RCA

Plain Talk and Technical Tips

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WV-500B Voltohmist

The RCA WV-500B VoltOhmyst is a solid-state, battery-operated electronic voltmeter which measures DC voltage from 0.01 to 1500 volts, DC current from .01 milliamperes to 1.5 amperes, AC rms voltage from 0.2 to 1500 volts, AC peak-to-peak voltage of complex waveforms from 0.5 to 4200 volts, and resistance values from 0.2 ohms to 1000 megohms. Seven overlapping ranges are provided for AC rms and resistance measurements, and eight ranges are provided for DC voltage and current measurement. The accuracy for all voltage and current functions is ±3% of full-scale.

All voltage and resistance measurements are made with the WG-410B single-unit probe and a convenient built-in switch. Separate test leads are provided for current measurement. The function switch is specially designed so that the two current input jacks are connected together in all functions except current measurement. This feature permits alternate voltage and current measurements without disconnecting the current test leads from the test circuit.

Automatic Gain Control

Automatic gain control of a television receiver differs fundamentally from AGC of an AM broadcast receiver because of the difference between video modulation and audio modulation. In an AM broadcast signal, tones lower than about 30 Hz are not transmitted; consequently, any .3-second sample of RF carrier amplitude will be the same as any other .3-second sample. Therefore, the AGC detector needs to have a time constant no greater than about 0.3 second in order to average the received signal and adjust the gain accordingly. The video which modulates a TV transmitter has much-lower-frequency components. For example, if an all-white picture is transmitted for 5 seconds, the frequency of the video is 0.1 Hz. Simply increasing the time constant of the AGC (to perhaps 30 seconds) is not a solution, because unwanted variations in signal level may have shorter periods than the modulating video.

There is one part of the video signal which always produces the same level of transmitter output, namely the horizontal sync pulse. For this reason, the AGC system is made to be sensitive only to sync pulses, and completely insensitive to video information. If the amplitude of sync pulses from the second detector is made to be always the same, all the shades of gray which comprise a scene can be displayed correctly. This type of AGC system is called "keyed AGC," and is used almost universally in modern TV receivers.

Figure 1 shows the basic keyed-AGC system. Under no-signal conditions, the control grid voltage is zero and the cathode is biased positive enough to hold the tube near cutoff. The signal at the plate consists of a series of positive pulses from the horizontal-output transformer, but these have no particular effect, since the tube cannot conduct. The bias voltage under these conditions is determined by the voltage division between R1 and R2, and is about +4.3 volts. This positive bias to the grids of the RF and IF amplifiers causes them to have maximum gain when no signal is present.

When the receiver is tuned to an active channel, video from the receiving section appears at the

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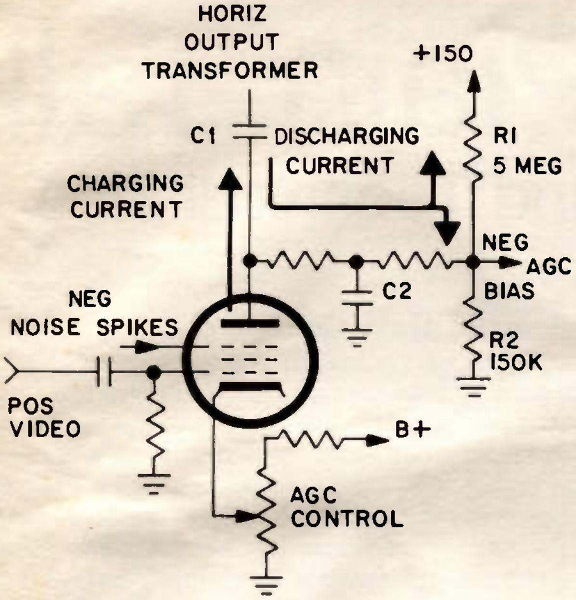

Figure 1 — Basic Keyed-AGC System

AGC keyer. As soon as the horizontal oscillator syncs to the incoming signal, each positive retrace pulse from the horizontal-output transformer appears at the plate of the AGC keyer at the same instant that a horizontal-sync pulse appears at the control grid.

With both control grid and plate driven positive, the keyer tube conducts, charging capacitor C1. Between pulses, the charge on C1 leaks off through R1 and R2, causing their junction to become negative with respect to ground. This voltage is filtered by C2 and fed to the grids of the RF and IF amplifiers.

The amount of charge on C1 is determined by the **amplitude** of the horizontal-sync pulses. If this amplitude increases, the charge increases, the currents through R1 and R2 increase, and the AGC voltage becomes more negative. This reduces the receiver gain and, consequently, the amplitude of horizontal-sync pulses from the receiver is maintained at a constant value.

If there were no noise-immunity provisions, a positive noise transient (spike) occuring simultaneously with a sync pulse would effectively increase the amplitude of pulse at the grid of the keyer and

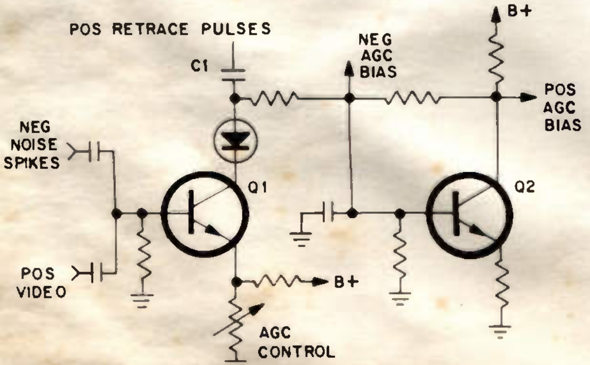

Figure 2 — Circuit for Forward and Reverse AGC

cause the AGC voltage to swing too far negative. To prevent this, the video signal is inverted and passed through a differentiator, a short-time-constant circuit which removes the sync pulses but passes noise spikes. These negative pulses are fed to the suppressor grid of the keyer tube, thereby reducing conduction. In effect, any unwanted noise pulse is fed to both the control grid and suppressor grid, but the polarities are opposite and they are cancelled.

Another method of separating noise spikes from sync pulses is to apply the composite video to a circuit which is biased so that it requires a signal more positive than the sync pulse to bring it out of cutoff. Its action is similar to a sync separator, except that noise spikes, instead of sync pulses, are the output. These spikes are fed to the AGC keyer as described above.

In solid-state receivers, it is normal for the AGC bias to be made more **positive** as the signal tends to increase (forward bias). Figures 2 and 3 show two methods of modifying the AGC keyer to accomplish this. In Figure 2, an NPN transistor (Q1) is used as a keyer. The circuit works much like the tube circuit, except that noise pulses are cancelled at the base of the transistor instead of being fed to separate elements of the amplifying device. The diode prevents the negative AGC voltage from leaking back through Q1. Q2 is simply an inverter which changes a negative-going input into a positive-going output; gain is very low and may be less than unity. This circuit is useful if both forward and reverse AGC is used in the same receiver.

In Figure 3, positive-going AGC is obtained by using a PNP transistor and reversing the polarities of all the inputs. In this circuit, C1 is **discharged** through the transistor during retrace time, and then it must charge through R1 during trace time. As in Figure 2, the function of the diode is to prevent the AGC voltage from "leaking off" through the transistor.

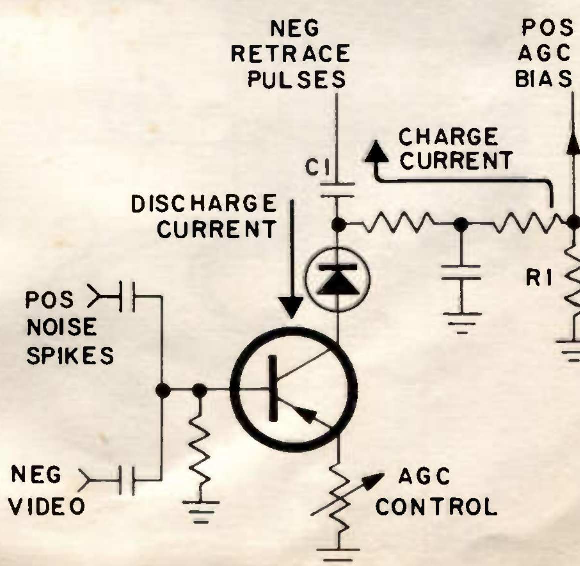

Figure 3 — Circuit for Forward AGC

Solid-State Horizontal Deflection

Receivers which utilize a vacuum-tube horizontal output must incorporate a matching device to the deflection yoke—the output impedance of the tube is inherently high (low current and high voltage) while the yoke itself has a much lower impedance, which requires a relatively high current at a correspondingly lower voltage. The horizontal-output transformer is used as a matching impedance in much the same way an audio-output transformer is used to match the high plate impedance of the audio-output tube to the low impedance of a speaker. Of course, the horizontal-output transformer also serves a second important function, that of supplying voltage pulses for the high-voltage rectifier, AGC keyer, burst amplifier, and sometimes the horizontal-AFC circuit.
In receivers using a transistor for the horizontal-output function, **impedance match** between device and yoke can be obtained without the use of a transformer. A transistor can be designed to provide high output current at very moderate voltage (low impedance); this removes the need for a transformer to match impedances, but, of course, the horizontal-output transformer is still needed to generate the various pulses already mentioned.

Although the transistor offers several advantages over a tube, there is an attending disadvantage—voltage transients resulting from rapid turn-on and turn-off of the device must be carefully controlled to prevent damage to the transistor. Ideally, the deflection system should use solid-state devices having low output impedance, in a circuit which does not generate significant switching transients. The CTC-40 deflection circuit is such a system.

Figure 1 is a simplified diagram of the system. The circuit uses two SCR's and two diodes connected so that each pair in combination (one SCR and one diode) form a switching circuit. Since the impedance of these devices is very low (high current capacity with very little volage drop), there is no need for a matching transformer. By connecting these devices in circuits which are resonant at the correct frequencies to provide trace and retrace, switching transients are avoided.

Before proceeding with an analysis of the actual circuit, it is necessary to examine the timing involved in a horizontal-deflection system. Since 15,734 horizontal lines are transmitted during each second of a color transmission, approximately 64 microseconds are required for each line. However, not all of this time is available for scanning the picture tube from left to right; a portion of it must be used to retrace from right to left. In practice, about 14 microseconds elapse during retrace and the remaining 50 microseconds are used for trace.The position of the beam on the picture tube is related to time in Figure 2.

Since the position of the beam is determined by

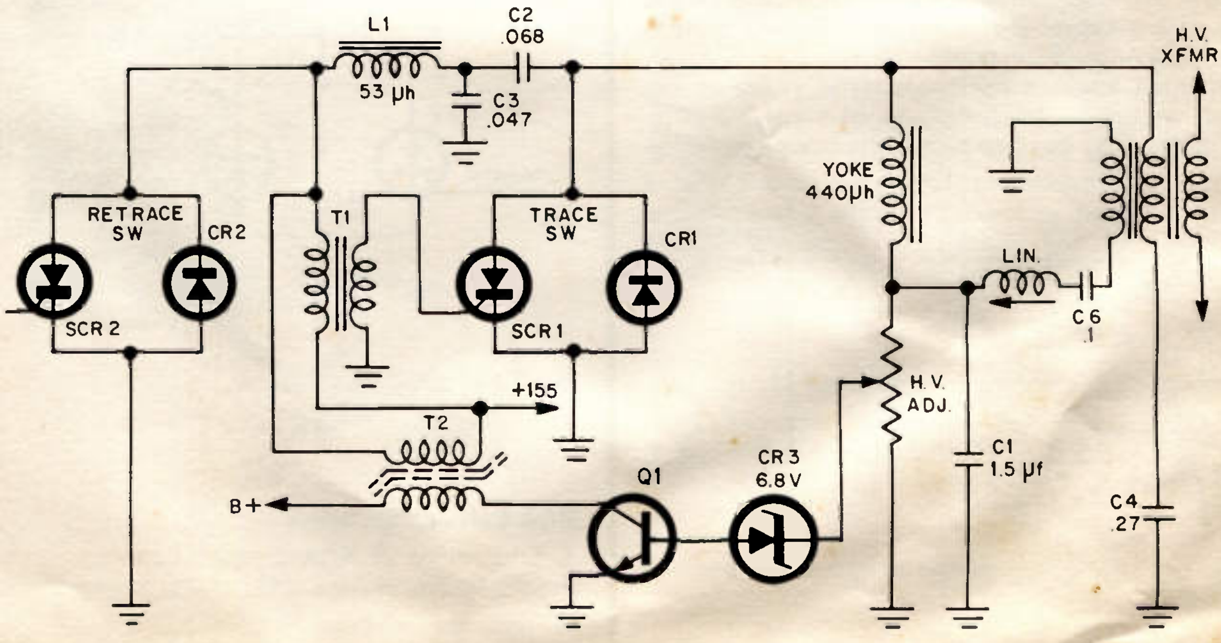

Figure 1 — Simplified Horizontal-Deflection Circuit

the current flowing through the yoke at any given instant, the curve of Figure 2 also shows yoke current. In the CTC 40, the yoke current reaches 4 amperes in one direction to deflect the beam to one edge of the picture-tube screen and 4 amperes in the opposite direction to deflect it to the other edge. Of course, when yoke current is zero there is no deflection and the spot is at the center of the screen.

The yoke current during retrace represents only **one-half** cycle of a complete alternation. That is, the current changes from maximum negative to maximum positive, but not back to maximum negative. Likewise, the yoke current during trace completes only one-half of an alternation. If resonant circuits are to be used to produce these half-cycles of current, their frequencies must be 35.7 kHz for retrace and 10 kHz for trace. If the yoke is switched into a 35.7 kHz circuit for one-half of a cycle and into a 10 kHz circuit for one-half of a cycle, the required currents can be caused to flow in the yoke.

Of course, the current produced by a resonant circuit is sinusoidal instead of having a linear rise, but this may be corrected easily by the use of a linearity circuit which adds harmonics of the correct phase to the basic current.

Returning to Figure 1, SCR 2 and CR 2 in combination are called the retrace switch. The function of this switch is to connect the yoke into a resonant circuit having the correct frequency for retrace, about 36 kHz.

To understand what happens when the retrace switch is closed, it is necessary to know the conditions under which the yoke is operating just prior to this instant. The yoke current is about 4 amperes and the electron path is from ground up through SCR 1, and down through the yoke and C1 to ground. At this time, the right side of C2 is clamped to ground by the conduction of SCR 1 and the left side has a potential of nearly +300 volts. The picture-tube beam is deflected almost to the right edge of the screen.

At the time when a horizontal-sync pulse is received, a positive trigger pulse of short duration is generated by the horizontal blocking oscillator and fed to the gate of SCR 2, causing it to conduct. This completes the circuit for C2 and allows it to discharge into the yoke. The complete path is from the right side of C2, through the yoke and C1 to ground, from ground through SCR 2, and back to C2 through L1. The basic retrace circuit is shown in Figure 3.

As the current from C2 rises to 4 amperes, the current through SCR 1 drops until the yoke current is being supplied by C2. When this occurs, SCR 1 becomes nonconducting, and it remains in the nonconducting state until the middle of the next trace.

About 3 microseconds are required for the current of C2 to build up to 4 amperes and cut off SCR 1. At the end of this short time, the trace switch opens and the yoke is connected into the retrace circuit. This point is the start of the waveform in Figure 2.

During the first half of retrace (first 7 microseconds of Figure 2), current decreases from 4 amperes to zero because the circuit is resonant at about 36 kHz. Then, due to the action of the resonant circuit, the current reverses and flows in the opposite direction. During this interval, which is the second half of retrace, electron flow is from the left side of C2, through L1 and CR 2 to ground, and from ground through C1 and the yoke to the right side of C2.

During the second half of retrace, SCR 2 cannot conduct because its anode is reverse biased. When current tries to reverse a second time (at the end of retrace), there is no circuit path as SCR 2 has no trigger to cause it to conduct. Therefore, the retrace switch is open and the yoke is disconnected from the retrace circuit.

(To be continued)

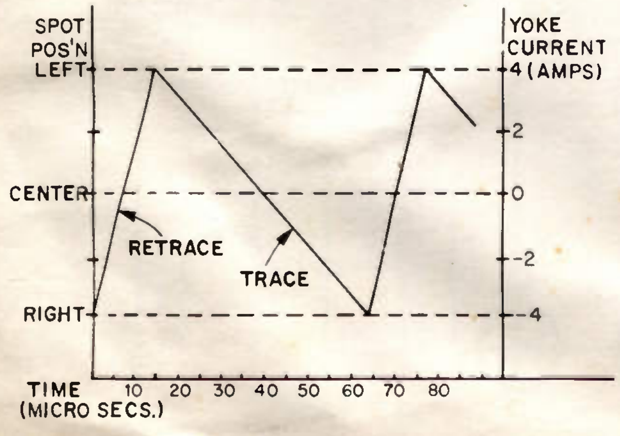

Figure 2 — Horizontal Timing Relations

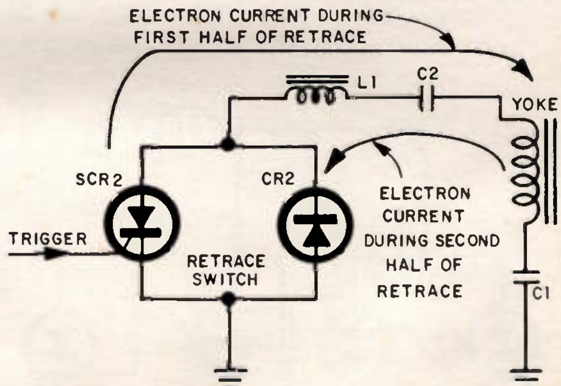

Figure 3 — Basic Retrace Circuit

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