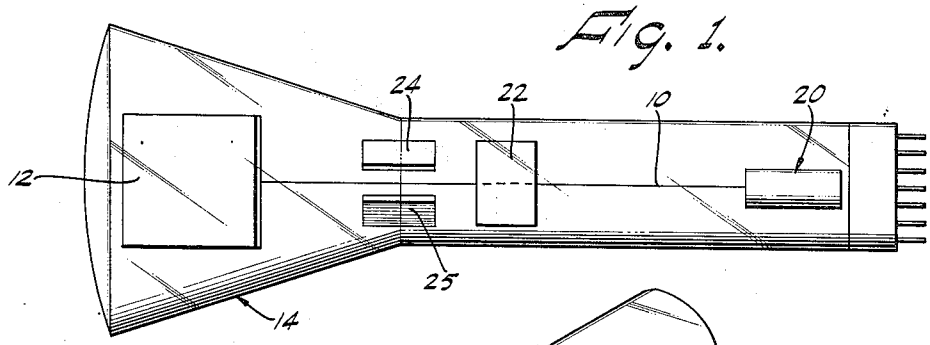
Aug. 7, 1956 W. E. EVANS, JR 2,758,235

MEANS AND TECHNIQUES FOR PREVENTING KEYSTONE EFFECTS

Filed June 22, 1953

Fig. 1.



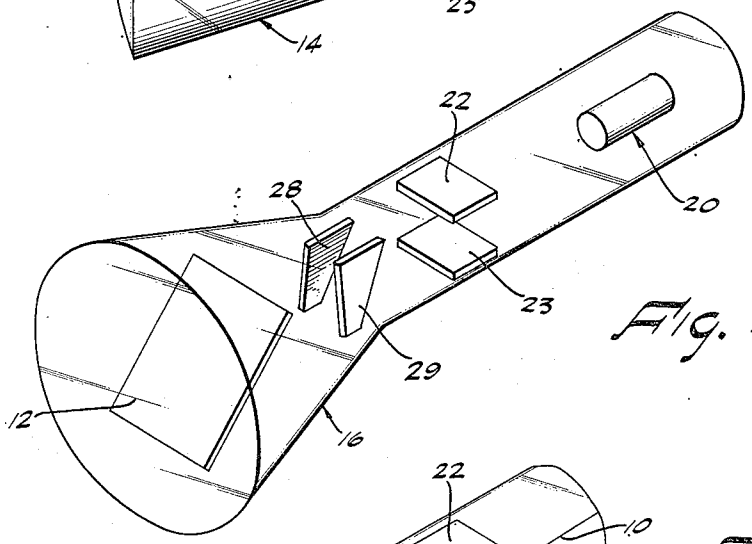


Fig. 4.

Fig. 2.

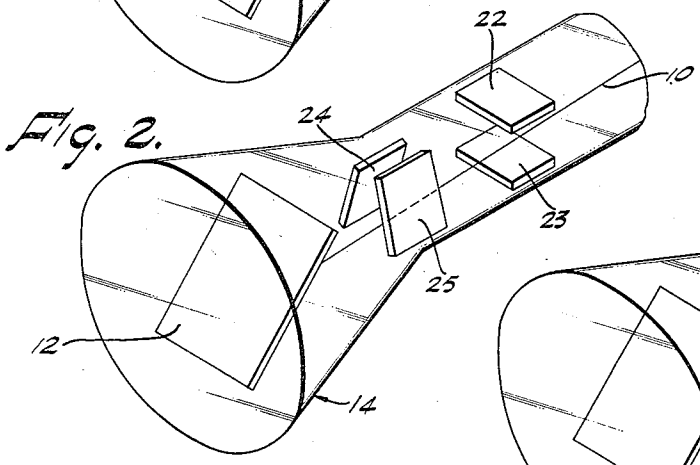
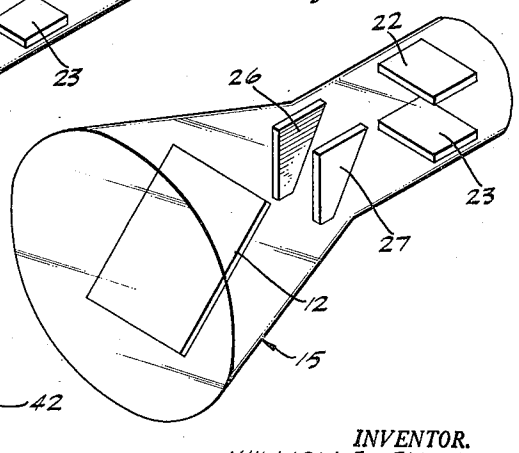


Fig. 3.



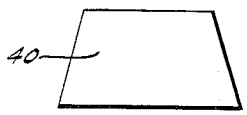


Fig. 5.

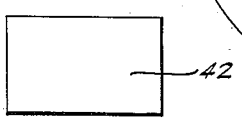


Fig. 6.

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MEANS AND TECHNIQUES FOR PREVENTING KEYSTONE EFFECTS

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12 Claims. (Cl. 313—78)

The present invention relates to improved means and techniques for preventing so-called keystone effects when a beam of charged particles, as in a cathode ray tube, iconoscope and the like is directed onto a target for scanning a selected portion thereof, with such target having its plane inclined a substantial amount with respect to the beam.

In scanning a target which is inclined a substantial amount with respect to the axis of the scanning beam, a trapezoidal or keystone shape pattern is scanned, instead of a desired rectangular or square pattern, unless precautions are taken. Such scanning may be accomplished where the target is a photo-sensitive plate such as a mosaic in an image recreating type of tube such as an iconoscope or where such target is a light emissive plate which emits light in response to electrons impinging thereon.

The keystone or trapezoidal pattern is obtained in devices of this character when the target is inclined a substantial amount with respect to the axis of scanning beam since the beam is deflected or "flared out" different amounts depending upon the particular point where the beam is intercepted by the target. When inclined, the target has what may be considered to be a portion relatively close to the beam source as well as a portion relatively far from the beam source. The beam when intercepted by such relatively close portion is deflected a smaller amount than when the same beam is later intercepted by the relatively far portion thereby to obtain a trapezoidal or keystone shaped pattern, field or raster instead of a desired square or rectangular pattern, as the case may be.

Heretofore, different proposals have been made to avoid the production of a keystone pattern involving special electrical circuitry connected to different elements of the tube in which keystoning occurs. The present invention, on the other hand, involves constructional features of the tube itself to accomplish the intended result, namely, structural features of the beam deflecting means.

It is therefore a general object of the present invention to achieve the desired results indicated above using the novel means and techniques described herein.

Another object of the present invention is to provide an improved tube construction having keystone correction means incorporated therein.

Another object of the present invention is to provide keystone correction without special external circuitry, other than that required to sweep or scan a rectangular raster.

Another object of the present invention is to provide improved means and techniques useful in producing scanning rasters for cathode ray tubes which have their electron gun structures directed at some angle to the target plate, i. e., fluorescent screen, or mosaic, other than normal to it.

Another object of the present invention is to achieve these indicated results by shaping the deflecting plates for the beam in a characteristic manner.

Another object of the present invention is to achieve these indicated results by the use of nonparallel beam deflecting plates.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. This invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 shows a view in elevation of a cathode ray tube embodying features of the present invention, a portion of such tube being shown also in the perspective view which constitutes Figure 2.

Figure 3 shows a perspective view of a portion of another tube showing a modified structure also embodying features of the present invention.

Figure 4 shows a perspective view of a portion of still another tube showing a modified structure also embodying features of the present invention.

Figures 5 and 6 show respectively a trapezoidal or keystone raster 40 which is customarily obtained, and a rectangular raster 42 which is obtained in accordance with features of the present invention.

The drawings show, for purposes of simplification, the invention applied to a cathode ray type of tube having its target in the form of a light emissive plate but it is understood, of course, that other tubes such as iconoscopes, i. e., image recreating tubes, also involve electron beam developing and deflecting means and the present invention is equally applicable to those types of tubes.

Each of the tubes disclosed in Figures 1–4 is considered to incorporate the following conventional elements, namely, a heated cathode for producing a source of electrons, means for accelerating said electrons to provide a beam of charged particles, i. e., electrons, and means for focusing said beam onto the target of the corresponding tube.

In accordance with important features of the present invention, novel cathode beam deflecting means are provided in a novel relationship with respect to the inclined target plate upon which the electron beam impinges.

The cathode beam in all of the figures is represented by the line **10** and the target plate is represented by the reference numeral **12** which are incorporated in the tube **14** illustrated in Figures 1 and 2 and in the tubes **15** and **16** illustrated respectively in Figures 3 and 4. The electron gun structure is represented by the reference numeral **20** and this incorporates conventional structure for producing the directed cathode beam **10**.

Each of the cathode ray tubes incorporates beam deflecting means, i. e., two pairs of electro-static plates between which the cathode beam passes for deflection thereby in accordance with voltages applied to such plates. A first pair of such plates includes conventional parallel spaced vertical deflection plates **22** and **23**, while the second pair of such plates (plates **24**, **25** in Figures 1 and 2; plates **26**, **27** in Figure 3; plates **28**, **29** in Figure 4) are arranged in a special manner with respect to the target plate **12**.

In Figures 1 and 2, the horizontal deflection plates **24** and **25** are flat plates which have their planes inclined, one with respect to the other i. e., the planes of plates **24**, **25** are divergent with the planes of each plate **24**, **25** making an acute angle with respect to the

planes of the parallel plates **22, 23**. It is observed that plates **24, 25** diverge in the downward direction in Figure 2; and that the target plate **12** is inclined with reference to the cathode beam **10** to extend backwardly and downwardly. The target plate **12** thus has its upper portion in Figure 2 in a relatively close position to the electron gun structure **20** while the lower portion of the plate **12** is relatively far from the gun structure. It is observed that the voltage applied between the vertical deflection plates **22, 23** establishes whether the cathode beam is directed onto either the upper or lower portion of the target **12** and, indeed, all positions intermediate thereof in all arrangements herein. Further, in all of the arrangements herein the horizontal deflection plates (assuming a voltage of constant intensity on such horizontal plates) produce a decreased effect on the beam when directed by the vertical plates to such lower or relatively far portion of the target than is the case when the beam is directed to the upper portion or relatively close portion of the target. This is so in Figures 1 and 2 since the electro-static field intensity between the plates **24, 25** is not uniform but is gradated in accordance with the divergence of the plates **24, 25**, the field intensity being relatively small where the separation is greatest and being relatively large where the separation is smallest. The cathode beam, of course, is deflected in an amount depending upon the intensity of the field through which the beam is directed by the vertical plates **22, 23**.

In other words, in the arrangement in Figures 1 and 2, the change in spacing of the horizontal plates produces a corresponding change in the deflection sensitivity of that set of plates depending upon the vertical position of the entering electron beam.

Theoretically, the curve of deflection sensitivity versus lateral displacement is not precisely linear but follows the following equation:

$$\frac{d}{D}=\frac{\frac{e}{s}+1}{2\frac{W}{W}\left(\frac{e}{s}-1\right)+2}$$

where

d=deflection sensitivity at point under consideration
D=deflection sensitivity at center of plates
e=spacing between plates at the wide end
s=spacing between plates at the narrow end
W=total width of deflection plates
w=distance from narrow end of plates to the plane of entry of the electron beam.

In the arrangement illustrated in Figure 3, the horizontal deflection plates **26, 27** both extend vertically, i. e., the planes of plates **26, 27** extend perpendicular to the planes of plates **22, 23**. The plates **26, 27**, however, are wedge-shaped or tapered with the smaller end of the plates **26, 27** extending downwardly.

Since the plates **26, 27** are tapered, the electrons which constitute the beam **10** are acted upon for a greater length of time when such beam is directed to the upper portion of the target **12** than is the case when such beam is directed to the lower portion of the target. Since the beam in the first instance is acted upon for a greater period or duration, the deflection imparted to the beam is greater than in the second instance where the beam passes between a smaller portion of the tapered plates **26, 27**.

Thus, while the arrangement illustrated in Figures 1 and 2 operates in accordance with a gradated field intensity between the plates **24, 25**, the arrangement shown in Figure 3, in comparison operates in accordance with transit time of the electrons which comprise the beam **10**. The arrangement illustrated in Figure 4 operates in accordance with both a gradated field intensity and transit time since, in such figure, the horizontal plates **28, 29** are inclined as in Figures 1 and 2 but to a lesser degree

and such plates are tapered in accordance with the teachings described above in connection with Figure 3.

In each arrangement there is a desired substantial linear distribution of deflection sensitivity so that, instead of obtaining a scanned pattern or raster **40** having a trapezoidal or keystone shape as illustrated in Figure 5, the scanned pattern or raster **42** is rectangular as illustrated in Figure 6.

It is noted that the equation set forth above neglects edge effects, and that while even the ideal curve which represents such equation is not precisely linear for planar deflection plates, the approximation appears sufficient; and, a more linear curve is obtainable when the deflection plates are curved slightly instead of being planar or when transit time correction is incorporated by using nonrectangular plates.

While the particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. In the art of preventing keystoning of a pattern scanned by a beam of charged particles, which beam is deflected by a pair of parallel plates between which said beam passes, the improvement which resides in providing a pair of diverging plates to produce less deflection force on said beam, which deflection force decreases in the direction of diversion of said plates.

2. In the art of preventing keystoning of a pattern scanned by a beam of charged particles which beam is deflected by a pair of parallel plates between which said beam passes, the improvement which resides in providing a pair of wedge-shaped beam deflecting plates between which said beam passes.

3. A tube of the character described comprising a source of charged particles, a target, means for forming a beam of said charged particles and for directing said beam on said target, said target having a portion relatively close to said source, and having a portion relatively far from said source, beam deflecting news comprising a pair of plates arranged to produce less deflecting force on said beam when said beam is directed on said far portion than when said beam is directed on said relatively close portion said beam deflecting means comprising a second pair of plates spaced from the aforementioned pair of plates and comprising substantially rectangular plates with their planes extending generally parallel.

4. A tube as set forth in claim 3 in which said pair of plates are non-parallel plates.

5. A tube as set forth in claim 3 in which said pair of plates are a pair of parallel wedge-shaped plates.

6. A tube as set forth in claim 3 in which said pair of plates are wedge-shaped.

7. A tube as set forth in claim 3 in which said pair of plates are non-parallel wedge-shaped plates.

8. Apparatus of the character described comprising means including a tube for producing a beam of charged particles and for projecting the same on a target, said target having its plane inclined with respect to the axis of the beam and having a relatively close portion and having a relatively far portion, beam deflecting means associated with the beam comprising a pair of spaced plates arranged to produce less deflecting force on said beam when it is projected on said far portion than when said beam is projected on said close portion said beam deflecting means comprising a second pair of plates spaced from the aforementioned pair of plates and comprising substantially rectangular plates with their planes extending generally parallel.

9. The arrangement as set forth in claim 8 in which

said pair of plates are non-parallel plates which diverge generally in the direction of said far portion.

10. An arrangement as set forth in claim 8 in which said pair of plates are a pair of parallel wedge-shaped plates.

11. An arrangement as set forth in claim 8 in which said pair of plates are wedge-shaped.

12. An arrangement as set forth in claim 8 in which said pair of plates are non-parallel wedge-shaped plates.

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