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(54) **PURE RED COLOR DETECTION CIRCUIT AND COLOR COMPENSATION CIRCUIT USING THE SAME**

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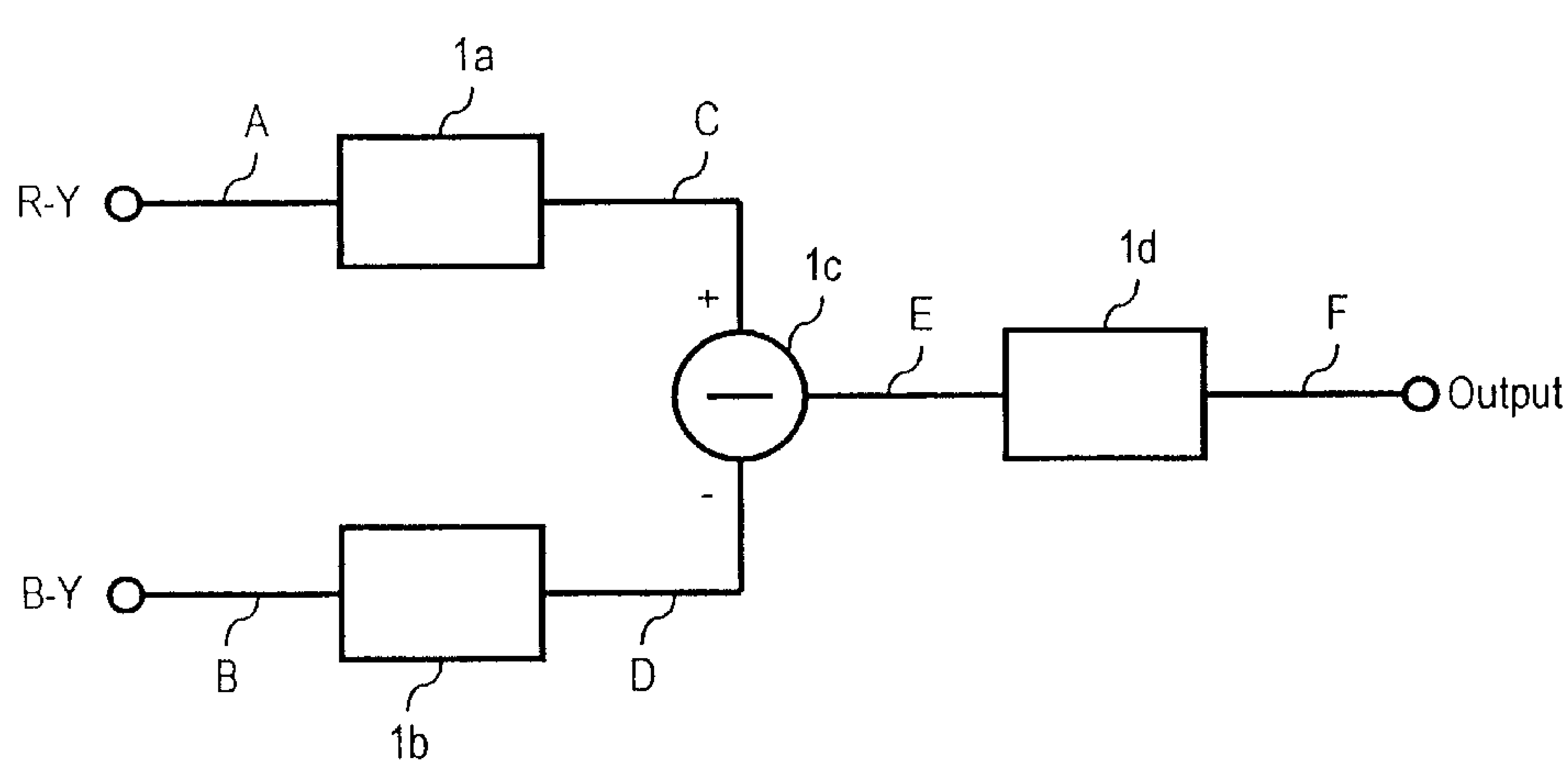
(57) **ABSTRACT**

Red color saturation is increased and red color with higher purity can be reproduced by composing: a red color detection circuit **1** for detecting a red color signal having higher purity by inputting color differential signals (R-Y) and (B-Y) modulated by color subcarrier, subtracting the absolute value of the (B-Y) signal from the positive polarity component of the (R-Y) signal and removing the negative part of the subtracted signal; Y signal compensation block including: first gain controller **50**b for controlling the output signal amplitude of red color detection circuit **1** and a subtracter **50**a for subtracting the output signal of first gain controller **50**b from a luminance signal Y; an (R-Y) signal compensation block including: second gain controller **51**b for controlling the output signal amplitude of red color detection circuit **1** and an adder **51**a for adding the output signal of second gain controller **51**b and the input (R-Y) signal; and a (B-Y) signal compensation block including: third gain controller **52**b for controlling the output signal amplitude of red color detection circuit **1**, a polarity inverter **52**c for inverting the output signal polarity of third gain controller **52**b, a switch circuit **52**d for selecting either input signal or output signal of polarity inverter **52**c, a polarity discriminator **52**e for discriminating the polarity of the input (B-Y) signal and controlling switch circuit **52**d and an adder **52**e for adding the output signal of switch circuit **52**d and the input (B-Y) signal.

11 Claims, 8 Drawing Sheets



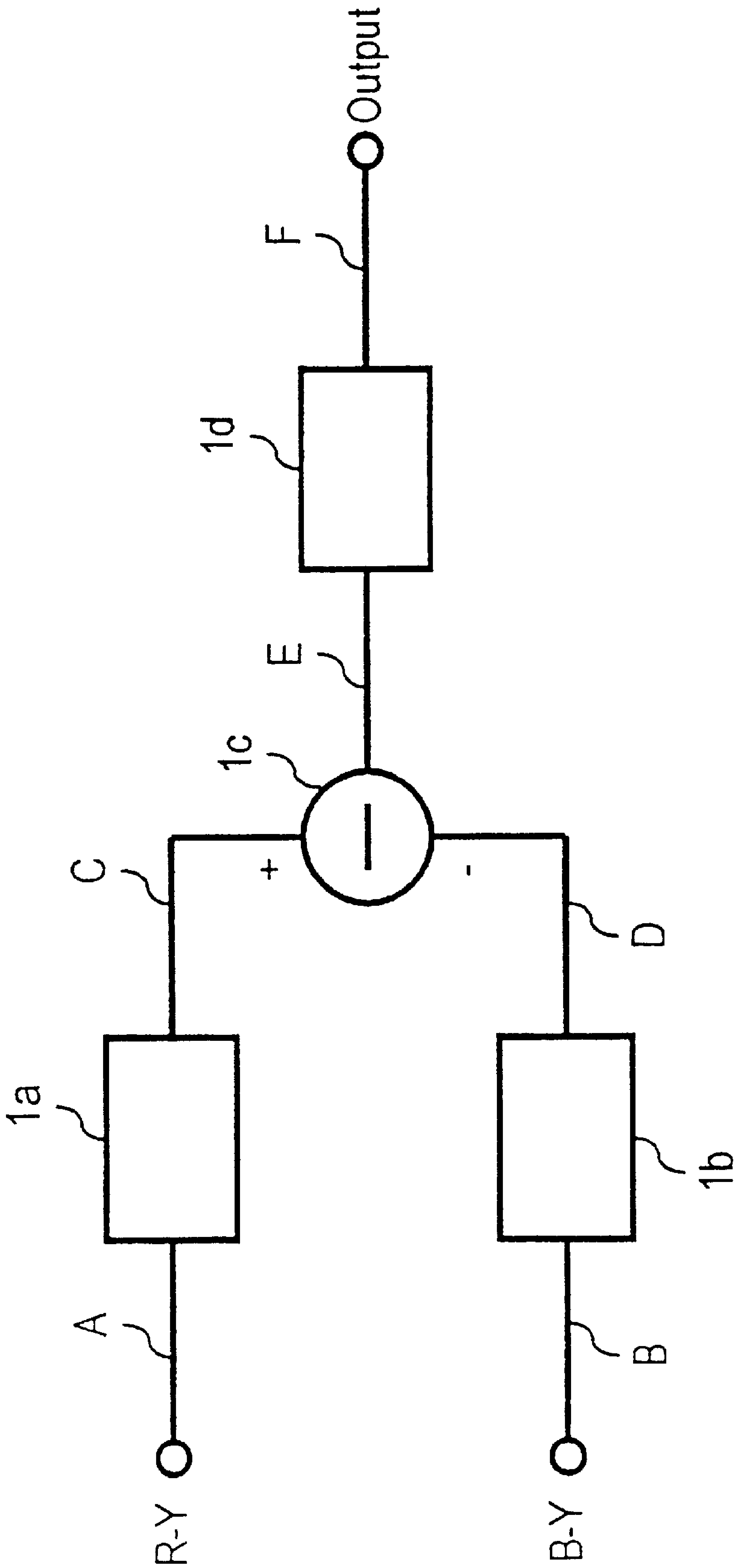
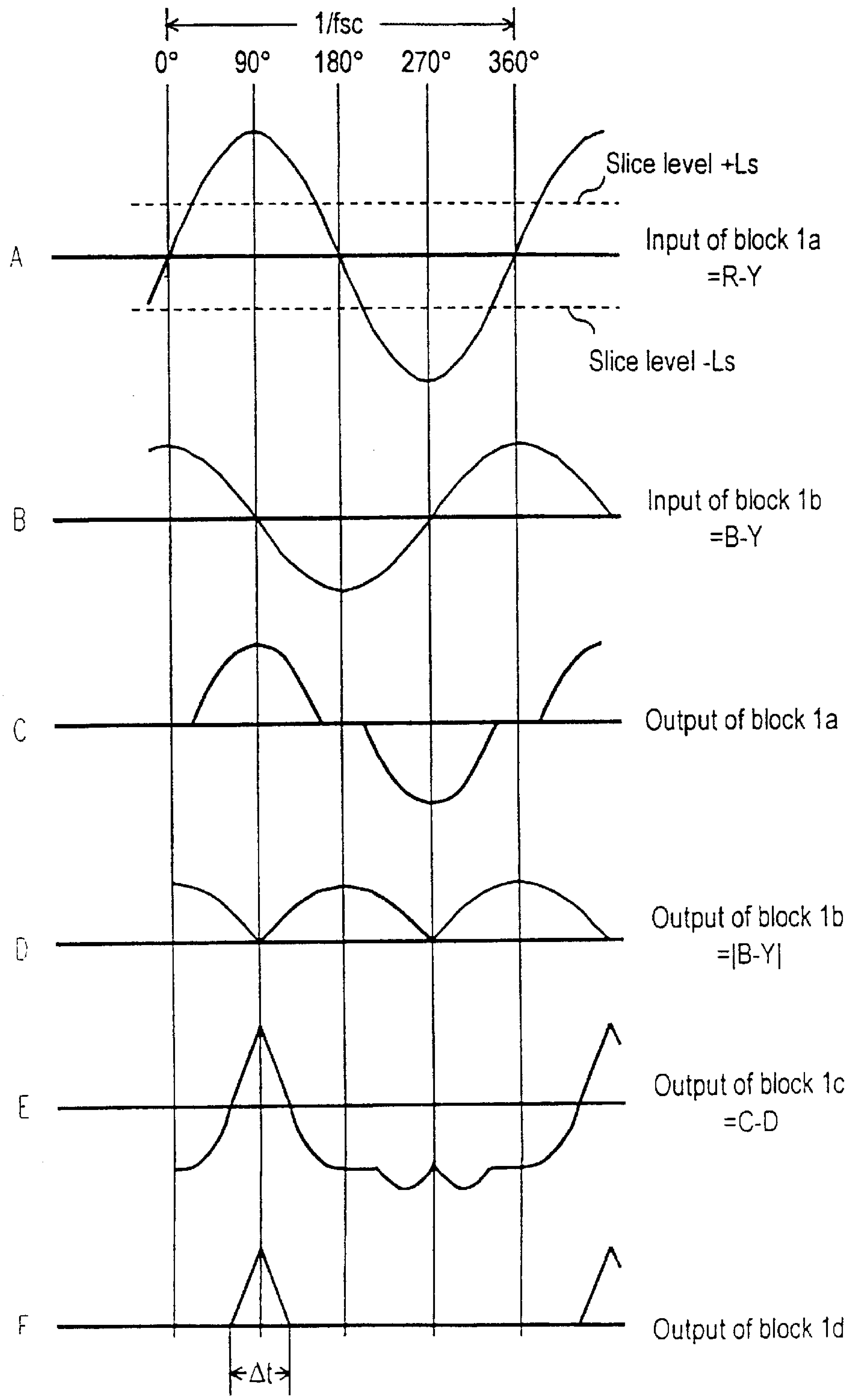


FIG. 1

FIG. 2


1/fsc
0°
90°
180°
270°
360°
Slice level +Ls
A
Input of block 1a
=R-Y
Slice level -Ls
B
Input of block 1b
=B-Y
C
Output of block 1a
D
Output of block 1b
=|B-Y|
E
Output of block 1c
=C-D
F
Output of block 1d
Δt

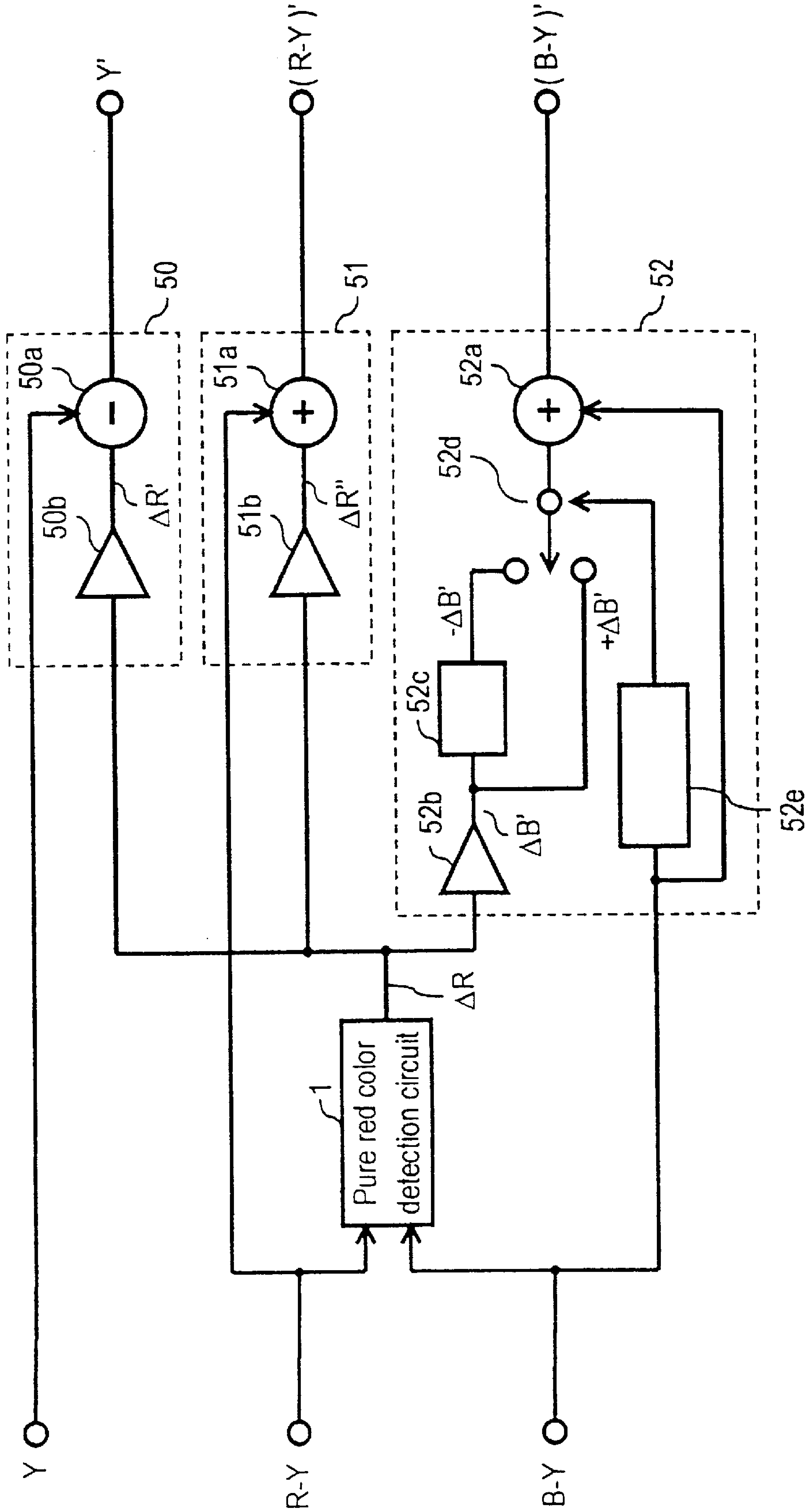

Y'
(R-Y)'
(B-Y)'
50
51
52
50a
51a
52a
52d
50b
ΔR'
51b
ΔR''
-ΔB'
+ΔB'
52c
52b
ΔB'
52e
ΔR
1
Pure red color detection circuit
Y
R-Y
B-Y

FIG. 3

FIG. 4A

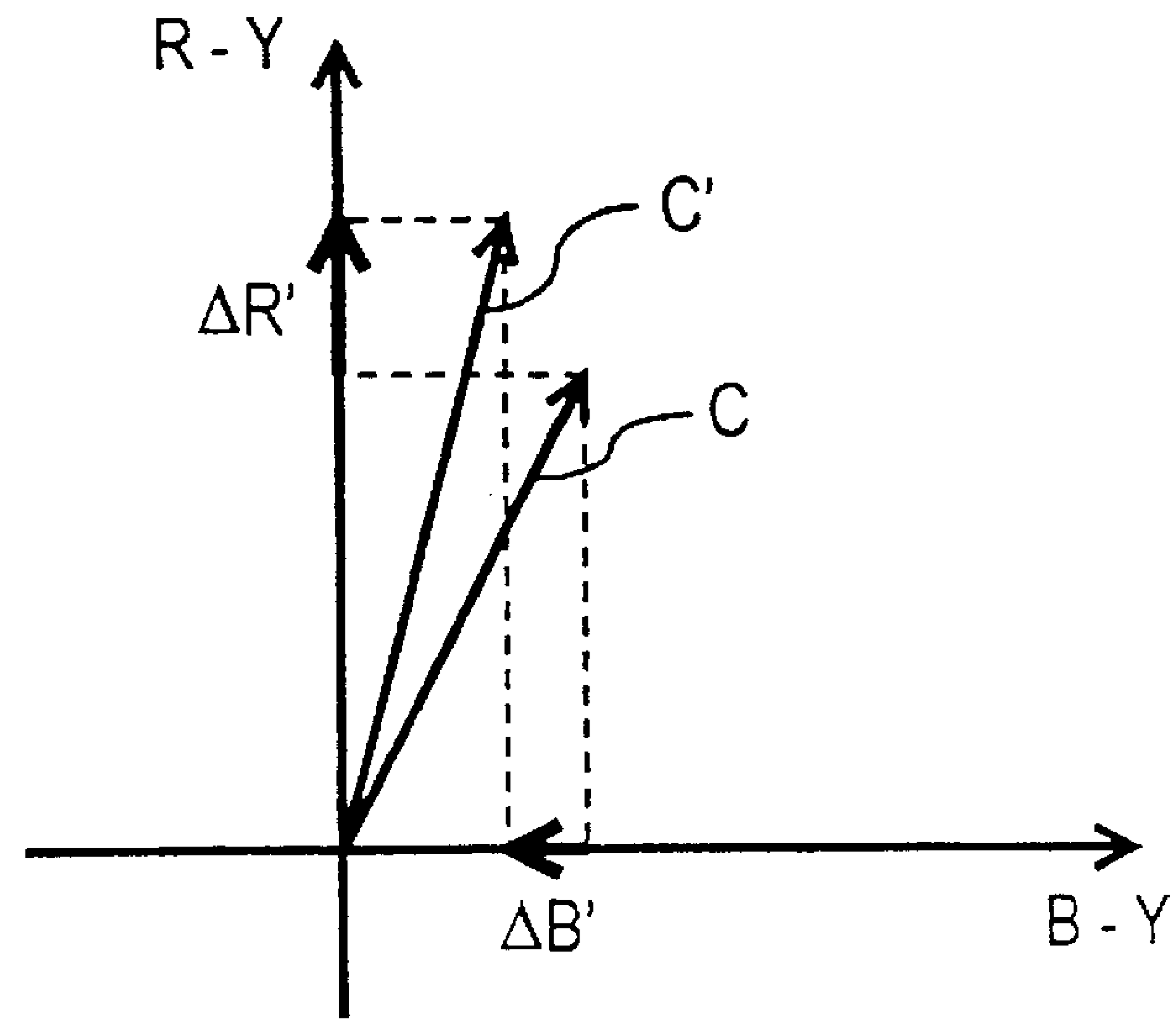
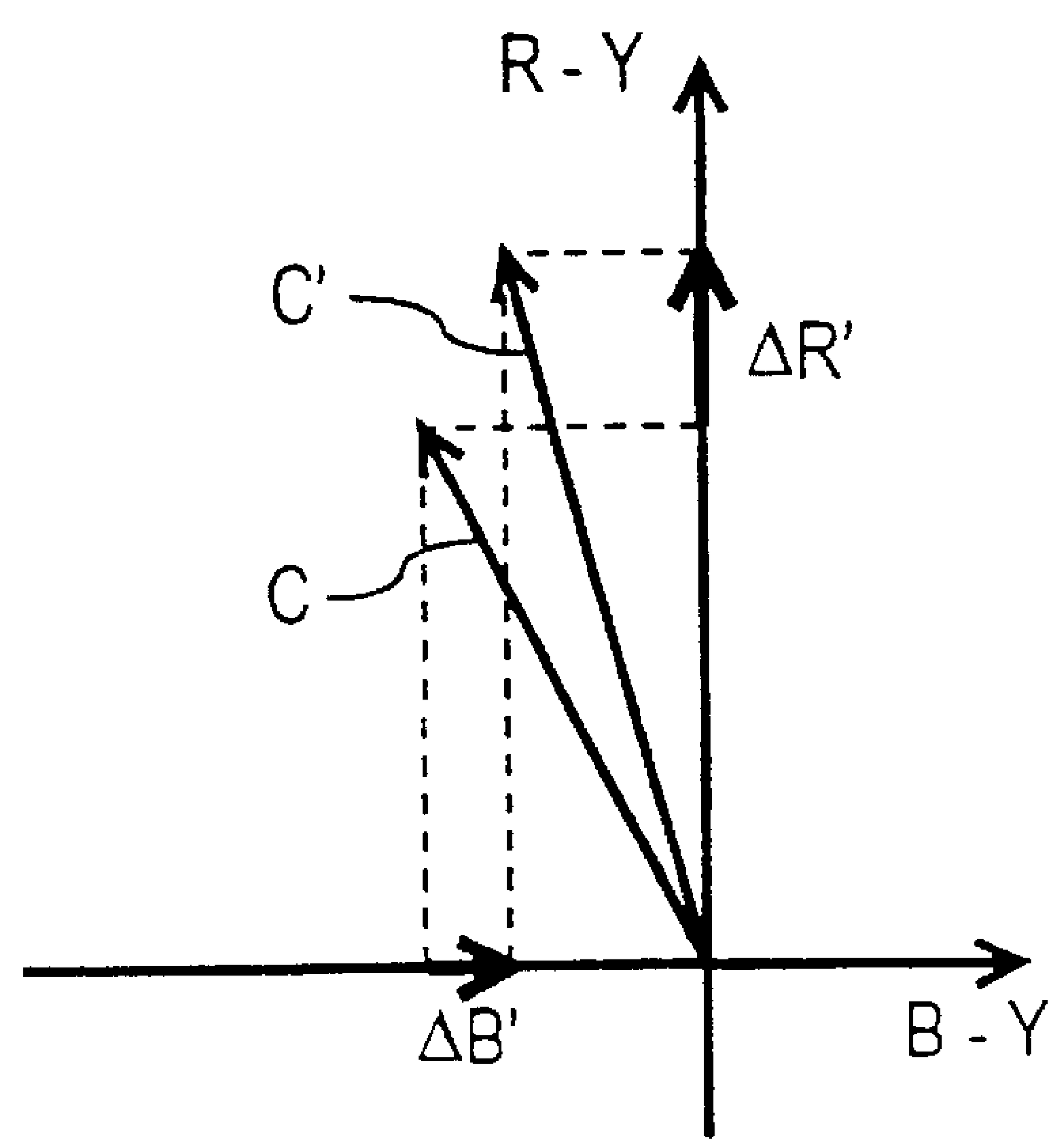


FIG. 4B



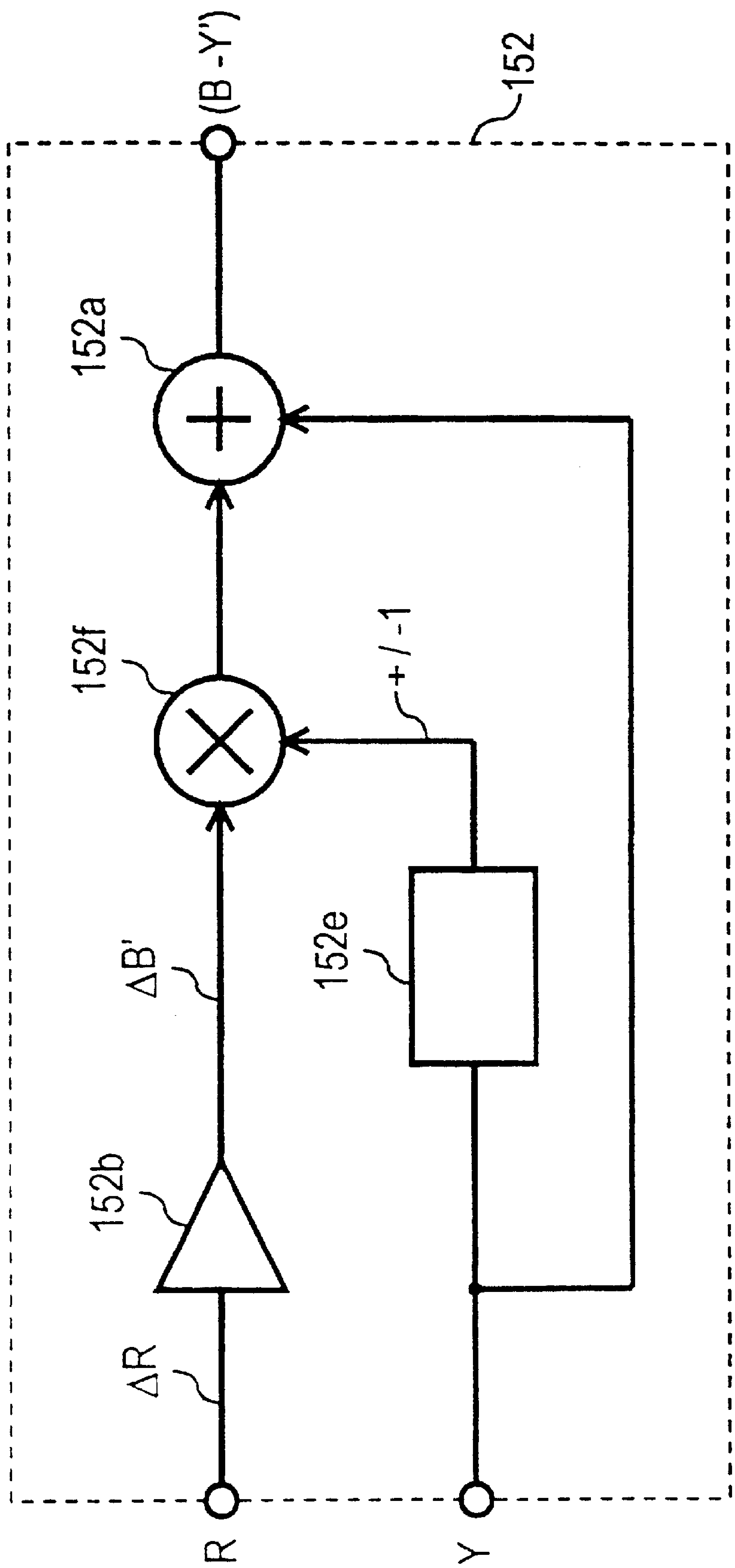


FIG. 5

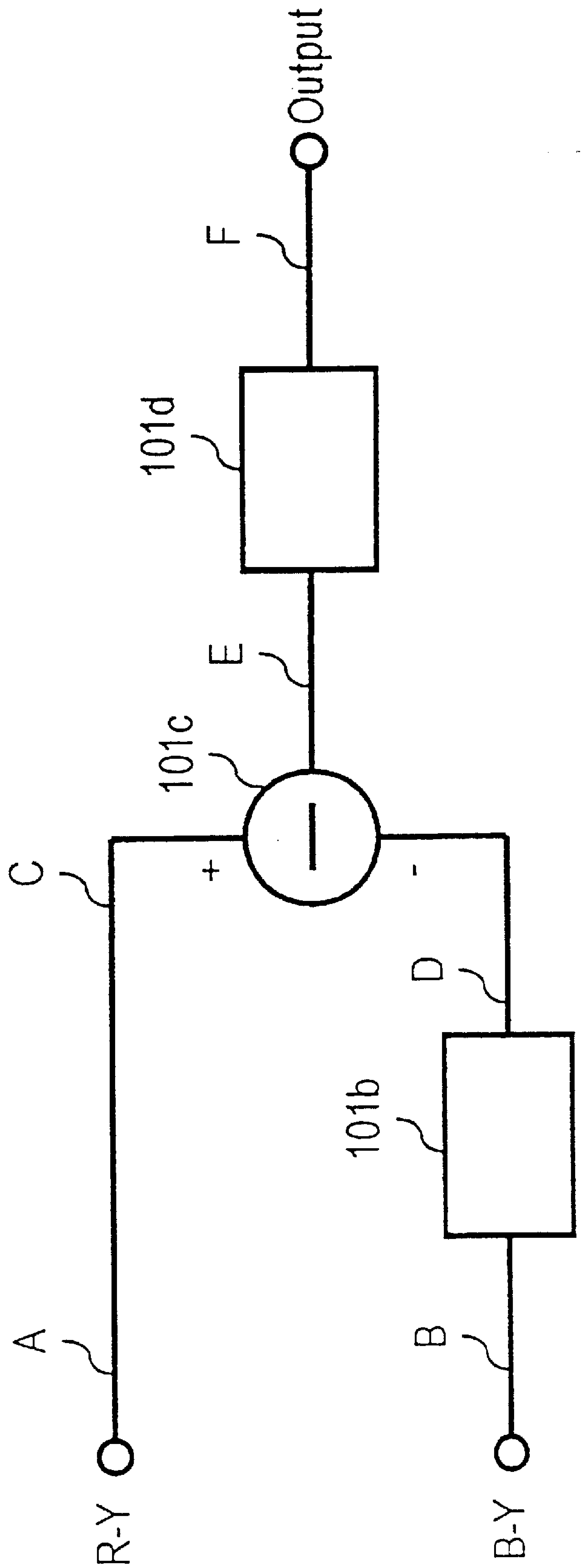
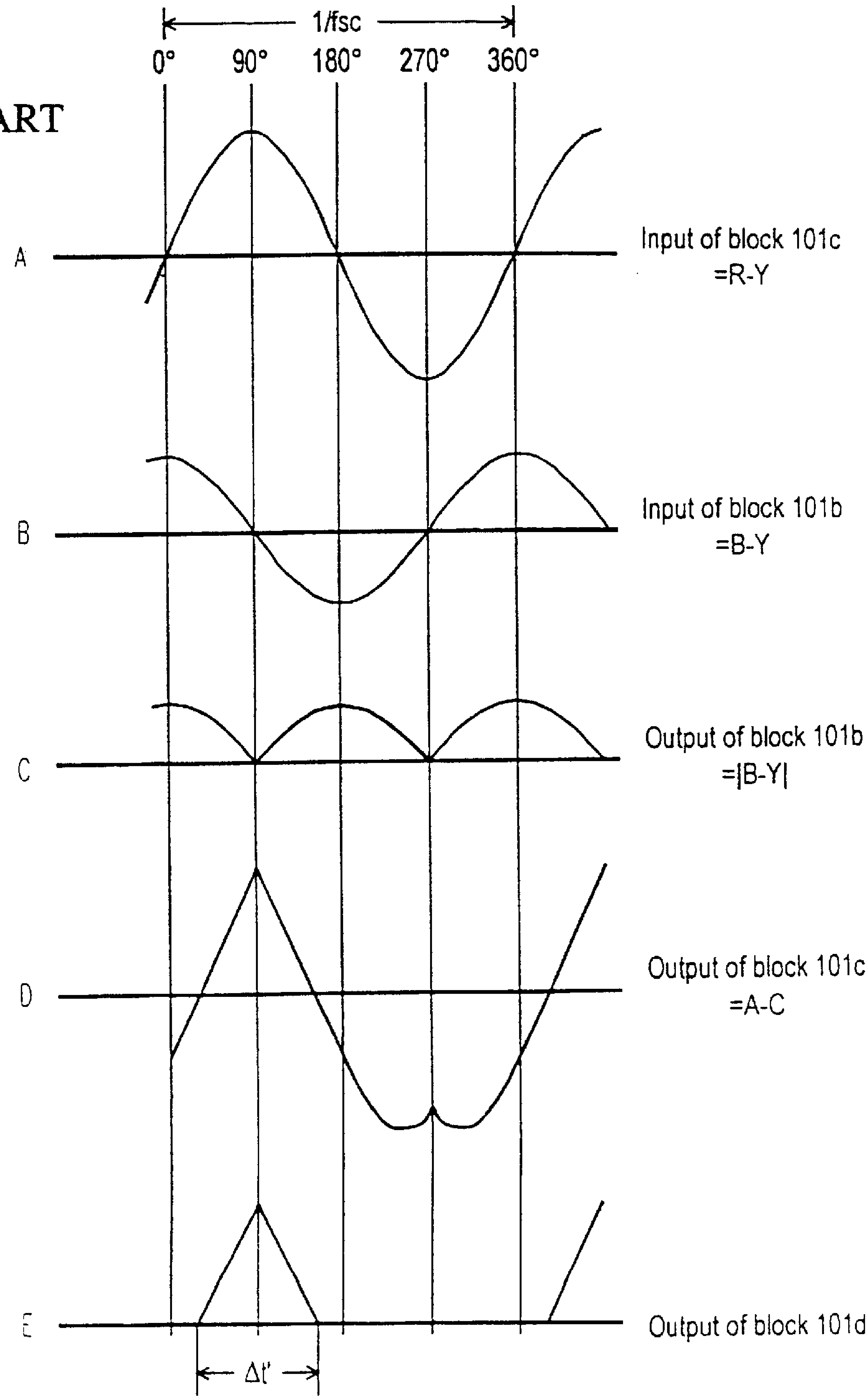


FIG. 6
PRIOR ART

FIG. 7

PRIOR ART



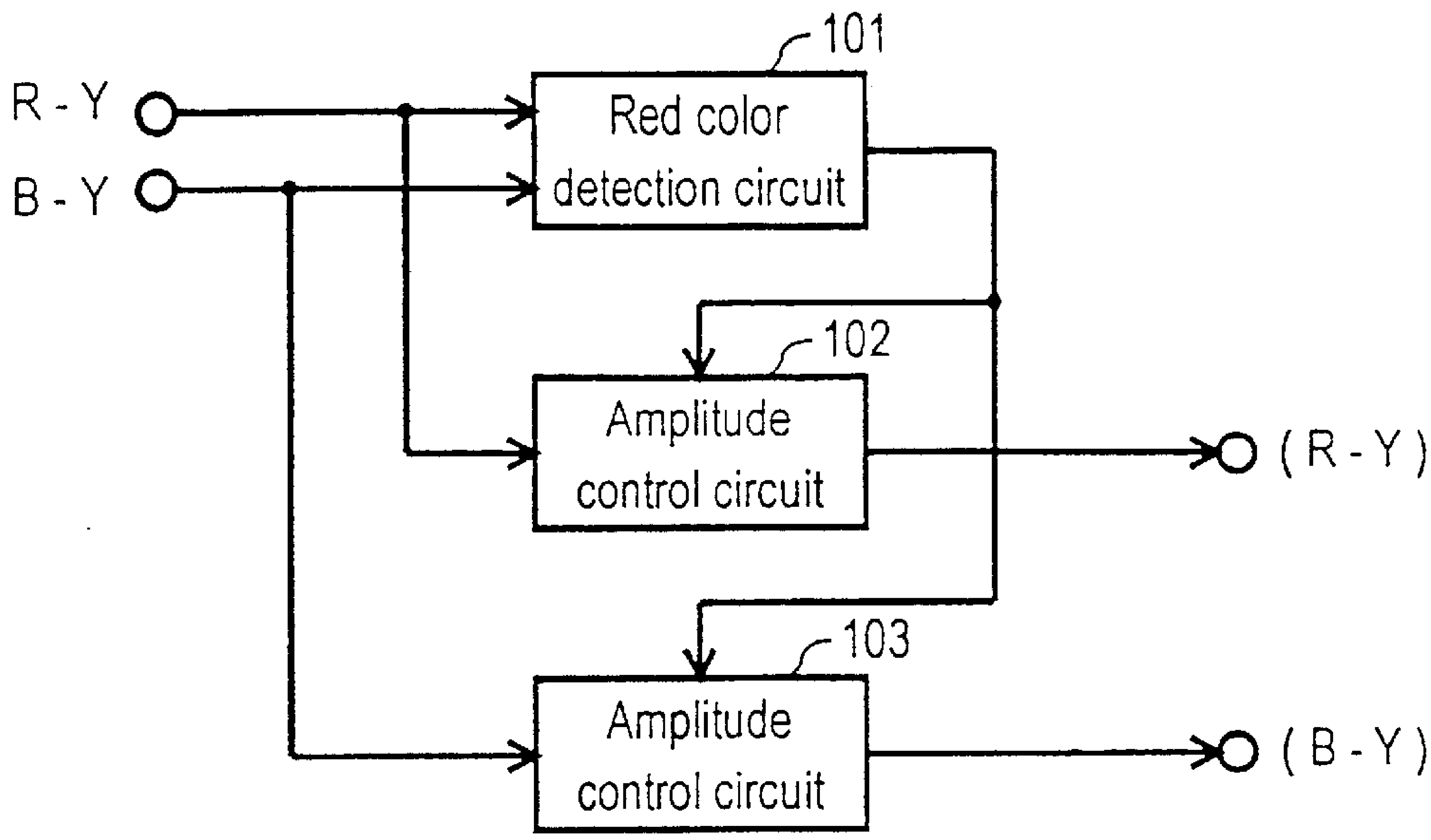


FIG. 8

PRIOR ART

PURE RED COLOR DETECTION CIRCUIT AND COLOR COMPENSATION CIRCUIT USING THE SAME

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

FIELD OF THE INVENTION

The present invention relates to a pure red color detection circuit and a color compensation circuit compensating color differential signals by using it and emphasizing the red color.

BACKGROUND OF THE INVENTION

Television receivers having a high additional value have been developed according to their increased screen sizes and high quality color television receivers having a good red color reproducibility are desired.

Block diagrams of a red color detection circuit and a color compensation circuit in accordance with the prior art disclosed in Japanese Patent Laid-Open No.5-233667 are shown in FIGS. **6** and **8**, respectively. The function of a red color detection circuit is explained below, referring to FIGS. **6** and **7**.

FIG. **6** shows a block diagram of a red color detection circuit **101** of the prior art and FIG. **7** shows signal waveforms at various points of red color detection circuit **101**. Red color detection circuit **101** includes an absolute value outputting circuit **101**b, a subtracter **101**c and a limiter **101**d. In FIG. **7**, waveforms A and B are color differential signals (R-Y) and (B-Y), respectively which are input to red color detection circuit **101** and the color differential signal (R-Y) is behind the color differential signal (B-Y) by 90 degrees in phase. An absolute value B-Y is made from the input color differential signal (B-Y) at absolute value outputting circuit **101**b and is output (waveform C) and is input to subtracter **101**c. Subtracting the output of absolute value outputting circuit **101**b B-Y (waveform C) from color differential signal (R-Y) (waveform A) at subtracter **101**c (waveform D) and only a positive part is outputted from limiter **101**d (waveform E).

Because this signal exists near the phase of 90 degrees, the detected output is a signal corresponding to a red color in the input chrominance signal.

The function of a color compensation circuit of the prior art is explained below, referring to FIG. **8**. The color compensation circuit includes red color detection circuit **101**, an amplitude control circuit **102** for a color differential signal (R-Y) and another amplitude control circuit **103** for a color differential signal (B-Y). A color differential signal (R-Y) and red color detected signal (waveform E) in FIG. **7** output from red color detection circuit **101** are supplied to amplitude control circuit **102** and the color differential signal (R-Y) is controlled by the red color detected signal so that the amplitude decreases. Also a color differential signal (B-Y) and the red color detected signal output from red color detection circuit **101** are supplied to amplitude control circuit **103** and also the color differential signal (B-Y) is controlled by the red color detected signal so that the amplitude decreases. Thus, suppressing a signal having a large red component prevents red color from saturation.

This circuit, however, aims to prevent red color saturation and a different kind of apparatus is necessary for improving red color reproducibility which is intended in the present invention. The present invention detects a signal closer to a pure red color in a red color detection circuit and decreases a Y/C ratio, emphasizes a red color without saturating the red color and as a result, improves red color reproducibility by decreasing the luminance signal Y by the red color detection signal and bringing a color phase of the chrominance signal C closer to a red color by the red color detection signal in the color compensation circuit.

SUMMARY OF THE INVENTION

A pure red color detection circuit of the present invention slices a subcarrier modulated color differential signal (R-Y) at a designated level at a slice circuit, generates an absolute value signal of a subcarrier modulated color differential signal (B-Y) at an absolute value outputting circuit, subtracts the absolute value B-Y from the sliced signal at a subtracter, takes out only a positive part of the subtracted signal at a limiter and outputs. The output signal is a signal having a narrow phase range near 90 degrees in the chrominance signal and as a result, a pure red color is detected.

A color compensation circuit of the present invention includes the above mentioned pure red color detection circuit, a Y signal compensation block, an (R-Y) signal compensation block and a (B-Y) signal compensation block and decreases a Y/C ratio, makes the chrominance signal containing a red color signal higher than a designated level close to a pure red color, emphasizes the red color without saturation and can improve red color reproducibility by outputting a luminance signal Y' which is made by subtracting the pure red signal detected at the pure red detection circuit from the input luminance signal Y, at the Y signal compensation block, outputting a color differential signal (R-Y)' which is made by adding the pure red signal detected at the pure red color detection circuit to the input (R-Y) signal, at the (R-Y) signal compensation block and outputting a color differential signal (B-Y)' which is made by subtracting the pure red signal detected at the pure red detection circuit from the input color differential signal (B-Y), at the (B-Y) signal compensation block.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a pure red color detection circuit in accordance with an exemplary embodiment of the present invention.

FIG. **2** shows waveforms at various points in a pure red color detection circuit in accordance with an exemplary embodiment of the present invention.

FIG. **3** is a block diagram of a color compensation circuit in accordance with an exemplary embodiment of the present invention.

FIG. **4** shows color phase coordinates explaining how to rotate a vector of a chrominance signal close to an (R-Y) axis at a color compensation circuit in accordance with an exemplary embodiment of the present invention.

FIG. **4A** shows color phase coordinates when the vector of a chrominance signal C is in a first quadrant.

FIG. **4B** shows color phase coordinates when the vector of a chrominance signal C is in a second quadrant.

FIG. **5** is another block diagram of a (B-Y) signal compensating block of a color compensation circuit in accordance with an exemplary embodiment of the present invention.

FIG. **6** is a block diagram of a red color detection circuit in accordance with the prior art.

FIG. **7** shows waveforms at various points in a red color detection circuit in accordance with the prior art.

FIG. **8** is a block diagram of a color compensation circuit in accordance with the prior art.

PREFERRED EMBODIMENTS OF THE INVENTION

(First exemplary embodiment)

The function of a pure red color detection circuit is explained below, referring to FIGS. **1** and **2**. All the signals treated in the exemplary embodiments are digital data. A block diagram of a pure red color detection circuit of the present invention is shown in FIG. **1** and waveforms at various points in the pure red color detection circuit are expressed by analog signals as shown in FIG. **2**. The pure red color detection circuit **1** includes a slice circuit **1**a, an absolute value outputting circuit **1**b, a subtracter **1**c and a limiter **1**d. In FIG. **2**, waveforms A and B are color differential signals (R-Y) and (B-Y) supplied to the pure red detection circuit, respectively and the color differential signal (R-Y) is delayed from the color differential signal (B-Y) by 90 degrees in phase. The color differential signal (R-Y) is sliced at sliced levels +/−Ls at slice circuit **1**a and a signal over the slice levels is output (waveform C in FIG. **2**) and is supplied to a subtracter **1**c. An absolute value B-Y is generated from the color differential signal (B-Y) at absolute value outputting circuit **1**b (waveform D) and is supplied to subtracter **1**c. The output of absolute value outputting circuit **1**b (waveform D) is subtracted from the output of slice circuit **1**a (waveform C) at subtracter **1**c (waveform E) and only a positive part of the subtracted signal it output from limiter **1**d (waveform F). The detected signal is narrower in width in the present invention than that of the prior art because of being added with a slice circuit (t indicated in waveform F, FIG. **2** of the present invention compared with t' indicated in waveform F, FIG. **7** of the prior art), and a signal concentrated near 90 degrees, expressing by a color phase, that is close to the (R-Y) axis is detected. As a result, a signal close to a pure red color contained in the input chrominance signal is detected.

Thus, according to the present invention, a purer red color can be detected by outputting a red color detection signal only from a chrominance signal including a red color signal higher than a designated slice level.

(Second exemplary embodiment)

The function of a color compensation circuit of the present invention is explained below, referring to a block diagram shown in FIG. **3**. The color compensation circuit includes a pure red color detection circuit **1**, a Y signal compensation block **50**, an (R-Y) signal compensation block **51** and a (B-Y) signal compensation block **52**. Y signal compensation block **50** includes a subtracter **50**a and a gain controller **50**b. (R-Y) signal compensation block **51** includes an adder **51**a and a gain controller **51**b. (B-Y) signal compensation block **52** includes an adder **52**a, a gain controller **52**b, a polarity inverter **52**c, signal selection circuit **52**d and a polarity discriminater **52**e. Pure red color detection circuit **1** are supplied with color differential signals (R-Y) and (B-Y) and outputs a pure red detection signal R. The pure red color detection signal R is supplied to Y signal compensation block **50** and (R-Y) signal compensation block **51**.

Pure red color detection signal R supplied to Y signal compensation block **50** is gain-controlled at gain controller **50**c and is supplied to subtracter **50**a. Subtracter **50**a subtracts the gain-controlled pure red color detected signal R' from the luminance signal Y and outputs the result. The output signal is a luminance signal Y', the luminance of which corresponding to the pure red color part is somewhat suppressed.

Pure red color detection signal R supplied to (R-Y) signal compensation block **51** is gain-controlled at gain controller **51**c and is supplied to adder **51**a. Adder **51**a adds the gain-controlled pure red color detected signal R' to the color differential signal (R-Y) and outputs the result. As shown in FIG. **4**, adder **51**a outputs a red color differential signal (R-Y)' with an increased amplitude, when the chrominance signal C is in a first quadrant (FIG. **4**A) or in a second quadrant (FIG. **4**B).

The output R of pure red color detection circuit **1** and the color differential signal (B-Y) are supplied to (B-Y) signal compensation block **52**. The output R of the pure red color detection circuit **1** is gain-controlled in gain controller **52**b (B') and its polarity is inverted by polarity inverter **52**c (−B'). Both signals before and after polarity inversion are supplied to a signal selection circuit **52**d. The other input color differential signal (B-Y) of (B-Y) signal compensation block **52** is discriminated its polarity by polarity discriminater **52**e and switches the connection in signal selection circuit **52**d. Signal selection circuit **52**d is controlled to select the output of polarity inverter **52**c (connect to the upper terminal of the switch in FIG. **3**) when polarity discriminater **52**e judges that the input color differential signal (B-Y) is positive and to select the input of polarity inverter **52**c (connect to the lower terminal of the switch in FIG. **3**) when polarity discriminater **52**e judges that the input (B-Y) signal is negative. Adder **52**a adds the positive or negative pure red color detected signal (B' or −B') of signal selection circuit **52**d to the input color differential signal (B-Y) and outputs the added signal. As shown in FIG. **4**, when the chrominance signal C is in a first quadrant (FIG. **4**A), in other words the color differential (B-Y) signal is positive, signal selection circuit **52**d selects the output of polarity inverter **52**c and (B-Y) signal compensation block **52** outputs the value corresponding to {(B-Y)−B'}. As a result, the amplitude of the (B-Y) signal decreases. When the chrominance signal C is in a second quadrant (FIG. **4**B), in other words the color differential signal (B-Y) is negative, signal selection circuit **52**d selects the input of polarity inverter **52**c and (B-Y) signal compensation block **52** outputs the value corresponding to −{(B-Y)−B'}. As a result the amplitude of the (B-Y) signal also decreases.

As shown in FIG. **4**, when the chrominance signal is in a first quadrant or in a second quadrant, the synthesized chrominance signal C' rotates to be close to the (R-Y) axis in phase, because the (R-Y) component increases and (B-Y) component decreases by using the pure red color detected signal. The Y/C ratio is decreased, because the level of the luminance signal Y is lowered by the pure red color detected signal for a red part. By lowering the luminance level for a red part and rotating, the phase of a color close to red towards the (R-Y) axis is realized. As a result, yellowish color included in red is eliminated and a red color with high purity is reproduced.

A block diagram of another composition of a (B-Y) signal compensation block included in a color compensation circuit is shown in FIG. **5**. The (B-Y) signal compensation block **152** includes an adder **152**a, a gain controller **152**b, a multiplier **152**f and a polarity discriminator **152**e.

The output R of pure red color detection circuit **1** and a (B-Y) signal are inputted to (B-Y) signal compensation block **152**. The output of pure red color detection circuit **1** R is gain-controlled in gain controller **152**b (B') and is supplied to multiplier **152**f. On the other hand, the (B-Y) signal is discriminated its polarity in polarity discriminater **152**e and if the (B-Y) signal is positive, a signal corresponding to −1 is outputted and if it is negative, a signal corresponding to +1 is outputted. The signals are supplied to multiplier **152**f. The output B' of gain controller **152**b is multiplied by the output of polarity discriminater **152**e, i.e. the value corresponding to 1 in multiplier **152**f and the multiplied output is supplied to adder **152**a. Therefore, multiplier **152**f works as a combination of a polarity inverter (**52**c in FIG. **3**) and a signal selection circuit (**52**d in FIG. **3**). Adder **152**a adds the output of multiplier **152**f to the other input (B-Y). Because multiplier **152**f works as a combination of a polarity inverter (**52**c in FIG. **3**) and a signal selection circuit (**52**d in FIG. **3**), the (B-Y) signal compensation block **152** also has the same function as the above mentioned (B-Y) signal compensation block **52**.

In the color phase coordinates shown in FIG. **4**, if the chrominance signal is in a first quadrant (FIG. **4**A), multiplier **152**f outputs the value corresponding to –B' and (B-Y) signal compensation block **152** outputs the value corresponding to {(B-Y)–B'} so that the amplitude decreases. If the chrominance signal C is in a second quadrant (FIG. **4**B), multiplier **152**f outputs the value corresponding to +B' and (B-Y) signal compensation block **152** outputs the value corresponding to –{(B-Y)–B'} so that the amplitude also decreases.

INDUSTRIAL APPLICABILITY

Thus, according to the present invention, in the pure red color detection circuit, a pure red color signal can be detected by slicing a color differential signal (R-Y) at a designated slice level, subtracting an absolute value of the color differential signal (B-Y) from the sliced (R-Y) signal and taking out only the positive part of the subtracted signal.

In a color compensation circuit using the pure red color detection circuit, the chrominance signal C can be rotated closer to the (R-Y) axis. This improvement is performed by decreasing the level of the high saturated red part and decreasing a Y/C ratio for a luminance signal Y, and adding the pure red detection signal and increasing the amplitude for the color differential signal (R-Y) and decreasing the amplitude by the pure red detection signal for the color differential signal (B-Y).

In a color television receiver using the above mentioned circuit, saturation is prevented for a strong red part, yellowish color contained in red is eliminated, highly pure red is reproduced and a picture with excellent color reproducibility can be obtained.

REFERENCE NUMERALS

1 . . . red color detection circuit
1a . . . slice circuit
1b . . . absolute value outputting circuit
1c . . . subtracter
1d . . . limiter
50 . . . Y signal compensation block
51 . . . (R-Y) signal compensation block
52 . . . (B-Y) signal compensation block
50a . . . subtracter
51a, **52**a, **152**a . . . adder
50b, **51**b, **52**b . . . gain controller
52c . . . polarity inverter
52d . . . signal selection circuit
52e, **152**e . . . polarity discrimination circuit
52f, **152**f . . . multiplier

What is claimed is:

1. A pure red color detection circuit comprising:

a slice [means] *circuit* for [inputting] *receiving* a color demodulated color-difference signal (R-Y) and for [extracting] *outputting* an (R-Y) signal component at a slice level (Ls);

absolute value means for inputting a color demodulated color-difference signal (B-Y) and for outputting an absolute value component of said [inputted] color-difference signal (B-Y);

subtraction means for subtracting the absolute value component of the (B-Y) signal [output from said absolute value means], from the (R-Y) signal *sliced* at said slice level (Ls) [and output from said slice means]; and

[limited means] *a limiter* for removing a negative component of [the] *a* signal output from said subtraction means and for outputting a red color component having an (R-Y) signal component in *a* first [and] *or a* second quadrant[s] *in a Cartesian plane*.

2. A color compensation circuit comprising:

red color detection means for detecting a red component, using color difference signals (R-Y) and (B-Y); and

Y signal compensation means [for compensating a Y signal, using the] *which receives an* output signal of said red color detection means; [and] wherein

said Y signal compensation means comprises:

[first] gain control means for decreasing [the] *an* output signal amplitude of said red color detection means; and

[second] subtraction means for subtracting [the] *an* output signal of said [first] gain control means from the Y signal.

3. A color compensation circuit comprising:

red color detection means for detecting a red component, using color difference signals (R-Y) and (B-Y); and

(R-Y) signal compensation means for compensating said (R-Y) signal, [using the] *which receives an* output signal of said red color detection means; [and] wherein

said (R-Y) signal compensation means comprises:

[second] gain control means for controlling [the] *an* output signal amplitude of said red color detection means; and

[first] addition means for adding said (R-Y) signal and [the] *an* output signal of said [second] gain control means.

4. A color compensation circuit comprising:

pure red color detection means for [inputting] *receiving* color demodulated (R-Y) and (B-Y) [signal] *signals* and detecting a red color from the (R-Y) and (B-Y) signals;

gain control means for controlling gain of a red [detecting] *detection* signal detected [as] *at* said pure red color detection means and outputted from said pure red color detection means; and

addition means [inputting] *for receiving* an output signal from said gain control means and the (B-Y) signal, and outputting a compensated (B-Y) signal as a (B-Y)' signal.

5. A color compensation circuit comprising:

pure red color detection means for [inputting] *receiving* color demodulated (R-Y) and (B-Y) signals and for detecting a red color from the (R-Y) and (B-Y) signals;

first and second gain control means for controlling gain of a red [detecting] *detection* signal detected at said pure red color detection means and outputted from said pure red color detection means;

first addition means for [inputting the] *receiving an* output signal from [said first] *a third* gain control means and the (B-Y) signal, and for outputting a compensated (B-Y) signal as a (B-Y)' signal; and second addition means for [inputting the] *receiving an* output signal from said second gain control means and the (R-Y) signal, and for outputting a compensated (R-Y) signal as a (R-Y)' signal.

6. A color compensation circuit comprising:

pure red color [detecting] *detection* means for detecting a red color component, using color-difference signals (R-Y) and (B-Y);

first, second and third gain control means for independently controlling gain of a signal detected at said pure red color detection means;

[second] *first* subtraction means for [inputting the] *receiving a* signal output from said first gain control means and a Y signal, and for subtracting the signal output from said [second] first gain control means from said Y signal;

first addition means [inputting the] *for receiving a* signal output from said second gain control means and the (R-Y) signal; [and]

second addition means [inputting the] *for receiving a* signal output from said third gain control means and the (B-Y) signal; [and] *wherein*

said pure red color detection means includes:

slice means for [inputting] *receiving* a color demodulated color-difference signal (R-Y) and for [extracting] *outputting* an (R-Y) signal component at a slice level;

absolute value means for inputting a color demodulated color-difference signal (B-Y) and for outputting an absolute value component of said [inputted] color-difference signal (B-Y);

[first] *second* subtraction means for subtracting the absolute value component of the (B-Y) signal [output from said absolute value means,] from the (R-Y) signal at said slide level [and output from said slice means]; and

limiter means for removing a negative component of [the] *a* signal output from said *second* subtraction means and for outputting a red color component having an (R-Y) signal component in first and second quadrants.

7. A color compensation circuit comprising:

red color detection means for detecting a red component, using color differential signals (R-Y) and (B-Y); and

(B-Y) signal compensation means for decreasing an absolute value of said color differential signal (B-Y), using [the] *an* output signal of said red color detection means[,]*;* wherein said (B-Y) signal compensation means includes:

[third] gain control means for decreasing the amplitude of [the] *an* output signal of said red color detection means;

polarity discrimination means for judging an output signal polarity of said color difference signal (B-Y);

polarity inverting means for inverting [the output] *a* signal polarity of *an output signal from* said [third] gain control means;

signal selection means for outputting an output signal of said polarity inverting means if said color differential signal (B-Y) has a positive polarity and outputting an output signal of said [third] gain control means if said color difference signal (B-Y) has a negative polarity; and

[third] addition means for adding [the] *an* output signal of said signal selection means and said color difference signal (B-Y).

8. A color compensation circuit comprising:

red color detection means for detecting a red component, using color differential signals (R-Y) and (B-Y); and

(B-Y) signal compensation means for decreasing an absolute value of said color differential signal (B-Y), using [the] *an* output signal of said red color detection means[,]*;* wherein said (B-Y) signal compensation means comprises:

[third] gain control means for decreasing [the] *an* amplitude of the output signal of said red color detection means;

polarity discrimination means for judging [the] *a* polarity of said color difference signal (B-Y) and outputting *a* +1 *if said color difference signal (B-Y) has a negative polarity* or *a* −1 [signal] *if said color difference signal (B-Y) has a positive polarity*;

multiplication means for multiplying [the] *an* output signal of said [third] gain control means by [the] *an* output signal of said polarity discrimination means; and

[third] addition means for adding [the] *an* output signal of said multiplication means and said (B-Y) signal.

9. A color compensation circuit as defined in claim 2, [further including a pure] *wherein said* red color detection [circuit which] *means* comprises:

slice means for slicing a color difference signal (R-Y) with a designated slice level and outputting *a sliced signal*;

absolute value means for outputting an absolute value of a color difference signal (B-Y);

[first] *second* subtraction means for subtracting [the] *an* output signal of said absolute value means from the [output] *sliced* signal of said slice means; and

limiter means for removing a negative polarity part of [the] *an* output signal of said [first] *second* subtraction means.

10. A color compensation circuit as defined in claim 3, [further including a pure] *wherein said* red color detection [circuit which] *means* comprises:

slice means for slicing a color difference signal (R-Y) with a designated slice level and outputting *a sliced signal*;

absolute value means for outputting an absolute value of a color difference signal (B-Y);

[first] subtraction means for subtracting [the] *an* output signal of said absolute value means from the [output] *sliced* signal of said slice means; and

limiter means for removing a negative polarity part of [the] *an* output signal of said [first] subtraction means.

11. A color compensation circuit as defined in claim 4, [further including a pure] *wherein said* red color detection [circuit which] *means* comprises:

slice means for slicing a color differential signal (R-Y) with a designated slice level and outputting *a sliced signal*;

absolute value means for outputting an absolute value of a color difference signal (B-Y);

[first] subtraction means for subtracting [the] *an* output signal of said absolute value means from the [output] *sliced* signal of said slice means; and

limiter means for removing a negative polarity part of [the] *an* output signal of said [first] subtraction means.

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