June 6, 1939. C. S. SPRAGUE ET AL 2,161,437

CATHODE RAY DEFLECTING ELECTRODE

Filed Sept. 30, 1935

Fig. 1

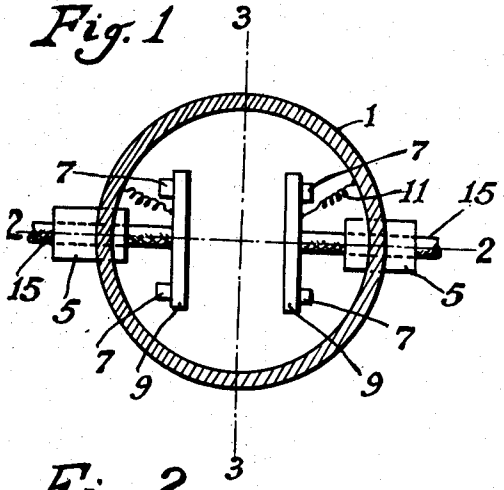


Fig. 4

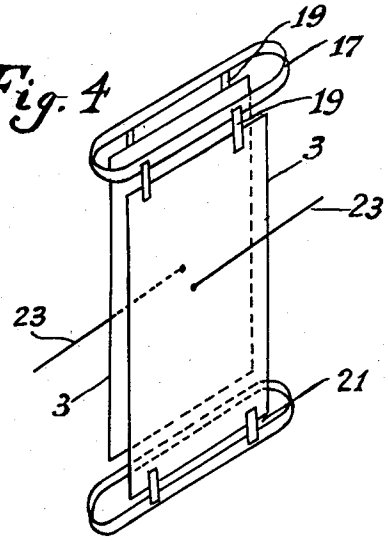


Fig. 2

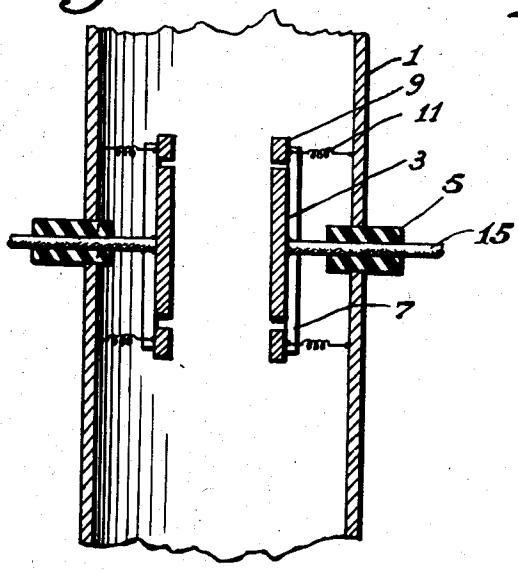
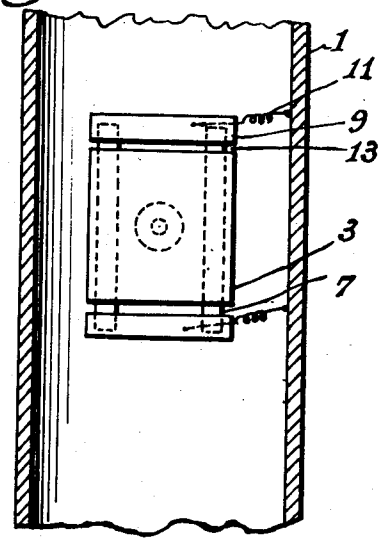


Fig. 3



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CATHODE RAY DEFLECTING ELECTRODE

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5 Claims. (Cl. 250—159)

This invention relates to electrode structures and, in particular, to electrostatic deflecting electrodes such, for example, as may be used in cathode ray apparatus for deflecting a beam of electrons.

The invention is concerned with overcoming some of the difficulties hitherto experienced with electron beam deflection system, such as "keystoning" and spurious velocity modulation. If in one type of a cathode ray tube, for example, a beam of electrons is developed and directed to impinge upon a fluorescent endwall and to traverse two mutually perpendicular electrostatic fields which are also perpendicular to the beam, then with suitable variation of the electrostatic field, such as a sinusoidal variation, a rectangular area of illumination should appear upon the tube endwall. However, it will be found that instead of a rectangular pattern, the actual produced pattern will closely approximate a trapezoid, due to, in part, the stray flux of the deflecting plate system producing distortion. The close resemblance of the produced trapezoidal area to the section of a keystone is responsible for this type of distortion being called "keystone effect" or more simply "keystoning".

In the usual construction of deflecting plate structures it is impossible to produce electrostatic fields without stray flux, and consequently, the field between deflecting plates is not uniform over the entire area of the plates. At the edges of the plates, particularly, the electrostatic lines of force exhibit large and varying curvature resulting in a non-uniform field. In the central portion of the deflecting plates, however, the lines of force are essentially parallel to each other and perpendicular to both of the parallel plates, so that a substantially uniform field results. Consequently when a beam of electrons traverses the space between the deflecting plates, deflecting voltages applied to the plates do not exercise uniform control over the entire path of beam in this space; the control being indefinite at the edges and substantially uniform in the central portions. The indefinite control at the edges of the deflecting plates results from the field having components (*a*) parallel to the direction of the beam, and (*b*) perpendicular to the beam and parallel to the deflecting plate surfaces.

As will be appreciated, the use of two pairs of mutually perpendicular plates for deflecting the beam of electrons requires that each pair of plates shall act upon the beam in only one direction, and the motion under these conditions will be perpendicular to the plates viewed from above. This is well known in the art, and for further reference the Nicolson Patent No. 1,479,696 may be consulted as well as the Johnson Patent No. 1,565,855. Obviously the production of an electrostatic field parallel to the plates will produce motion parallel to the plates and consequently introduce distortion since the motion parallel to one pair of plates should result only from the flux produced by the other set of plates. It will therefore be seen that it is extremely advantageous to eliminate the spurious motion of the electron beam produced by the non-uniform field at the edges of the plate.

The distorted electro-static field acting along the path of beam of electrons produces a still further distortion, inasmuch as the component of the field acting along the path of the electron beam tends to accelerate or decelerate the beam depending upon the sign of the field. Since the magnitude of this acceleration or deceleration is a function of the voltage applied to the plates, it will be readily appreciated that the beam velocity will be modulated in accordance with the applied voltages.

This is undesirable, since modulating the beam velocity results in the intensity of illumination of the fluorescent end-wall being non-uniform. At the same time, the variation beam velocity produces the undesirable feature of variable beam deflection sensitivity, since, as is well known, increasing the beam velocity reduces the produced deflection of the beam when the deflecting field is held constant. The deflection increases as the beam velocity is reduced under this same condition of constant field. Obviously the elimination of non-uniform electro-static field intensity at the edges of the deflection plates will enhance, in a large degree, the operation of cathode ray tubes, for example.

Further, than this, the increasing use of cathode ray tubes for oscilloscopic purposes in industry as a measuring instrument requires that the deflection of the cathode ray be substantially proportional to the applied deflecting voltages over the entire viewing or recording area. It will be appreciated that the elimination of the uncontrolled stray electrostatic field from the edges of the deflecting electrodes will permit cathode ray tubes to function so as to fulfill this desired condition.

Our invention, which is directed toward the elimination of these uncontrolled stray electrostatic fields and consequently to the elimination of distortion in reproducing patterns comprises the application of shield electrodes adjacent to

the edges of the deflecting electrodes and connecting these shield electrodes to a common point which may be one of the deflecting electrodes ground, or the wall of the tube, if it be metal or conducting so as to establish a common potential for these electrodes.

The application of the shield electrodes produces a flux across the gap between the deflecting electrodes and the shield electrode, and therefore provides a definite electrostatic field configuration so that the lines of force are substantially predetermined in space. These shield electrodes control the stray flux and produce thereby substantially uniform electrostatic fields through which the beam of electrons passes. Consequently keystoning and velocity modulation are substantially eliminated.

By the use of the shield electrodes, the component of the electrostatic field parallel to the cathode beam is restricted to the gap between the shield and deflecting electrodes and thus is ineffective as regards the influencing of the velocity of the beam of electrons. The fringing of the electrostatic field in the gap between the shield and the deflecting electrodes is substantially without influence on the beam of electrons since the leakage flux is small and confined to a very small volume immediately adjacent to the gap, as will be readily appreciated from the configuration of the electrodes.

For a more complete description and understanding of this invention refer now to the drawing of which

Figure 1 shows one embodiment of the invention.

Figure 2 shows a view which is a section through 2—2.

Figure 3 is a section through 3—3, and

Figure 4 shows a modification of the invention.

Referring now to Figure 1, the tube wall 1 is shown supporting a pair of deflecting electrodes 3 through the medium of the insulating supports 5. Mounted on the deflecting electrodes 3 are insulating support members 7, which support directly above and below and in the same plane as the electrodes 3, strips of metal 9. These strips of metal are connected by light flexible leads 11 to the wall 1, which in Figure 1 is assumed to be made of metal. A small gap 13 is left between the shield electrodes 9 and the electrodes 3. The disposition of the component parts of this structure is shown in more detail in the section drawings of Figure 2 and Figure 3 where like parts carry the same reference numeral.

It is to be understood that while the drawing shows only one pair of deflecting electrodes an identical pair of deflecting electrodes and shield electrodes may be mounted above or below and in perpendicular relation to the pair of electrodes 3 shown. Deflecting voltages may be applied to the plates through the conductors 15.

When it is desired to use a glass tube in the construction of the cathode ray apparatus, the modification shown in Figure 4 may be used advantageously.

A metal strip is bent into an oval shape and spot welded to form a flattened hoop 17 as shown in Figure 4. The strip may be of any metal but it is desirable that a hard non-porous non-magnetic metal such as tantalum be used, in order to facilitate degassing of the metallic parts in the latter stages of processing the tube. In order to avoid spurious magnetic deflecting fields, non-magnetic metal should be used for the shield and deflecting electrodes. The thickness of the strip may be of the order of .006 inch although the thickness is not critical. However, from the standpoint of ease of working and economical construction, this value has been found to be satisfactory.

It has been found that the width of the electrode 17 determines the effectiveness of shielding and that the optimum width depends on the spacing of the deflecting electrodes. Good shielding is obtained provided the ratio of the spacing of the deflecting electrodes 3 to the width of the shield electrodes 17 does not exceed 3. These hoop-like shield electrodes 17 are spot welded to short supporting members 19, which for convenience may be No. 20 B. & S. gage tantalum wire, which are also spot welded to one of the two deflecting electrodes 3, which is the one usually grounded. The shield electrodes 17 are so positioned that a small gap generally smaller than the width of electrode 17 exists between it and the edge of the deflecting electrodes 3 adjacent to the shield 17. The use of this construction enables the stray electrostatic field to be controlled and directed to the shield electrodes 17. By making the length of the electrode 17 slightly larger than the width of the electrodes 3, stray flux from the edges of the electrodes 3 will converge on the electrodes 17 rather than impinge on exterior or other adjacent conductors. Obviously the length of the electrode 17 should not be less than the width of the electrode 3 in order to prevent distorting the electrostatic deflecting field produced within the space separating the two electrodes 3. It has been found that a satisfactory length of the shield electrode 17 is obtained when its length is equal to the sum of the width of the electrodes 3 and twice the distance between them.

An electrostatic field is set up in the gaps 21 which is in the direction of the path of the cathode ray beam. But as explained above in discussing Figures 1, 2, and 3 this field is substantially ineffective with regard to varying the velocity of the beam of electrons.

At the same time the elimination of the uncontrolled components of the stray electrostatic fields accomplished through the use of the shield electrodes 17 eliminates keystoning, as explained above.

It will be appreciated that while shield electrodes might be applied to the vertical edges of the deflecting electrodes 3, in practice this is not generally necessary inasmuch as the beam is not deflected sufficiently toward these edges to be under the influence of the distorted electrostatic field along these edges.

Other forms of guard rings or shields may be used without departure from the spirit or scope of this invention and we believe that we are entitled to all such modifications as fall fairly within the spirit and scope of the appended claims.

Having now described our invention, what we claim is:

1. An electrode assembly for deflecting electron beams within a cathode ray tube comprising a pair of elongated spaced and parallelly disposed deflecting electrodes; a ring-like electrode positioned at at least one end of said deflecting electrodes, said ring-like electrode lying in a plane parallel to the direction of movement of the beam between the deflecting plates, said ring-like electrode being located in the area between said deflecting electrodes; and means for establishing electrical contact between said ring-like electrode and one only of the deflecting electrodes.

2. In a cathode ray tube deflecting electrode

assembly, a pair of parallel spaced deflecting electrodes, a shielding electrode bounding the end plane of each of said deflecting electrodes, supporting means for the deflecting electrodes, means for supporting the shielding electrodes in predetermined spaced relation relative to the deflecting electrodes, and connecting means to establish electrical contact between one of the deflecting electrodes and the adjacent shielding electrode.

3. In a cathode ray tube, in combination, a pair of electrostatic deflecting electrodes, shielding electrodes supported thereon each end thereof and insulated therefrom, said shielding electrodes each having a surface thereof co-planar with the edge of the adjacent deflecting electrode and connecting means for establishing electrical contact between said shielding electrodes and one of said deflecting electrodes.

4. In an electron tube wherein there is developed a controlled electron stream, a pair of opposed electrodes positioned adjacent to the normal path of the developed electron stream for deflecting the electron stream when suitable energizing potentials are applied thereto, at least one shielding electrode positioned to bound at least one end of the pair of opposed electrodes, said shielding electrode being spaced apart from said deflecting electrodes and positioned also to surround the normal path of the electron stream and to have a surface thereof co-planar with each deflecting electrode, and an electrical connection between said shield electrode and at least one of the opposed electrode members.

5. In a cathode ray electron beam deflecting system a pair of parallel spaced deflecting electrodes, a shielding electrode comprising a tantalum member surrounding a plane equal in length to the width of each electrode and equal in width to the spacing between said electrodes, supporting means for the deflecting electrodes, means for supporting the shielding electrodes in predetermined spaced relation relative to the deflecting electrodes and co-planar therewith said spacing being smaller than the width of said shielding electrode, and connecting means for establishing electrical contact between one of the deflecting electrodes and the shielding electrodes.

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