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BEAM-CONTROLLING SYSTEM FOR TRICOLOR KINESCOPES

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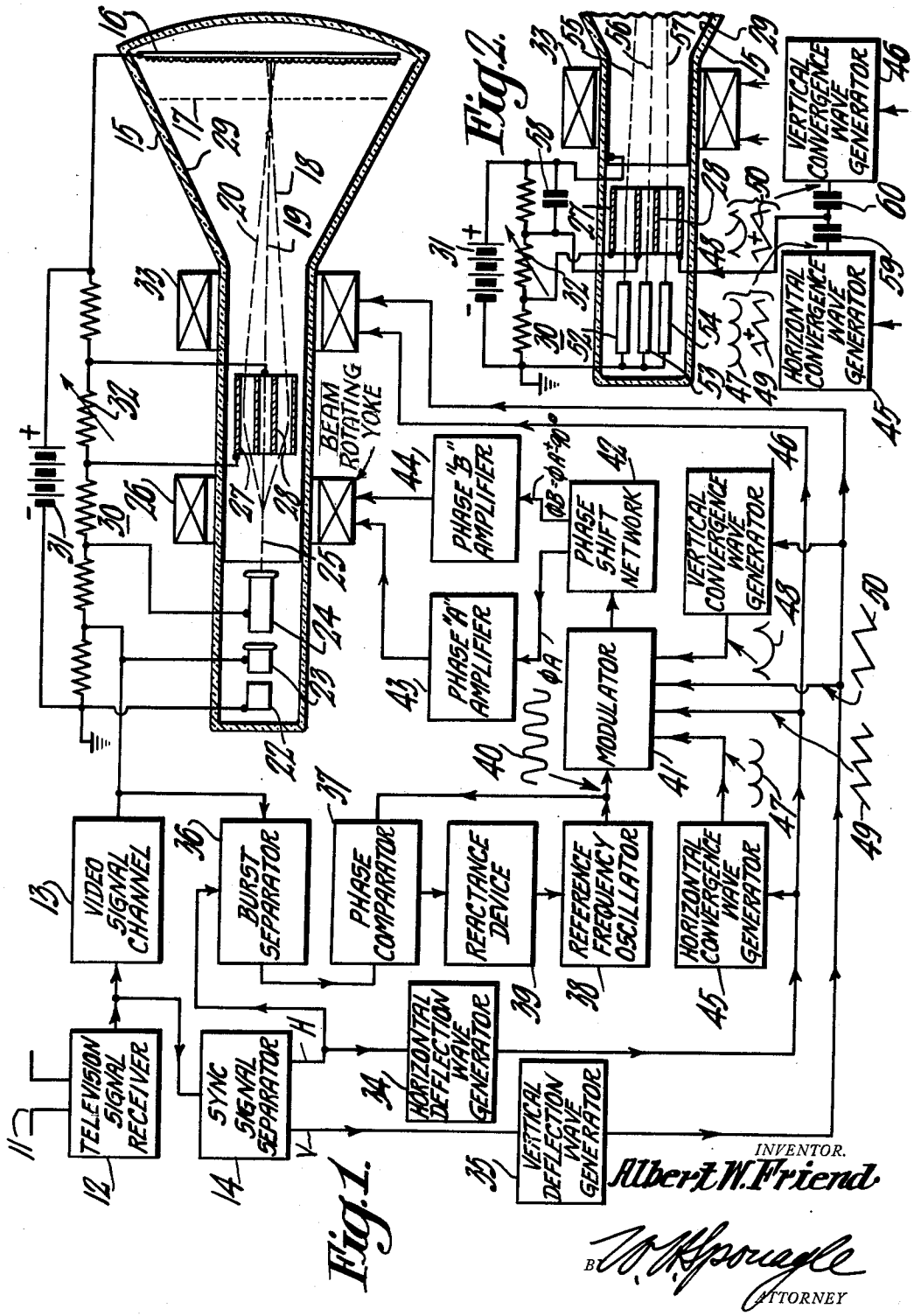

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BEAM-CONTROLLING SYSTEM FOR TRICOLOR KINESCOPES

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18 Claims. (Cl. 315—13)

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This invention relates to systems for controlling the electron beams of cathode ray tubes and particularly to systems in which a plurality of beams is 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 Patent No. 2,595,548 issued May 6, 1952, to Alfred C. Schroeder, 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 beam components impinging upon it fom different angles, the angle of impingement determining the particular color of the light produced by the phosphor areas. The invention also pertains to a kinescope of the type described in another article titled "A One-Gun Shadow-Mask Color Kinescope," by R. R. Law published in the Proceedings of the I. R. E., vol. 39, No. 10, October 1951, at page 1194. Such a tube also is the subject matter of a copending U. S. patent application of Russell R. Law, Serial No. 165,552, filed June 1, 1950, and titled "Color Television."

It is necessary to effect substantial convergence of the different electron beam components at all points of the raster scanned thereby in the plane of 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 beam deflection.

The type of beam convergence apparatus shown in the Friend paper, to which reference has been made, has been found to operate satisfactorily. It does, however, require the use of relatively complicated apparatus which consumes substantial amounts of power for its energization.

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It, therefore, is an object of this invention to provide an improved beam convergence controlling system for use with cathode ray tubes such as a tri-color kinescope.

Another object of the invention is to provide an improved beam convergence controlling system which is simpler and utilizes less complicated apparatus than heretofore employed.

A further object of the invention is to provide an improved beam convergence controlling system in which a substantial decrease may be effected in the energizing power consumption therefor.

In accordance with this invention, the apparatus which is provided for controlling the convergence of a plurality of electron beam components in a predetermined plane comprises, in general, a means for producing a plurality of electron beam components for traversing predeflection paths that are spaced respectively about the longitudinal axis of the tube; additional means located adjacent to the pre-deflection beam paths and energizable in a manner to effect the desired beam convergence; together with a further means by which to energize one of the two first-mentioned means as a predetermined function of the raster scanning beam deflection. In this manner, the beam convergence angle may be varied in a manner suitable to maintain the desired beam convergence in the predetermined plane at all points in the scanned raster.

More particularly, it will be understood that the term "beam components" as used in this specification and in the appended claims denotes either a plurality of individual electron beams emanating, respectively, from a plurality of electron guns or from a single electron gun provided with suitable electron-optical, or other apparatus, for forming three individual beams and, in addition, those components of a single electron beam to which is imparted a spinning motion so as to trace a substantially conic locus at different positions thereof. Accordingly, the apparatus by which a plurality of such electron beam components is produced may include on the one hand, three electron guns and, on the other hand, a single electron gun, together with the auxiliary apparatus by which the spinning motion is imparted to the beam. Likewise, the means by which the convergence of the beam components is effected may be dynamically, as well as statically, energized where it is employed in combination with a plurality of electron guns for producing three electron beams. On the

other hand, where such apparatus is employed in conjunction with a single spinning beam type of apparatus, it may be energized only in a static manner so as to effect the desired convergence of the beam components. Additionally, the energizing means may be employed to control the operation of the beam component-producing apparatus in the case of a single beam embodiment of the invention, whereas in the three beam apparatus it is employed to dynamically control the operation of the beam-converging apparatus so as to effect the desired variation in the beam convergence angle.

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 block circuit diagram of a color television signal-receiving and image-reproducing apparatus embodying one form of the invention in which a single electron gun is employed to produce a single electron beam; and

Figure 2 is a fragmentary illustration of an embodiment of the invention in connection with a tri-color kinescope in which a plurality of electron guns is employed to produce a like plurality of electron beams.

Reference first will be made to Figure 1 of the drawing for a description of one illustrative embodiment of the invention. The composite television signal is intercepted by an antenna 11 which is coupled to a television signal receiver 12. It will be understood that this apparatus may be entirely conventional equipment such as that found in present black and white television receivers. Briefly, it may comprise carrier wave amplifying apparatus, a frequency converter and a signal detector by means of which the video and system control signals, such as the synchronizing pulses, are removed from the carrier wave. Accordingly, the output circuit of the receiver 12 may be coupled in a conventional manner to a video signal channel 13 and also to a sync signal separator 14. The video signal channel functions to convey the color-representative video signals to an image-reproducing device so as to suitably control the electron beam-producing apparatus in a desired manner to produce a color image. The sync signal separator also functions in the usual way to separate the horizontal and vertical synchronizing pulses from the video signals and also from one another.

In the present case, the image-reproducing device is a single-gun type of tri-color kinescope 15. The form of kinescope which is illustrated in Figure 1 of the drawing is substantially of the same type as that disclosed in the I. R. E. paper by R. R. Law, previously referred to.

Essentially, such a kinescope includes a luminescent screen 16 formed of a multiplicity of small phosphor dots, each of subelemental dimensions and arranged in groups and also having the property of being respectively capable of reproducing the image colors when excited by an electron beam. This type of kinescope also is provided with an apertured masking electrode 17 which is located behind the luminescent screen and is provided with apertures for and in alignment with the respective groups of phosphor dots. A plurality of electron beam components is directed through the apertures of the electrode 17 from different directions so as to strike respectively individual phosphors capable of producing the different image colors.

In the present case, the three electron beam components 18, 19 and 20 for exciting respectively the green, red and blue phosphors are derived in a manner to be described from a single electron gun having a cathode 22, a control grid 23 and a focussing electrode 24 producing a single electron beam 25. The three beam components 18, 19 and 20 are produced by means including a beam-rotating yoke 26 comprising two 90° displaced windings which, when energized respectively by two 90° phase-displaced sinusoidal waves, produce a spinning divergence of the beam 25 from the longitudinal axis of the tube. The divergent beam components are then converged by suitable electron-optical apparatus, such as a pair of coaxial cylindrical electrodes 27 and 28. These electrodes are statically energized so as to effect initial convergence of the beam components 18, 19 and 20 substantially in the plane of the masking electrode 17. This initial beam convergence may be effected at any predetermined point in the scanned raster, such as the center point as shown. The beam components 18, 19 and 20 are suitably accelerated by means including a final anode 29 in the form of a wall coating on the inner wall of the tube, for example. The various described electrodes are statically energized in a substantially conventional manner by means of connections to a voltage divider 30 connected across a source of unidirectional energy 31. The voltage divider resistor 32 preferably should be variable so as to allow adjustment of the static convergence potential impressed upon the cylindrical electrodes 27 and 28.

The deflection of all three beam components 18, 19 and 20 is effected by means of a common deflection yoke 33. Energization of the deflection yoke is effected by substantially sawtooth waves at horizontal and vertical deflection frequencies derived respectively from deflection wave generators 34 and 35 which are coupled for control to the sync signal separator 14 in a conventional manner. Energization of the electron gun control grid electrode 23 is effected under the control of the video signals by a suitable coupling of this electrode to the video signal channel 13.

In order that the receiving apparatus, such as shown in Figure 1, be capable of operating synchronously with the associated transmitting apparatus, not only for the deflection of the electron beam components of the color kinescope 15 to scan the usual rectangular raster, but also with respect to the demodulation of the received color carrier wave, a burst of reference frequency energy is transmitted in the back porch region of the blanking intervals in the manner described in a publication titled "Recent Developments in Color Synchronization in the RCA Color Television System" issued February 1950 by Radio Corporation of America. Figure 9 of this publication deals particularly with the receiver apparatus in this type of color synchronizing system. The burst type of color synchronizing system forms the subject matter of a copending U. S. patent application of Alda V. Bedford, Serial No. 143,800, filed February 11, 1950, and titled "Synchronizing Apparatus." Hence, the receiver embodying the present invention also includes a burst separator apparatus 36 which is coupled to

the output circuit of the video signal channel 13. The burst separator is essentially a gating device. It is rendered operative only during the back porch intervals of the composite television signal under the control of horizontal synchronizing pulses derived from the sync signal separator 14.

By means of the burst gate separator, controlled in the manner described, there is produced in its output circuit a short burst of energy having the frequency of the color carrier wave. This energy burst is impressed upon a phase comparator 37 which also receives a wave of substantially the same frequency from a local reference frequency wave generator 38. Any phase difference between the separated energy burst and the wave from the generator 38 is detected by the phase comparator 37. Such a phase difference is a result of any deviation of the local reference frequency wave from the frequency of the received color carrier wave. The output circuit of the phase comparator 37, in which there is developed a voltage representative of the magnitude and sense of any phase difference, is coupled to a reactance device 39 which in turn is coupled to the reference frequency generator 32 in the usual manner for controlling the frequency of the locally generated wave.

The beam rotating yoke 26 is suitably energized to produce the desired initial divergence of the electron beam 25 to cause the described spinning of it to trace a conic locus at a frequency which is related to the frequency at which the color representative video signals are received. In the present case where it is assumed that these color video signals are modulated upon a color subcarrier wave of a comparatively high frequency within the usual video signal band, the frequency of the reference frequency oscillator 32 corresponds to the frequency of the color subcarrier wave. The output of the reference frequency oscillator is substantially a sine wave 40 at the color subcarrier wave frequency. This sine wave is impressed upon an amplitude modulator 41, which may be of conventional design, for the purpose of effecting an amplitude modulation thereof in a manner to be described in accordance with this invention.

The modulated sine wave derived from the modulator 41 is impressed upon a phase-shifting network 42. This apparatus also may be of a conventional character employing such devices as a delay line or its equivalent so as to effect a 90° phase shift of the reference frequency wave. Accordingly, it will be understood that there is derived from one output circuit of the phase-shifting network a modulated reference frequency sine wave of a first phase such as ϕA, and from a second output circuit a phase designated as ϕB which is equal to $\phi A \pm 90°$.

ϕA phase of the modulated sine wave is impressed upon a phase A amplifier 43. The ϕB phase of the sine wave is impressed upon a phase B amplifier 44. These devices may also be conventional amplifiers capable of effecting a substantially undistorted amplification of a substantially sine wave signal at a frequency of approximately 4 mc.

The respective output circuits of the amplifiers 43 and 44 are coupled to the two 90° displaced windings of the beam-rotating yoke 26. It, therefore, will be understood that, aside from the amplitude modulation of the sine wave 40, the energization of the beam-rotating yoke 26 is of a conventional character and produces the desired divergence of the electron beam 25 so as to cause it to spin in a manner to traverse a substantially conic locus.

The modulation of the sine wave 40 is effected at either or both of the horizontal and vertical deflection frequencies and by means of suitably shaped wave at those frequencies. Accordingly, the modulator 41 is provided with a plurality of modulating signal input circuits. Two of these circuits are coupled respectively to horizontal and vertical convergence wave generators 45 and 46. These generators may be of the type disclosed in Figure 20 of the I. R. E. paper by Friend previously referred to. Accordingly, substantially parabolic waves 47 and 48, respectively, at horizontal and vertical deflection frequencies are impressed upon two of the modulator signal input circuits. Similarly, substantially sawtooth waves 49 and 50, respectively, also may be impressed upon two others of the modulator input circuits. As shown, the sawtooth waves may be derived from the horizontal and vertical deflection wave generators 34 and 35. Alternatively, it will be understood that they also may be derived from the horizontal and vertical convergence wave generators 45 and 46, respectively.

Thus, it is seen that the substantially sinusoidal wave 40 at the reference frequency is modulated in amplitude as a function of the deflection of the electron beam components 18, 19 and 20 by means of the deflection yoke 33. The function of the beam deflection in accordance with which the sine wave 39 is modulated may be any desired combination of the parabolic waves 47 and 48, and the sawtooth waves 49 and 50. It will be appreciated that the substantially coaxial cylindrical electrodes 27 and 28 located and statically energized as they are, will produce a predetermined substantially constant converging effect upon the beam components traversing the space between the two electrodes. Therefore, any variation in the initial divergence of the beam components prior to their entry into the electrode space of the convergence apparatus will be maintained in the resulting convergence angles of the beam components upon emergence from this apparatus. Thus, by varying the initial divergence angle of the spinning electrode beam as a function of beam deflection, there will be produced a variation in the final convergence angle of the beam components of a character to maintain the desired beam convergence substantially in the plane of the masking electrode 17. It also will be appreciated that the production of beam convergence in the manner described not only may be achieved by apparatus which is simpler than that heretofore employed, and which involves the production of no high voltage signals, but also the power required to effect the convergence may be considerably less by virtue of the fact that the beam convergence effectively is controlled at a point which is considerably closer to the source of the electron beam than in apparatus heretofore employed. It is well known that less power is required to effect a given final position of an electron beam when the control of the beam is effected at a point which is more remote from the final target.

A somewhat different form of the invention is illustrated in Figure 2 to which reference now will be made. In this case, the tri-color kinescope 15 includes a plurality of diagrammatically shown electron guns 52, 53 and 54 producing, respectively, individual electron beams 55, 56 and 57. This type of kinescope also includes the coaxial cylindrical convergence electrodes 27 and

28 located adjacent to the predeflection paths of the electron beams. The electrodes of the kinescope 15 are statically energized in a substantially conventional manner such as that indicated. Preferably, in this case, a bypass capacitor 58 is connected from the inner cylindrical electrode 28 to a point of fixed potential, such as ground or the final anode 29, as shown. It also will be understood that the deflection yoke 33 is energized in a conventional manner such as that shown in Figure 1.

In this case, the beam convergence means comprising the cylindrical electrodes 27 and 28, in addition to being statically energized as in the apparatus of Figure 1, are dynamically energized by means of respective couplings including capacitors 59 and 60 to the horizontal and vertical convergence wave generators 45 and 46. In this case, it will be understood that these generators are substantially of the same type as those shown in Figure 20 of the Friend I. R. E. paper previously referred to. Accordingly, both parabolic and saw-tooth waves at the horizontal and vertical deflection frequencies are derived from the respective generators. Suitable combinations of these waves at desired amplitudes are impressed upon one of the cylindrical electrodes such as the electrode 27 as shown. By this means, it will be seen that the convergence angle of the electron beam components 55, 56 and 57 may be varied according to a desired function of the raster-scanning deflection of these beams so as to produce convergence of the beam components at all points of the scanned raster.

Accordingly, the invention, as disclosed in a number of illustrative embodiments, provides an improved beam convergence-controlling apparatus for use in cathode ray tubes such as a tricolor kinescope. Such apparatus is seen to be considerably simpler and of a much less complicated nature than the electron-optical apparatus previously employed. Furthermore, by virtue of the character and location of the beam convergence apparatus, it may be dynamically energized in the desired manner with considerably less power consumption than in previously used apparatus.

The nature of the invention may be ascertained from the foregoing description of a number of illustrative embodiments thereto. Its scope is pointed out in the appended claims.

What is claimed is:

1. In a color television image-reproducing system including a cathode ray tube having a luminescent screen of a type producing light of the component colors of an image when impinged by electron beam components approaching it from different angles and deflected to scan a raster at said screen, apparatus for controlling the convergence of said beam components in a plane in the vicinity of said screen, said apparatus comprising, means producing a plurality of electron beam components traversing pre-deflection paths that are spaced respectively about the longitudinal axis of the tube, means including a pair of coaxial cylindrical field-producing electrodes to effect said beam convergence, said cylindrical electrodes being positioned relative to said longitudinal tube axis in such a manner that said beam components traverse the space between said electrodes, and means energizing one of said two first-mentioned means as a function of said beam deflection to vary said beam convergence angle in a manner to maintain beam convergence in said plane at all points of the scanned raster.

2. Electron beam convergence-controlling apparatus as defined in claim 1 wherein, said electron beam component-producing means includes an electron gun developing a single electron beam, and apparatus located between said electron gun and said coaxial cylindrical electrodes and energizable to produce a rotating field by which to effect a spinning divergence of said beam in a conic locus entering said space between said electrodes.

3. Electron beam convergence controlling apparatus as defined in claim 2 wherein, said rotating field-producing apparatus includes an electromagnetic coil system, and said energizing means includes apparatus producing two 90° phase-displaced sine waves modulated in amplitude as a function of said raster-scanning beam deflection.

4. Electron beam convergence-controlling apparatus as defined in claim 1 wherein, said electron beam component-producing means includes a plurality of electron guns developing a plurality of electron beams.

5. Electron beam convergence-controlling apparatus as defined in claim 4 wherein, said energizing means is coupled to said coaxial cylindrical electrodes to vary the field produced thereby as a function of horizontal and vertical deflection of said raster-scanning beam deflection.

6. In a color television image-reproducing system including a cathode ray tube having a luminescent screen of a type producing light of the component colors of an image when impinged by electron beam components approaching it from different angles and deflected to scan a raster at said screen, apparatus for controlling the convergence of said beam components in a plane in the vicinity of said screen, said apparatus comprising, means including an electron gun developing a single electron beam, apparatus adjacent to the path of said electron beam and energizable to produce a rotating field by which to effect a spinning divergence of said beam in a conic locus, means producing a substantially constant field in said conic beam locus to effect said beam convergence, and energizing means coupled to said rotating field-producing apparatus and including apparatus producing two 90° phase-displaced sine waves modulated in amplitude as a function of said raster-scanning beam deflection.

7. Electron beam convergence-controlling apparatus as defined in claim 6 wherein, said energizing means includes an oscillator producing a sinusoidal wave, a modulator coupled to said oscillator, and a 90° phase-shifting network coupled between said modulator and said rotating field-producing apparatus.

8. Electron beam convergence controlling apparatus as defined in claim 1 wherein, said modulator is provided with a plurality of modulating signal input circuits, and said energizing means also includes a plurality of wave generators coupled respectively to said modulator input circuits.

9. Electron beam convergence-controlling apparatus as defined in claim 8, wherein, at least one of said wave generators is of a character to produce a substantially parabolic wave at one of said raster-scanning beam deflection frequencies, and at least one other of said wave generators is of a character to produce a substantially saw-tooth wave at one of said raster-scanning beam deflection frequencies.

10. Electron beam convergence-controlling apparatus as defined in claim 9 wherein, two of said

wave generators are of a character to produce substantially parabolic and sawtooth waves respectively at one of said raster-scanning beam deflection frequencies.

11. Electron beam convergence-controlling apparatus as defined in claim 10 wherein, two others of said wave generators are a character to produce substantially parabolic and sawtooth waves respectively at the other of said raster-scanning beam deflection frequencies.

12. In a color television image-reproducing system including a cathode ray tube having a luminescent screen of a type producing light of the component colors of an image when impinged by electron beam components approaching it from different angles and deflected to scan a raster at said screen, apparatus for controlling the convergence of said beam components in a plane in the vicinity of said screen, said apparatus comprising, electron gun means developing a plurality of electron beam components traversing pre-deflection paths that are spaced respectively about the longitudinal axis of the tube, means including a pair of coaxial cylindrical field-producing electrodes and energizable to effect said beam convergence, said cylindrical electrodes being positioned relative to said longitudinal tube axis in the region of said pre-deflection beam paths in such a manner that said beam components traverse the space between said electrodes, and means energizing said cylindrical electrodes as a function of said beam deflection to vary said beam convergence angle in a manner to maintain beam convergence in said plane at all points of the scanned raster.

13. Electron beam convergence-controlling apparatus as defined in claim 12 wherein, said energizing means includes a plurality of wave generators coupled to at least one of said cylindrical electrodes.

14. Electron beam convergence-controlling apparatus as defined in claim 13 wherein, said wave generators are of a character to produce convergence-controlling wave energy at horizontal and vertical deflection frequencies respectively.

15. Electron beam convergence-controlling apparatus as defined in claim 14 wherein, said wave generators are of a character to produce substantially parabolic convergence-controlling waves.

16. Electron beam convergence-controlling apparatus as defined in claim 15 wherein, said wave generators are of a character to produce both substantially parabolic and sawtooth convergence-controlling waves at both horizontal and vertical frequencies respectively.

17. Electron beam convergence-controlling apparatus as defined in claim 12 wherein, said electron gun means is constructed in a manner to develop concurrently a plurality of individual electron beams.

18. Electron beam convergence-controlling apparatus as defined in claim 17 wherein, said electron gun means comprises a plurality of substantially similar individual electron guns.

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