

July 27, 1954

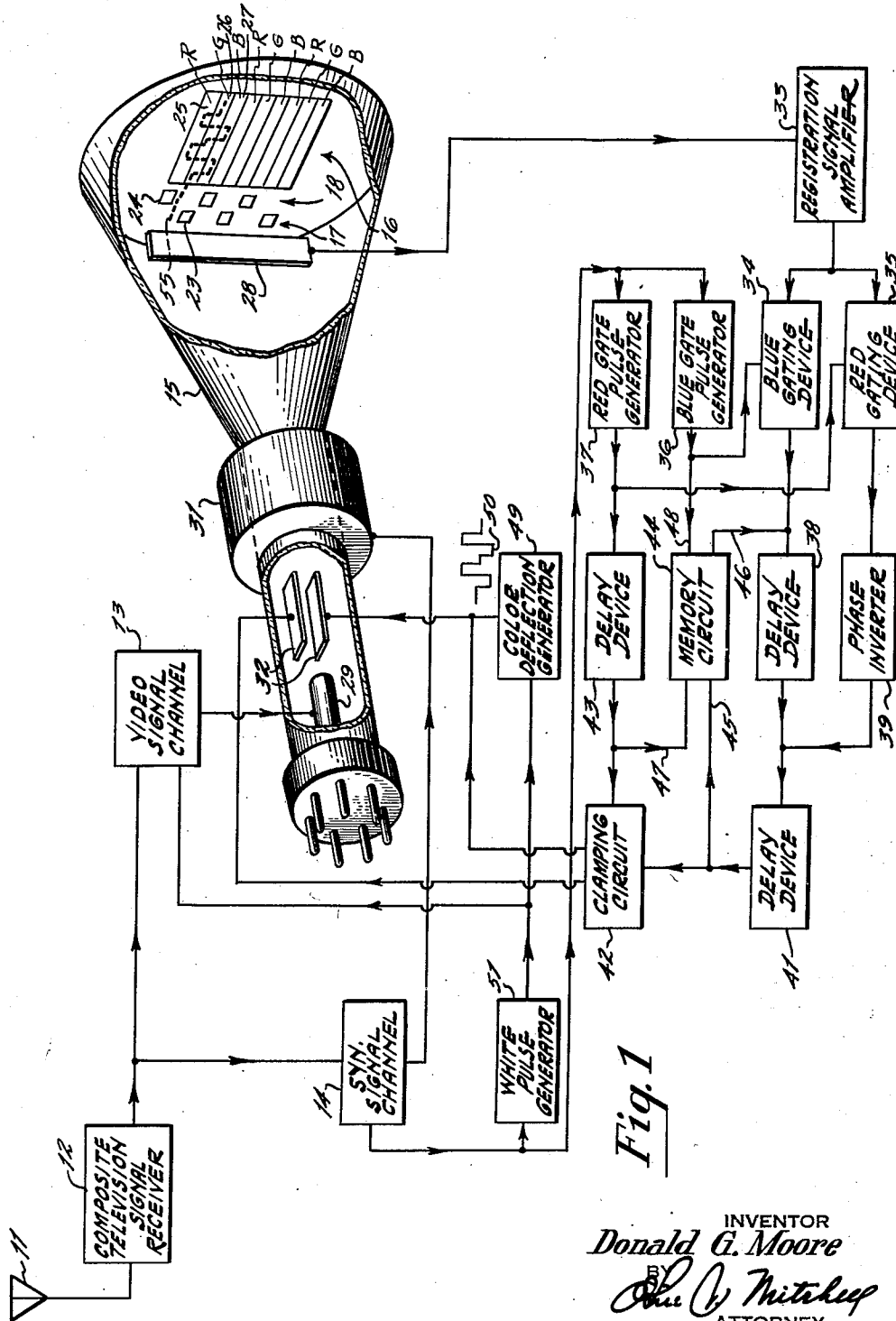
D. G. MOORE

2,685,047

COLOR TELEVISION ELECTRON BEAM DEFLECTION CONTROL SYSTEM

Filed Feb. 25, 1950

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

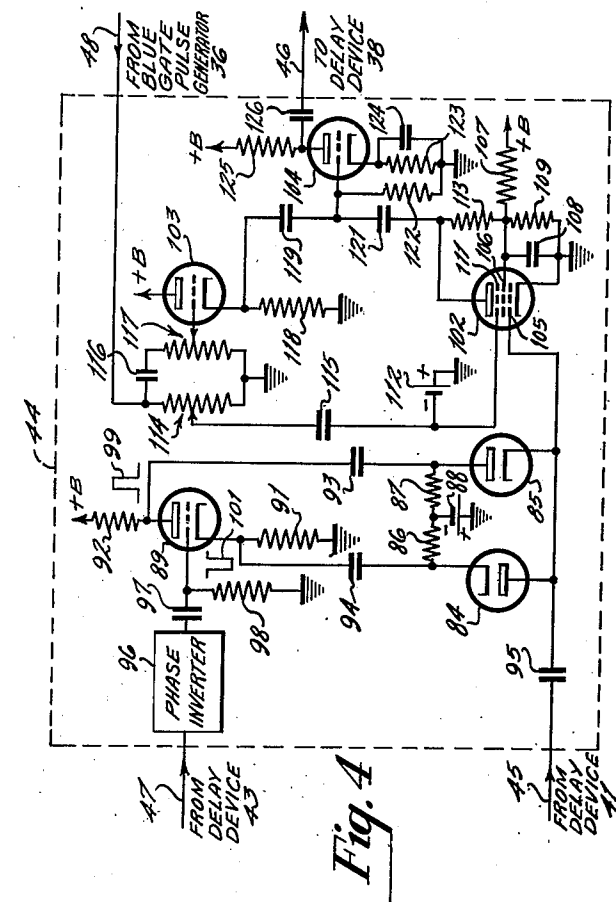


Fig. 2

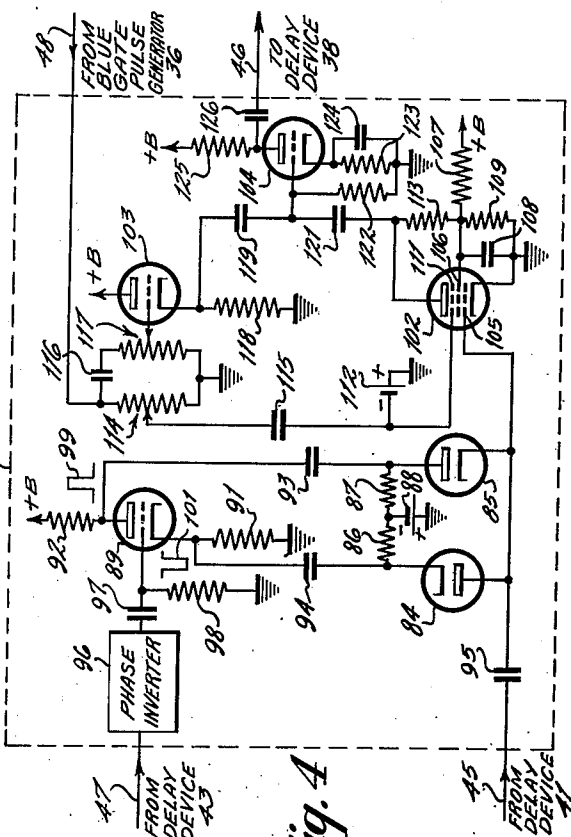


Fig. 3

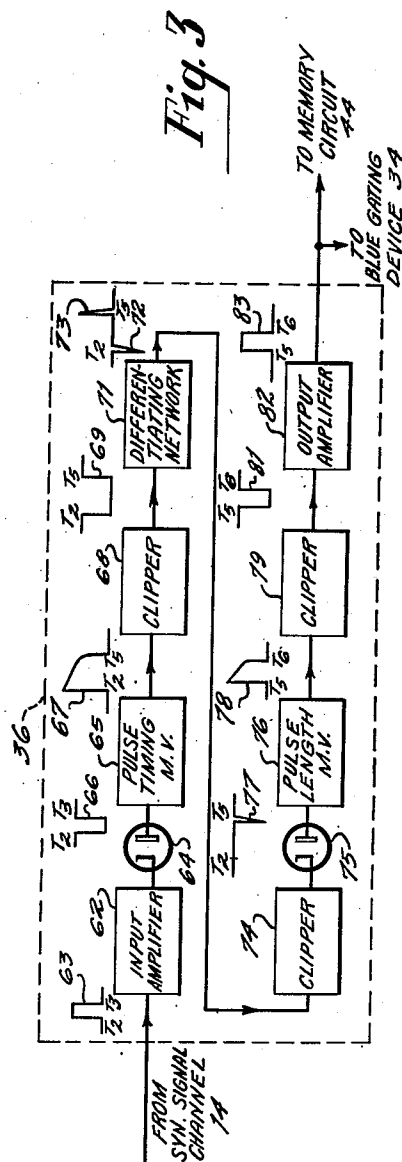


Fig. 4

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2,685,047

COLOR TELEVISION ELECTRON BEAM
DEFLECTION CONTROL SYSTEMDonald G. Moore, Princeton, N. J., assignor to
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Application February 25, 1950, Serial No. 146,230

14 Claims. (Cl. 315—12)

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This invention relates generally to color television systems of the type using a single color kinescope for the production of images substantially in their natural colors. The invention relates particularly to improvements for effecting registration of an electron scanning beam and the individual phosphor areas of a color kinescope of the type referred to.

Color television images may be reproduced by a kinescope having discrete phosphor areas capable respectively of producing light of the different component image colors. One type of tube with which the present invention is particularly adapted for use forms the subject matter of a copending application of Donald S. Bond, Serial No. 146,282, filed February 25, 1950 and entitled "Electron Beam Tubes." This tube is provided with a screen having separate light-producing and signal-generating regions. The light-producing region consists of a plurality of phosphor lines or strips capable respectively of emitting light of the different component image colors. The phosphor strips are arranged in groups which, in a three-color television system, comprise three strips. Where the image is to be reproduced in red, green and blue colors, for example, each group of phosphor strips includes strips capable respectively of emitting red, green and blue light. In the Bond tube the phosphor strips are arranged horizontally and substantially parallel with one another. The phosphor strips of each of the successive horizontally-arranged groups of strips are selectively excited by an electron beam.

In order to selectively excite the phosphor strips for the production of the desired colors, it is necessary that substantially precise registration be effected between the electron beam and the phosphor strips. One manner in which the necessary registration of the beam and the phosphor strips may be effected forms part of the subject matter of a copending application of Donald S. Bond and Donald G. Moore, Serial No. 146,283, filed February 25, 1950, now Patent No. 2,634,325 granted April 7, 1953 and entitled "Electron Beam-Controlling Systems."

It is an object of the present invention to effect registration between an electron exciting beam and successive groups of phosphor strips in a kinescope of the type described in an improved and more efficient manner.

Another object of the invention is to effect registration between an electron scanning beam and successive groups of color phosphor strips by correcting the position of the beam only to the degree necessary to compensate for changes between the scanning of successive horizontal

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lines of the image-producing region of the luminescent kinescope screen.

In accordance with this invention, signals representative of any misregistration between the electron beam and a group of color phosphor lines are generated in a marginal region adjacent to the luminescent screen. The signals are used to develop a correcting signal for impression upon an auxiliary electron beam-deflecting system. The auxiliary deflecting system functions to correctly position the beam in precise register with the group of phosphor strips prior to its deflection over the strips. Inasmuch as the signals derived from the signal-generating region of the kinescope screen are of relatively short time duration, the developed correcting signal is impressed upon the auxiliary deflecting apparatus through a clamping circuit which functions to maintain the necessary beam deflection correction for the duration of the traversal time of the beam over the color phosphor strips. The correcting information is effectively stored in the clamping circuit so that, during the next traversal of the signal-generating region of the kinescope screen, the generated registration signals represent only incremental misregistration of the beam with the succeeding group of phosphor strips. The stored correcting information is impressed upon a memory circuit so that it may be combined with the incremental misregistration information to produce a new correcting signal for impression upon the auxiliary deflecting apparatus. By means of such an arrangement, the new correcting information differs from the old by an amount equal to the incremental misregistration information derived from the signal-generating region of the kinescope screen.

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 taken in connection with the accompanying drawings.

In the drawings,

Figure 1 is a block circuit diagram of a color television signal-receiving and image-reproducing system embodying the registration apparatus of the present invention;

Figure 2 is a series of curves illustrating the time relationship of the operation of different parts of the improved registration system;

Figure 3 is a block circuit diagram showing the essential components of any one of the pulse generators employed in the improved registration system; and,

Figure 4 is a schematic circuit diagram of a representative memory circuit used in the improved registration system.

Referring first to Figure 1 of the drawings, color television signals are intercepted by an antenna 11 which is coupled to a composite television signal receiver 12 for the impression of the intercepted signals thereon. It will be understood that the receiver 12 may include such conventional apparatus as a radio frequency amplifier, a frequency converter, an intermediate frequency amplifier and a second or signal detector. A composite television signal is derived from the receiver 12 consisting of a video signal component and the horizontal and vertical synchronizing signal component.

The video signal component of the composite television signal is impressed upon a video signal channel 13. The synchronizing signal component of the composite television signal is impressed upon a synchronizing signal channel 14. It will be understood that the video and synchronizing signal channels may be conventional. Accordingly, the video signal channel may include one or more stages of video signal amplification and direct current re-insertion circuits to intensity modulate an electron scanning beam. Similarly, the synchronizing signal channel may include deflection voltage generators for control by the synchronizing signals to energize the beam deflection apparatus.

The image-reproducing system also includes a color kinescope 15, preferably of the type covered by the copending Bond application referred to. It is provided with a target screen comprising a luminescent, light-producing region 16 and a registration signal-generating region located in a vertical marginal area. The signal-generating region of the screen comprises two vertical groups or columns 17 and 18 of secondary electron emissive targets such as 23 and 24. The luminescent screen 16 is formed of a multiplicity of substantially horizontal, parallel phosphor strips arranged in groups of three, for a three-color television system, for reproducing an image in red, green and blue color components. One group of such phosphor strips consists of red, green and blue strips 25, 26 and 27 respectively. The signal-generating targets of the group 18 including the target 24 are aligned with the red phosphor strips such as 25. Similarly, the signal-generating targets of the group 17 such as the target 23 are aligned with the blue phosphor strips such as 27. The kinescope also is provided with a secondary electron collector 28 located adjacent to the signal-generating target region.

The kinescope further is provided with a conventional electron gun 29 by which to develop an electron beam for impingement of the target screen. An electromagnetic deflection system including a yoke 31 is provided to deflect the electron beam over the target screen to form the usual television raster. In addition, the kinescope is provided with a pair of auxiliary deflecting plates 32 which, when energized, effect relatively small vertical deflections of the electron beam.

The secondary electron collector 28 is coupled to a registration signal amplifier 33 for the impression thereon of signal effects produced by the secondary electron emission from the registration signal-generating targets such as 23 and 24. It will be observed that, by reason of the fact that the target groups 17 and 18 are located

in two vertical columns, the secondary electron emission from the blue targets such as 23 will precede in time the secondary electron emission from the red targets such as 24. Accordingly, the signal effects derived from the collector 28 consist of time-spaced pulses representing the secondary electron emission from the respective columns of targets.

Such a signal wave is amplified by the registration signal amplifier 33 and impressed concurrently upon blue and red gating devices 34 and 35, respectively. Both of these devices normally are inoperative so that there is no transfer of energy to their respective output circuits. In order to selectively render the gating devices 34 and 35 operative, there are provided blue and red gating pulse generators 36 and 37, respectively. The pulses produced by these devices are generated under the control of the horizontal synchronizing signals derived from the synchronizing signal channel 14. The blue and red gating pulses derived respectively from the generators 36 and 37 are impressed upon the blue and red gating devices 34 and 35, respectively, to control the gating of the registration signals.

The blue gating device is coupled to a delay device 38 which functions to delay the blue gated registration signal pulses sufficiently to effect coincidence thereof with the red gated registration signal pulses. The red gating device 35 is coupled to a phase inverter 39 which serves to reverse the polarity of the red gated registration signal pulses relative to the blue gated registration signal pulses. The output circuits of the delay device 38 and the phase inverter 39 are connected as shown so as to combine the delayed blue pulse with the phase inverted red pulse. In this manner, there is produced a correcting signal having polarity and magnitude representative of the sense and magnitude of the deviation of the electron beam from precise registration with the group of phosphor strips of the kinescope luminescent screen 16.

The delay device 38 and the phase inverter 39 are coupled to an oscillation preventing delay device 41 which, in turn, is coupled to a clamping circuit 42 for the impression upon this circuit of the correcting signal. The operation of the clamping circuit is controlled by a clamping pulse received from a delay device 43 connected between the red gating pulse generator and the clamping circuit as shown. Thus, the signal and clamping pulse are applied concurrently to the clamping circuit. A low impedance clamping circuit enables the omission of both delay devices. The output of the clamping circuit is coupled to the auxiliary deflecting plates 32 for the impression thereon of a voltage having a polarity and magnitude sufficient to effect the desired correction of the electron beam position relative to the group of phosphor screen strips.

To operate the system continuously for successive horizontal groups of phosphor strips, a memory circuit 44 is provided. The correcting signal information which it is desired to store in the memory circuit between successive horizontal lines of the image is derived from the delay device 41 as shown by a connection 45. The correcting signal is released from the memory circuit later and combined with additional information derived from the blue gating device 34 by means of a connection 46. The storing and releasing operations of the memory circuit are controlled by a pulse impressed thereon by a connection 47 to the delay device 43 and by an-

other pulse impressed thereon by a connection 48 to the blue gating pulse generator 36.

There also is provided a color deflection generator 49, the output of which is coupled to the deflecting plates 32. The function of this generator is to develop a stair-step voltage wave 53 having three different amplitude levels so as to effect a corresponding deflection of the electron beam for color-selecting purposes.

A so-called white pulse generator 51, operating under the control of horizontal synchronizing pulses derived from the synchronizing signal channel 14, produces pulses which are impressed upon the video signal channel 13 and upon the color deflection generator 49. The impulses derived from the generator 51, when impressed upon the video signal channel 13, serve to control the intensity of the electron beam developed by the gun 29 in a manner to produce maximum intensity thereof during the time that the beam is traversing the marginal signal-generating target region of the kinescope screen. Also, during this time the impression of these pulses upon the color deflection generator 49 serves to render it inoperative so that there is no corresponding deflection of the electron beam during its time of traversal of the signal-generating screen region.

In view of the foregoing description of the image reproducing system embodying the present invention, its operation may be completely understood with the following additional explanation. This portion of the description will be given with additional reference to the curves of Figure 2. These curves represent the timing of the apparatus during the period in which the electron beam traverses the signal-generating screen region including the two columns of target electrodes 17 and 18. It will be understood that this traversal occurs during the later stages of the horizontal blanking periods. In Figure 2 the curve 52 represents the horizontal blanking period. The curve 53 represents a horizontal synchronizing pulse. The curve 54 represents a white pulse under the control of which the intensity of the electron beam is increased to maximum or other predetermined value. Consequently, the electron beam, in traversing a representative horizontal line of the kinescope screen, is indicated by the dashed line 55 of Figure 1. It will be assumed that, in traversing the signal-generating region, the beam is out of register with the green phosphor strip 26 in the direction of the red phosphor strip 25. Consequently, in traversing the signal-generating region, there will be emitted a greater number of secondary electrons from the red target 24 than from the blue target 23. The registration signal wave derived from the collector 23 is represented by the curve 56 of Figure 2. It will be seen that the amplitude indicated at 57 is somewhat less than the amplitude indicated at 58. These signals correspond respectively to the secondary electron emission from the blue and red targets 23 and 24.

It is this type of registration signal wave 56 which is impressed upon the blue and red gating devices 34 and 35, respectively, by the registration signal amplifier 33. In Figure 2, the curve 59 represents the time of occurrence of one of the blue gating pulses by which to effect operation of the blue gating device 34. It may be seen that these events coincide with the occurrence of the blue registration signal 57. Likewise, the curve 61 represents a red gating pulse to render the red gating device 35 operative in coincidence

with the occurrence of the red registration signal 58.

After delaying the blue registration signal and inverting the phase of the red registration signal, there is produced by their combination a correcting signal for impression upon the deflecting plates 32. The polarity of this signal, as impressed upon the deflecting plates, is of a character to effect a downward deflection of the electron beam. The magnitude of the correcting signal voltage impressed upon the plates 32 is suitable to control the amount of downward deflection so that the beam is brought into register with the green phosphor strip 26.

It will be appreciated that the present invention may be used advantageously in field and line sequential color television systems. Additionally, the operation of the type of tube diagrammatically illustrated herein and forming the subject matter of the copending Bond application referred to may be used to particular advantage in a color television system operating according to the dot or elemental multiplex principle. In a television system of this latter character, the color information of each elemental area of the image is represented by successive instantaneous amplitudes of a video signal wave. Accordingly, when such a video signal wave is used to control the intensity of an electron beam, a tube of the character described may be operated so that each of the component colors of the different elemental areas of each horizontal line of the image is produced during a single horizontal deflection of the electron beam. In the present system, the entire video signal wave may be used to control the electron beam intensity. Alternatively, if desired, the wave may be sampled to derive only the successive instantaneous amplitudes thereof. In this case, the signal samples are used to modulate the beam intensity.

A system operating in accordance with the elemental multiplex principle is covered in a copending application of John Evans, Serial No. 111,384, filed August 20, 1949 and titled "Color Television." Accordingly, it will be understood that the video signal channel 13 may include suitable sampling apparatus to derive from such a video signal wave the necessary color information to operate a tube of the type described. One such sampling system is disclosed in the copending Evans application referred to. Another suitable sampling system forms the subject matter of a copending application of George C. Sziklai, Serial No. 145,420, filed February 21, 1950 and titled "Color Television Receiving Systems."

It will be understood, therefore, that while the electron beam is being deflected to form one horizontal line of the image, it is modulated in intensity at successive instants in accordance with the different color components of the elemental areas of the image line. The intensity modulation of the electron beam is used to excite the appropriate phosphor strips under the control of a color-selecting deflection produced by the deflecting plates 32. A stair-step wave 50 derived from the color deflection generator 49 impresses suitable voltages upon the deflecting plates 32. As indicated by the dashed line in the light-producing region of the luminescent screen 16, the electron beam is deflected vertically to impinge successively upon the different phosphor strips 25, 26 and 27. It will be understood that, during the times that the beam is in register with the red strip 25, its intensity is controlled by a

red representative video signal. A similar relationship exists for the green and blue strips 26 and 27.

During the blanking period between the scan- 5
sion of successive horizontal lines of the screen 16 the electron beam is caused to traverse the signal-generating marginal region including the target groups 17 and 18. During each traversal of the target region the corrective deflection of the beam given to it in the preceding line is 10
effective to control its position during this excursion. Accordingly, by the operation of the clamping circuit 42, in conjunction with the memory circuit 44, there is produced a new correcting voltage for impression upon the plates 32 15
which represents a combination of the old correcting voltage and any incremental correcting voltage necessary to effect the desired precise registration.

Reference now will be made to Figure 3 for a 20
disclosure of one of the gate pulse generators shown diagrammatically in Figure 1. For purposes of illustration, the blue gate pulse generator 36 will be described, it being understood that the red gate pulse and white pulse generators 37 and 51, respectively, may be substantially identical. The blue pulse generator 36 includes an input amplifier 62. This may be an entirely conventional device capable of amplifying pulses such as a horizontal synchronizing pulse 63. The amplifier 62 is coupled by means of an isolation stage which may consist of a diode 64 to the control circuit of a pulse timing multivibrator 65. It will be noted that the pulse 66, derived 35
from the diode 64, is similar to the horizontal synchronizing pulse 63 except that it is of reverse polarity. Also, it will be noted that the pulses 63 and 64 occur between times T_2 and T_3 indicated on the time scale of Figure 2 and corresponding with the time of occurrence of the horizontal synchronizing pulse 53.

The pulse timing multivibrator 65 is a monostable multivibrator which has the characteristic of having one stable and one unstable state. It normally is in its stable state and may be triggered for operation to its unstable state. The time during which it remains in its unstable state is dependent upon its circuit constants. An illustrative form of multivibrator is shown in the book entitled "Time Bases" by Puckle, published in New York by John Wiley and Sons Inc. and in London by Chapman and Hall Ltd. Monostable multivibrators suitable for use in the present apparatus are shown in Figs. 27 and 28 of the reference appearing respectively at pages 50 and 51.

It will be understood that the pulse timing multivibrator 65 is triggered from its normal stable state to its unstable state at time T_2 in response to the pulse 63. Accordingly, there is developed in the output of the multivibrator 65 a pulse having substantially the form shown at 67. It will be noted that the pulse 67 extends from time T_2 to time T_3 . The purpose of the multivibrator 65 is to time the generation of the blue gating pulses with reference to the horizontal synchronizing pulses. In this connection it will be noted that time T_3 is that coinciding with the leading edge of the blue gating pulse 59 of Figure 2.

The pulse 67 is impressed upon a clipper 68 by which it is made substantially rectangular as indicated at 69. The clipper also functions to invert the polarity of the pulse 67.

The pulse 69 is impressed upon a differentiat-

ing network 71 which functions to produce sharp negative and positive pulses 72 and 73, respectively, occurring at times T_2 and T_3 respectively.

The pulses 72 and 73 are impressed upon another clipper 74 which is responsive only to pulses of positive polarity, such as the pulse 73. The output of the clipper 74 is coupled through an isolation stage such as a diode 75 to the control circuit of a pulse length multivibrator 76. It will be noted that there is impressed upon the multivibrator 76 a pulse 77 of negative polarity occurring at time T_3 . The pulse 77 is produced by the operation of the clipper 74 in response to the pulse 73 impressed thereon.

The pulse length multivibrator 78 preferably is a monostable multivibrator of substantially the same type as the multivibrator 65. The function of the multivibrator 78 is to control the length or time duration of the blue gating pulse. Accordingly, its circuit constants are adjusted to produce a pulse 79 extending from times T_3 to T_4 . This, it will be observed, corresponds to the width or time duration of the blue gating pulse 59 of Figure 2.

The pulse 79 is impressed upon another clipper 79 by which an inverted and clipped pulse 81 is produced. This pulse is amplified and inverted in polarity by an output amplifier 82, to produce a pulse 83. This pulse may be seen to correspond to the blue gating pulse 59 of Figure 2.

In view of the foregoing description of the blue gating pulse generator 36, it will not be necessary to describe the red and white pulse generators 37 and 51, respectively. Each of these generators will be understood to include pulse timing and pulse length multivibrators of the monostable type. The respective pulse timing multivibrators have circuit constants suitable to control the time of occurrence of the leading edges of the pulses to be developed with reference to the horizontal synchronizing pulses. Similarly, the pulse length multivibrators are provided with circuit constants suitable to control the length or time durations of the generated pulses.

The circuit details of the memory circuit 44 of Figure 1 are illustrated in Figure 4 of the drawings. In general, the memory circuit consists of two major components. One is a clamping circuit by which to store the correcting signal information from one horizontal image line to another. The other main component of the memory circuit is a gating device by which to transfer the stored correcting signal information to the delay device 38 of Figure 1 for combination with the incremental correcting signal information newly derived from the blue gating device 34.

The clamping circuit preferably is of a type similar to that used for the clamping circuit 42 of Figure 1 which is covered by Patent 2,299,945, granted October 27, 1942 to K. R. Wendt and titled "Direct Current Reinserting Circuit." The memory circuit clamping apparatus is a low voltage device relative to the high voltage clamping circuit 42. It comprises two diodes 84 and 85 having the cathode of the former coupled to the anode of the latter through two equal resistors 86 and 87. The other diode electrodes are directly connected together as shown. The junction point of resistors 86 and 87 is connected to ground through a source of negative biasing voltage represented by a battery 88. The clamping circuit also is provided with a keying tube 89. The cathode of the tube 89 is connected to ground

through a load resistor 91. The anode of the tube 89 is connected to a source of space current, indicated at +B, through a second load resistor 92. Preferably, the resistors 91 and 92 are equal in value. The anode of the keying tube 89 is coupled to the anode of the diode 85 by a capacitor 93. Similarly, the cathode of the tube 89 is coupled by a capacitor 94 to the cathode of the diode 84.

The clamping circuit described is provided with the correcting signal information which it is desired to retain by a coupling including a capacitor 95 to the delay device 41 of Figure 1. The clamping circuit is operatively controlled by a signal derived from the delay device 43 of Figure 1. The control signal is impressed upon the clamping circuit through a phase inverter 96 by which the pulse of positive polarity derived from the delay device 43 is converted to a pulse of negative polarity. This pulse is impressed upon the control grid of the keying tube 89 by a capacitor 97 for which there is provided a leak resistor 98.

Normally the keying tube 89 is in a conducting state. In response to the impression of a negative control impulse upon the grid thereof, it is biased to a point beyond cut off. Accordingly, there is developed, at the anode of the keying tube, a positive pulse 99 which is impressed by the capacitor 93 upon the anode of the diode 85. Similarly, a negative pulse 101, derived from the cathode of the keying tube, is impressed upon the cathode of the diode 84. By this means the diodes 84 and 85 are rendered conducting to alter the charge on the capacitor 95 in accordance with the correcting signal information derived from the delay device 41. Following the occurrence of the pulses 99 and 101, the diodes 84 and 85 are rendered non-conducting, thereby storing the correcting signal information derived from the delay device 41 in the capacitor 95.

The memory circuit of Figure 4 also includes apparatus for transferring the correcting signal information stored in the capacitor 95 to the delay device 38 of Figure 1. This apparatus generally may be characterized as a gating device. It consists of a gating electron tube 102, a polarizing electron tube 103, and a pulse-combining electron tube 104.

The gating tube 102 preferably is a multi-grid tube and for one particular system which has been successfully operated it is a pentode. The control, or number one, grid 105 of the gating tube is connected directly to the storage capacitor 95 of the clamping circuit. The screen, or number two, grid 106 of the gating tube is connected to a source of positive potential indicated at +B through a resistor 107. The screen grid 106 also is by-passed to ground by a capacitor 108 which is shunted by a resistor 109. The suppressor, or number three, grid 111 of the gating tube has impressed thereon a negative potential derived from a suitable source such as indicated by the battery 112. The cathode of the gating tube 102 is grounded and the anode is connected to the positive terminal of a source of space current, indicated at +B, through resistors 107 and 113.

Normally, by reason of the impression of the negative potential upon the suppressor grid 111, the gating tube 102 is biased beyond cut-off so that it is non-conductive, irrespective of the stored signal energy impressed upon the control grid 105 thereof. The gating tube is rendered conductive periodically by means of pulses de-

derived from the blue gate pulse generator 36 of Figure 1. As indicated in Figure 4, the conductor 48, extending from the pulse generator 36, is terminated by the grounded resistive element of a potentiometer 114. The movable contact element of the potentiometer 114 is coupled by a capacitor 115 to the suppressor grid 111 of the gating tube 102.

The potentiometer 114 also is shunted by a series connection of a capacitor 116 and the resistive element of another potentiometer 117. The movable contact element of the potentiometer 117 is directly connected to the control grid of the polarizing tube 103. The anode of this tube preferably is directly connected to the positive terminal of a source of space current indicated at +B. The cathode of the polarizing tube is connected to ground through a load resistor 118.

The cathode of the polarizing tube 103 and the anode of the gating tube 102 are coupled by capacitors 119 and 121, respectively, to the control grid of the pulse-combining tube 104. A leak resistor 122 is provided for the coupling capacitors 119 and 121. The cathode of the pulse-combining tube is connected to ground by a self-biasing network including a resistor 123 and a by-pass capacitor 124. The anode of the pulse-combining tube is connected to the positive terminal of a source of space current indicated at +B through a load resistor 125. The anode of the pulse-combining tube 104 also is coupled by a capacitor 126 to the delay device 38 by way of conductor 46.

In describing the operation of the memory circuit of Figure 4, it will be understood that the keyed clamping circuit, including diodes 84 and 85, functions in the manner described to store in the capacitor 95 correcting signal information of either positive or negative polarity relative to ground. In view of the described negative biasing of the suppressor grid 111 of the gating tube 102, no current is conducted in this tube until one of the blue gate pulses such as 59 of Figure 2 occurs. The impression of a blue gate pulse in positive polarity upon the suppressor grid 111 of the gating tube overcomes the negative biasing of this electrode to render the tube conducting. The degree to which the tube is rendered conducting, neglecting for the moment the effect of the control grid 105, is determined by the setting of the potentiometer 114. This adjustment should be made so that there is developed at the anode of the gating tube 102 a pedestal pulse having an amplitude of a value between the extremes of non-conduction and maximum or saturated conduction in the tube. Accordingly, when additionally considering the concomitant effect of the correcting signal energy stored in the capacitor 95 upon the conductivity of the gating tube 102, it will be seen that its conduction of space current is either greater or less than the pedestal pulse value depending upon whether the stored correcting signal energy impressed upon the control grid 105 is of positive or negative polarity relative to ground. Thus, it is seen that it is possible to identify the polarity of the stored correcting signal energy in the anode circuit of the gating tube 102 on the basis of the amplitudes of the pulses developed therein with respect to the described pedestal pulse.

The blue gate pulse derived from the generator 36 also is impressed in positive polarity upon the control grid of the polarizing tube 103. Accordingly, it will be seen that there is developed at

the cathode of this tube a pulse having a polarity relative to ground which is opposite to the polarity of the pedestal pulse developed at the anode of the gating tube 192. By proper adjustment of the potentiometer 117, the pulse developed at the cathode of the polarizing tube 103 may be made to neutralize or completely cancel out the pedestal pulse.

Hence, it may be seen that there is impressed upon the control grid of the pulse-combining tube 104 pulses of either positive or negative polarity relative to ground in accordance with the polarity of the correcting signal energy stored in the capacitor 95 of the clamping circuit component of the memory circuit 44. Accordingly, by coupling the output circuit of the pulse-combining tube 104 to the delay device 38 of Figure 1 in the manner described, there is impressed upon this delay device a pulse representing the correcting signal for the preceding line of the kinescope screen scanned by the electron beam. It also will be noted that this information is transferred to the delay device 38 concurrently with the additional transfer to this device of the blue registration signal derived from the blue gating device 34 of Figure 1 and representing any incremental correcting signal indicative of any additional deviation of the electron beam, in traversing the signal-generating target area of the screen, from precise registration with the next succeeding group of phosphor strips to be scanned. It will be appreciated that the described impression of the correcting signal information upon the delay device 38 of Figure 1 concurrently from the memory circuit 44 and from the blue gating device 34 is achieved by operating both the memory circuit and the blue gating device by the same blue gating pulse derived from the generator 36.

The new correcting signal produced in the manner described is impressed upon the delay device 41 of Figure 1 and subsequently upon the clamping circuit 42. Substantially concurrently with the impression of the new correcting signal information upon the clamping circuit 42 a clamping pulse derived from the red gating pulse generator 37 through the delay device 43 is impressed upon the clamping circuit 42 to store the new correcting signal energy therein. At the same time this clamping pulse is impressed by conductor 47 upon the memory circuit 44 to store the new correcting signal information in the clamping circuit thereof. In this manner the new correcting signal information is available for transfer in the manner described for the production of a correcting signal for the following line of the image to be reproduced.

It will be seen that the present invention provides a system by which to control the deflection of an electron beam so that it may be brought into precise register with the light-producing strips of a kinescope of the type disclosed in the copending Bond application referred to. Inasmuch as the beam deflection control system embodies a memory circuit by which the correcting signal information of one beam deflection over the kinescope screen may be used to contribute to the development of a correcting signal for a succeeding beam deflection, it is necessary only to develop registration signals representative of any required additional line-to-line corrective deflection of the beam. Such an arrangement provides an improved control system which is capable of operating in a highly efficient manner.

It is advantageous in a color television receiver,

particularly of the type described, insuring better color-selection. Obviously the system may be used beneficially to control beam deflection in camera tubes, such as the well known iconoscope, orthicon and image-orthicon, for example. By such use more accurate video signals may be generated. It will be apparent that the deflection control system of this invention may be used to advantage also in black and white television systems; in fact, whenever it is necessary to maintain accurate registration of an electron beam and a target electrode scanned thereby.

The inclusion of a memory circuit in a control system of this character enables accurate control of raster size and position on the kinescope screen. This beneficial result is produced by requiring a correction between successive lines which is representative only of the line-to-line deviation of the scanning deflection system, which ordinarily is small.

Furthermore, in accordance with one of the features of this invention, there is provided a memory circuit of a type capable for transferring from an input circuit to an output circuit signal effects of either positive or negative polarity. Additionally, as one of the components of the memory circuit, an improved type of gating device is provided. By reason of the described biasing and operative control of a multi-grid electron tube, it is seen that signals may be produced in the output circuit of the tube of different amplitudes representative respectively not only of the amplitudes of the signals impressed upon the input circuit of the tube, but also of the polarity of the input signals. Thus, by the additional use of a means for combining neutralizing signals with such output signals, there may be derived signals of either polarity corresponding to the polarity of the input signals.

The nature of the invention may be ascertained from the foregoing disclosure of an illustrative embodiment thereof. The scope of the invention is set forth in the appended claims.

What is claimed is:

1. An electron beam deflection control system for a color television receiver embodying a kinescope having a luminescent screen including a multiplicity of groups of substantially horizontal strips of material capable respectively of producing light of the different component colors of an image to be reproduced in response to excitation by an electron beam deflected over said screen, said kinescope also having electrode structure adjacent to one edge of said screen to generate registration signals responsive to traversal thereof by said beam and representative of the orientation of said beam with successive groups of said screen strips, said control system comprising, beam-deflecting means adjacent to said electron beam path and energizable to effect registration of said beam with successive groups of said screen strips, means for developing correcting signals from said registration signals, means for energizing said beam-deflecting means by said correcting signals, means for storing said correcting signals respectively during successive horizontal deflections of said beam over said screen, and means to combine said stored correcting signal for each horizontal beam deflection to develop a correcting signal for said next horizontal beam deflection.

2. An electron beam deflection control system as defined in claim 1, wherein said beam-deflecting energizing means includes a clamping circuit.

3. An electron deflection control system as de-

lined in claim 2, including additionally means for keying said clamping circuit subsequently to the generation of said registration signals.

4. An electron beam deflection control system as defined in claim 1, wherein said correcting signal-storing means includes a clamping circuit.

5. An electron beam deflection control system as defined in claim 4, including additionally a gating device coupled to said clamping circuit and operative to transfer said stored correcting signals to said correcting signal developing means.

6. An electron beam deflection control system as defined in claim 5, including additionally means for operating said gating device concurrently with the generation of said registration signals, and means for keying said clamping device subsequently to the generation of said registration signals.

7. An electron beam deflection control system for use in a color television system embodying a kinescope having a luminescent screen including a multiplicity of groups of substantially horizontal strips of material capable respectively of producing light of the different component colors of an image to be reproduced in response to excitation of an electron beam deflected over said screen, said kinescope also having electrode structure adjacent to one edge of said screen to develop registration signals responsive to traversal thereof by said beam and representative of the orientation of said beam with successive groups of said screen strips, said control system comprising, a pair of beam deflecting plates in said kinescope energizable to effect registration of said beam with successive groups of said screen strips, means for developing correcting signals from said registration signals, means including a clamping circuit for impressing said correcting signals upon said deflecting plates means including a memory circuit for storing said correcting signals respectively during successive horizontal deflections of said beam over said luminescent screen, a gating device in said memory circuit operative to release said correcting signals stored in said memory circuit, means to periodically operate said gating device immediately preceding the development of said correcting signals, and means to combine said released correcting signals for each horizontal beam deflection with generated registration signals for the next horizontal beam deflection to develop a correcting signal for said next horizontal beam deflection.

8. Apparatus for the selective transfer of signals of either positive or negative polarity from an input circuit to an output circuit, said apparatus comprising, a normally inoperative electron gating tube having an input electrode coupled to said input circuit for the substantially continuous impression thereon of signals of either positive or negative polarity, an output electrode and a control electrode for said gating tube, means including a source of gating pulses coupled to said control electrode to periodically operate said gating tube to develop at said output electrode pulses of greater or less than a predetermined pedestal pulse magnitude depending upon the polarity of the signals impressed upon said input electrode, and means including a source of polarizing pulses having a polarity opposite to that of said pedestal pulses coupled to said output electrode to neutralize said pedestal pulses, thereby to produce for impression upon said output circuit positive and negative pulses corre-

sponding respectively to the positive and negative signals derived from said input circuit.

9. Apparatus of the type defined in claim 8, wherein said gating tube has a plurality of space current control grids, one of which comprises said input electrode and another of which comprises said control electrode.

10. Apparatus of the type defined in claim 8, wherein said gating tube is a pentode, of which the control or number one grid comprises said input electrode and the suppressor or number three grid comprises said control electrode.

11. Apparatus of the type defined in claim 8, wherein said control electrode is negatively biased to normally prevent space current conduction in said gating tube, and said gating pulses are of positive polarity to render said gating tube conducting for the production of said pedestal pulses.

12. Apparatus of the type defined in claim 8, wherein said source of polarizing pulses includes an electron polarizing tube having an input electrode coupled to said source of gating pulses and an output electrode coupled to the output electrode of said gating tube.

13. Apparatus of the type defined in claim 12, wherein said pedestal pulse-neutralizing means includes an electron pulse-combining tube having an input electrode coupled to the output electrodes respectively of said gating tube and said polarizing tube, and one output electrode coupled to said output circuit.

14. Apparatus for the selective transfer of signals of either positive or negative polarity from an input circuit to an output circuit, said apparatus comprising, an electron gating tube having an anode and a plurality of space current control grids, one of said grids being coupled to said input circuit for the substantially continuous impression thereon of signals of either positive or negative polarity, a source of negative biasing voltage coupled to a second one of said grids to render said gating tube normally non-conducting, means coupled to said second grid and including a source of positive gating pulses of a magnitude to render said gating tube conductive to a predetermined degree to develop at said anode a negative pedestal pulse, said tube conductivity being greater or less than said predetermined degree depending upon the polarity of the signals impressed upon said first grid, whereby to develop at said anode negative signal pulses of greater or less magnitude than said pedestal pulses, a polarizing electron tube having a control grid and a cathode, the control grid of said polarizing tube being coupled to said source of positive gating pulses to develop at said cathode positive pedestal-neutralizing pulses equal in magnitude to said negative pedestal pulses, and a pulse-combining electron tube having a control grid coupled to the anode and cathode respectively of said gating and polarizing tubes and an anode coupled to said output circuit for the impression thereon of positive and negative pulses corresponding respectively to the positive and negative signals derived from said input circuit.

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