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FLAT DISPLAY TUBE AND METHOD
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ABSTRACT OF THE DISCLOSURE

A thin flat display tube in which a plurality of individual electron beams corresponding in number to the number of horizontal lines desired in a display are sequentially projected into a flat narrow space and deflected onto a display screen. Such individual beams are produced by an elongated or linear cathode capable of controlled emission of electrons from selected points to form beams, each of which is controlled by electrostatically and sequentially controlling the acceleration and focusing of the pencil beam segments. Each beam is intensity modulated in accordance with image information contained in a received television signal, for example, or by other data to be displayed and/or controlled. Consult the specification for other features and details.

This invention is related to flat television display tubes, and, more particularly, to flat or shallow depth image reproduction tubes and beam generation and scanning systems therefor. In most known short depth or flat cathode ray display tubes (e.g., envelope, electron source, accelerating and deflecting structures and display screen) an electron beam is aimed along an edge of the display screen past a first series of deflection plates. Deflection of a beam into the space between the display screen and a second set of deflection plates is effected by potentials on one of the first deflection plates and impingement of the deflected beam under the display screen is effected by a potential on the second set of deflection plates. The point of impingement can be varied continuously by sequential variation of potentials on the respective deflection plates to produce, for example, a conventional television raster. Tubes generally of this type are disclosed in Aiken Pat. 2,795,731 and several beams may be controlled in a corresponding manner for control of color displays.

Multi-beam tubes are also disclosed in the patent literature as in Roberts Pat. 2,858,464. In Roberts' patent the beam forming structure comprises an elongated cathode in a perforated or slotted tubular member which produces a plurality of beams or a sheet of electrons. A second tubular structure having a series of perforations angularly disposed with respect to the perforations or slot in the first tubular member surrounds the first tubular member and a deflection field is utilized to deflect all electrons (beams or sheet) to cause sequential alignment of beams or segments of the sheet of electrons with the second series of perforations.

Objects of the present invention include providing improvements in thin, flat display tubes, an improved multi-beam scanning device and method, primarily for use in flat display tubes and devices.

In accordance with the present invention, instead of projecting one or several beams along the edge of the display area and then manipulating the beam for horizontal and vertical traversal of the display screen, a plurality of individual beams are generated, one for each line of a conventional television display raster by means of a linear cathode ray gun structure having means for individually focusing each individual beams and in which intensity control is effected by increasing or decreasing the bias on the emission electrode. Thus, the invention incorporates a unique scanning device having a plurality of individualized electron beams each individually capable of being electrostatically controlled, focused, and accelerated into an area of the tube for deflection onto a fluorescent screen. The screen may be for direct view in the sense that the light produced is visible from the surface of the phosphor struck by the screen thereby reducing the energy requirements for a high light output. In addition, the scanning structure per se may be oriented so as to project one or a plurality of individualized beams along a path such that as the spot of light is caused to traverse a line of impingement on the display screen, the angle of impingement is substantially constant to maintain the shape of the light spot produced substantially constant. These and other features, objects and advantages of the invention will become apparent from the following description taken with the accompanying drawings in which:

FIG. 1 is a perspective view of a shallow depth flat display tube partly cut-away and illustrating the invention;

FIGS. 2, 3, 4, 5, and 6 are exploded perspective views of a multi-electron beam forming, focusing and accelerating structure incorporating the invention;

FIGS. 7 and 8 are diagrammatical cross sectional views of a flat display tube incorporating the invention;

FIGS. 9 and 10 are illustrations of a further embodiment of the invention;

FIG. 11, taken with the wave form diagrams of FIGS. 12, 13 and 14 illustrate another aspect of the invention;

FIGS. 15—20 inclusive, illustrate a direct view application of the invention;

FIG. 21 is a diagrammatical showing of input circuitry and devices for use with a flat display device incorporating the invention;

FIG. 22 is a circuit diagram of a shift counter circuit and output connections thereto for controlling the grid structure of the scanning device of this invention, and

FIGS. 23, 24, 25A, 25B, and 25C inclusive, illustrate one application of the invention to a color display.

The embodiment of the invention as illustrated in FIG. 1 comprises an envelope which may be of glass, which may be made from two shallow shaped sections in the forms of shallow rectangular trays fused together along the contacting edges (not shown). Face plate 21 constitutes the viewing area of the tube and has the inner wall thereof a conventional phosphor coating which serves as the viewing screen. The screen may be a simple phosphor or a combination of phosphors responsive to electron bombardment by scanning electron beam or beams to produce light and, unless otherwise noted, it will be assumed that such phosphors and screen structures are conventional.

Cathode 25 is an elongated indirectly heated emission cylinder (heating element not shown) having a conventional electron emissive coating thereon such as an oxide type material, and capable of emitting electrons along its length. Alternately, the heating element itself may be coated with an oxide coating (barium or strontium oxide, for example) to constitute the cathode. Spaced from cathode 25 are a series of emission control grids 26 coating with a slotted emission control plate 27, slot 28 in plate 27 having a length substantially along the length of cathode 25. Grids 26 and slotted control plate 27 are effective when proper potentials are applied thereto, as described later, to effectively cut off emission from the cathode except for a selected area or point where emission is desired. Further, this grid control structure is capable of controlling emission from any point along the length of the cathode or from several points from the entire length of the cathode simultaneously, if this be desired. Thus, there is no significant loss of energy as the beam dividing structure is capable of controlled emission along its length. While this
control function and structure effectively turns off the rest of the cathode emission while emission is occurring at only one point. It will be apparent that groups of grid elements may be assigned independent display control functions and, accordingly, may be controlled independently, as groups, with a separate control plate therefor.

Fig. 1 shows a group of elements drawn from the region surrounding the cathode to the emission grid plate control structure by virtue of positive potential placed upon the emission grid, travel toward the emission grid and gain velocity and momentum. When electrons reach the emission grid, a great number of electrons strike the grid and are retained but some travel through the vertical slit or slot 28. Spaced from slot 28 is a focusing and accelerating assembly 29 which contains an individual focusing and accelerating structure for each individual beam passing through slot 28. The focusing and accelerating structure electrostatically focuses each beam into a thin pencil beam, the focal point of beam being the fluorescent screen. Since the distance between the acceleration anode and the screen varies (generally linearly) the focusing field will be varied in order to keep the focal point moving continuously on the screen. If the beam is magnetically deflected instead of electrically, however, electrostatic focusing is preferred.

After focusing, the individual beams pass through the accelerating anode where high positive potentials give the electrons energy and velocity necessary to produce visible light on the display screen.

As shown in FIG. 1, each beam thus formed, focused and accelerated is deflected by a pair of deflection plates 30 and 31 which have proper deflection potentials applied thereon to cause the beam to traverse a horizontal line of impingement 32 which is substantially parallel to the side of the fluorescent screen. The beam is deflected to the right by a horizontal field, 32, in the region of the cathode by virtue of positive potentials supplied on a selected emission grid element 26, pass through slot 28. It will be appreciated that there will be one beam for each line of the raster on screen 22. Each beam thus formed is focused and accelerated by focusing and accelerating structure 29. Slotted plate 27 is mounted on insulating support posts 34 and 35 by means of suspension mounting holes in the plate. As described earlier, conductors for supplying potential to emission plate 27 is by means of a conductor, not shown, passing through the header plate 35.

Focusing and accelerating anodes 29B and 29A may be constituted by a pair of conductive plates 29A and 29B. Plate 29A has an aligned vertical row of beam passages apertures 46-1, 46-2, 46-3, 46-N corresponding in number, and aligned with the beam passing spaces between grid elements 26-1, 26-2, 26-3, ... 26-N. Likewise, plate 29B has a series of aligned apertures or passages 47-1, 47-2, 47-3, ... 47-N, the passages 47 being aligned with the passages 46 and defining therebetween focusing lens structures for each individualized electron beam passing through slot 28, respectively. The preferred forms of these elements are shown in greater detail hereinafter but it suffices for present purposes to say that these structures electrostatically focus and accelerate each beam into a thin pencil beam and that the relative potentials between the plates 29A and 29B may be varied in order to dynamically maintain the point of focus of each individual beam, as it traverses the line of impingement 32 at the point of impingement. Thus, as the beam impinges upon the screen 22 it will be continuously in focus. Dynamic focus in display tubes is well known in the art with respect to large area displays. However, since the variations are substantially linear in tubes made according to this invention, the matter of dynamic focusing is simplified. It will also be understood that after focusing, the beam passes through the accelerating anode 29A and the applied high positive potential on anode 29A give the electrons the energy and velocity necessary to produce visible light on display screen 22. Finally, in a simplified form shown in FIGS. 1 and 2, the beam is caused to traverse the line of impingement 32 on display screen 22 by means of a pair of deflection plates 30 and 31 which have proper deflecting potentials applied thereto. For example, the plate 30 may have a positive potential applied thereto so as to deflect the beam from the line of impingement into the screen to which it impinges the display screen by means of a stronger positive potential applied to plate 30 than is applied to plate 31. The orientation of deflection plates 30 and 31 and the electron source structure shown in FIG. 1, project beams which would normally impinge at varying acute angles as the beam traverses fluorescent screen 22, so that due to this varying angle of impingement, the size of the light spot produced may vary according to the position of the white spot along the line of impingement. However, this effect is obviated by structure and manner of operation to be described later herein, it being the purpose of the present discussion to explain basic aspects of the invention.

With reference now to FIGS. 3, 4, 5, and 6, preferred forms of the focusing and accelerating electrode structure 29 will be described. With reference to FIG. 3, the focusing and accelerating anodes comprise a first conductive metal plate 59 in which a series of holes 51-1, 51-2, 51-3, ... 51-N have been drilled or otherwise formed and into each of holes 51-1, 51-2, 51-3, etc. is press fitted cylindrical metal tubes 52-1, 52-2, 52-3, ... 52-N, respectively. Similarly, conductive metal plate 53 has a similar series of holes 54 into which similar cylinders 55 have been fitted. Anode plates 50 and 53 are separated by an insulating plate 56 made of mica, ceramic or other insulating material which has elongated slot 57 of a length to accommodate all of the holes 51-1, etc. and 54-1, etc. and these anode plates may be adhered to or otherwise fixed in relation to each of the side block 56. The struct-
ture may then be supported by support posts such as support posts 36, 37, 38, and 39 as shown in FIG. 2.

In this instance, there is a large potential difference between the focusing anode 53 and accelerating anode 50 (several thousand volts). This causes a fringing or convergent electrical field to be set up between the interior surfaces of the two coaxially aligned cylindrical anodes. The convergent electrical field lines between the pairs of anode cylinders has a convergent lens effect on an electron beam passing through the cylinder pair and by holding the voltage on the accelerating anode 53 constant (to maintain the velocity of the electrons constant) and raising or lowering the voltage on the focusing anode 50, the field can be made more or less convergent. By varying the potential difference between the focusing anode 50 and the accelerating anode 53, the focus can be continually changed through the horizontal sweep as the required focal length is maintained.

Instead of using cylinders as described in connection with FIG. 3, the anode members (focusing and accelerating) may be made in accordance with the structure shown in FIG. 4. In this case, focusing anode 50 may be a solid block of metal 55 and the cylinders 52 being constituted by the walls of the holes 51-1, 51-2, etc. Similarly, accelerating anode 53 may be constituted by a similar block of metal having similar holes 54-1, 54-2, etc. therein. Alternately, focusing and accelerating toward the structure may be made in accordance with the arrangement shown in FIG. 5 whereby the anode plates 50' are drilled with apertures 51-1', 51-2', etc., 51-N', formed therein and cylinders 52-1', 52-2', etc., 52-N' are carried therein, but not flush with one side or the other of the plates. Accelerating anode 53' has apertures and cylinder inserts similarly formed, and insulator plate 56' is formed to accommodate the projection of the cylindrical inserts. Moreover, it is apparent that the anode cylinders may telescope, one within the other. In this case, the alignment of the set up is that the inner faces of the anode plates 50' and 53' have for one another. FIG. 6 is a variant showing the elimination of the insulating substrate 56, spacer posts 36', 37', 38' and 39' being portions of support rods 36, 37, 38 and 39 of FIG. 2, for example. It will be appreciated that the focusing and accelerating anode structure may be made simply by boring aligned series of properly shaped holes in an insulating substrate and depositing or otherwise applying conductive metal surfaces thereon to form the focusing lens and accelerating anode structure or a nonconductive substrate may be formed with opposed rows of cavities, filled with conductor material and the bored to provide electron beam passage. Thus, variation in lens design is possible within the present invention it being important that the structure has the focusing and acceleration characteristics desired herein.

It has been mentioned earlier that when the electron beams are caused to traverse a line of impingement on the display screen, the angle of impingement, in accordance with the embodiment disclosed in FIG. 1, varies as the beam is caused to traverse the line of impingement thereby varying slightly the horizontal shape of the light spot as it impinges. In order to eliminate and minimize this effect, the beams may be bent or deflected by a single deflection element or a plurality of deflection elements oriented in opposed relation to the display screen. Thus, with reference to FIGS. 7, 8 and 9, the cathode 25, grids 26, and focusing and acceleration anodes 29, e.g., the multi-beam forming structure, is disposed at an angle \( \alpha \) (FIG. 7) to a line parallel to the display screen 22. In this instance, a planar deflection plate or electrode 60, which may be a conductive coating on the rear wall 61 of envelope 20, cooperates with a deflection grid 62 to bend or deflect the beam toward the display screen 22. (Although deflection grid 62 is shown in the space between deflection electrode 60 and the electron screen, it will be appreciated that grid 60 may be a transparent conductive coating on face plate 22.) Only one electron beam is shown in FIG. 7 but all beams have similar trajectories. In operation, as the beam leaves the accelerating and focusing anode structure 29, the electron beam passes between deflecting plate 60 and deflecting grid 62 of the deflecting plate and the deflecting grid have applied thereto a varying electric field to establish a varying electrostatic field generally perpendicular to the direction of electron beam travel, e.g., transverse to the direction of travel of the electron beam. If the deflection plate 60 is negative and the deflecting grid 62 is made positive the electrons will be deflected and accelerated toward the deflection grid 62. This will result in the electron beam being bent or deflected toward the deflection grid 62 and passing onto the grid structure and striking the viewing portion 21 or screen 22 to enhance where the electron beam is known that electrons projected through a region perpendicular to an electrostatic field follow a parabolic trajectory, so it can be seen from FIG. 8 that the angle \( \beta \) of impingement of the electron beam on display screen 22 can be held more uniformly constant by making the configuration of the deflection plate conformal to a plate extending over the entire wall 61' of the tube and a grid 62' extending at least across the rear of the viewing screen. As shown in FIG. 7, the angle of incidence or impingement is made even more uniform if the electron beam is projected at a small angle \( \alpha \) toward the rear of the tube, e.g., at an angle of 180° plus \( \alpha \) to the display screen 22. As described earlier herein, focusing will be continually compensated throughout the sweep cycle by adjusting the focusing potential between the focusing anode and the accelerating anode.

Further, it is believed that a uniform angle of impingement may be effected by utilizing the continuous deflection plate 60 illustrated in FIGS. 7 and 8 by curving or canceling the deflection plate toward the screen which will cause the electron path to bend only gradually while passing through the deflection plate or the rear edge of the electron source but to bend severely toward the far end of the deflection plate, thus, tending to equalize the impinging angle.

FIG. 9 is somewhat similar to the structure shown in FIG. 8 except here instead of a continuous deflection plate 60, the deflection element has been broken up into a plurality of deflection elements 70-1, 70-2, 70-3, 70-N (beam forming, focusing and accelerating structure 25, 26 and 29 being shown separately in diagrammatic form). Deflection electrodes or elements 70 may be in the form of simple vertical or elemental stripes made of transparent conductive material which may be deposited on a nonconductive substrate or supporting surface, as for example, the rear wall of 61 of the tube.

As in the case of the embodiment shown in FIG. 8, the electron beams entering the region between the deflection electrode elements 70 and deflection grid 62 travel in a straight line to a point at which an electrostatic field has been established between one of the deflection elements 70-1, 70-2 . . . 70-N. By initially producing or establishing this electrostatic field near the far end of the tube remote from the electron beam source, and moving the field by increments toward the electron beam source, the beam may be made to impinge at a desired location on the display screen much in the same manner as is described in detail in the aforementioned Aiken patent. This approach, of course, required an additional sequential triggering or commutat-
trace an image composed of a rectangular array of dots in a pattern much like a half tone newspaper photograph. Functionally, such beams would be projected upward to a certain elevation, the beam would traverse from left to right and then be cut off. Then, the beam would be projected upward to a point slightly lower than the previous trace and then traverse a horizontal line from left to right and repeat. Moreover, there may be multiple beam sources at the right and left side of the screen as well as along the bottom (and top if desired) so as to effect color display (FIG. 23), the beams from the respective sources seeking out their own color phosphors from different directions.

The embodiments described above are indirect displays in that the beams strike and the image may be viewed on a side or surface opposite the viewing side or surface. In accordance with the embodiment illustrated in FIGS. 15-20, the phosphor display screen is viewed from the side or surface struck by the electron beams. In FIG. 15 the multi-beam source designed specifically with the numeral 80 includes cathode, emission control structure and focusing and accelerating anode structure as described earlier herein. Likewise, as described earlier, the electron beams enter the region between the deflection plate 71 and deflection grid 72 and is deflected thereby in amounts and direction according to the direction of the electrostatic field between these deflection elements. The present arrangement differs from those described earlier herein in that the deflection plate 71 is in the form of a conductive layer deposited on a nonconductive substrate or support surface, such as the rear wall or panel of the tube. In this case, however, the fluorescent phosphor (not shown) is deposited directly upon this conductive layer. Furthermore, the deflection plate 71 has a positive potential applied thereto whereas the deflection grid 72 may have a negative potential applied thereto or even so that in effect electron beams are directed to impinge upon the fluorescent phosphor screen and the image may be viewed through the deflection grid 72. Due to the high incidence of peripheral light, the grid will not be particularly noticeable. In any event, the grid may be applied to the interior tube surface 73 in the form of transparent conductive material (and in some cases both deflection electrodes may be applied on exterior envelope surfaces). The advantage of this construction and manner of operation lies in its reduction of the amount of energy usually required to produce an equivalent amount of light output and more efficient utilization of light produced. Conventionally, an electron beam strikes on the screen with high velocity and has to force its way through the phosphor coating in order to create light. The light energy discharged then has to travel through the phosphor to emit visible light that can be seen by the viewer. By bombarding the surface which is to be viewed instead of the non-viewing surface, significant savings in energy can be obtained and the energy available is more effectively utilized. In addition, lower electron velocities can be utilized and therefore lower focusing and deflecting potentials are required, all with attendant benefits in making the equipment portable or operable from low energy sources and the utilization of smaller components. FIG. 16 is a diagrammatic view of the arrangement shown in FIG. 15, the observer being designated O. It will also be appreciated that instead of a single deflection plate 71, multiple deflection elements illustrated in FIG. 9 may be utilized and this is diagrammatically illustrated in FIG. 17.

FIGS. 18 and 19 are modifications of the embodiment illustrated in FIG. 7 to illustrate applications of the direct view principle illustrated in FIGS. 15 and 16 with the multi-beam source 80′ being contained within an offset section 205 of the tube 20. FIG. 20 is a further illustration of the modification of the invention shown in FIG. 7 as applied to the direct view principle described herein.
The tube structure and multi-beam scanning devices described earlier herein may be effectively utilized by adapting circuitry well known in the art. In order to illustrate this, reference is made to FIGS. 21 and 22. Specifically, FIG. 21 is a block diagram of a receiver 91 associated with a display device of the present invention as applied with respect to conventional television signals. Thus, a receiving circuit includes a conventional antenna 90, for receiving conventional transmitted television signals and supplying same to receiver circuit 91. The receiver circuit 91 contains the conventional devices for home television receivers, for example, such as the usual RF and IF amplifying sections, detecting and control circuits and standard audio circuitry. Picture information is fed from receiver circuit 91 to video amplifier 92 and video amplifier 92 applies amplified video signal between emission control plate and the cathode to control the intensity of a beam and, accordingly, the brightness of the trace in essentially the same manner as effected in conventional television receivers. With reference to FIG. 1 the video information is applied between emission plate 27 and cathode 25. As noted earlier, the use of conventional and since it has no part in the present invention, it is not disclosed here.

Further, control information is fed from receiver circuit 91 to sync separator circuit 93 from which horizontal sweep pulses are applied to horizontal sweep generator 94 which produces the horizontal sweep voltages applied to the deflection plates.

Vertical sync pulses are also fed from the sync separator circuit 93 to the grid controlling circuit 95 described in greater detail in connection with FIG. 22. It should be noted at this point that if a ring counter type circuit is used as a grid controlling device, horizontal sync pulses can be used to trigger the grid controlling circuit and the vertical sync pulses may, for the most part, be ignored. As noted earlier herein, the focus will be continually modified so as to compensate for the different distances from the acceleration anode to a point of impingement on the screen so periodically varying voltages will be applied across the accelerating and focusing anodes. Accordingly, an output from the sync separator circuit 93, the horizontal sync pulses are utilized to trigger a focus compensation generator 96 which produces a varying voltage applied to the focusing anode. Alternatively, control of focus compensation circuit 96 may be obtained from the horizontal sweep generator, as is shown by connection 89.

With reference now to FIG. 22, vertical sync pulses from sync separator 93 are fed into a bistable multivibrator 97 which is control gate for controlling a pair of ring counters 98 and 99, respectively, which are used to effect sequential switching of the control grids, one ring counter circuit 98 being utilized to control odd numbered grid elements and the other ring counter 99 being used to control even numbered grid circuits, depending on the steady state condition of control flip-flop 97. As shown in FIG. 22, outputs of the ring counters are applied through coupling circuits, such as transistor followers, T1, T2, etc., to the grid elements. Thus, if pulses are fed into ring counter 98, the output signal will sequentially pass from coupling transistor T1, T2, T3, etc., for the total number of stages desired and then on the activation of the final stage in the ring counter, the control flip-flop gate circuit 97 will be reset into its other steady state condition to thereby permit counter pulses to pass through the gate into ring counter 99 and control the inactive portion of scan line. In operation, all transistors except a selected one are off so a negative potential (−V) has been placed on these grid wires. With the selected transistor on, the grid connected thereto has a positive potential with respect to the cathode to permit electrons to flow in the region of the grid wire having the positive potential.

It will be appreciated that instead of using a control gate such as flip-flop 97, a single shift register with odd numbered control grids connected in sequence to the first
The 3.58 megacycles signal causes the electron beam to oscillate vertically as it traverses the screen horizontally as can be seen by FIG. 25. The green portion of the color picture is excited twice as often as the red and blue colors, but for only half as long. This necessitates that the green color information be run through a frequency doubler and this signal used to gate the electron beam. This method of color reproduction is the method used on the "chromation" or "Lawrence" type tube and is only briefly described herein for purposes of illustrating the wide utility of the invention.

While there has been shown and described in detail the fundamental novel features of the invention, it will be understood that many variations are possible, some of which have been disclosed herein, and that various other modifications and changes in the form and details of the invention may be made by those skilled in the art without departing from the scope and spirit of the invention.

I claim:
1. In a flat cathode ray display tube a flat envelope having front and rear walls and having an electron responsive display screen adjacent a wall thereof, a multi-beam electron gun assembly for producing a plurality of individually controllable electron scanning beams projectable along parallel paths between the said front and rear walls, respectively, to impinge on said display screen along lines of impingement, respectively, comprising, an elongated electron emissive cathode at one side of said envelope, control electrode means for controlling the intensity of electrons emitted from said elongated cathode, a grid structure for controlling emission of electrons from said cathode at any selected point along the length thereof, said grid structure being between said elongated cathode and said control electrode means, focusing and acceleration electrode means for focusing and accelerating electrons emitted from any selected point on said elongated cathode, said focusing acceleration electrode means including a pair of conductive plate members supported in spaced relationship to each other, each plate having a plurality of apertures therein aligned with said elongated cathode, the number of apertures in each of said plates corresponding to the number of lines of impingement upon said display screen, and means for deflecting a selected beam issuing from any of said focusing and acceleration electrode means onto said display screen and to traverse a line of impingement.

2. The invention defined in claim 1, wherein said apertures are constituted by conductive cylindrical members affixed to each plate.

3. The invention defined in claim 1, wherein said multi-beam electron gun assembly is aimed at a direction greater than 180° but less than 210° with respect to said display screen.

4. The invention defined in claim 1, wherein said means for deflecting includes deflection electrodes oriented so that any deflection field established between them is substantially normal to the plane of said display screen and wherein said multi-beam electron gun is aimed at a direction toward said the rear wall of said tube and away from said display screen.

5. The invention defined in claim 1, wherein said display screen is positioned such that it is viewed from the surface thereof impinged upon by the electron beams.

6. The invention defined in claim 1, including at least one further of said multi-beam electron gun along another side of said display screen, said display screen being constituted of a plurality of multifaceted protuberances, with at least one facet facing in a direction to be impinged upon by only one beam from one of said multi-beam sources and
at least one facet facing in a direction to be impinged upon by only one beam from the other of said multi-beam source, and each of said facets facing a multi-beam source having a different color producing phosphor thereon.

7. In a flat multi-beam display tube having a display screen, an integral focusing and accelerating electrode structure for each beam, comprising an elongated multi-electron beam source, a first elongated conductive planar member having a plurality of passages therein each such passage being aligned with one of the beams from said multi-beam source, respectively, a second elongated conductive planar member having a plurality of passages therein corresponding in number to the number of passages in said first conductive planar member, each passage in said second conductive planar member being coaxially aligned with a corresponding passage in said first conductive planar member, means mounting said conductive planar members in spaced apart relation with respect to each other and said multi-beam source, means applying a fixed high electron beam accelerating voltage to the second of said planar members with respect to said source, means for applying a variable lower potential to said first conductive planar member, whereby a variable converging electrostatic beam focusing lens is formed for each individual beam of said multi-beam source between surfaces of said aligned passages, respectively, and a substantially uniform acceleration force is applied to all beams exiting from passages in said second conductive planar member.

8. The invention defined in claim 7, wherein said passages are constituted by conductive tube members secured to said conductive planar members.

9. The invention defined in claim 7, wherein said elongated multi-beam source includes an elongated heated cathode member capable of emitting electrons along its length, a plurality of grid wires transverse to the long dimension of said elongated cathode, means for applying to each of said grid wires, individually, a beam control and switching potential, a planar conductive member commonly spaced from all of said grid wires, and means for applying intensity modulating potentials to the last named planar conductive member.

10. The invention defined in claim 7, wherein said display screen is positioned such that it is viewed from the surface thereof impinged upon by the electron beams.

11. The invention defined in claim 7, wherein said means mounting said conductive planar members in spaced apart relation includes a nonconductive substrate, one of said conductive planar members being on one side of said nonconductive substrate and the other of said conductive planar members being on the other side of said nonconductive substrate, said substrate having electron passage means therein.

12. The invention defined in claim 11, wherein said conductive planar members are constituted by conductive platings on said nonconductive substrate, said passages being constituted by plating on walls of apertures formed in said substrate transverse to the surfaces of said nonconductive substrate.

13. The invention defined in claim 7, including means for establishing a beam deflection field normal to said display screen, said second conductive planar member being oriented with respect to said deflection field such that electron beams exiting from apertures in said second conductive member, if undeflected, travel in a direction away from said display screen.

14. The invention defined in claim 13, wherein any electron beam exiting from said second conductive planar member is caused to traverse a plurality of parabolic paths to said display screen each parabolic path being according to the field strength of said deflection field.

15. A method of producing an image on a display screen in an evacuated flat envelope having an elongated source of electrons at one side of said envelope, said elongated source of electrons having a length at least equal to one length dimension of the image to be produced on said display screen, comprising the steps of: permitting electron emission from said source from a first selected point along its length for a predetermined period of time and preventing electron emission from other selected points along the length of said source during said predetermined period of time, intensity modulating said electron emission from said first selected point, simultaneously accelerating and focusing the beam electrons emitted from said first selected point, deflecting said beam of electrons emitted from said first selected point to impinge upon said display screen along a line of impingement, sequentially terminating emission from said selected point and initiating emission from another selected point on said elongated cathode, and modulating, accelerating, focusing, and deflecting each succeeding beam whereby a plurality of lines of impingement are traversed on said display screen, each line of impingement being traversed by one of said beams emitted from a selected point on said elongated source, respectively.

16. The method defined in claim 15, wherein said display screen is positioned with respect to paths of said beams that the surface of said display screen is impinged upon by said beams is the screen viewing surface seen by an observer.

17. The method defined in claim 15, wherein said steps of deflecting includes establishing a plurality of deflection fields, each in sequence, and each being oriented in a direction normal to the plane of said display screen.

18. The method defined in claim 15, wherein the steps of deflecting a beam includes, establishing a deflecting field having a direction normal to said display screen, the steps of permitting electron emission, simultaneously accelerating and focusing, include aiming beams from selected points in a direction greater than 180° but less than 210° to the direction of said deflecting field.

19. The invention defined in claim 18, wherein said display screen is positioned with respect to paths of said beams that the surface of said display screen impinged upon by said beams is the screen viewing surface seen by an observer.

20. The invention defined in claim 18, including the step of estimating a fixed electrical guiding field for guiding deflected beams to substantially uniform angles of impingement on said display screen.

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