

Jan. 4, 1949.

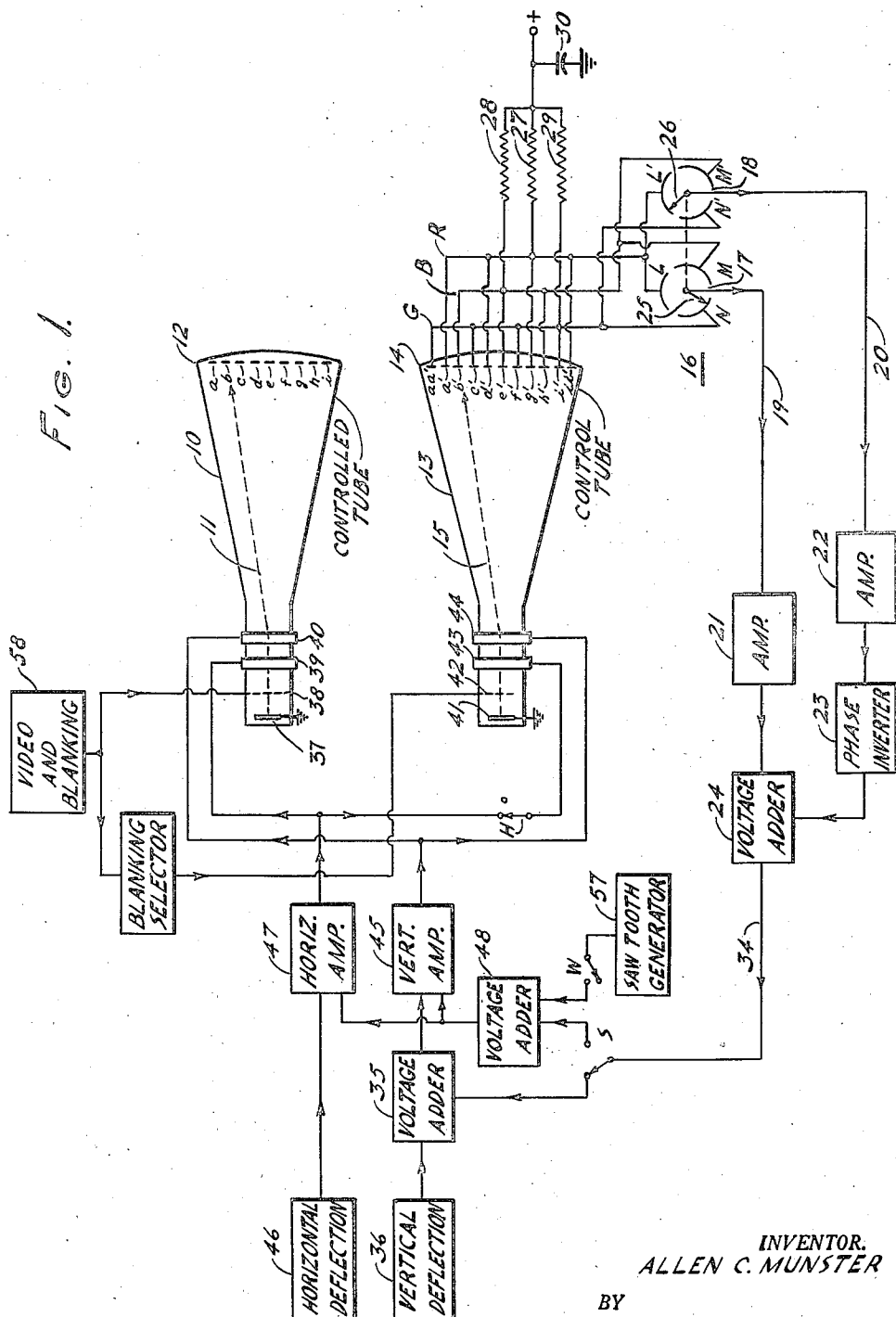
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2,457,911

DEVIATION CORRECTION FOR CATHODE-RAY BEAMS

Filed Nov. 23, 1946

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 2.

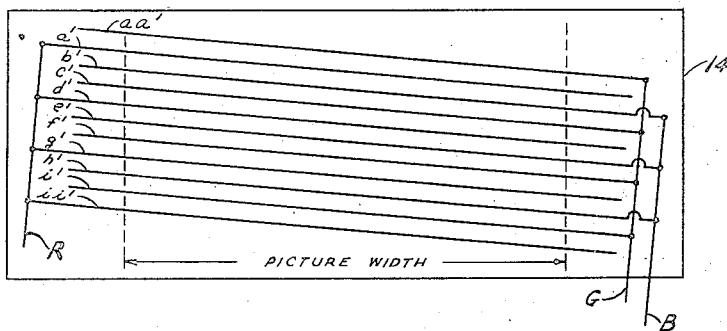


Fig. 3.

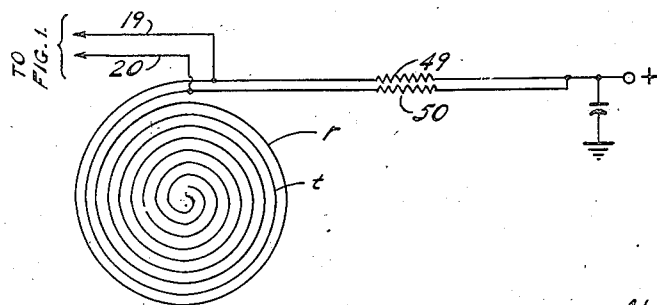
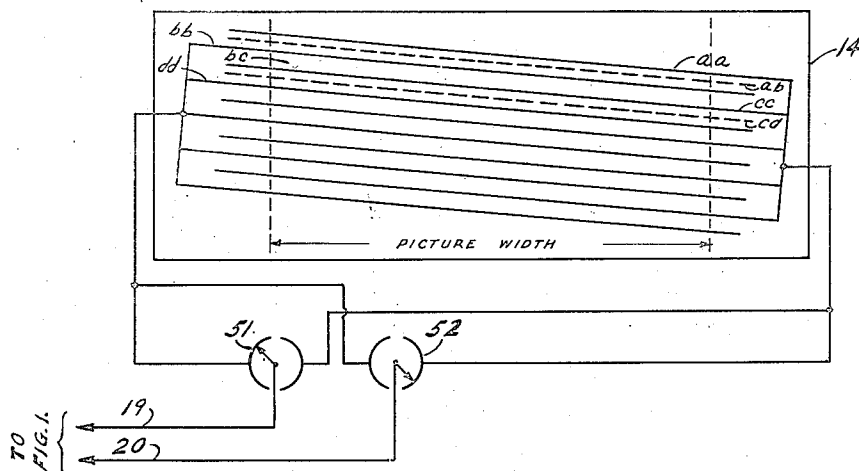


FIG. 4.

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DEVIATION CORRECTION FOR CATHODE-
RAY BEAMS

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8 Claims. (Cl. 315-9)

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The invention described and claimed herein relates to control means for cathode ray tubes. More particularly, the invention provides automatic control means for correcting, substantially instantaneously, an unintended deviation in a controllable physical feature of an electron beam, as for example, an unintended deviation in the position of the beam.

The present invention is of particular utility in television systems where it may be conveniently employed to correct an undesired departure of the spot of the scanning electron beam from a preselected path the beam is intended to follow. Control of this nature is particularly desirable in multi-color television systems employing a cathode-ray tube having a multi-color striped or mosaic-line screen, or in three-dimensional television systems employing a cathode-ray tube having differently polarized screen elements in striped arrangement, since deviation of the scanning spot from its intended scanning path introduces error in the picture being viewed which may be noticeable and objectionable.

In black and white television systems employing a conventional scanning pattern comprised of a plurality of vertically-displaced parallel lateral lines, the beam spot of the viewing tube may deviate vertically from its scanning path a limited amount without the effect of such deviation being noticeable to the observer. But in multi-color or stereoscopic television systems employing striped screens, considerably less vertical deviation is permissible before the error is noticeable. In short, for good quality of reproduction in these types of color and three-dimensional television systems, it is important that the spot of the scanning beam adhere closely to the line it is intended to scan. Apparatus which may be satisfactory for controlling the scanning of a black and white television tube, may not be at all satisfactory for controlling the scanning of a multi-color or polarized television tube, because of the more rigid requirements of color and three-dimensional presentation.

The instant invention provides an additional beam which functions as the control means, and this control beam is effective in one embodiment of the invention, to maintain the spot of the electron scanning beam accurately positioned as the said spot moves along a predetermined path despite undesired and unavoidable fluctuations in tube potentials which tend to displace the spot therefrom.

An important advantage of the present invention is that the control beam is free of any

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intensity-modulating signals which are applied to the beam which is to be controlled, as for example, the scanning beam of the camera or viewing tubes. The control system is therefore continuously effective irrespective of whether or not the scanning beam of the camera or viewing tube is intensity modulated to zero, or to a very low value.

It is an object of this invention to provide a second beam of electrified particles as a control means for correcting, substantially instantaneously, unwanted deviations of a first beam of electrified particles from a predetermined desired condition with respect to a controllable physical feature thereof, as for example, with respect to its instantaneous position.

It is another object of this invention to provide a control beam for maintaining the scanning beam of a cathode-ray tube accurately positioned upon a predetermined path.

It is a further object of this invention to provide a control beam which is effective to maintain the intensity-modulated scanning beam of a cathode ray tube accurately positioned upon a predetermined scanning path irrespective of the instantaneous intensity of the modulated beam.

It is another object of this invention to provide control means capable of correcting, substantially instantaneously, undesired vertical deviations of a scanning beam from a substantially horizontal scanning pattern; and as a more specific object, capable of functioning in three-color television systems employing an every-third-line interlace scanning pattern.

These and other objects and features of the present invention will be clear from a consideration of the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is an illustration, partly schematic, partly diagrammatic, of a circuit embodying one form of the invention;

Figure 2 is a diagrammatic representation of one arrangement of control-tube screen target which may be employed with the system illustrated in Figure 1;

Figure 3 is a diagrammatic representation of an alternate arrangement of control-tube screen target which may be employed with every-other-line interlace scanning; and

Figure 4 is a schematic representation of a spiral-scan control target.

Referring now to Figure 1, there is illustrated a cathode ray tube 10 having electron beam 11 impinging upon screen 12. The scanning ac-

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curacy of beam 11 is controlled by the novel means of the present invention and tube 10 is therefore indicated in Figure 1 as being the controlled tube. Controlled tube 10 may serve as the picture tube of a television receiver, or as the camera tube of a television transmitter, or may serve other cathode ray tube functions.

For the purpose of facilitating the description of the present invention, tube 10 will be assumed to be the picture tube of a three-color television receiver, having a screen 12 comprised of luminescent material arranged in closely spaced, substantially horizontal, parallel lines. Adjacent lines will be assumed to be comprised of different luminescent material, as for example, a different phosphor; and every third line will be assumed to be comprised of the same phosphor. Or, alternatively, screen 12 may be comprised of a common fluorescent material, as for example, a white phosphor, to one surface of which color filter material has been applied in closely-spaced, narrow, lateral strips or lines, adjacent strips being different color filters and every third strip being the same color filter.

In Figure 1 of the drawing, only nine horizontal line positions of screen 12 are shown. These are identified by the reference letters *a* to *i* inclusive, and they are intended to be illustrative of the much larger number of lines of which the screen of an actual three-color television picture tube is comprised.

In accordance with the present invention, a second screen and a second beam are provided which function to assure accuracy of scanning on the part of beam 11 of tube 10. The second screen and second beam are preferably contained in a separate envelope; and accordingly there is shown, in Figure 1, an auxiliary tube 13 containing the second screen and beam to which reference has just been made. Tube 13 will be referred to as the control tube, and it may, with the exception of screen 14, be of conventional construction. In the particular embodiment now being described, screen 14 is comprised of a plurality of narrow, closely spaced, mutually insulated, substantially horizontal, parallel strips of conductive material, which may, but need not, be luminescent. These conductive strips function as the target plates for beam 15 of the control tube. For each line of mosaic-line screen 12 there is a corresponding target strip on screen 14; and for reasons that will become clear, an extra strip is preferably added at the top and bottom of the target screen.

In the embodiment being described, control-tube beam 15 is deflected both vertically and horizontally in such manner that its scanning pattern is similar to, and preferably identical with, that of beam 11. If the horizontal deflections of beams 11 and 15 be identical, then the lengths of the target strips may of course, be equal to the lengths of the lines of screen 12. If the horizontal deflection of control beam 15 be smaller or larger than that of beam 11, then the target strips may be shorter or longer than the lines of screen 12; but the time required for the control beam to complete one lateral sweep, should be equal to the time required for beam 11 to scan one line. And of course the vertical deflections of both beams should be equal, or at least proportional, during the scanning of a line.

Referring now to Figure 2, there is illustrated schematically the physical arrangement and the electrical connections of the target strips of screen 14 as employed in the embodiment of my

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invention now being described. Only eleven target strips, *a'* to *i'*, inclusive, *aa'* and *ii'*, are shown, but these are intended to be representative of the large number of target strips of which the screen of tube 13 will ordinarily be comprised, the actual number of strips being preferably larger by two than the number of lines in the picture tube. Nine of the strips shown, i. e. strips *a'* to *i'* inclusive, correspond to the nine lines, *a* to *i* inclusive, of fluorescent screen 12 which are shown in Figure 1. The other two strips, *aa'* and *ii'*, are extra target strips, one being provided at the top of the screen and the other at the bottom of the screen. The target strips are shown as having a slight downward slope to the right, which corresponds with the scanning lines of fluorescent screen 12, it being understood that the customary scanning action is from left to right across the image and downward.

Every third target strip of screen 14 is electrically connected to a common lead, thus forming three groups of interlaced target elements. In Figures 1 and 2 of the drawings, a group comprising strips *a'*, *d'*, *g'* and *ii'* are shown connected to common lead R, a second group comprising strips *b'*, *e'* and *h'* are shown connected to common lead B; and a third group comprising strips *aa'*, *c'*, *f'* and *i'* are shown connected to common lead G. The target strips connected to lead R may be deemed to correspond to lines of screen 12 comprised of a luminescent phosphor which under electron bombardment emits a red color. Similarly, the target strips connected to leads B and G may be considered as corresponding to lines of screen 12 comprised of blue and green phosphor respectively.

Referring again to Figure 1, a suitable positive potential is applied to each of the target strips by way of the common leads R, B, G, and resistors 27, 28, 29, respectively. Capacitor 30 is a by-pass capacitor. Each of the three common leads, R, B and G, is connected to suitable switching means 16 through which control signals are passed to feedback connections 19 and 20. The control signals referred to are derived from the impingement of electrons of beam 15 upon one of the conductive target strips. For as the impinging electrons return to cathode 41 through one of the resistors 27, 28, 29, a signal is developed at the ungrounded end of the resistor, which is available for control purposes.

In order to effectuate the desired control, the switching means provided in the present illustration are adapted to accomplish the following: (a) provide an open circuit between each of the feedback connections 19, 20 and the target strip corresponding to the line intended to be scanned; (b) provide a closed circuit between one feedback connection and the target strip corresponding to the line adjacent and above the line intended to be scanned; (c) provide a closed circuit between the other feedback connection and the target strip corresponding to the line adjacent and below the line intended to be scanned.

The switching means for accomplishing the above may be of any suitable form, preferably electronic. However, for the purpose of describing the instant embodiment, it will suffice to illustrate and describe a mechanical switching arrangement. There is accordingly shown in Figure 1, a pair of rotary-type switches 17 and 18, having rotatable switch arms 25, 26 respectively and each having three arcuate contact-segments L, M, N and L', M', N' respectively. Each of the

three common leads R, B and G, is connected to one of the three segments of each switch. In the illustration, lead B is connected to segments M and M', lead R is connected to segments L and L', and lead G is connected to segments N and N'.

Switch arms 25, 26 are ganged together and are rotated clockwise simultaneously, as by a synchronous motor (not shown), with switch arm 25 lagging switch arm 26 by one segment. The leads of feedback connections 19 and 20 extend from switch arms 25 and 26 to amplifiers 21 and 22, respectively. These amplifiers are preferably D-C. amplifiers so that the D-C. component of the correction voltage may be preserved. Or, alternatively, means may be included in amplifiers 21, 22, for accomplishing D-C. insertion.

In the embodiment illustrated in Figure 1, the output of amplifier 22 is shown applied to a phase inverter 23, but if desired, the inversion of the signal may of course be accomplished by having amplifier 22 comprise one more, or one less, stage than amplifier 21. The output signals of amplifier 21 and the inverted signals of amplifier 22 are combined in voltage adder 24 and are applied by way of common connection 34 and switch S to voltage adder 35 where they are combined with the vertical deflection signals from source 36.

If desired, the control signals fed back by way of connections 19 and 20 may be applied respectively to opposing elements of the vertical deflecting means in which case inversion of the signals of one of the paths is unnecessary.

Referring again to cathode ray tubes 10 and 13, it has been indicated previously that these tubes, with the exception of screen 14, may be of conventional construction; therefore, tube elements and associated circuits, which are conventional and well known are merely shown in block forms. Tube 10 is shown in the drawing as having a cathode 37, a signal grid 38, horizontal deflecting means indicated by block 39, and vertical deflecting means indicated by block 40. Control tube 13 is shown as having cathode 41, a signal grid 42, horizontal deflecting means indicated by block 43, and vertical deflecting means indicated by block 44.

Vertical deflection signals from source 36 are applied by way of voltage adder 35 and amplifier 45 to vertical deflection means 40 of tube 10 and are applied simultaneously to vertical deflecting means 44 of tube 13.

Horizontal deflection signals from source 46 are applied through amplifier 47 to horizontal deflecting means 39 of tube 10 and, in the preferred embodiment now being described, are simultaneously applied to the horizontal deflecting means 43 of control tube 13. In some embodiments of my invention, as is described later in the specification, the horizontal deflecting signals are not applied to the control tube, the control beam being deflected vertically only.

Picture and blanking signals, as from source 58, are applied to control grid 38 of tube 10, while blanking signals only are applied to control grid 42 of control tube 13 since beam 15 is preferably not intensity modulated. If desired, the application of blanking signals to grid 42 of tube 13 may also be omitted, but if this be done, a gating tube is inserted in the control-signal feedback connection 34, arranged to bar the feedback of control signals produced during retrace periods.

The operation of the instant embodiment of my novel circuit will now be described. As indicated above, vertical deflection signals from source 36

are applied simultaneously to vertical deflecting means 40 of tube 10 and 44 of tube 13 to the end that electron beams 11 and 15 are moved in a similar vertical manner. Horizontal deflection signals from source 46 are applied simultaneously to horizontal deflecting means 39 and 43 to move beams 11 and 15 through similar horizontal scanning paths. Other potentials influencing deflection, as for example, the Aquadag potentials (not shown) are likewise applied to both tubes from common sources.

Assume an instant in the scanning pattern when beam 11 of picture tube 10 is scanning a blue phosphor line, as for example line b. At that same instant, coordinated beam 15 of control tube 13 is focused upon target strip b'. Target strip b' is connected to common lead B, and lead B is connected to segment M of switch 17 and segment M' of switch 18. Assume further that an unavoidable fluctuation occurs in one or more of the potentials affecting vertical deflection, causing beams 11 and 15 to deviate in a downward direction from their proper positions. In so deviating, some or all of the electrons of control beam 15 strike target strip c' and a voltage is developed across resistor 29 whose magnitude is a function of the number of electrons which impinge upon strip c'. As stated above, beam 15 is not intensity modulated with picture signals, and the intensity of the beam, and the size of the beam spot, during the scanning periods are predetermined and fixed. Consequently, the voltage produced across resistor 29 by the impingement of electrons upon target strip c' is also predetermined and fixed, except for the fact that the downward deviation of beam 15 may be so small that only the lower portion of the beam spot encounters target strip c', in which case a smaller voltage is developed. Incidentally, the size of the spot of beam 15 may preferably be such that when the beam is centered upon, for example strip b', the periphery of the spot just escapes contact with adjacent strips a' and c'.

Returning now to the example being described, in which a downward deviation has just occurred causing electrons to strike target strip c', it will be seen that strip c' is connected to common lead G, and lead G is connected to segment N of switch 17 and N' of switch 18. Rotating switch arm 25 of switch 17 is in contact with segment N, and the voltage produced across resistor 29 is applied by way of connection 19 to the input circuit of amplifier 21. The voltage developed across the output circuit of amplifier 21 is applied by way of lead 34 to voltage adder 35 where it is combined with the vertical deflecting signals from source 36. The polarity and magnitude of the voltage delivered by amplifier 21 is such that it is effective to move beams 11 and 15 in an upward direction, preferably to such an extent that target strip b' is overshot and a portion of the electrons strike target strip a' which is adjacent and above.

It will be noticed that when control beam 15 deviated downwardly from strip b' to c', no correction signal was obtained from amplifier 22 for the reason that connection 20 was open at switch 18, switch arm 26 being out of contact with segment N'.

It should be mentioned here that the frequency response characteristics of amplifier 21 and 22 are preferably such that steep wave front control signals may be passed therethrough, thus

permitting the control voltages to reach the voltage adder with a minimum of delay.

Assume now that beams 11 and 15 have deviated upwardly from line positions b , b' , either as a result of the application of an over-shooting correcting voltage as described above, or as a result of unavoidable fluctuations in voltages determining vertical deflection. When an upward deviation from line positions b , b' occurs, electrons from beam 15 strike target strip a' , which is connected to common lead R, lead R being connected to segment L of switch 17 and segment L' of switch 18. Switch arm 25 of switch 17 is not in contact with segment L, and feedback connection 19 is consequently open at switch 17. Switch arm 26 of switch 18 is, however, in contact with segment L', and the voltage produced across resistor 27 as a result of electrons striking target strip a' is therefore applied across the input circuit of amplifier 22. For input signals of like polarity, the output signals of amplifier 22 are either of opposite polarity from those of amplifier 21, or if of the same polarity are inverted in phase inverter 23; and the signal is then applied to voltage adder 35 by way of connection 34. The effect of combining the signals from amplifier 22 with the vertical deflection signals from source 36 is to move beams 11 and 15 in a downward direction, preferably to such an extent that strip b' is overshoot and a portion of the electrons strike target strip c' .

It will be observed that when line positions b , b' are being properly scanned, the voltage developed across resistor 28, as a result of electrons impinging upon target strip b' , is not applied to voltage adder 35 for the reason that both the feedback circuits 19 and 20 are open at segments M and M' of switches 17 and 18 respectively.

It will be seen that in the embodiment just described, the control or correcting voltages are applied at the slightest deviation of the control-beam spot from its proper position. And if over-shooting control voltages are employed, as by suitable adjustment of the gain and time-delay introduced by amplifiers 21, 22, then the beam, following an unwanted departure, is given an oscillatory motion whose frequency is preferably higher than that of the picture elements, and amplifiers 21 and 22 are peaked amplifiers adapted to pass the oscillatory frequency, as well as lower frequencies.

In order to effectuate the desired switching, switch arms 25, 26 are rotated in coordination with the movement of scanning beams 11 and 15, the rotating speed of the switch arms being dependent upon the scanning pattern being employed. In a three-color system employing a multi-color mosaic-line screen, an every-third-line interlaced scanning pattern may be conveniently employed. With such a scanning pattern, switch arms 25 and 26 of switches 17 and 18 are rotated clockwise, and are so timed as to remain in engagement with each switch segment during the scanning of a field, i. e. during the scanning of the lines common to a single color. For example, arm 25 engages segment N and arm 26 engages segment L' at the instant that beams 11 and 15 start to sweep line positions b , b' respectively. Beams 11 and 15 complete scanning of the color field of which line b is a component, at the same instant that rotating arms 25, 26 complete their respective passages over switch segments N and L'. During the period required for beams 11 and 15 to return to line positions c , c' at the top of the screen, 75

switch arms 25, 26 traverse the spaces between switch segments N, L and L', M'.

As beams 11 and 15 scan the next color field, the uppermost line positions of which are c , c' respectively, the arrangement shown in Figure 1 continues to be effective to provide vertical deflection control similar to that just described in connection with the preceding field. This may be readily confirmed by an examination of the circuit arrangement of Figure 1, and a detailed description thereof is not believed to be necessary.

The control system illustrated in Figure 1 and described above, is also applicable to television systems employing every-other-line interlaced scanning or every-line sequential scanning. Where every-other-line interlaced scanning is to be used with the arrangement illustrated in Figure 1, every third target strip may be connected to a common lead, just as in the case of every-third-line interlace scanning, but if this be done switch elements 25, 26 should be rotated counter-clockwise instead of clockwise, and the speed of rotation should be such that elements 25, 26 sweep over a switch segment during the time required to scan a single line position. This requires a very high rotary speed, well beyond the capabilities of most mechanical switches, but well within the capabilities of an electronic switching device, as for example, a radial-beam tube. The switching arrangement shown schematically in Figure 1 and thus far referred to in mechanical terms, may be deemed to be also a schematic representation of a radial-beam tube in which elements L, M, N and L', M', N', represent separate anodes arranged in circular fashion about cathodes 31, 32, and in which rotating elements 25 and 26 represent beams of electrons which are rotated about the axes of the tubes in known manner, as by the application of a rotating magnetic and/or electric fields.

Assume the system to be as described in the above paragraph, i. e., having an every-other-line interlaced scanning pattern and radial-beam tube switches, the beams of which rotate counterclockwise at a speed of one anode for each line-scan, with element 26 lagging element 25 by one anode as shown in Figure 1. The angular positions occupied by elements 25, 26 in the drawing assume that line b , or a line of the same field as line b , is being scanned. It may be readily seen from an examination of the circuit of Figure 1, that at all times during the scanning cycle, the voltage developed across the resistor corresponding to the line intended to be scanned, is not fed back to the voltage adder 35 because of the fact that both circuits are open at the switches. However, for a downward deviation, it will be seen that a correcting signal is fed back by way of connection 19 and amplifier 21, while for an upward deviation, a correcting signal of opposite polarity is fed back by way of connection 20, amplifier 22 and phase inverter 23.

If the target-strip pattern and switching arrangement shown in Figure 1 be employed when the scanning pattern requires that every line be scanned in sequence, then radial-beam tubes are preferably employed as switches, and the beams represented by switch elements 25, 26, should be rotated clockwise at a speed of one anode for each line scanned, with element 25 lagging element 26 by one anode. If this be done, then control is obtained in a manner similar to that described above for every-third-line and every-other-line scanning.

It is to be understood that my invention is not limited to the specific pattern of interlaced target strips illustrated in Figures 1 and 2. Other target strip arrangements may of course be used. For example, where an every-other-line interlaced scanning pattern is to be employed, screen 14 of control tube 13 may conveniently take the form shown in Figure 3.

In Figure 3 only two target strip networks are employed and these are so positioned that the target strips correspond to the spaces between the mosaic lines of picture tube 10. Where the arrangement of Figure 3 is used, the operation is as follows: Assume line position *a* of tube 10 is being scanned. The spot of coordinated beam 15 is then positioned in the space *ab*, located between target strips *aa* and *bb*, and the spot follows the path indicated by the dotted line. If desired, the spot may be of such size that some of the electrons impinge upon target strip *aa*, and a substantially equal number upon strip *bb*, in which case control voltages of equal and opposite polarity are fed back, and are effective to maintain the beam spot substantially centered in the space *ab*. Following the scanning of line *a* of tube 10, line *c* is next scanned, during which time the spot of beam 15 occupies the space *cd* between target strips *cc* and *dd*. Upon completing the scanning of a field comprised of alternate lines, beams 11 and 15 return to the top of the screen; line *b* is then scanned and the control-beam spot moves along space *bc* located between target strips *bb* and *cc*.

With the arrangement of Figure 3, switching is only necessary at the end of each field; hence a pair of two-segment rotary type mechanical switches, 51, 52, driven at a speed of one revolution per frame, will be satisfactory.

With respect now to the matter of deflecting control beam 15 in a horizontal direction as well as in a vertical direction, I have assumed in the preferred embodiments described above, both horizontal and vertical deflection signals to be applied to control beam 15. If this be done, and if the deflection characteristics of tubes 10 and 13 be alike, control beam 15 moves in an identical manner with that of beam 11. In some cases, it may be preferable, as for purposes of increasing the accuracy of the control, to use a control tube which is of larger size than the picture or camera tube which is to be controlled; and in that case control beam 15 may be moved over a similar but proportionately larger scanning pattern than beam 11.

If desired, the horizontal deflection of control beam 15 may be shortened, or even eliminated altogether, as by means of switch H. In the latter case, attention is drawn to the fact that if the lines to be scanned have a slight downward slope, as is ordinarily the case, then the end of a line just scanned may be at a lower level than the beginning of one or more lines next adjacent below. In the case of every-third-line interlaced scanning, for example, the end of a line which has just been scanned is probably at a lower level than the beginning of the next two lines immediately therebeneath. It will therefore be seen that, if the control beam is deflected vertically only, its normal downward movement during the scanning of a line would, in certain scanning patterns, bring the control beam across levels corresponding to portions of one or more lines next adjacent below the line being scanned. In such cases, it is desirable to eliminate the usual downward slope of the scan-

ning line and to maintain the scanning lines absolutely horizontal. This may be accomplished by means of the control voltages. It will be understood from what has been said previously that the control voltages developed by the impingement of control-beam electrons upon a target strip are variable to the extent that the voltages developed increase in magnitude as the encroachment of the control-beam spot upon the target strip increases. Hence, in order to prevent the scanning beam from taking its usual downward course as it moves from left to right across the image, the control system may be so adjusted that as the control voltages increase in magnitude they compensate for the linear change occurring in the vertical deflection potentials during the scanning of a line. At the end of each line-scan, the control signals are blanked out, whereupon the scanning and control beams, during retrace, abruptly drop through one or two line positions to take up the proper positions for scanning the next line of the pattern.

It is also to be understood that my control system is not limited to scanning patterns in which the lines to be scanned are horizontal, or substantially horizontal, i. e. having the customary slight downward slope. On the contrary, my system will operate quite satisfactorily with scanning patterns of various configurations as, for example, with a spiral scanning pattern. As will be understood by those skilled in the art, a spiral scanning pattern may be obtained by amplitude-modulating horizontal and vertical deflection signals which are sinusoidal and 90° out of phase. If it be assumed that the horizontal deflection signals provided by source 46 of Figure 1 are 90° out of phase with the vertical deflection signals provided by source 36, and that both be sinusoidal, then the modulation necessary for spiral scanning may be provided by a saw-tooth voltage from generator 57 by way of switch W and voltage adder 40 to vertical and horizontal amplifiers 45 and 47, so as to control the gain thereof. The control voltages fed back by way of lead 34 may then be applied by way of switch S to voltage adder 48 to control the accuracy of the radial deflection.

For the control of spiral scanning, two target strips of spiral configuration may be employed, as is illustrated in Figure 4. The space between the strips defines the path the beam is intended to follow. If the beam deviates outwardly, electrons impinge upon target strip *r*, and the voltage developed across resistor 49 is fed back as through connection 49 of Figure 1, amplifier 21, voltage adder 24, conductor 34 and switch S, and applied to voltage adder 48 to alter the saw-tooth wave in desired manner. Similarly, if the beam deviates inwardly, electrons impinge upon target strip *t*, and the voltage developed across resistor 50 is fed back as through connection 20 of Figure 1, amplifier 22, phase inverter 23, voltage adder 24, conductor 34 and switch S, and applied to voltage adder 48. It will be observed that in the control of the spiral scanning arrangement just described, no switching means is required.

Thus far my description of the invention has indicated that control strips are provided along both lengthwise edges of the path the control beam is intended to follow thus providing positive control against unwanted deviations in either of two opposing directions.

If desired, control elements may be provided along one edge only of the preselected path of the control beam. In that event, and assuming lat-

eral scanning, the vertical deflection signal, common to both the scanning and control beams, may be biased to such an extent that, in the absence of the correction signal, the control beam departs from its intended path by a predetermined amount in the direction of the control element associated therewith, and electrons which thereupon impinge upon the control strip are utilized to develop a correction voltage of sufficient magnitude to substantially overcome the bias. Hence, in the absence of voltage deviations, the control beam follows its intended path; and so, of course, does the controlled scanning beam.

The magnitude of the bias referred to above, may be substantially equal to the maximum deflection-voltage deviations, of opposite sign to the bias, which are anticipated. Such deviations, when they occur, merely tend to overcome, or at least diminish, the bias and thus cause the control beam to withdraw, at least partially, from the control strip, thereby diminishing the correction signal developed. The net result is that the beams remain substantially in their proper vertical positions.

When voltage deviations of the same sign as the bias occur, the control beam tends to invade the control strip by an increased amount and correction signals of increased magnitude are developed which are effective to overcome substantially the said voltage deviations of same sign.

Suitable switching and feedback means for the biased system above described are provided by switch 17, feedback path 19, amplifier 21, etc., of the circuit illustrated in Figure 1, it being understood that only one switch and one feedback circuit are required for the biased system.

Control means which does not employ a second electron beam to accomplish results similar to those of the instant invention are described and claimed in a joint copending application of mine and David E. Sunstein filed Nov. 23, 1946, Serial No. 711,968, and assigned to Philco Corporation. Certain advantages over the instant invention and also some disadvantages are obtained from the employment of a single beam as will become clear from a reading of the aforesaid joint copending application.

I have described several embodiments of my invention. Other embodiments not requiring invention will occur to those skilled in the art.

Having described my invention,

I claim:

1. In an electrical system: means for producing a first beam of electrified particles; means for producing a second beam of electrified particles; means, including common means, for simultaneously deflecting both said beams cyclically along similar preselected paths; means for maintaining said second beam at substantially fixed intensity during deflection along said path; means associated with said second beam and responsive to deviations of said second beam from its preselected path for generating correcting voltages identifiable with the direction of said deviations; and means operating in synchronism with said deflection cycles for selectively applying said correcting signals to both said beams in such manner as to oppose said deviations.

2. A cathode-ray system comprising: means for generating a first cathode-ray beam; means for generating a second cathode-ray beam; means, including common means, for effecting simultaneous deflection of both said beams substantially along preselected paths; means for modulating the intensity of said first beam while

maintaining the intensity of said second beam substantially fixed during deflection along said paths; means responsive to deviations of said second beam from said preselected path for generating correcting voltages; and means responsive to said correcting voltages for so modifying the operation of certain of said common deflecting means as to oppose said deviations.

3. In a cathode-ray system; means for generating a first cathode-ray beam; means for generating a second cathode-ray beam; means for applying signals from common sources to both said beams to deflect both said beams in predetermined similar manner; means for applying a modulating signal to said first beam only while maintaining said second beam at substantially fixed intensity; means associated with said second beam responsive to unwanted deviations of said second beam for generating correcting signals; and means responsive to said correcting signals and operative upon both said cathode-ray beams for opposing said deviations.

4. In a cathode-ray system; means for generating a cathode-ray scanning beam; means for generating a second cathode-ray beam for control purposes; means, including common sources of deflection-determining potentials, for deflecting said scanning beam substantially along a preselected scanning path and for simultaneously deflecting said control beam substantially along a preselected control path corresponding in pattern to said scanning path; means for maintaining said control beam at substantially fixed intensity during deflection along said preselected control path; a first target plate so positioned as to be bombarded by electrons of said control beam in the event said beam departs in a predetermined direction from said preselected path; a second target plate so positioned as to be bombarded by electrons of said control beam in the event said beam departs in the opposite direction from said preselected path; means for deriving a first control voltage from the change in the electrical potential of said first target plate resulting from bombardment thereof by said electrons; means for deriving a second control voltage from the change in the electrical potential of said second target plate resulting from the bombardment thereof by said electrons; and means for applying said first and second control voltages in opposing relation to certain of said deflecting means to effect control of both beams.

5. In a cathode-ray system: means for generating an electron scanning beam; means for generating a second electron beam for control purposes; means, including common sources of deflection-determining potentials, for deflecting said scanning beam cyclically in a preselected pattern comprised of a plurality of interlaced scanning fields and for simultaneously deflecting said control beam cyclically in a preselected pattern comprised of a plurality of interlaced fields corresponding in configuration to said scanning fields; means for maintaining said control beam at substantially fixed intensity during deflection in said preselected pattern; a plurality of interlaced groups of conductive control elements associated with said control beam; means responsive to changes in the electrical potential of said control elements for deriving signals from the bombardment of said control elements by said control beam; means synchronized with said deflecting cycles for disregarding signals derived from the bombardment of control elements belonging to a group corresponding to the field then

intended to be scanned, and for utilizing signals derived from the bombardment of elements belonging to groups corresponding to fields not intended to be then scanned, to correct the deflections of both said beams.

6. In a cathode-ray system: means for generating an electron scanning beam; means for generating a second electron beam for control purposes; means, including common sources of deflection-determining potentials, for simultaneously cyclically deflecting both said beams in accordance with preselected patterns; means for maintaining said control beam at substantially fixed intensity during said deflection; a first group of conductive control elements positioned to be bombarded by electrons of said control beam in the event said control beam departs in a first direction from a first portion of said pattern and in a second direction from a second portion of said pattern; a second group of conductive control elements positioned to be bombarded by electrons of said control beam in the event said control beam departs in a second direction from a first portion of said pattern and in a first direction from a second portion of said pattern; means responsive to changes in the electrical potential of said control elements for deriving control voltages from the bombardment of said control elements; and means synchronized with said deflection cycles for utilizing said control voltages to oppose departures of both said beams from their respective preselected patterns.

7. In an electrical system: means for generating a first beam of electrified particles; means for generating a second beam of electrified particles; means for applying potentials from common sources to both beams to place both beams

substantially in predetermined similar conditions; means for applying an additional signal to said first beam to vary its intensity while maintaining said second beam at substantially fixed intensity; means associated with said second beam responsive to unwanted deviations of said second beam from said predetermined condition for generating correcting signals characteristic of the nature of said deviations; and means responsive to said correcting signals and operative upon both said cathode-ray beams for opposing said deviations.

8. A cathode-ray system comprising: means for generating a first cathode-ray beam; means for generating a second cathode-ray beam; means, including common means, for effecting concurrent deflection of both said beams substantially along preselected paths; means for maintaining said second beam at substantially fixed intensity during deflection along said path; means associated with said second beam responsive to changes in the electrical potential of said path for detecting deviation of said second beam from said preselected path and for generating control signals characteristic of the nature of said deviation; and means responsive to said control signals and operative upon both said cathode-ray beams for opposing said deviation.

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