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DEFLECTION SYSTEM FOR CATHODE-RAY TYPE STORAGE TUBES

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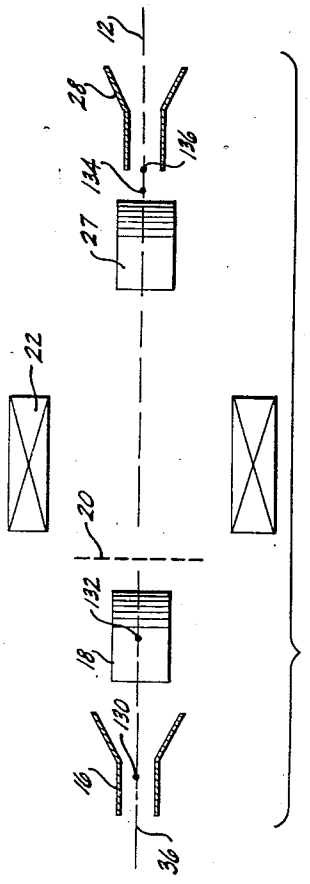

FIG. 2.

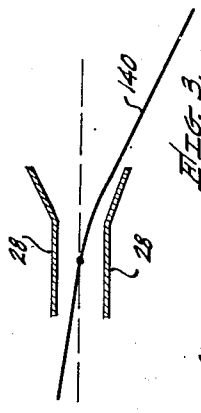

FIG. 3.

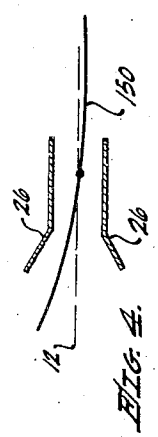

FIG. 4.

FIG. 1.

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DEFLECTION SYSTEM FOR CATHODE-RAY TYPE STORAGE TUBES

Nobuo John Koda, Culver City, and Henry Millard Smith, Pacific Palisades, Calif., and Charles L. Corderman, Winchester, and Franklin A. Rodgers, Concord, Mass.; said Koda and said Smith assignors to Hughes Aircraft Company, a corporation of Delaware; said Corderman and said Rodgers assignors to Massachusetts Institute of Technology, Cambridge, Mass., a corporation of Massachusetts

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6 Claims. (Cl. 315—27)

This invention relates to electron discharge devices and more particularly to an improved deflection system for a character writing cathode-ray type storage tube.

A character writing storage tube which has recently been developed is described in a copending application, Serial No. 387,984, now Patent No. 2,727,872, filed by Henry M. Smith on October 23, 1953, entitled "Direct Viewing Storage Tube With Character Writing Electron Gun." The storage tube of this application essentially comprises a writing beam electron gun, two pairs of character-selection plates, a thin metallic apertured character matrix, an electron lens for focusing the character matrix on a storage target assembly, two pairs of writing beam deflection plates for directing the focused electron writing beam towards selected elemental areas of the storage target assembly, and a luminescent viewing screen. An electron flood gun is also positioned adjacent the writing beam deflection plates of the storage tube to reproduce information stored by the target electrode on the viewing screen. The writing beam produced by the writing beam gun is directed through the selection plates which direct the writing beam through one of the apertures in the character matrix which has the outline of a selected character. The beam is thus shaped to have a cross-section corresponding to a desired character. The electron lens is employed to focus the beam on a predetermined elemental area of the storage target assembly irrespective of the aperture in the character matrix which it has traversed, and the deflection plates are employed to deflect the writing beam from this predetermined elemental area to selected elemental areas on the storage target in accordance with the information to be reproduced.

In the event the electron lens used is a magnetic lens, the electron beam will be converged toward the axis of the tube and at the same time be rotated. In this respect, the device of the present invention is primarily concerned with a deflection system employing a magnetic lens or "converging" coil. Accordingly a selection voltage is applied to the selection plates to direct the beam through the character matrix at small angles with respect to the longitudinal axis of the tube and the converging coil converges the writing beam back toward the axis of the tube. However, at the deflection plates, the stream is inherently projected through the plates so as to have a trajectory which is generally at one of the above mentioned small angles with respect to the axis of the tube. It will then be impossible to center each character within a single predetermined elemental area on the storage target without correcting for the transverse motion imparted to the stream by the electrostatic field produced between the selection plates, i. e., misreregistration of the beam at the target will result.

It is, therefore, an object of the invention to provide an improved deflection system for a character writing cathode-ray type storage tube.

Another object of the invention is to provide means whereby character misreregistration produced by the selection of a writing character in deflecting a writing beam of electrons in a character writing storage tube is minimized.

In accordance with the invention, a separate or additional set of metallic correction or compensation plates is disposed about the longitudinal axis of a character writing storage tube between the electron lens or converging coil and the deflection plates. A voltage proportional to the voltage between the selection plates is then applied to the compensation plates to direct the writing beam, having a cross section determined by any perforation or aperture in the character matrix, along the longitudinal axis of the tube through the deflection plates.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings in which an embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention.

Fig. 1 is an isometric view of the deflection system of the present invention;

Fig. 2 is a symmetric sectional view of a portion of the deflection system shown in Fig. 1;

Fig. 3 is a symmetric sectional view of a pair of metallic deflection plates shown with a typical uncorrected writing beam trajectory; and

Fig. 4 is a symmetric sectional view of a pair of metallic compensation plates shown with a typical corrected writing beam trajectory.

Referring to Fig. 1, a writing beam deflection system **10** is shown for recording any character such as, for example, a number or a letter. The deflection system **10** is employed in the evacuated envelope **11** of a storage tube, the axis of which is indicated by **12**. At the left extremity of the envelope **11**, as viewed in Fig. 1, a writing beam electron gun **14** is shown.

In the direction of electron flow from the gun **14**, there is shown a first pair of character-selection plates **16**, a second pair of metallic character-selection plates **18**, a character matrix **20**, a converging coil **22**, a first pair of compensation plates **24**, a second pair of compensation plates **26**, and two pairs of metallic deflection plates **27**, **28**. A flood gun **30** is positioned adjacent one of the deflection plates **28** to reproduce information stored on a storage target **32**, which is positioned transversely to the axis **12** directly to the right of the flood gun **30** as shown in the drawing. Also, a luminescent viewing screen **34** is disposed adjacent to and to the right of the storage target **32** as shown in the drawing.

The character matrix **20** is constituted of a thin metallic plate having apertures therein in the form of characters such as letters or numbers which may be portrayed on the viewing screen **34**. Writing gun **14** is employed to produce a writing beam, which is directed from the writing gun **14** to the storage target **32** along path **36** through the character matrix **20**. Flood electrons are directed from the flood gun **30** to the viewing screen **34** along paths indicated by **38**. On the storage target **32**, the reference numeral **40** indicates the position of a letter "E" being "written" or recorded on the storage target **32**; and numeral **42** indicates the letter "E" being reproduced by operation of the flood gun **30** on the viewing screen **34**.

Two deflection circuits **44** and **45**, which are used to select a character in the matrix **20** and to aid in redirect-

ing the stream along the axis 12, are shown comprising two selection voltage generators 46 and 47 which are connected across two pairs of voltage dividers 48 and 50, 49 and 51. The common junction of the voltage dividers 48 and 50, 49 and 51 may then be grounded or maintained at another appropriate reference potential. The two pairs of character selection plates 16 and 18 are connected to taps 52 and 53, 54 and 55 on voltage dividers 48 and 50, 49 and 51, respectively. Corresponding compensation plates are connected to taps 56 and 57, 58 and 59, on voltage dividers 48 and 50, 49 and 51, respectively.

The sensitivity of deflection plates are rated in transverse deflection per unit voltage. Alternatively, the compensation plates 24 and 26 may have applied voltages equal to the character selection voltages applied to the selection plates 16 and 18, respectively, if the compensation plates have the same sensitivity as their corresponding character selection plates.

By the action of converging coil 22, the writing beam 36 will be rotated as it is directed from the character selection plates to the compensation plates. In order to eliminate a possible error from this rotation, the converging coil may be designed to rotate the beam 90 mechanical degrees. For this reason, compensation plates 24 and 26 are disposed at an angle of 90 degrees with respect to their corresponding character selection plates 16 and 18, respectively. The converging coil 22 may, of course, be designed to rotate the writing beam 36 through any other angle so long as the compensation plates are appropriately and proportionately positioned.

A deflection voltage generator 60 is connected to the deflection plates 27 and 28 for directing the writing beam toward a selected elemental area on the storage target 32.

In the absence of any sort of compensation plates such as the plates 24 and 26, the writing beam 36 is directed through a selected aperture in the character matrix 20 and converged back towards the axis 12 by converging coil 22. The writing beam 36 then crosses the axis 12 at some point between the deflection plates 27 and 28. The deflection plates may then direct the beam 36 to any particular elemental area on the storage target 32 to write or to record any given character on the target. Any character represented in the character matrix 20 may thus be first selected by selection generators 46 and 47 and then positioned anywhere on the storage target 32. However, it is generally desirable to reproduce each selected character at the same position in any chosen elemental area on the viewing screen 42, which is selected by appropriate selection voltages.

If compensation plates are not employed for redirecting the writing beam 36 along the axis 12 through the deflection plates 27, 28, it will be impossible to deflect each character in the character matrix 20 to approximately the same elemental area on the storage target 32 with the same deflection voltages impressed upon the deflection plates 27, 28.

It is undesirable to apply an additional voltage to the deflection plates in order to compensate for the transverse motion of the writing beam 36 as it leaves the region of the converging coil 22. In the first place, the addition of a correction voltage to the deflection voltage requires that a substantial amount of additional circuitry be provided. Further, the maximum voltage swing of the deflection plates would be increased. The latter is undesirable because a portion of the flood electrons produced by the flood gun 30 inevitably return on the positive plate of the deflection plates 27, 28 and tend to load the deflection voltage amplifier. The deflection voltage amplifier is generally not impervious to deflection plate current, and the deflection voltage will thereby be changed, whereby other misregistration errors will be introduced. These other errors cannot be corrected with any substantial degree of facility because the flood electron current

to a positive deflection plate is not a linear function of the deflection plate voltage.

It is further desirable to make the deflection plates as short as possible when compensation plates are not employed. This is illustrated in Fig. 2 where character selection plates 16 and 18 are shown disposed to the left of character matrix 20 and where converging coil 22 is shown adjacent character matrix 20 and deflection plates 27, 28 are shown to the right of converging coil 22. By an extrapolation of the writing beam trajectory, the writing beam 36 can be thought of as leaving the axis at a focal point 130 within the selection plates 16 and at a second focal point 132 within the selection plates 18. Converging coil 22 then redirects this stream back toward the axis 12 at two separate focal points 134 and 136 corresponding, respectively, to the focal points 130 and 132. A representative value of distance between the focal points 134 and 136 is 0.25 inch. This means that perfect correction by applying an additional correction voltage to the deflection plates 27, 28 can never be accomplished because the focal points 134 and 136 cannot be made to fall at the center of the vertical and horizontal deflection plates 27 and 28. Better corrections can, however, be obtained by making the deflection plates as short as possible whereby their centers will be brought closer to the focal points 134 and 136. It is further desirable to make the deflection plates 27, 28 as short as possible because a leakage magnetic field produced by the converging coil 22 causes the writing beam 36 to rotate as it passes through both the vertical and the horizontal deflection plates 27, 28. The vertical deflection plates will generally be at right angles to the horizontal deflection plates. Since there is rotation of the beam between the vertical and horizontal deflection plates, an error is produced, the electrical deflection produced on the beam by each pair of deflection plates being no longer at right angles with respect to each other.

The lengths of the deflection plates 27, 28 are limited by the sensitivity necessary to produce deflection with a practicable deflection voltage. A representative length for the deflection plates 27, 28 is 1.5 inches. The fact that deflection plates 27, 28 must be of a substantial length is illustrated in Fig. 3 where a writing beam trajectory 140 is illustrated. The sensitivity of a pair of deflection plates is directly proportional to the length of the plates and inversely proportional to their spacing and the axial accelerating voltage of the writing beam.

In order to prevent an interception of writing beam 36, the plates 28 shown in Fig. 3 must therefore be spaced a substantial distance apart. In order to maintain an adequate sensitivity, deflection plates 28 must, therefore, have an extended length. This is not true of the compensation plates 24 and 26 because, as illustrated in Fig. 4, the compensation plates 26 are shown with a modified writing beam trajectory 150. The compensation plates 26 only serve to redirect the writing beam 36 along the axis 12 of the deflection system 10, and therefore may be disposed closer to the axis 12 and made shorter. A representative length may be 0.75 inch.

What is claimed is:

1. In a cathode-ray type storage tube having a writing beam gun for producing a writing beam of electrons, a writing beam deflection system comprising a character matrix spaced from the writing beam gun, means for directing the writing beam from the writing beam gun toward said character matrix, two pairs of character selection plates disposed about the path of the beam in quadrature with each other for directing the beam to a selected area on said character matrix, means for producing a magnetic lens adjacent said character matrix for focusing the portion of the beam penetrating through said character matrix on a predetermined plane spaced a substantial distance therefrom, two pairs of compensation plates disposed about the path of the beam at an angle with respect to that of said selection plates

equal to the amount of rotation imparted to the beam by said magnetic lens, means for applying a difference of potential between said selection plates, and means for applying a difference of potential between said compensation plates proportional to the difference of potential applied between said selection plates.

2. In a cathode-ray type storage tube having a writing beam gun for producing a writing beam of electrons, a writing beam deflection system comprising an apertured character matrix having apertures in the shape of characters, means for directing the writing beam from the writing beam gun toward said character matrix, two pairs of character selection plates disposed about the path of the beam for directing the beam through a selected aperture in said character matrix, a converging coil disposed adjacent said character matrix about the path of the beam for converging the beam toward a predetermined focal point, said converging coil imparting substantially 90 degrees rotation to the writing beam, two pairs of compensation plates disposed at an angle of substantially 90 degrees with respect to that of said selection plates, said compensation plates being disposed near said focal point along the writing beam path, means for applying a difference of potential between said selection plates, and means for applying a difference of potential between said compensation plates substantially proportional to the difference of potential applied between said selection plates, whereby the writing beam is redirected along the axis of the tube.

3. In a cathode-ray type storage tube having a writing beam gun for producing a writing beam of electrons, a writing beam deflection system comprising an apertured character matrix having apertures in the shape of informative symbols, means for directing the writing beam from the writing beam gun toward said character matrix, two pairs of character selection plates disposed about the path of the beam in quadrature with each other for directing the beam through a selected aperture in said character matrix, a converging coil disposed adjacent said character matrix about the path of the beam for converging the beam toward a predetermined focal point, said converging coil imparting substantially 90 degrees rotation to the writing beam, two pairs of compensation plates disposed at an angle of substantially 90 degrees with respect to that of said selection plates, said compensation plates being disposed near said focal point along the path of the writing beam, and means for applying the same difference of potential between said selection plates and between said compensation plates, said selection plates and said compensation plates having substantially the same sensitivity.

4. In a cathode-ray type storage tube having a writing beam gun for producing a writing beam of electrons and a storage target for storing an electrostatic charge pattern, a writing beam deflection system comprising a character matrix spaced from the writing beam gun, means for directing the writing beam from the writing beam gun toward said character matrix, two pairs of character selection plates disposed about the path of the beam for directing the beam to a selected area on said character matrix, a converging coil disposed adjacent said character matrix about the path of the beam for converging the beam toward a predetermined focal point, two pairs of compensation plates disposed about the path of the beam at an angle with respect to that of said selection plates equal to the amount of rotation imparted to the beam by said converging coil, said compensation plates being disposed near said focal point along the writing beam path, two pairs of deflection plates disposed adjacent said compensation plates and about the path of the writing beam, means for applying a difference of potential between said selection plates, means for applying a difference of potential between said compensation plates proportional to the difference of potential applied between said selection plates, and means for applying a difference of potential between said deflection plates to direct the writing beam toward a selection elemental area on the storage target.

5. In a cathode-ray type storage tube having a writing beam gun for producing a writing beam of electrons, a writing beam deflection system comprising an apertured character matrix having apertures in the shape of characters, means for directing the writing beam from the writing beam gun toward said character matrix, first and second pairs of character selection plates disposed at right angles with respect to each other successively along the path of the beam for directing the beam through a selected aperture in said character matrix, a converging coil disposed adjacent said character matrix about the path of the beam for converging the beam toward a predetermined focal point, said converging coil imparting substantially 90 degrees rotation to the writing beam, first and second pairs of compensation plates disposed at an angle of substantially 90 degrees with respect to said first and second pairs of selection plates, respectively, said compensation plates being disposed near said focal point along the writing beam path, means for applying a difference of potential between said selection plates, and means for applying a difference of potential between said compensation plates substantially proportional to the difference of potential applied between said selection plates, whereby the writing beam is redirected along the axis of the tube.

6. A cathode-ray type storage tube comprising an evacuated envelope, a writing beam gun disposed at one end of said envelope for producing a writing beam of electrons, a target electrode disposed at the opposite end of said envelope for storing an electrostatic charge pattern, an apertured character matrix, having apertures in the shape of informative symbols spaced from said writing beam gun, means for directing said writing beam from said writing beam gun toward said character matrix along a predetermined path, first and second pairs of character selection plates disposed at right angles with respect to each other successively along said path for directing said beam through a selected aperture in said character matrix, a converging coil disposed adjacent said character matrix about the path of said beam for converging said beam toward a predetermined focal point, said converging coil imparting substantially 90 degrees rotation to said writing beam, first and second pairs of compensation plates disposed at an angle of substantially 90 degrees with respect to said first and second pairs of said selection plates, respectively, said compensation plates being disposed near said focal point along the path of said writing beam, two pairs of deflection plates disposed adjacent said compensation plates about the path of said writing beam, means for applying the same difference of potential between said selection plates and said compensation plates having substantially the same sensitivity, and means for applying a difference of potential between said deflection plates to direct said writing beam to a selected elemental area on said storage target.

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