paths of the electrons into a narrow beam. However, even though the electron paths are converged into a narrow beam, the number of electrons comprising the cross sectional area of the beam at any point in its path become fewer as the distance from the center of the beam increases. This follows from the fact that the like charges of the electrons create repelling forces which tend to scatter the electrons in the beam.

When the individual electrons leave the grid of the tube they do so in many devirgent paths due to the mutual repulsion of their like charges. Thus, when they reach the convergence lens, it is obviously quite difficult for the lens to orientate all of the divergent paths of the electrons into the desired convergent path. While the electrons traveling in the center area of the beam can be directed in a composite beam with a good degree of concentration, the electrons which move on the outer edge of the path from their initially leaving the cathode can seldom be concentrated together, because the lens action of the convergent lens only concentrates the beam in a spot at the point of imaging on the screen. Thus, throughout the travel of the outer electrons toward the screen, their path is attempted to be converged into a concentrated whole. While this converging action is occurring, the repulsive force of like charges is causing the beam to diverge. Thus, this clashing of forces occurs throughout the travel of the electron beam to the screen. Accelerating the electrons to a very high speed, may tend to reduce defocusing of the beam by this scattering action. Nevertheless, the mutual repulsion between the electrons determines the sharpness at which a beam may be focused on the screen.

Thus, in any electron beam directed on the screen in the manner generally known in the art, the spot will always have a tendency to become less definite on its outer edges. This fuzziness at the edge of the spot,



due to the fewer number of electrons around the edge of the beam creates a condition that is compounded by the distortion generally incurred in deflection of the beam to a particular spot on the screen. The deflecting of the beam adds distortion to the beam's image on the screen, because of the non-uniformity of electrostatic or electromagnetic deflecting fields and further because the beam, after being partially deflected by the forward part of the deflecting field, then must cross the lines of force of the latter part of the deflecting field at an angle that varies from 90°. Also, in prior art devices, the electron beam is normally deflected at a point when it has considerable cross sectional area inasmuch as the beam only reaches its smallest cross sectional area at its point of contact with the screen of a cathode ray tube. This deflection of the beam at a point when it has considerable cross sectional area emphasizes the distortion effect of the deflection means, makes the circular spot "out of round" as well as causing greater dispersion of the individual electron components of the beam.

The present invention utilizes an electron gun capable of generating a beam having its individual electron paths directed along the longitudinal axis of the tube. A beam shaping aperture in the form of a true circle, cuts out the center section of the beam, thereby pasing only the concentrated center element of electrons onto the screen. As the beam passes through the shaping aperture, the electrons are traveling in parallel paths so that a subsequent electronic lens sees them as coming from infinity and crosses them over at a distance equal to the focal length of the lens. The electronic lens is capable of focusing the received circular electron beam onto the cathode ray tube screen substantially free from distortion, as in a manner well known in the electronic lens art. At the point of cross over of the electron beam traveling to the screen, the beam's cross section is at a minimum. At this point the center of the deflection system is located so that the deflection of the beam is accomplished where the beam's cross sectional area is at a minimum. This permits the beam to be deflected at a point where distortion resulting therefrom will be minimized. Thus, the dual purpose of the lens is to image the beam shaping member on the screen of the tube and to cross over the beam at the center of the deflection system.

Curved deflection plates are used, which creates a field between the plates whose lines of potential are curved. This permits the deflecting beam to penetrate the potential lines between the plates at substantially a right angle, regardless of the degree of deflection incurred when passing between the plates. Further, in the curved plates, the field between the plates is the most intense at its narrowest spacing becoming less intense as the plates diverge. Therefore, the beam passes between the plates with its smallest cross section contacting that portion of the field which is the strongest, and when its cross sectional area has increased, contacts that part where the field is less intense. The beam thus receives its greatest deflection at the point where it has the smallest cross sectional area. Accordingly, the use of the curved plates as disclosed herein, reduces considerably, distortion resulting from deflection of the beam.

An object of the present invention is the provision of a cathode ray tube optical system capable of providing a spot on a cathode ray tube screen having an improved resolution.

Another object of the invention is to provide a spot on the screen of a cathode ray tube having uniformity in size over the entire face of the screen.

Still another object of the invention is to deflect the beam at its point of smallest cross section.

A further object of the invention is to provide for substantially distortion-free deflection of an electron beam.

Other objects and features of the invention will become apparent to those skilled in the art as the disclosure is made in the following detailed description of a preferred embodiment of the invention as illustrated in the accompanying sheet of drawing, in which:

Figure 1 is a perspective representation in accordance with the principles of the invention;

Figure 2 is a sectional view of a cathode ray tube illustrating the arrangement of the electro-optical system;

Figure 3 is a perspective view illustrating the manner in which the circular bundle of shaped electron streams are produced from the electron beam by the beam shaping member;

Figure 4 illustrates schematically, the effect the curved lines of potential between the curved plates has on an electron beam passing therebetween.

Referring to Figures 1 and 2, the cathode ray tube is shown as at **9** and mounted therein is an electron source **11**, a control grid **12**, an accelerating electrode **13** and an anode **14** all of which comprise a beam generating means. In operation, a beam of electrons is admitted from the source **11** and directed through the control grid **12** enroute to the target or screen **10**. Control grid **12** is spaced from source **11** and may be in the form of a cylinder having an aperture therein through which the electron beam may pass, as is well known to those skilled in the art. The anode **14** focuses the beam so that the individual paths of the electrons are parallel with the longitudinal axis of the tube. The parallel electron beam, as focused by lens **14** and as shown as **18**, is intercepted by shaping member **15**. Shaping member **15** has a circular aperture therein. The axis of the aperture being on the longitudinal axis of the tube. Shaping member **15** functions to pass only the center portion of the electron beam. Thus, only a dense circular portion of the center of the electron beam is passed in a parallel path to the electron convergence lens **16**.

Figure 3 illustrates pictorially how the shaping plate **15** cuts out the center portion of the electron beam **18**. Plate **15** is capable of stopping all portions of the beam other than that striking its aperture **20**, passing therethrough only the shaped beam **19**.

At this point, the electrons are traveling in substantially parallel paths, so the lens **16** sees the spot image received as coming from infinity. Electronic lens **16**, which may be a convergence lens, crosses over the electron beam at a distance equal to the focal length of the lens. This cross over point **23** (see Figure 2) is the point at which the cross sectional area of the beam is at a minimum. Point **23** is also the established center point of the deflection system **17**. Thus, deflection system **17** deflects the beam to the screen at its point of smallest cross section in response to predetermined signals from the control unit.

With reference to Figure 4, the curved plates **27** and **28** are illustrated in schematic form. Potential distribution lines **21** passing between the plates represent the electrostatic field. As shown, the field is more intense at point *e*, the narrowest space between the curved plates, and becomes less dense at the widest point of divergence *f*. Lines **19** represent the path of the electron beam through the curved plates and its angle of deflection. It is readily apparent from an inspection of Figure 4 that as electron beam passes between the plates, regardless of its deflection, it will always contact the lines of potential between the plates at substantially a right angle. Further, at its point of smallest cross sectional area, it receives its greatest degree of deflection inasmuch as the intensity of the field is greater at its point of entry *e* to the plates. This arrangement considerably reduces the distortion occurring in beam **19** as it passes through the deflection means.



With reference again to Figure 2, the distance *a* represents the object distance, with distance *b* representing the focal length and distance *c* representing the image distance. The ratio of *a* to *c* determines the magnification capable of being exhibited by lens **16** whereas distance *b* is the focal length of the lens, permitting focusing of the image by lens **16** onto screen **10**.

In summary, the beam generating means generates and projects an electron beam **18** having individual paths parallel to the longitudinal axis of the tube. Electron beam **18** is intercepted by shaping member **15** in its movement towards the cathode ray tube screen. Shaping member **15** cuts out the intensified center portion of beam **18**, passing on a shaped circular beam **19**. The paths of the individual electrons in shaped beam **19** are still parallel with the longitudinal axis of the tube. Accordingly, electronic lens **16** sees shaped beam **19** as coming from infinity and crosses over the beam, focusing the shaped spot onto the screen. The deflection system is so positioned that it deflects the beam to the desired spot on the screen at the point of cross over of the beam and thus, at its point of smallest cross section. The curved deflection plates create a deflection field capable of reducing the distortion normally incurred in deflecting a beam and thus, permits the spot to be focused on the screen with reduced distortion.

It is to be understood that while the specific embodiment focuses the image of the spot on the screen, it is also possible to have the screen intercept the electron beam at a point varying from, but near the imaging point. While the latter arrangement does not give as clear a spot on the screen as is obtained by focusing, the latter arrangement is still considered to be a part of this invention.

We claim:

1. In a cathode ray tube having a collimated stream of electrons, the combination comprising: a mask having an aperture positioned in the path of said stream—whereby a portion of said collimated electron stream traverses said aperture; an electron lens positioned to be traversed by the portion of said stream that traverses said aperture; means, comprising said lens, for causing the stream of electrons emerging from said aperture to converge in the focal plane of said lens; and a deflection system positioned in said focal plane.

2. A cathode ray tube comprising: means for producing a collimated stream of electrons; an electron optical system; a mask, having an electron stream shaping aperture, positioned in the path of said stream between said collimating means and said electron optical system; means, comprising said electron optical system, for causing the stream of electrons emerging from said aperture to cross over at the focal point of said optical system; a deflection system positioned to straddle said crossover point; and a viewing screen positioned to display the image of said aperture.

3. A cathode ray tube comprising: means for producing an electron beam and directing it along the axis of said tube; means for collimating said electron beam; an electron lens; a mask, having a limiting aperture, positioned in the path of said stream between said collimating means and said lens; means for causing said aperture to become the object of said electron lens; means for causing the electrons emerging from said aperture to traverse said lens—whereby said emergent stream is converged and caused to cross over at the focal point of said lens; a deflection system positioned at said crossover point—whereby said deflection system operates of the smallest cross section of said electron stream; and a viewing screen positioned in the image plane of said lens—whereby the image of said aperture appears on said viewing screen.

4. The combination of claim 3 wherein said deflection system comprises deflection plates.

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# CERTIFICATE OF CORRECTION

Patent No. 2,986,668

May 30, 1961

Dan J. Haflinger et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 24, for "hinge" read -- image --.

Signed and sealed this 26th day of December 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents

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