May 17, 1960 K. SCHLESINGER 2,937,312

CATHODE RAY DEVICE

Filed Feb. 21, 1957 2 Sheets-Sheet 1

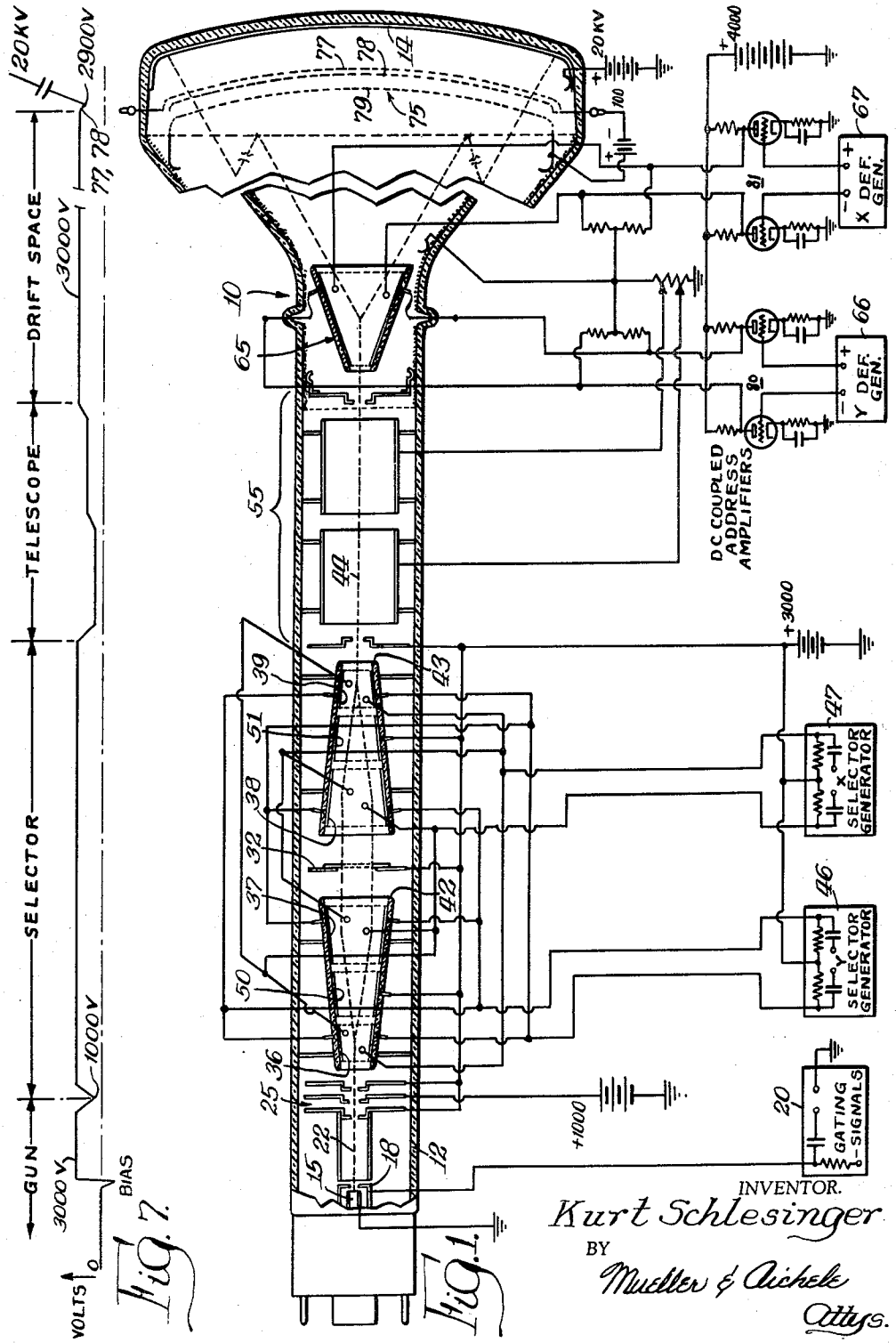

Fig. 1.

Fig. 2.

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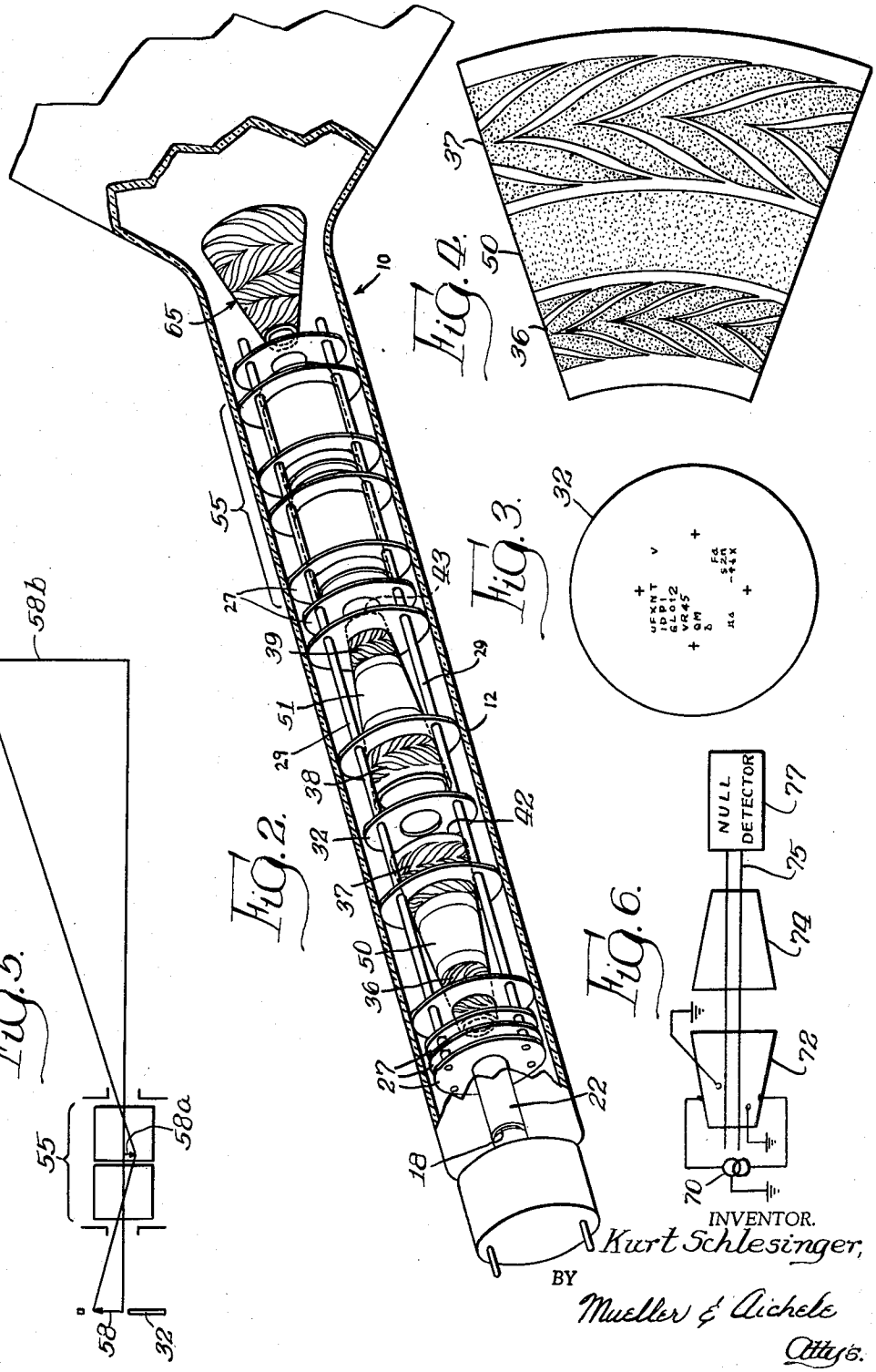

FIG. 2.

FIG. 4.

FIG. 3.

FIG. 5.

FIG. 6.

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CATHODE RAY DEVICE

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8 Claims. (Cl. 315—8.5)

This invention relates to cathode ray devices and more particularly to such devices which are adapted for character writing.

In present day character writing tubes it is known to form the desired characters on the screen by imaging objects in a perforated matrix and to select the desired image by illuminating one such character any time in the matrix. Generally, solenoids which provide axial magnetic fields are used for returning and realigning the electron beam after it has passed through the matrix and before it is positioned on the screen. However, prior art cathode ray tubes which are capable of forming characters have been comparatively large devices, and have generally required complex circuitry for character selection and positioning of the characters on a screen. Furthermore, in employing magnetic fields provided by solenoids, problems may arise in providing sufficient shielding and power to produce such fields, while at the same time the solenoids add to the size and weight of the apparatus. Furthermore, known character writing tubes require the addition of correcting circuitry to compensate for interrelations among the various functions within the tube, and to secure proper alignment of the characters as presented on a screen.

An object of the present invention is to provide a novel and improved character writing cathode ray tube in which character selection, focussing, magnification, and positioning of the image on the screen or target are all obtained by electrostatic apparatus, with the various functions being independent from one another.

Another object is to provide a character writing tube which may be operated by means of comparatively simple, low power circuits.

A still further object is to provide improved character selection in a cathode ray tube by insuring proper alignment of the character images projected onto the screen.

Another object is to provide character selection apparatus adapted to form a series of aligned and stable images on a viewing screen.

A still further object is to provide a character writing cathode ray tube which can be housed in the same envelope with further cathode ray apparatus so that multiple displays may be presented, for example, a radar display with accompanying character identification of the images.

A feature of the invention is the provision of a character writing tube which utilizes matched and aligned electrostatic yokes in the form of interleaved electrodes on a supporting form, to obtain character selection and axial beam positioning, thus making the tube comparatively light in weight and small in size.

Another feature is the provision of a character writing cathode ray device including two pairs of balanced and matched electrostatic yokes, each having terminals connected to a common character selecting signal source.

A further feature is the provision of a character selector for a cathode ray tube including a pair of matched electrostatic yokes mounted as a unit on a single insulating form to deflect and collimate the beam. One

such pair of yokes is mounted on each side of a character matrix so that the beam may be directed through any portion of the matrix and then returned to the axis of the tube.

A still further feature is the provision of a character writing cathode ray tube in which the various characters may be presented upon a given spot of the tube screen and arrested in such a position by the use of tandem pairs of electrostatic yokes, each having precisely matched electrical lengths, axes of deflection, and axes of symmetry, so that character selection may be obtained independently of beam address apparatus of the tube.

Another feature of the invention is the provision of a system of electrostatic electron lenses to obtain images of desired size on the screen in a character writing tube where various dimensions thereof are relatively fixed due to other considerations.

Further objects, features and the attending advantages of the invention will be apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

Fig. 1 is a sectional view of the electron beam device of the invention, together with energizing circuitry therefor;

Fig. 2 is a perspective cut-away view of the neck portion of the electron beam device;

Fig. 3 is a view of the character matrix as used in the device;

Fig. 4 shows the lay-out of a pair of electrostatic yokes as used in the device;

Fig. 5 is a diagram useful in explaining the operation of a lens system in the device;

Fig. 6 is a diagram useful in explaining the electrostatic yoke alignment; and

Fig. 7 is a potential distribution diagram of the cathode ray device of Fig. 1.

The invention comprises a cathode ray tube in which the beam is directed through selected portions of a matrix having cut-out, or stencil portions, in order to form an image which may be projected on the screen. The electron beam is deflected away from the tube axis and collimated by a first pair of electrostatic yokes and then returned to the axis by a second pair of electrostatic yokes, both pairs of yokes being mounted in tandem style on associated supporting forms. The yokes are constructed so that each had a virtual plane of deflection, or plane where the beam approach and exit paths intersect, and the yokes provide deflection in any radial direction outwardly from the axis of the yoke and at any given angle with respect thereto. The yokes are further matched in sensitivity and aligned so that they may all operate from a common character selector signal or voltage.

After the beam has illuminated a desired portion of the matrix, it is passed through an image forming lens comprising a long barrel lens unit which is focused on the matrix to form an image on the tube screen of desired size. A further electrostatic yoke aligned with the character selector yokes is used to position the characters on the screen. In order to conveniently deflect the beam and yet have it at high energy level at the screen, a post-acceleration system is incorporated. The various functions mentioned above including character selection, focus, and address, are separate and independent from one another, thereby simplifying the circuitry used with the tube.

As shown in Figs. 1 and 2, the cathode ray device, or tube, **10** comprises an evacuated enclosure including a neck section **12** and the screen **14**. An electron source or cathode **15** is disposed at the end of the neck section to provide electrons to be directed through a control grid **18** which is connected to a source of gating signals **20**. The electrons are directed along a path **22** which coin-

cides with the axis of the tube and through a lens **25** to provide focusing. As shown in Fig. 2, various elements within the neck section **12** are supported by means of discs **27** which are tied together by struts **29**.

After passing through lens **25**, the beam is directed through a system of four electrostatic yokes which provide character selection by directing the beam outwardly from the axis through a desired portion of matrix **32** and back to the axis. As shown in Fig. 3, matrix **32** includes cut-out portions forming a stencil in which the characters are arranged in eight rows and eight columns. These cut-out portions are in the shape of various letters and numerals.

The character selector system includes four electrostatic yokes or deflectors **36, 37, 38** and **39**. The deflectors are arranged in two pairs of tandem units **36, 37** and **38, 39**, both tandem units being identical. The pairs **36, 39** and **37, 38** are matched in the sense that they have equal deflection factors, that is, equal signals applied thereto will produce equal deflection angles. Deflector **36** is used to deflect the beam outwardly from the axis in any desired radial direction and at any desired angle with respect to the axis. Deflector **37** provides collimation of the beam so that it travels a path parallel to the axis and normal to the matrix **32**. After passing through matrix **32**, deflector **38** redirects the beam toward the axis and into deflector **39** which directs the beam so that it travels along the path **44**, which is an extension of axial path **22**.

Because the beam parallax of the matrix **32** may amount to as much as ¼", deflectors **37** and **38** have a wider aperture than deflectors **36** and **39**. Since the deflection sensitivities are to be equal, the length of the collimating deflectors **37** and **38** has to exceed the length of deflectors **36, 39** by the aperture ratio, that is, the units all have the same diameter to length ratio.

Deflectors **36** and **37** are mounted as tandem units on a single insulating form **42** and similarly units **38** and **39** are mounted on a form **43**. Fig. 4 shows a plane development of deflectors **36, 37** which are printed on the innerside of the conical form **42**. It may be noted that the deflectors each have four electrodes which are symmetrically positioned with respect to each other, with each of the electrodes extending longitudinally and being of zig-zag shape with apex portions extending in opposite directions around the tubular form and having an overall angular extent of approximately 270°. The electrodes are interleaved to provide a conductive coating on the innerside of the forms and the adjacent edges of the electrodes are of complementary sinusoidal configuration so that the electric field produced by applying a potential to alternate electrodes has an effective angular extent of approximately 180° and a substantially sinusoidal distribution throughout this extent. A description of units of this type is given in my article entitled "Progress in the Development of Post-Acceleration and Electrostatic Deflection" appearing in the proceedings of the IRE at page 659 in the May 1956 issue.

If the deflectors **36—39** are constructed to have equal deflection sensitivity and coincident axes of deflection, conditions which are further discussed subsequently, it is possible to connect the 16 terminals of these units in parallel to provide a four terminal device which may be coupled to signal generators **46** and **47** for common energization thereof to provide the character selection. Shields **50** and **51** are disposed between the deflectors **36, 37** and **38, 39**, respectively, to serve as protection against wall charges and to cut down on fringe field interaction.

It has been found in a practical construction of the apparatus that exactly equal sensitivity between deflector pair **36, 39** and deflector pair **37, 38** may be difficult to achieve and that mismatch of these pairs can prevent the image from forming on a single spot of screen **14** when different characters are selected. However, analysis has shown that the rays seem to come from a common center at a point midway between the deflectors **37** and **38**, even in the case of severe mismatch between the units. In order to obviate difficulty from such mismatching of the deflectors, an image forming lens **55** is provided for the beam as it emerges from the selector. If this lens is focused on the midpoint between deflectors **37** and **38**, mismatching of the type described can be overcome and the image can be arrested on the screen. The lens **55** may be constructed in the form of a "telescope" optical system **55**. In this system the barrel is long enough to form an intermediate image between the ends thereof and the system is focused on matrix **32**, to provide desired image size on screen **14** with given tube dimensions. The division of the barrel into two sections as shown in Fig. 1 permits image size control over a limited range. Fig. 5 illustrates the electron optics involved in this portion of the tube by showing a narrow image **58** in the plane of matrix **32** upon which the optical system **55** is focused. An intermediate image **58*a*** is formed within the system **55** and this image is projected into the plane of screen **14** to form an enlarged image **58*b*** as shown in Fig. 5. In the construction of any given tube, certain limitations may be placed upon the positioning of lens system **55** and the magnification which it must produce. For example, it may be found, due to the length of deflector units **38** and **39**, that system **55** may not be positioned near enough to matrix **32** to permit the desired magnification of the projected images on screen **14**. Furthermore, a limitation may exist for the distance between lens system **55** and the screen **14** due to tube geometry such as the screen size and maximum deflection angle within the tube. Accordingly, I have found a so-called telescope optical system to be advantageous in permitting image size control within certain limitations of tube geometry.

To take advantage of the operation of system **55** in presenting characters which are arrested upon the screen, certain further conditions must also be met. Analysis and practice have shown that for ray tracing purposes electrostatic yokes such as deflectors **56—39** may be replaced by a principal deflection plane normal to the tube axis and positioned near the midline of the yoke under consideration. If the deflector is cylindrical this plane would pass through the center of the unit, while if the deflector is conical in shape, this plane would appear slightly ahead of the center of the unit. These so-called principal planes of deflection must be parallel to one another in the construction of the character selector and the planes of units **36, 37** and units **38, 39** must have precisely the same separation in order to permit the image to appear arrested upon the screen. Accordingly, deflectors **36** and **37** are mounted in tandem on the same supporting form **42** and deflectors **38** and **39** are mounted in tandem on the same supporting form **43** in order to maintain the exact deflection plane spacing. Although exact spacing of units **36, 37** and **38, 39** is not necessary, matrix **32** must be mounted midway between these tandem units as a requisite for image arresting through the lens system **55**.

As the beam emerges from lens system **55** it is passed through a further deflector **65** which is an electrostatic yoke having four interleaved electrodes similar in construction to the previously described deflectors. This unit provides address or positioning of the characters on screen **14** and is coupled to deflection circuits **66** and **67** for this purpose.

As an aid in the alignment of the deflector units **36—39** and **65**, a suitable alignment jig can be used. As shown in Fig. 6 this may take the form of a high frequency oscillator **70** having an output coupled to two of the four terminals of a deflector unit **72**. The remaining terminals of unit **72** are connected to ground and oscillator **70** provides signals symmetrical with respect to ground. An elongated dipole probe **75** is positioned within unit **72** and connected to a null detector **77** for indicating zero signal

pickup by dipole 75. A null indication occurs when the plane through the dipole wires is at right angles to the field of the deflector unit 72. With the apparatus disposed in this position, a further deflector unit 74 is connected to the oscillator and this unit is rotated until the null indication is again established, at which time the units are in alignment. By employing suitable amplifiers in the circuits 70 and 77, it is possible to increase the sensitivity of this system to obtain high accuracy in aligning the deflectors.

After the beam has been deflected by address deflector 65 it is directed through a barrier mask 75 before impinging screen 14. Mask 75 is constructed in accordance with the teachings of my article appearing in the May 1956 issue of the "Proceedings of the IRE" (previously mentioned). Briefly, this mask includes a conductor 77 on the screen side of the mask and the coating 78 supported with but insulated from conductor 77. The coating 78 is composed of material such as magnesium oxide having a high degree of secondary emission so that when struck by electrons, this coating will assume the potential of a collector mesh 79 connected to the drift space through which the beam travels between the mask and deflector 65. Conductor 77 is maintained at a potential approximately 100 volts negative with respect to the drift space so that the beam travels through a negative going potential gradient of approximately 100 volts in passing through mask 75. Screen 14 is maintained at a high voltage, here shown as 20,000 volts, thus forming a post-acceleration system between mask 75 and the screen in order to provide an image of the desired intensity.

In considering the circuitry shown in Fig. 7, it may be noted that cathode 15 is grounded and that the address amplifiers 80 and 81 are also grounded. These amplifiers provide signals of suitable level from the deflection signal sources 66 and 67. The amplifiers are direct current coupled to a deflector 65 in order to permit scanning with complex wave forms. It is convenient to have the control grids therein operating near ground since this permits the use of low level clamping circuits. Because the address amplifiers 80 and 81, as well as the cathode 15 are grounded, circuits for the cathode ray tube are simplified since they need not be operated at potentials which are referenced above ground level.

As shown in Figs. 1 and 7, the beam is directed toward focussing lens 25 with a potential of 3000 volts. The beam is also maintained at 3000 volts in the selector system. It has been found advisable to maintain such a comparatively low beam energy in the selector system in order to limit the heat dissipation on the matrix 32. The telescopic lens system 55 is maintained at suitable potentials below 3000 volts in order to effect proper focussing in image size on screen 14. In emerging from system 55 the beam is maintained at an energy level of 3000 volts in passing through the drift space between address deflector 65 and mask 75. However, it is recognized that this potential may be varied depending upon image size requirements at screen 14.

In a constructed embodiment of the invention, the matrix 32 shown in Fig. 3 included 64 characters arranged within an area ⅜" by ⅜", each of the characters being 12–16 mils. in height. With the construction as shown, it is possible to produce characters ⅛" in height on the screen. It may be noted that the tube is a relatively compact structure since all the gun elements are internal and no accessories are needed on the outerside of the neck section 12. Furthermore, since the apparatus is of the electrostatic type, the device will be of comparatively light weight. It is contemplated that practical overall dimensions for a given tube would include a 19" screen and a 60° deflection angle from the address deflector 65. The remaining apparatus in neck section 12 can be contained within a length of approximately 12" between the cathode 15 and deflector 65. Accordingly, the overall length is approximately 32", which is considerably less than that of known tubes. Furthermore, it should be pointed out that the character writing device of the present invention may be utilized in a dual cathode ray tube in which a second gun is provided to form another display in addition to the characters presented by the present system. Such a dual construction is possible since the apparatus employs no external magnetic fixtures.

I claim:

1. A cathode ray tube adapted to form a character image in response to control signals applied thereto, including in combination electron beam supply means to provide an electron beam and direct the same along an axis, matrix means having cut out portions adapted to be illuminated by the beam to form an image as the same is directed therethrough, a character selector system for displacing the beam along paths outwardly from the axis and through selected portions of said matrix means and for redirecting the beam along the axis, said selector system including four electrostatic deflection yokes having identical beam deflection sensitivities to provide deflection in radial and angular directions with respect to said axis, said deflection yokes each comprising a plurality of pairs of deflection members for bidirectional deflection of a beam passed therethrough, a pair of said deflection yokes being disposed on each side of said masking means for collimating and decollimating the beam, said deflection yokes being directly coupled together for common energization thereof by control signals, an evacuated enclosure for said device including target means spaced outwardly from said selector system, and means for directing said beam from said selector system toward said target means.

2. A cathode ray device adapted to form a character image in response to control signals applied thereto, including in combination electron beam supply means to provide an electron beam and direct the same along an axis, matrix means having portions adapted to be illuminated by the beam to form an image, a character selector system for displacing the beam along paths outwardly from the axis and through selected portions of said matrix means and for redirecting the beam along the axis, said selector system including four electrostatic deflection yokes having interleaved electrodes and matched beam deflection sensitivities to provide deflection in radial and angular directions with respect to the axis, a first pair of said deflection yokes being disposed on a common form on one side of said masking means and a second pair of said deflection yokes being disposed on a common form on the opposite side of said masking means, said four yokes being coupled together for common energization thereof by control signals, an evacuated enclosure for said device including a target spaced outwardly from said selector system, and means for directing the beam from said selector system toward said target.

3. An electron tube adapted to provide a character image in response to control signals applied thereto, said tube including in combination, matrix means having a plurality of characters which can be illuminated as an electron beam is directed through various portions thereof, beam supply means to provide an electron beam and direct the same along an axis toward said matrix means, a character selecting system to direct said electron beam through selected portions of said matrix means, said selecting system including first and second electrostatic deflection yokes disposed in the named order between said beam supply means and one side of said matrix means, said selecting system also including third and fourth electrostatic deflection yokes disposed in the named order on the other side of said matrix means, said deflection yokes each comprising a plurality of pairs of deflection plates for bidirectional deflection of a beam, said first deflection yoke being adapted to deflect said beam away from the axis and into said second deflection yoke, said second deflection yoke being adapted to deflect

said beam in a direction substantially parallel with the tube axis and toward said matrix means so that the same passes therethrough and into said third deflection yoke, said third deflection yoke being adapted to deflect said beam toward the axis and into said fourth deflection yoke, said fourth deflection yoke being adapted to deflect said beam so that it travels along the axis, means for applying signals to said selecting system for controlling the portion of said matrix means into which said beam is directed thereby, an evacuated enclosure for said tube including target means spaced from said fourth deflection yoke, and means for directing said beam from said selecting system into said target means.

4. A cathode ray tube adapted to form a character image in response to control signals applied thereto, including in combination electron beam supply means to provide an electron beam and direct the same along an axis, a character selection system disposed on the axis and comprising first, second, third and fourth electrostatic yokes having virtual deflection planes and equal deflection sensitivities, said yokes each having a plurality of pairs of deflection members adapted to be energized for bidirectional beam deflection, the virtual deflection planes of said first and second yokes and of said third and fourth yokes being equally spaced, a matrix disposed midway between said second and third yokes, said matrix having portions adapted to be illuminated by the beam to form an image as the same is directed therethrough, means for energizing said yokes by a common character selection signal so that the beam is directed through selected portions of said matrix and returned to the axis, an evacuated enclosure for said device including target means spaced outwardly from said selection system to be impinged by the beam.

5. A cathode ray tube adapted to form a character image in response to control signals applied thereto, including in combination electron beam supply means to provide an electron beam and direct the same along an axis, a character selection system disposed on the axis and comprising first, second, third and fourth electrostatic yokes having virtual deflection planes and equal deflection sensitivities, said yokes each including a plurality of pairs of deflection members for bidirectional beam deflection, the virtual deflection planes of said first and second yokes and of said third and fourth yokes being equally spaced, a matrix disposed midway between said second and third yokes, said matrix having cut-out portions adapted to be illuminated by the beam to form an image as the same is directed therethrough, means directly interconnecting said yokes for energizing said yokes by a common character selection signal so that the beam is directed through selected portions of said matrix and returned to the axis, an evacuated enclosure for said device including target means spaced outwardly from said selection system, and a lens system disposed between said selection system and said target means, said lens system being adapted to form an intermediate image of a character of said matrix and to focus the same on said target means.

6. A cathode ray tube adapted to form a character image in response to control signals applied thereto, including in combination electron beam supply means to

provide an electron beam and direct the same along an axis of said tube, a character selection system comprising first, second, third and fourth electrostatic yokes having virtual deflection planes and equal deflection sensitivities, said first and second yokes being mounted in tandem on a common form on the axis, said third and fourth yokes being mounted in tandem on a common form on the axis and being complementary to said first and second yokes, a matrix disposed midway between said second and third yokes, said matrix having cut-out portions adapted to be illuminated by the beam to form an image as the same is directed therethrough, means for energizing said yokes by a common character selection signal for directing the beam through selected portions of said matrix and returning the same to the axis, an evacuated enclosure for said device including target means spaced outwardly from said selection system, a lens system disposed between said selection system and said target means, said lens system being focussed on said matrix to provide an image on said target means, a further electrostatic deflection yoke positioned intermediate said lens system and said target means, and means for energizing said further electrostatic yoke to position characters on said target means.

7. A cathode ray tube adapted to form a character image in response to control signals applied thereto, including in combination electron beam supply means to provide an electron beam and direct the same along an axis of said tube, first and second identical electrostatic beam deflection assembly adapted to displace a beam between a given path and selected paths parallel thereto, each of said beam deflection assemblies including two sets of deflection members with each set being energizable to provide bidirectional beam displacement, a matrix having a plurality of character portions adapted to be illuminated by the beam to form an image, said first and second beam deflection assemblies being disposed on opposite sides of said matrix to receive the beam from said axis and direct the same through a selected portion of said matrix and return the same to said axis, means for energizing said deflection assemblies with character selection signals, an evacuated enclosure for said device including target means spaced outwardly from said deflection assemblies, and means for directing the beam from said path toward a selected portion of said target means.

8. The cathode ray tube of claim 7 in which each electrostatic beam deflection assembly includes two deflection yokes each comprising four zig-zag electrodes with apex portions extending in opposite directions and substantially 270° about the axis, said electrodes being interleaved and having complementary sinusoidal sides to provide deflection fields for the beam.

References Cited in the file of this patent

UNITED STATES PATENTS

2,379,880	Burgess	July 10, 1945
2,735,956	McNaney	Feb. 21, 1956
2,761,988	McNaney	Sept. 4, 1956
2,769,116	Koda	Oct. 30, 1956
2,770,748	Schlesinger	Nov. 13, 1956
2,790,103	McNaney	Apr. 23, 1957