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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Automatic Chroma Control Circuit

We, RCA CORPORATION, formerly Radio Corporation of America, a corporation organised 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:—

This invention relates to an improvement in automatic chroma control (A.C.C.) circuits for use in color television receivers.

Automatic chroma control circuits have been provided that derive a d.c. voltage proportional to the amplitude of the color synchronizing signal bursts and utilize it to vary the gain of the chrominance signal amplifier inversely to changes in the burst amplitude. The burst signal is selected for use as a reference because it has a fixed amplitude, and therefore, any variation in its amplitude is usually proportional to undesired variations in amplitude of the chrominance signal. In an open loop A.C.C. system the burst and chrominance amplifiers are operated in parallel so that the A.C.C. voltage derived from the bursts at the output of the burst amplifier and applied to control the gain of the chrominance amplifier is not affected by the gain of the chrominance amplifier. In a closed loop A.C.C. system, the chrominance and burst amplifiers are in series so that the A.C.C. voltage derived from the bursts at the output of the burst amplifier is directly affected by the gain of the chrominance amplifier to which it is applied.

In either type of A.C.C. circuit, variations in the gain of the burst amplifier caused by noise induced voltage at its input electrode can produce corresponding erroneous changes in the amplitude of the bursts at its output and in the value of the A.C.C. voltage derived from them. The application of this A.C.C. voltage to the chrominance amplifier produces a corresponding erroneous change in its gain so that the chrominance signals at its output do not have the desired amplitude.

Automatic chroma control circuitry embodying this invention includes means to compensate for errors introduced by noise at the input of the burst amplifier. This objective is achieved by modifying the A.C.C. voltage derived from the burst signal with the noise induced voltage at the input electrode of the burst amplifier.

The invention may be best understood by reference to the following description and the accompanying drawings in which:

FIGURE 1 is a schematic diagram partially in block form of a color television receiver having a closed loop type of A.C.C. system incorporating the present invention, and

FIGURE 2 is a schematic block diagram which illustrates the application of this invention to a color television receiver having an open loop A.C.C. system.

The general organization of the various components of the receiver of FIGURE 1 is as follows. An antenna 2 intercepts transmitted signals and applies them to a tuner, I.F. amplifier and second detector, all designated by the numeral 4. Detected signals are amplifier in video amplifier 6 and applied to kinescope 8. They are also applied via driver amplifier 10 to synchronize deflection system 11, the output of which is applied to the deflection windings 13 of the kinescope 8. An output of an amplifier 10 and keying pulses from the deflection system 11 are

[*Price 5s. 0d. (25p)*]

applied to A.G.C. circuit 16. The A.G.C. circuit 16 produces a voltage that is applied to control the gain of the tuner and I.F. amplifier so that the video signal is maintained at a desired level at the input of the video amplifier 6.

In the chrominance channel, the chrominance signals and color synchronizing bursts appearing at the output of the amplifier 10 are amplified by a frequency selective chrominance amplifier 12, the gain of which is to be controlled in accordance with this invention. Separation of the bursts from the output of the chrominance amplifier 12 is effected by a burst separating means shown as a burst gate amplifier 14. The color burst is applied to the frequency determining portion 17 of the crystal controlled color reference oscillator 18 so as to synchronize its phase and frequency. The output of the oscillator 18 is applied to color signal detection circuits 20 along with chrominance signals coupled from the output of the chrominance amplifier 12 via lead 22. The color signals are then applied to respective portions of the color kinescope 8. Color synchronizing burst are prevented from interfering with the operation of the color signal detection circuits by pulses supplied to it via lead 24 from a keyed burst blanking triode 26. The triods 26 also aids in translating the A.C.C. potential provided by circuit 28 to control the gain of the chrominance amplifier 12.

The driver amplifier 10 includes pentode tube 30 having a control grid 31 coupled to the output of the second detector 4. A grid leak resistor 32 is connected between ground and the grid 31, and the cathode 34 is connected to ground. The screen grid 36 is provided with a suitably bypassed positive operating potential by a screen resistor 38 and bypass capacitor 40. Amplified video signals are produced across an anode resistor 42 connected between anode 44 and a point of positive potential. These video signals are applied via lead 45 to the A.G.C. system 16 and the deflection system 11.

Chrominance signals and the color synchronizing bursts are separated from the rest of the amplified video signals appearing at the anode 44 and applied to a control grid 46 of pentode 47 of the chrominance amplifier 12. The input of chrominance amplifier 12 is developed across the resonant circuit to signal ground comprised of a d.c. blocking capacitor 48, an inductor 50, a resistor 52 and a bypass capacitor 54. The pentode 47 is biased by a parallel resistor 58 and capacitor 60 connected between cathode 56 and ground. Operating potential for the screen grid 62 is supplied from a point of positive voltage via a voltage divider formed by resistors 66 and 69. Suitable bypass of signal frequencies is provided by a capacitor 68. The suppressor grid 70 is internally connected to the cathode 56. Amplified chrominance signals and color synchronising bursts are produced across a primary winding 72 of a bandpass output transformer 74 by connecting the winding in series with a voltage dropping resistor 76 between the anode 77 and a point of positive d.c. potential. Suitable signal bypass is provided by capacitor 78. The signals appearing across lower portion 80 of the secondary winding of transformer 74 are coupled via lead 22 to the color signal detection circuits 20. Both the primary winding 72 and the secondary winding 80, 82 are tuned to resonance for the chrominance signals by inherent stray capacitance.

The chrominance signals and bursts across the entire secondary windings are coupled by a capacitor 84 to control grid 86 of pentode 87 comprising the burst gate amplifier 14. The pentode 87 is rendered conductive when the bursts are present by positive pulses 88 coupled from an auxiliary winding 90 on the line deflection transformer. These pulses are coupled to the grid 86 via a voltage divider comprised of a resistor 92 and the grid leak resistor 94. Between bursts, when the chrominance signals are present at the grid 86, the pentode 87 is held nonconductive by reason of the positive voltage developed during the burst interval and stored by the RC circuit consisting of parallel cathode resistor 95 and capacitor 98. Suitable positive potential for the screen is supplied by resistor 100 and a bypass capacitor 102. Positive operating potential for the anode 103 is supplied via a choke 104 and the primary winding 106 of an output transformer 108. A signal ground is supplied by a capacitor 111.

Selection of the color subcarrier frequency from the amplified color synchronizing bursts appearing across the primary winding 106 is accomplished by the filter 17, which is comprised of a crystal 109 and a variable capacitor 110 connected in series across the secondary winding 112 of the transformer 108. The junction of the winding 112 and the capacitor 110 is connected to ground. The value of impedance coupled into the circuit via the primary winding 106 is reduced by making the numbers of turns on the secondary winding 112 small in comparison with the number of turns in the primary winding 106. The effective inductance of the secondary winding 112 is reduced by connection of a resistor 113, which has a low value, in shunt with the secondary winding 112. The crystal 109 is manufactured to exhibit an inductive reactance at the frequency of the color subcarrier. The capacitor 110 is adjusted so that the circuit 112, 109, 110 and 113 is resonant at the subcarrier frequency. The Q of this circuit is sufficiently high to practically eliminate the flow of currents of other frequencies during the period when the burst

is present. The voltage wave of color subcarrier frequency that is produced across the capacitor 110 is applied to a control grid 114 of a pentode amplifier 115 of the oscillator 18 so as to synchronize its phase and frequency to that of the burst.

In the oscillator 18 the cathode 116 is connected to ground. A parallel resonant circuit, comprised of tuning capacitor 118, bypass capacitor 120 and inductor 122, is connected between ground and the screen grid 124. Positive operating potential for the screen grid is supplied via a resistor 126. The capacitor 120 is a bypass capacitor so that the inductor 122 is effectively in parallel with the capacitor 118 at the oscillator frequency. It will be noted that the crystal 109 and capacitor 110 are effectively in parallel between the control grid 114 and ground so that the control grid 114, cathode 116 and screen grid 124 operate like a tuned plate tuned grid oscillator. The strength of the oscillations can be adjusted by varying the inductance of the inductor 112. An output transformer 128 couples the oscillations to the color signal detection circuits 20.

The oscillator 18 provides a control voltage that varies with the amplitude of the bursts as follows. In the absence of the bursts, the oscillator action produces an alternating current voltage at the grid 114 which is rectified by the grid cathode diode, so as to produce a negative d.c. voltage component at the grid 114. The magnitude of the alternating current wave at the grid 114, and hence the magnitude of the d.c. voltage component, can be adjusted within limits by changing the inductance of the inductor 122. When the bursts are present, and when their subcarrier frequency is added in phase with the alternating current wave produced at the grid 114 by the oscillator action, the d.c. voltage component produced thereat is increased in proportion to the amplitude of the bursts. The d.c. voltage component produces a corresponding direct current in the grid leak path to be discussed. The burst gate amplifier 14, filter 17, grid 114 and the cathode 116 thus constitute means coupled to the output of the chrominance amplifiers 12 for producing a direct current control voltage that varies in value in accordance with the amplitude variations of the bursts.

The A.C.C. circuit 28 is comprised of a current responsive amplifier such as transistor 129 having its emitter 130 connected via a grid leak resistor 132 to the grid 114 of the oscillator pentode 115. A capacitor 134 is connected between the emitter 130 and ground for purposes of removing the color subcarrier frequency from the emitter 130. A ground connection is made to the base electrode 136 of the transistor 129, and its collector 138 is connected by a load resistor 140 to a point of positive potential. Due to the fact that color synchronizing bursts are not transmitted during the field or vertical blanking periods, the alternating current wave supplied from the capacitor 110 to the grid 114 of the pentode 115 decays in amplitude during these periods, thus causing the d.c. voltage component at the grid 114 to be reduced and introducing line frequency components into the current supplied to the emitter 130. A capacitor 142 connected between the collector 138 and ground in combination with the load resistor 140 forms a filter that aids in removing these components from the A.C.C. signal.

In the grid leak path for the grid 114 of the oscillator amplifier 115, a small portion of the grid leak current flows between the emitter 130, and the grounded base 136. Transistor action causes the remainder of the grid leak current to flow through the collector 138, the load resistor 140 and the power supply, not shown, and produce at the collector 138 a voltage that varies in the same sense as the rectified voltage at the grid 114. Both voltages change in a negative direction as the amplitude of the bursts increases. Because the resistance of the load resistor 140 is large, the changes in the d.c. voltage at the collector 138 are much greater than changes in the d.c. component of the voltage at the grid 114. A distinct advantage of the circuit is that the small impedance of the forward biased base-emitter junction permits the presence of the transistor 128 to have little or no effect on the operation of the oscillator 18.

Although the amplified voltage at the collector 138 varies in the correct direction for A.C.C. purposes, its variations occur within a range that is too positive for direct application to the gain control grid 46 of the chrominance amplifier 12, and therefore, means are provided for translating it. For this purpose, resistors 146 and 148 are connected in series between the collector 138 and a source of negative potential, and the d.c. translated A.C.C. signal is produced at their junction 149. It is applied to the grid 46 by a connection between the junction 149 and the ungrounded side of a filter capacitor 54. The capacitor 54 further reduces signal components of field frequency.

Although other sources of negative voltage for the resistor 148 could be used, the particular one illustrated is the grid 150 of the blanker triode 26. Its anode 152 is connected to a point of positive operating potential by a resistor 154, and its cathode 155 is biased by a parallel resistor 156 and capacitor 158. Positive pulses 160 are derived from the line deflection circuit in the deflection system 11 and are coupled to the grid 150 by a capacitor 164, resistor 166 and grid leak resistor 168. These components serve to clip and clamp the pulses 160 so as to cause the triode

26 to conduct during the time when the color synchronizing bursts are present. The conduction of the triode 26 produces positive pulses at the cathode 155 that are coupled via the lead 24 to a point, not shown, in the color signal detection circuit 20. These pulses are used for various purposes in that circuit. During the crest of the pulses 160, capacitor 164 is charged, and in between pulses it slowly discharges to ground through the resistors 166 and 168 so as to produce a negative d.c. voltage at their junction. The bypass capacitor 54 and the resistor 148 form a filter that reduces the amplitude of the pulse voltage at the grid 46. The resistance of the resistors 148 and 146 is large enough in comparison with the resistance of the load resistor 140 as to have little effect on the value of the current at the collector 138.

If the grid leak resistor 94 were connected to ground rather than to the emitter 130, positive noise at the grid 86 of the burst gate amplifier tube 87 could cause the grid to draw current and to charge the capacitor 84, as well as any inherent capacitance between the grid and ground, to a negative voltage that reduces the gain of the burst gate amplifier 14. When this occurs, the amplitude of the bursts applied to the crystal filter 17, the fundamental frequency across the capacitor 110, and the d.c. component of the voltage at the grid 114 of the oscillator amplifier 115 and all reduced. As a result, less leakage current flows between the grid 114 and the emitter 130 and the A.C.C. voltage across the load resistor 140 diminishes. This increases the gain of the chrominance amplifying stage 12 so as to increase the level of the chrominance signals applied to the color signal demodulation circuit 20. This change in level is an error inasmuch as it is caused by the noise at the grid 86 of the burst gate amplifier 87 and not by any change in the amplitude of the bursts applied thereto.

In accordance with this invention, such an error may be minimized by returning the grid leak resistor 94 to the emitter 130 as described, rather than to ground. With this connection, an increase in the noise at the grid 86 increases the current flowing into the emitter 130 from the grid leak resistor 94 so as to tend to compensate for the decrease in current flowing between the emitter 130 and the grid 114. If the increase in the compensating current between the grid 86 and the emitter 130 is exactly equal to the decrease in current flowing between the grid 114 and the emitter 130, no change is produced in the A.C.C. voltage by the presence of noise as the total current flowing through the emitter 130 is unaffected by the noise. The amount of compensating current is determined by the ratio of the resistors 92 and 94 and their equivalent parallel resistance.

It is important to note, however, that noise at the grid 86 has no significant direct effect on the voltage at the grid 114 because the filter 17 has such a narrow bandwidth. Any change in the voltage at the grid 114 is caused indirectly by the effect of noise at the grid 86 on the amplitude of the bursts. This is important because as the noise at the grid 86 increases, the amplitude of the bursts and the negative d.c. voltage component at the grid 114 decreases. Whereas, application of noise to grid 114 would result in an increase in the negative d.c. voltage component. However, it would be undesirable to couple the noise at grid 86 to grid 114 as it would seriously interfere with the operation of the oscillator and result in the introduction of a substantial amount of colored noise in the picture.

Although other circuit parameters could be used for the circuit of FIGURE 1, the following is a list of those which have been found to provide satisfactory operation.

Resistor 132	68K ohms
Capacitor 134	.1 μf
Transistor 129	2N3565
Capacitor 142	.047 μf
Resistor 94	33K ohms
Resistor 140	3.16M ohms
Resistor 146	470K ohms
Resistor 148	4.7M ohms
Resistor 168	220K ohms
Capacitor 54	0.1 μf

Reference is now made to FIGURE 2 in which certain stages shown in FIGURE 1 in schematic form are illustrated by rectangles identified by the same numerals. The changes used to adopt the invention for an open loop type A.C.C. circuit utilizing a voltage responsive amplifier are indicated in schematic form. The output of the driver amplifier 10 is coupled via a network 172, which may be the same as 48, 50, 52, and 54 of FIGURE 1, to the chrominance amplifier 12. The output of the chrominance amplifier 12 is applied to the chrominance signal demodulation circuits 20. However, the control grid 86 of the burst gate amplifier 14 is connected to a suitable point in the coupling network 172 rather than to the output of the chrominance amplifier 12, as in FIGURE 1. Changes in the gain of the chrominance amplifier 12 have no effect on the bursts supplied to the bust gate amplifier 14, and hence the A.C.C. circuit is of the open loop type. As the grid leak resistor 94′ and 132′ of the burst gate amplifier and the oscillator 18 may have slightly different values than in FIGURE 1, they are indicated by primed numbers.

As explained in connection with FIGURE 1, the voltage at the grid 114 of the oscillator 18 has a d.c. component that changes with the amplitude of the color synchroniz-

ing bursts. In the circuit, the grid 114 is coupled via a resistor 173 and an a.c. bypass capacitor 175 to the input of a d.c. voltage amplifier 174, and its output is connected to the control grid 46 of the chrominance amplifier 12. However, as discussed in connection with FIGURE 1, the d.c. voltage at the grid 114 can be altered by changes in the gain of the burst amplifier 14 produced by noise at its grid 86. In order to compensate for such alteration, a resistor 176 is connected between the grid 86 and the junction between the resistors 173 and the capacitor 175. The relative values for the resistors 173 and 176 are chosen to provide optimum compensation. The sum of their resistance is chosen to be such that their presence does not adversely affect the operation of either the burst gate amplifier 14 or the oscillator 18.

Co-pending patent application No. 25643/68 (Serial No. 1198207) describes and claims features of an automatic chroma control circuit for a television receiver which are included in the chroma control circuit described herein.

WHAT WE CLAIM IS:—

1. An automatic chroma control circuit for a color television receiver, wherein said receiver includes a color synchronizing burst gate amplifier having an output electrode and input electrode to which color synchronizing bursts are applied, a chrominance signal amplifier, said circuit including control voltage deriving means coupled to said output electrode of said burst gate amplifier for deriving a control voltage having a direct current component that varies in value in response to variations in the amplitude of the color synchronizing bursts at said output electrode of said burst gate amplifier, characterized by means for varying the gain of said chrominance signal amplifier in response to a predetermined combination of the control voltage and any direct current component of voltage at said input electrode of said burst gate amplifier.

2. An automatic chroma control circuit according to Claim 1, wherein said receiver also includes a color reference oscillator having an input electrode, characterized by said means for varying the gain of said chrominance signal including an amplifier whose input is coupled to both the input electrode of said burst gate amplifier and to the input electrode of said color reference oscillator.

3. An automatic chroma control circuit according to Claim 2, characterized by said amplifier being coupled in the grid leak path of said color reference oscillator.

4. An automatic chroma control circuit substantially as described and illustrated in the accompanying specification and drawings.

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