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Funakawa et al.

[11] **3,895,252**

[45] **July 15, 1975**

[54] **VERTICAL CONVERGENCE CIRCUIT**

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[73] Assignee: **Hitachi, Ltd.,** Japan

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[30] **Foreign Application Priority Data**

Apr. 28, 1972 Japan 47-42221

[52] **U.S. Cl.** ..... **315/13 C**

[51] **Int. Cl.** **H01j 29/70**

[58] **Field of Search**.. 315/27 R, 13 C, 13 R, 27 TD, 315/370, 371

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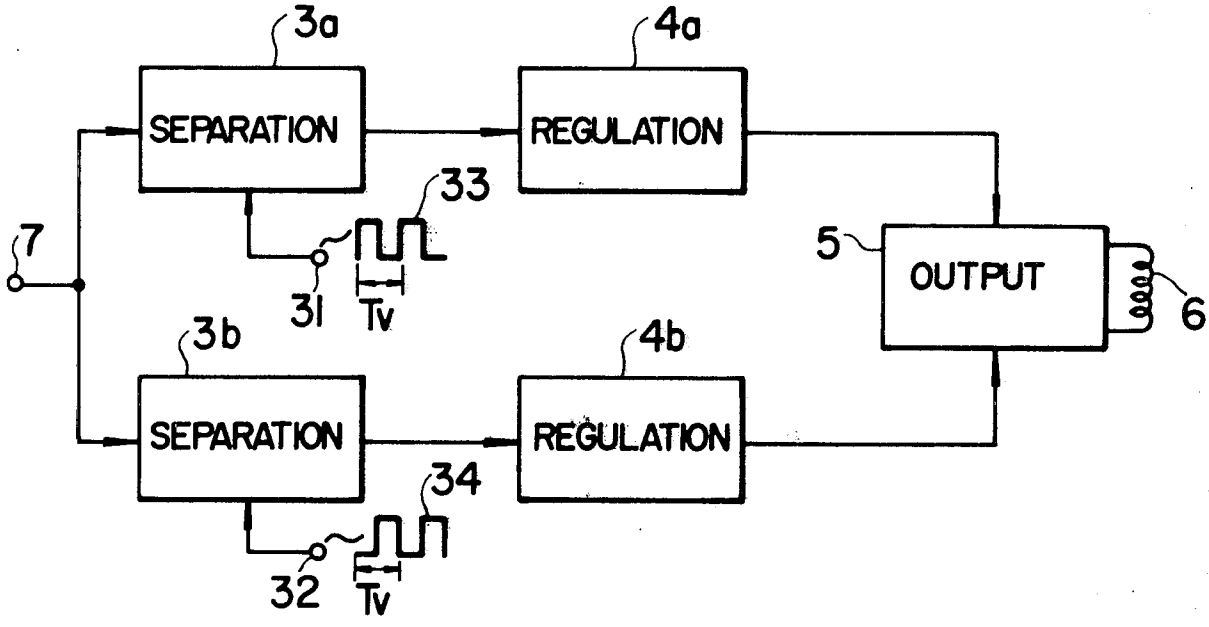
Attorney, Agent, or Firm—Craig & Antonelli

[57] **ABSTRACT**

A vertical convergence circuit comprising means for producing a correcting signal having a parabolic waveform in synchronism with vertical scanning, means for separating this correcting signal into two waveforms corresponding solely to the former half and latter half respectively of the vertical scanning period, means for amplifying these two separated correcting signals independently of each other and regulating the amplitude thereof independently of each other, means for inverting the polarity of the two correcting signals independently of each other, and means for applying to the same convergence coil the two correcting signals whose amplitude is regulated and whose polarity is selected by the amplitude regulating means and polarity inverting means.

1 Claim, 9 Drawing Figures



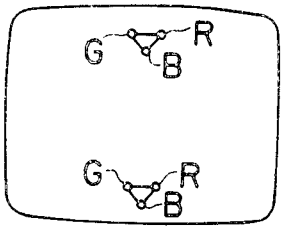


FIG. 1

FIG. 2a

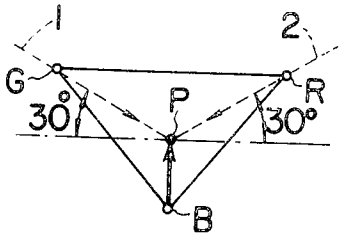


FIG. 2b

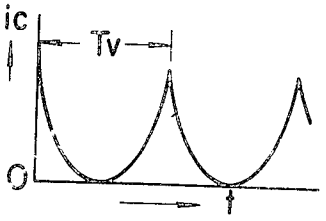


FIG. 3a

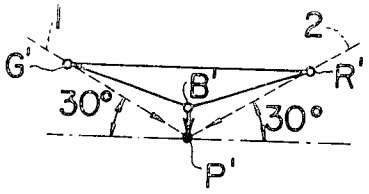


FIG. 3b

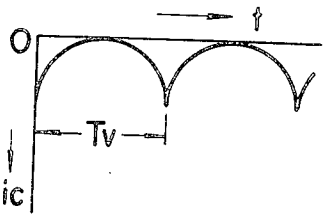


FIG. 4

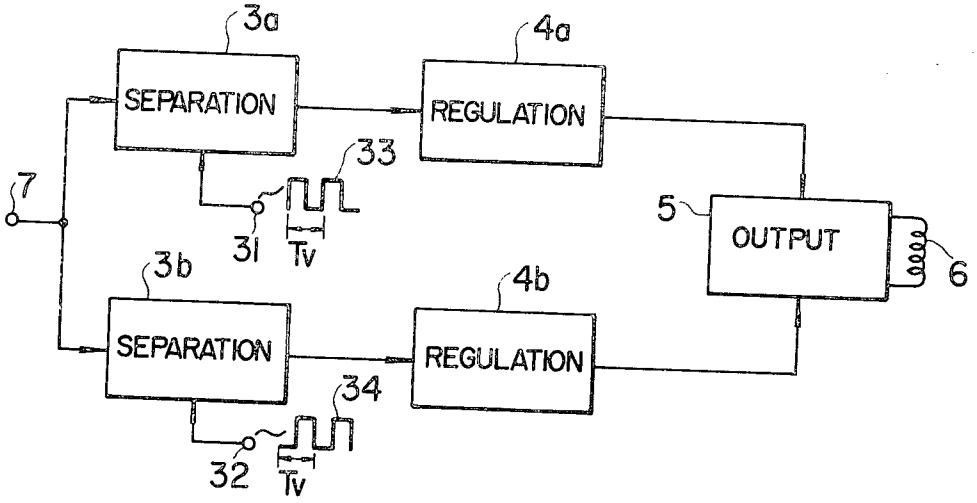


FIG. 5

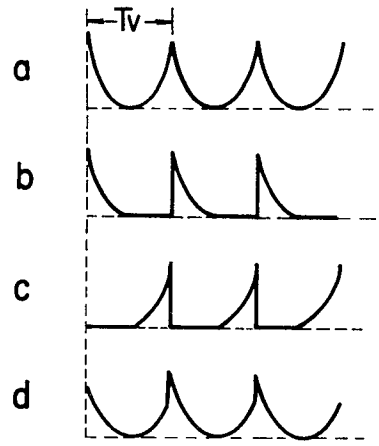


FIG. 6a

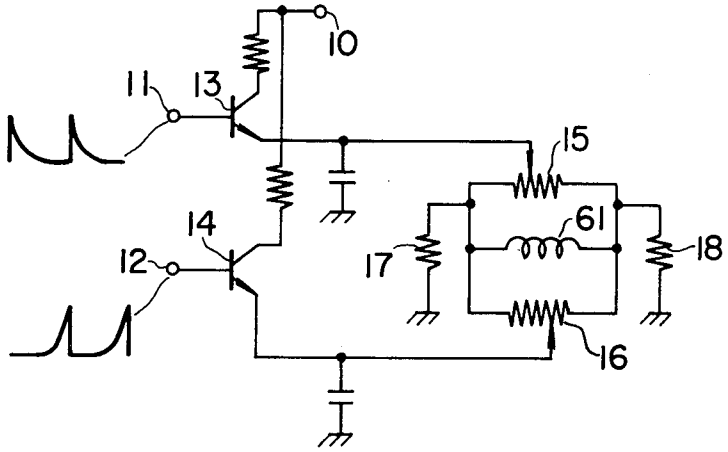
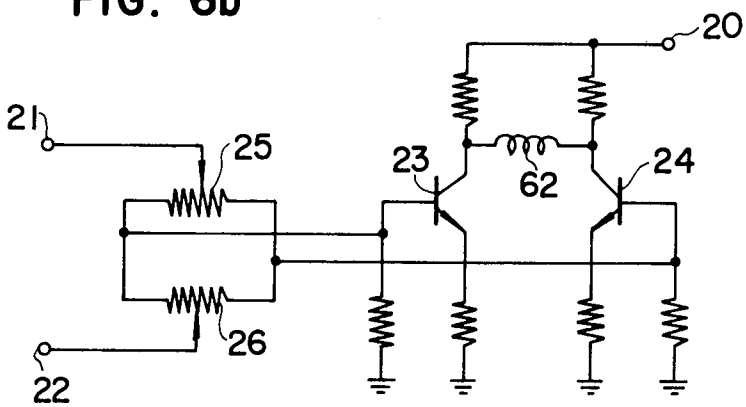


FIG. 6b



VERTICAL CONVERGENCE CIRCUIT

This invention relates to a convergence circuit for use in color television receivers and more particularly to a dynamic convergence circuit for carrying out desired regulation of the blue electron beam in the vertical direction in a color picture tube having three electron guns.

In a color picture tube such as a shadow mask type color picture tube having a plurality of electron guns, it is known that convergence of electron beams of the electron guns throughout the area of the phosphor screen of the color picture tube is difficult to attain and misconvergence as shown in FIG. **1** occurs commonly. FIG. **1** shows an example of misconvergence occurring at an upper middle portion, central portion and lower middle portion of the screen and this misconvergence is represented by triangles formed by red, green and blue beams designated by R, G and B respectively. Desired convergence of these three beams can be attained at the central portion of the screen by means of static convergence alignment. However, misconvergence as shown in FIG. **1** occurs at the upper middle portion and lower middle portion of the screen and the degree of misconvergence becomes greater at a point remoter from the center of the screen. Such misconvergence is shown in an enlarged scale in FIG. **2***a*. In order to correct this misconvergence by deflecting the beams, the beam spots of the red beam R and green beam G may be transferred to the intersection P of broken lines **1** and **2** along these broken lines **1** and **2** respectively and the beam spot of the blue beam B may be transferred upward in FIG. **2***a* to attain desired convergence. However, due to the fact that generally the beam spots of the red beam R and green beam G can only be transferred on straight lines along the straight broken lines 1 and **2** shown in FIG. **2***a*, the desired convergence of the three beams can only be attained at the intersection P of the straight broken lines **1** and **2**. Thus, when this intersection P is included within a triangle having three vertices R, G and B as shown in FIG. **2***a*, the beam spot of the blue beam B may be transferred upward in FIG. **2***a* to attain the desired convergence of the three beams R, G and B. It is commonly known that, in order to cause such transfer of the beam spot of the blue beam B, a correcting current of parabolic waveform whose period is equal to the vertical scanning period T_V as shown in FIG. **2***b* may be supplied to the convergence coil for the blue beam.

In a conventional color picture tube of the kind in which the deflection angle is less than about 90°, the convergence alignment for the blue beam B has been successfully attained by merely transferring the beam spot of the blue beam B in one direction since the convergence point P is included within a triangle having three vertices R, G and B as shown in FIG. **2***a*. Thus, it has been only necessary to supply a correcting current having a waveform as shown in FIG. **2***b* to the convergence coil while varying only the magnitude thereof without varying the polarity. However, in the case of a color picture tube of the kind in which the deflection angle is wide or of the order of 110°, a misconvergence triangle as shown in FIG. **3***a* may be formed by red, green and blue beams R', G' and B'. In such a case, the beam spot of the blue beam B' exists on the screen at a point above the convergence point P' for the beam spots of the red beam R' and green beam G', and thus;

the beam spot of the blue beam B' must be transferred downward in FIG. **3***a* in the direction opposite to the direction shown in FIG. **2***a* in order to bring the beam spot of the blue beam B' to the point P'. In the case of such a triangle, a parabolic correcting current as shown in FIG. **3***b* having a polarity opposite to that shown FIG. **2***b* must be supplied to the convergence coil in order to transfer the beam spot of the blue beam B' to the point P' thereby attaining the desired convergence. It will thus be seen that, in color picture tubes of wide angle deflection type, there appears the beam triangle of the form shown in FIG. **2***a* or the beam triangle of the form shown in FIG. **3***a* depending on the color picture tube and deflection coils.

It is an object of the present invention to provide a novel and improved convergence circuit which is capable of easily and simply attaining convergence alignment without requiring any especial skill for the correction of misconvergence.

Another object of the present invention is to provide a dynamic convergence circuit for correcting misconvergence in which the misconvergence at an upper portion of the screen of a color picture tube can be corrected independently of the misconvergence at a lower portion of the tube screen, and the blue beam can be transferred in any desired vertical direction.

In accordance with the present invention which attains the above objects, the convergence coil for the blue beam is connected in a bridge circuit so that the amplitude of the correcting current supplied to the convergence coil can be continuously varied and the polarity thereof can also be varied. Further, the parabolic waveform of the correcting current is separated into a waveform corresponding solely to the former half of the vertical scanning period and a waveform corresponding solely to the latter half of the vertical scanning period and these waveforms are applied to independent amplifiers so that their amplitudes can be regulated independently of each other.

Other objects, features and advantages of the present invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a diagrammatic view showing misconvergence triangles formed by red, green and blue beams on the screen of a color picture tube;

FIG. **2***a* is a schematic enlarged view of a triangle as shown in FIG. **1**;

FIG. **2***b* shows a current waveform required for correcting the blue beam in a misconvergence tirangle as shown in FIG. **2***a*;

FIG. **3***a* is a schematic enlarged view of another form of the triangle;

FIG. **3***b* shows a current waveform required for correcting the blue beam in a misconvergence triangle as shown in FIG. **3**a;

FIG. **4** is a block diagram of an embodiment of the present invention;

FIG. **5** shows signal waveforms appearing at various parts of FIG. **4**; and

FIGS. **6***a* and **6***b* are circuit diagrams showing two forms of the practical circuitry of the embodiment of the present invention.

The present invention will now be described in detail with reference to FIGS. **4** to **6**. FIG. **4** is a basic block diagram of a convergence circuit for the blue beam according to the present invention, and FIG. **5** shows sig-

nal waveforms appearing at various parts of the circuit shown in FIG. 4.

Referring to FIG. 4, a parabolic waveform signal whose period is equal to the vertical scanning period is applied to an input terminal 7 of the convergence circuit, and this signal is applied to a pair of separating means 3*a* and 3*b* to be separated into a signal corresponding solely to the former half of the vertical scanning period and a signal corresponding solely to the latter half of the vertical scanning period respectively. In order to attain the separation of the signal applied to the separating means 3*a* and 3*b* through the input terminal 7, a train of gate pulses 33 is applied to an input terminal 31 of the separating means 3*a* and another train of gate pulses 34 is applied to an input terminal 32 of the separating means 3*b*. The separating means 3*a* and 3*b* may be in the form of a switching means which operates in such a manner that the input signal appears at the output thereof during the period of time in which the gate pulse is applied thereto, while such input signal does not appear at the output thereof during the period of time in which no gate pulse appears. These pulse signals 33 and 34 have the same repetition period as the vertical scanning period T_V, are synchronous with the vertical scanning and have a duty factor of 50% . However, the pulse signal 33 applied to the gate pulse input terminal 31 of the separating means 3*a* is 180° out of phase from the pulse signal 34 applied to the gate pulse input terminal 32 of the separating means 3*b*. The parabolic waveform signal corresponding to the former half of the vertical scanning period and the parabolic waveform signal corresponding to the latter half of the vertical scanning period are applied from the separating means 3*a* and 3*b* to respective regulating means 4*a* and 4*b* which regulate the amplitude of these signals to the level required for correction and which can freely invert the polarity of these signals as required. These regulating means 4*a* and 4*b* are connected to an output circuit 5 to which a convergence coil 6 for the blue beam is connected

A parabolic waveform signal having a repetition period the same as the vertical scanning period T_V as shown by *a* in FIG. 5 is applied to the input terminal 7 of the convergence circuit. The signal having such a waveform may be obtained by applying to an integrating means the saw-tooth waveform signal having the same period as the vertical scanning period derived from the vertical deflection circuit. This parabolic waveform signal is separated by the separating means 3*a* and 3*b* into a signal corresponding solely to the former half of the vertical scanning period as shown by *b* in FIG. 5 and a signal corresponding solely to the latter half of the vertical scanning period as shown by *c* in FIG. 5. More precisely, the separating means 3*a* is rendered conductive only during the period of time corresponding to the former half of the vertical scanning period in response to the application of the pulse signal 33 to the gate pulse input terminal 31 thereof, and thus, the parabolic waveform signal applied to the input terminal 7 appears at the output of the separating means 3*a* in the form of an output waveform as shown by *b* in FIG. 5. Similarly, due to the fact that the pulse signal 34 having a phase opposite to that of the pulse signal 33 is applied to the gate pulse input terminal 32 of the separating means 3*b*, the parabolic waveform signal applied to the input terminal 7 appears at the output of the separating means 3*b* in the form of an output waveform as shown by *c* in FIG. 5. The two signals corresponding to the former half and latter half of the vertical scanning period in this manner are applied to regulating means 4*a* and 4*b* respectively in which their amplitude and polarity are regulated to be suitable for correction. The two signals thus regulated are applied through the output circuit 5 to the convergence coil 6 for correcting misconvergence of the blue beam. One form of the current waveform flowing through the convergence coil 6 is shown by *d* in FIG. 5. This example represents the case in which the correcting signals appearing from the respective regulating means 4*a* and 4*b* have different amplitudes to deal with the difference between the degrees of misconvergence at the upper and lower portions of the screen. In this manner, the amplitude of the correcting signal for the former half of the vertical scanning period can be regulated independently of the amplitude of the correcting signal for the latter half of the vertical scanning period. Thus, the convergence alignment can be remarkably facilitated due to the fact that convergence alignment for the upper portion of the screen can be attained independently of that for the lower portion of the screen.

FIG. 6*a* shows one preferred form of the practical circuitry of the convergence circuit embodying the present invention. FIG. 6a shows the stages following the separating means 3*a* and 3*b* and represents the case in which the regulating means 4*a*, 4*b* and the output circuit 5 are unitarily combined. The signal shown by *b* in FIG. 5 for correcting the misconvergence occurring in the former half of the vertical scanning period or the upper portion of the screen is applied to an input terminal 11, and the signal shown by *c* in FIG. 5 for correcting the misconvergence occurring in the latter half of the vertical scanning period or the lower half of the screen is applied to another input terminal 12. These signals are applied to the base of respective amplifying transistors 13 and 14 which are connected at the collector thereof to a bias voltage applying terminal 10. A pair of variable resistors 15 and 16 are provided for regulating the amplitude and polarity of the correcting current supplied to a convergence coil 61 for the blue beam. A capacitor is connected between ground and the emitter of each of the transistors 13 and 14 so as to prevent damage to the transistors 13 and 14 due to direct application of a high voltage which may be induced in the convergence coil 61 and leads therefor due to a spark. A pair of fixed resistors 17 and 18 constitute a bridge circuit together with the variable resistors 15 and 16 so that the direction and amplitude of the correcting current flowing through the convergence coil 61 can be varied depending on the position of the sliding terminal of the variable resistor 15 or 16. When the sliding terminal of the variable resistor 15 (or 16) is in its intermediate position such that the resistances of the left-hand and right-hand portions of the resistor are equal to each other, the current from the transistor 13 (or 14) is not supplied to the convergence coil 61. As the sliding terminal moves in either direction from this neutral point, the current flows through the convergence coil 61 in one direction or the other depending on the moving direction of the sliding terminal, and the amplitude of the current is increased as the sliding terminal approaches either extremity.

As described above, the parabolic correcting voltage is separated into two portions for correcting the misconvergence occurring in the former half and latter

half of the vertical scanning period and such voltages are applied to the base of the respective transistors **13** and **14.** For example, a voltage having a waveform as shown by *b* in FIG. **5** is applied to the base of the transistor **13** and a voltage having a waveform as shown by *c* in FIG. **5** is applied to the base of the transistor **14.** Thus, when the transistor **13** is conducting, the transistor **14** is cut off, while when the transistor **14** is conducting, the transistor **13** is cut off. Therefore, the emitter current of the transistors **13** and **14** flows alternately through the convergence coil **61.** Since the amplitude and direction of the emitter current of the transistor **13** can be selected independently of those of the emitter current of the transistor **14** by manipulating the variable resistors **15** and **16,** the desired convergence alignment can be easily and simply attained even when the degree of misconvergence at the upper portion of the screen differs from that at the lower portion of the screen. In an extreme case, the direction of the misconvergence correcting current for the upper portion of the screen can be reversed relative to the direction of such current for the lower portion of the screen.

FIG. **6***b* shows another preferred form of the practical circuitry of the convergence circuit embodying the present invention, and the stages following the separating means **3***a* and **3***b* are also merely shown as in FIG. **6***a*. The signal for correcting the misconvergence occurring in the former half of the vertical scanning period is applied to an input terminal **21,** and the signal for correcting the misconvergence occurring in the latter half of the vertical scanning period is applied to another input terminal **22.** A pair of variable resistors **25** and **26** are similarly provided for regulating the amplitude and polarity of these correcting signals. A pair of transistors **23** and **24** act to amplify the correcting signals and are connected at the collector thereof to a bias voltage applying terminal **20.** A convergence coil **62** for the blue beam is connected across the collectors of the transistors **23** and **24.**

The operation of the circuit shown in FIG. **6***b* is basically entirely the same as that of the circuit shown in FIG. **6***a* except that the amplitude and polarity of the correcting signals are first regulated and then the correcting signals are amplified to be applied to the convergence coil **62.**

It will be understood from the foregoing detailed description that convergence alignment can be remarkably easily and simply attained according to the present invention by virtue of the fact that the beam spot of the electron beam for providing the blue color can be transferred in any desired vertical direction and the misconvergence occurring at the upper portion of the screen and the misconvergence occurring at the lower portion of the screen can be corrected independently of each other.

What is claimed is:

1. A dynamic vertical convergence circuit comprising means for producing a signal for correcting misconvergence, said signal being synchronous with the vertical scanning and having the same repetition period as the vertical scanning period; means for separating said correcting signal into a first half signal having a waveform corresponding solely to the former half of the vertical scanning period and a second half signal having a waveform corresponding solely to the latter half of the vertical scanning period; a first transistor having a base supplied with said first half signal, a collector connected to a power supply source, and an emitter; a second transistor having a base supplied with said second half signal, a collector connected to said power supply source, and an emitter; a first variable resistor having a sliding terminal; a second variable resistor having a sliding terminal and connected in parallel with said first variable resistor; a first fixed resistor connected between a point of a reference potential and one of the connecting points of said first and second variable resistors; a second fixed resistor connected between a point of a reference potential and the other connecting point of said first and second variable resistors; a convergence coil connected in parallel with said first and second variable resistors; means for connecting the emitter of said first transistor directly to said sliding terminal of said first variable resistor so that said second half signal does not cause conduction between said emitter of said first transistor and said reference potential; and means for connecting the emitter of said second transistor directly to said sliding terminal of said second variable resistor so that said first half signal does not cause conduction between said emitter of said second transistor and said reference potential; whereby the amplitude and polarity of said first and second half signals supplied from the respective sliding terminals of said first and second variable resistors to said convergence coil can be regulated independently of each other by suitably sliding the sliding terminals of said first and second variable resistors.

* * * * *