

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) DYNAMIC CONVERGENCE CIRCUITS

(71) We, RCA CORPORATION, a corporation organized under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates generally to dynamic convergence circuits for a multibeam color kinescope, and particularly to novel and improved vertical rate convergence circuits therefor.

It is customary in color television receivers employing a multibeam kinescope, such as the conventional three-gun, shadow-mask kinescope, to provide dynamic correction of beam misconvergence errors that result in the operation of such devices. The nature of the correction requires energization of beam path control means, e.g. deflection yokes, with waveforms at both line and field rates. A widely accepted approach to the problem utilizes individual electromagnets associated with internal pole pieces confining their effect to individual beams, and with separate windings on each electromagnet for respective vertical and horizontal frequency control.

The present invention is directed to convergence circuitry especially suited to development and control of the current in the vertical convergence windings of the above-mentioned electromagnets. A feature of the present invention is the provision of such vertical rate convergence circuits in a form requiring only a single input voltage source. This is in contrast with many prior art circuits that require multiple input voltage sources. Typical of such prior art circuits is reliance on inputs from several vertical output transformer secondary windings in addition to a waveform derived, for example, from a vertical output tube cathode circuit.

In addition to complicating the coupling structure required between deflection and convergence circuits, the use in much prior art

circuits of secondary winding sources increases the possibility of horizontal interference with vertical deflection circuit operation. The principles of the present invention permit avoidance of the use of output transformer secondary windings as convergence input sources.

It is a practical necessity that the dynamic convergence circuitry of a color television receiver incorporate a set of controls that permit adequate adjustment of the convergence currents to adapt the correction to the particular pattern of misconvergence errors encountered.

In the conventional convergence structure associated with a delta beam arrangement, the beam shifts for red and green are diagonal (involving both vertical and horizontal components of motions) while the beam shift introduced by the blue convergence winding is vertical only. The diagonal axes of red and green beam motion are crossed. As a consequence, similar sense changes in red and green convergence currents introduce opposing horizontal shifts of the red and green beams accompanied by common direction vertical shifts.

Conversely, mutually opposed changes in red and green convergence currents introduce opposing vertical shifts of the red and green beams accompanied by common direction horizontal shifts. By interrelating the red and green convergence winding energizations such that both master and differential control of their currents can be provided, the matching of red and green beam landing points can be separated into convenient horizontal line and vertical line alignments. Convergence adjustment can then be completed by appropriate adjustment of the blue convergence adjustment to complete the horizontal line alignment.

In many of the misconvergence patterns that require correction, the misconvergence at the top of the picture does not match the misconvergence at the bottom of the picture. A practical convergence adjustment arrangement must take this into account by providing some

way to change end-of-scan waveform magnitude relative to beginning-of-scan waveform magnitude. A difficulty common in prior art circuit arrangements is that controls provided to solve this problem by adjusting, for example, the end-of-scan magnitude relative to a beginning-of-scan magnitude (set by another control) tend to disturb the beginning-of-scan magnitude, requiring readjustment of the other control.

A feature of the present invention is the possibility of providing for substantial confinement of the effect of each control to a particular half of the picture, whereby correction of a misconvergence pattern may be rapidly achieved without the complication of time-consuming interplay between controls.

In accordance with an embodiment of the present invention, the red and green vertical convergence windings are effectively paralleled and driven at each end with a respectively different modification of a vertical rate waveform derived from a single voltage source in the receiver's vertical deflection circuit. The drive circuit at one end utilizes an arrangement of diodes and resistors to provide drive only during the end-of-scan half of the vertical trace interval. The circuit output appears across a diode which conducts during the beginning-of-scan interval, minimizing the circuit's effect during that period. A second drive circuit supplies a waveform to the opposite end of the parallel windings. This waveform is effective in controlling winding current during the conduction of the above-mentioned diode (i.e., during the beginning-of-scan half of the trace interval), but has little effect thereon when the diode is open due to the altered impedance of the load. Master and differential controls are associated with each drive circuit, whereby horizontal line alignment and vertical line alignment adjustments may be individually made for top and bottom of the raster.

In further accordance with the invention embodiment, waveforms from each of the red-green drive circuits may be separately and adjustably fed to the blue convergence winding to permit relatively isolated top and bottom blue corrections. An advantageous circuit arrangement permits each of the top and bottom blue controls to alter both the magnitude and polarity of the current waveform.

An object of the present invention is to provide a novel and improved vertical rate dynamic convergence circuit permitting substantially isolated correction of misconvergence errors at raster top and bottom to be provided.

In the accompanying drawing:

FIGURE 1 illustrates schematically a vertical rate convergence circuit for a color television receiver which embodies the principles of the present invention; and

FIGURES 2a, 2b, 2c and 2d comprise a

series of schematic diagrams illustrating a step-by-step development of the FIGURE 1 circuit, and of aid in explaining its operation.

In FIGURE 1, a block 11 represents the vertical deflection circuits of a color television receiver from which is derived an output voltage for use by the convergence circuitry of the invention. This voltage is presented between an output terminal IS and a (grounded) reference terminal G, and, illustratively, is of a partially integrated sawtooth waveshape (see waveform 50 of FIG. 2a).

A first drive circuit coupled between source terminals IS and G includes, in series in the order named: (1) a (relatively large valued) coupling capacitor 13; (2) a shaping network comprising the parallel combination of a fixed resistor 15 and a diode 17; (3) a variable resistor 19; and (4) a diode 21. The diodes 17 and 21 are oppositely poled in the series circuit.

A second drive circuit coupled between source terminals IS and G comprises a C—R differentiating circuit, and includes, in series in the order named: (1) a capacitor 31; (2) a fixed resistor 33; and (3) the resistance element of a variably tapped potentiometer 35.

The vertical convergence windings VR and VG of the respective red and blue convergence magnets (23 and 25) are directly tied at one end to the junction of variable resistor 19 and diode 21 in the first drive circuit. Bridging the opposite ends of the windings VR and VG are, in parallel, the resistance elements of potentiometers 27 and 29. The variable tap of potentiometer 27 is directly connected to the variable tap of the potentiometer 35 in the second drive circuit. A fixed resistor 37 links the variable tap of potentiometer 29 to the junction of capacitor 31 and resistor 33 in the second drive circuit.

The series combination of variable resistor 19 and diode 21 (in the first drive circuit) is shunted by (1) a fixed voltage divider formed by fixed resistor 41 and fixed resistor 43; and (2) an adjustable voltage divider comprising the potentiometer 45. The vertical convergence winding VB of the blue convergence magnet 49 is connected between the variable tap of potentiometer 45 and the junction of voltage divider resistors 41 and 43. Shunting the winding VB is the resistance element of a potentiometer 47, the variable tap of which is returned to the junction of capacitor 31 and resistor 33 in the second drive circuit.

Explanation of the operation of the FIGURE 1 circuit, and the functions performed by the controls it provides, will be undertaken in a step-by-step development of the circuit, aided by reference to the schematic series of FIGURES 2a—2d.

Considering initially the first drive circuit and the function of control 19, reference may

be made to FIGURE 2a. The positive-going portion of input waveform 50, as passed by capacitor 13, causes conduction by diode 21. Such conduction causes severe attenuation of this waveform as presented across the windings VR, VG. Thus, during the beginning-of-scan interval there would be no significant drive from this circuit.

However, during the succeeding half of the vertical trace interval, diode 21 opens, and diode 17 conducts. Therefore, the negative-going portion of the input waveform is presented across the windings VR, VG with relatively little attenuation, and provides drive during the end-of-scan period. Conducting diode 17 in conjunction with resistor 15 shapes the input waveform for optimum bottom half convergence. Variable resistor 19 provides a master amplitude control for red-green winding current in the end-of-scan period, and thus is suitable for vertical line alignment at the raster bottom.

Next considering the addition of the second drive circuit and the function of control 35, reference may be made to FIGURE 2b. The second drive circuit serves to differentiate the partially integrated sawtooth input in order to provide a substantially sawtooth voltage across the resistance element 35. During the beginning-of-scan period, when diode 21 of the first drive circuit is conducting, the adjustable sawtooth voltage source represented by element 35 sees a low impedance load (comprising windings VR, VG in series with conducting diode 21), and therefore provides significant current drive through the windings.

Potentiometer 35 provides a master amplitude control for red-green winding current in this beginning-of-scan period, and thus is suitable for vertical line alignment at the raster top. When diode 21 opens, the load seen by the second drive circuit rises to a high impedance value, and only a small degree of current control is provided thereby.

In FIGURE 2c, the addition of potentiometer 27 to the configuration of FIGURE 2b is shown. The potentiometer 27 provides a means for changing the division of current drive (from the first drive circuit) between the windings VR and VG, and accordingly provides a control for horizontal line alignment (the adjustment having a differential effect on the VR and VG currents) at the raster bottom (i.e., when the first drive circuit is controlling).

In FIGURE 2d, the addition of potentiometer 29 to the configuration of FIGURE 2c is shown. The presence of potentiometer 29 allows a differential voltage to be produced between the coils VR and VG during the first half of scan. As the tap (returned to the differentiated voltage source) is adjusted, the currents of VR and VG are varied differentially. In the second half of scan, when diode 21 is not conducting, this control is relatively

ineffective in view of the altered impedance conditions described in connection with control 35. Potentiometer 29 thus provides horizontal line alignment at the raster top.

As pointed out above, potentiometer 27 is effective when the first drive circuit is controlling. This occurs during second half of scan when diode 21 is not conducting. During the first half of the vertical scan potentiometer 27 is relatively ineffective since its current contribution to the windings VR and VG is much smaller than the current contribution of the potentiometer 29. It can be seen that the variable arm of potentiometer 27 is connected to a point of much lower potential than the variable arm of potentiometer 29 on the voltage divider-differentiator consisting of capacitor 31 and resistors 33 and 35 (see FIGURE 1). Useful voltage levels are present on this divider only during the first half of vertical scan due to the differentiating action of this circuit.

The voltage across the series combination of resistor 19 and diode 21 is an attenuated version of the input during the first half of scan, and a relatively unattenuated version thereof during the second half of scan by reason of the diode action previously described. For control of blue convergence current at raster bottom, the winding VB is bridged between a fixed divider (41, 43) of such voltage wave and an adjustable divider thereof (provided by potentiometer 45). Tap adjustment to voltage division levels greater than that provided by the fixed divider results in blue convergence drive in one direction, while tap adjustment to division levels smaller than the fixed division results in reverse direction drive.

For control of blue convergence current at raster top, a voltage from the second drive differentiation circuit is supplied to winding VB via the potentiometer 47 bridged across it. Tap movement to one side of the electrical center of potentiometer 47 provides beginning half current drive of one polarity and tap movement to the other side results in reversing this drive.

Presented below, by way of example, is a table of values for the parameters of the FIGURE 1 circuit which may be employed to provide a satisfactorily operating circuit:

Capacitor 13	500 microfarads	
Resistor 15	68 ohms	
Diode 17	FDH600 (2 series connected)	120
Resistor 19	90 ohms (variable)	
Diode 21	FDH600	
Resistor 27	30 ohms (variable)	
Resistor 29	90 ohms (variable)	
Capacitor 31	65 microfarads	125
Resistor 33	33 ohms	
Resistor 35	60 ohms (variable)	
Resistor 37	56 ohms	
Resistor 41	100 ohms	

Resistor 43 100 ohms
 Resistor 45 500 ohms (variable)
 Resistor 47 500 ohms (variable)

WHAT WE CLAIM IS:—

- 5 1. A convergence circuit for a television receiver having at least one pair of convergence windings, a convergence voltage wave-
 10 form source, a first drive circuit means coupled to said source and to one end of each of said pair of windings for energizing
 15 said windings and including restricting means for substantially restricting said energization to only one half of the vertical scan interval,
 20 and second drive circuit means coupled to said source and to the opposite ends of said wind-
 25 ings for developing a driving voltage during both halves of the vertical scan interval, said
 30 restricting means serving in its operation to change the load presented to said second drive
 35 circuit means in the respective halves of the vertical scan interval in such manner that said second drive circuit means effectively
 controls energization of said windings only during the remaining half of the scan interval.
2. A convergence circuit as claimed in Claim 1 in which at least one drive circuit is
 comprised of: a network shunted across said
 source and including the series combination of
 resistive means and a diode poled to conduct
 during a predetermined portion of the cycle
 of said vertical rate gates, and means for
 effectively shunting a convergence winding
 across said diode whereby said network ener-
 gizes said winding only during the portion
 of the cycle when the diode is nonconducting.
3. A convergence circuit as claimed in
 Claim 2 wherein means are provided to vary
 the resistance exhibited by said resistive means
 to control the magnitude of said energization

during said portions of said cycles when said diode is nonconducting. 40

4. A convergence circuit as claimed in Claim 3 wherein said second drive circuit means is effectively included in series with said winding across said diode, said second drive circuit means effectively controlling energiza- 45
 tion of said winding only during the cycle portion when said diode is conducting.

5. A convergence circuit as claimed in Claim 1, comprising at least a third conver- 50
 gence winding and at least a third drive circuit means being a first voltage divider shunted across said source, a potentiometer presenting a resistance element between respectively end terminals, and having an adjustable tap, 55
 means for shunting said resistance element across said source, and means for connecting said winding between said tap and an inter-
 mediate point in said voltage divider whereby tap adjustment varies both sense and magni- 60
 tude of the energization of said winding.

6. A convergence circuit as claimed in Claim 5, comprising first means associated with each drive circuit means for varying the energization controlled thereby in both wind- 65
 ings in the same sense, and second means associated with each drive circuit means for varying the energization controlled thereby in both windings in mutually opposing
 70 sense.

7. A convergence circuit substantially as hereinbefore described with reference to the accompanying drawing.

T. I. M. SMITH,
 Chartered Patent Agent,
 50 Curzon Street, London, W1Y 8EU
 Agent for the Applicant.

Resistor 43 100 ohms
 Resistor 45 500 ohms (variable)
 Resistor 47 500 ohms (variable)

WHAT WE CLAIM IS:—

- 5 1. A convergence circuit for a television receiver having at least one pair of convergence windings, a convergence voltage waveform source, a first drive circuit means coupled to said source and to one end of each of said pair of windings for energizing said windings and including restricting means for substantially restricting said energization to only one half of the vertical scan interval, and second drive circuit means coupled to said source and to the opposite ends of said windings for developing a driving voltage during both halves of the vertical scan interval, said restricting means serving in its operation to change the load presented to said second drive circuit means in the respective halves of the vertical scan interval in such manner that said second drive circuit means effectively controls energization of said windings only during the remaining half of the scan interval.
- 10 2. A convergence circuit as claimed in Claim 1 in which at least one drive circuit is comprised of: a network shunted across said source and including the series combination of resistive means and a diode poled to conduct during a predetermined portion of the cycle of said vertical rate gates, and means for effectively shunting a convergence winding across said diode whereby said network energizes said winding only during the portion of the cycle when the diode is nonconducting.
- 15 3. A convergence circuit as claimed in Claim 2 wherein means are provided to vary the resistance exhibited by said resistive means to control the magnitude of said energization

during said portions of said cycles when said diode is nonconducting. 40

4. A convergence circuit as claimed in Claim 3 wherein said second drive circuit means is effectively included in series with said winding across said diode, said second drive circuit means effectively controlling energization of said winding only during the cycle portion when said diode is conducting. 45

5. A convergence circuit as claimed in Claim 1, comprising at least a third convergence winding and at least a third drive circuit means being a first voltage divider shunted across said source, a potentiometer presenting a resistance element between respectively end terminals, and having an adjustable tap, means for shunting said resistance element across said source, and means for connecting said winding between said tap and an intermediate point in said voltage divider whereby tap adjustment varies both sense and magnitude of the energization of said winding. 50

6. A convergence circuit as claimed in Claim 5, comprising first means associated with each drive circuit means for varying the energization controlled thereby in both windings in the same sense, and second means associated with each drive circuit means for varying the energization controlled thereby in both windings in mutually opposing sense. 55

7. A convergence circuit substantially as hereinbefore described with reference to the accompanying drawing. 60

T. I. M. SMITH,
 Chartered Patent Agent,
 50 Curzon Street, London, W1Y 8EU
 Agent for the Applicant. 65