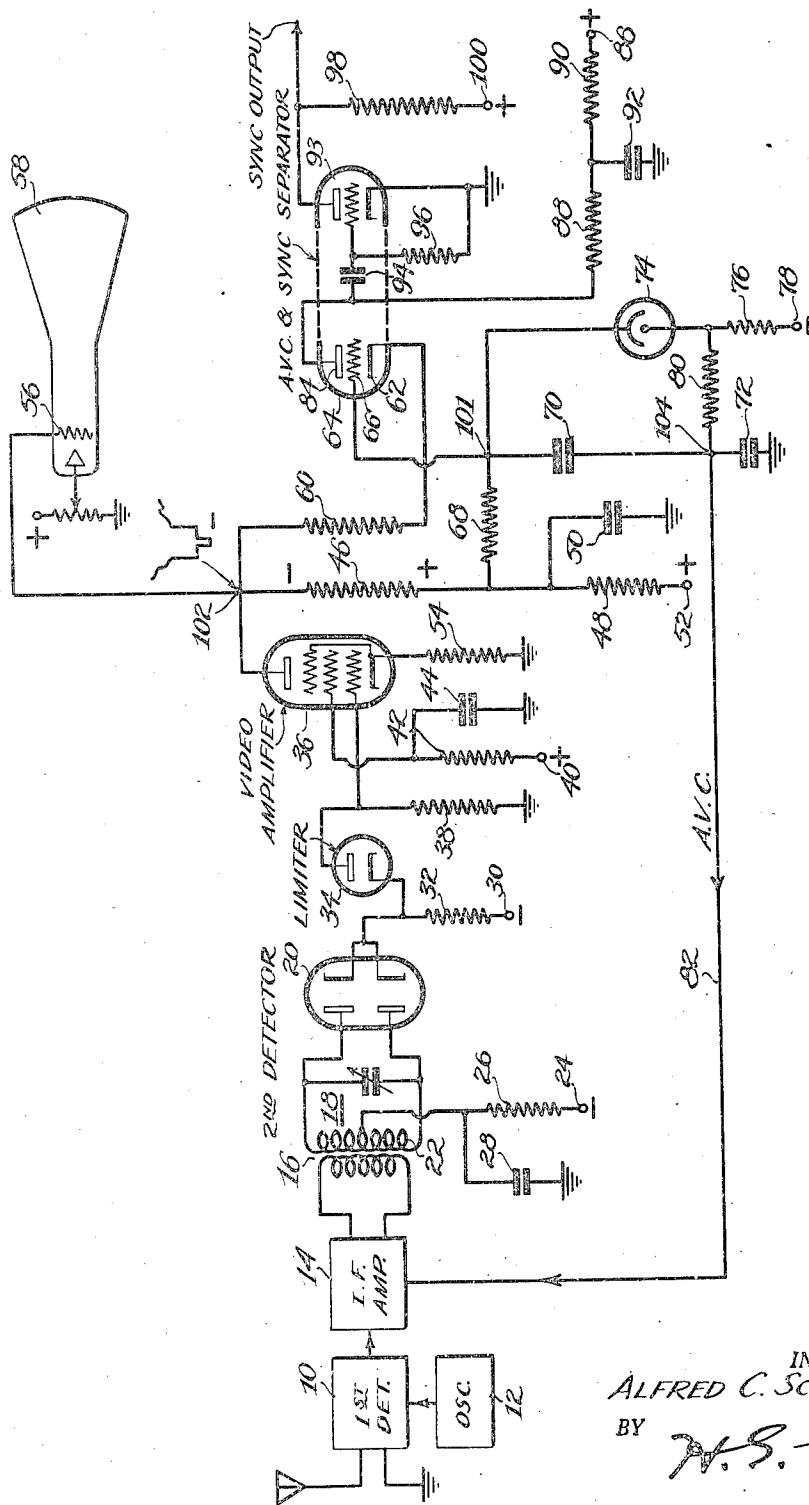


Sept. 6, 1949.

A. C. SCHROEDER
AUTOMATIC VOLUME CONTROL AND SYNC SEPARATOR
FOR TELEVISION RECEIVERS
Filed March 12, 1945

2,481,045



INVENTOR.
ALFRED C. SCHROEDER
BY *H. S. Grover.*
ATTORNEY

UNITED STATES PATENT OFFICE

2,481,045

AUTOMATIC VOLUME CONTROL AND SYNC SEPARATOR FOR TELEVISION RECEIVERS

Alfred C. Schroeder, Feasterville, Pa., assignor to
Radio Corporation of America, a corporation
of Delaware

Application March 12, 1945, Serial No. 532,386

11 Claims. (Cl. 178-7.5)

1

The present invention relates to a control system for television signal receivers, and more particularly to an improved form of automatic gain control or AVC system which additionally includes means for separating the synchronizing information in the television signal from the video portion thereof.

In television systems in which the D.-C. component of the video signal is transmitted, variations in this D.-C. component result in variations in the average amplitude of the transmitted carrier. Consequently, gain control or AVC systems based on average carrier amplitude are not satisfactory, and other arrangements, such as those utilizing a voltage derived from the peak amplitude of the carrier, that is, its amplitude during the synchronizing portion of the composite television signal, have been proposed. One of these latter arrangements is disclosed in Patent No. 2,246,939, granted to R. S. Holmes on June 24, 1941. This patent also describes means whereby the synchronizing or "sync" and video components which appear at relatively different amplitude levels in the television signal may be separated by the same circuit from which the AVC voltage is derived.

A common feature of automatic gain control systems, as incorporated in television receivers of the above class, lies in the provision of means for peak-rectification of the synchronizing component of the received signal, together with additional means for utilizing this rectified component in inverse degree to control the amplification of the I. F. stages of the receiver. To obtain a relatively smooth rectified control voltage in such systems, it has heretofore been customary to provide filter elements in the rectifier circuit having a time constant which is long with respect to the period of the synchronizing impulses. Such systems, however, have the disadvantage of not responding quickly enough at certain times to eliminate certain types of interference, as for example that produced by aircraft in the vicinity of the receiver. The present invention discloses an AVC system which provides a relatively smooth rectified voltage having a value which is a measure of the height of the sync pulses and therefore a measure of the amplitude of the incoming signal, and which, in addition, is extremely quick-acting. This voltage, when fed back to the I. F. stages, improves the response of the receiver in a manner not possible with systems of conventional design. Furthermore, by the employment in the system of the present invention of direct capacitive coupling

2

between the rectifier circuit and the control elements of the receiver I. F. stages, the time required for application of this AVC voltage is still further lessened in comparison with standard arrangements.

According to a further feature of the present invention, the AVC voltage is derived from the system at a point following the video amplifier, instead of at a point following the detector and before the video amplifier as in the aforementioned Holmes patent. Not only does this result in a higher AVC potential, but it permits the D.-C. information in the television signal to be applied directly to the kinescope without the necessity of employing separate D.-C. reinserting elements.

One object of the present invention, therefore, is the provision of a quick-acting automatic gain control or AVC system for television receivers.

Another object of the present invention is the provision of a circuit for receiving a television signal which includes the D.-C. component thereof, the circuit being so designed that this D.-C. component is not lost in passing through the circuit, but is instead retained for application directly to the image-producing device without the necessity of employing separate D.-C. reinserting elements.

A still further object of the invention is the provision of simple and effective means for limiting the amplitude of any random noise which may be included in the television signal to an amplitude comparable to the amplitude of the synchronizing signal.

An additional object of the invention is the provision of means for utilizing a single three-element electron discharge tube as an AVC voltage rectifier and also to separate the synchronizing or sync pulses from the video signals. The cathode and control electrode of the tube act as a diode to peak-rectify the synchronizing pulses, while the cathode, control electrode, and anode of the same tube act as a separator to provide only sync pulses for application as control potentials to the deflection generators.

Other objects and advantages will be apparent from the following description and from the drawing, the single figure of which is a circuit diagram of a preferred form of the invention.

In the drawing the invention is shown applied to a television receiver of the superheterodyne type. The receiver comprises a converter or first detector 10, a tunable oscillator 12, and an intermediate-frequency amplifier 14 which usually includes a plurality of stages. The output of the

intermediate-frequency amplifier 14 is applied to a suitable demodulator or detector unit. One form of connection of this type is shown by the drawing where the amplifier output is supplied through a tuned I. F. transformer 16 to a second detector 18 which may be of the push-pull type, as represented by the twin diode 20, which may be a 6H6 type, for instance.

The two plates or anodes of the twin diode 20 are respectively connected to opposite ends of the secondary winding 22 of transformer 16. The midpoint of this secondary winding 22 is connected to the terminal 24 to which a voltage source (not shown) has its negative terminal connected. Through this connection a negative voltage of the order of 3 volts is supplied through a relatively low or small resistor 26. While values which have been found suitable in practice are given herein for certain of the components of the circuit herein described, as well as for various potentials applied to these components, it will be clearly understood that these values are being given merely as examples, and that other values may be substituted for any or all of those given as may prove desirable or necessary.

The joined cathodes of diode 20 are connected to the terminal 30 whereat the negative terminal of a suitable voltage source (not shown) is connected. This source connected at terminal 30 may be arranged to supply to the cathodes of tube 20 a negative potential of the order of 17 volts through a resistor element 32. The signal output of detector 18 is applied to the cathode of a limiter tube 34, the anode of which is connected to the control electrode of a video amplifier 36, the latter preferably being a tube of the general type of a 6AC7.

A grid resistor 38 is provided between the control electrode of amplifier tube 36 and ground. It will be noted that the D.-C. voltages on source terminals 24, 30 and the grounded end of resistor 38 are such in the example given that while the anodes of detector tube 20 are operated at the above assumed D.-C. potential of 3 volts negative to ground, these electrodes are relatively positive with respect to the cathodes of the same tube to which an assumed D.-C. potential of -17 volts relative to ground is applied. Furthermore, this latter D.-C. voltage also appears on the cathode of the limiter tube 34 the anode of which is approximately at D.-C. ground potential. The relative polarity of the D.-C. voltages on the various electrodes of tubes 20 and 34 is, therefore, correct for operation of these tubes.

The screen electrode of the video amplifier tube 36 is connected to the positive terminal 40 of a relatively high voltage source (not shown) through resistor element 42 forming part of a filter circuit which also includes a condenser 44. The anode of the video amplifier tube 36 is connected through an output resistor 46 to one end of a resistor element 48 which in combination with a condenser 50 constitutes the plate filter circuit of tube 36. The opposite end of resistor 48 is connected to the positive terminal 52 of a suitable voltage source (not shown). Bias for tube 36 is provided by a cathode biasing resistor 54.

The anode of tube 36 is connected directly to the control electrode 56 of an image-producing cathode-ray tube 58 which is of conventional type and, therefore, not illustrated in detail. The upper end (in the drawing) of output resistor 46 is connected through an isolating or decoupling resistor 60 to the cathode 62 of a

triode 64 which may be half of a tube of the general type of a 6SN7. The lower end of output resistor 46 is joined to the grid 66 of triode 64 through a grid resistor 68.

Grid 66 is connected to ground through two series condensers 70 and 72. A voltage regulator glow tube 74 such as one of the 991 type is connected between grid 66 and one end of a resistor 76 the other end of which is connected to the negative terminal 78 of a suitable voltage source. A resistor element 80 connects the upper plate (in the drawing) of condenser 72 to the upper end of resistor 76, while the charge on condenser 72 is applied to the I. F. amplifier 14 over a conductor 82.

The triode 64 performs the function of an AVC and sync separator tube in a manner to be hereinafter described in connection with a description of the operation of the circuit. The anode 84 of triode 64 is provided with a positive D.-C. voltage of suitable value from source terminal 86 through two resistors 88 and 90. The junction point of these resistors 88 and 90 is grounded through a bypass condenser 92.

Anode 84 is coupled to the grid of a second triode 93 (which may be the other half of the 6SN7 above mentioned) through a coupling condenser 94, the grid of triode 93 being biased by a resistor 96. The output of triode 93 appears across a load resistor 98 connected between the anode of the tube and the positive terminal 100 of a suitable voltage source.

The operation of the circuit is as follows:

The television signal output of the I. F. amplifier 14, which includes the D.-C. component of the video signal as well as periodically recurring horizontal and vertical synchronizing pulses, is detected by the twin diode 20 in the usual manner. The output of twin diode 20 is applied to the control electrode of video amplifier tube 36 by a D.-C. coupling circuit which includes the limiter tube 34, the latter acting to restrict any undesired noise pulses which may be present in the television signal to an amplitude comparable to that of the synchronizing pulses, and thus reduce the deleterious effect of such noise pulses on the deflecting circuits.

By a proper choice of constants for the video amplifier screen filter circuit 42, 44 and plate filter circuit 48, 50, such, for example, as those values hereinafter are given, the gain of the amplifier 36 can be made substantially constant for a wide band of frequencies down to D.-C. Furthermore, since the distributed capacity to ground of the system is low, due in part to the omission of the usual coupling condensers, the high frequency response is materially improved in comparison with conventional circuits.

The signal on the plate of the video amplifier 36, which retains the D.-C. information in the signal due to the D.-C. input coupling to the video amplifier through limiter tube 34, is applied directly to the cathode-ray tube control electrode 56. The output of tube 36, which appears as a varying voltage with the polarity indicated in the drawing across the plate resistor 46, is also applied between the cathode 62 and grid 66 of triode 64, these two electrodes acting in effect as a diode rectifier.

The current flow through the rectifier circuit, including cathode 62, grid 66, plate resistor 46 and grid resistor 68, causes voltage variations to appear across resistor 68 in response to variations in the output of tube 36 as developed across resistor 46. These voltage variations across re-

5

sistor 68 cause the potential at point 101 to fluctuate in value, and also cause fluctuations in the positive charge built up on grid condenser 70 from point 101 on the voltage-divider network consisting of resistors 48, 68 and 76 connected between terminals 52 and 78. The fluctuating positive charge on condenser 70 is smoothed out by the R.-C. filter circuit 72, 80 to provide a positive D.-C. voltage at point 104 the instantaneous value of which is a measure of the height of the sync pulses and, therefore, a measure of the amplitude of the incoming signal. The decoupling resistor 60 acts to prevent the triode 64 from loading the plate of the video amplifier 36 with extra capacity, and at the same time reduces the effect of noise on the triode 64.

The polarity of the television signal at point 102 is such that the sync pulses extend in a negative direction. Consequently, a decrease in amplitude of the sync pulses as a result of fading or attenuation of the incoming signal will cause the voltage at point 102 to become less negative or, in other words, will reduce the potential drop across resistor 46. This will reduce the current flow in the rectifier circuit, which in turn decreases the voltage drop across resistor 68. As the voltage on each end of resistor 68 approaches the same value, the positive charge on condenser 70 increases. This increase in the charge on condenser 70 is applied from point 104 over conductor 82 to the I. F. amplifier 14 to increase the gain thereof in any suitable manner.

In a circuit employing the values set forth, the D.-C. voltage on grid 66 is about 55 volts above the required I. F. control voltage to produce a signal giving that voltage on grid 66. The latter voltage is, therefore, dropped through a 55 volt glow tube 74 so that the D.-C. voltage at point 104 is of proper value for application to the I. F. amplifier 14.

It will be noted that since the I. F. amplifier 14 is directly connected to the grid 66 of triode 64 through the condenser 70, the system provides an unusually fast-acting AVC voltage in response to variations in current flow between cathode 62 and grid 66.

The composite television signal appearing on the cathode 62 of triode 64 includes both video and sync components. To separate the sync pulses from this composite signal, the plate 84 of triode 64 is connected to the terminal 86 whereat a source of positive voltage (not shown) is connected. To keep the voltage on plate 84 sufficiently low with respect to cathode 62 so that the triode 64 will act as a good sync signal separator, the voltage from terminal 86 is passed through a relatively large dropping resistor 90. The sync pulses then appear across the plate resistor 88, but the relative D.-C. potentials on cathode 62 and plate 84 are such that the less negative video signals on cathode 62 are not passed by the tube. The sync pulses across resistor 88 are then applied through the coupling condenser 94 to the triode 93, where they are further amplified and clipped to appear across the output resistor 98.

The following values for the components of the system hereinabove described are given as being illustrative of those which have been found suitable in practice. However, it should be clearly understood that these values are merely examples, and that values which depart widely from those given below may be employed if desirable or necessary.

6

Resistors

26=470	ohms	60= 10,000	ohms
32= 15,000	ohms	68=200,000	ohms
38= 3,900	ohms	76=330,000	ohms
42= 82,000	ohms	80=220,000	ohms
46= 3,300	ohms	88= 5,000	ohms
48= 12,000	ohms	90=5	megohms
54=15	ohms	96=330,000	ohms

Condensers

44=1.5	mf.	72= 3,300	mmf.
50= 10	mf.	92= .1	mf.
70= 820	mmf.	94= 3,900	mmf.

Voltages (with respect to ground)

At terminal 24=	3 volts
At terminal 30=	17 volts
At terminal 40=	+300 volts
At terminal 52=	+135 volts
At terminal 78=	33 volts
At terminal 86=	+300 volts
At terminal 100=	+ 15 volts

While I have illustrated and described, and have pointed out in the annexed claims, certain novel features of my invention, it will be understood that various omissions, substitutions and changes in the form and details of the system illustrated may be made by those skilled in the art without departing from the spirit of the invention.

I claim:

1. In a television receiver which includes a second detector preceded by an intermediate frequency amplifier, the combination of a video amplifier having an impedance element in the output thereof across which a complete video signal is developed, a rectifier circuit, including a further impedance element, for peak-rectifying the video signal, a resistance-condenser combination having an output time constant which is long with respect to the period between successive synchronizing impulses, said resistance-condenser combination including a pair of condensers connected in series, means for developing a normally substantially constant charge on both condensers of said pair, means for applying said peak-rectified signal in series with the series connected condensers of said resistance-condenser combination to vary the said normally constant charge on both condensers of said pair, and means for applying the output of said resistance-condenser combination as it appears between said two condensers to said intermediate-frequency amplifier to control the gain thereof.

2. The combination of claim 1, in which the time constant of one of the condensers of said pair as included in said resistance-condenser combination is greater than the time constant of the other of said condensers.

3. In a television receiver which includes a second detector preceded by an intermediate frequency amplifier, the combination of a video amplifier having an impedance element in the output thereof across which a complete video signal is developed, means for connecting the video amplifier plate end of said impedance element to the cathode of a grid-controlled electron discharge device, means for connecting the other end of said impedance element through a resistor to the grid of said electron discharge device, a pair of capacitors, means connecting the grid of said electron discharge device to ground through said pair of capacitors, means for developing a

normally substantially constant direct current charge on each of said capacitors, means providing a discharge path for each of said capacitors, and a connection from a point intermediate the capacitors of said pair to said intermediate-frequency amplifier.

4. The combination of claim 3 in which the time constant of one of said capacitors and its associated discharge path is greater than the time constant of the other capacitor and its associated discharge path.

5. The combination of claim 3, further comprising voltage-regulating means direct current connected from a point intermediate the two capacitors of said pair to the grid of said electron discharge device, whereby the direct current voltage at said point intermediate said two capacitors is lower by a substantially constant amount than the direct current voltage appearing on said grid.

6. In a television receiver adapted to receive a composite series of video signals, said receiver including a detector preceded by at least one intermediate-frequency amplifier stage, and a video amplifier connected to said detector so that the video signal output of said video amplifier contains sync pulses extending in a generally negative direction, the combination of an impedance in the output of said video amplifier across which said video signals are developed, an electron discharge device having at least an anode, a cathode and a control electrode, means conductively connecting the cathode and control electrode of said electron discharge device in shunt with the output impedance of said video amplifier so that the cathode and control electrode of said electron discharge device will act in effect as a diode to rectify the sync pulse voltage output of said video amplifier as developed across said output impedance, a voltage divider network, means for applying the rectified output of said electron discharge device to an intermediate point of positive polarity on said voltage divider network so that the positive potential of such point will vary in accordance with variations in the rectified output of said electron discharge device, means for applying said varying positive potential to said intermediate-frequency amplifier stage so as to control the gain thereof, and means in the anode circuit of said electron discharge device for separating from the output of said video amplifier the said sync pulses.

7. A television receiver in accordance with claim 6, in which said means for applying a varying positive potential to said intermediate-frequency amplifier stage includes a pair of capacitors connected between ground and the point on said voltage divider network to which the rectified sync pulse output of said electron discharge device is applied, the connection to said intermediate-frequency amplifier stage being made intermediate the capacitors of said pair.

8. In a television receiver which includes a second detector preceded by an intermediate frequency amplifier, the combination of a video amplifier having an output impedance and an input

circuit direct-coupled to said second detector to provide across said impedance a signal which contains sync pulses and retains the second-detector direct-current component, an electron discharge device having a cathode and a second electrode, means conductively connecting said cathode and second electrode in shunt with said impedance so that said electron discharge device rectifies that portion of said signal representing sync pulses, means for maintaining said second electrode at a substantially constant potential for steady signal amplitude and superimposing on said potential the rectified output potential of said electron discharge device, and means for applying the variations of said superimposed potentials to the intermediate frequency amplifier to control the gain thereof.

9. The combination defined by claim 8 in which said last-mentioned means comprises two capacitors connected in series between a fixed potential point and said second electrode, the common point between said capacitors being connected to said intermediate frequency amplifier.

10. The combination defined by claim 9 wherein the ratio of capacity of said capacitors is approximately four to one, the smaller capacitor being connected to said second electrode.

11. In a television receiver having a second detector preceded by an intermediate frequency amplifier, the combination of an automatic gain control and sync separator comprising an impedance across which a complete video signal is developed including sync pulses and direct-current information from the second detector, a triode having a cathode and a control electrode connected respectively to spaced points of said impedance through decoupling resistance whereby the peak voltage of the sync pulses is measured, means connected to said control electrode for deriving a gain-control voltage from said measured peak voltage, a capacitor shunted across said means for making the gain control fast acting; said triode also having an anode, and means for maintaining a low direct-current potential difference between said cathode and anode whereby the sync pulses are separated and amplified.

ALFRED C. SCHROEDER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,890,454	Bruce	Dec. 13, 1932
2,018,982	Travis	Oct. 29, 1935
2,144,605	Beers	Jan. 24, 1939
2,194,278	George	Mar. 19, 1940
2,196,364	Schlesinger	Apr. 9, 1940
2,227,001	Schlesinger	Dec. 31, 1940
2,408,821	Stearns	Oct. 8, 1946

FOREIGN PATENTS

Number	Country	Date
621,465	Germany	Apr. 13, 1933