Sept. 21, 1954 D. S. BOND 2,689,926

ELECTRON BEAM TUBES

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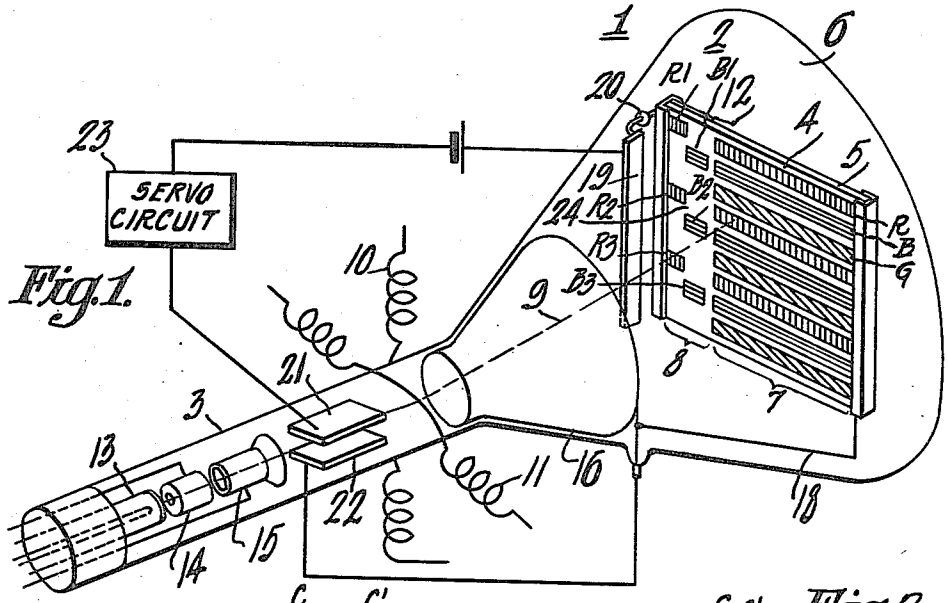


Fig. 1.

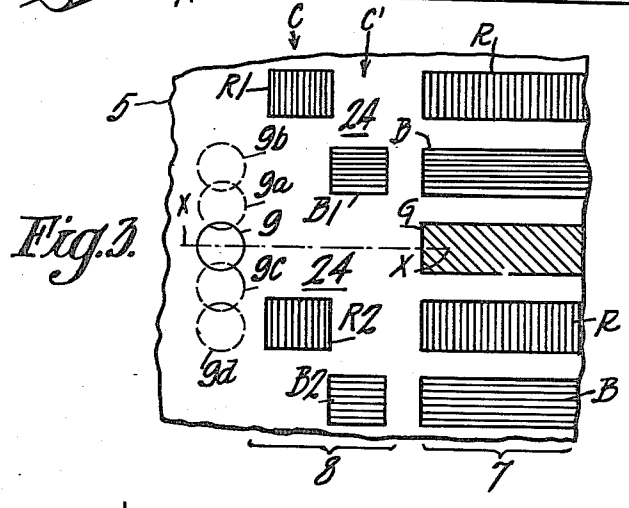


Fig. 3.

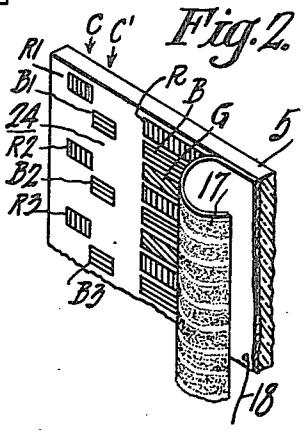


Fig. 2.

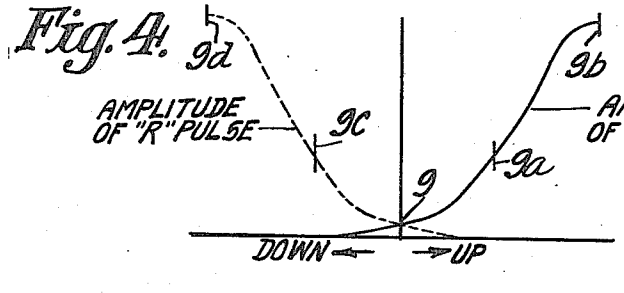


Fig. 4.

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ELECTRON BEAM TUBES

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5 Claims. (Cl. 315—12)

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In electron-beam tubes of the kind in which I am especially interested, the target comprises a multiplicity of sub-elemental phosphor areas or lines. When the tube is of the "color-kinescope" variety, each phosphor line emits light of a particular color component. In color-kinescopes, as in other "line-target" tubes, the big problem is to keep the beam in register with the phosphor lines.

One solution of the problem of beam-to-line registry in color-kinescopes is set forth by Zworykin in his U. S. Patent 2,415,059, issued January 28, 1947. Zworykin teaches the use of control signals generated by a number of photocells. Each photocell is sensitive to one of the colors emitted by the phosphor-lines. The control signals are employed to accelerate or decelerate the deflection of the beam in accordance with its departures from the color-line being scanned. The control signals thus serve to retain the instantaneous line-deflection path of the scanning beam on that line. The amplitude of the control signals in Zworykin's system is a function of the intensity of the lights which the photocells pick up from the screen. It will therefore be apparent that when any portion of the televised scene contains a dark, or semi-dark, area, no photo-electric signals, or only very weak ones, are available for control purposes.

I obviate the above-described and other less apparent objections to present day beam-to-line registry systems by providing a cathode-ray tube containing an electron-sensitive screen or target having discrete light-emissive and signal-generating areas. I dispose the signal-generating area adjacent to a marginal edge of the light-emissive area. Hence the beam in traversing the signal-generating indicia may be endowed (by the grid of the "gun" of the tube) with any constant intensity required to generate "vernier" control signals of a uniformly usable amplitude. In traversing the light-emissive area, the beam may be varied in intensity, as dictated by video signals applied to the grid, without affecting the amplitude of the control signals picked up from the signal-generating area.

I achieve greater accuracy of beam control when I provide separate beam-deflecting elements for the "scanning" and "vernier" deflecting forces. Thus, although I may apply the "horizontal" and "vertical" scanning forces to the beam in the usual way (e. g., through a magnetic yoke disposed on the exterior of the tube) I prefer to apply the "vernier" deflecting forces to one of a pair of auxiliary electrodes.

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All of these features of my invention are illustrated in the accompanying drawing, wherein:

Fig. 1 is a partly schematic broken-away view in perspective of an electron-image tube containing a target or screen electrode having discrete signal-generating and light-emissive areas. The tube is provided with a pair of deflecting electrodes to which "vernier" deflecting forces, derived from the signal-generating target area, are applied to the beam;

Fig. 2 is an enlarged view in perspective of a portion of the color screen. A part of the metallized surface of the screen is rolled back to reveal its phosphor lines;

Fig. 3 is a chart of a portion of the surface of the screen showing various possible positions of the beam; and

Fig. 4 is a curve to which I refer in explaining the operation of my tube under the conditions indicated in Fig. 3.

In applying my invention to a color-kinescope, I may use a conventional image-tube envelope 1 having a bulbous portion 2 and a rearwardly extending neck-portion 3. The vacuous space between the bulb and neck is continuous. I prefer to employ the rear surface 4 of a separate glass plate 5 as the foundation of my bi-part screen. However, I may use the inner surface of the window 6 as the foundation. Alternatively, if the window and neck of the envelope are suitably oriented, I may employ a non-transparent foundation plate (not shown). In any event, the screen comprises a light-emissive area 7 and a discrete signal-generating area 8. The signal-generating area 8 is disposed along a marginal edge of the light-emissive area 7. Both of these screen areas 7 and 8 are accessible to the electron-beam 9 when the beam is subjected to a conventional scanning movement. The scanning movement results from horizontal and vertical deflecting forces supplied by electromagnetic coils 10 and 11. These coils are disposed at right angles to each other on the neck 3 of the tube.

An opaque coating 12 on the back of the signal-generating area 8 of the plate 5 conceals that area from the view of an observer looking into the window.

The source of the beam 9 is a conventional electron-gun. The gun which is shown here comprises an indirectly heated cathode 13, a grid 14 and a first anode 15. The grid controls the intensity of the beam during its excursion across both areas 7 and 8 of the screen. A portion of the inner surface of the neck 3 and bulb 2 has a conductive coating 16. This coating is the sec-

ond anode of the device. The outer surface of the light-emissive area 7 may comprise a transparent aluminum film 17 (Fig. 2). This conductive film 17 may be connected, as by a lead 18, to the second anode 16.

A strip-like conductor 19 is supported, as on insulating beads 20, along the outer edge of the signal-generating area 8. A pair of deflecting plates 21, 22 is disposed, in front of the electron-gun, in horizontal planes on opposite sides of the path of the beam 9. The metal strip 19 collects the electrified particles or signals emitted by the signal-generating area 8 when it is bombarded by the beam 9. The signals impinging upon the collector electrode are applied through an appropriate "servo" circuit 23 to the deflecting plate 21. The other plate is maintained at a high positive potential, for example by connecting it to the second anode 16. When thus applied, the signals operate to impart "vernier" vertical deflecting forces to the beam. Alternatively, as suggested by Zworykin Patent 2,415,059 (previously mentioned) and Zworykin 2,304,755, the vernier or "correcting" signals may be applied to an appropriate one of the magnetic deflection coils 10 or 11. In this later connection, however, I call attention to the fact that the coils 10 and 11 are "current" (as distinguished from "voltage") actuated devices of high inductance and that the correcting force of the vernier signals is usually a voltage containing relatively high frequency components. Therefore, the servo circuit 23 may be simplified by applying this voltage directly to one of the electrostatic plates 21, 22, instead of converting it into current of the amplitude required to produce an appropriate magnetic deflecting force. One such servo circuit is claimed in co-pending application Ser. No. 146,230, in the name of Donald G. Moore. Another is claimed in application Ser. No. 146,283, now U. S. Patent 2,634,325, in my name jointly with Donald G. Moore. Said patent applications are filed concurrently with the subject case.

In making the screen, I provide its foundation surface 4 with a number (say, two hundred and forty) of groups of (say, three) narrow phosphor-stripes or lines, R, B and G. Each line is capable of emitting light of a particular color component when bombarded by electrons.

As taught by Leverenz in U. S. Patent 2,310,863, when the phosphor lines which make up the different groups are to emit blue, green and red light, respectively, the materials of which the lines are composed may comprise: Silver-activated zinc sulfide and zirconium silicate for the blue lines B. Alpha-willemite activated with manganese or zinc cadmium sulfide activated with silver for the green lines G. Chromium-activated aluminum berylliate or zinc cadmium sulfide activated by silver for the red lines R.

The parallel phosphor-lines R, B and G preferably, though not necessarily, extend horizontally. In the space between the ends of the lines R, B and G and the edge of the foundation surface 4, I provide a number (in this case, two) or parallel columns C, C' of signal-generating indicia. In the instant case, the indicia take the form of line-segments, R1, R2 etc., B1, B2, etc. They are arranged in register with the blue (B) and the red (R) lines of each of the several groups of phosphor lines.

The particular (line-segment) contour and (two-element) "code" arrangement of the signal-generating indicia here shown is especially suited for use in connection with conventional phosphor-line screens. This is so because the simplicity and economy of the code indicia facilitate both the manufacture of the screen and the design of the control circuits which may be associated therewith.

I may employ any of a variety of ray-emissive materials in the signal-generating area 8. I prefer, however, to use secondary-electron emissive materials in preference to light-emissive or ultraviolet-ray or X-ray or infra-red ray emitters. The use of secondary-electron emissive materials simplifies the problem of collecting the signal-bearing emanations from the code indicia. Thus, as previously pointed out, I may employ as the signal-collector electrode a single strip of metal 19. I may dispose an additional collector electrode (not shown) between the second column C' of indicia and the adjacent terminals of the light-emissive strips, though this is usually unnecessary. The collector electrode or electrodes should not prevent the beam from impinging upon any portion of the signal-generating or light-emissive areas. This condition is avoided, in the instant case, by mounting the collector 19 along the edge of the glass plate 5 in a plane normal to its foundation surface 4.

One might assume that I should form the indicia R1, B1 etc. of a material having the highest obtainable secondary-electron to primary-electron emissive ratio. Such, however, is not necessarily the case. The principal requirement is that there be a usefully great difference in the emissive-ratios of the code marks and the surface 24 immediately surrounding the same. Thus, I may make the code marks B1, R1 etc. of a material (e. g. glass or carbon-black) having a secondary-to-primary electron emissive-ratio of less than unity, providing I make the surrounding surface 24 of a material (e. g. silver or aluminum) having an emissive ratio greater than that of the other. In the interests of simplicity, however, I prefer to make the code marks of the more highly emissive material and to use the surface of the glass foundation plate 5 as the contrastingly less-emissive area 24.

I find it convenient to refer to the chart of Fig. 3 and to the curve of Fig. 4 in explaining the manner in which the secondary-electron emissive indicia B1, R1, etc. operate to generate signals capable of effecting the "up" or "down" vernier adjustment required to bring the beam 9 into register with a particular phosphor line.

Let use assume that the beam starts its movement across the signal-generating area 8 at the various points indicated by the beam spots 9, 9*a*, 9*b*, 9*c* or 9*d*. Let us also assume that the phosphor line upon which the beam should impinge is the green line G. In the particular arrangement or "code" of the signal-generating indicia here shown, there is a code-mark opposite each of the blue and red phosphor lines (B and R) but none opposite the green line (G). Hence, if the beam 9 is moving along an axis *x*—*x* which coincides with the longitudinal axis of the phosphor line G, it will pass through the signal-generating area 8 without encountering either the indicia B1 or R1. Thus, no control signal will be generated. Nor is any required, since the beam is where it should be, i. e., in register with the line G. This condition of "no signal" is indicated by the point 9 on the curve of the chart.

If the beam should start its excursion across the signal-generating area at one of the points indicated by the beam spots 9*a* or 9*b*, i. e., above

the central axis x—x, it will encounter the indicia or code mark B1. Hence, secondary-electrons will be released in a quantity proportional to the percentage of the total beam area impinging upon the code mark B1. As a result, a vernier beam-deflecting signal of the magnitude required to move the beam the proper distance into register with the line G will be generated. This condition is indicated by the points 9*a* and 9*b* on the curve of the chart. The information necessary to ensure the proper direction of this movement is supplied to the time-discriminating means of the servocircuit 23 (Fig. 1) by reason of the fact that in the columnar arrangement of the indicia, the first column (C) is allotted to the "down" movement.

If, as indicated by the beam spots 9*c* and 9*d*, the beam strikes the signal-generating area at a point beneath the line x—x, it will encounter a secondary-electron emission code-mark when it reaches the first column, C, where it will strike the mark R2. Here again a beam-deflecting signal of the magnitude (indicated by points 9*c*, 9*d* on the left or "red" curve of the chart) and (upward) direction required to move the beam the proper distance into register with the green phosphor-line G.

I have described the screen of the tube of my invention as containing a signal-generating "code" of a simple yet practical pattern. My disclosure in this respect is intended as illustrative. I may use other signal-generating line or dot codes for the same purpose (i. e., beam-to-line register), or indeed for other purposes, for example, controlling the focus or the timing of the beam, or for securing linear, vertical, radial or other directional scanning of a high order of precision.

I claim as my invention:

1. The combination with an electron-beam tube of the type provided with horizontal and vertical beam-deflecting means and containing a target having discrete light-emissive and signal-generating areas upon which the beam may successively and repeatedly be directed by said horizontal and vertical beam-deflecting means, of auxiliary beam-deflecting, means disposed adjacent to the path of said beam for applying to said beam vernier deflecting forces derived from said signal-generating area of said target.

2. The invention as set forth in claim 1 and wherein said auxiliary beam-deflecting means comprises a pair of electrodes disposed in substantially horizontal planes on opposite sides of the path of said beam within said tube, whereby said vernier deflecting forces serve to deflect said beam in a vertical direction only.

3. The invention as set forth in claim 2 and wherein said first-mentioned beam-deflecting means are of the magnetic type and are disposed on the exterior of said tube intermediate said target and said pair of horizontally disposed electrodes.

4. An electron-discharge device comprising an evacuated envelope containing an electron-sensitive screen having a light-emissive area and a secondary-electron emissive signal-generating area, a collector electrode disposed adjacent to said signal-generating area in a position to collect secondary-electrons from said area, an electron gun for generating a beam of electrons, said gun being disposed in a position to activate said light-emissive and signal-generating areas of said screen, horizontal and vertical beam-deflecting elements disposed exterior of said envelope intermediate said gun and screen, and auxiliary beam-deflecting elements mounted within said envelope for applying vernier deflecting forces to said beam in accordance with signals picked up by said collector electrode from said secondary-electron emissive signal-generating area of said screen.

5. The invention as set forth in claim 4 and wherein said light-emissive area of said screen comprises a plurality of sub-elemental phosphor areas, and said signal-generating area comprises a plurality of secondary-electron emissive signal-generating indicia individual to said sub-elemental phosphor areas.

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