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BEAM CONVERGENCE SYSTEM FOR TRI-COLOR KINESCOPE

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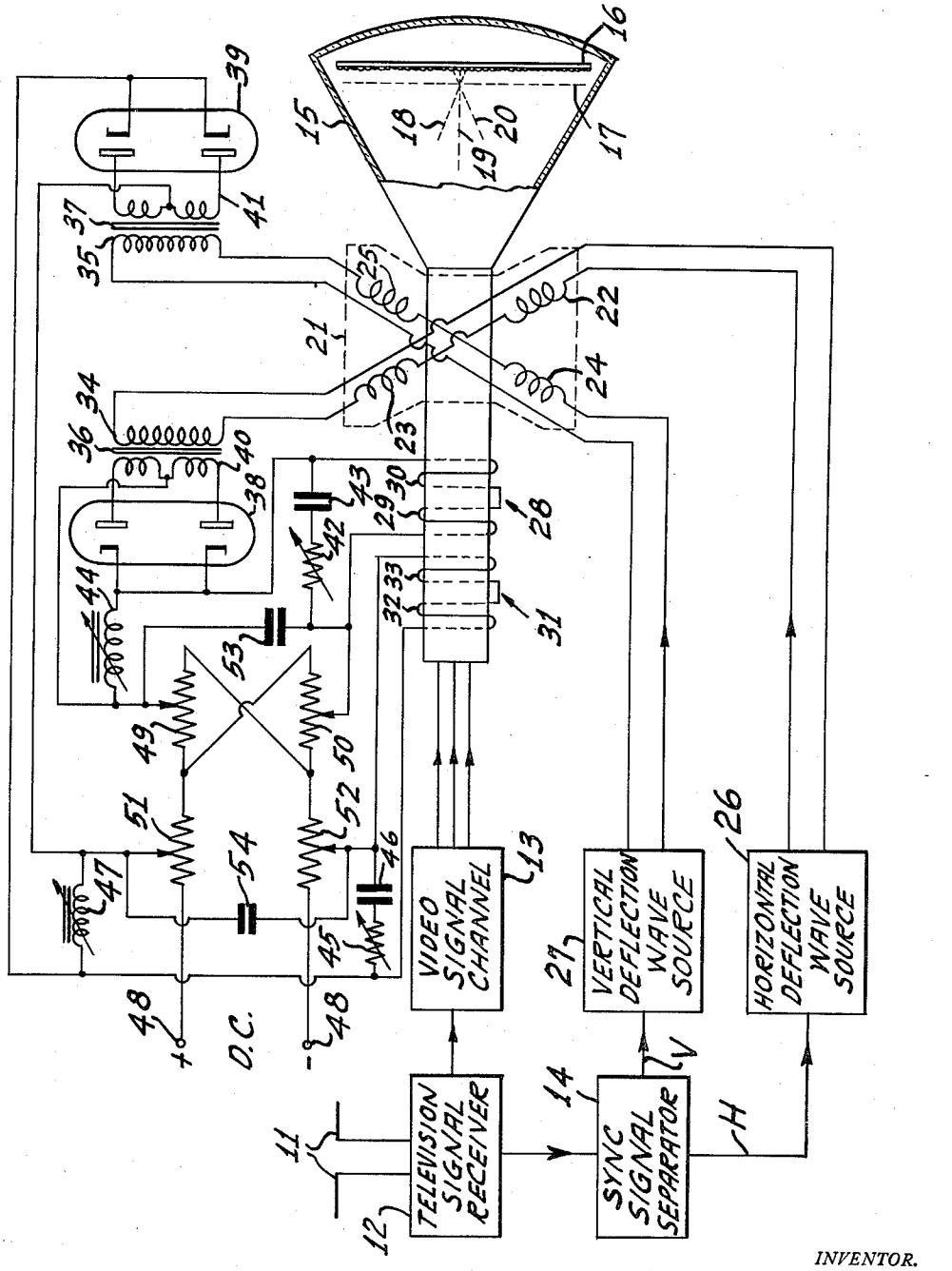

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BEAM CONVERGENCE SYSTEM FOR TRI-COLOR KINESCOPE

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This invention relates to systems for controlling the electron beam energy of cathode ray tubes. It pertains particularly to the control of a plurality of electron beam components used in television kinescopes so as to effect substantial convergence of the components at all points of a raster scanned at a target electrode.

One type of cathode ray tube in which there is encountered the problem of maintaining substantial convergence of a plurality of beam components at a target electrode is a color kinescope, such as that disclosed in a paper by H. B. Law titled "A Three-Gun Shadow-Mask Color Kinescope" published in the Proceedings of the IRE, vol. 39, No. 10, October 1951 at page 1186. Such a tube has a luminescent screen consisting of a multiplicity of phosphor areas of sub-elemental dimensions. Different ones of the phosphor areas are capable of producing light of the component image colors when excited by electron beam energy. In this tube, the different light-producing phosphor areas are excited respectively by a plurality of electron beams, or by a plurality of components of a single beam, approaching the screen from different angles through an apertured electrode. Color selection is secured by the angle at which the electron beam components approach the screen. A tube of the kind described forms the subject matter of U. S. Patent 2,595,548 granted May 6, 1952, to Alfred C. Schroeder for "Picture Reproducing Apparatus."

The expression "electron beam components" as used in this specification and claims will be understod to denote the phosphor-exciting electronic energy produced either by a single, or by a plurality of, electron guns. This energy may be continuous or pulsating as required without departing from the scope of the invention. An example of a color kinescope in which different components of a single electron beam are used to excite a phosphor screen of the kind described is disclosed in a paper by R. R. Law, titled "A One-Gun Shadow-Mask Color Kinescope" published in the Proceedings of the IRE, vol. 39, No. 10, October 1951, at page 1194. Such a tube forms the subject matter of a copending U. S. application of Russell R. Law, Serial No. 165,552, filed June 1, 1950 and titled "Color Television Reproducing Tube."

The successful operation of a multi-color kinescope of the type referred to requires that the plurality of electron beam components be made to converge substantially at the apertured electrode at all points in the scanned raster. In view of the fact that the different points of such a target electrode are at different distances from the point or region of the electron beam deflection, it is necessary to provide a field-producing means which is variably energized to produce the desired dynamic convergence control. One such electron beam control system is disclosed in a paper by Albert W. Friend titled "Deflection and Convergence in Color Kinescopes" published in the Proceedings of the IRE, vol. 39, No. 10, October 1951 at page 1249. Such a system forms the subject matter of a copending U. S. application of Albert W. Friend, Serial No. 164,444, filed May 26, 1950, and titled "Electron Beam Control System." In the system

disclosed in this copending Friend application, electron-optical apparatus is energized both statically and dynamically to produce the desired result. By means including the static energization of the electron-optical apparatus, the Friend system referred to effects initial convergence of the electron beam components substantially at the center of the raster to be scanned. The dynamic energization of the electron-optical apparatus is effected as functions of both the horizonal and vertical beam deflection. Ideally these functions are generally parabolic. However, somewhat complicated apparatus often is required to produce the desired energizing waveforms.

Therefore, it is an object of this invention to provide an improved and simplified electron beam control system for multi-beam kinescopes.

Another object of the invention is to provide electromagnetic beam convergence apparatus which may be energized in a unique manner from the beam deflection apparatus in order to effect substantial convergence of a plurality of electron beam components in all parts of a raster scanned thereby.

The electron beam convergence system in accordance with the present invention is primarily for use in conjunction with a cathode ray image-reproducing tube wherein a plurality of electron beam components which traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube are angularly deflected both horizontally and vertically to scan a raster at a target electrode. The beam convergence system comprises at least one double magnetic lens system. Where only one such lens system is used, it may be energized at either the horizontal or vertical deflection frequency. In the event that two such double magnetic lens systems are employed, they may be energized respectively at the horizontal and vertical deflection frequencies. The lens systems are located adjacent to the predeflection paths of the beams. The field produced by the respective components of each of the double magnetic lens systems extend substantially longitudinally of the tube axis but in opposite directions. By arranging these field components in opposite polarities, the individual tendencies to rotate the beam components about the longitudinal axis of the tube are cancelled. The energization of the double electromagnetic lens systems in accordance with this invention is effected by rectifying the deflection currents employed to energize the raster scanning beam deflection yoke. The rectified deflection currents are further shaped and combined with a uni-directional component and impressed upon the double magnetic lens system for the energization thereof.

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 connection with the accompanying drawing.

The single figure of the accompanying drawing is a circuit diagram, mostly in block form except for the illustrative details of the apparatus, embodying the present invention for effecting the convergence of a plurality of electron beam components at all points in a raster scanned in a predetermined plane.

Reference first will be made to Figure 1 of the drawings for a description of an illustrative embodiment of the invention. The television receiver represented in this figure is generally conventional and includes an antenna **11** to which is coupled a conventional television signal receiver **12**. It will be understood that the receiver **12** may include such usual apparatus as carrier wave amplifiers at both radio and intermediate frequencies, a frequency converter and a carrier wave de-

modulator or signal detector. Accordingly, it will be understood that there are derived from the receiver 12 a composite television signal including the video and synchronizing signal components. The composite television signal, including the video signal component, which is derived from the receiver 12 is impressed upon a video signal channel 13. Also, this signal including the synchronizing signal component, is impressed upon a sync signal separator 14. The video signal channel is coupled to the usual electron beam control apparatus, customarily referred to as electron gun apparatus (not shown), of an image-reproducing device such as a kinescope 15.

In the illustrative embodiment of the invention, it is assumed that the invention is used in a color television system. In this case, the kinescope may be of the same general type disclosed in the H. B. Law paper previously referred to. It will be understood, however, that the kinescope alternatively may be of other types, such as that shown in the aforementioned R. R. Law paper. In any case, however, the kinescope has a substantially flat luminescent screen 16 which is provided with a multiplicity of small phosphor areas arranged in groups and capable respectively of producing light of the different primary colors in which the image is to be reproduced when excited by electron beam energy. In back of, and spaced from the screen 16, there is an apertured masking electrode 17 having an aperture for, and in alignment with, each group of phosphor areas of the screen 16. As previously indicated, the kinescope will be understood to have electron gun apparatus by which to develop respective electron beams 18, 19 and 20 which are caused to approach the target electrode structure, including the luminescent screen 16 and the masking electrode 17, from three different angles which, for convenience, have been shown greatly exaggerated in the drawing. By means of the different angles of approach these beams are caused to excite the different colored light-producing phosphors.

The color kinescope 15 also is provided with apparatus by which to deflect the plurality of electron beam components 18, 19 and 20 both vertically and horizontally to scan a substantially rectangular raster at the luminescent screen 16. For this purpose, the deflection apparatus includes a yoke 21 which, in general, is of a conventional type. It consists of a pair of interconnected coils 22 and 23 forming a horizontal deflection winding, and another pair of coils 24 and 25 forming a vertical deflection winding. The yoke is mounted around the neck of the kinescope 15 in the region adjacent to the point at which the neck joins the conical section of the tube. The horizontal winding 22—23 and the vertical winding 24—25 of the yoke are energized by substantially conventional apparatus.

The yoke energizing apparatus includes horizontal and vertical deflection wave sources 26 and 27, respectively, which are coupled to the synchronizing signal separator 14. The sync signal separator, which may be of the type disclosed in U. S. Patent 2,207,775 granted July 16, 1940, to A. V. Bedford, separates the synchronizing signals from the video signals and also from one another to produce horizontal and vertical frequency synchronizing signals respectively in its output circuits H and V. As indicated, these circuits are coupled to the associated deflection wave sources. It will be understood that each of the deflection wave sources 26 and 27 includes the usual apparatus by which suitable deflection waves at the horizontal and vertical frequencies are deevloped for impression upon the deflection yoke windings as described.

In accordance with the present invention, the beam convergence apparatus includes two double magnetic lens systems, one for energization at the horizontal deflection frequency and the other at the vertical deflection frequency. These two lens systems are shown diagrammatically for clarity and convenience of illustration. The horizontal frequency double magnetic lens system 28 includes two coils 29 and 30 coaxially mounted relative to the neck of the kinescope 15. The two coils 29 and 30 are shown serially connected and are indicated as having the same number of turns and as being wound in opposite directions. Accordingly, the traversal of the two coils of the horizontal convergence magnetic lens system 28 by the same current will effectively produce two axial magnetic fields of substantially the same magnitude but of opposite polarity in the region of the predeflection paths of the electron beam components 18, 19 and 20. Similarly, there is provided a vertical frequency convergence double electromagnetic lens system 31 mounted around the neck of the kinescope 15. The vertical convergence magnetic lens system 31 also comprises two substantially identical coils 32 and 33 wound in opposite directions and serially connected for energization by the same current wave.

It is seen that, by providing apparatus, such as the two coils of each of the convergence magnetic lens systems, by which to produce axial magnetic fields of opposite polarity and of the same magnitude, any rotational effect produced upon the electron beam components by one of these coils is cancelled or overcome by a substantially equal and opposite rotational effect produced by the other coil. The net rotational effect upon the electron beam components by either or both of the convergence magnetic lens systems 28 and 31 is effectively zero. Hence, the electron beam components 18, 19 and 20 will have the same relative positions in the region of the target electrode, including the luminescent screen 16, as they would have in the absence of the described electromagnetic lens systems for effecting beam convergence.

In accordance with another feature of the present invention, the convergence magnetic lens systems 28 and 31 are energized by waves derived directly from the beam deflection apparatus. To achieve this result, the primary windings 34 and 35 respectively of transformers 36 and 37 are connected in series with the respective horizontal and vertical deflection windings 22—23 and 24—25 of the deflection yoke 21. Full wave rectification of these substantially sawtooth yoke currents is effected by means including double diodes 38 and 39 connected respectively to the secondary windings 40 and 41 of the transformers 36 and 37.

The output of the horizontal deflection frequency rectifier including the double diode 38 is impressed upon the terminals of the horizontal convergence magnetic lens system 28. Similarly, the output of the vertical deflection frequency rectifier, including the double diode 39, is impressed upon the terminals of the vertical convergence magnetic lens system 31. Each of these convergence magnetic lens systems is shunted by suitable wave shaping circuits and amplitude controlling apparatus. In the case of the horizontal convergence magnetic lens system 28, the coils 29 and 30 are shunted by a series arrangement of a variable resistor 42 and a capacitor 43. By means of this apparatus, the desired wave shape which, as described is generally parabolic, may be effected and adjusted as required by means of the variable resistor 42. There also is provided a shunting inductor 44 which also is of a variable character for the purpose of adjusting the amplitude of the dynamic convergence wave at horizontal frequency which is impressed upon the lens system 28.

The vertical convergence magnetic lens system 39 also is provided with similar apparatus including a variable resistor 45 and a series connected capacitor 46 connected in shunt with the coils 32 and 33 for wave shaping purposes. Also, a variable inductor 47 is shunt connected for the purpose of controlling the amplitude of the vertical dynamic convergence wave.

The apparatus in accordance with the present invention also includes facilities for effecting the initial or static convergence of the electron beam components 18, 19 and 20 at a predetermined point in the raster, such as

the center thereof. This beam convergence is effected by providing suitable connections of a pair of terminals 48 to a source of uni-directional energy such as indicated. Potentiometers 49 and 50 associated with the horizontal convergence magnetic lens system 28 and potentiometers 51 and 52 associated with the vertical convergence magnetic lens system 31 are connected in series to the D. C. source terminals 48. The potentiometers 49 and 50 are used to adjust the static energization of the horizontal magnetic lens system 28 for effecting initial convergence of the electron beam components. In a like manner, the potentiometers 51 and 52 are employed to effect the desired static energization of the vertical convergence magnetic lens system 31. A capacitor 53 connected between the potentiometers 49 and 50 effectively by-passes dynamic energy at the horizontal deflection frequency. Similarly, a capacitor 54 connected between the potentiometers 51 and 52 serves to by-pass vertical deflection frequency components around these potentiometers.

It may be seen from the foregoing description of an illustrative embodiment of the invention that there is provided relatively simple apparatus by means of which to effect both static and dynamic convergence of a plurality of electron beam components which traverse predeflection paths that are spaced about the longitudinal axis of the tube substantially in the plane of a target electrode. Furthermore, the apparatus in accordance with the invention is energized in a unique manner by rectifying the substantially sawtooth deflection currents for impression upon the magnetic beam convergence apparatus. By this means, it is not necessary to develop waves of the desired shape at a relatively low level and to amplify such low level signals suitably for excitation of the magnetic lens apparatus. The amplification of waves of such complex form is not as simple as the high level rectification of the deflection waves in accordance with the present invention.

Having set out the character of the invention in the foregoing description, its scope is defined in the appended claims.

What is claimed is:

1. In a cathode ray tube image-reproducing system wherein, a plurality of electron beam components, which traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube, are angularly deflected by electromagnetic apparatus both horizontally and vertically to scan a raster at a target electrode, an electron beam convergence system comprising, a double magnetic lens system energizable to produce axial fields of similar magnitude but of opposite polarity for traversal by said beam components, rectifier means coupled to said beam deflection apparatus to produce a convergence control wave, and means coupling said rectifier means and said lens system to energize said lens system by said convergence control wave.

2. In a cathode ray tube image-reproducing system wherein, a plurality of electron beam components, which traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube are angularly deflected by electromagnetic apparatus both horizontally and vertically to scan a raster at a target electrode, an electron beam convergence system comprising, a double electromagnetic lens system energizable to produce axial fields of similar magnitude but of opposite polarity for traversal by said beam components, rectifier means including a transformer having a winding coupled to said beam deflection apparatus for traversal by sawtooth wave current at one of said deflection frequencies to produce a convergence control wave at said one deflection frequency, and means coupling said rectifier means and said lens system to energize said lens system by said convergence control wave.

3. In a cathode ray tube image-reproducing system wherein, a plurality of electron beam components, which

traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube, are angularly deflected by electromagnetic apparatus both horizontally and vertically to scan a raster at a target electrode, an electron beam convergence system comprising, two double magnetic lens systems, each separately energizable to produce respective pairs of axial fields for traversal by said beam components, the fields of each of said pairs of axial fields being of similar magnitude but of opposite polarity, horizontal and vertical frequency rectifier means coupled respectively to said horizontal and vertical deflection apparatus to produce horizontal and vertical frequency convergence control waves, and means coupling said horizontal and vertical rectifier means respectively to said two double magnetic lens systems to energize said lens systems by said respective convergence control waves.

4. In a cathode ray tube image-reproducing system wherein, a plurality of electron beam components, which traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube, are angularly deflected by electromagnetic apparatus both horizontally and vertically to scan a raster at a target electrode, an electron beam convergence system comprising, a beam deflection yoke having horizontal and vertical windings, means including respective sources of sawtooth waves at horizontal and vertical deflection frequencies coupled to said yoke for energizing said respective horizontal and vertical windings, a double magnetic lens system energizable to produce axial fields of similar magnitude but of opposite polarity for traversal by said beam components, rectifier means coupled to one of said deflection yoke windings to produce a convergence control wave, and means coupling said rectifier means and said lens system to energize said lens system by said convergence control wave.

5. An electron beam convergence system as defined in claim 4 wherein, said rectifier means includes a transformer having a winding connected in series with one of said deflection yoke windings.

6. In a cathode ray tube image-reproducing system wherein, a plurality of electron beam components, which traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube, are angularly deflected by electromagnetic apparatus both horizontally and vertically to scan a raster at a target electrode, an electron beam convergence system comprising, an electron beam deflection yoke having horizontal and vertical windings, means including source of sawtooth waves respectively having horizontal and vertical deflection frequencies coupled to said yoke windings for energizing said yoke, two double magnetic lens system each separately energizable to produce respective pairs of axial fields for traversal by said beam components, the fields of each of said pairs of axial fields being of similar magnitude but of opposite polarity, two rectifier means coupled respectively to said horizontal and vertical yoke windings to produce respective convergence control waves at horizontal and vertical deflection frequencies, and means coupling said respective rectifier means and said two double magnetic lens systems to separately energize said two lens systems by said respective convergence control waves at horizontal and vertical deflection frequencies.

7. An electron beam convergence system as defined in claim 6 wherein, each of said last-named coupling means includes a resistive-capacitive wave-shaping network.

8. An electron beam convergence system as defined in claim 6 wherein, each of said last-named coupling means includes a variable amplitude determining inductor.

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