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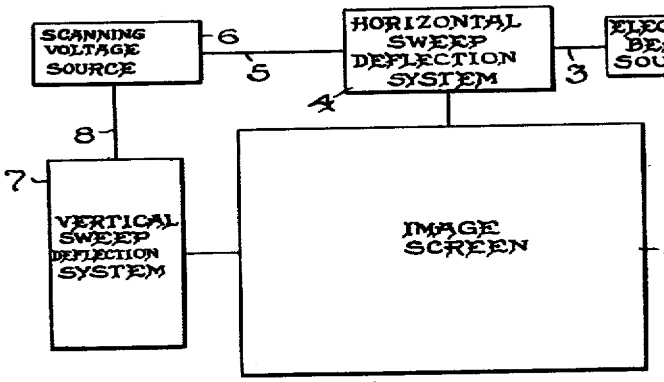

FIG. 1.

FIG. 2.

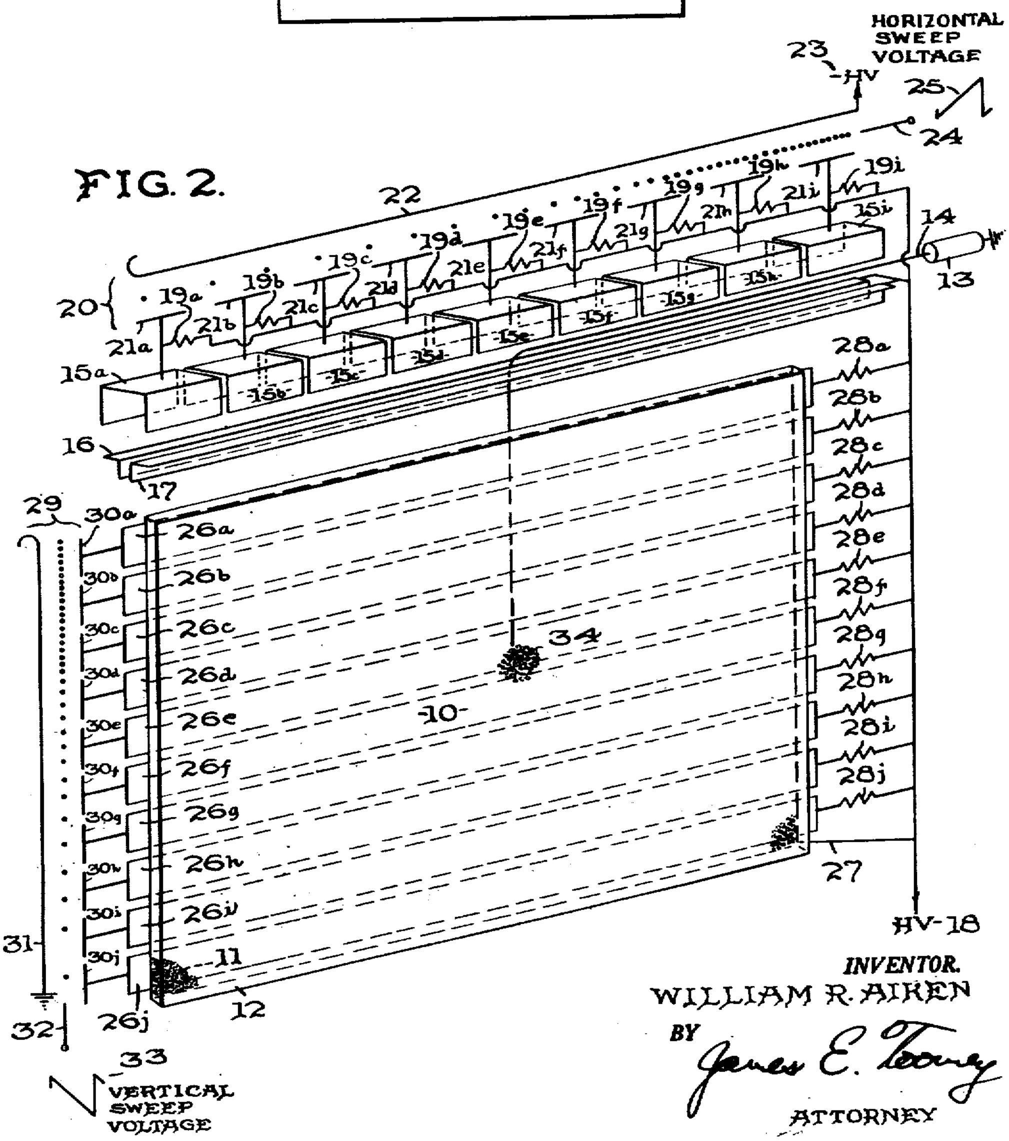

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FIG. 3.

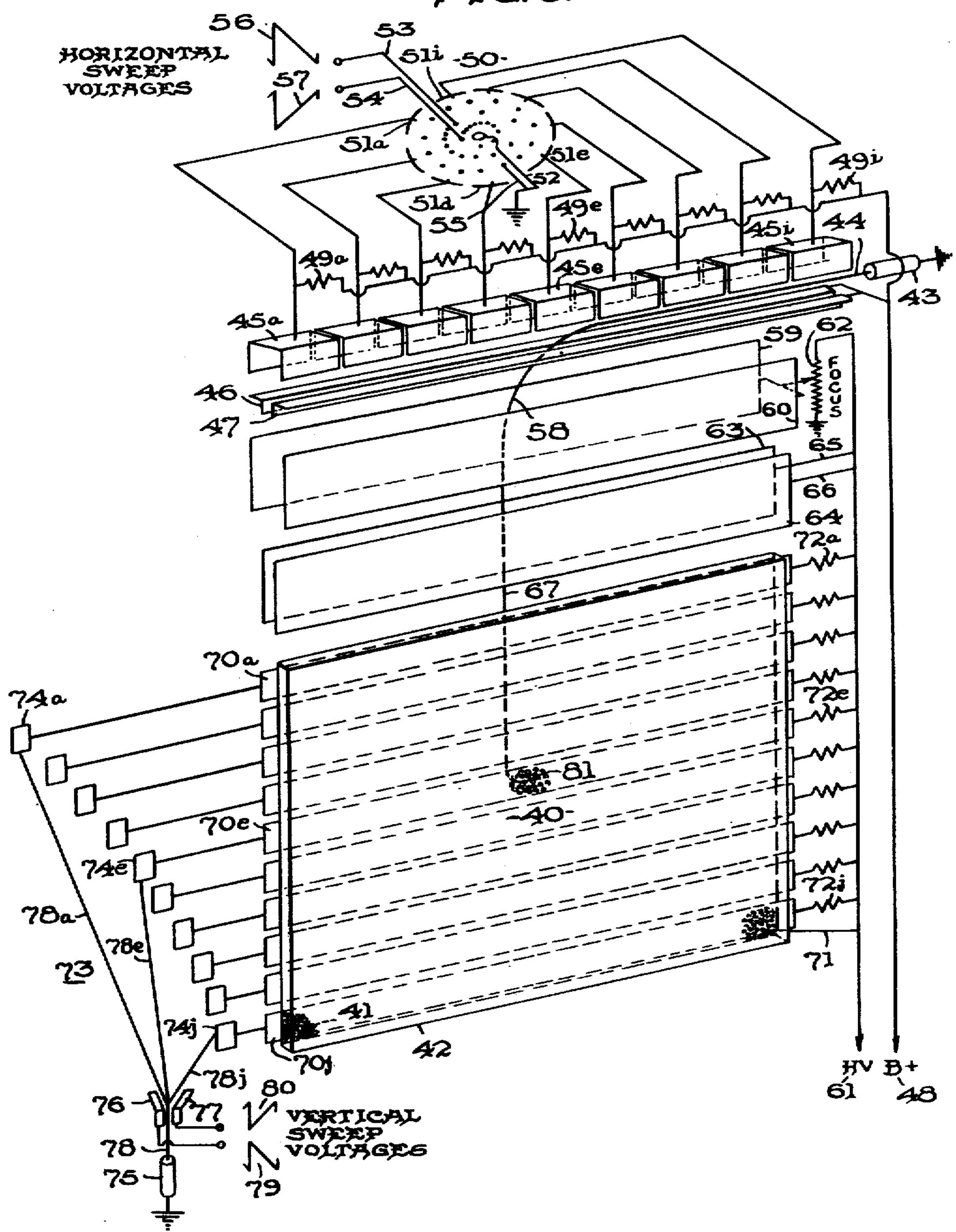

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FIG. 4.

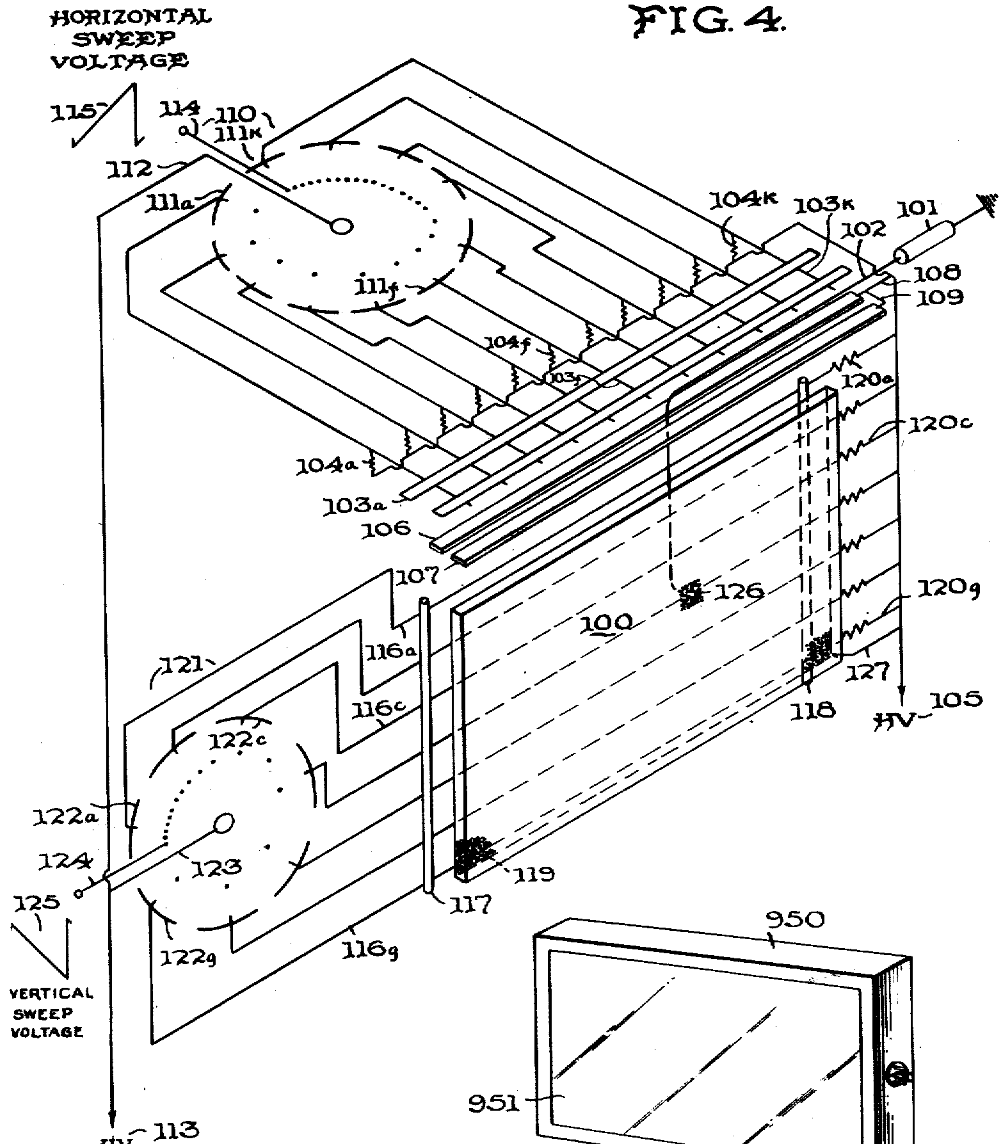

FIG. 75.

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FIG. 5.

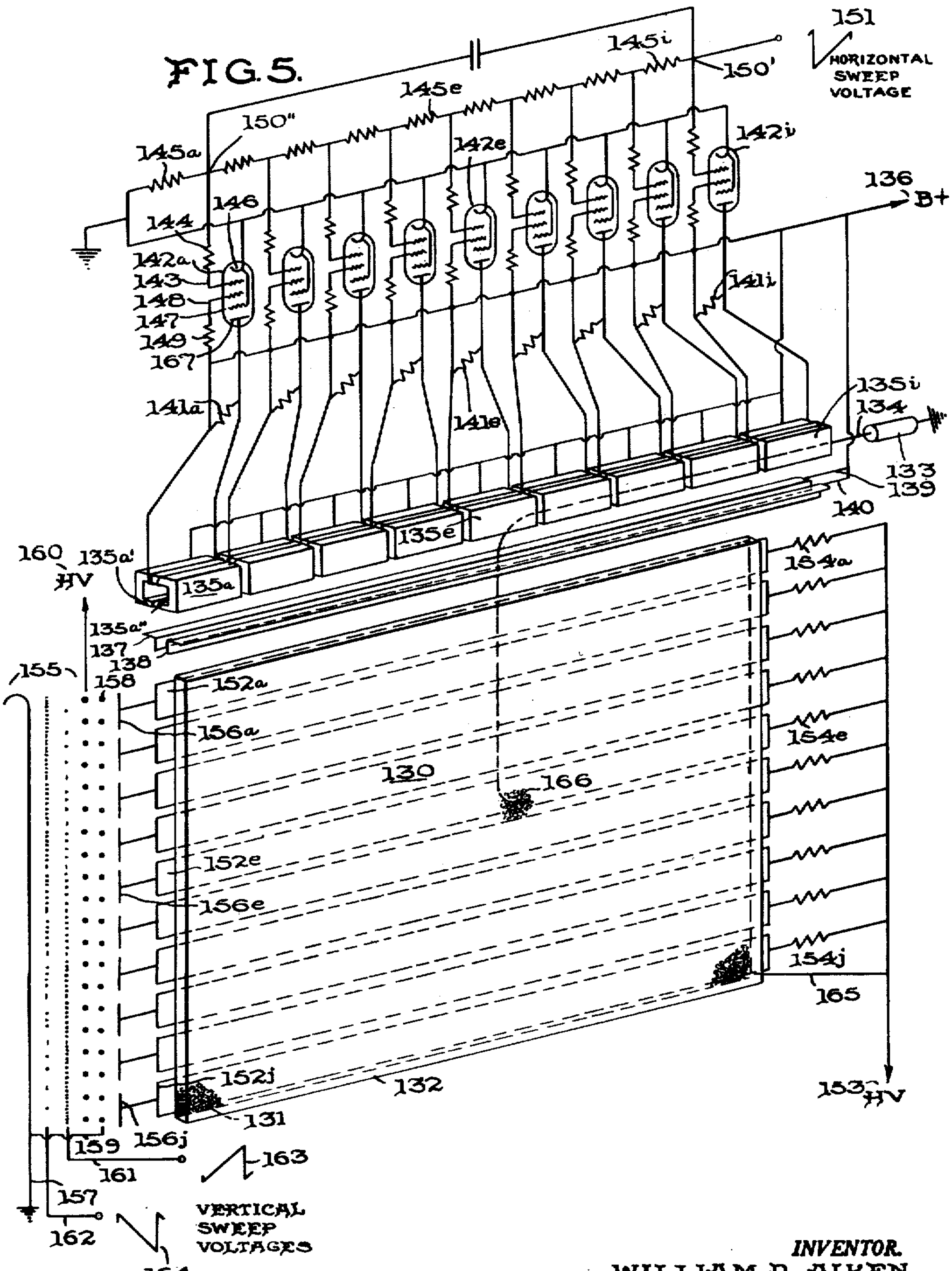

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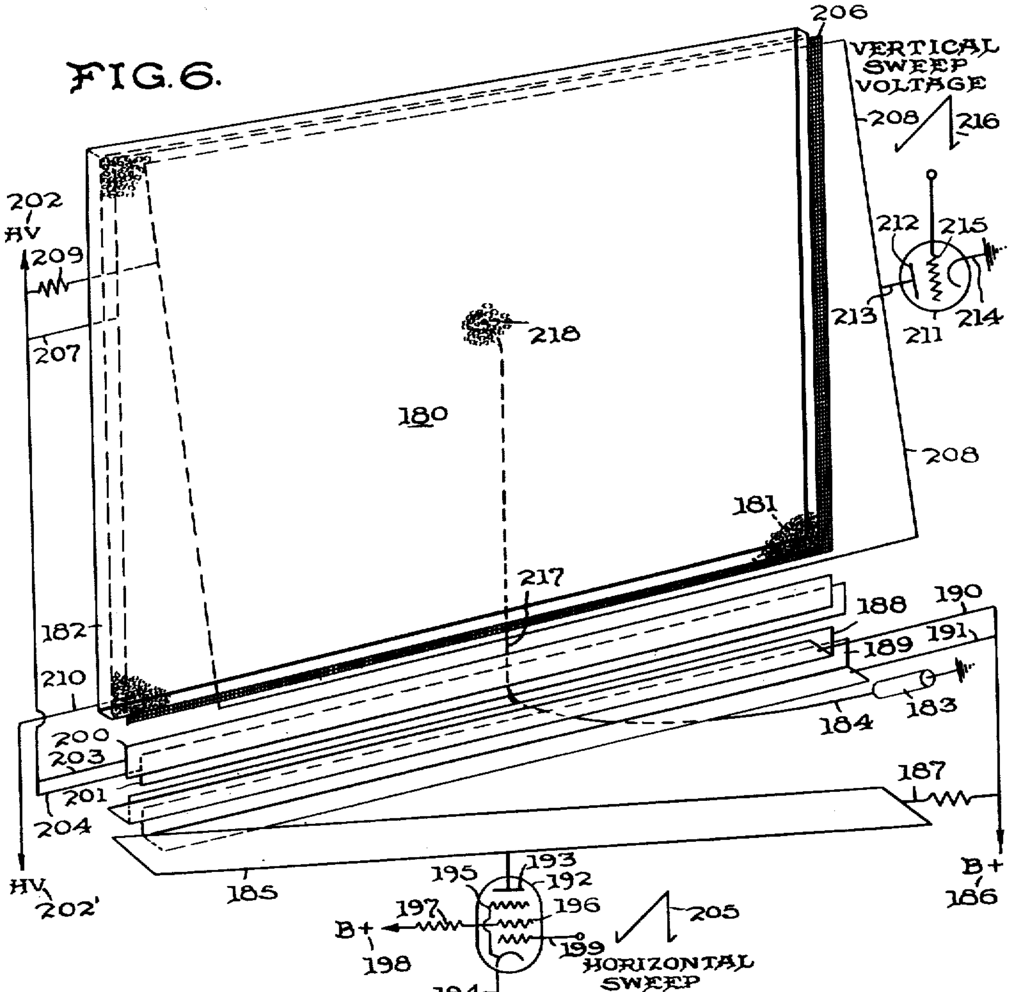
FIG. 6.



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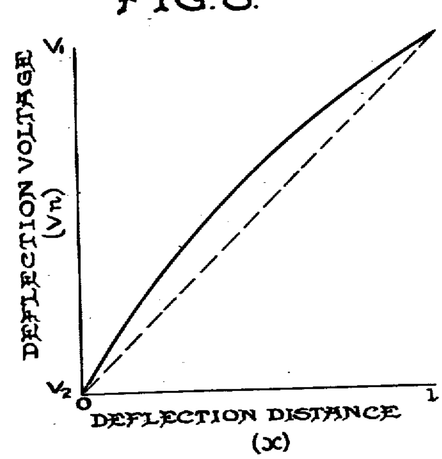

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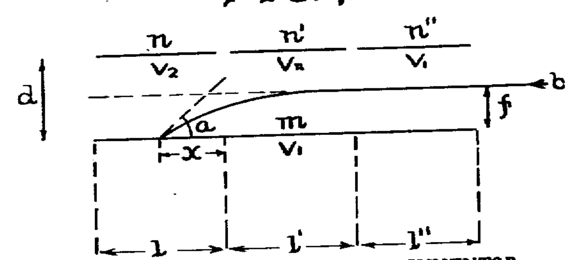

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FIG. 9.

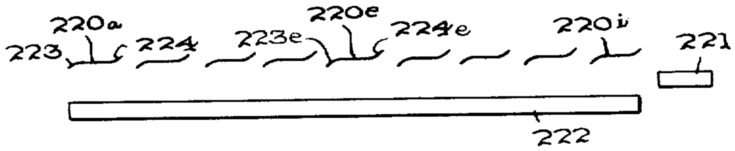


FIG. 10.

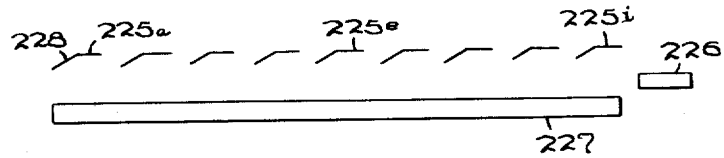
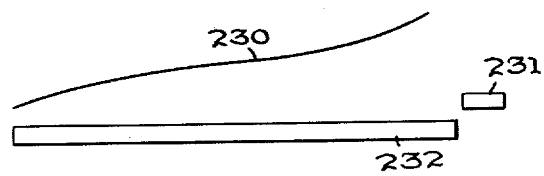


FIG. 11.



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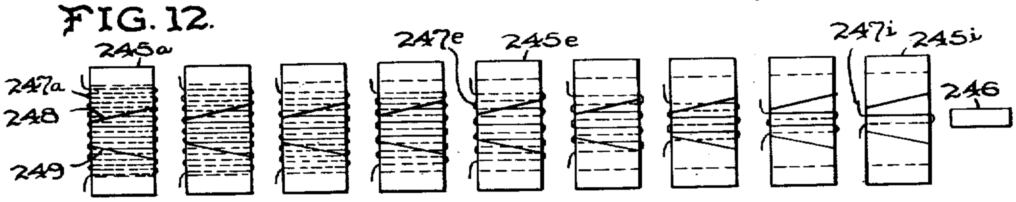

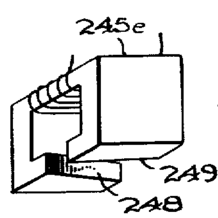

FIG. 13.

FIG. 14.

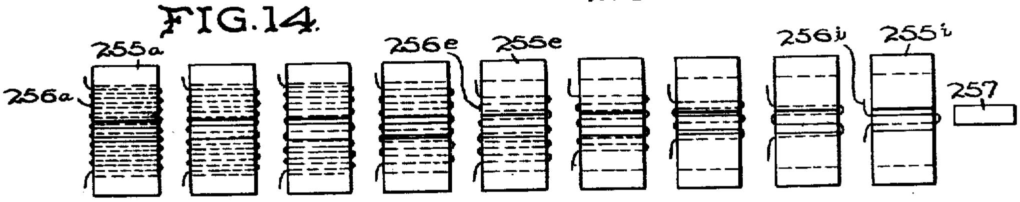

FIG. 15.

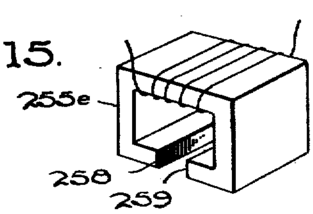

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FIG. 16.

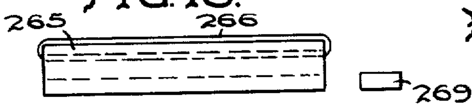
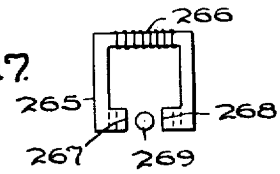


FIG. 17.



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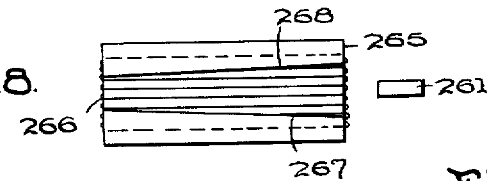

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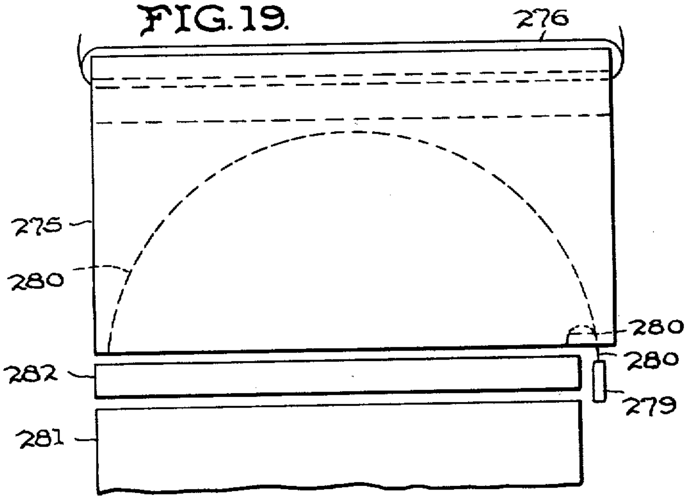

FIG. 20.

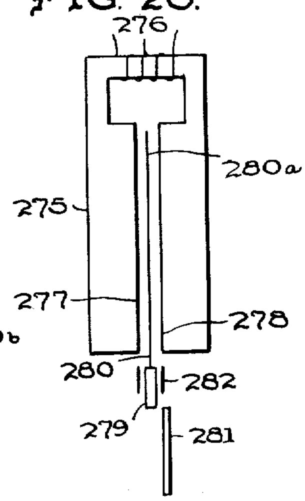

FIG. 21.

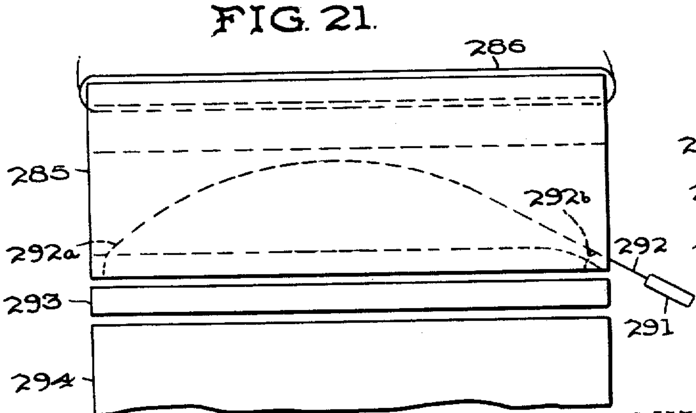

FIG. 22.

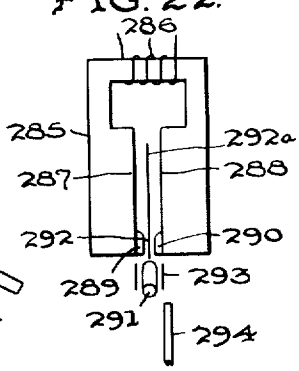

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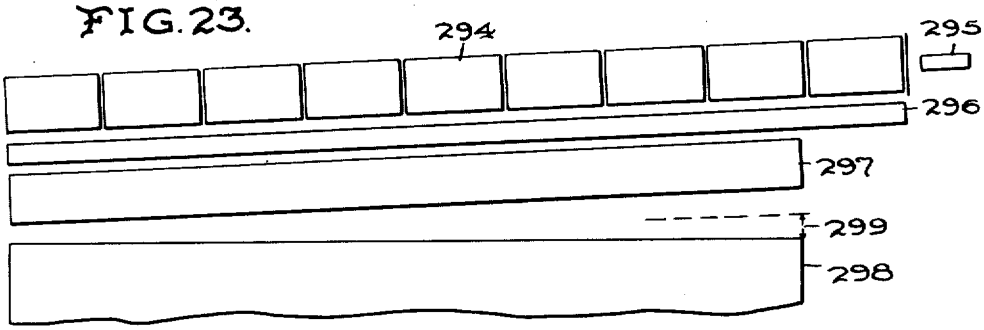
FIG. 23.



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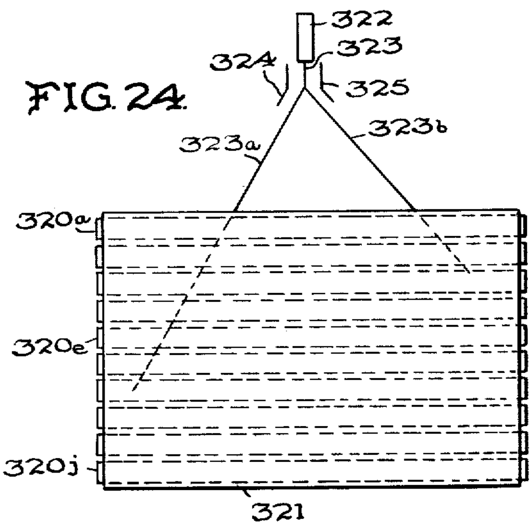

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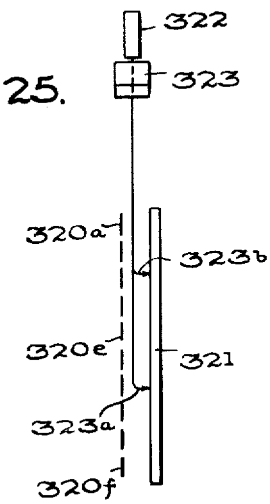

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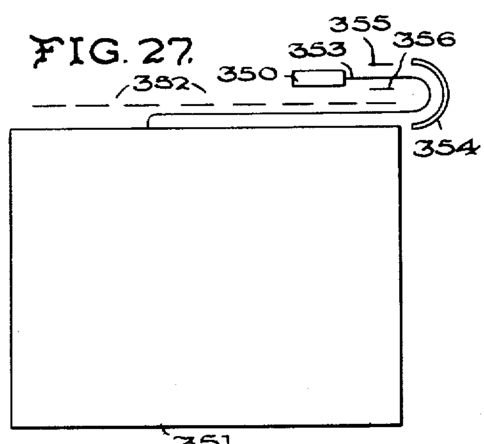

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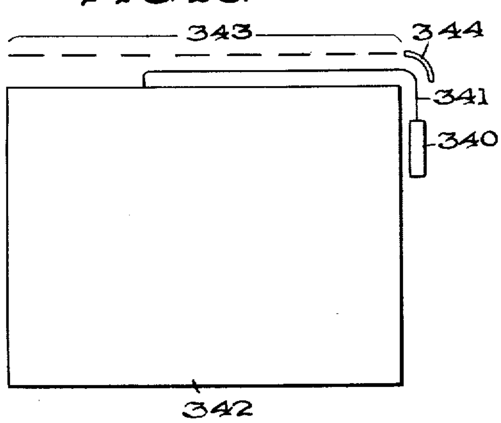

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FIG. 28.

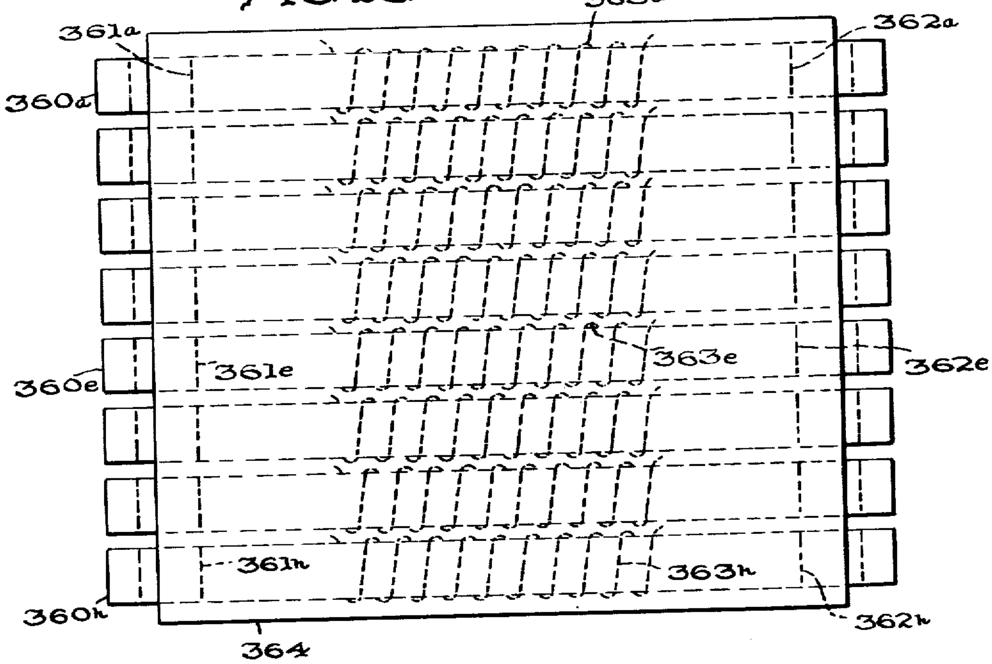

FIG. 29.

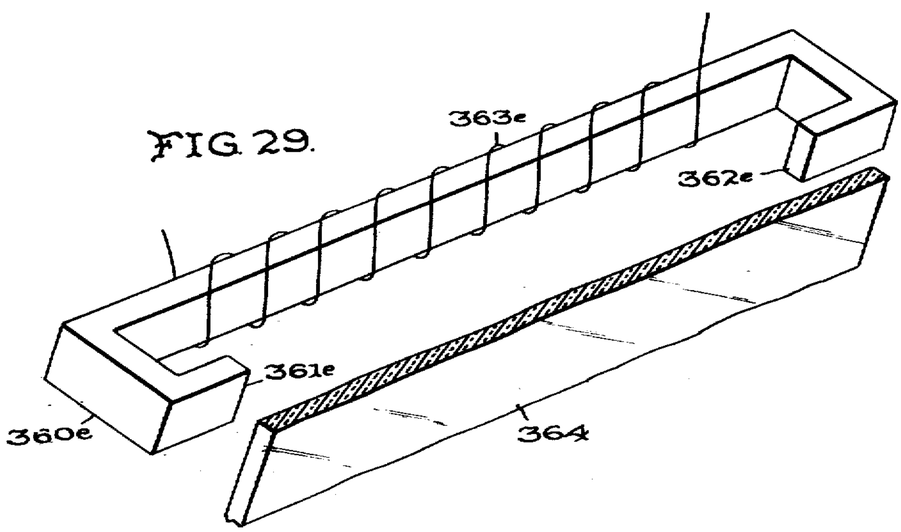

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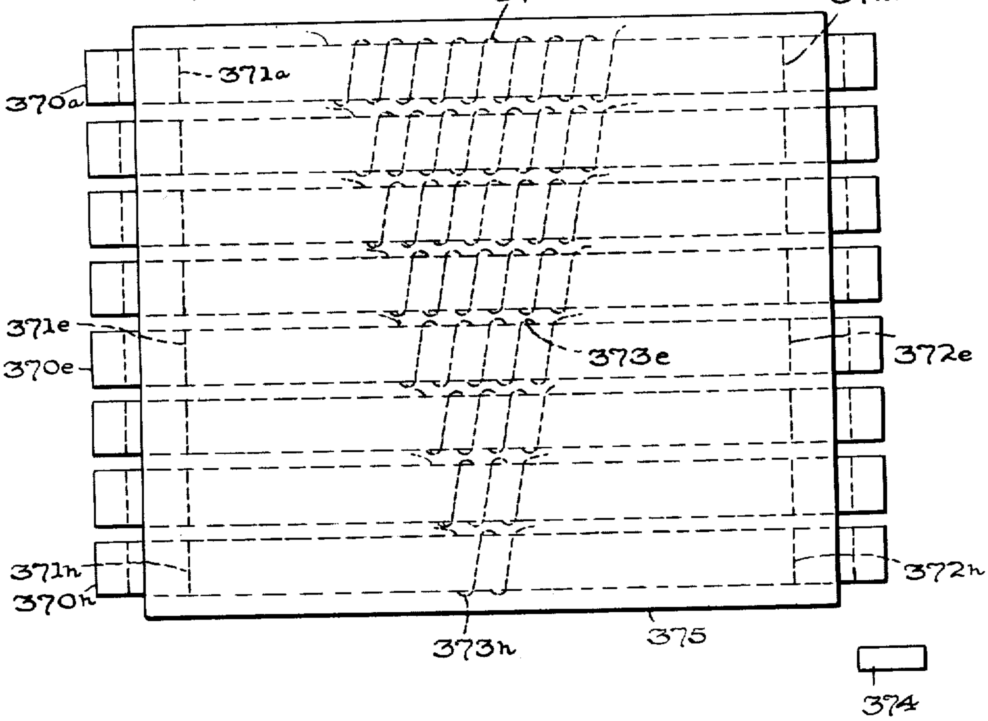
FIG. 30.



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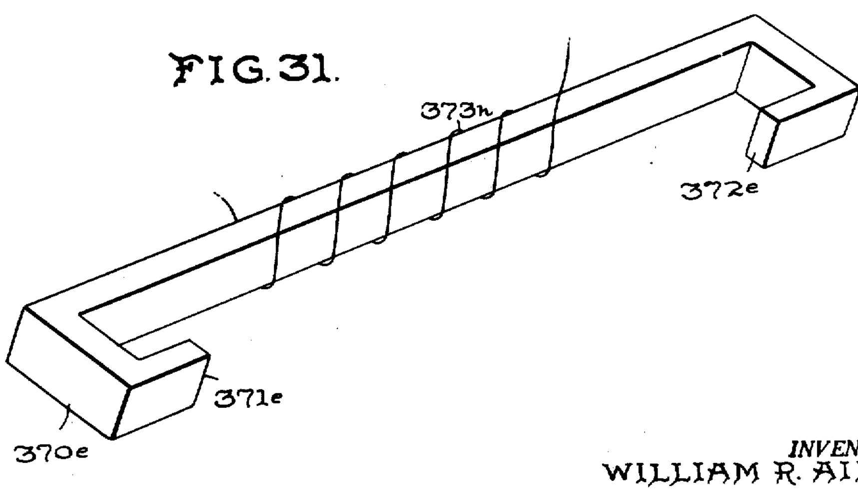

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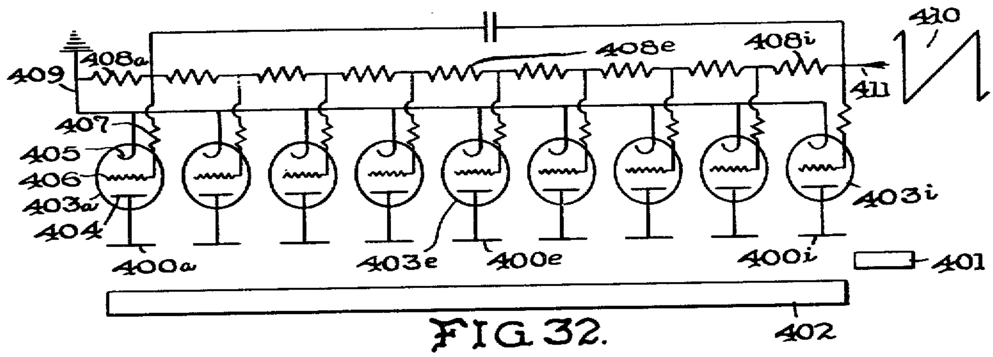

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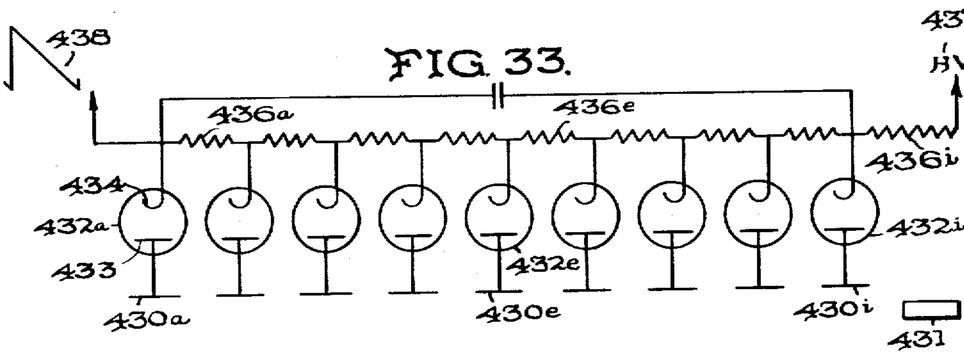

FIG. 33.

FIG. 34.

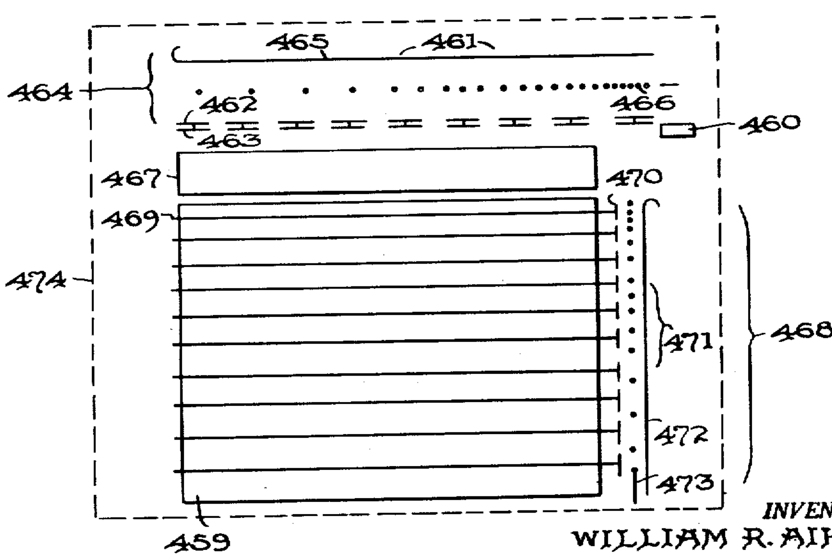

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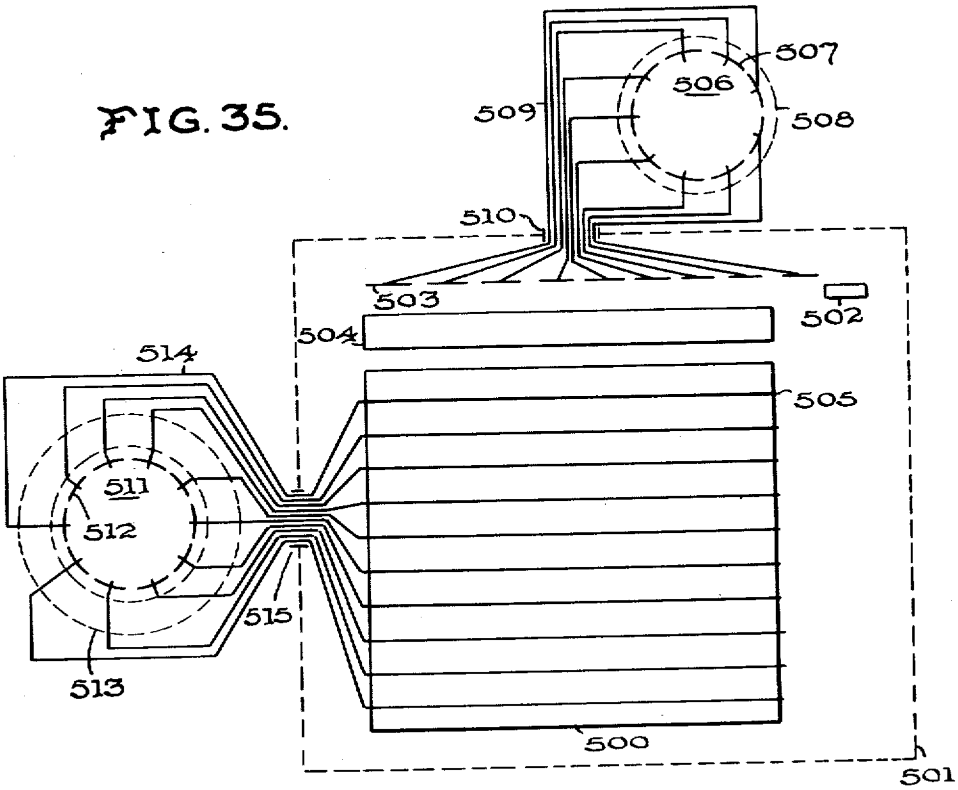
FIG. 35.



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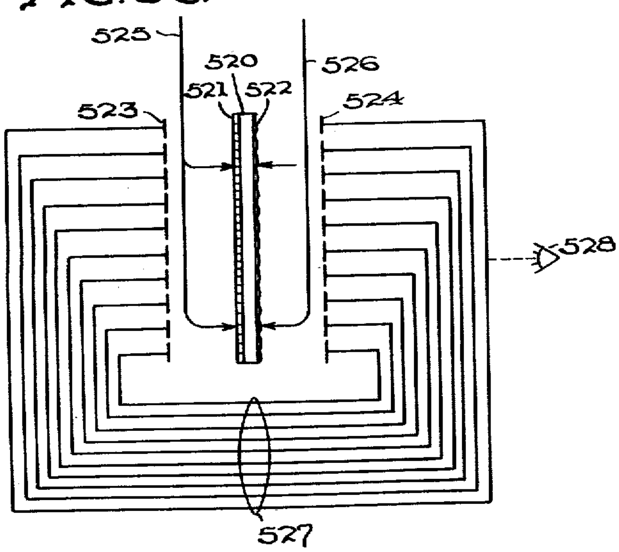

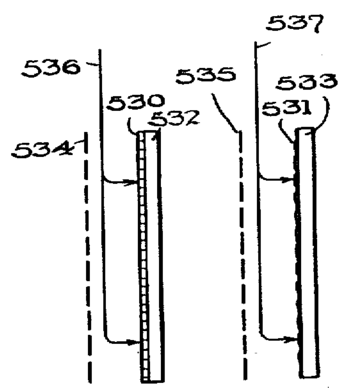

FIG. 37.

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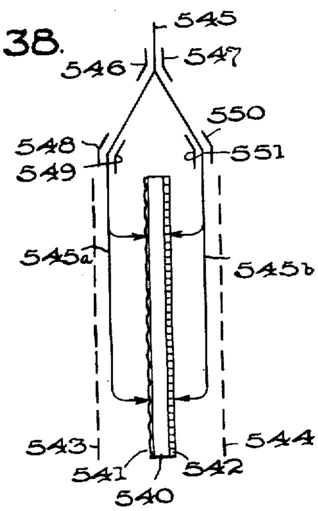
FIG. 38.



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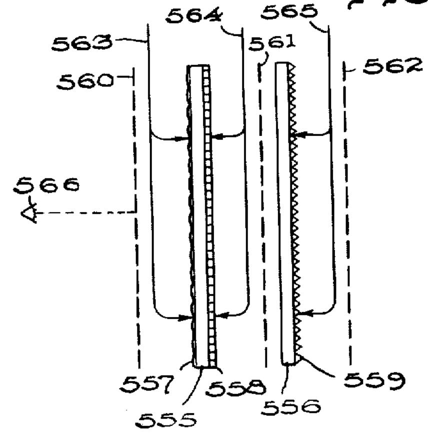


FIG. 40.

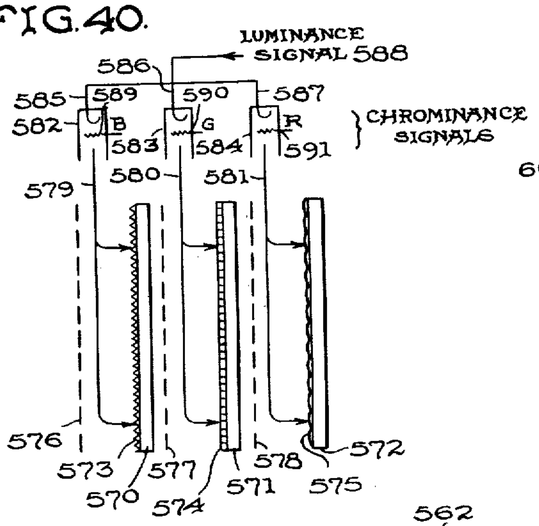
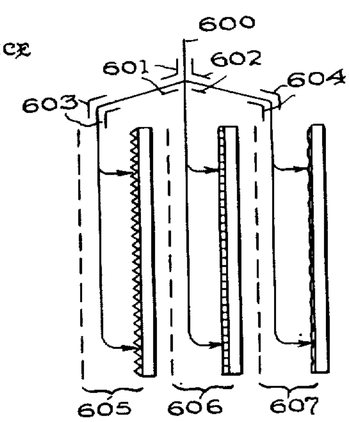


FIG. 41.



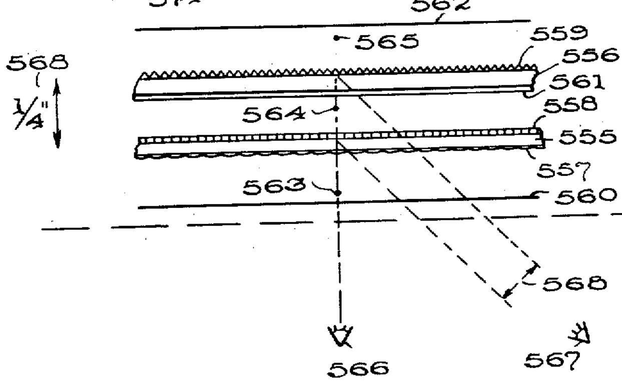


FIG. 42.

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FIG. 43.

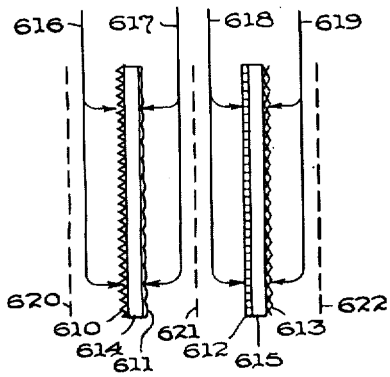
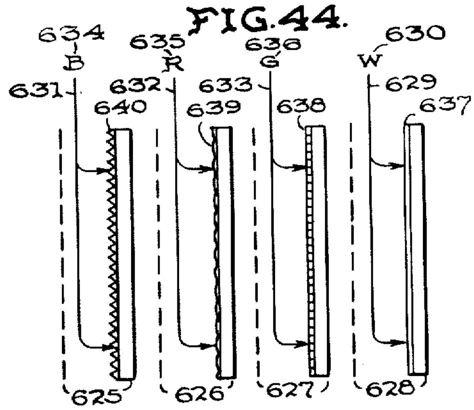


FIG. 44.



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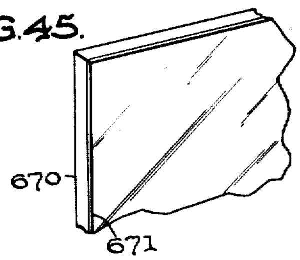


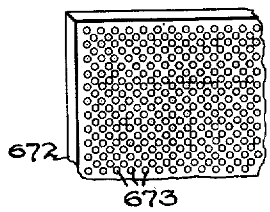
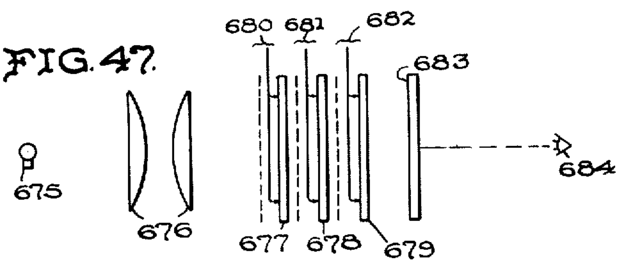


FIG. 46.

FIG. 47.



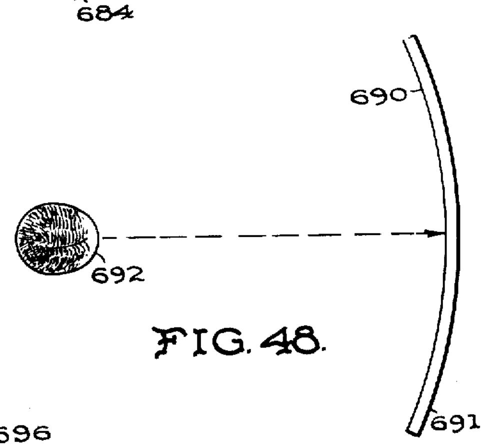


FIG. 48.

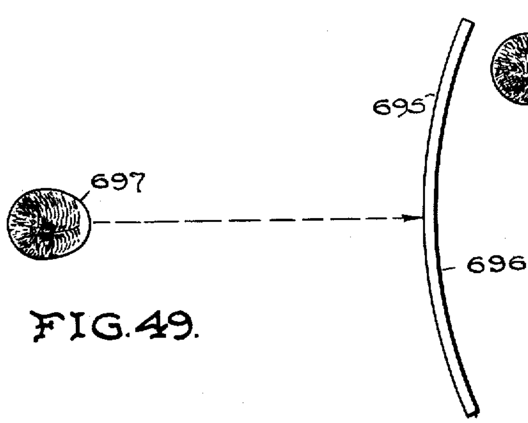


FIG. 49.

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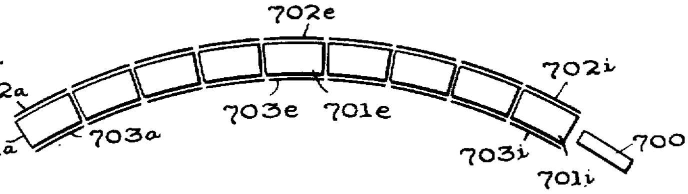
FIG. 50.



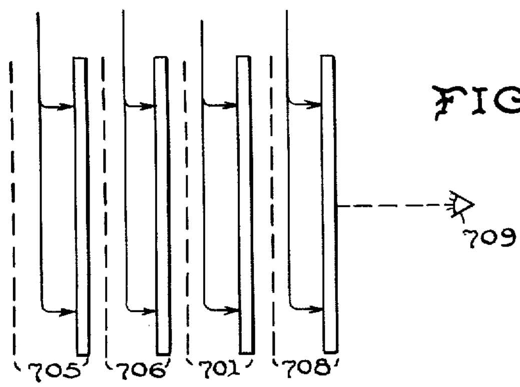


FIG. 51.

FIG. 52.

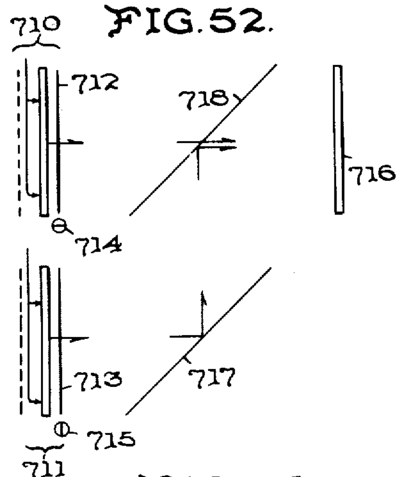


FIG. 53.

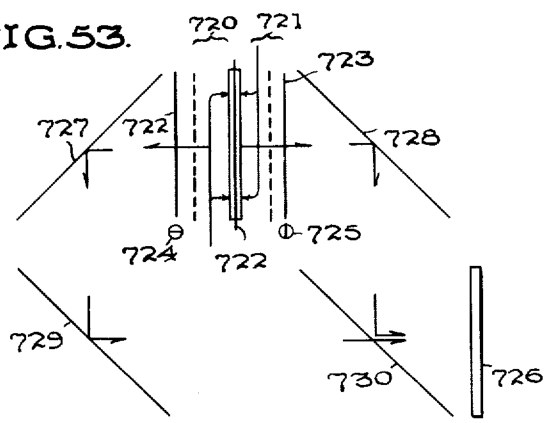


FIG. 55.

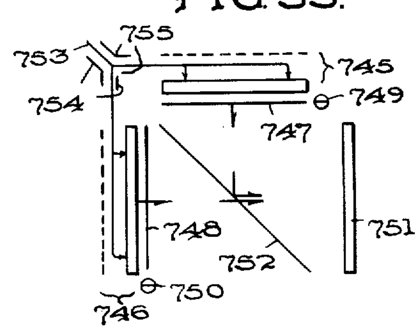


FIG. 54.

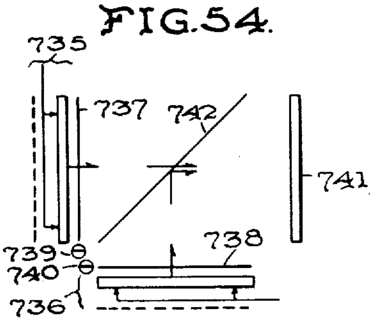


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FIG. 56.

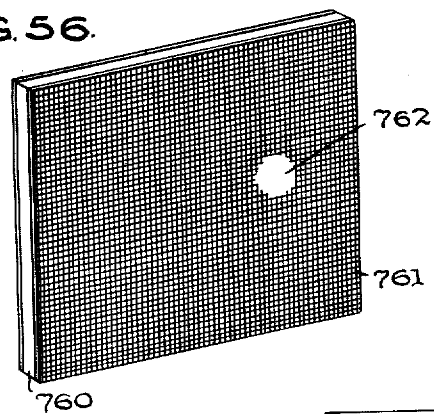

FIG. 57.

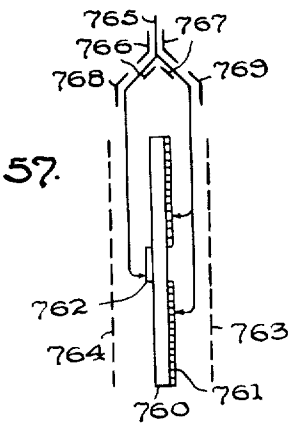

FIG. 58.

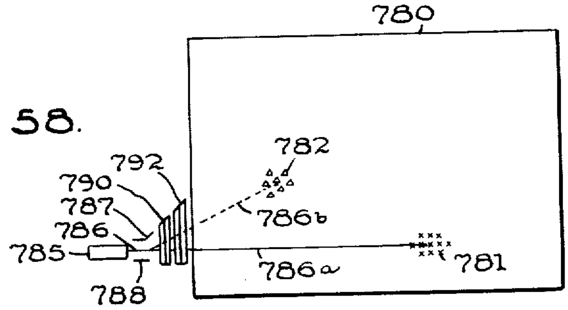

FIG. 59.

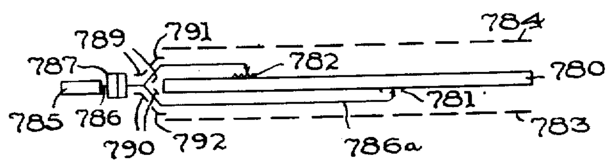

FIG. 60

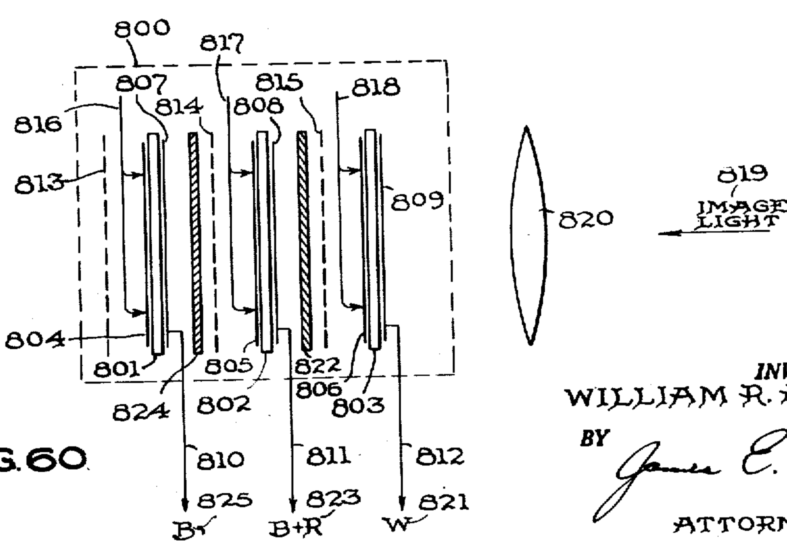

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FIG. 61.

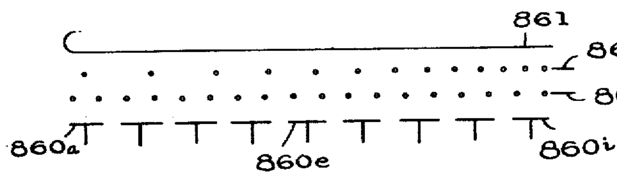

FIG. 62.

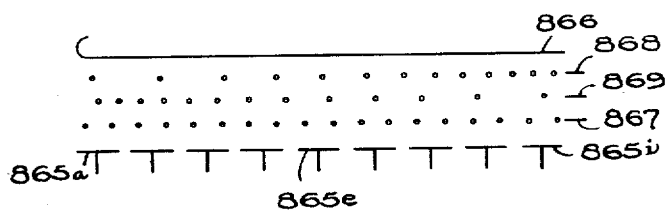

FIG. 63.

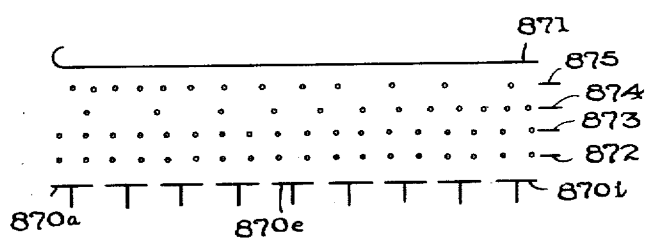

FIG. 64.

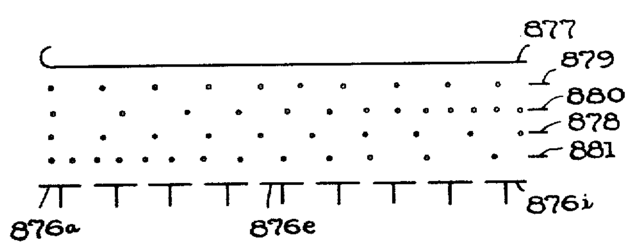

FIG. 65.

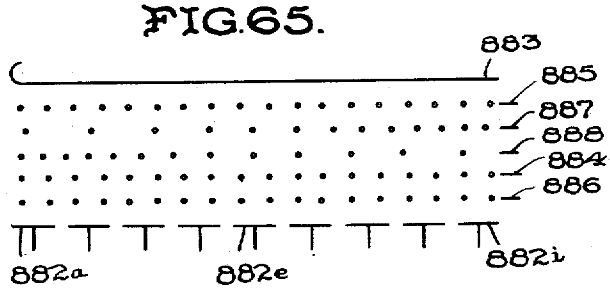

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FIG. 66.

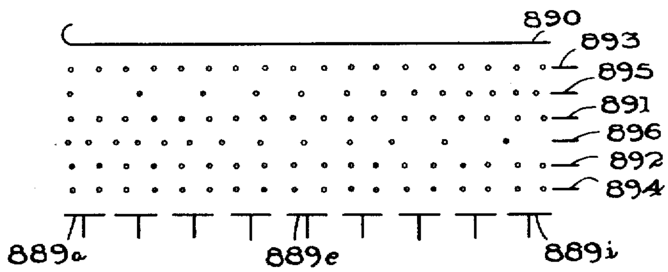

FIG. 67.

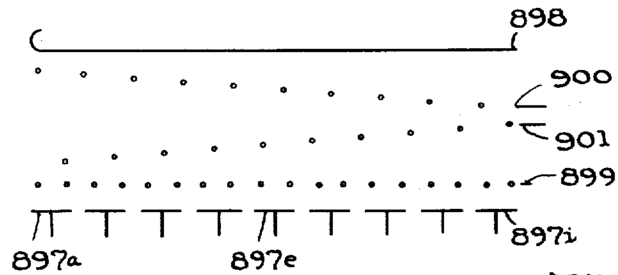

FIG. 68.

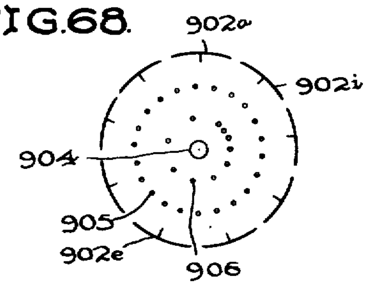

FIG. 69.

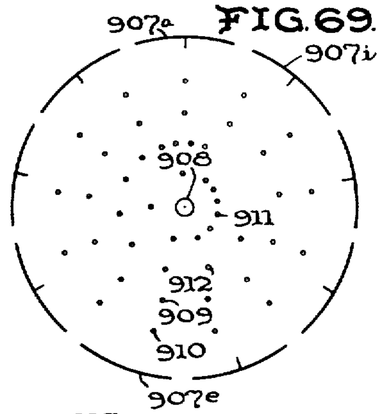

FIG. 71.

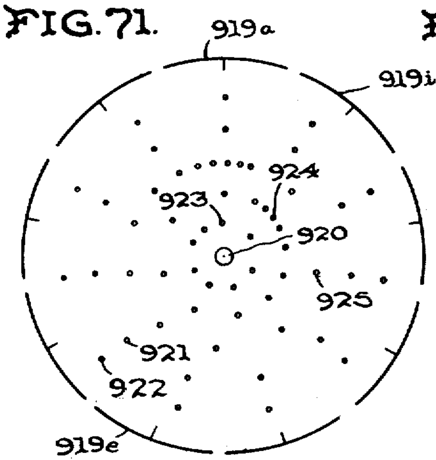

FIG. 70.

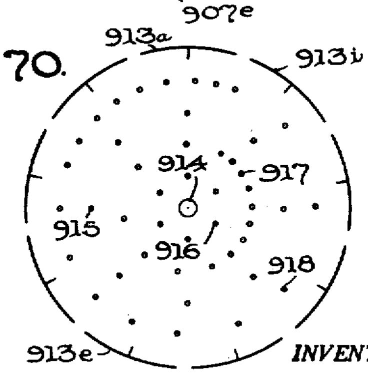

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FIG. 72.

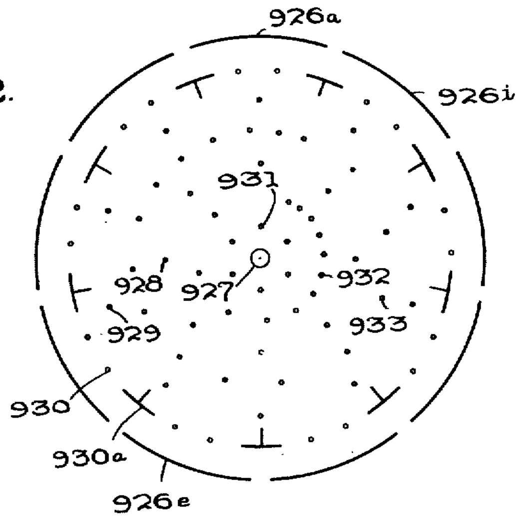


FIG. 73.

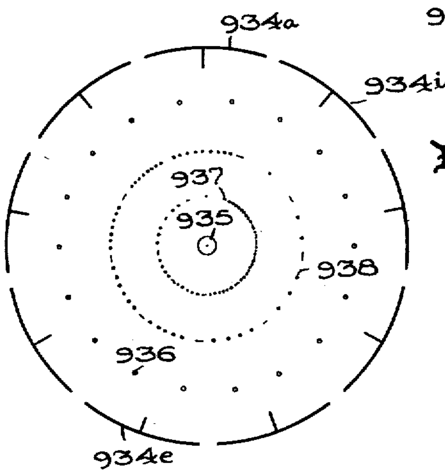
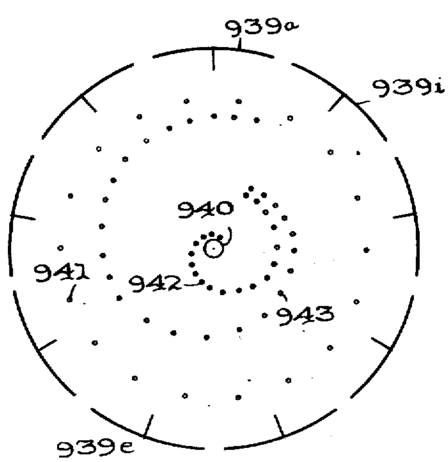


FIG. 74.



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2,795,731
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2,795,731

CATHODE RAY TUBE

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Application December 4, 1953, Serial No. 396,120

147 Claims. (Cl. 315—21)

The present invention generally relates to electric space discharge devices and more particularly relates to cathode ray tubes and beam deflection systems therefor. Certain features of the present invention relate primarily to cathode ray tubes for use in the fields of monochrome and polychrome television image presentation and control components therefor.

Heretofore, cathode ray tubes of general application, and particularly cathode ray tubes adapted for use in monochrome and polychrome image presentation, primarily have been of types wherein the electron source or sources and associated deflection systems are arranged to deliver the beam substantially perpendicular to or at substantial angles on the order of 45° or more with respect to the viewing screen.

Commercially practicable cathode ray tubes for presentation of color video signals and capable of use with dot-sequential or simultaneous color systems, such as the system recently developed by the NTSC, as heretofore proposed have all required use of dissimilar phosphor areas of line or elemental dimension, and further require complex grid or masking structures of fine constructional detail. Such presentation systems are necessarily difficult to produce because of such fine constructional detail, and are complicated to maintain in proper operating condition because of inherent critical alignment of the scan pattern of the electron beam or beams with the grid or masking structures throughout the raster area.

It is an object of this invention to present cathode ray tubes of simplified design.

It is another object of this invention to present cathode ray tubes of lesser volume and greater compactness than found in conventional cathode ray devices of comparable viewing area.

It is also an object of this invention to present cathode ray tubes which are extremely shallow in depth.

It is another object of this invention to present cathode ray tubes of design capable of ease of manufacture in large quantities.

It is another object of this invention to present cathode ray tubes of improved design adaptable for polychrome image presentation of either additive or subtractive type.

It is another object of this invention to present cathode ray tubes of simplified design suitable for polychrome image presentation capable of use with either simultaneous or sequential televsion video signal systems.

It is a further object of this invention to present cathode ray tubes of improved design suitable for polychrome image presentation and not requiring use of dissimilar phosphor areas of line or elemental dimension or use of fine detail grid or masking structures associated with a viewing screen.

It is a further object of this invention to present color image presentation systems which may be arranged to inherently provide superposed color images and image raster linearity.

It is a further object of this invention to present cathode

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ray tubes of improved design suitable for three dimensional image presentation.

It is an additional object of this invention to present cathode ray tubes of improved design suitable for polychrome radar signal presentation.

It is an additional object of this invention to present television camera image tubes of improved design, suitable for either monochrome or polychrome video signal generation.

It is an additional object of this invention to present control components particularly adapted for control of deflection of one or more electron beams in cathode ray scanning systems of the types presented.

It is yet another object of this invention to present multi-anode space discharge switching devices, particularly adapted for use with cathode ray scanning systems in accordance with the present invention and of wide application in electronic control circuits.

These and other objects of the invention will be apparent from the following description and accompanying drawings which serve to illustrate various exemplary embodiments thereof.

Fig. 1 is a diagrammatic presentation in block form of the general arrangement of a cathode ray tube and control components therefor as contemplated by the present invention, wherein an electron beam from a suitable electron source is delivered throughout the horizontal dimension of an image screen by a deflection system comprising at least one deflection element arranged to accomplish such deflection in a plane substantially parallel and adjacent to the image screen, and wherein the electron beam is further delivered throughout the vertical dimension of the image screen by a deflection system comprising at least one deflection element arranged to deflect said beam toward said image screen.

Fig. 2 is a schematic exploded perspective view of a monochrome cathode ray tube and associated components embodying certain features of the present invention, wherein the electron source is arranged to provide an electron beam in substantially parallel proximity with the viewing screen, wherein the horizontal sweep deflection system comprises a plurality of electrostatic deflection plates, the deflection control voltage to each of which is provided from a lineally arranged triode control tube comprising a variably spaced control grid, and wherein the vertical sweep deflection system comprises a plurality of electrostatic elongated plates arranged in a plane substantially parallel and slightly spaced from the viewing screen, the control voltages for said plurality of vertical sweep deflection plates being provided from a lineally arranged triode control tube comprising a variably spaced control grid.

Fig. 3 is a schematic exploded perspective view of a further embodiment of the present invention as applied to a monochrome cathode ray tube and associated components, wherein the electron source is arranged to provide an electron beam in substantially parallel proximity with the viewing screen, wherein the horizontal sweep deflection system comprises a plurality of electrostatic deflection elements, the deflection voltages being provided from a radially arranged pentode control tube comprising two inversely variably spaced control grids, the resulting initial deflection of the beam being at acute angles, and wherein the vertical sweep deflection system comprises a plurality of elongated plates arranged in a plane substantially parallel and adjacent to the viewing screen, the control voltages for said plurality of vertical sweep deflection plates being provided by scanning a plurality of collector plates respectively associated therewith by an electron beam.

Fig. 4 is a schematic exploded perspective view of a further embodiment of the present invention as applied to a monochrome cathode ray tube and associated components, wherein the electron source is arranged to provide an electron beam substantially parallel to and slightly offset from the viewing screen, wherein the horizontal sweep deflection system comprises a plurality of electrostatic grid wires, the control voltages to each of which is provided from a radially arranged triode control tube comprising a variably spaced control grid, and wherein the vertical sweep deflection system comprises a plurality of electrostatic grid wires arranged in a plate substantially parallel and adjacent to the viewing screen, the control voltages to each of which is provided from a radially arranged triode control tube comprising a variably spaced control grid.

Fig. 5 is a schematic exploded perspective view of a monochrome cathode ray tube and associated components utilizing further features of the present invention, wherein the electron source is arranged substantially parallel to and slightly offset from the viewing screen, wherein the horizontal sweep deflection system comprises a plurality of electromagnetic deflection elements, each respective deflecting field thereby being successively varied under control of a pentode control tube, and wherein the vertical sweep deflection system comprises a plurality of electrostatic elongated plates arranged in a plane substantially parallel and adjacent to the viewing screen, the control voltage for each of which is provided from a lineally arranged hexode control tube comprising two inversely and segmentally variably spaced control grids.

Fig. 6 is a schematic exploded perspective view of a monochrome cathode ray tube and associated components, further utilizing certain features of the present invention, wherein an electron source is arranged to provide an electron beam in substantially parallel proximity with the lower edge of the viewing screen, wherein the horizontal sweep deflection system comprises a single electrostatic deflection element spaced relatively close to the initial electron beam axis at points relatively remote from the electron source, the control voltage for single deflection element being provided by a pentode control tube, and wherein the vertical sweep deflection system comprises a single electrostatic deflection plate arranged relatively close to the viewing screen in its upper portion, the control voltage for said latter deflection plate being provided by a triode control tube.

Fig. 7 is a sectional presentation in schematic form of typical electrostatic sweep deflection elements to illustrate certain considerations involved in selection of sweep deflection control voltages and sweep deflection element dimensions to accomplish sweep linearity, particularly as applied to low order voltage sweep deflection systems of the types illustrated in Figs. 3 and 6.

Fig. 8 is a graphical presentation illustrating a typical characteristic sweep deflection beam position, as reflected by change in deflection or control voltage on a given horizontal deflection element in sweep deflection systems of the types presented in Figs. 3, 6 and 7.

Fig. 9 is a schematic front elevational view of a modified form of a plurality of sweep deflection elements, wherein said deflection elements are of curved configuration to provide a satisfactorily linear sweep rate under given control conditions.

Fig. 10 is a schematic front elevational view of a modified form of a plurality of sweep deflection elements, wherein portions of said deflection elements are slanted with respect to the initial electron beam trajectory in order to provide a satisfactorily linear sweep rate under given control conditions.

Fig. 11 is a schematic front elevational view of a modified form of single sweep deflection element, wherein said single deflection element is of curved configuration in order to provide a satisfactorily linear sweep rate under given control conditions.

Fig. 12 is a schematic bottom elevational view of a plurality of electromagnetic horizontal sweep deflection elements individually arranged to provide a magnetic field of relatively greater density in positions thereof remote from the electron beam source.

Fig. 13 is a schematic perspective view of one of the plurality of magnetic deflection elements illustrated in Fig. 12.

Fig. 14 is a schematic bottom view of a plurality of the electromagnetic deflection elements for use in a horizontal deflection system according to the present invention, constructed and arranged to provide magnetic fields of relatively greater density at points relatively remote from the electron beam source.

Fig. 15 is a schematic perspective view of one of the plurality of electromagnetic deflection elements illustrated in Fig. 14.

Fig. 16 is a schematic front elevational view of a single electromagnetic deflection element, suitable for use in a horizontal sweep deflection system according to the present invention, wherein a non-linear magnetic field of greater density relatively remote from the electron source is provided by variably spaced pole piece faces of relatively lesser spacing in the portions relatively remote from the electron source.

Fig. 17 is a schematic end elevational view of the electromagnetic deflection element illustrated in Fig. 16, as viewed from the end remote from the electron source.

Fig. 18 is a schematic bottom view of the electromagnetic deflection element illustrated in Figs. 16 and 17.

Fig. 19 is a schematic front elevational view of a modified arrangement of a single electromagnetic horizontal sweep control deflection element and electron source, wherein horizontal sweeping may be accomplished by change in magnetic field intensity or velocity modulation of the electron beam.

Fig. 20 is a schematic end elevational view of the electromagnetic deflection element illustrated in Fig. 19.

Fig. 21 is a schematic front elevational view of another modified form of a single electromagnetic horizontal sweep deflection element of the general type disclosed in Figs. 19 and 20, wherein the pole pieces are modified in construction to provide a closer spacing and consequent increased magnetic field density in the latter portion of the beam trajectory therebetween to provide a substantially vertical beam exit direction.

Fig. 22 is a schematic end elevational view of the arrangement illustrated in Fig. 21.

Fig. 23 is a schematic front elevational view of a modified arrangement of horizontal sweep deflection system, wherein the electron source, and the associated horizontal sweep deflection elements and accelerating elements are inclined at a slight angle to position portions of the system which are relatively remote from the electron beam source relatively near the viewing screen to provide a more vertical beam trajectory under given conditions.

Fig. 24 is a schematic front elevational view of a modified arrangement of electron source and horizontal sweep control system wherein the electron source is arranged in a plane parallel to and slightly offset from the viewing screen and arranged a distance above the screen, wherein horizontal sweep deflection is accomplished by use of opposing deflection plates, and wherein vertical sweep deflection is accomplished by a plurality of electrostatic deflection elements arranged in a plane substantially parallel and adjacent to the viewing screen.

Fig. 25 is an end elevational view of the arrangement illustrated in Fig. 24.

Fig. 26 is a schematic front elevational view of a modified arrangement of the viewing screen, horizontal deflection system, and electron source wherein the electron source is arranged to provide a "folded" electron beam trajectory having an initial portion substantially parallel to the vertical side of the viewing screen.

Fig. 27 is a schematic front elevational view of the viewing screen, electron source, and associated horizontal deflection elements, wherein the electron source is "folded" to provide an electron beam trajectory having an initial portion substantially opposite in direction from the trajectory direction during horizontal sweep deflection.

Fig. 28 is a schematic front elevational view illustrating a further arrangement as contemplated by the present invention, wherein the vertical sweep deflection system comprises a plurality of electromagnetic deflection elements which may be selectively energized to accomplish vertical sweep control in a manner similar to that employed for control of the plurality of electromagnetic deflection elements presented in Fig. 5.

Fig. 29 is a schematic perspective view of one of the electromagnetic deflection elements and associated viewing screen, as illustrated in Fig. 28.

Fig. 30 is a schematic front elevational view illustrating a further arrangement wherein a plurality of electromagnetic deflection elements are constructed and arranged to accomplish vertical sweep deflection by presenting a non-linear magnetic field of greater density relatively remote from the electron source when said elements are simultaneously energized.

Fig. 31 is a schematic perspective view of one of the electromagnetic deflection elements illustrated in Fig. 30.

Fig. 32 is a schematic view of a typical control arrangement for a plurality of deflection elements wherein a single triode control tube is associated with each deflection element.

Fig. 33 is a schematic view of a typical control arrangement for a plurality of deflection elements wherein a single diode control tube is associated with each deflection element.

Fig. 34 is a schematic front elevational view of a viewing screen, associated deflection elements, and deflection control tubes, wherein the viewing screen, deflection elements, and control tubes are arranged in a common envelope.

Fig. 35 is a schematic front elevational view of a viewing screen, associated deflection elements, and deflection control tubes, wherein the viewing screen and deflection element control tubes are arranged in separate envelopes.

Fig. 36 is a schematic end elevational view illustrating one manner in which the concepts of the present invention may be employed in polychrome image presentation, wherein two-color image presentation is accomplished by use of different colored phosphors on a common transparent viewing plate and separate electron beams are employed, this embodiment serving to further illustrate the concept of electrical connection of like deflection elements respectively associated with a plurality of viewing screens.

Fig. 37 is a schematic end elevational view illustrating another arrangement for two-color presentation, wherein different colored phosphors are associated with separate transparent plates, and wherein separate electron beams are utilized.

Fig. 38 illustrates a further form of two-color presentation, wherein two phosphor coatings are applied to a common transparent plate and a common electron source is employed.

Fig. 39 illustrates an exemplary full-color embodiment of the present invention, wherein three primary colors are utilized, phosphors of two colors being applied to opposite sides of a common transparent plate and a phosphor of a third color is applied to a separate plate, the arrangement further utilizing separate electron beams for activation of each phosphor surface.

Fig. 40 illustrates a further full-color embodiment of the present invention, wherein a separate plate is utilized for phosphors of each of the three primary colors and separate electron beams are employed.

Fig. 41 illustrates an additional full-color embodiment of the present invention, wherein three phosphor surfaces are activated from a single electron beam source.

Fig. 42 is a top sectional presentation in schematic form of a full-color arrangement of viewing screens, such as presented in Fig. 39, for example, to set forth considerations of parallax as affecting superposition of the color images.

Fig. 43 illustrates a further embodiment of full-color presentation in accordance with the present invention, wherein phosphors of four primary colors, red, green, blue, and yellow being shown by way of example, are respectively applied to opposing faces of two separate transparent plates.

Fig. 44 illustrates a further embodiment of the present invention, wherein four color signal components are respectively applied to four electron sensitive surfaces arranged from the viewer in the order blue, red, green, and white.

Fig. 45 is a detail perspective view of a typical electron sensitive color surface, wherein said surface is of substantially uniform continuity and of thickness to provide partial transparency.

Fig. 46 is a detail perspective view of a modified form of electron sensitive color surface, wherein the electron sensitive material is arranged in discontinuous, substantially non-transparent dots with adjacent uncoated portions to provide overall partial transparency.

Fig. 47 illustrates a typical embodiment of the present invention as applied to a subtractive color system, wherein a white light source and an image projection system are employed.

Fig. 48 is a plan view which schematically illustrates an embodiment of the present invention suitable for three dimensional presentation, wherein panoramic depth perception is accomplished by arranging a viewing screen to provide a concave viewing surface.

Fig. 49 is a schematic plan view of a further embodiment of the present invention suitable for panoramic presentation, wherein a viewing screen is arranged to provide a convex viewing surface.

Fig. 50 is a detail top view of one form of deflection elements which may be employed in association with the panoramic presentations illustrated in Figs. 48 and 49, wherein the electron beam is delivered throughout the horizontal dimension of the curved viewing screen by maintaining field defining elements on the convex side of the viewing screen at a slightly higher deflection potential than is maintained on respectively associated deflection elements on the concave side of said viewing screen.

Fig. 51 is a further embodiment of the present invention, wherein a plurality of viewing screen systems are arranged in depth to provide three dimensional presentation of a relief character.

Fig. 52 is a further embodiment of the present invention suitable for three dimensional presentation, wherein two viewing screen systems are arranged in a side-by-side manner and respectively associated with polarizing filters, a suitable projection system being provided to produce an image having stereoptic properties when viewed with polarizing viewing filters.

Fig. 53 is a modified form of stereoptic three dimensional presentation of the general type presented in Fig. 52, wherein two viewing screen systems are arranged in an opposing manner.

Fig. 54 is a modified form of the type of three dimensional presentation shown in Fig. 52, wherein two viewing screen systems are arranged in a respectively perpendicular manner.

Fig. 55 is a further modified form of the type of three dimensional presentation shown in Fig. 52, wherein two viewing screen systems are arranged in a respectively perpendicular manner and a single electron source is employed.

Fig. 56 illustrates a perspective view of one typical application of the present invention to radar signal presentation, involving presentation of moving radar targets in one color and stationary radar targets in another color.

Fig. 57 is an end elevational view of the type of presentation illustrated in Fig. 56, schematically showing the arrangement of vertical sweep deflection elements therewith.

Fig. 58 illustrates a front elevational view of another typical application of the present invention to radar signal presentation.

Fig. 59 is a top schematic view of the type of presentation illustrated in Fig. 58, schematically showing the arrangement of horizontal sweep deflection elements therewith.

Fig. 60 illustrates a typical application of the present invention to polychrome television camera image tubes for producing chromatic and/or black and white video signals.

Fig. 61 illustrates a schematic arrangement of a lineal tetrode control tube.

Fig. 62 illustrates a schematic arrangement of a lineal pentode control tube.

Fig. 63 illustrates a schematic arrangement of a lineal hexode control tube.

Fig. 64 illustrates a schematic arrangement of another form of lineal hexode control tube.

Fig. 65 illustrates a schematic arrangement of a lineal heptode control tube.

Fig. 66 illustrates a schematic arrangement of a lineal octode control tube.

Fig. 67 illustrates a schematic arrangement of a lineal pentode control tube, wherein the desired control characteristics are accomplished by a variable spacing between the portions of the tube components.

Fig. 68 is a schematic arrangement of a radial tetrode control tube.

Fig. 69 is a schematic arrangement of a radial hexode control tube.

Fig. 70 is a schematic arrangement of a modified radial hexode control tube.

Fig. 71 is a schematic arrangement of a radial heptode control tube.

Fig. 72 is a schematic arrangement of radial octode control tube.

Fig. 73 is a schematic arrangement of a modified form of radial pentode control tube wherein the variable spacing of the two control grids is respectively and inversely segmental.

Fig. 74 is a further modification of a radial pentode control tube, wherein the desired characteristics are accomplished by variably spacing associated portions of the tube components.

Fig. 75 is a perspective view illustrating the exterior of an electronic picture television tube embodying the invention.

The present invention, as generally illustrated in block form in Fig. 1, broadly contemplates cathode ray tubes comprising electron beam scanning arrangements wherein an electron beam source **1** is disposed in such a manner relative to an electron sensitive image screen **2**, in an evacuated envelope, not shown, to produce an electron beam **3** in substantially parallel proximity with the electron sensitive surface of said image screen **2** and wherein said electron beam **3** is subjected to a horizontal sweep deflection system **4**, preferably controlled by a horizontal deflection voltage **5** of generally conventional waveform and frequency from a suitable scanning voltage source **6** and operable to deflect the electron beam **3** downwardly parallel and adjacent to the electron sensitive surface of image screen **2** consecutively and successively to various horizontally disposed portion of said image screen **2**, the electron beam **3** thereby being delivered to a vertical sweep deflection system **7**, operable to further deflect the electron beam **3** at consecutive and successive vertically disposed levels throughout the vertical dimension of image screen **2**, the vertical sweep deflection system **7** preferably being responsive to a suitable, conventional frequency, vertical sweep voltage **8** of generally conventional waveform derived from scanning voltage source **6**. As will be more fully apparent from the specific embodiments of the invention hereinafter presented, horizontal sweep deflection system **4** and vertical sweep deflection system **7** each comprise one or more sweep deflection elements arranged to accomplish the desired deflection by virtue of deflection control voltages delivered thereto by associated control components. This invention also contemplates advantageous arrangements of pluralities or combinations of such electron beam scanning arrangements as set forth in Fig. 1 in superposed relation to provide polychrome video signal presentation or generation. This invention further contemplates various three dimensional presentation arrangements advantageously utilizing beam scanning arrangements as set forth in Fig. 1.

In one arrangement for image presentation as contemplated by the present invention, as illustrated in Fig. 2, viewing screen **10** comprises an electron sensitive material surface **11**, such as luminescent phosphor, coated upon a suitably optically transparent supporting plate **12**, of material such as glass or mica. An electron beam source **13**, which may be an electron gun of conventional design, is arranged above and slightly offset from the electron sensitive material **11** and positioned relative thereto to impart to the electron beam **14** an initial trajectory in substantially parallel proximity with the upper edge of the viewing screen **10**, as indicated in the exploded illustration. It will be readily understood that, in this as well as other embodiments of the invention hereinafter presented, electron beam **14** is appropriately intensity modulated by the video signal of the image developed on viewing screen **10**, in a manner known to the art.

The horizontal sweep deflection system employed in the embodiment illustrated in Fig. 2 comprises a beam control zone defined by a plurality of electrostatic deflection elements **15** individually identified by the suffix letters *a* through *i*, respectively, and field defining elements **16** and **17**, as shown. The control zone for the trajectory of electron beam **14** is provided by connection of field defining elements **16** and **17** directly to a suitable high voltage source indicated at **18**, and connection of deflection elements **15*a*** through **15*i***, inclusive, to high voltage source **18** through high order resistances **19*a*** through **19*i***, inclusive, individually associated therewith. Horizontal sweep deflection control of electron beam **14** by sweep deflection elements **15*a*** through **15*i***, inclusive, requires the electrostatic potential of a given deflection element **15**, taking deflection element **15*e*** for example, to be reduced from the potential of high voltage source **18** to a low order potential. Successive low order potentials on deflection elements **15*a*** through **15*i***, inclusive, to accomplish successive delivery of electron beam **14** in successive substantially vertical trajectories adjacent to electron sensitive surface **11** substantially throughout the horizontal dimension thereof, are derived from a control tube generally indicated at **20** of the lineal triode type, comprising a plurality of anodes **21*a*** through **21*i***, inclusive, a common cathode **22** maintained at a negative high voltage by connection with a suitable negative high voltage source **23** and a variably spaced control grid **24**, to which is applied a suitable horizontal sweep voltage, such as indicated at **25** of initial potential to establish control tube **20** in non-conductive condition as to all of anodes **21** except anode **21*a*** at the time of initiation of horizontal sweep and of amplitude to cause electron beam **14** to be deflected throughout the horizontal dimension of the viewing screen **10** during the horizontal sweep period.

By operation of the above described typical horizontal sweep deflection system, it will be apparent that during a given instant of horizontal sweep, such as when anode **21*e***, for example, of control tube **20** assumes conductive condition, the relatively negative potential on deflection element 15*e* will serve to deflect the electron beam 14 in a substantially vertical direction adjacent and substantially parallel to electron sensitive surface 11.

Considering further the arrangement illustrated in Fig. 2, the vertical sweep deflection system employed in conjunction with the horizontal sweep deflection system above described is in several aspects similar thereto. A plurality of electrostatic sweep deflection elements 26, individually identified by the suffix letters *a* through *j* respectively, are arranged substantially parallel and adjacent to the viewing screen 10 and spaced therefrom a distance to permit passage of the successive, contiguous substantially vertical trajectories of electron beam 14 therebetween. As indicated at 27, electron sensitive surface 11 is maintained at high voltage by connection with high voltage source 18 to provide a vertical sweep control zone with said vertical sweep deflection elements 26 for said successive trajectories. Sweep deflection elements 26*a* through 26*j*, inclusive, are respectively and individually connected to high voltage source 18 through suitable high order resistances 28*a* through 28*j*, inclusive. A suitable vertical sweep deflection control tube of the lineal triode type, generally indicated at 29, comprises a plurality of anodes 30, individually identified by the suffix letters *a* through *j*, inclusive, which anodes 30 are respectively and individually connected to deflection elements 26*a* through 26*j*, inclusive. Said control tube 29 further comprises a common low order voltage cathode 31 and a variably spaced control grid 32, and serves to deliver the desired deflection potentials to deflection elements 26*a* through *j*, inclusive, in a successive and consecutive downward manner when a suitable vertical sweep voltage is impressed upon variably spaced control grid 32 as indicated at 33, which vertical sweep voltage 33 is of initial potential to establish all of anodes 30 in conductive condition in order to initiate the vertical sweep at the upper portion of viewing screen 10. Thus, at a given instant of vertical sweep, when anode 30*d* assumes non-conductive condition for example, electron beam 14 will be deflected by deflection element 26*e* toward electron sensitive surface 11 and cause optical activation of a portion of said viewing screen 10 by impingement or registration therewith, as indicated at 34.

Another embodiment of the present invention, as illustrated in Fig. 3, utilizes a modified form of horizontal deflection system employing a relatively low order deflection control voltage and acute initial horizontal sweep deflection angles. This embodiment further utilizes a modified form of vertical sweep deflection control utilizing an electron beam switching arrangement.

Considering the arrangement illustrated in Fig. 3 in greater detail, viewing screen 40 comprises an electron sensitive surface 41 coated upon a suitable optically transparent target plate 42, as in the embodiment illustrated in Fig. 2. Low order voltage electron source 43 is arranged above and slightly offset from electron sensitive surface 41 and similarly positioned relative thereto to impart to the electron beam 44 an initial trajectory in substantially parallel proximity with the upper horizontal edge of the viewing screen 40.

The horizontal sweep deflection system shown in Fig. 3 comprises a beam control zone defined by a plurality of electrostatic deflection elements 45, three of which are indicated at 45*a*, 45*e* and 45*i*, and said control zone being further defined by field defining elements 46 and 47. The accelerating field for the initial trajectory of electron beam 44 is provided by connection of field defining elements 46 and 47 directly to a suitable B+ voltage source indicated at 48 and separate connection of deflection elements 45 to B+ voltage source 48 through load resistances 49, three being indicated at 49*a*, 49*e*, and 49*i*. Horizontal sweep deflection control of electron beam 44 by deflection elements 45 requires that the electrostatic potential of a given deflection element 45, taking deflection elements 45*e* for example, is reduced from the potential of B+ voltage source 48 to a low order potential. Successive low order potentials on consecutive deflection elements 45 to accomplish successive delivery of electron beam 44 substantially throughout the horizontal dimension of the high voltage accelerating and focusing zone hereinafter described, are derived from a control tube of the radial pentode type, generally indicated at 50. Radial control tube 50 comprises a plurality of anodes 51, four being indicated at 51*a*, 51*d*, 51*e* and 51*i*, individually connected to said elements 45, a low order voltage common cathode 52, two inversely variably spaced control grids 53 and 54, and a low order voltage suppressor grid 55. Suitable horizontal sweep voltages, such as indicated at 56 and 57, are respectively applied to control grids 53 and 54 and are of initial potentials to establish control tube 50 in non-conductive condition as to all of anodes 51 except anode 51*a* at the time of initiation of horizontal sweep and of amplitudes to establish said elements 45 successively and consecutively in conductive condition to cause the electron beam 44 to be deflected throughout the horizontal dimension of viewing screen 40 during the horizontal sweep period. It will be understood that optimum design of radial control pentode 50 requires that control grids 53 and 54 are constructed to provide that when a given anode, such as 51*e* for example, assumes conductive condition the preceding anode, 51*d*, is maintained in conductive condition for a time sufficient to prevent distortion of the relatively negative deflection field presented electron beam 44 by deflection element 45*e*.

Upon initial deflecton of the electron beam and exit thereof from the initial control zone at point 58, for example, the electron beam trajectory passes through focusing anodes 59 and 60 maintained at a suitable focusing potential by connection to a high voltage source 61 through a suitable variable resistance focus control 62. Accelerating anodes 63 and 64 are directly connected to high voltage source 61 as indicated at 65 and 66. Focusing anodes 59 and 60 and accelerating anodes 63 and 64 conjunctively define a focusing and accelerating zone and operate to focus and accelerate electron beam 44 to thereby deliver said beam 44 in successive substantially vertical beam trajectories, one such beam trajectory being shown at 67.

It will be apparent that the arrangement of horizontal sweep deflection elements in conjunction with focusing and accelerating anodes presented in Fig. 3 provides certain design advantages over the type of horizontal sweep deflection presented in Fig. 2 in that a low order horizontal sweep deflection control is accomplished.

By use of the above described two stage horizontal sweep deflection system, it will be apparent that during a given instant of horizontal sweep such as when anode 51*e*, for example, of control tube 50 assumes conductive condition, the relative negative potential on deflection element 45*e* will serve to deflect the electron beam 44 downwardly at a substantial angle and cause the deflected beam to enter the field defined by field defining electrodes 46 and 47 and the focusing and accelerating zone defined by anodes 59, 60, 63 and 64, and that the accelerating and focusing effect of said latter zone will cause the beam trajectory to be further deflected and delivered adjacent viewing screen 40 in a substantially vertical direction, as indicated at 67.

Considering further the arrangement illustrated in Fig. 3, the modified form of vertical sweep deflection system therein employed utilizes a plurality of electrostatic sweep deflection elements 70, three being indicated at 70*a*, 70*e*, and 70*j*, which are arranged substantially parallel and adjacent to the viewing screen 40 a distance to permit passage of electron beam 44 therebetween. As indicated at 71, electron sensitive surface 41 is maintained at high voltage by connection with high voltage source 61 to constitute a vertical sweep control zone with said sweep deflection elements 70. Deflection elements 70 are respectively and individually connected to high voltage source 61 through suitable high order resistances 72, three being indicated at 72a, 72e and 72j. The sweep deflection control voltages necessary for sweeping control of deflection elements 70 are generated in this embodiment by operation of an electron beam switching unit, generally indicated at 73, which comprises a plurality of electron collector plates 74, three being indicated at 74a, 74e and 74j, which are respectively and individually connected to deflection elements 70, said electron beam switching unit in turn comprising a suitable low order voltage electron beam source 75 and beam deflection elements 76 and 77 arranged to successively deliver an electron beam 78 from said source 75 consecutively to electron collector plates 74a through 74j in that order when suitable vertical sweep voltages 79 and 80 are respectively applied to deflection elements 76 and 77. The initial potentials of vertical sweep voltages 79 and 80 are selected to cause impingement of electron beam 78 on electron collector plate 74a as indicated at 78a at the time of initiation of the vertical sweep at the upper portion of viewing screen 40. Thus, at a given instant of vertical sweep, for example, when electron beam 78 impinges upon electron collector plate 74e, as indicated at 78e, deflection element 70e assumes a relatively low order voltage and electron beam 44 is deflected by said deflection element 70e toward and impinges on electron sensitive surface 41 to cause optical activation thereof, as indicated at 81.

In the embodiment shown in Fig. 3, as well as in other embodiments of the invention herein disclosed, dynamic focusing may be employed, as by superimposing increments of the horizontal and vertical sweep control voltages to a focusing means, such as in electron source 43 or electrodes 59 and 60 in Fig. 3, for example. It is also possible to improve focus parameters in certain instances in arrangements as disclosed herein by suitably varying the relative spacing between portions of various elements. Thus, focusing electrodes 59 and 60 in Fig. 3, for example, may be spaced relatively close at opposing portions thereof relatively remote from electron source 43 and/or vertical sweep deflection elements 70, for example, may be arranged at a slight angle, though still substantially parallel, with electron sensitive surface 41, in order to improve the focus of electron beam 44 at various points of contact thereof with electron sensitive surface 41 where maximum focus throughout the raster area is desired.

A further modified embodiment of the invention, as illustrated in Fig. 4, is arranged generally similar to the embodiments presented in Figs. 2 and 3, but utilizes horizontal and vertical sweep deflection elements comprising elongated wires arranged at right angles to the beam trajectory, and further utilizes horizontal and vertical deflection control tubes of the radial triode type wherein a variably spaced control grid is employed.

Considering the embodiment illustrated in Fig. 4 in more detail, the general arrangement of viewing screen 100, low order voltage electron beam source 101, and electron beam 102 is as corresponding elements are presented in Fig. 2.

The modified horizontal sweep deflection system employed in the embodiment illustrated in Fig. 4 comprises a plurality of electrostatic sweep deflection wires 103, three being indicated at 103a, 103f, and 103k, connected through high order resistances 104, three being shown at 104a, 104f, and 104k, to a high voltage source 105. The horizontal sweep control zone for the initial trajectory of electron beam 102 further comprises field defining elements 106 and 107 connected directly to high voltage source 105, as indicated at 108 and 109. The horizontal sweep deflection control tube, generally indicated at 110, comprises a plurality of anodes 111, three being indicated at 111a, 111f, and 111k, respectively and individually connected with horizontal sweep deflection elements 103, and further comprises a common low order voltage cathode 112 maintained at a suitable negative voltage by connection with a negative high voltage source 113 and a variably spaced control grid 114. In the general manner previously indicated, reduced potential sweep deflection control voltages are consecutively delivered to deflection wires 103 by impressing upon control grid 114 of control tube 110 a suitable horizontal sweep voltage as indicated at 115 of initial potential to establish a conductive condition only with respect to anode 111a at the time of initiation of horizontal sweep, and of amplitude to cause electron beam 102 to be deflected throughout the horizontal dimension of viewing screen 100 during the horizontal sweep period. Thus, when a given control tube anode, taking 111f for example, assumes conductive condition, deflection element 103f is reduced to a low order potential and electron beam 102 will be deflected substantially vertically and in a direction substantially parallel and adjacent to viewing screen 100.

Vertical sweep deflection wires 116, three of which are indicated at 116a, 116c, and 116g, are supported in a suitable manner such as by insulators 117 and 118, and are arranged substantially parallel to the electron sensitive surface 119 of viewing screen 100 and spaced therefrom a distance to allow passage of electron beam 102 therebetween and are connected to high voltage source 105 through high order resistance 120, three being indicated at 120a, 120c, and 120g. The vertical sweep control zone for said electron beam 102 is completed by connection of said electron sensitive surface 119 to said high order voltage source 105, as indicated at 127.

The vertical deflection sweep control tube, indicated generally at 121, comprises a plurality of anodes 122, three being indicated at 122a, 122c, and 122g, a common cathode 123 connected to negative voltage source 113 and a variably spaced control grid 124. In a manner similar to that described in connection with previous vertical sweep deflection control circuits, a vertical sweep voltage such as indicated at 125 is delivered to control grid 124 of control tube 121 of initial potential to establish all of anodes 122 in conductive condition upon initiation of vertical sweep. Thus, when anode 122c assumes non-conductive condition, electron beam 102 will be deflected toward and impinge upon electron sensitive surface 119 of viewing screen 100, as indicated at 126.

In a further modified embodiment of the present invention, as illustrated in Fig. 5, a horizontal deflection system employing a plurality of electromagnetic sweep deflection elements is presented, wherein the energizing circuit for each of the plurality of electromagnetic sweep deflection elements comprises an individually connected pentode control tube. The arrangement presented in Fig. 5 is a further modification of embodiments earlier presented in that the vertical sweep deflection system employs a modified form of control tube, specifically a lineally arranged hexode, comprising two inversely and segmentally variably spaced control grids.

Considering the arrangement shown in Fig. 5 in further detail, the viewing screen 130, comprising the electron sensitive surface 131 coated on a suitable transparent plate 132, the low order voltage electron source 133, and electron beam 134 are respectively associated in the manner illustrated in exploded form in Fig. 2. The horizontal sweep deflection system shown in Fig. 5 comprises a horizontal sweep control zone defined by a plurality of electromagnetic horizontal sweep deflection elements 135, three of which are indicated at 135a, 135e, and 135i, maintained at a suitable electrostatic potential by connection to a B+ voltage source 136. Further defining the control zone for the beam trajectory with said electron deflection elements 135 are field defining elements 137 and 138 arranged as shown and directly connected to said B+ voltage source 136 as indicated at 139 and 140, it being understood that the initial trajectory of electron beam 134 lies equispaced between the pole pieces 135a′ and 135a″ of deflection elements 135. Each of electromagnetic sweep deflection elements **135** is respectively connected in parallel with a plurality of damping resistances **141**, three of which are indicated at **141***a*, **141***e*, and **141***i*. The deflection system also includes pentode sweep deflection control tubes **142**, three of which are indicated at **142***a*, **142***e*, and **142***i*, which tubes **142** each comprise an anode **167** individually connected to said B+ voltage source **136** through the field winding of the associated element **135**, thus serving to consecutively energize electromagnetic deflection elements **135**. Control grids **143** of said pentode control tubes **142** are respectively connected through resistances **144** to a low order voltage through a voltage divider system comprising resistors **145**, three of which are shown at **145***a*, **145***e*, and **145***i*. Cathodes **146** and suppressor grids **147** of control pentodes **142** are connected to a similar low order voltage, while screen grids **148** of control pentodes **142** are connected to a B+ voltage source **136**, as are damping resistances **141**, the screen grids **148** being suitably connected to said B+ voltage source **136** through resistances **149**, as indicated.

By comparison of the mode of operation of horizontal electrostatic deflection elements **15** in the embodiment shown in Fig. 2, it will be apparent that proper control of the respective driving circuits comprising control pentodes **142** for delivery of the necessary sweep deflection currents to energize electromagnetic deflection elements **135** requires that a deflection control voltage be delivered to the voltage divider system consisting of resistances **145** at points **150′** and **150″**, as indicated, the horizontal sweep deflection control voltage being generally as indicated at **151** and of initial potential to establish only control pentode **142***a* in conductive condition at the time of initiation of a given horizontal sweep and of amplitude to consecutively establish each of the control tubes **142** in conductive condition and thereby, through energization of the associated element **135**, cause deflection of electron beam **134** substantially throughout the horizontal dimension of viewing screen **130** during the horizontal sweep period.

The vertical sweep deflection system employed in the embodiment of the present invention illustrated in Fig. 5 comprises electrostatic sweep deflection elements **152**, three of which are indicated at **152***a*, **152***e*, and **152***j*, arranged parallel and adjacent to electron sensitive surface **131** of the viewing screen **130** and connected to a suitable high voltage source **153** through suitable high order resistances **154**, three of which are indicated at **154***a*, **154***e*, and **154***j*. Suitable sweep deflection voltages are delivered to vertical sweep deflection elements **152** from a lineal hexode control tube generally indicated at **155**, comprising a plurality of anodes **156**, three of which are indicated at **156***a*, **156***e*, and **156***j*, individually and respectively connected to deflection elements **152**. Control tube **155** further comprises a common low order voltage cathode **157**, a suppressor grid **158** connected thereto, a suitable screen grid **159** connected through a secondary high voltage source **160**, and two inversely and segmentally variably spaced control grids **161** and **162**. Vertical sweep voltages **163** and **164** are respectively applied to control grids **161** and **162**, which voltages **163** and **164** are of suitable initial potentials to cause only anode **156***a* of control tube **155** to be in conductive condition upon initiation of a given horizontal sweep and are of amplitudes to selectively and consecutively establish said anodes in conductive condition and thereby cause successive deflection of the electron beam **134** substantially throughout the vertical dimension of viewing screen **130**.

Thus, in the given scanning instant illustrated in Fig. 5, electron beam **134** follows the initial trajectory shown until deflected downwardly by the magnetic field presented across the beam trajectory by horizontal sweep deflection element **135***e*, whereupon the beam continues to follow a substantially vertical trajectory between electron sensitive surface **131**, maintained at high voltage by connection with high voltage source **153** as indicated at **165**, and those of vertical sweep deflection elements **152** maintained at high voltage from high voltage source **153** by non-conduction of associated control anodes **156** until encountering vertical sweep deflection element **152***e* associated with control anode **156***e* in conductive condition, whereupon the relatively low voltage potential presented by deflection element **152***e* causes the electron beam **134** to be deflected toward and impinge upon the electron sensitive surface **131** as indicated at **166**.

Another modified embodiment of the invention, as illustrated in Fig. 6, utilizes a general arrangement of horizontal sweep deflection system employing a single electrostatic deflection element arranged with the electron beam source generally below and slightly offset from the viewing screen, and further utilizes a vertical sweep deflection system comprising a single electrostatic deflection element.

Considering the embodiment illustrated in Fig. 6 in greater detail, viewing screen **180** comprises an electron sensitive surface **181** coated on a suitable optically transparent planar target plate **182**. Low order voltage electron source **183** is arranged below and slightly offset from the electron sensitive surface **181** to impart to electron beam **184** an initial trajectory in substantially parallel proximity with the lower edge of viewing screen **180**. The horizontal sweep deflection system shown in Fig. 6 comprises a control zone defined by single electrostatic sweep deflection element **185** connected to a suitable B+ voltage source **186** through a suitable resistance **187**. Further defining the free field for the horizontal beam trajectory of electron beam **184** with said deflection element **185** are field defining elements **188** and **189** directly connected to said B+ voltage source **186**, as indicated at **190** and **191**. Said sweep deflection element **185** is arranged at an angle with field defining elements **188** and **189** and the initial trajectory of electron beam **184**, as shown, in order to accomplish deflection of electron beam **184** throughout the horizontal dimension of viewing screen **180** by delivery of a suitable deflection control voltage thereto from a pentode control tube, generally indicated at **192**, comprising an anode **193** connected to said deflection element **185**, a low order voltage cathode **194**, a suppressor grid **195** connected to said cathode **194**, a screen grid **196** connected through a suitable resistance **197** to a B+ voltage source **198** and a control grid **199**. The horizontal sweep deflection system further comprises high voltage accelerating anodes **200** and **201** directly connected to a suitable high voltage source **202** as indicated at **203** and **204**. A horizontal sweep deflection control voltage generally indicated at **205** is delivered to control grid **199** of control tube **192** and is of initial potential to cause deflection of electron beam **184** adjacent to the left edge of viewing screen **180** and is of sufficient amplitude to cause deflection of electron beam **184** throughout the horizontal dimension of viewing screen **180** during the horizontal sweep period.

Turning now to a detailed consideration of the vertical sweep deflection system illustrated in Fig. 6, the vertical sweep control zone for electron beam **184**, following its exit from the accelerating field provided by anodes **200** and **201**, comprises an electron pervious screen **206**, of construction to minimize shadow effect, directly connected to high voltage source **202** as indicated at **207**, and vertical sweep deflection element **208** connected to high order voltage source **202** through a suitable resistance **209**, said element **208** being arranged at an angle with respect to said screen **206**, having portions thereof relatively remote from said electron source **183** positioned relatively close to said screen **206**. Electron sensitive surface **181** is maintained at a high voltage substantially higher than provided by high voltage source **202** by direct connection with a suitable high voltage source **202′** as indicated at **210**. The control tube constituting the vertical sweep deflection control means is generally indicated at **211**, and comprises an anode **212** directly connected to vertical sweep deflection element **208** as indicated at **213**, a low order voltage cathode **214** and a control grid **215**, to which is applied a suitable vertical sweep deflection voltage **216** of initial potential sufficient to cause deflection of electron beam **184** adjacent the upper edge of viewing screen **180** and of amplitude to cause deflection of electron beam **184** throughout the vertical dimension of viewing screen **180** during the vertical sweep period.

It will be apparent to those skilled in the art that employment of electron pervious screen **206** immediately adjacent electron sensitive surface **181** makes possible use of a vertical sweep deflection system operable under a relatively low order high voltage **202** as compared with the potential at which the electron sensitive surface **181** is maintained by connection thereof to high voltage source **202'**. A further advantage of the type of vertical sweep deflection system illustrated in Fig. 6 is that, by use of a properly constructed electron pervious screen **206** and electron sensitive surface **181** at a relatively higher potential, a substantial focusing and acceleration of electron beam **184** is accomplished immediately prior to impingement thereof on electron sensitive surface **181**.

Thus, at the given scanning instant illustrated in Fig. 6, electron beam **184** follows the initial trajectory shown until deflected upwardly by the electrostatic field presented by horizontal sweep deflection element **185**. Upon entry of the electron beam **184** into the accelerating zone defined by accelerating anodes **200 and 201**, the beam **184** is accelerated and further deflected to impart a substantially vertical trajectory thereto as indicated at **217**. At this instant the vertical sweep deflection voltage appearing on deflection element **208** will cause the electron beam **184** to be deflected through electron pervious screen **206**, at which point electron beam **184** will be further accelerated by the accelerating potential maintained on electron sensitive surface **181** and impinge thereon as indicated at **218**.

In sweep deflection arrangements utilizing a single sweep deflection element, such as disclosed in Fig. 6, and hereafter disclosed in Figs. 11 and 16, it will also be readily apparent that the desired deflection of the electron beam may also be accomplished by maintaining the sweep deflection element at a constant voltage and suitably velocity modulating the electron beam at the proper sweep rate in a manner known to the art.

In order to accomplish satisfactorily linear sweep rates in various horizontal and vertical sweep deflection system arrangements such as presented in Figs. 2 through 6, as well as in further exemplary embodiments thereof such as hereinafter presented, it will be apparent that design considerations require selection of proper deflection element spacing and dimensions under given control voltage conditions.

Accordingly, reference is now made to Figs. 7 and 8 to illustrate the important considerations for the proper design of sweep deflection elements and control means associated therewith in order to accomplish a linear sweep rate, with particular regard, by way of example, to design considerations to develop a linear sweep rate when an initial sweep deflection at an acute angle is employed, such as in the type of sweep control illustrated in Fig. 3. In terms of the voltage values, element characters and dimensional characters set forth in the simplified example illustrated in Fig. 7, an electron beam b of voltage V_1 is arranged to pass through the beam trajectory shown in dotted line, which trajectory is spaced a distance f in a control zone between a lower deflection element m and a plurality of upper sweep deflection elements n, n', and n'', three being shown by way of example. Suitable deflection voltage waveforms and amplitudes to be applied to sweep deflection elements n, n', and n'', and the dimensions of said sweep deflection elements should be such that a reduction in voltage on a given deflection element n' when the voltage on n is at a reduced value from the value V_1 to a value V_n will cause deflection of the beam b an amount so as to deliver said beam b from the beam deflection zone defined by deflection elements n, n', and m at an angle a a distance x beyond the deflection field of the sweep deflection element n', for example. Proper design of this simplified embodiment of the invention further dictates that as voltage V_n on deflection element n' is reduced from V_1 to V_2, the distance d of separation of elements n, n', and n'', and the element m, and the dimension l (selected, in the simplest case, to equal the length of deflection element n plus the separation distance between n and n'), must provide that x vary from 1 to 0 and that change in x shall be nearly constant to achieve satisfactory horizontal sweep linearity. The term "sweep deflection" has been ascribed herein to the type of action which occurs when one or more sweep deflection elements has impressed thereon a varying voltage, as when V_n varies from V_1 to V_2 to cause x to vary from 1 to 0, for example.

In practice it has been found that sweep deflection systems of the type presented in Fig. 7 characteristically exhibit a degree of non-linearity of sweep rate when V_n uniformly decreases from V_1 to V_2. A typical indication of such non-linear relation to V_n and x, which is not necessarily the true wave shape in all cases, is presented in Fig. 8. It has been further found, however, that a given non-linearity may be minimized by proper selection of dimensions l, l', l'', d and f and proper selection of voltages V_1 and V_2, and that said non-linearity may be substantially eliminated to provide sweep linearity well within satisfactory tolerances by proper selection and/or design of sweep deflection voltage control tube characteristics, the non-linearity of the selected control tube in the optimum case being substantially equal and opposite to the non-linearity presented by a plot similar to Fig. 8 under a selected set of deflection element dimensions and deflection voltages. Thus, deflection elements n, n' and n'' may be delivered voltage waveforms to accomplish a linear sweep rate by use of a plurality of control tubes of the desired characteristics and load conditions in a suitable control circuit of the type hereinafter presented in Fig. 32. Alternatively, the above considerations will make apparent to those skilled in the art the requisite design to accomplish satisfactory linearity of sweep rate in the event deflection control tubes of the lineal or radial types herein presented are employed.

As has been indicated, design advantages lie in utilizing a deflection system employing relatively low order voltages. Thus, in a beam deflection system designed in accordance with the considerations presented in connection with Fig. 7, wherein V_1 equals 400 volts, V_2 equals 60 volts, f equals $d/2$, l equals l' equals l'', n equals n' equals n'', and l/d equals 1.5, it was found that angle a was $30°\pm5°$, and that non-linearity of sweep rate was less than 15% when V_n was uniformly varied from V_1 to V_2. It was further found that this non-linearity of sweep rate in a system utilizing overlapping plate energization was reduced to less than 3% when any of several commercially available pentode control tubes were used with anode loads on the order of 10K–40K ohms for generation of the deflection control voltage from a linear sawtooth sweep voltage.

From the nature of the typical horizontal and vertical sweep deflection systems presented in Figs. 2 through 5, inclusive, it will be apparent that each type of horizontal sweep deflection system thereby presented may be used in conjunction with each type of vertical sweep deflection system presented and that various components are adaptable for use in other sweep deflection systems. For example, vertical sweep field defining electron pervious screen **206**, illustrated in Fig. 6 in association with a single vertical sweep deflection element, may be similarly employed with plural deflection elements to operate a vertical sweep deflection system at a lesser order high voltage than would otherwise be required. Further, the deflection sweep control arrangement for presenting the proper sweep deflection voltages to the deflection elements employed in any given arrangement of horizontal or vertical sweep deflection system utilizing plural deflection elements may be variously of the lineal type as presented in Figs. 2 and 5, of the radial type as presented in Figs. 3 and 4, or may comprise an electron beam switching unit as presented in Fig. 3. Alternatively, suitable circuitry comprising control tubes of conventional design such as presented in Fig. 5 may be utilized.

It will also be apparent that the sweep deflection element design and relative arrangement with respect to the viewing screen as shown in the embodiments illustrated in Figs. 2 through 6, and numbers thereof as shown in Figs. 2 through 5, are subject to wide variations from the designs, relative arrangements and numbers thereof presented.

It is to be additionally noted that a particularly advantageous feature of the types of horizontal and vertical sweep deflection systems presented in Figs. 2 through 5, as well as in other such arrangements employing a plurality of deflection elements for sweeping the electron beam throughout a given image screen dimension, resides in the fact that the nature of the control zones and adjacency of the field defining and deflection elements presented to the electron beam by the respective sweep deflection systems is such that, for given operating field and deflection voltages, no substantial electrical limitation is presented as to the size of the image screen which may be scanned. Thus, in the embodiment illustrated in Fig. 3 for example, when the horizontal sweep deflection system is designed to operate at a B+ voltage on the order of 400 v. and the vertical sweep deflection system is designed to operate at a HV voltage on the order of 16 kv., the dimensions of the viewing screen may be materially increased without necessitating a corresponding increase in HV and B+ voltage values, the only limitation in such regard being acceptability of image intensity level. It will also be understood that the values of the necessary deflection voltages delivered to the respective horizontal and vertical sweep deflection elements likewise are not substantially affected by the size of the image screen. Moreover, the arrangements presented are not restricted in size by beam deflection angle limitations inherent in cathode ray tubes of conventional design. Thus, beam scanning systems are hereby presented which do not require substantially increased accelerating voltages, increased deflection voltages, nor increased depth to accomplish an increase in image screen dimensions.

With the various number of typical arrangements of horizontal and vertical sweep deflection systems in view, as are presented in Figs. 2 through 6, consideration is now given to additional exemplary arrangements of these deflection systems in order to further illustrate additional modifications thereof suitable for use in the various arrangements contemplated by the present invention.

Fig. 9 serves to schematically present a modified configuration of electrostatic deflection elements of the general types presented in Figs. 2 and 3, wherein deflection elements **220**, three being indicated at **220**_a_, **220**_e_, and **220**_i_, are arranged with an electron source **221** and a suitable field defining element **222** to produce horizontal sweep deflection. Curved portions **223** and **224** of deflection elements **220** may be designed to additionally compensate for any non-linearity of sweep rate presented by a given set of deflection conditions. Thus, for example, a lag in sweep linearity at the beginning of sweep deflection by a given sweep deflection element **220**_e_ can be substantially compensated for by curvature **223**_e_, and an increase in linearity of sweep rate during the latter portion of the deflecting action by a given deflection element **220**_e_ may be compensated for by a curved configuration such as presented at **224**_e_.

Fig. 10 serves to present yet another modification of horizontal sweep deflection element configuration of the general type presented in Fig. 9, wherein deflection elements **225**, three being indicated at **225**_a_, **225**_e_, and **225**_i_, are associated with a suitable electron source **226** and a field defining element **227**, said deflection elements **225** being designed to compensate for a given non-linearity of sweep rate by arrangement of a portion of deflection elements **225** at an angle with the beam trajectory as shown at **228**.

Fig. 11 serves to illustrate a further modified confiuration for a single horizontal sweep deflection element of the general type presented in Fig. 6, wherein the single deflection element **230**, associated with an electron source **231** and a suitable field defining element **232**, is of curved configuration to accomplish linearity of sweep rate under given design and control conditions. While Fig. 11 shows the electron source **231** to be positioned so as to emit a beam that extends parallel to the field defining element **232**, it will be understood that said electron source may also be positioned in such a manner that its beam is initially inclined relative to said field defining element.

Although the sweep deflection element configurations presented in Figs. 9 through 11 have been illustrated in arrangements for use in horizontal sweep deflection systems, it will be readily understood that vertical sweep deflection elements may likewise employ similar configurations to accomplish satisfactory vertical sweep linearity under given design and control conditions.

Fig. 12 is a schematic bottom view of a plurality of electromagnetic deflection elements **245**, three being indicated at **245**_a_, **245**_e_, and **245**_i_, of the general type presented in Fig. 5, suitable for being simultaneously energized to produce the desired horizontal sweep deflection by presenting to the electron beam trajectory from electron source **246** a plurality of magnetic fields of relatively greater density at points remote from the electron source as a consequence of a relatively greater number of field windings individually associated therewith, as indicated at **247**_a_, **247**_e_, and **247**_i_. Electromagnetic deflection elements **245**, as illustrated in Fig. 12, also illustrate a modification in deflection element pole piece design wherein pole piece faces **248** and **249** are spaced with portions thereof relatively close together at points relatively remote from electron source **246** in order to accomplish linearity of sweep rate under given sweep deflection control conditions.

Fig. 13 is a schematic perspective view of electromagnetic deflection elements **245**_e_ illustrated in Fig. 12, showing in greater detail the variable spacing of pole piece faces **248** and **249**.

Fig. 14 is a schematic bottom view of a plurality of electromagnetic sweep deflection elements of the type presented in Fig. 5, illustrating a further design suitable for a mode of operation wherein magnetic fields of relatively greater density remote from the electron source may be simultaneously generated. In this arrangement, electromagnetic elements **255**, three being indicated at **255**_a_, **255**_e_, and **255**_i_, are constructed with field windings **256**, three being indicated at **256**_a_, **256**_e_, and **256**_i_, to provide relatively greater field density remote from electron source **257**.

Fig. 15 is a schematic perspective view of deflection element **255**_e_, illustrated in Fig. 14, showing in further detail parallel pole piece faces **258** and **259** thereof.

Figs. 16, 17, and 18, inclusive, respectively present schematic front end and bottom views of a single electromagnetic deflection element **265** suitable for use in lieu of the plurality of electromagnetic elements illustrated in Fig. 5, wherein a suitable field winding **266** and angled pole pieces **267** and **268** are associated with an electron beam, not shown, from a suitable electron beam source **269** to provide linearity of sweep deflection.

Figs. 19 and 20 respectively present front and end elevational views of a single electromagnetic horizontal sweep deflection element, electron beam source, field defining elements, and viewing screen, wherein electromagnetic sweep deflection element **275** comprises field winding **276** and pole piece faces **277** and **278**, and wherein an electron beam source **279** is arranged to deliver an electron beam **280** in a direction substantially perpendicular to the horizontal dimension of viewing screen **281**. Horizontal sweep deflection in this arrangement, i. e., successive delivery of electron beam **280** in sweep deflection trajectories from trajectory **280*a*** to trajectory **280*b***, is accomplished either by progressively increasing the magnetic field density generated by winding **276** or by suitable velocity modulating electron beam **280** at beam source **279**. It will be noted that by the arrangement presented in Figs. 19 and 20, the exit trajectory of electron beam **280** through either extreme trajectory **280*a*** or **280*b*** will be substantially vertical upon delivery of electron beam **280** to accelerating zone **282** and that self focusing of electron beam **280** will be accomplished because of the reverse bend nature of the beam trajectory.

Figs. 21 and 22 respectively present a schematic front elevational view and a schematic end elevational view of another modified form of a single electromagnetic horizontal sweep deflection element of the general type presented in Figs. 19 and 20. In this modification, electromagnetic sweep deflection element **285** comprises field winding **286** and pole piece faces **287** and **288**, portions of which are of relatively small dimension of separation, as indicated at **289** and **290**. Electron source **291** is arranged to deliver electron beam **292** between pole piece faces **287** and **288** in a trajectory having a substantial upward component, as shown. As in the arrangement shown in Figs. 19 and 20, delivery of electron beam **292** throughout the horizontal dimension of accelerating zone **293** and viewing screen **294** is accomplished either by varying the magnetic field density of electromagnetic deflection element **285** by suitable control of field winding **286** or by velocity modulation of electron beam **292** at beam source **291**, thus imparting to electron beam **292** sweep deflection trajectories **292*a*** and **292*b***. Pole piece face portions **289** and **290** of relatively reduced separation serve to provide a relatively greater field density during the latter portions of beam trajectories **292*a*** and **292*b***, causing the exit direction of beam trajectory to be substantially vertical as beam **292** enters accelerating zone **293**, as indicated.

Fig. 23 illustrates a modified arrangement of electron source, initial deflection zone, accelerating zone, and viewing screen of the general type presented in Fig. 3 where deflection elements **294**, electron source **295**, field defining zone **296**, and accelerating zone **297** are canted a slight angle with respect to viewing screen **298** to place the deflection system components relatively close to viewing screen **298** at points relatively remote from the electron source and thereby compensate for a given deviation from vertical of electron beam trajectories adjacent viewing screen **298**, the angle of cant, schematically indicated at **299**, being selected so that a raster area having vertical sides results. It will also be apparent that any such deviation from vertical of the sides of the raster area may be alternatively or conjunctively compensated for by superposing or mixing a suitable increment of the vertical sweep control voltage with the horizontal sweep control voltage.

Figs. 24 and 25 respectively present front and end elevational views of another form of horizontal sweep deflection system contemplated by the present invention, wherein a plurality of vertical sweep deflection elements **320**, three being identified at **320*a***, **320*e***, and **320*j***, are arranged parallel to and spaced a slight distance from viewing screen **321** and a suitable electron source **322** is arranged a substantial distance from said screen in a manner to deliver an electron beam **323** through a trajectory lying substantially parallel and adjacent to a viewing screen **321**, comprising an electron sensitive surface, not shown. Horizontal sweep deflection elements **324** and **325**, which may be either electrostatic or electromagnetic in character, are arranged in equispaced relation with said trajectory and are employed to deflect electron beam **323** throughout the horizontal dimension of viewing screen **321**, as typically indicated at **323*a*** and **323*b***, suitable anti-keystoning voltages being impressed on deflection elements **324** and **325** in a manner known to the art, as desired. It will be understood that suitable control of vertical sweep deflection elements **320** in conjunction with the horizontal sweep deflection system presented in Figs. 24 and 25 will result in viewing screen **321** being scanned throughout both dimensions thereof by electron beam **323**. It will be readily apparent that embodiments of the invention of the type illustrated in Figs. 24 and 25 exhibit a characteristic compactness in depth in common with other embodiments thereof herein disclosed, but also necessitate an elongated side portion to accommodate the electron source and initial sweep deflection means, thus rendering an embodiment such as shown in Figs. 24 and 25 less desirable in certain applications of the invention where overall compactness is an important consideration.

Fig. 26 presents a schematic front elevational view of a viewing screen and modified form of horizontal sweep deflection system, wherein the electron source **340** is arranged to deliver an electron beam **341** in a direction parallel to and slightly offset from a vertical edge of viewing screen **342**, which electron beam **341** is in turn delivered to a horizontal sweep deflection system, the deflection elements of which are generally indicated at **343**, by deflection field **344**, which may be electrostatic or electromagnetic in character.

Fig. 27 is a schematic front elevational view of a modified arrangement of electron beam source **350**, viewing screen **351** and horizontal sweep deflection system **352**, wherein electron source **350** is arranged to impart to electron beam **353** an initial trajectory substantially opposite in direction from the beam trajectory during horizontal sweep deflection, the electron beam **353** being delivered to horizontal sweep deflection system **352** by means of deflection field **354**, suitable focusing and/or accelerating fields **355** and **356** being employed to deliver electron beam **353** to deflection field **354**, as desired.

It will be understood that the folded beam arrangements presented in Figs. 26 and 27 are merely illustrative of possible arrangements of an electron beam source for producing an electron beam having a substantial portion of the trajectory thereof parallel and adjacent to an associated viewing screen and arranged for use in conjunction with horizontal and vertical sweep deflection systems operated in accordance with the present invention.

Moreover, it will be understood that any of the horizontal sweep deflection systems above presented may be arranged along the vertical dimension of a given viewing screen by suitable arrangement of the electron beam source and associated initial sweep deflection system along said vertical dimension. It will be equally apparent that sweep deflection systems herein termed vertical sweep deflection systems are susceptible for use for deflection of an electron beam throughout the horizontal dimension of a given viewing screen in the event the initial beam sweep deflection system is arranged vertically with respect thereto.

Fig. 28 presents a schematic front elevational view illustrating the arrangement of a plurality of electromagnetic deflection elements suitable for use in a vertical sweep deflection system with cathode ray tubes of relatively small dimension as contemplated by the present invention. In Fig. 28, electromagnetic vertical sweep deflection elements **360**, three being indicated at **360*a***, **360*e***, and **360*h***, comprise opposing pole pieces **361**, three being indicated at **361*a***, **361*e***, and **361*h***, and **362**, three being indicated at **362*a***, **362*e***, and **362*h***, and further comprise field windings **363**, three being indicated at **363*a***, **363*e***, and **363*h***, of a substantially identical number of turns, which are capable of being consecutively energized. The plurality of electromagnetic vertical sweep deflection elements **360** are arranged to produce the indicated magnetic fields adjacent viewing screen **364** to accomplish deflection of an electron beam, not shown, delivered from a suitable horizontal sweep deflection system employed therewith.

Fig. 29 is a schematic perspective view of one of electromagnetic deflection elements **360**, such as **360*e***, illustrated in Fig. 28, to show a typical arrangement thereof with viewing screen **364**, a portion of which is shown in fragmentary perspective.

Fig. 30 is a schematic front elevational view illustrating a further arrangement of a plurality of vertical sweep deflection elements of the general type presented in Figs. 28 and 29, wherein electromagnetic deflection elements **370**, three of which are indicated at **370*a***, **370*e***, and **370*h***, comprise opposing pole piece faces **371** and **372**, three of faces **371** being indicated at **371*a***, **371*e***, and **371*h***, and three of faces **372** being indicated at **372*a***, **372*e***, and **372*h***. Elements **370** further comprise field windings **373**, three being indicated at **373*a***, **373*e***, and **373*h***. Field windings **373** of electromagnetic deflection elements **370** are constructed of a relatively greater number of field windings **373** for elements **370** relatively remote from electron source **374** to provide a vertical sweep deflection system capable of being simultaneously energized, as shown. Electromagnetic deflection elements **370** are placed adjacent viewing screen **375** in the manner illustrated in Fig. 29 to provide a plurality of contiguous electromagnetic deflection fields adjacent viewing screen **375** which, when simultaneously energized to increase the respective magnetic fields of deflection elements **370** throughout the sweep period, will cause an electron beam, not shown, delivered vertically into the vertical sweep deflection area, to be deflected toward and impinge upon viewing screen **375**.

Fig. 31 presents a schematic perspective view of one of the electromagnetic deflection elements **370** illustrated in Fig. 30, element **370*e*** being shown by way of example.

Fig. 32 schematically presents a typical control circuit for a plurality of sweep deflection elements **400**, three being indicated at **400*a***, **400*e***, and **400*i***, suitably associated with an electron source **401** and a field defining means **402**. In the circuit presented, a plurality of control tubes of the conventional triode type **403**, three being indicated at **403*a***, **403*e***, and **403*i***, each comprises an anode **404** connected through a suitable load resistance, not shown, to a suitable voltage source, not shown, and further comprises a low order voltage cathode **405**, and a control grid **406**. Control grids **406** are respectively connected through resistances **407** across successive portions of a voltage divider system comprising resistances **408**, three of which are indicated at **408*a***, **408*e***, and **408*i***, as shown. One end of the voltage divider system comprising resistances **408** is connected to cathodes **405** of control tubes **403** as indicated at **409** and a suitable sweep voltage such as indicated at **410** is delivered to the voltage divider system comprising resistances **408** as indicated at **411**. In order to accomplish the desired deflection control, sweep voltage **410** has a suitable initial potential to establish only control tube **403*a*** in conductive condition on initiation of sweep deflection and is of sufficient amplitude to establish the anodes of control tubes **403** consecutively in conductive condition and thereby cause deflection of the electron beam in successive trajectories substantially throughout the horizontal dimension of the viewing screen, not shown.

Fig. 33 schematically presents a further control arrangement of the general type presented in Fig. 32 for a plurality of deflection elements **430**, three being indicated at **430*a***, **430*e***, and **430*i***, associated with a suitable electron source **431**, wherein a plurality of control tubes **432** of the diode type, three being indicated at **432*a***, **432*e***, and **432*i***, are utilized, which control diodes **432** each comprise an anode **433** connected through a load resistance, not shown, to a suitable high voltage source, not shown, and a cathode **434**. Cathodes **434** are connected across a voltage divider system comprising resistances **436**, three being indicated at **436*a***, **436*e***, and **436*i***. The voltage divider system comprising resistances **436** is connected to a suitable high voltage source **437**, as indicated, and has impressed thereon a suitable deflection sweep voltage **438** of initial potential to establish only control diode **432*a*** in conductive condition at the time of initiation of sweep deflection and of amplitude to cause deflection of the electron beam throughout the associated dimension of the viewing screen, not shown.

It is also contemplated by the present invention that certain control components of the sweep deflection control systems employed may be mounted in a common evacuated envelope with the electron source and viewing screen or, as desired, may be arranged in evacuated envelopes separate therefrom. Accordingly, Fig. 34 illustratively presents a typical arrangement of a viewing screen **459**, an electron source **460**, a horizontal sweep deflection system indicated generally at **461**, comprising a plurality of anodes **462** connected to horizontal sweep deflection elements **463**, said control tube being indicated generally at **464**, and further comprising the common cathode **465** and variably spaced control grid **466** therefor, which horizontal sweep deflection system further comprises field defining zone **467**. The vertical sweep deflection system, generally indicated at **468**, in the arrangement illustrated in Fig. 34, comprises electrostatic deflection wires **469**, respectively and individually connected to each of a plurality of anodes **470** of a lineal triode control tube, generally indicated at **471**, further comprising a common cathode **472** and a variably spaced control grid **473**. As schematically indicated, the electron source **460**, the horizontal sweep deflection system **461** and the vertical sweep deflection system **468** are arranged in a single evacuated envelope **474**.

Fig. 35 presents a schematic front elevational view of a viewing screen and associated horizontal and vertical sweep deflection systems, wherein radial deflection control tubes mounted in separate envelopes are employed. In this arrangement, a viewing screen **500** has associated therewith in common envelope **501** an electron source **502**, horizontal sweep deflection elements **503**, a field defining zone **504** and vertical sweep deflection elements **505**. A horizontal sweep radial control tube, generally indicated at **506**, comprises a plurality of anodes **507** and separate envelop **508**. Separate connections **509** are made from anodes **507** of control tube **506** with respective horizontal sweep deflection elements **503** through a suitable socket connector **510** in envelope **501**. Similarly, the vertical sweep deflection control tube **511**, comprising a plurality of anodes **512** and a separate envelope **513**, is arranged to be respectively connected, as indicated at **514**, with respective deflection elements **505**, through a suitable socket connector **515** in envelope **501**.

As has been indicated, the embodiments of the present invention, as illustrated in Figs. 1 through 6, along with various modifications of components thereof as presented in connection with Figs. 9 through 27 and 32 through 35, have been directed primarily to arrangements for monochrome video signal presentation. It is to be emphasized that the present invention is readily adaptable to arrangements for polychrome image presentation and it is the purpose of Figs. 36 through 46, inclusive, to present various typical arrangements therefor.

Fig. 36 schematically presents a two-color image producing embodiment of the present invention, and serves also to illustrate certain features common to all applications of the present invention to polychrome picture presentation. Referring to Fig. 36, a transparent plate **520** is coated with an electron sensitive color producing surface **521** on one side thereof, blue-green being shown by way of example, and further coated with another electron sensitive color producing surface **522** on the other side thereof so that said surfaces are relatively arranged in parallel and close juxtaposition, red-orange being shown by way of example. A plurality of sweep deflection elements **523** are arranged parallel and adjacent to electron sensitive color surface **521** and a plurality of electron deflection elements **524** are correlatively associated with said electron sensitive color producing surface **522**. Electron beams **525** and **526** are respectively delivered between sweep deflection elements **523** and electron sensitive color producing surface **521** on the one hand, and deflection elements **524** and electron sensitive color producing surface **522** on the other.

Like vertical sweep deflection elements **523** and like vertical sweep deflection elements **524** are electrically connected as indicated at **527** to provide vertical superposition of the respective color images developed on electron sensitive color producing surfaces **521** and **522**, as indicated. In an identical manner, the correlatively associated horizontal sweep deflection elements, not shown, which serve to deliver electron beams **525** and **526** adjacent respectively adjacent surfaces **521** and **522** have like elements thereof electrically connected to provide horizontal superposition of the respective color images. It will be further apparent that the electrical connection of correlatively associated deflection elements and the selection of appropriate deflection element dimensions and control voltages under given design conditions will provide superposed color images and inherent image raster linearity.

Such arrangement and connection of like deflection elements is advantageously employed with any system utilizing plural electron sensitive surfaces such as are hereinafter disclosed. Also, by such arrangement, sets of deflection elements correlatively associated with the plural surfaces are synchronously controlled by suitable sweep deflection voltages from a common sweep deflection voltage generating control circuit. Thus, in accordance with the present invention, it will be understood that, in Fig. 36, electron beams **525** and **526** are delivered in the indicated manner from correlatively associated horizontal sweep deflection elements forming components of a horizontal sweep deflection system, not shown, and that vertical sweep deflection elements **523** and connected sweep deflection elements **524** form components of a vertical sweep deflection system such as have been presented above in connection with monochrome embodiments of the present invention.

In polychrome arrangements, as typified in Fig. 36, at least the electron sensitive color producing surface **522** facing the viewer **528** must be sufficiently transparent to pass light produced by activation of electron sensitive color producing surface **521** on the remote face of plate **520** with minimum light loss. Similarly, it will be apparent that sweep deflection elements **524** must be equally transparent to the color images developed on electron surfaces **521** and **522**. Such transparency of sweep deflection elements **524** may be suitably provided by construction of respective sweep deflection elements **524** of strips of conductive glass, of known transparent printed circuitry, or of grid wires such as are presented in the embodiment shown in Fig. 4, sufficiently thin to allow the color image to be observed with a minimum of optical interference.

Fig. 37 schematically presents a modified form of two-color image presentation, wherein different electron sensitive color producing surfaces **530** and **531**, blue-green and red-orange respectively being shown by way of example, are coated upon separate transparent plates **532** and **533**. A suitable plurality of vertical sweep deflection elements **534** are arranged substantially parallel and adjacent to electron sensitive surface **530** and sweep deflection elements **535** are similarly arranged with respect to electron sensitive surface **531**, as shown. Electron beam **536** is delivered substantially parallel and adjacent to electron sensitive surface **530** and electron beam **537** is similarly delivered adjacent electronsensitive surface **531**, as shown. The beam scanning operation utilized with the arrangement presented in Fig. 37 is identical with that utilized for the arrangement presented in Fig. 36.

Fig. 38 schematically illustrates a modified form of the arrangement presented in Fig. 36, wherein a common transparent plate **540** has coated on one side thereof an electron sensitive color producing surface **541**, red-orange being shown by way of example, and on the other side thereof another electron sensitive color producing surface **542**, blue-green being shown by way of example, and wherein respective vertical sweep deflection elements **543** and **544** are associated therewith. With this general arrangement, a single electron beam **545** may be utilized to scan both image producing materials **541** and **542** by delivering to suitable beam deflecting elements **546** and **547** an appropriate sequencing signal. Further beam deflecting elements **548, 549, 550** and **551** may be employed to deflect electron beam **545** through trajectories **545***a* and **545***b* substantially parallel and adjacent to electron sensitive materials **541** and **542**, as desired.

Fig. 39 generally constitutes a combination of the embodiments of the invention illustrated in Figs. 36 and 37, and presents an arrangement of electron sensitive color producing surfaces and associated components suitable for full color image presentation. In this embodiment, transparent plates **555** and **556** are coated with electron sensitive color producing surfaces **557, 558** and **559**, which are respectively red, green and blue, by way of example. Said surfaces **557, 558** and **559** have respectively associated therewith a plurality of sweep deflection elements **560, 561** and **562** and electron beams **563, 564** and **565**. It will be understood that, as in previous color embodiments, components of the arrangement arranged between the viewer **566** and the electron sensitive surface **559** most remote from said viewer **566** must be substantially optically transparent. It will also be understood that like sweep deflection elements **560, 561** and **562** are electrically connected and controlled through association with a common vertical sweep deflection system, as previously indicated, to provide superposed color images on surfaces **557, 558** and **559**, as observed by the viewer **566**.

Fig. 40 schematically presents a typical arrangement suitable for full color presentation, wherein three separate transparent plates **570, 571** and **572** are arranged in parallel and close juxtaposition and respectively have coated thereon electron sensitive color producing surfaces **573, 574** and **575**, indicated to be respectively blue, green and red producing phosphors, by way of example. Respectively associated with each of electron sensitive surfaces **573, 574** and **575** are a plurality of sweep deflection elements **576, 577** and **578** and electron beams **579, 580** and **581**. The system presented in Fig. 40 is typical of those arranged in accordance with the present invention which are suitable for color image presentation fully compatible with the recently proposed NTSC color system. To illustrate, electron guns **582, 583** and **584** may be utilized for presentation of color signals produced according to the recently developed NTSC color system, by delivery of the luminance component of the color signal simultaneously to cathodes **585, 586** and **587** of electron guns **582, 583** and **584** as indicated at **588** while delivering respective blue, green and red chrominance signals to grids **589, 590** and **591** of electron guns **582, 583** and **584**, as indicated at B, G, and R.

Fig. 41 is a further modification of a full color image presentation system in accordance with the present invention, wherein a single electron beam **600** is sequentially delivered by deflection means **601, 602, 603** and **604** to a plurality of color image reproducing systems, indicated generally at **605, 606** and **607** for reproducing color images in blue, green and red respectively, by way of example. It will be apparent that the color sequencing beam delivery system employed in the full color arrangement presented in Fig. 41 is similar in design and operation to that presented in Fig. 38.

From the various full color embodiments of the present invention shown in Figs. 39 through 41, as well as in various other color embodiments hereinafter presented, it is evident that appropriate consideration may be given to the question of whether adequate superposition of color images occurs when the associated color surfaces are viewed from angles other than perpendicular, i. e., the effect of parallax because of finite separation of the respective color producing surfaces. Accordingly, a treatment of a typical presentation involving apparent parallax and a manner in which such parallax may be substantially eliminated is presented in Fig. 42.

Fig. 42 presents a top schematic view of the general arrangement of color image presentation systems shown in Fig. 39, and like designating numerals have been assigned thereto. Obviously, no parallax problems are presented by the corresponding elements of color signals developed on red surface **557**, green surface **558** and blue surface **559** when the viewer **566** is perpendicular to the various viewing surfaces because of automatic superposition of color images resulting from identical control of deflection elements respectively associated with the surfaces in the manner previously set forth. Assuming, however, the viewer is at an angle of 45 degrees with respect to the surface, as indicated at **567**, the question whether corresponding red, green and blue elements would appear separated the distance indicated at **568** deserves further scrutiny.

It has been amply demonstrated by optical acuity tests that the human eye is relatively less sensitive to color definition than to black and white definition in the decreasing color order green, red and blue, and that serious degradation of blue color definition occurs only when the system bandwidth assigned to the blue spectrum is substantially less than 500 kc. Such inability of the human eye to perceive color definition has been utilized in the proposed NTSC system by reducing the bandwidth of all color signals and only the white signal (i. e., luminance, including mixed highs of fine color detail) is transmitted at the full four megacycle bandwidth.

In color systems according to the present invention, it has been found that the thickness dimension of transparent plate **555** may be satisfactorily selected at substantially less than $\frac{1}{10}$ of one inch, so that no parallax problem is presented by the red and green images because of the resulting close spacing between surfaces **557** and **558**. It has been further found that arrangements in accordance with the present invention may be constructed with a dimension of approximately $\frac{1}{4}$ inch between green producing surface **588** and blue producing surface **559**, as indicated at **568**, when deflection elements **561** are grid wires, thin conductive glass, or comprise transparent printed circuitry arranged on the surface of transparent plate **556** nearest the viewer. Thus, tolerances are provided so that full color systems in accordance with the present invention may be designed to substantially eliminate apparent parallax of color images throughout normal viewing angles.

Fig. 43 schematically presents another full color embodiment of the present invention, suitable for presenting full color images utilizing four electron sensitive color producing surfaces **610**, **611**, **612** and **613** respectively coated on two transparent plates **614** and **615**, as shown, for producing color images which are respectively blue, red, green and yellow, by way of example. Respectively associated with said electron sensitive color producing surfaces **610** through **613**, inclusive, are electron beams **616**, **617**, **618** and **619** and sweep deflection elements **620**, **621**, and **622**, as shown, it being apparent that deflection elements **621** are arranged to deflect both electron beam **617** and electron beam **618** toward associated electron sensitive color producing surfaces **611** and **612**.

Fig. 44 represents four image producing systems, generally indicated at **625**, **626**, **627** and **628**, arranged, as shown, to generate respective images in blue, red, green and white. As will be apparent, the arrangement of image producing systems presented in Fig. 44 is suitable for simultaneous color image presentations of the type contemplated by the recently developed NTSC system, by modulation of electron beam **629**, associated with image presentation system **628**, with the luminance signal as indicated at **630**, and by simultaneous delivery to electron beam **631**, **632** and **633** of the respective blue, red and green chrominance signals, as respectively indicated at **634**, **635** and **636**.

It is also to be understood that a presentation utilizing four image producing systems as are generally indicated at **625**, **626**, **627** and **628** in Fig. 44 may be utilized with a simultaneous subtractive color presentation system. Such subtractive embodiment advantageously utilizes image producing system **628** as a white light source by synchronously scanning the electron sensitive white producing surface **637** thereof with electron beam **629**. Such subtractive presentation system further requires that respective electron sensitive surfaces **638**, **639** and **640** of systems **627**, **626** and **625** are of the selective color absorptive type, and are suitably arranged, as in the following exemplary manner; surface **638** being minus-green or magenta, surface **639** being minus-red or cyan, and surface **640** being minus-blue or xanth.

It will be understood that the various types of color presentation systems as shown in Figs. 40 and 44 may have any two electron sensitive color producing surfaces coated on a single transparent plate in the manner shown in Figs. 36, 39 and 43. Further, the various systems presented in Figs. 36, 37, 39, 40, 43 and 44 may utilize a common electron beam source in the manner generally illustrated in Figs. 38 and 41, as desired, for presentations compatible with sequential color presentation.

In polychrome embodiments of the present invention generally, as has been indicated in connection with the arrangement shown in Fig. 36, electron sensitive color producing surfaces arranged intermediate to a viewer and a relatively remotely situated electron sensitive color producing surface must be substantially optically transparent. It is the purpose of Figs. 45 and 46 to present two suitable methods of arranging electron sensitive materials to form such surfaces whereby transparency may be accomplished with conventional electron sensitive materials of the luminescent type. In Fig. 45, transparent plate **670** has coated thereon a thin coating of electron sensitive color producing material **671** which is continuous throughout the viewing area and of coating thickness to provide the required transparency in a manner known to the art. Fig. 46 presents a further arrangement having the advantage of greater resistance to "burning," wherein transparent plate **672** has coated thereon a large number of discontinuous elements of electron sensitive color producing material **673**, optical transparency being provided by spacing between material elements **673**, as shown. Alternatively, optically transparent electron sensitive color producing materials of recent development may be used to impart the required optical transparency.

Fig. 47 presents a typical adaptation of the present invention to subtractive color presentation wherein white light from a suitable source **675** is projected successively through a suitable lens system **676** and a plurality of electron sensitive color absorptive surfaces **677**, **678** and **679**, relatively arranged in parallel superposition, which may be respectively minus-red (cyan), minus-green (magneta), and minus-blue (xanth), for example. Said color absorptive surfaces **677**, **678** and **679** are respectively scanned by deflection systems **680**, **681** and **682**, arranged in accordance with the present invention. By operation of such arrangement, a full color image is projected on a suitable viewing screen **683** and presented to the viewer **684**, as indicated.

Embodiments of the present invention heretofore presented, including both monochrome and polychrome adaptations, develop images which are two dimensional in character. It also is contemplated by the present invention to provide various types of three dimensional presentation, either of monochrome or polychrome nature. Accordingly, it is the purpose of Figs. 48 through 55, inclusive, to schematically present various arrangements of the present invention suitable for producing images of a three dimensional character.

Fig. 48 schematically illustrates a typical embodiment of the present invention wherein a viewing screen **690** is arranged to provide a viewing surface **691** of concave configuration substantially through the horizontal dimension thereof with respect to viewer **692**, to provide a visual image having three dimensional characteristics by virtue of having panoramic depth perception properties. It will be understood that one or more additional viewing screens of the same construction can be employed in tandem position with the one illustrated in Fig. 48.

Fig. 49 schematically illustrates a further typical embodiment of the present invention, wherein a viewing screen **695** is arranged to present a viewing surface **696** of convex configuration substantially throughout the horizontal dimension thereof with respect to the viewer **697** to provide a visual image having three dimensional characteristics by virtue of having panoramic depth perception properties. It will be understood that one or more additional viewing screens of the same construction can be employed in tandem position with the one illustrated in Fig. 49.

Fig. 50 schematically presents a top view of a typical arrangement of electron source and horizontal sweep deflection elements, suitable for use in deflection systems employed with viewing screens of a concave nature as illustrated in Fig. 48 or with viewing screens of convex nature as illustrated in Fig. 49. As shown in Fig. 50, electron source **700** and a plurality of horizontal sweep deflection elements **701**, three being indicated at **701***a*, **701***e*, and **701***i*, are arranged in curved relation and a curved beam trajectory, not shown, lying generally parallel to and slightly offset from the curvature of the associated viewing screen or screens, not shown, is provided by maintaining a plurality of opposing field defining elements **702**, three being shown at **702***a*, **702***e* and **702***i*, and field defining elements **703**, three being shown at **703***a*, **703***e* and **703***i*, at relative field defining potentials such that the potential of a given field defining element **702** on the convex side of the deflection system is slightly lower than the field potential of a given field defining element **703** to thereby provide the necessary curved beam trajectory.

Fig. 51 illustrates a further embodiment of the present invention suitable for three dimensional image presentation, wherein a plurality of like viewing screens or sets of viewing screens and correlatively associated sweep deflection elements **705**, **706**, **707** and **708** are arranged in depth from the viewer **709** to provide three dimensional image presentation of a relief character.

Fig. 52 presents a typical embodiment of the present invention suitable for three dimensional presentation of the stereoptic type, wherein two electron sensitive screen systems, generally indicated at **710** and **711**, are arranged in a side-by-side manner and respectively associated with polarizing filters **712** and **713** of opposing polarity as indicated at **714** and **715**. The two polarized images thus generated are delivered to a suitable viewing screen **716** by a projection means comprising reflection mirror **717** and semi-transparent mirror **718** of known design, in the manner indicated. The superposed images thus appearing on viewing screen **716** will produce a stereoptic image when viewed with polarizing viewing filters in a manner known to the art.

Fig. 53 presents a further embodiment of the present invention suitable for three dimensional presentation of a stereoptic character wherein two electron sensitive screen systems **720** and **721** are arranged in an opposing manner, and suitably optically separated as by optical mask **722**. In a manner similar to that employed in the system presented in Fig. 52, light polarizing filters **722** and **723** of opposing polarity, as indicated at **724** and **725**, are respectively associated with screen systems **720** and **721**. The resulting polarized images may be superimposed on a suitable viewing screen **726** by reflective mirrors **727**, **728** and **729**, and a semi-transparent mirror **730**, arranged as indicated.

Fig. 54 schematically presents another arrangement of electron sensitive screen systems suitable for three dimensional image presentation of a stereoptic character, wherein a screen system, generally indicated at **735**, is arranged perpendicular to a second electron sensitive screen system **736** arranged in accordance with the present invention. Said systems **735** and **736** are respectively associated with light polarizing filters **737** and **738** of opposing polarity as indicated at **739** and **740**. The resulting polarized images are superimposed on a suitable viewing screen **741** by means of a semi-transparent mirror **742**, arranged as indicated.

Fig. 55 presents a modified form of three dimensional presentation of a stereoptic character, wherein two screen systems generally indicated at **745** and **746** are associated with light polarizing filters **747** and **748** of opposing polarity, as indicated at **749** and **750**. As in Fig. 54, the resulting polarized images are superimposed on a suitable viewing screen **751** by means of a semi-transparent mirror **752**, as indicated. In the arrangement shown in Fig. 55, screen systems **745** and **746** may utilize a single electron beam **753** from a common electron beam source, not shown, which beam **753** is suitably sequentially delivered thereto by application of proper sequencing voltages to deflection elements **754** and **755**.

It is to be understood that various three dimensional presentation systems, such as are presented in Figs. 48 through 55, may be arranged as schematically indicated to provide three dimensional presentation of a monochrome character or may utilize a group of color producing viewing screens such as are presented in Figs. 36 through 44, in any given three dimensional image presentation system, to accomplish three dimensional image presentation in color.

It will be apparent that the concepts contributed by the present invention have wide application in cathode ray scanning devices and in electron beam deflection control therefor. In addition to being susceptible of use in monochrome and polychrome television image presentation, the scanning arrangements contemplated by the present invention may be employed in cathode ray oscilloscope applications, it being evident that the sweep deflection systems of tubes so employed may be controlled by voltages not necessarily sawtooth in waveform. Moreover, the screen scanning system arrangements presented will be understood to have general application as well in various other cathode ray scanning systems, such as for radar image presentation and video image producing equipment.

Accordingly, it is the purpose of Figs. 56 through 59, inclusive, to present two representative types of radar information presentation particularly adapted for use in the present invention, and it is the purpose of Fig. 60 to present a typical arrangement of video color image producing device embodying the principles of the present invention.

Considering Figs. 56 and 57 in further detail, to illustrate particular application of the present invention to one type of radar signal presentation, a suitable polychrome viewing screen comprising a transparent plate **760** has coated on the opposing sides thereof suitable electron sensitive color producing surfaces **761** and **762**, which are respectively green and white by way of example, only the activated portions of which are shown. Respectively associated with each of electron sensitive surfaces

761 and 762 are deflection elements 763 and 764 arranged in accordance with the present invention. An electron beam 765 is selectively delivered adjacent surfaces 761 and 762 by deflection elements 766, 767, 768 and 769, as shown. Utilizing radar target distinguishing circuits known to the art, a selective signal may be delivered to deflection elements 766 and 767 to cause stationary radar target signals to activate electron sensitive surface 761 and moving target signals to activate the other electron sensitive surface 762. With such an arrangement, moving target signals are presented on a common viewing screen with stationary target signals in a distinguishing color for ready recognition, the entire presentation system being of simple, shallow construction.

Considering Figs. 58 and 59 in further detail, to illustrate an application of the present invention particularly suitable for special signal presentation, a suitable polychrome viewing screen comprising a transparent plate 780 has coated on the opposing sides thereof electron sensitive color producing surfaces 781 and 782, which are respectively yellow and blue by way of example, only the activated portions of which are shown. Respectively associated in parallel and adjacent relation with each of electron sensitive surfaces 781 and 782 and co-extensive therewith to the extent necessary are a plurality of vertically elongated horizontal sweep deflection elements 783 and 784 arranged parallel to and slightly offset from said surfaces 781 and 782, as illustrated in Fig. 59. An electron source 785, producing an electron beam 786, has associated therewith vertically arranged deflection elements 787 and 788 and horizontally arranged deflection elements 789, 790, 791 and 792, as shown. Suitable sequencing voltages are delivered to deflection elements 787 through 792, inclusive, to successively deliver electron beam 786 along a trajectory 786*a* parallel to a first base, not shown, and along trajectory 786*b* parallel to a second base, not shown. Horizontal sweep deflection elements 783 and 784 are controlled in accordance with the present invention at rates corresponding to the first and second bases selected, and a signal may be delivered synchronously to the electron source 785 to provide sequential unblanking of the beam only for a gated signal for example, in a manner known to the art. Thus, in the illustrated embodiment, one type of signal information may be presented in yellow, as indicated at 781, along one base, and another type of signal information may be presented in blue, as indicated at 782, along a second base, the two types of information being clearly presented in contrasting colors on a single viewing screen of simple design and shallow construction.

Fig. 60 schematically illustrates a typical application of the present invention to a polychrome image camera tube. Such an image tube, generally indicated at 800, comprises a plurality of target plates 801, 802 and 803 with photo-emissive electrical charge image producing surfaces 804, 805 and 806 respectively coated thereon. Respectively coated on the opposing sides of each of target plates 801, 802 and 803 are transparent conductive coatings 807, 808 and 809, to which are respectively connected signal output leads 810, 811 and 812. Sweep deflection systems, the vertical sweep deflection elements of which are shown at 813, 814 and 815, together with electron beams 816, 817 and 818, are respectively arranged with respect to photo-emissive surfaces 804, 805 and 806, in accordance with the present invention, as shown. Operation of each of the signal developing sections of the image tube 800, as illustrated, is similar to that of iconoscopes in general in that image light 819 from the image to be reproduced is delivered through a suitable lens system 820 to photo-emissive surfaces 804, 805 and 806, causing photo-electrons to be emitted from the light receiving portions thereof. These photo-electrons are attracted to respective deflection elements 813, 814 and 815, at least a portion of which are maintained relatively positive with respect thereto at any given time, and thus create an electrical charge image on the photo-emissive surface. Electron beams 816, 817 and 818 are of a velocity to strike respective photo-emissive surfaces 804, 805 and 806 only where image light 819 has caused photo-electron emission, in the conventional manner. Where the scanning electron beams 816, 817 and 818 strike the photo-emissive surfaces, a capacitative signal is generated on each of the output leads 810, 811 and 812. The illustrated arrangement separates image light 819 into its color components in the manner hereinafter set forth. White images are seen by the tube section comprising output lead 812 and a white signal is obtained therefrom as indicated at 821. Interposed between this section and the next adjacent section is a color filter 822 selected to pass any two of the three primary colors, red and blue being passed, in the embodiment illustrated, by use of a magenta filter. The output signal obtained from output 811 will accordingly represent the blue-red components of the image as indicated at 823. Between the section of image tube 800 comprising output 811 and the adjacent section comprising output 810, there is interposed a blue filter 824 so that a signal representing the blue component of the image appears on output 810, as indicated at 825. By mixing circuits known to the art, any of the primary colors may be obtained by proper electrical mixing or subtracting of signals 821, 823 and 825. Thus, the red signal can be obtained by subtracting blue signal 825 from the blue and red signal 823 and a green signal obtained by subtracting the blue and red signal 823 from white signal 821.

In the arrangement shown, a particular design may render necessary placement of optically transparent electrostatic shields between each of vertical deflection elements 814 and 815 and respectively adjacent conductive pickup coatings 809 and 808 in order to minimize capacitative coupling therebetween. It will be understood that deflection elements 814 and 815 may be constructionally associated with respective color filters 824 and 822, as by being coated thereon, as desired.

It will also be understood that a typical monochrome image camera tube embodying the present invention may utilize the single white signal generating section comprising output lead 812 and associated components to produce a black and white video signal.

The term control tube has been employed to denote such control arrangements whether or not the components thereof are mounted in a separate or common envelope with the cathode ray tube envelope, and the types of control tubes presented in the embodiment of the invention illustrated in Figs. 2 through 6 are to be understood as merely illustrative of the types of sweep deflection element control suitable for systems designed in accordance with the present invention.

Accordingly, it is the purpose of Figs. 61 through 67 to present additional exemplary lineal control tubes utilizing one or more variably spaced control elements and it is the purpose of Figs. 68 through 74 to present additional exemplary types of similarly designed radial control tubes suitable for sweep deflection control as contemplated by the present invention.

Fig. 61 illustrates a schematic arrangement of a lineal tetrode control tube employing a plurality of anodes 860, three being indicated at 860*a* 860*e* and 860*i*, a common cathode 861, a screen grid 862, and a variably spaced control grid 863.

Fig. 62 illustrates a schematic arrangement of a lineal pentode control tube comprising a plurality of anodes 865, three being indicated at 865*a*, 865*e* and 865*i*, a common cathode 866, a screen grid 867 and two inversely variably spaced control grids 868 and 869.

Fig. 63 illustrates a schematic arrangement of a lineal hexode control tube employing a plurality of anodes 870, three being indicated at 870*a*, 870*e* and 870*i*, a common cathode 871, a suppressor grid 872, a screen grid 873 and two inversely variably spaced control grids 874 and 875.

Fig. 64 illustrates a schematic arrangement of another form of lineal hexode control tube, comprising a plurality of anodes **876**, three being indicated at **876a**, **876e** and **876i**, a common cathode **877**, a screen grid **878**, an accelerating grid or virtual cathode **879** and two inversely variable control grids **880** and **881** also functioning as a suppressor grid.

Fig. 65 illustrates a schematic arrangement of a lineal heptode control tube, comprising a plurality of anodes **882**, three being indicated at **882a**, **882e** and **882i**, a common cathode **883**, a screen grid **884**, an accelerating grid or virtual cathode **885**, a suppressor grid **886** and two inversely variable control grids **887** and **888**.

Fig. 66 illustrates a schematice arrangement of a suitable lineal octode control tube, comprising a plurality of anodes **889**, three being indicated at **889a**, **889e** and **889i**, a common cathode **890**, a first screen grid **891**, a second screen grid **892**, an accelerating grid or virtual cathode **893**, a suppressor grid **894**, and two inversely variably spaced control grids **895** and **896**.

Fig. 67 illustrates a schematic arrangement of another form of lineal pentode control tube illustrating the principle that the desired control tube characteristics may be accomplished by variably spacing control tube components. Thus, the illustrated lineal pentode comprises a plurality of anodes **897**, three being indicated at **897a**, **897e** and **897i**, a common cathode **898**, a screen grid **899**, a first control grid **900** with portions thereof variably spaced from cathode **898**, and a second control grid **901** with portions thereof variably spaced from control grid **900** and from screen grid **899**.

Fig. 68 presents a schematic arrangement of a tppical radial tetrode control tube comprising a plurality of anodes **902**, three being indicated at **902a**, **902e** and **902i**, a common cathode **904**, a screen grid **905** and a variably spaced control grid **906**.

Fig. 69 presents a schematic arrangement of a typical radial hexode control tube, comprising a plurality of anodes **907**, three being indicated at **907a**, **907e** and **907i**, a common cathode **908**, a screen grid **909**, a suppressor grid **910** and two inversely variably spaced control grids **911** and **912**.

Fig. 70 presents a schematic arrangement of another typical radial hexode control tube, comprising a plurality of anodes **913**, three being indicated at **913a**, **913e** and **913i**, a common cathode **914**, a screen grid **915**, an asselerating grid or virtual cathode **916**, and two inversely variably spaced control grids **917** and **918**, control grid **918** also serving as a suppressor grid.

Fig. 71 presents a schematic arrangement of a typical radial heptode control tube comprising a plurality of anodes **919**, three being indicated at **919a**, **919e** and **919i**, a common cathode **920**, a screen grid **921**, a suppressor grid **922**, an asselerating grid or virtual cathode **923**, and two inversely variably spaced control grids **924** and **925**.

Fig. 72 presents a schematic arrangement of a typical radial octode control tube illustrating use of a suppressor grid having beaming portions to isolate current conduction to a given anode arranged radially between such beam portions, which control tube comprises a plurality of anodes **926**, three being indicated at **926a**, **926e** and **926i**, a common cathode **927**, a first screen grid **928**, a second screen grid **929**, a segmental suppressor grid **930** having beaming portions **930a**, an accelerating grid or virtual cathode **931** and two inversely variably spaced control grids **932** and **933**.

Fig. 73 is a schematic arrangement of another form of typical radial pentode control tube, comprising a plurality of anodes **934**, three being indicated at **934a**, **934e** and **934i**, a common cathode **935**, a screen grid **936** and two inversely and segmentally variable control grids **937** and **938**.

Fig. 74 presents a further modification of a radial pentode control tube, to illustrate the principle that the desired characteristics may be accomplished by variably spacing components of the control tube. As shown, the control tube arrangement presented in Fig. 74 comprises a plurality of anodes **939**, three being indictated at **939a**, **939e** and **939i**, a common cathode **940**, a screen grid **941**, a first control grid **942** variably spaced from common cathode **940**, and a second control grid **943** variably spaced from said first control grid **942** and screen grid **941**.

Generally, sweep deflection control tubes such as are presented in Figs. 3, 5, 62 through 67, and 69 through 74, inclusive, which employ a plurality of inversely variably spaced control grids, in effect provide a beaming action between a common cathode and a plurality of anodes, and are relatively more efficient than similar tubes employing a single variably spaced control grid from the standpoint of power consumption. As indicated in connection with the operation of control tube **50** illustrated in Fig. 3, for example, optimum design of control tubes of this type should be such as to produce a beaming action which will maintain at least one precedingly conductive adjacent anode in conductive condition when a given anode thereof assumes a conductive deflection control condition in order to prevent distortion of the given deflection field. It will be understood that the variable spacing of control tubes of the types presented generally may be accomplished by segmental variation of a control grid, as illustrated in Figs. 5 and 73 by variable spacing between tube components, as illustrated in Figs. 67 and 74, or by other arrangements known to the art of one or more components to provide the desired characteristics under given operating conditions. It will be also understood that various designs of tube components which serve to facilitate the beaming action, such as grid projection **930a** in Fig. 72, are subject to use in conjunction with any selected arrangement of control tube components and may be of various configurations to accomplish the intended purpose. In connection with variably spaced control grids of the types herein disclosed, in the event undue control grid-cathode current is encountered during portions of the sweep cycle when the sweep voltage is relatively positive so as to materially interfere with the desired control action, it will be readily apparent to those skilled in the art that at least some of the control grid portions respectively operatively associated with the control anodes may be connected to adjacent grid portions through suitable isolating resistances so as to accomplish the desired control action as to all control anodes.

It will be further understood that control tubes and associated circuits for use as components of sweep deflection systems in accordance with the present invention should be designed to provide proper amplification and voltage characteristics along the general lines presented in Figs. 7 and 8 to insure linearity of sweep rate.

With the various types of sweep deflection control and design considerations therefor in view, a wide variety of sweep deflection control tubes and associated circuits, as well as other switching arrangements capable of delivering the desired control voltages necessary to accomplish beam scanning under given design conditions, will be suggested to those skilled in the art.

Although various types of control tubes have been disclosed which utilize one or more variably spaced control grids and although such control tubes have particular application for generation of sweep deflection control voltages in sweep deflection systems as contemplated by the present invention, it will be apparent that control tubes of these types are capable of wide application as radial beam electronic switching devices for use in other arrangements, such as in electronic counting circuits, telephonic systems, and the like.

Although control tubes of the type employing at least one variably spaced control grid have been described in association with a plurality of anodes, it will be apparent that the simplicity of switching control afforded by use of one variably spaced control grid or two inversely variably spaced control grids in common with several anodes is particularly advantageous when a series of considerable number, i. e. a multiplicity, of anodes are selectively so controlled.

As a result of utilization of electron beam scanning systems arranged with one or more image screens in accordance with the present invention, the cathode ray tube envelope may be of shallow dimension in depth and formed in any suitable manner, such as by having a back or rear portion of sheet metal or glass in the configuration of a shallow tray **950** and having a transparent face plate **951** joined in a manner known to the art with said back or rear portion as illustrated in Fig. 75.

While the present invention has been described with the aid of various embodiments and typical arrangements thereof, it will be understood that the invention is not limited to the particular constructional details shown and described, which may be departed from without departing from the spirit and scope of the invention.

This application is a continuation-in-part of application Serial Number 355, 965, filed May 19, 1953.

I claim:

1. An electron space discharge device comprising a target plate, means for delivering a cathode ray along a path which extends in proximate non-registering relation with said target plate, means operable to deflect said cathode ray from said path to paths successively adjacent to various portions of said target plate, and means operable to apply deflecting forces to different points along said last paths to deflect said cathode ray successively toward various portions of said target plate.

2. The method of scanning a target plate with a cathode ray, comprising delivering said cathode ray in a path slightly offset from said target plate, deflecting said beam through a series of contiguously arrayed paths lying substantially parallel and adjacent to said target plate, and successively deflecting said cathode ray toward said target plate at various points along said paths.

3. The method of scanning a target plate with an electron beam, comprising initially delivering a substantially linear beam of electrons in a direction substantially parallel to and slightly offset from said target plate, successively deflecting said electron beam through a series of contiguously arrayed trajectories lying substantially parallel and adjacent to said target plate, and further successively deflecting said electron beam into registration with said target plate at points variously spaced along said trajectories.

4. A cathode ray tube comprising an electron sensitive image screen, means arranged to deliver an electron beam substantially parallel and slightly offset from said image screen, a sweep deflection system arranged to deflect said electron beam throughout one dimension of an area which lies in substantially parallel and in coextensive relation with said image screen, and a second sweep deflection system arranged to further deflect said electron beam toward said image screen substantially throughout the other dimension thereof.

5. A cathode ray tube comprising an electron sensitive image screen, means arranged to deliver an electron beam through a trajectory substantially parallel and adjacent to said image screen, a sweep deflection system comprising means operable to generate a beam deflecting field consecutively along said trajectory to deflect said beam through successive trajectories substantially parallel and adjacent to said image screen, and a second sweep deflection system comprising means operable to generate a beam deflecting field consecutively transversely along said successive trajectories adjacent to said image screen to further deflect said electron beam successively toward different portions of said image screen, thereby causing said beam to scan said image screen bi-directionally.

6. The method of canning an electron sensitive image screen with an electron beam, comprising delivering said electron beam in a direction substantially parallel and slightly offset from said electron sensitive image screen, deflecting said beam successively through a series of contiguously arrayed trajectories lying substantially parallel to said electron sensitive image screen, and successively deflecting said electron beam toward said electron sensitive image screen at various points along said trajectories.

7. The method of scanning an electron sensitive image screen with an electron beam comprising initially delivering a substantially linear beam of electrons in a direction substantially parallel to and slightly offset from said electron sensitive image screen, successively deflecting said electron beam through a series of contiguously arrayed paths lying substantially parallel to and in facing relation with said electron sensitive image screen, and further deflecting said electron beam into registration with said electron sensitive image screen at points successively advanced from the initial line of deflection.

8. A cathode ray tube comprising an electron sensitive viewing screen, means arranged to deliver an electron beam in substantially parallel and proximate relation with said viewing screen, a sweep deflection system comprising means operable to produce a varying deflecting field successively along said beam path to deflect said beam in successive trajectories substantially parallel and adjacent to said viewing screen, and a second sweep deflection system comprising means operable to produce a varying deflecting field along said successive trajectories to further deflect said electron beam successively toward different portions of said viewing screen.

9. A cathode ray tube comprising an electron sensitive viewing screen arranged to present an image having three dimensional characteristics, means operable to deliver an electron beam in substantially parallel and adjacent relation with said viewing screen, a sweep deflection system for deflecting said electron beam substantially throughout one dimension of an area lying substantially parallel to and in facing relation with said viewing screen, and a second sweep deflection system for further deflecting said electron beam toward said viewing screen substantially throughout the other dimension thereof.

10. A cathode ray tube suitable for polychrome image presentation, comprising a plurality of electron sensitive color producing surfaces for presenting the image in color, all of the image presenting surfaces of the tube being arranged in substantially parallel juxtaposition relative to each other, means operable to deliver an electron beam respectively substantially parallel and adjacent to each of said electron sensitive surfaces, and means arranged with respect to each of said surfaces to deflect said electron beam toward each of the electron sensitive surface associated therewith.

11. A cathode ray tube suitable for polychrome television image presentation, comprising a plurality of electron sensitive color producing surfaces, means operable to deliver an electron beam respectively substantially parallel and adjacent to each of said electron sensitive surfaces served by said beam, and means operable to deflect each of said electron beams toward the said electron sensitive surface associated therewith to cause superposition of the color images produced on said surfaces.

12. A cathode ray tube in accordance with claim 11, wherein said electron sensitive color producing surfaces are arranged to present a color image having three dimensional characteristics.

13. An electron space discharge device comprising a target plate, deflection means mounted substantially coextensive with a dimensional edge of the target plate, means for delivering a linear electron beam adjacent said deflection means, means operable to energize said deflection means in a manner to effect deflection of said electron beam successively over adjacent paths parallel and adjacent to said target plate, and means operable to further deflect said electron beam into registration with said target plate.

14. An electron space discharge device comprising a target plate, means for delivering a linear electron beam along a trajectory in substantially parallel and at least partially coextensive relation with one dimensional edge

of said target plate, means operable to successively deflect said electron beam from said trajectory adjacent to various portions of said target plate, and means operable to thereafter effect deflection of said electron beam toward said target plate.

15. A cathode ray tube comprising an electron sensitive viewing screen, means for delivering a linear electron beam along a path which extends in substantially parallel and coextensive relation with one dimensional edge of said electron sensitive viewing screen, means operable to successively deflect said electron beam adjacent to various portions of said electron sensitive viewing screen, and means operable to thereafter effect deflection of said electron beam from the adjacent positions into registration with said electron sensitive viewing screen.

16. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam in a trajectory which is in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising at least one horizontal sweep deflection element and horizontal sweep deflection control means operable to control said deflection element to deflect said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising at least one vertical sweep deflection element and vertical sweep deflection control means operable to deliver a deflection voltage thereto to cause said electron beam to be further deflected toward and impinged upon said viewing screen.

17. A cathode ray tube in accordance with claim 16, wherein said electron source is arranged to deliver said electron beam in substantially parallel proximity to a horizontal edge of said viewing screen.

18. A cathode ray tube in accordance with claim 16, wherein said electron source is arranged to deliver said electron beam in substantially parallel proximity to the upper edge of said viewing screen.

19. A cathode ray tube in accordance with claim 16, wherein said horizontal sweep deflection system comprises a horizontal sweep control zone defined by a plurality of electrostatic horizontal sweep deflection plates arranged transversely along and adjacent to said beam trajectory which are individually connected through suitable resistances to a positive voltage source, said control zone being further defined by field defining plates spaced along said trajectory a distance to allow passage of the beam therebetween, said field defining plates being connected to said positive voltage source.

20. A cathode ray tube in accordance with claim 19, wherein said horizontal sweep deflection control means comprises at least one electric space discharge device having remote cutoff characteristics.

21. A cathode ray tube in accordance with claim 20, wherein said horizontal sweep deflection control means is a control tube comprising a plurality of anodes individually connected to said horizontal sweep deflection plates, a common cathode, and at least one variably spaced control grid, said control grid being arranged with respect to said plurality of anodes to consecutively establish said anodes in conductive condition when a suitable horizontal sweep voltage is delivered thereto.

22. A cathode ray tube in accordance with claim 21, wherein said control tube comprises a plurality of inversely spaced control grids operable to selectively and consecutively establish only a portion of said anodes in conductive condition when suitable horizontal sweep voltages are applied thereto.

23. A cathode ray tube in accordance with claim 21, wherein said plurality of anodes and plurality of control grids are respectively radially and concentrically arranged with respect to said common cathode.

24. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising a horizontal sweep control zone defined by a plurality of electrostatic horizontal sweep deflection plates arranged transversely along and adjacent to said beam trajectory which are individually connected through suitable resistances to a B plus voltage source, said control zone being further defined by field defining plates longitudinally disposed below and parallel to said beam trajectory and spaced in a direction transversely of said trajectory a distance to allow passage of the beam therebetween, said field defining plates being connected to said B plus voltage source, horizontal sweep deflection control means operable to apply relatively negative sweep deflection voltages consecutively to said horizontal sweep deflection plates to thereby deflect said electron beam downwardly in successive trajectories between said field defining plates at acute angles with respect to the aforesaid beam trajectory, said horizontal sweep deflection system further comprising a plurality of opposed accelerating anodes arranged in equispaced relation transversely of said successive trajectories, said accelerating anodes serving to accelerate said electron beam when delivered through said successive trajectories to thereby deliver said beam substantially parallel and adjacent to said electron sensitive surface in successive substantially vertical trajectories substantially throughout the horizontal dimension thereof, a vertical sweep deflection system comprising at least one vertical sweep deflection element and vertical sweep deflection control means operable to deliver a deflection voltage thereto to cause said electron beam to be further deflected toward said viewing screen and cause impingement of said electron beam thereon.

25. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity to an edge of said viewing screen, a horizontal sweep deflection system comprising at least one horizontal sweep deflection element and horizontal sweep deflection control means operable to control said deflection element to deflect said electron beam in successive trajectories parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising a plurality of vertical sweep deflection plates arranged transversely of said successive trajectories, substantially parallel to said electron sensitive surface and offset therefrom a distance to permit said successive beam trajectories to pass between said electron sensitive surface and said vertical sweep deflection plates, said vertical sweep deflection plates being individually connected to a high order voltage source through suitable high order resistances and said electron sensitive surface being connected to said high order voltage source to provide a vertical sweep control zone for said electron beam successively delivered through said trajectories, and vertical sweep deflection control means operable to consecutively deliver deflection voltages to each of said vertical sweep deflection plates to cause said electron beam to be further deflected toward said viewing screen and cause impingement of said electron beam thereon.

26. A cathode ray tube in accordance with claim 25, wherein said vertical sweep deflection control means comprises at least one electric space discharge device having remote cutoff characteristics.

27. A cathode ray tube in accordance with claim 26, wherein said horizontal sweep deflection control means is a control tube comprising a plurality of anodes individually connected with each of said horizontal sweep deflection plates, a common cathode, and at least one variably spaced control grid, said control grid being arranged with respect to said plurality of anodes to consecutively establish said anodes in conductive condition when a suitable horizontal sweep voltage is delivered thereto.

28. A cathode ray tube in accordance with claim 27, wherein said control tube comprises a plurality of in-

versely variably spaced control grids operable to selectively and consecutively establish only a portion of said anodes in conductive condition when suitable horizontal sweep voltages are applied thereto.

29. A cathode ray tube in accordance with claim 28, wherein said plurality of anodes and plurality of control grids are respectively radially and concentrically arranged with respect to said common cathode.

30. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with a horizontal edge of said viewing screen, a horizontal sweep deflection system comprising a plurality of horizontal sweep deflection elements and horizontal sweep deflection control means operable to control said deflection elements to deflect said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising a plurality of vertical sweep deflection elements and vertical sweep deflection control means operable to deliver deflection voltages thereto to cause said electron beam to be further deflected toward said viewing screen and cause impingement of said electron beam thereon.

31. A cathode ray tube in accordance with claim 30, wherein said viewing screen is of curved configuration with respect to the viewer substantially throughout the horizontal dimension thereof to provide three dimensional characteristics to the image presented.

32. A cathode ray tube in accordance with claim 31, wherein said curved configuration is convex with respect to the viewer.

33. A cathode ray tube suitable for full color image presentation comprising at least three electron sensitive primary color producing surfaces arranged in a substantially parallel and juxtaposed manner, means operable to deliver an electron beam respectively substantially parallel and adjacent to each of said electron sensitive surfaces, and means operable to deflect each of said electron beams toward the adjacent electron sensitive surface to cause impingement of said beam thereon.

34. A cathode ray tube in accordance with claim 33, wherein three electron sensitive color producing surfaces are arranged from the viewer in the order red, green and blue.

35. A cathode ray tube in accordance with claim 34, wherein said electron sensitive color producing surfaces are of curved configuration with respect to the viewer substantially throughout the horizontal dimension thereof to provide three dimensional characteristics to the color image.

36. A cathode ray tube in accordance with claim 35, wherein said curved configuration is convex with respect to the viewer.

37. A cathode ray tube suitable for television image presentation, comprising an electron sensitive light producing surface coated on a transparent target plate, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with the upper horizontal edge of said electron sensitive surface, a horizontal sweep deflection system comprising a horizontal sweep free field zone defined by a plurality of electrostatic horizontal sweep deflection plates arranged transversely along and adjacent to said beam trajectory which are individually connected through suitable resistances to a B plus voltage source, said free field zone being further defined by field defining plates longitudinally disposed below and parallel to said beam trajectory and spaced in a direction transversely of said trajectory a distance to allow passage of the beam therebetween, said field defining plates being connected to said B plus voltage source, horizontal sweep deflection control means comprising a radial control tube in turn comprising a plurality of anodes individually connected to said horizontal sweep deflection plates, a common cathode maintained at a relatively negative potential, and two inversely variably spaced control grids, said control grids being arranged with respect to said plurality of anodes so that when suitable inverse horizontal sweep voltages are delivered thereto said plurality of anodes are selectively and consecutively established in conductive condition in a manner to apply relatively negative sweep deflection voltages successively and consecutively to said horizontal sweep deflection plates to thereby deflect said electron beam downwardly in successive trajectories between said field defining plates at acute angles with respect to the aforesaid beam trajectory, said horizontal sweep deflection system further comprising a plurality of opposed accelerating anodes arranged in equispaced relation transversely of said successive trajectories, said accelerating anodes serving to accelerate said electron beam when delivered through said successive trajectories to thereby deliver said beam substantially parallel and adjacent to said electron sensitive surface in successive substantially vertical trajectories substantially throughout the horizontal dimension thereof, a vertical sweep deflection system comprising a plurality of vertical sweep deflection plates arranged transversely of said substantially vertical trajectories, substantially parallel to said electron sensitive surface and offset therefrom a distance to permit said substantially vertical beam trajectories to pass between said electron sensitive surface and said vertical sweep deflection plates, said vertical sweep deflection plates being individually connected to a high order voltage source through suitable high order resistances and said electron sensitive surface being connected to said high order voltage source to provide a vertical sweep control zone for said beam as said beam is successively delivered through said substantially vertical beam trajectories, vertical sweep deflection control means comprising a radial control tube in turn comprising a plurality of anodes individually connected to said vertical sweep deflection plates, a common cathode maintained at a relatively negative potential, and two inversely variably spaced control grids, said control grids being arranged with respect to said plurality of anodes so that, by delivery of suitable inverse vertical sweep voltages thereto, said plurality of anodes are selectively and consecutively established in conductive condition in a manner to apply deflection voltages successively and consecutively to said vertical sweep deflection plates to thereby cause impingement of said beam on said electron sensitive surface successively substantially throughout the vertical dimension thereof.

38. A cathode ray tube in accordance with claim 37, wherein said electron sensitive light producing surface is of convex configuration throughout the horizontal dimension thereof with respect to the viewer to provide three dimensional characteristics to the image generated thereon.

39. A cathode ray tube arranged in accordance with claim 37, suitable for color image presentation, wherein said electron sensitive light producing surface generates an image in one primary color and is arranged in parallel and close juxtaposition with a second electron sensitive light producing surface which generates an image in a second primary color and with a third electron sensitive light producing surface, which generates an image in a third primary color, said second and third electron sensitive surfaces each having correlatively associated therewith a plurality of horizontal sweep deflection plates and a plurality of vertical sweep deflection plates in like manner as corresponding sweep deflection plates are associated with the first recited electron sensitive surface, said horizontal and vertical sweep deflection plates associated with said second and third electron sensitive surfaces being electrically inter-connected with the corresponding horizontal and vertical sweep deflection plates associated with said first electron sensitive surface, the respective horizontal sweep deflection plates thereby being under common control of said horizontal sweep deflection control means

and the respective vertical sweep deflection plates thereby being under common control of said vertical sweep deflection control means to cause superposition of the respective color images.

40. A cathode ray tube in accordance with claim 39, wherein said plurality of parallel and juxtaposed electron sensitive color producing surfaces are arranged from the viewer in the order red, green and blue.

41. A cathode ray tube in accordance with claim 40, wherein said electron sensitive color producing surfaces are of convex configuration substantially throughout the horizontal dimension thereof with respect to the viewer to provide three dimensional characteristics to the images generated thereon.

42. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising a control zone defined by a plurality of electrostatic deflection elements arranged transversely along and adjacent to said beam trajectory, which elements are individually connected through suitable resistances to a high order voltage source, said control zone being further defined by field defining plates longitudinally disposed below and parallel to said beam trajectory and spaced in a direction transversely of said trajectory at a distance to allow passage of the beam there-between, said field defining plates being connected to said high order voltage source, horizontal sweep deflection control means operable to deliver deflection voltages to said deflection elements in a manner to cause deflection of said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising at least one vertical sweep deflection element and vertical sweep deflection control means operable to deliver a deflection voltage thereto to cause said electron beam to be further deflected toward said viewing screen and cause impingement of said electron beam thereon.

43. A cathode ray tube in accordance with claim 42, wherein said horizontal sweep deflection control means comprises a plurality of control tubes, each respectively associated with one of said horizontal sweep deflection elements by connection of the anode thereof to said element, said tubes each further comprising a low order voltage cathode and a control grid respectively connected through suitable resistances across a voltage divider system having delivered thereto a horizontal sweep voltage in a manner to consecutively establish each of the anodes of said tubes in conductive condition to thereby apply a relatively negative potential consecutively to said horizontal sweep deflection elements to cause said electron beam to be deflected downwardly between said field defining plates in successive substantially vertical trajectories.

44. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam in a trajectory in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising a plurality of horizontal sweep deflection elements and horizontal sweep deflection control means operable to control said deflection elements to deflect said electron beam in successive substantially vertical trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising a plurality of vertical sweep deflection elements and vertical sweep deflection control means operable to deliver deflection voltages thereto to cause said electron beam to be further deflected toward said viewing screen and cause impingement of said electron beam thereon.

45. A cathode ray tube in accordance with claim 44, wherein at least one of said horizontal and vertical sweep deflection control means comprises an electron beam switching unit comprising a plurality of electron collector plates individually connected to the sweep deflection elements to be controlled, an electron beam source arranged to deliver an electron beam generally toward said electron collector plates, and electron beam deflection means associated therewith to impinge said electron beam successively on said electron collector plates by delivery of suitable sweep voltages to said beam deflection means.

46. A cathode ray tube in accordance with claim 45, wherein said electron beam switching unit is a component of said vertical sweep deflection system and is delivered a suitable vertical sweep voltage.

47. A cathode ray tube comprising an electron sensitive viewing screen of concave configuration with respect to the viewer, means for producing an electron beam having a trajectory substantially parallel and adjacent to said viewing screen, a sweep deflection system comprising means operable to produce a beam deflecting field transversely and consecutively along said trajectory to deflect said beam in successive trajectories substantially parallel and adjacent to said viewing screen, and a second sweep deflection system comprising means operable to produce a beam deflecting field transversely and consecutively along said successive trajectories to deflect said electron beam from said latter trajectories successively toward various portions of said viewing screen.

48. A cathode ray tube suitable for color image presentation, comprising an electron sensitive light producing surface adapted to present an image in one color and having associated therewith an electron source and horizontal sweep deflection elements arranged to deliver an electron beam through substantially vertical trajectories lying substantially parallel and adjacent to said surface and vertical sweep deflection elements arranged to deflect said beam from said successive trajectories successively toward various portions of said surface, a second electron sensitive light producing surface adapted to present an image in another color and arranged in parallel juxtaposition with said first electron sensitive surface and having correlatively associated therewith a plurality of horizontal sweep deflection elements and a plurality of vertical sweep deflection elements in like manner as corresponding sweep deflection elements are associated with the first recited electron sensitive surface, said horizontal and vertical sweep deflection elements associated with said second electron sensitive surface being respectively under common control of suitable horizontal and vertical sweep deflection control means to cause superposition of the respective color images.

49. A cathode ray tube in accordance with claim 48, wherein said electron sensitive color producing surfaces are of concave configuration substantially throughout the horizontal dimension thereof with respect to the viewer to provide three dimensional characteristics to the color images generated thereon.

50. A cathode ray tube suitable for television image presentation, comprising an electron sensitive light producing surface coated on a transparent target plate, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with the upper horizontal edge of said electron sensitive surface, a horizontal sweep deflection system comprising a horizontal sweep control zone defined by a plurality of electrostatic horizontal sweep deflection plates arranged transversely along and adjacent to said beam trajectory, said sweep deflection plates being individually connected through suitable resistances to a high order voltage source, said sweep control zone being further defined by field defining plates longitudinally disposed below and parallel to said beam trajectory and spaced in a direction transversely of said trajectory a distance to allow passage of the beam therebetween, said field defining plates being connected to said high order voltage source, horizontal sweep deflection control means comprising a plu-

rality of control tubes, each respectively associated with one of said horizontal sweep deflection plates by connection of the anode thereof to said plate, said tubes each further comprising a low order voltage cathode and a control grid respectively connected through suitable resistances across successive portions of a voltage divider system having one end thereof maintained at a low order voltage and having delivered to the other end thereof a sweep voltage to consecutively establish each of the anodes of said tubes in conductive condition to thereby apply relatively negative potentials consecutively to said horizontal sweep deflection plates to cause said electron beam to be deflected downwardly between said field defining plates in successive substantially vertical trajectories lying substantially parallel and adjacent to said electron sensitive surface, a vertical sweep deflection system comprising a plurality of vertical sweep deflection plates arranged transversely of and substantially parallel to said substantially vertical trajectories, and offset from said electron sensitive surface a distance to permit said successive beam trajectories to pass between said electron sensitive surface and said vertical sweep deflection plates, said vertical sweep deflection plates being individually connected to a high order voltage source through suitable resistances and said electron sensitive surface being connected to said high order voltage source to provide a vertical sweep control zone for said successive trajectories, vertical sweep deflection control means comprising an electron beam switching unit in turn comprising a plurality of electron collector plates individually connected to said vertical sweep deflection elements, an electron beam source arranged to deliver an electron beam generally toward said electron collector plates, electron beam deflection means associated therewith to impinge said electron beam on the electron collector plate connected to the uppermost vertical sweep deflection element at the time of initiation of vertical sweep by delivery of suitable vertical sweep voltages to said beam deflection means to cause said electron beam to impinge successively on each of said electron collector plates to impart to said vertical sweep deflection elements a relatively negative voltage in descending order thereof to further deflect the downwardly directed electron beam passing through said successive trajectories toward said electron sensitive surface, thereby causing impingement of said beam on said electron sensitive surface substantially throughout the vertical dimension thereof.

51. A cathode ray tube in accordance with claim 50, wherein said electron sensitive light producing surface is of concave configuration substantially throughout the horizontal dimension thereof with respect to the viewer to provide three dimensional characteristics to the image generated thereon.

52. A cathode ray tube arranged in accordance with claim 50, suitable for color image presentation, wherein said electron sensitive light producing surface generates an image in one color and is arranged in parallel and close juxtaposition with a second electron sensitive light producing surface which generates an image in a second color, said second electron sensitive surface having correlatively associated therewith a plurality of horizontal sweep deflection plates and a plurality of vertical sweep deflection plates in like manner as corresponding sweep deflection plates are associated with the first recited electron sensitive surface, said horizontal and vertical sweep deflection plates associated with said second electron sensitive surface being electrically interconnected with the corresponding horizontal and vertical sweep deflection plates associated with said first electron sensitive surface, the respective horizontal sweep deflection plates thereby being under common control of said horizontal sweep deflection control means and the respective vertical sweep deflection means thereby being under common control of said vertical sweep deflection control means to cause superposition of the respective color images.

53. A cathode ray tube in accordance with claim 52, wherein said plurality of parallel and juxtaposed electron sensitive color producing surfaces respectively generate color images which are red-orange and blue-green in character.

54. A cathode ray tube in accordance with claim 53, wherein said plurality of parallel and juxtaposed electron sensitive color producing surfaces are of concave configuration throughout the horizontal dimension thereof with respect to the viewer to provide three dimensional characteristics to the images generated thereon.

55. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising a plurality of electrostatic sweep deflection wires arranged transversely along and adjacent to said beam trajectory and further comprising field defining plates placed along said trajectory a distance to allow passage of said beam therebetween, horizontal sweep deflection control means operable to control said horizontal sweep deflection wires in a manner to deflect said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising at least one vertical sweep deflection element and vertical sweep deflection control means operable to control said vertical sweep deflection element to cause said electron beam to be further deflected toward and impinged upon said viewing screen.

56. A cathode ray tube in accordance with claim 55, wherein said horizontal sweep deflection control means comprises a control tube comprising a plurality of anodes individually connected with each of said horizontal sweep deflection wires, a common cathode, and one variably spaced control grid, said control grid being arranged with respect to said plurality of anodes to consecutively establish said anodes in conductive condition when a suitable horizontal sweep voltage is delivered thereto.

57. A cathode ray tube in accordance with claim 56, wherein said anodes, control grid and common cathode are lineally arranged.

58. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising at least one horizontal sweep deflection element and horizontal sweep deflection control means operable to control said deflection element to deflect said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising a plurality of electrostatic vertical sweep deflection wires arranged transversely along and adjacent to said successive beam trajectories, which wires are individually connected through suitable high order resistances to a high order voltage source, and vertical sweep deflection control means operable to deliver deflection voltages consecutively to said vertical sweep deflection wires to cause said electron beam to be further deflected toward and impinge upon said viewing screen.

59. A cathode ray tube in accordance with claim 58, wherein said vertical sweep deflection control means is a control tube which comprises a plurality of anodes individually connected to each of said vertical sweep deflection wires, a common cathode, and at least one variably spaced control grid, said control grid being arranged with respect to said pluraltiy of anodes to consecutively establish said anodes in conductive condition when a suitable vertical sweep voltage is delivered thereto.

60. A cathode ray tube in accordance with claim 59,

wherein said anodes, control grid and common cathode are lineally arranged.

61. A cathode ray tube comprising a viewing screen having an electron sensitive surface, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising a plurality of electrostatic sweep deflection wires and horizontal sweep deflection control means operable to consecutively deliver deflection voltages to said wires to deflect said electron beam in successive trajectories substantially parallel and adjacent to said surface, a vertical sweep deflection system comprising a plurality of vertical sweep deflection wires and vertical sweep deflection control means operable to deliver deflection voltages to said latter wires to cause said electron beam to be further deflected toward and impinge upon said electron sensitive surface.

62. A cathode ray tube suitable for three dimensional image presentation comprising an electron sensitive surface, means arranged to deliver an electron beam in substantially parallel proximity with said surface, a first sweep deflection system for delivering said electron beam substantially parallel and adjacent to said surface substantially throughout one dimension thereof, and a second sweep deflection system for further deflecting said electron beam to cause impingement thereof upon said viewing screen substantially throughout the other dimension thereof, said electron sensitive surface having associated therewith a plurality of like electron sensitive surfaces, each having correlatively controlled sweep deflection elements, said plurality and first recited electron sensitive surfaces being arranged in depth with respect to the viewer to provide three dimensional presentation of a relief character.

63. A cathode ray tube suitable for association with a white light source to provide color image presentation of the subtractive type, comprising a plurality of electron sensitive surfaces which on activation respectively selectively absorb light of different primary colors, said electron sensitive surfaces being arranged in a substantially parallel and superposed manner intermediate said white light source and a viewer, means operable to deliver an electron beam respectively substantially parallel and adjacent to each of said electron sensitive surfaces, and means operable to deflect each of said electron beams toward the adjacent electron sensitive surface to cause impingement of said beam thereon.

64. A cathode ray tube in accordance with claim 63, comprising three electron sensitive color absorbing surfaces which are cyan, magenta and xanth.

65. A cathode ray tube in accordance with claim 63, wherein sets of said plurality of said selective color absorbing surfaces are arranged in depth with respect to the viewer to provide three dimensional color presentation of a relief character.

66. A cathode ray tube suitable for television image presentation of the subtractive type, comprising an electron sensitive surface which on activation selectively absorbs light, coated on a transparent target plate, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with the upper horizontal edge of said electron sensitive surface, a horizontal sweep deflection system comprising a horizontal sweep control zone defined by a plurality of electrostatic horizontal sweep deflection wires arranged transversely along and adjacent to said beam trajectory, said wires being individually connected through suitable resistances to a high voltage source, said sweep control zone being further defined by a plurality of field defining plates longitudinally disposed below and parallel to said beam trajectory and spaced in a direction transversely of said trajectory a distance to allow passage of the beam therebetween, said field defining plates being connected to said high voltage source, horizontal sweep deflection control means comprising a lineal control tube in turn comprising a plurality of anodes individually connected to said horizontal sweep deflection wires, a common cathode maintained at a relatively negative potential, and a variably spaced control grid, said control grid being arranged with respect to said plurality of anodes so that when a suitable horizontal sweep voltage is delivered thereto said plurality of anodes are consecutively established in conductive condition and apply relatively negative sweep deflection voltages consecutively to said horizontal sweep deflection wires to deflect said electron beam downwardly in successive substantially vertical trajectories between said field defining plates to thereby deliver said beam substantially parallel and adjacent to said electron sensitive surface in successive substantially vertical trajectories substantially throughout the horizontal dimension thereof, a vertical sweep deflection system comprising a plurality of vertical sweep deflection wires arranged transversely of said substantially vertical trajectories, and substantially parallel to said electron sensitive surface and offset therefrom a distance to permit said substantially vertical beam trajectories to pass between said electron sensitive surface and said vertical sweep deflection wires, said vertical sweep deflection wires being individually connected to a high order voltage source through suitable high order resistances and said electron sensitive surface being connected to said latter high order voltage source to provide a vertical sweep control zone for said electron beam trajectories, vertical sweep deflection control means comprising a lineal control tube in turn comprising a plurality of anodes individually connected to said vertical sweep deflection wires, a common cathode maintained at a relatively negative potential, and a variably spaced control grid, said control grid being arranged with said plurality of anodes so that by delivery of a suitable vertical sweep voltage thereto, said plurality of anodes are consecutively established in conductive condition in a manner to apply a relatively negative voltage consecutively to said vertical sweep deflection wires to thereby cause successive impingement of said beam on said electron sensitive surface substantially throughout the vertical dimension thereof.

67. A cathode ray tube in accordance with claim 66, wherein said electron sensitive surface has associated therewith a plurality of like electron sensitive surfaces arranged in depth with respect to the viewer to provide three dimensional presentation of a relief character.

68. A cathode ray tube arranged in accordance with claim 66, suitable for color image presentation, wherein said electron sensitive surface which on activation selectively absorbs light of one primary color and is arranged in parallel juxtaposition with a second electron sensitive surface which on activation selectively absorbs light of a second primary color and with a third electron sensitive surface which on activation selectively absorbs light of a third primary color, said second and third electron sensitive surfaces each having correlatively associated therewith a plurality of horizontal sweep deflection wires and a plurality of vertical sweep deflection wires in like manner as corresponding sweep deflection wires are associated with the first recited electron sensitive surface, said horizontal and vertical sweep deflection wires associated with said second and third electron sensitive surfaces being electrically interconnected with the corresponding horizontal and vertical sweep deflection wires associated with said first electron sensitive surface, the respective horizontal sweep deflection plates thereby being under common control of said horizontal sweep deflection control means and the respective vertical sweep deflection wires thereby being under common control of said vertical sweep deflection control means to cause superposition of the respective images appearing on said surfaces.

69. A cathode ray tube in accordance with claim 68, wherein said plurality of parallel and juxtaposed electron sensitive color absorbing surfaces of cyan, magenta and xanth.

70. A cathode ray tube in accordance with claim 68, wherein sets of said electron sensitive selective color absorbing surfaces are arranged in depth with respect to the viewer to provide three dimensional color presentation of a relief character.

71. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with the lower horizontal edge of said viewing screen, a horizontal sweep deflection element and horizontal sweep deflection control means operable to control said deflection element to deflect said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising at least one vertical sweep deflection element and vertical sweep deflection control means operable to deliver a deflection voltage thereto to cause said electron beam to be further deflected toward and impinged upon said viewing screen.

72. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising a horizontal sweep control zone defined by a plurality of electromagnetic horizontal sweep deflection elements, each comprising a field winding and each having the pole pieces thereof arranged transversely along and adjacent to said beam trajectory, said electromagnetic deflection elements being electrostatically connected to a B plus voltage source, said sweep control zone being further defined by field defining plates longitudinally disposed below and parallel to said beam trajectory and spaced in a direction transversely of said trajectory a distance to allow passage of the beam therebetween, said field defining plates being connected to said B plus voltage source, horizontal sweep deflection control means operable to consecutively energize the windings of said electromagnetic sweep deflection elements to cause said electron beam to be deflected along successive substantially vertical trajectories between said field defining plates, a vertical sweep deflection system comprising at least one vertical sweep deflection element and vertical sweep deflection control means operable to deliver a deflection voltage thereto to cause said electron beam to be further deflected toward and impinged upon said viewing screen.

73. A cathode ray tube in accordance with claim 72, wherein said horizontal sweep deflection control means comprises a plurality of control tubes, each in turn comprising an anode individually connected to said B plus voltage source through the respective field windings of said electromagnetic sweep deflection elements, a low order potential cathode, and a control grid, said control grid being connected across a voltage divider system having applied thereto a suitable horizontal sweep voltage in a manner to consecutively establish each of said control tubes in conductive condition.

74. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with an edge of said viewing screen, a horizontal sweep deflection system comprising at least one horizontal sweep deflection element and horizontal sweep deflection control means operable to control said deflection elements in a manner to deflect said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising a single vertical sweep deflection plate substantially co-extensive with said viewing screen and arranged at an angle with respect to said viewing screen so that portions of said sweep deflection plate relatively remote from said electron source are positioned relatively close to said viewing screen, said vertical sweep deflection plate being connected through a suitable resistance to a high order voltage source and said viewing screen being connected to a high order voltage source, a vertical sweep deflection control means comprising a control tube in turn comprising an anode connected to said vertical sweep deflection plate, a cathode maintained at a relatively low order potential, and a control grid which, when delivered a suitable vertical sweep voltage, establishes said anode at a potential to cause the electron beam delivered through said successive substantially vertical trajectories to be deflected by said vertical sweep deflection plate toward said viewing screen.

75. A cathode ray tube comprising an electron sensitive surface coated on a transparent target plate, an electron source arranged to deliver an electron beam through a trajectory in substantially parallel proximity with an edge of said electron sensitive surface, a horizontal sweep deflection system comprising at least one horizontal sweep deflection element and horizontal sweep deflection control means operable to control said deflection element to deflect said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising a vertical sweep control zone defined by at least one vertical sweep deflection element arranged transversely along and adjacent to said successive beam trajectories, said vertical sweep deflection element being connected through a suitable resistance to a high order voltage source, said vertical sweep control zone being further defined by an electron pervious screen arranged immediately adjacent said electron sensitive surface, said screen being connected to said high voltage source, said electron sensitive surface being connected to a higher order voltage source than said electron pervious screen, and vertical sweep deflection control means operable to deliver a suitable deflection voltage to said vertical sweep deflection element to cause said electron beam to be deflected toward said electron pervious screen and drawn therethrough by the relatively higher potential maintained on said electron sensitive surface to cause acceleration of said beam and impingement thereof on said electron sensitive surface.

76. A cathode ray tube in accordance with claim 75, wherein said vertical sweep deflection element comprises a single electrostatic sweep deflection plate substantially co-extensive with said electron sensitive surface arranged with portions of said plate relatively remote from the first recited electron beam trajectory positioned relatively close to said electron sensitive surface.

77. An electron space discharge device comprising means for delivering an electron beam with the axis thereof in a plane, means for applying lateral deflection forces to different points along the path of said electron beam to bend the beam from correspondingly different points along its axis to successively trace a series of contiguously arrayed paths in said plane, and deflection means operable to thereafter successively deflect said beam from various portions of said plane.

78. An electron space discharge device comprising a target plate, means for delivering a beam along a path which extends in substantially parallel and proximate relation with said target plate, means mounted substantially co-extensively with a dimension of the target operable to deflect said electron beam to successively trace a series of contiguous paths in a plane adjacent said target, and deflection means operable to deflect said beam out of said plane in the direction of said target plate.

79. An electron space discharge device comprising means for delivering an electron beam with the axis thereof in a plane, means for applying lateral deflection forces to said beam at different points along its axis to bend same from correspondingly different points thereon to successively trace a series of contiguous paths in said plane,

and deflection means operable to successively deflect the beam from said plane at spaced, different intervals along said paths.

80. An electron space discharge device comprising a target plate, means for delivering an electron beam with the axis thereof in a plane, means disposed substantially co-extensively with one dimension of said target plate for effecting deflection of said beam within said plane at successively spaced points along said dimension, and means disposed substantially co-extensively with a second dimension of said target plate for deflecting said beam out of said plane into registration with said target plate at successive points variously disposed along said second dimension.

81. A cathode ray tube suitable for monochrome television image presentation, comprising an electron sensitive image screen, means arranged to deliver an electron beam in a path in substantially parallel proximity with said image screen, a sweep deflection system comprising means operable to produce a varying deflecting field at different points along said trajectory to deflect said beam in correspondingly different successive trajectories substantially parallel and adjacent to said image screen, and a second sweep deflection system comprising means operable to produce a varying deflecting field at different points along said successive trajectories to further deflect said electron beam successively toward correspondingly different portions of said image screen.

82. A cathode ray tube in accordance with claim 81, wherein said electron sensitive image screen is substantially planar.

83. A cathode ray tube suitable for television image presentation, comprising an electron sensitive light producing surface coated on a transparent target plate, an electron source arranged to deliver an electron beam through a trajectory lying in substantially parallel proximity with the lower horizontal edge of said electron sensitive surface, a horizontal sweep deflection system comprising a horizontal sweep control zone defined by a plurality of electromagnetic horizontal sweep deflection elements arranged with the pole pieces thereof equispaced transversely along said beam trajectory and each having a magnetic field winding associated therewith, said elements being electrostatically connected to a suitable B plus voltage source, said sweep control zone being further defined by field defining plates longitudinally disposed below and parallel to said beam trajectory and spaced in a direction transversely of said trajectory a distance to allow passage of the beam therebetween, said field defining plates being connected to said B plus voltage source, horizontal sweep deflection control means comprising a plurality of control tubes in turn each comprising an anode individually connected to said B plus voltage source through the respective field windings of said electromagnetic sweep deflection elements, a low order potential cathode, a screen grid, a suppressor grid, and a control grid, said control grid being connected across a voltage divider system maintained at one end thereof at a low order potential and having applied to the other end thereof a suitable horizontal sweep voltage in a manner to consecutively establish each of said control tubes in conductive condition to thereby energize the field winding of each of said electromagnetic sweep deflection elements in consecutive manner to deflect said electron beam upwardly in successive substantially vertical trajectories between said field defining plates substantially throughout the horizontal dimension of said electron sensitive surface, a vertical sweep deflection system comprising a single vertical sweep deflection plate arranged at an angle with respect to said surface and having portions thereof relatively remote from said electron source positioned relatively close to said surface, said vertical sweep deflection plate being connected through a suitable resistance to a high order voltage source, an electron pervious screen arranged immediately adjacent said electron sensitive surface and connected to said high voltage source, said electron sensitive surface being connected to a high order voltage source, a vertical sweep deflection control means comprising a control tube in turn comprising an anode connected to said vertical sweep deflection plate, a cathode maintained at a relatively low order potential, and a control grid which, when delivered a suitable vertical sweep voltage, causes the electron beam delivered through said successive substantially vertical trajectories to be deflected by said vertical sweep deflection element toward said electron pervious screen substantially throughout the vertical dimension thereof, the electron beam being drawn through said electron pervious screen by the relatively high potential maintained on said electron sensitive surface to cause acceleration and impingement of said beam on said electron sensitive surface.

84. A cathode ray tube in accordance with claim 83, wherein a single electron sensitive surface is employed to provide a monochrome image.

85. A cathode ray tube in accordance with claim 84, wherein said electron sensitive surface is substantially planar.

86. A cathode ray tube comprising an electron sensitive surface, an electron source arranged a substantial distance from one edge of said surface in a manner to deliver an electron beam in a trajectory lying substantially parallel and adjacent to said electron sensitive surface, a first sweep deflection system comprising opposed deflection elements equispaced from said trajectory in a direction substantially parallel to said electron sensitive surface, means for delivering suitable sweep voltages to said deflection elements to cause said electron beam to be successively delivered adjacent to various portions of said electron sensitive surface, a second sweep deflection system comprising at least one sweep deflection element arranged generally transversely of said trajectory and spaced from said electron sensitive surface a distance to permit said beam trajectory to pass between said surface and said transversely arranged sweep deflection element, and second sweep deflection control means operable to deliver a deflection control voltage to said transversely arranged sweep deflection element to cause said electron beam to be further deflected toward and impinged upon said electron sensitive surface successively at points thereof variously spaced from said edge of said surface.

87. A cathode ray tube in accordance with claim 86, wherein said second weep deflection system comprises a plurality of transversely arranged sweep deflection elements.

88. A cathode ray tube in accordance with claim 87, wherein said plurality of sweep deflection elements are electrostatic plates.

89. A cathode ray tube comprising an electron sensitive viewing screen, an electron source arranged to deliver an electron beam through a generally vertical trajectory in substantially parallel proximity with said viewing screen, a horizontal sweep deflection system comprising a least one horizontal sweep deflection element and horizontal sweep deflection control means operable to control said deflection element in a manner to deflect said electron beam in successive trajectories substantially parallel and adjacent to said viewing screen, a vertical sweep deflection system comprising a plurality of vertical sweep deflection elements arranged transversely along and adjacent to said successive trajectories, which vertical sweep deflection elements are individually connected through suitable resistances to a high order voltage source, the vertical sweep control zone provided thereby being further defined by connection of said electron sensitive surface to said high order voltage source, vertical sweep deflection control means comprising a control tube in turn comprising a plurality of anodes individually connected to said vertical sweep deflection elements, a common cathode maintained at a relatively negative potential, and two inversely variably spaced control grids, said control grids

being arranged with respect to said plurality of anodes so that, by delivery of suitable vertical sweep voltages to said control grids, said plurality of anodes are selectively and consecutively established in conductive condition in a manner to apply a relatively negative voltage successively and consecutively to said vertical sweep deflection elements to thereby cause successive impingement of said beam on correspondingly different portions of said electron surface.

90. A cathode ray tube in accordance with claim 89, wherein the components of said control tube are lineally arranged.

91. A cathode ray tube comprising two electron sensitive image producing surfaces, means arranged with respect to each of said surfaces to deliver an electron beam substantially parallel and adjacent to each of said surfaces, said electron sensitive surfaces each further having associated therewith a plurality of sweep deflection elements, correlatively arranged and controlled to effect deflection of each of said electron beams substantially throughout one dimension of the electron sensitive surface associated therewith, and a second plurality of sweep deflection elements correlatively arranged with said electron sensitive surfaces and controlled to further deflect each of said electron beams toward the image screen associated therewith substantially throughout the other dimension thereof, polarizing filters of opposing polarity respectively so arranged with said electron sensitive surfaces, and means for projecting the respective images developed on said electron sensitive surfaces on a single viewing surface to provide thereon an image having stereoptic properties when viewed through relatively opposed polarizing filters.

92. A cathode ray tube in accordance with claim 91, wherein all of said image producing surfaces are scanned with an electron beam from a common electron beam source.

93. A cathode ray tube suitable for full-color image presentation comprising at least four electron sensitive surfaces arranged in a substantially parallel and juxtaposed manner, means operable to deliver an electron beam respectively substantially parallel and adjacent to each of said electron sensitive surfaces, and means operable to deflect each of said electron beams toward the adjacent electron sensitive surface to cause impingement of said beam thereon.

94. A cathode ray tube in accordance with claim 93, wherein a white luminance image is presented on one of said electron sensitive color producing surfaces and respectively different primary chrominance images are presented on the remaining electron sensitive surfaces.

95. A cathode ray tube in accordance with claim 94, wherein said white luminance image is presented on the said electron sensitive color producing surface most remote from the viewer.

96. A cathode ray tube in accordance with claim 95, wherein said electron sensitive surfaces are arranged from the viewer to respectively generate images in the order blue, red, green and white.

97. A cathode ray tube in accordance with claim 96, wherein two sets of associated color image producing surfaces are arranged with respectively opposed polarizing filters, and have associated therewith means for projecting the images developed thereon on a single viewing surface to provide a color image having stereoptic properties when viewed through relatively opposed polarizing filters.

98. A cathode ray tube suitable for television image presentation, comprising an electron sensitive surface coated on a transparent target plate, an electron source arranged a substantial distance from one edge of said surface in a manner to deliver an electron beam in a trajectory lying substantially parallel and adjacent to said electron sensitive surface, a horizontal sweep deflection system comprising opposed deflection elements equispaced from said trajectory in a direction substantially parallel to said electron sensitive surface, means for delivering suitable horizontal sweep and anti-keystoning voltages to said deflection elements to cause said beam to be delivered adjacent to said electron sensitive surface substantially throughout the horizontal dimension thereof, a vertical sweep deflection system comprising a plurality of vertical sweep deflection plates arranged generally tranversely of said trajectory, substantially parallel to said electron sensitive surface and offset therefrom a distance to permit said beam trajectory to pass between said surface and said vertical sweep deflection plates, said vertical sweep deflection plates being individually connected to a high order voltage source through suitable high order resistances and said electron sensitive surface being connected to said high order voltage source to provide a vertical sweep control zone for said electron beam trajectory, vertical sweep deflection control means comprising a lineal control tube in turn comprising a plurality of anodes individually connected to said vertical sweep deflection plates, a common cathode maintained at a relatively negative potential, and two inversely variably spaced control grids, said control grids being arranged with respect to said plurality of anodes so that, by delivery of suitable vertical sweep voltages to said control grids, said plurality of anodes are selectively and consecutively established in conductive condition in a manner to apply a relatively negative voltage successively and consecutively to said vertical sweep deflection plates to thereby cause impingement of said beam on successive portions of said electron sensitive surface substantially throughout the vertical dimension thereof.

99. A cathode ray tube in accordance with claim 98, wherein two of said electron sensitive surfaces and associated scanning systems are respectively arranged with polarizing filters of opposing polarity and are associated with means for projecting the respective images developed on said surfaces on a single viewing surface to provide thereon an image having stereoptic properties when viewed through relatively opposed polarizing filters.

100. A cathode ray tube arranged in accordance with claim 98, suitable for color image presentation, wherein said electron sensitive surface generates a white image and is arranged in parallel juxtaposition with second, third, and fourth electron sensitive surfaces, each respectively generating color images in different primary colors, and second, third, and fourth electron sensitive surfaces each having correlatively associated therewith a plurality of horizontal sweep deflection elements and a plurality of vertical sweep deflection elements in like manner as corresponding sweep deflection elements are associated with the first recited electron sensitive surface, said horizontal and vertical sweep deflection elements associated with said second, third, and fourth electron sensitive surfaces being electrically interconnected with the corresponding horizontal and vertical sweep deflection elements associaed with said first electron sensitive surface, the respective horizontal deflection elements thereby being under common control of said horizontal sweep deflection means and the respective vertical sweep deflection elements thereby being under common control of said vertical sweep deflection control means to cause superposition of the respective white light and color images.

101. A cathode ray tube in accordance with claim 100, wherein said electron sensitive surfaces are arranged from the viewer to respectively generate images in the order blue, red, green and white.

102. A cathode ray tube in accordance with claim 101, wherein two sets of associated color image producing surfaces are arranged with respectively opposed polarizing filters and have associated therewith means for projecting the images developed thereon on a single viewing surface to provide an image having stereoptic properties when viewed through relatively opposed polarizing filters.

103. A cathode ray tube system in accordance with

claim 102, wherein said image producing surfaces are scanned with an electron beam from a common electron beam source.

104. A cathode ray tube image screen scanning system having a plurality of horizontal sweep deflection elements adapted to be arranged in substantially parallel proximity with an image screen, a plurality of vertical sweep deflection elements adapted to be arranged substantially parallel and adjacent to an image screen, horizontal sweep deflection control means operable to deliver deflecting voltages to said horizontal sweep deflection elements, and vertical sweep deflection control means operable to deliver deflection voltages to said vertical sweep deflection elements.

105. A cathode ray tube image screen scanning system adapted to be arranged substantially parallel and adjacent to an image screen, comprising means for defining an electron beam control zone in proximity with an edge of said image screen, including a plurality of sweep deflection elements arranged transversely along said screen edge, and field defining plates disposed parallel and adjacent to said sweep deflection means, horizontal sweep deflection control means operable to control said sweep deflection elements to deflect the electron beam from said zone in successive trajectories between said field defining plates, a plurality of vertical sweep deflection elements arranged generally transversely and adjacent to said successive trajectories, and vertical sweep deflection control means operable to deflect the beam from said successive trajectories into registration with correspondingly different points on said screen.

106. A cathode ray tube having a shallow dimension in depth, comprising an electron beam source, an image screen, means for delivering an electron beam from said source through successive, contiguous trajectories, all disposed substantially parallel and adjacent to said image screen and arrayed throughout the effective area thereof, and means arranged substantially co-extensive with said image screen to cause said electron beam to be deflected from said successive, contiguous trajectories and impinged upon said image screen.

107. An electron space discharge device comprising an image screen, means for emitting an electron beam in a direction substantially parallel and adjacent to said screen, means operable to sweep said beam within a plane substantially parallel to said screen, and means operable to deflect said beam successively at different levels thereof toward said screen.

108. An electron space discharge device comprising an image screen, means operable to produce a rapidly descending negative field adjacent and relative to said screen, and means for delivering an electron beam into the space between said screen and said field producing means in the direction in which said negative field descends.

109. An electron space discharge device comprising an image screen, a plurality of vertically superposed parallel elements disposed adjacent and substantially parallel to said screen, means for delivering an electron beam into the space between said screen and said elements in a direction substantially parallel to the plane defined by the said elements, and means operable to apply to said elements in succession a negative bias with regard to said screen.

110. A cathode ray tube comprising a rear portion in the shape of a shallow substantially rectangular tray, an image screen covering the open side of said tray, means located within said tray adjacent a corner thereof for delivering an electron beam along a line substantially parallel to an edge of said screen, means operable to deflect said beam in a direction perpendicular to said edge in succession at different points longitudinally of said edge, and means operable to deflect the beam from its deflected trajectories toward said screen.

111. An electron space discharge device comprising a target screen, electron sensitive coatings applied to both faces of said screen, means for delivering electron beams past both sides of said screen in trajectories extending substantially parallel and adjacent thereto, and means operable to deflect both said beams in a direction toward said screen.

112. An electron space discharge device comprising a target screen, electron sensitive coatings applied to both sides of screen, means for delivering electron beams at either side of said screen in a direction substantially parallel and adjacent thereto, means operable to sweep said beams within planes substantially parallel to said screen, and means operable to deflect said beams successively at different levels thereof toward said screen.

113. An electron space discharge device comprising an electron sensitive image screen, means for delivering an electron beam in proximate relation with said image screen, means for deflecting said electron beam parallel and adjacent to the various portions of said image screen, and a plurality of deflection members, each of which is further selectively operative to deflect and cause impingement of said electron beam on correspondingly different portions of said image screen.

114. An electron space discharge device comprising an electron sensitive image screen, means for delivering an electron beam in proximate relation with said image screen, means operable to deflect said electron beam successively to the various portions of an area which is coextensive with and spaced from said image screen, and deflection means operable to further deflect said electron beam from said area to impinge successively on correspondingly different portions of said image screen.

115. An electron space device comprising an electron sensitive image screen, means for delivering an electron beam along a path which lies in proximate coextensive relation with said image screen, means operable to deflect said electron beam successively along the coextensive portion of the path into trajectories adjacent said image screen, and means operable to further deflect said beam successively from said trajectories into impingement on various portions of said image screen.

116. A cathode ray tube suitable for image presentation comprising a plurality of electron sensitive surfaces for presenting an image, the image presenting surfaces being aligned in substantially juxtaposed relation with each other, means operable to deliver an electron beam respectively substantially parallel and adjacent to each of said electron surfaces, and means arranged in adjacent relation with respect to each of said surfaces operable to deflect said electron beam toward each of the electron sensitive surfaces associated therewith.

117. An electron space discharge device comprising a target, a set of deflection means spaced from said target to establish a zone therebetween, means for delivering an electron beam along a path which extends in adjacent non-registering relation with said zone, and means operable to apply deflecting forces at different points along said path to deflect said beam into said zone at correspondingly different points.

118. An electron space discharge device comprising a target, deflection means disposed in spaced relation with said target, means for delivering an electron beam into the space between said target and said deflection means along a path which extends in non-registering relation with the target, and means connected to apply beam bending signals to said deflection means to effect bending of the beam from the path selectively at different points into registration with correspondingly different points on said target.

119. A cathode ray tube comprising a target screen, a luminescent coating applied to one face of said screen, a cathode ray gun arranged to deliver an electron beam past the coated side of said screen parallel and adjacent thereto, and means operable to deflect said beam from said path at the different points at different times into registration with the coated side of said screen.

120. A cathode ray tube comprising a target screen,

a luminescent coating on one side of said screen, means disposed adjacent said screen operable to produce a field of a predetermined value at different points at different times, and an electron gun arranged to direct an electron beam into the space between said screen and said field producing means for deflection into said screen by said field at a point which is at said predetermined value.

121. A cathode ray tube comprising a target screen, a luminescent coating on one side of said screen, means operable to produce a rapidly descending negative field adjacent and relative to the coated side of said screen, and an electron gun arranged to send an electron beam into the space between the coated side of said screen and said field producing means in the direction in which the negative field descends.

122. A cathode ray tube comprising a target screen, a luminescent coating on one side of said screen, a plurality of vertically superposed parallel wires disposed adjacent and parallel to the coated side of said screen, an electron gun arranged to direct an electron beam into the space between the coated side of said screen and said wires in a direction substantially parallel to the plane defined by said wires, and means operable to apply to said wires a negative bias with regard to the coating on said screen in rapid succession.

123. A cathode ray tube comprising a target screen, a luminescent coating on one side of said screen, a plurality of vertically superposed parallel wires disposed adjacent and parallel to the coated side of said screen, an electron gun arranged to direct an electron beam into the space between the coated side of said screen and said wires in a direction substantially parallel to the plane defined by said wires, means for sweeping said beam in said plane, and means operable to apply to said wires a negative bias relative to the coated side of said screen in rapid succession.

124. A cathode ray tube comprising a transparent target screen, a luminescent coating on one face of said screen, an electron gun located above and laterally of said screen and arranged to direct its beam along a horizontal line above and parallel to said screen, means operable to deflect said beam in a downward direction in rapid succession at different points longitudinally thereof, and means operable to deflect the downwardly directed runs of said beam toward the coated surface of said target screen.

125. A cathode ray tube comprising a transparent target screen; a luminescent coating on one face of said screen; an electron gun located above and laterally of said screen and arranged to direct its beam along a horizontal line above and parallel to said screen; a first grid of longitudinally juxtaposed wires disposed transversely above an initial path of said beam; a pair of parallel electrodes disposed below and parallel to said initial path and spaced in a direction transversely of said beam to provide a gap extending parallel to and below the initial path of said beam; a first voltage generator operable to apply in rapid succession a negative bias to the individual wires of said grid, commencing with the wire farthest from said gun, to deflect said beam downwardly through said gap in a plane parallel to the coated surface of said screen; a second grid of vertically superposed horizontal wires disposed parallel to the coated surface of said screen behind the downwardly directed runs of said beam; and a second voltage generator operable to apply a negative bias in rapid succession to consecutively lower wires of said second grid to deflect the downwardly directed runs of said beam toward the coated surface of said screen.

126. A cathode ray tube comprising a rear portion of sheet metal in the shape of a shallow rectangular tray, a transparent target screen covering the open side of said tray, a luminescent coating on the inner face of said screen, an electron gun located within said tray adjacent an upper corner thereof and arranged to direct its electron beam along a line parallel to the upper edge of said screen, means operable to deflect said beam in a downward direction in rapid succession at different points longitudinally of said upper edge, and means operable to deflect the downwardly deflected runs of said beam toward the coated surface of said screen.

127. A cathode ray tube comprising a rear portion of sheet metal in the shape of a shallow rectangular tray, a transparent target screen covering the open side of said tray, a luminescent coating on the inner face of said screen, an electron gun located within said tray adjacent an upper corner thereof and arranged to direct its electron beam along a line parallel to the upper edge of said screen, a first grid of longitudinally juxtaposed transversely extending wires disposed within said tray above an initial path of said beam, a pair of parallel electrodes disposed below the initial path of said beam and spaced in a direction transversely of said beam to provide a gap below and parallel to the initial path of said beam, a first voltage generator operable to apply in rapid succession a negative bias to the individual wires of said first grid relative to said electrodes to deflect said beam in a downward direction parallel to the coated face of said screen through said gap, a second grid of vertically superposed horizontal wires disposed parallel to the target screen behind the downwardly directed run of said beam, and a second voltage generator operable in synchronism with said first voltage generator to apply a negative bias in rapid succession to consecutively lower wires of said grid relative to the coating on said screen so as to deflect the downwardly directed runs of said beam toward the coated side of said screen.

128. A cathode ray tube comprising a target screen, luminescent coatings applied to both faces of said screen, means arranged to send electron beams past both sides of said screen parallel and adjacent thereto, and means operable to deflect both said beams in a direction toward said screen.

129. A cathode ray tube comprising a target screen, luminescent coatings applied to both sides thereof, electron guns arranged to emit electron beams at either side of said screen in a direction parallel and adjacent thereto, means operable to sweep said beams within planes parallel to said screen, and means operable to deflect said beams successively at different levels thereof toward said screen.

130. A cathode ray tube comprising a target screen, different luminescent coatings on both sides of said screen, a plurality of vertically superposed parallel wires disposed at either side of said screen, adjacent and parallel to said screen electron guns arranged to direct electron beams into the spaces between said screen and the wires at either side thereof in a direction substantially parallel to the vertical planes defined by said wires, and means operable to apply to said wires a negative bias with regard to the respective coatings on said screen in rapid succession starting with the uppermost ones of said wires.

131. A cathode ray tube for television reception, comprising at least one electron gun, so arranged that it produces an electron beam substantially parallel to a plane fluorescent screen, deflection means for deflecting the electron beam produced by said gun in a plane parallel to said screen, an array of substantially parallel conductors disposed crosswise to the electron beam and in facing spaced relation with said screen, means for controlling said deflecting means to effect the line scanning, and means for establishing a potential wave running substantially undistorted and with the speed of the frame sweep across said array to produce an electric field between the array and the screen deflecting the electron beam on to the screen, and at the same time focusing it at the screen.

132. A cathode ray tube comprising a target screen, a luminescent coating applied to one side thereof, a

cathode ray gun arranged to emit an electron beam in a direction parallel and adjacent to the coated side of said screen, means for sweeping said beam within a plane parallel to said screen, and means for deflecting said beam successively at different levels thereof toward the coated side of said screen.

133. In an electron space discharge device, an electron sensitive target, means arranged to emit an electron beam in a direction substantially parallel and adjacent to said target, and means for applying at different times to different intervals along the parallel portion of the beam, forces which deflect the beam into registration with correspondingly different parts of the target at the different times.

134. The method of presenting a visual signal on an electron sensitive screen which comprises delivering a beam substantially parallel and adjacent to the electron sensitive screen, and at different times deflecting said beam at different intervals along the parallel portions thereof to move the beam into point registration with correspondingly different portions of said screen.

135. An electron space discharge device comprising an electron sensitive image screen, means arranged to emit an electron beam in a direction substantially parallel and adjacent to said screen, means for sweeping said beam adjacent and parallel said screen, and means for applying forces to deflect said beam successively at different intervals thereof toward the electron sensitive screen.

136. The method of presenting a visual signal on an electron sensitive screen which comprises projecting a beam substantially parallel and adjacent to the screen, sweeping said beam adjacent and parallel to said screen, and applying forces to deflect said beam successively at different intervals thereof toward the screen.

137. An electron space discharge device comprising an electron sensitive screen, at least one electron gun arranged to emit an electron beam in a direction parallel and adjacent to said screen, means associated with the gun for sweeping said beam substantially parallel to said screen, and deflection means comprising an array of conductor members arranged crosswise to the beam path for applying at different times to different intervals along the parallel portion of the beam, forces which deflect the beam into registration with the screen at correspondingly different points thereon.

138. A cathode ray tube comprising an electron sensitive screen, an electron beam source, vertical deflection means comprising an array of substantially parallel conductor members extending substantially coextensively with the screen, and arranged crosswise to the beam path and spaced from the screen to permit delivery of the beam between the array and the screen, horizontal deflection means for sweeping said beam between said array and said screen, and means for controlling said conductor members of the array in the application of deflecting forces successively to the beam to deflect same onto different intervals of the screen.

139. A visual signal presenting arrangement comprising a cathode ray tube member having an electron sensitive screen, beam projection means for emitting a beam in a direction substantially parallel and adjacent to said screen, sweep means for sweeping said beam parallel to said screen, and deflection means for deflecting said beam successively in a direction toward the screen at different intervals along its length; means operative to energize said beam projection means, and a signal source including sweep energizing means operable to supply energizing signals to said sweep means, and means operable in synchronism with the sweep energizing means to supply signals to energize said deflection means successively and cyclically and thereby control said beam in a raster producing operation.

140. A cathode ray tube comprising a target screen, a luminous coating applied to one side thereof, an electron gun arranged to emit an electron beam in a direction parallel and adjacent to the coated side of said screen, means operable to sweep said beam within a plane parallel to said screen, and means operable to deflect said beam toward the coated side of said screen at progressively varying distances across said screen.

141. A cathode ray tube comprising a target screen, a luminescent coating on one side of said screen, means adjacent and parallel to the coated side of said screen operable to produce a beam deflecting field rapidly progressing across said screen, and an electron gun arranged to send an electron beam into the space between the coated side of said screen and said field producing means.

142. A cathode ray tube comprising a substantially plane fluorescent screen, means for setting up an electron beam in a plane substantially parallel to the plane of said screen, means for deflecting said beam in the plane parallel to said screen in one dimension thereof and means for deflecting an end portion of said beam towards and into impact with said screen at a position which is controllable in another dimension in the plane of said screen.

143. An electron space discharge device comprising a first and a second electrical conducting member disposed in spaced relation to establish a control zone therebetween, means for delivering an electron beam along a path which extends in adjacent non-registering relation with said zone, and means operable to apply deflecting forces independently and selectively to different points along said path to deflect said beam into said control zone at correspondingly different points.

144. An electron space discharge device comprising target means, deflection means disposed in spaced relation with said target means to establish a zone therebetween, an electron beam source including control means for varying the point of entry of said beam into said zone, transition means located between said control means and said zone including at least means operative to define a field separating said zone from said control means, and means for applying energizing potentials to said deflection means to effect deflection of the beam selectively from its path in said zone into registration with said target.

145. An electron space discharge device comprising target means, deflection means disposed in spaced relation with said target means to establish a zone therebetween, beam focusing means disposed adjacent said zone, and means operable to deliver an electron beam through said beam focusing means into said zone in substantially parallel relation with said target for selective deflection by said deflection means into registration with said target means.

146. An electron space discharge device comprising target means, deflection means disposed in spaced relation with said target means to establish a zone therebetween, beam accelerating means disposed adjacent said zone, and means operable to deliver an electron beam through said beam accelerating means into said zone in substantially parallel relation with said target for selective deflection by said deflection means into registration with said target means.

147. A cathode ray tube comprising an electron sensitive target, electron source means arranged to deliver electrons along different paths substantially parallel and adjacent to said target, deflection means comprising a plurality of substantially parallel conductor members arranged crosswise to the electron paths and spaced from the target to permit delivery of the electrons along paths between the conductor members and the target, and means for coupling energizing potentials to said conductor members to control same to selectively deflect the electrons into registration with different points on said target.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

1,962,873	Parker	June 12, 1934
2,059,575	Gibson	Nov. 3, 1936
2,071,382	Balsley	Feb. 23, 1937
2,090,001	Hamacher	Aug. 17, 1937
2,211,844	Brett	Aug. 20, 1940
2,307,188	Bedford	Jan. 5, 1943
2,363,962	Heil	Nov. 28, 1944
2,394,196	Morgan	Feb. 5, 1946
2,416,914	Eaton	Mar. 4, 1947
2,449,339	Sziklai	Sept. 14, 1948
2,449,558	Lanier	Sept. 21, 1948
2,513,742	Pinciroli	July 5, 1950
2,558,019	Toulon	June 26, 1951
2,563,807	Alfven	Aug. 14, 1951
2,623,190	Roth	Dec. 23, 1952
2,641,699	Gloess et al.	June 9, 1953
2,642,535	Schroeder	June 16, 1953
2,672,573	Charton	Mar. 16, 1954
2,692,532	Lawrence	Oct. 26, 1954
2,711,478	Krawinkel	June 21, 1955
2,711,493	Lawrence	June 21, 1955

FOREIGN PATENTS

315,362	Great Britain	Feb. 12, 1931

CERTIFICATE OF CORRECTION

Patent No. 2,795,731 June 11, 1957

William Ross Aiken

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

Column 33, line 70, for "canning" read -- scanning --; column 48, line 47, for "weep" read -- sweep --; line 58, for "a least" read -- at least --.

Signed and sealed this 20th day of August 1957.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,795,731 June 11, 1957

William Ross Aiken

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

Column 26, line 1, for "represents" read -- presents --; column 28, line 62, for "use in" read -- use of --; column 31, line 5, after "881" insert -- , control grid 881 --; line 13, for "schematice" read -- schematic --; line 31, for "tppical" read -- typical --; same column 31, lines 45 and 46, and line 53, for "asselerating", each occurrence, read -- accelerating --.

Signed and sealed this 10th day of September 1957.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents