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BEAM-CONTROLLING SYSTEMS FOR MULTI-BEAM CATHODE RAY TUBES

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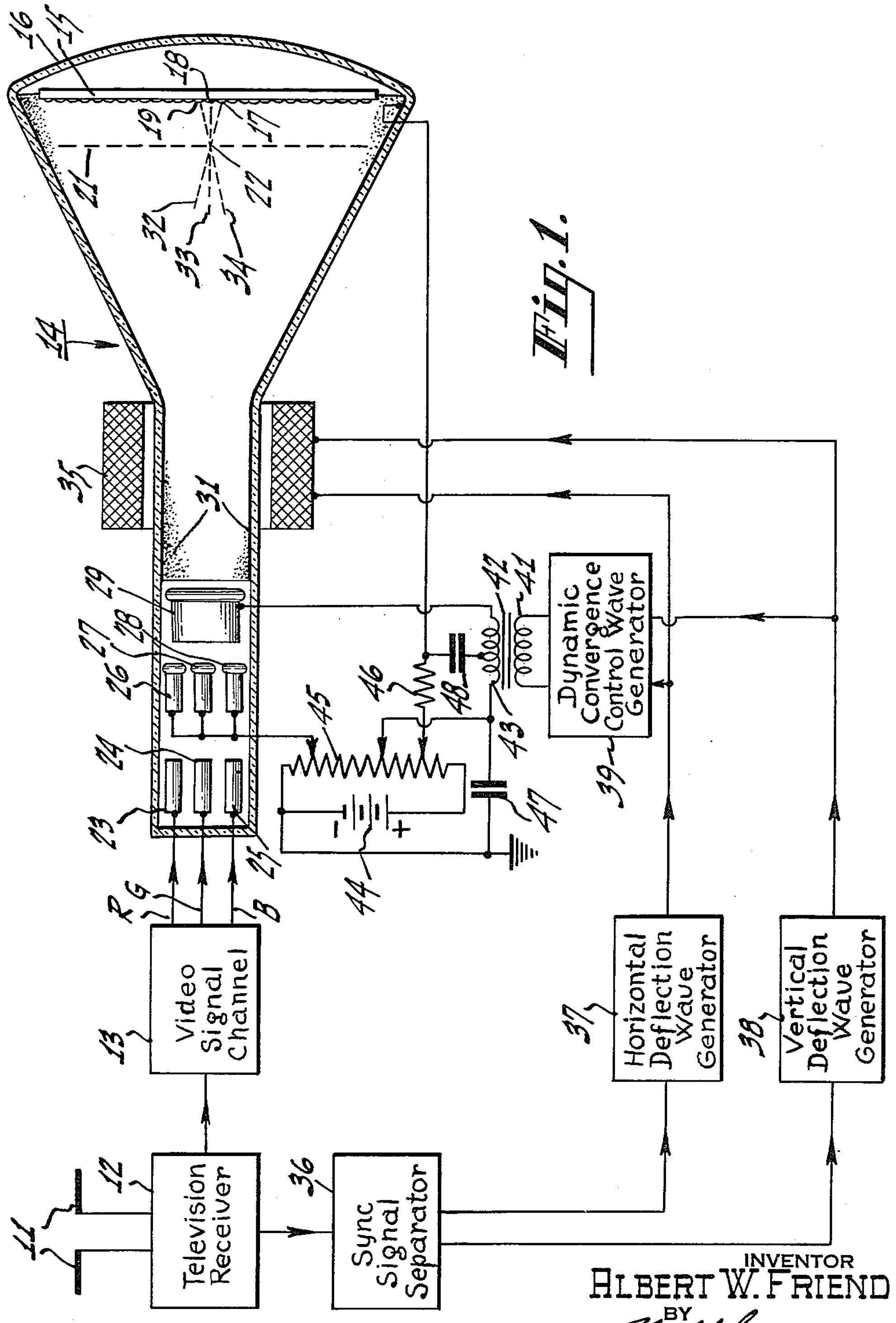

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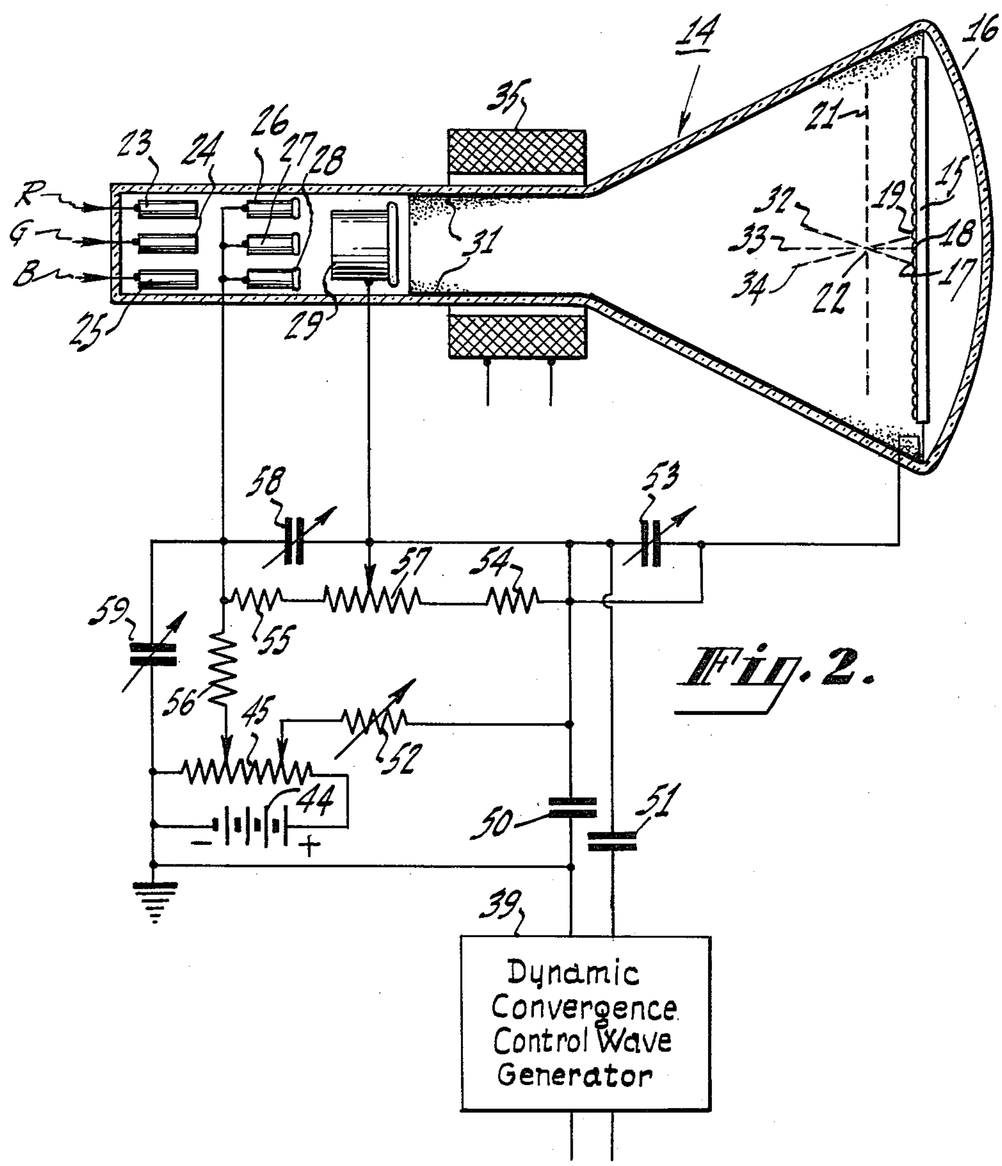

Fig. 2.

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BEAM-CONTROLLING SYSTEMS FOR MULTI-BEAM CATHODE RAY TUBES

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17 Claims. (Cl. 315—17)

This invention relates to systems for controlling the electron beams of cathode ray tubes and particularly to systems in which a plurality of beams are deflected by a common deflection apparatus.

One type of cathode ray tube with which the present invention may be successfully employed is a color kinescope of the general type described in an article titled "A Three-Gun Shadow-Mask Color Kinescope," by H. B. Law published in the Proceedings of the I. R. E., vol. 39, No. 10, October 1951, at page 1186. Such a tube also forms the subject matter of a copending application of Alfred C. Schroeder, Serial No. 730,637 filed February 24, 1947, now Patent No. 2,595,548 granted May 6, 1952 and titled "Picture Reproducing Apparatus." Such a tube has a luminescent screen as part of a target electrode in which different phosphor areas produce differently colored light when excited by electron beams impinging upon it from different angles, the angle of impingement determining the particular color of the light produced by the phosphor areas.

It is necessary to effect substantial convergence of the different electron beams at all points of the raster scanned thereby at the target electrode. In general, this convergence may be effected by means of apparatus such as that disclosed in an article titled "Deflection and Convergence in Color Kinescopes" by A. W. Friend, published in the Proceedings of the I. R. E., vol. 39, No. 10, October 1951 at page 1249. One such system in accordance with the disclosure of this article forms the subject matter of a copending application of Albert W. Friend, Serial No. 164,444 filed May 26, 1950, and titled "Electron Beam Controlling System." Such beam convergence apparatus includes an electron-optical system by which to control the beam convergence angles. The electron-optical system is variably energized as a function of the radial angle of deflection of the beams.

In order to minimize the magnitude of the dynamic energy required to effect beam convergence, the deflection yoke for the plurality of beams preferably is made as nearly anastigmatic as practicable. This fact, and the additional fact that the target electrode in such a tube may be a substantially plane electrode, tend to create a distortion of the scanned raster which is generally of the pin-cushion type. Also, in some cases, there is a tendency to de-focus the individual beams.

An object of the present invention, therefore, is to provide an improved beam-controlling system for a cathode ray tube of the kind described wherein dynamic convergence of a plurality of beams is effected at all points of the scanned raster without effecting any substantial pin-cushion or other type of distortion of the raster.

Another object of the invention is to provide an improved beam-controlling system in which, not only are a plurality of electron beams maintained in substantial convergence over an entire raster of substantially undistorted form, but also all of the individual beams are maintained in good focus throughout the scanned raster.

Still another object of the invention is to provide a dynamic control of a plurality of electron beams of a cathode ray tube for effecting dynamic convergence thereof in which the control derived from a network which is compensated so as to produce a uniform response as a function of frequency.

In accordance with the present invention the improved beam-controlling system includes a means, such as an astigmatic yoke, for concurrently deflecting a plurality of electron beams both horizontally and vertically to scan a raster at a target electrode, which preferably is a substantially flat electrode, and in which electron-optical means is located adjacent the predeflection paths of the beams and is adapted to be energized in a manner to effect convergence of the beams at the target electrode. A wave having a complex form, such as one which is essentially parabolic, for example, is developed and varies in magnitude as a function of the angle of the beam deflection. Such a wave is impressed in one magnitude upon the electron-optical means so as to effect the desired convergence of the beams. The same wave in somewhat smaller magnitude is impressed upon the beam-accelerating anode, which is generally in the form of a wall coating, for the purpose of producing the desired rectangularity of the scanned raster.

In accordance with another feature of the present invention, the control wave is impressed upon the electron-optical apparatus and the beam-accelerating anode in the different magnitudes by means of a coupling transformer, the full output of which is impressed upon the electron-optical apparatus and less than the full output of which, derived, for example, from an intermediate tap on the secondary winding, is impressed upon the beam-accelerating anode. Alternatively, there may be used a capacitive coupling device including an attenuator network for producing the different magnitudes of the control wave and which also may be compensated by capacitors for minimizing variations in the output as a function of frequency.

In accordance with still another feature of the invention a somewhat lesser magnitude of the control wave is impressed upon the individual beam-focussing anodes so that the individual beams may be maintained in good focus at all points of the raster, irrespective of the different fields to which the beams may be subjected for converging and raster distortion correcting purposes.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a diagram of a color television signal-receiving and image-reproducing apparatus embodying one form of an electron beam-controlling system in accordance with this invention; and,

Figure 2 is a fragmentary diagram of another form of the present invention for use with a multi-beam color kinescope.

Reference first will be made to Figure 1 of the drawings. The signal-receiving and image-reproducing apparatus indicated is primarily intended for use in a color television system. Nevertheless, it will be understood that the invention may also be used with any multi-beam cathode ray tubes. The present invention is susceptible of use with any of the different proposed color television signalling systems. The received signals are intercepted by an antenna **11**. It will be understood that these signals, aside from the manner in which the color information is conveyed, are essentially the same in form as the conventional black and white television signals. The received signals which are modulated upon a carrier wave are conveyed from the antenna 11 to a television receiver 12 which, it will be understood, may be entirely conventional. In operation, it functions to derive the composite television signal from any of the carrier waves upon which it may be modulated. The composite signal, as conventionally employed, includes a video signal component and a synchronizing signal component.

The composite signal derived from the receiver 12 is impressed upon a video signal channel 13 which may be of a conventional type. The three color-representative video signals derived from the video signal channel 13 may be separated into three different individual color channels "R," "G," and "B." It will be understood that these individual channels "R," "G," and "B" respectively convey the red, green, and blue video signals. These signals are employed to control the image-reproducing apparatus.

This apparatus may consist of a color kinescope 14 of the general type disclosed in the article by H. B. Law previously referred to. The kinescope includes a luminescent screen 15, which comprises a substantially flat transparent plate which is mounted in back of, and somewhat spaced from, the end wall 16 of the tube. The luminescent portion of the screen which is on the side of the transparent plate remote from the end wall 16 comprises a multiplicity of groups of phosphor dots. Each of these dots is of sub-elemental image dimensions so that each group of such dots has elemental image dimensions. For example, one such group of dots consists of red, green and blue light producing dots 17, 18 and 19, respectively. The groups of phosphor dots may be arranged in any desired pattern such as clusters of circular, triangular or hexangular configurations. Alternatively, it will be understood that, so far as the practice of the present invention is concerned, the phosphor light-producing areas of the screen 15 alternatively may consist of linear strips of phosphor material extending from one side of the screen to the other.

The kinescope 14 is also provided with an apertured masking electrode 21 for use in conjunction with the luminescent screen 15. This masking electrode is mounted in back of and in spaced relationship to the luminescent screen. It also is provided with apertures conforming in shape generally to the configuration of the groups of phosphor dots. For example, in the case of substantially circular groups of phosphor dots, the masking electrode apertures such as 22 will be substantially circular. There is an aperture provided in this electrode for each group of phosphor dots on the screen 15. The apertures of the masking electrode 21 also are suitably arranged with respect to the associated groups of phosphor dots so that proper selected excitation of these dots may be effected to produce the desired component colors of the image.

The color kinescope 14 also is provided with three schematically shown electron guns 23, 24 and 25 for exciting the respectively red, green and blue phosphor dots or areas of the screen 15. Also as part of the electron-optical system of the tube, there are provided with or as parts of the electron guns, second or beam-focussing anodes 26, 27 and 28. The kinescope also is provided with a substantially cylindrical convergence anode 29. Another significant part of the electron-optical system of the tube is the final or beam-accelerating anode 31. This is shown as a conductive wall coating formed on the inside of the kinescope envelope and extending from the neck thereof in the vicinity of the convergence anode 29 along the conically shaped portion of the kinescope to a point in the vicinity of the target electrode structure including the luminescent screen 15 and the apertured masking electrode 21.

The individual beam-focussing anodes 26, 27 and 28, in conjunction with the convergence anode, all suitably energized, function to effect the proper focussing of the electron beams derived from the guns 23, 24 and 25 so as to have the desired spot sizes at the luminescent screen 15. The convergence anode 29, in conjunction with the beam-accelerating anode 31, both suitably energized, function to effect substantial convergence of the red, green and blue light producing electron beams 32, 33 and 34 respectively substantially in the plane of the masking electrode 21. It will be understood that the representation of the target electrode structure, together with the indicated electron beams, is considerably exaggerated for the purpose of more clearly indicating the mode of operation of this apparatus.

The kinescope is also provided with a deflection yoke 35 for effecting the desired angular deflection of the electron beams. Since it is desired to scan a substantially rectangular raster, the beams are angularly deflected both horizontally and vertically by means of the yoke 35. Accordingly, it will be understood that this yoke consists of the usual arrangement of pairs of horizontal and vertical deflecting coils. In the present case, however, it is preferred that the yoke 35 be wound in such a manner that it is substantially anastigmatic. In other words, it is desired to produce a deflecting field which is as nearly homogeneous in all parts thereof as it is convenient to produce. By this means the problem of effecting the necessary convergence of the electron beams in all points of the scanned raster is minimized.

The signal-receiving and image-reproducing apparatus of Figure 1 also includes a conventional synchronizing signal separator 36 coupled to the television receiver 12. It will be understood that this apparatus performs the usual function of separating the horizontal and vertical synchronizing signals from the composite television signal and also of further separating the horizontal and vertical synchronizing signals from one another. The separated horizontal and vertical synchronizing signals are impressed in the usual manner respectively upon horizontal and vertical deflection wave generators 37 and 38. This apparatus may also be conventional, serving to produce substantially saw-tooth energy at both the horizontal and vertical scanning frequencies. The deflecting waves are impressed upon the proper coils of the deflecting yoke 35 in a conventional manner.

The apparatus also includes a dynamic convergence control wave generator 39. This apparatus may be similar in form to that shown in Figure 20 of the article by A. W. Friend, previously referred to. It is coupled to both the horizontal and vertical deflection wave generators 37 and 38 for control at those frequencies. It will be understood that it produces substantially parabolic waves having both horizontal and vertical frequency components.

Such a convergence wave is developed in the primary winding 41 of an output transformer 42 coupling the convergence control wave generator 39 to the various electrodes of the color kinescope 14 in a manner to be described. The transformer also is provided with a secondary winding 43 which is connected to the kinescope electrodes to impress thereon the dynamic convergence control wave. These various connections will be described presently.

There also is impressed upon the electrodes forming the electron optical apparatus of the kinescope 14, unidirectional potentials which provide the static components of the electrode energization. Such unidirectional energy may be derived conveniently from a suitable power supply which is represented herein schematically by a battery 44. A voltage divider 45 is connected across the terminals of the power supply 44, the negative terminal of which is connected to ground as shown. A relatively low positive potential with respect to ground is impressed upon the individual beam-focussing electrodes 26, 27 and 28. For example, this potential may be from 2 to 4 kilovolts. An intermediate value of positive potential derived from the voltage divider 45 is impressed by means of a circuit including the secondary winding 43 of the coupling transformer 42 upon the convergence anode 29. The static convergence anode potential, for example, may be from 8 to 10 kilovolts. It is seen that, by reason of the potential difference between the individual beam-focussing anodes and the convergence anode, an electron-optical effect is produced by means of which the desired focussing of the individual beams is effected. Also a relatively high positive potential with respect to ground derived from the voltage divider 45 is impressed by a circuit including a current-limiting resistor 46 upon the beam-accelerating anode 31. This static potential, for example, may be from 18 to 20 kilovolts. Again, it may be seen that the static potential difference between the convergence and beam-accelerating anodes 29 and 31, respectively, produces an electron-optical effect by means of which the three electron beams 32, 33 and 34 may be made to converge substantially in the masking electrode aperture 22 at the center of the raster to be scanned. A blocking capacitor 47 is connected between the intermediate potential tap and the grounded terminal of the voltage divider 45 to prevent short-circuiting of a portion of the unidirectional power supply.

By means of the described connection, including the secondary winding 43, of the coupling transformer 42 to the convergence anode 29, a dynamic control of this electrode is produced by the substantially parabolic wave derived from the generator 39. Since the parabolic control wave varies as a function of the angular beam deflection, it is seen that the potential difference between the convergence and beam-accelerating anodes 29 and 31 is varied, thereby varying the effectiveness of the electron-optical device formed by these two electrodes. Such a variation effects a variation of the angles of convergence of the beams 32, 33 and 34 as functions of the horizontal and vertical deflection of these beams for raster scanning purposes. By suitably adjusting the magnitude of the parabolic control wave and the shaping thereof, the beams may be made to converge in the plane of the apertures of the masking electrode 21 throughout the entire raster.

However, the combined effect of deflecting the electron beams so as to scan a substantially rectangular raster at the flat or plane surface of the screen 15 by means of the anastigmatic yoke 35 tends to create a distortion of the raster of the type commonly known as pin-cushion distortion. The top and bottom, and left and right sides, of the raster are bowed inwardly instead of being straight. In accordance with the present invention, however, this distortion may be substantially eliminated by the impression of some of the dynamic control wave energy upon the beam-accelerating electrode 31. Accordingly, an intermediate tap on the secondary winding 43 of the coupling transformer 42 is coupled by a capacitor 48 to the beam-accelerating anode 31. It, therefore, is seen that the dynamic control wave is impressed upon the beam-accelerating anode 31 in a somewhat smaller magnitude than it is upon the beam convergence anode 29.

It will be understood that the general manner in which the described apparatus embodying the invention operates to produce the desired correction of any raster distortion is by modulating the potential of the beam-accelerating anode. In order to correct for the type of raster distortion in which the top and bottom are bowed inwardly, it is necessary that the modulation be effected by a wave which is repetitive at the horizontal scanning frequency. The wave also should be one which changes smoothly from an initial condition at one side of the raster to a final condition at the other side. At the start of each horizontal scansion by the electron beams, the correcting wave is added to the static potential of the beam-accelerating anode 31. The correcting wave is of such a character that from its initial value it decreases through a zero value to a value such that

it subtracts from the static potential of this anode at the middle of the line. From this point to the right hand side of the raster the shape of the correcting wave is reversed to that described. In other words, it changes in value in the opposite sense from a subtraction from the static potential through zero to an addition to the static potential in the final beam position.

It will be apparent that the correction of the raster distortion occurring at the sides requires the use of a similar wave at the vertical scanning frequency. The combination of two such waves produce substantially complete correction of the pin-cushion type of raster distortion. If it is desired to correct raster distortion for only the top and bottom, or for only the two sides, only an appropriate one of the two correcting waves need be employed. Also, the top and bottom edges of the raster may be straightened by means of the described arrangement while some different means may be employed for straightening the left and right sides thereof, if desired.

By reason of the described modulation of the potential of the beam-accelerating anode 31, it is seen that, if steps were not taken to prevent it, a variation would be produced in the potential difference between the beam-accelerating anode and the convergence anode 29. In such a case, it is seen that the desired convergence of the electron beams 32, 33 and 34 would be adversely affected. Therefore, in accordance with this invention, the wave which is used to modulate the potential of the beam-accelerating anode also is impressed upon the convergence anode so as to correspondingly modulate its potential. Such a modulation of the potential of the convergence anode, however, must be in addition to the variation in the potential of this electrode for the purpose of effecting dynamic beam convergence. Hence, the convergence anode must be additionally modulated for beam-converging purposes. Since the wave needed to effect dynamic beam convergence and to correct raster distortion are similar in shape and phase, it is possible to use the same wave, or portions thereof, for both purposes. Consequently, the dynamic convergence control wave derived from the generator 39 is impressed upon both the convergence and beam-accelerating anodes 29 and 31. Also, in view of the foregoing discussion of the mode of operation of this device, it is seen that the control wave is impressed in greater magnitude upon the convergence anode than it is upon the beam-accelerating anode.

This proportioning of the waves impressed respectively upon the convergence and beam-accelerating anodes may be conveniently effected where a transformer such as the transformer 42 is employed for coupling the control wave generator 39 to the electrodes of the color kinescope 14. The proportioning is accomplished by employing an intermediate tap on the secondary winding 43 for the derivation of the smaller magnitude of the control wave for impression upon the beam-accelerating anode 31. An alternative way of effecting the same result is to provide separate secondary windings on the transformer 42, the respective turns ratios of the secondary windings to the primary winding being suitable to effect the desired proportioning of the control waves to be used.

It also will be understood that, in cases where the electron-optical apparatus for effecting dynamic beam convergence is electromagnetic instead of electrostatic as illustratively disclosed in Figure 1, the control wave for effecting the modulation of the beam-accelerating anode may be derived from the circuits employed to energize the electromagnetic dynamic beam convergence apparatus. In such a case, it may be necessary to amplify such a wave sufficiently to provide the necessary peak-to-peak voltage to effect the desired modulation.

Another form of the invention is shown in Figure 2 to which reference now will be made. Only as much of an image-reproducing apparatus as is necessary for an understanding of the invention has been shown in this figure. Apparatus which is similar to that shown in Figure 1 is designated by like reference characters. In this case, the dynamic control voltage is impressed, not only upon the beam-accelerating anode for pin-cushion distortion correction and upon the convergence anode for effecting beam convergence, but also upon the individual beam-focussing anodes so as to maintain good focus of the three beams at all points of the scanned raster.

The dynamic convergence control wave generator **39** is coupled by output capacitors **50** and **51** to the electrode structure of the color kinescope **14**. A relatively high potential point on the voltage divider resistor **45** is connected by a variable resistor **52** to the beam-accelerating anode **31** for the impression thereon of the desired static potential. A variable capacitor **53** coupled between the output capacitor **51** and the beam-accelerating anode **31** serves to impress a control wave of substantially parabolic form derived from the generator **39** upon the beam-accelerating anode. As in the preceding instance, the control wave effectively modulates the potential of the beam-accelerating anode.

There also is provided a voltage-dividing and signal-attenuating network including a series connection of resistors **54**, **55** and **56** together with an intermediately connected potentiometer **57**. This resistor network is connected across adjustable points of the voltage divider resistor **45**. The high static potential point of this resistor network is connected as described to the beam-accelerating anode **31**. An intermediate point is connected to the convergence anode **29** and the relatively low potential point is connected to the individual beam-focussing electrodes **26**, **27** and **28**. Also the output capacitor **51** is connected to the convergence anode **29** so as to impress the maximum amplitude of control voltage derived from the generator **39** upon this electrode. It may be seen that the capacitors **50** and **53**, together with the other components of the resistor network form a voltage dividing network whereby only a fractional portion of the control wave derived from the generator **39** is impressed upon the beam-accelerating anode **31**.

In accordance with another feature of the present invention, the dynamic control wave derived from the generator **39** also is impressed by means of a variable capacitor **58** upon the individual beam-focussing anodes **26**, **27** and **28**. The parameters of the coupling circuits are chosen so that the control wave which is impressed upon the individual beam-focussing anodes is of minimum amplitude.

The voltage-distributing network preferably is provided with facilities by which not only to adjust the attenuation of the control wave derived from the generator **39**, but also to correct or compensate this attenuation as a function of frequency. For example, the variable resistor **52** and the variable capacitor **53** enable an adjustment of the control wave attenuation and a compensation of it as a function of frequency for the wave which is impressed upon the beam-accelerating anode **31**. A similar effect is produced by variable capacitors **58** and **59**, together with resistors **55** and **56** and the potentiometer **57** with respect to the compensated attenuation of the control wave impressed upon the individual beam-focussing anodes **26**, **27** and **28**. Resistor **56** also may be made variable, if desired, to provide an additional range of compensation.

The control of the beam-accelerating anode by means of the substantially parabolic wave derived from the generator **39** for the purpose of correcting the pin-cushion distortion of the raster and also the control of the potential of the convergence anode **29** by a portion of the same wave to effect dynamic beam convergence control is accomplished in this form of the invention substan-

tially in the same manner as in the embodiment shown in Figure 1. Additionally, however, in this case, the substantially parabolically shaped control wave derived from the generator **39** is impressed upon the individual beam-focussing anodes **26**, **27** and **28**, after suitable attenuation thereof by the described resistor network, so that the individual beam focus may be controlled as a function of the angular beam deflection. It may be seen that any dynamic energization of the convergence anode **29**, while maintaining a constant static energization of the individual beam-focussing anodes, produces a variation in the electron-optical effects existing between the beam-focussing and the convergence anodes. The magnitude of the electrostatic field produced between the focussing anodes and the convergence anode determines the focus of the individual beams at the luminescent screen **15**. It is apparent, therefore, that a variation in the electrostatic field which produces individual beam focus, will ordinarily produce some variation in the focussing of these beams.

In cases where the individual beam focus variation is sufficient to be objectionable, it is desirable to prevent it. In accordance with the present invention, this variation in beam focus is prevented by dynamically controlling the potential of the individual beam-focussing anodes so as to correspond generally with the dynamic control of the convergence anode. In cases where satisfactory operation may be obtained by maintaining a substantially constant field between the individual beam-focussing anodes and convergence anode, the control wave should be impressed upon the beam focussing anodes in substantially the same magnitude as the wave impressed upon the convergence anode. However, it is generally more desirable to impress a somewhat smaller magnitude of the control wave upon the beam-focussing anodes. By such means, it is possible to produce good focus of the individual beams at all points of the raster scanned at the luminescent screen **15**. Such a result is attained by suitably varying the focus of the individual beams as they are deflected so as to take into account the changing lengths of the paths traversed by the beams to the screen in accordance with functions of the radial deflection angles.

The static potentials impressed upon the individual beam-focussing anodes, the convergence anode and the beam-accelerating anode, may be substantially the same as those indicated for the apparatus of Figure 1. The control signal produced by the generator **39** should have a peak-to-peak amplitude of from 15% to 25% of the static potential of the beam-accelerating anode **31**. The different proportions of this signal which are impressed upon the other anodes of the kinescope will depend to a considerable degree upon the particular operating conditions and other factors such as the size and spacing of the kinescope electrodes.

In general, for both forms of the invention shown respectively in Figures 1 and 2, is is desirable for satisfactory operation that the convergence anode potential be varied in approximate inverse proportion to the square root of the cosine of the radial angle of beam deflection from the central axis of the tube. Such a potential variation, it is seen, is one which is substantially parabolic and it is this general wave shape which also is required for the dynamic control of the beam-accelerating anode for pin-cushion raster distortion and/or the control of the individual beam-focussing anodes for the maintenance of good beam focus. In most cases, the control wave is produced by combining substantially parabolic waves at both the horizontal and vertical deflection frequencies in approximately a 2 to 1 ratio of horizontal to vertical frequency waves. For example, a wave at horizontal deflection frequency having a peak-to-peak amplitude of from 800 to 2000 volts may be combined with a wave at vertical deflection frequency having a peak-to-peak amplitude of from 400 to 1100 volts.

It is seen from the foregoing description that there is provided by the present invention a means of effecting, not only dynamic control of the convergence angles of a plurality of beams in a cathode ray device such as a multi-color kinescope, but at the same time, provides a means for effecting a correction of a pin-cushion raster distortion and also may produce a dynamic control of the individual beam-focussing.

The nature of the invention may be ascertained from the foregoing description of the two illustrative embodiments thereof. The scope of the invention is set forth in the appended claims.

What is claimed is:

1. In an image-reproducing system including a cathode ray tube having a target electrode, a beam-accelerating anode and wherein a plurality of electron beam components traverse pre-deflection paths that are spaced about the longitudinal axis of the tube, a beam-controlling system comprising, means concurrently deflecting said plurality of beam components angularly both horizontally and vertically to scan a raster at said target electrode, electron-optical means adjacent said pre-deflection beam paths and of a character to effect convergence of said beam components at said target electrode, a source of a wave having an amplitude varying as a function of the angle of said beam deflection, means impressing said wave in predetermined magnitude upon said electron-optical means to effect substantial convergence of said beam components at all points of said scanned raster, and means impressing said wave in less than said predetermined magnitude upon said beam-accelerating anode to produce substantial rectangularity of said scanned raster.

2. A beam-controlling system as defined in claim 1 wherein, said beam-deflecting means includes an anastigmatic yoke, whereby to facilitate said beam convergence but thereby tending to produce pin-cushion type of distortion of said scanned raster.

3. A beam-controlling system as defined in claim 1 wherein, said wave source is of such a character to produce a substantially parabolically shaped wave varying as a function of said horizontal angular beam deflection.

4. A beam-controlling system as defined in claim 3 wherein, said wave source is of such a character to produce a wave which varies also as a function of said vertical angular beam deflection.

5. A beam-controlling system as defined in claim 1 wherein, said electron-optical means is of an electrostatic character and includes a convergence anode and said beam-accelerating anode.

6. A beam-controlling system as defined in claim 1 wherein, said means impressing said wave upon said electron-optical means and said beam-accelerating anode includes an inductive coupling device.

7. A beam-controlling system as defined in claim 1 wherein, said means impressing said wave upon said electron-optical means and said beam-accelerating anode includes a capacitive coupling device.

8. In an image-reproducing system including a color kinescope having a target electrode, including a multiplicity of phosphor areas capable respectively of producing light of different colors when excited by a plurality of electron beam components impinging thereon from different angles, a beam-accelerating anode and wherein said beam components traverse pre-deflection paths that are spaced about the longitudinal axis of the tube, a beam-controlling system comprising, means concurrently deflecting said plurality of beam components angularly both horizontally and vertically to scan a raster at said target electrode, electron-optical means adjacent said pre-deflection beam paths and of a character to effect convergence of said beam components at said target electrode, a source of a substantially parabolically shaped wave varying as a function of the angle of said beam deflection, means including a coupling transformer impressing said wave in predetermined magnitude upon said electron-optical means to effect substantial convergence of said beam components at all points of said scanned raster, and means including said coupling transformer impressing said wave in less than said predetermined magnitude upon said beam-accelerating anode to produce substantial rectangularity of said raster.

9. A beam-controlling system as defined in claim 8 wherein said electron-optical means includes a convergence anode and said beam-accelerating anode and wherein, one terminal of a secondary winding of said coupling transformer is connected to a substantially fixed source of unidirectional voltage, the other terminal of said transformer secondary winding being coupled to said convergence anode, and an intermediate tap on secondary winding being coupled to said beam-accelerating anode.

10. A beam-controlling system as defined in claim 9 wherein, said source of unidirectional energy includes a voltage divider, said one terminal of said secondary transformer winding being connected to an intermediate point on said voltage divider and said beam-accelerating anode being connected to a higher potential point on said voltage divider, said intermediate transformer tap being capacitively coupled to said beam-accelerating anode.

11. A beam-controlling system as defined in claim 10, and including beam-focussing means connected to a relatively low potential point on said voltage divider.

12. In an image-reproducing system including a color kinescope having a target electrode, including a multiplicity of phosphor areas capable respectively of producing light of different colors when excited by a plurality of electron beam components impinging thereon from different angles, a beam-accelerating anode and wherein said beam components traverse pre-deflection paths that are spaced about the longitudinal axis of the tube, a beam-controlling system comprising, means concurrently deflecting said plurality of beam components angularly both horizontally and vertically to scan a raster at said target electrode, electron-optical means adjacent said pre-deflection beam paths and of a character to effect convergence of said beam components at said target electrode, a source of a substantially parabolically shaped wave varying as a function of the angle of said beam deflection, means including a coupling capacitor impressing said wave in predetermined magnitude upon said electron-optical means to effect substantial convergence of said beam components at all points of said scanned raster, and means impressing said wave in less than said predetermined magnitude upon said beam-accelerating anode to produce substantial rectangularity of said raster.

13. A beam-controlling system as defined in claim 12 wherein, said wave-impressing means includes an attenuator network including a plurality of serially connected resistors, the different magnitudes of said wave being derived from different points of said resistors.

14. A beam-controlling system as defined in claim 13, and having in addition a source of unidirectional energy including a voltage divider, different potential points of which are connected to said attenuator network.

15. A beam-controlling system as defined in claim 14, said attenuator network also comprising a plurality of capacitors connected respectively in shunt with certain of said resistors to compensate said network for substantially uniform response as a function of frequency.

16. A beam controlling system as defined in claim 15 wherein, said electron-optical means includes a convergence anode and said beam-accelerating anode, and also includes focussing means for said beams and wherein, a relatively low potential point on said attenuator network is connected to said beam-focussing means, a relatively high potential point on said network is connected to said beam-accelerating anode and an intermediate potential point on said network is connected to said convergence anode.

17. A beam-controlling system as defined in claim 16 wherein, said intermediate potential point on said net-

work comprises a movable contact on one of said resistors and wherein, said capacitors in shunt with said one resistor are variable to adjust the compensation of said network for each adjustment of said movable contact.

References Cited in the file of this patent

UNITED STATES PATENTS

2,092,081	McLennan	Sept. 7, 1937
2,126,287	Schlesinger	Aug. 9, 1938
2,178,093	Zworykin et al.	Oct. 31, 1939
2,188,647	Busse	Jan. 30, 1940
2,196,838	Rogowski et al.	Apr. 9, 1940
2,287,408	Baldwin	June 23, 1942
2,434,196	Cawein	Jan. 6, 1948
2,572,861	Hutter	Oct. 30, 1951