RCA
Plain Talk
and Technical Tips

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Color Television Workshop-10

Servicing Techniques Portable Color TV

Color Television Workshop-10 has as its theme a series of advanced service techniques that will speed up the troubleshooting of RCA hybrid portable color receivers.

In preparing this training program, RCA Technical Training began with the basic premise that removing the chassis before the fault is located is a good way to make servicing difficult. Often the repair could have been made without removing the chassis; or time is lost when kine, high voltage, and yoke extensions have to be hooked up for diagnosis. To circumvent this problem all the servicing techniques presented throughout the workshop can be performed with the chassis in its cabinet.

This does not imply that Workshop-10 is a "beginners" program. To the contrary, a good background in troubleshooting will be helpful. To illustrate this, the drawing for a typical lesson is shown in Figure-1. The problem shown is to isolate a deflection fault to either the horizontal-output tube and damper, or to the flyback transformer and yoke.

The solution is to operate the output tube and damper into a resistive load as a means of establishing controlled test conditions. Then a scope can be used to pinpoint the problem. Obviously, the same technique can be used with practically any vacuum-tube deflection system.

Other lessons in Workshop-10 include signal tracing the IF and video amplifiers with clamped bias, signal tracing the vertical system after it has been "converted" to an amplifier, symptom analysis of the video-output system, etc.

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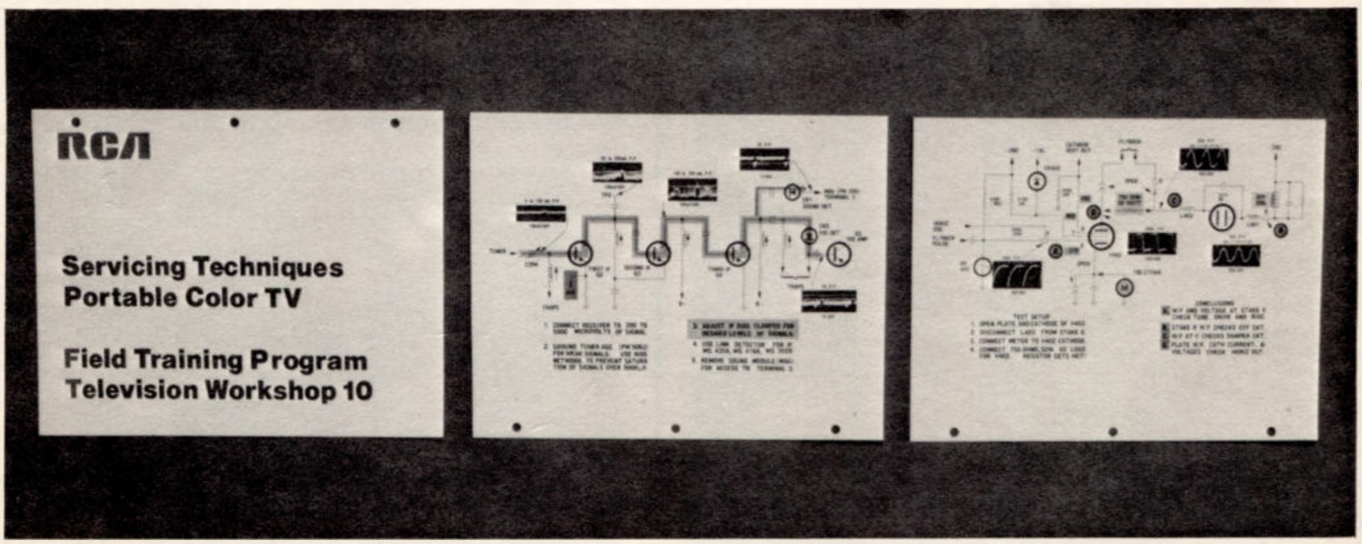

Figure 1—Typical Workshop Pages

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A publication for the service industry prepared by RCA Consumer Electronics

Workshop-10

Continued from Page 1

The final two lessons explain the troubleshooting techniques that are used in servicing the transistorized horizontal-deflection system of the RCA CTC 60 chassis. As you will learn in this workshop, the advanced design of this circuitry allows some new symptoms to appear. For examples, a shorted horizontal-output transistor does not trip the circuit breaker, and an open regulator transistor produces a narrow raster (about ⅓ of normal).

Workshop-10 is a "hands on" service seminar. Consequently, your local RCA Distributor Service Manager, who will be the instructor, will be installing "bugs" for you to find, and he will expect you to make the test setups and perform the troubleshooting. If you have not received an invitation, contact him for the time and place of the next Workshop-10 program in your area.

CableGuard Shielded Tuner

All 1973 model year, 21″ and 25″ (diagonal), RCA XL-100 Color Television Receivers are equipped with the CableGuard shielded tuner. This tuner helps eliminate the problem of direct-signal pickup when the receiver is connected to a CATV system in areas where strong on-air signals are present. Direct signal pickup causes ghosts, smears, or bars in the picture.

Receivers equipped with the CableGuard shielded tuner have a 75-ohm coaxial cable, which is connected permanently to the VHF tuner, and fitted with a male connector protruding outside the back cover. Thus, when the CATV cable is connected to the receiver's cable, there is nothing unshielded in the CATV signal path. Consequently no direct signal can enter the tuner and degrade the picture.

The CableGuard shielded tuner itself is unique because all leads and components that could pick up "air" signals are inside the tuner. Also, the antenna input filter is completely enclosed in a metal box, and the access holes in the tuner shield have been eliminated. These design improvements minimize the direct pickup of air signals of electrical noise while the XL-100 color set is connected to the cable system.

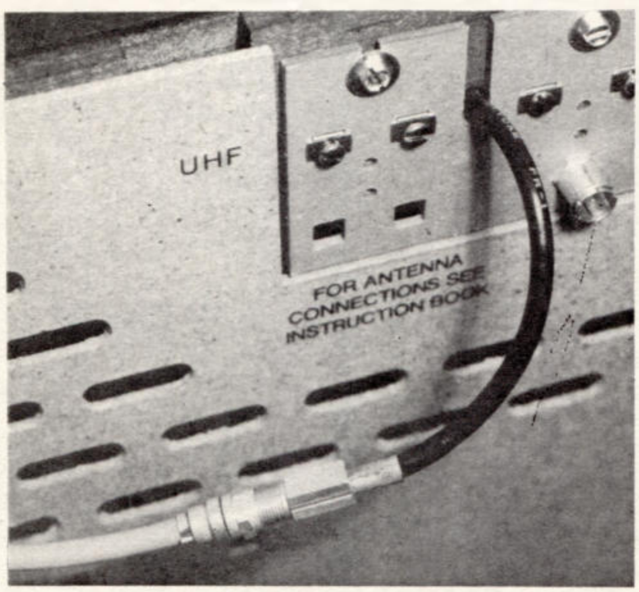

Figure 2—CableGuard Shielded Tuner Connected to CATV System

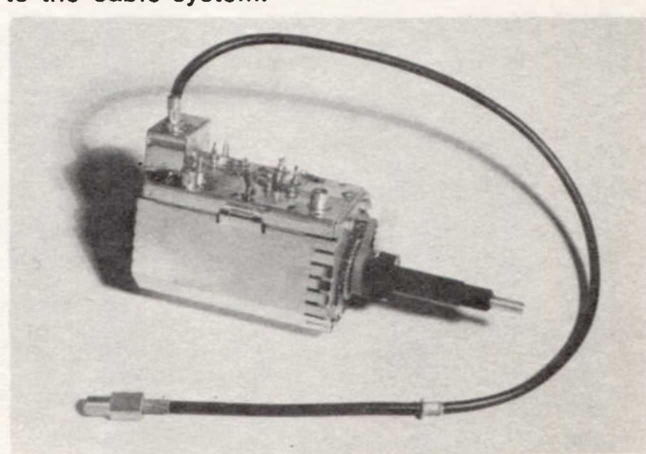

Figure 3—CableGuard Shielded Tuner

RCA Recognizes:

Barney Bretemps, Service Manager, Eastco, East Hartford, Connecticut. Barney is shown receiving a certificate of accomplishment for exceeding his product training goal in the RCA Consumer Electronics Technical Training Recognition Program. Barney trained over 300 Connecticut service technicians in servicing the RCA XL-100 color chassis. N. Cliff Smith, General Manager of Eastco, East Hartford, is making the presentation.

Multivibrator Circuits

Three general types of multivibrators are found in electronic equipment. The types are astable (free running), monostable (one shot), and bistable (flip-flop). All three circuits are quite similar, differing mainly in feedback and triggering circuitry.

Astable Multivibrator

The astable free running, multivibrator is actually a type of oscillator in which the pulse width as well as the frequency can be varied. This capability makes it particularly useful in consumer products and test equipment. Television chassis often use a derivative of the circuit for deflection oscillators.

Figure-4 shows a simplified schematic of an astable multivibrator. Note that positive feedback is applied from the collector of one transistor to the base of the other via capacitors. These two capacitors (C1 and C2) along with the associated resistors (R3 and R4) determine the length of time each transistor is "on" (conducting) and therefore the frequency of oscillation.

When B+ is applied to this circuit, one of the transistors will initially conduct more than the other, as dictated by collector resistors (R1 and R2) and/or the biases established by voltage divider networks (R3/R4 and R5/R6). The regenerative action of positive feedback will drive this transistor to saturation. The other transistor will thus be at cutoff. For explanation, assume that Q1 conducts first. With this condition, the collector voltage of Q1 will drop towards zero and the collector of Q2 will be close to B+. This allows capacitor C1 to charge because it is connected between B+ and ground via R3 and the emitter/collector of Q1. During this time, capacitor C2 charging current flows through the emitter/base circuit of Q1 and on through R2 to the positive supply. Thus sufficient base current flows to hold Q1 in conduction. After a period of time, the voltage at the junction of C1 and R3 will be high enough to forward bias the base/emitter junction of Q2. At this time Q2 switches from cutoff to saturation and capacitor C2 then charges in the reverse direction through the emitter/collector circuit of Q2 and through R5 to B+. During this time, capacitor C1 charges through the base/emitter junction of Q2, holding it in saturation. After a given time (as determined by the R-C time constants) the base of Q1 will become forward biased as described in the previous paragraph. Then Q1 will go to saturation and Q2 to cutoff as at the start. Thus this action will continue just as in other oscillators.

Monostable Multivibrator

Figure-13 shows a monostable, or "one-shot," multivibrator. Note the similarity to the previously described astable multivibrator. The most significant difference is that capacitor C2 and Resistor R5 are replaced by a resistor (R7). The value of R3 is low enough to ensure that transistor Q2 will saturate and Q1 will be cut off until the circuit is "triggered" in the manner to be described. When a positive trigger pulse is applied to the base of Q1 (via C3 and CR 1), it is forced into conduction. When this

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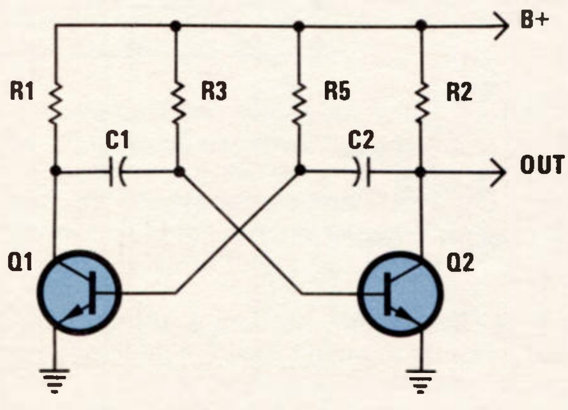

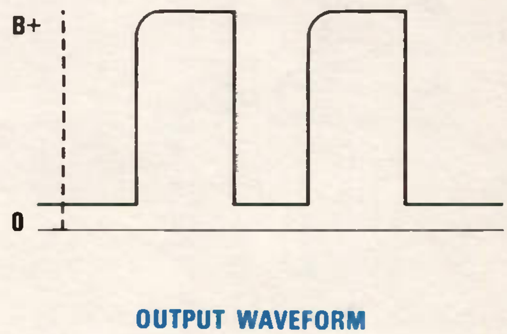

Figure 4—Astable (Free-Running) Multivibrator

Understanding Horizontal-Output Circuits

Part Two

(Continued from Nov.-Dec.)

Part one of this article described the components and function of a tube-type horizontal-output circuit. The circuit operation was also briefly described. This concluding text describes the operation of the circuit in some detail in hopes that the reader will have a better understanding of this "mysterious" circuit and will be more able to service it.

Horizontal-Output Stage Operation

As the reader will recall, horizontal scan begins at the right side of the screen when the horizontal-output tube is driven into conduction by the drive signal from the horizontal oscillator. Accordingly, the detailed discussion of circuit operation begins at this time.

Right Side Scan

Figure-5 reveals the operation of the horizontal-output circuit when the right side of the picture is scanned. This occurs when the horizontal-output tube is driven "on," allowing the current through the horizontal-output tube and horizontal-output transformer/yoke circuit to increase at a linear rate. The horizontal-output tube current is supplied by discharging the energy stored in the capacitors of the B-Boost circuit. The discharge of the B-Boost circuit causes this energy to be transferred and stored in the magnetic field of the horizontal-output transformer and yoke as the electron beam is deflected from the center of the screen to the right.

The voltage/current conditions of the circuit during right side scan of the picture are shown in Figure-6. The three waveforms at the right, depict the voltages and currents in various parts of the horizontal-output circuit with respect to time. The horizontal-output tube has been replaced with a closed switch in this simplified illustration. When the switch closes, voltage is applied across the horizontal-output transformer for the duration of time that the switch is closed—about 32 µS.

The waveform at the top-right illustrates grid-drive to the horizontal-output tube. As the grid-drive voltage increases in a positive direction, the horizontal-output tube begins conduction at time zero (0), when the signal voltage exceeds the −50 volts grid bias, and continues for a period of 32 µS which is sufficient to scan from the center of the screen to the right side. During this time, the horizontal-output tube plate voltage (depicted by center waveform) decreases from +810 volts to approximately +30 volts as the energy withdrawn from the B-Boost circuit is stored in the horizontal-output transformer and yoke. At the same time, the current in the horizontal coils of the deflection yoke increases in a linear manner from zero to its maximum value as the electron beam scans from the center of the screen to the right side. This is shown by the bold-line section of the bottom waveform.

Retrace Interval

Following the right-side scan, horizontal retrace is initiated by the cutoff of the horizontal-output tube. The resulting interruption of current flow in the primary of the horizontal-output transformer and the rapid collapse of the magnetic field in the horizontal-output transformer and yoke windings create a high positive pulse of about 5000 volts. Thus, it is necessary for the horizontal oscillator to drive the output-tube grid far negative in order to maintain the cutoff condition. The horizontal grid-drive signal has a large, negative-going spike of about 200 volts that is adequate to assure cutoff

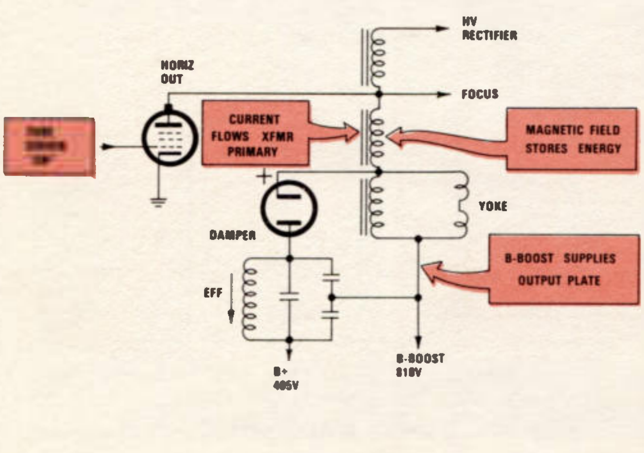

Figure 5—Horizontal-Output Stage Conducts (Right Side)

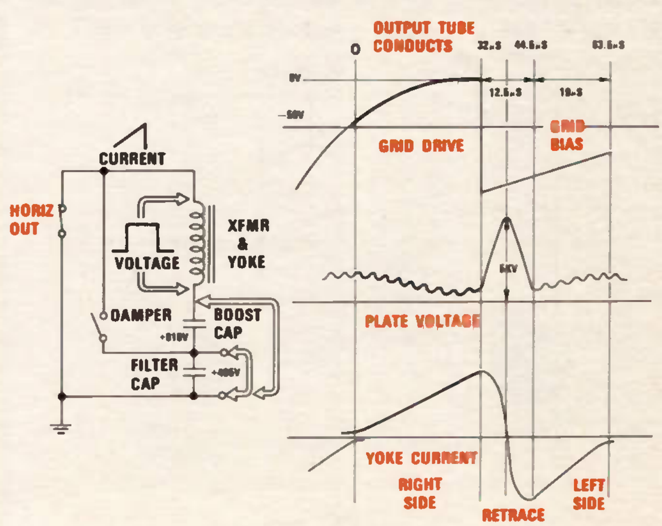

Figure 6—Right-Side Scan Action

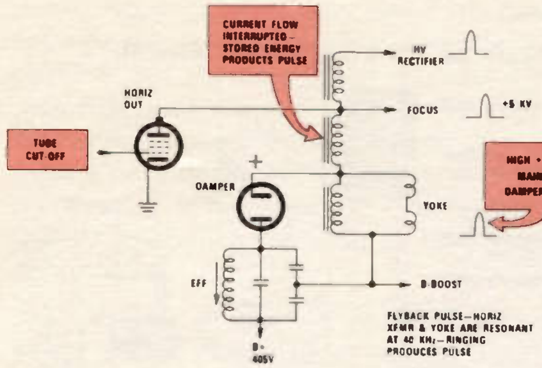

Figure 7—Retrace Interval

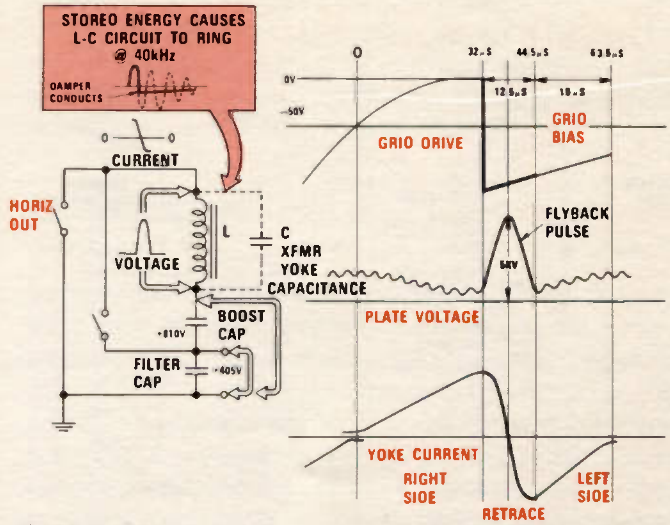

Figure 8—Retrace Action

grid voltage. The 5000-volt positive pulse, so produced, is rectified and used as focus voltage in many chassis. This pulse voltage is also stepped-up to about 25 kV and rectified to furnish the 2nd anode potential for the color picture tube.

The simplified illustration (Figure-8) shows the horizontal-output tube switch open because the negative-going portion of the grid signal drives the horizontal-output tube far beyond cutoff—illustrated by the bold line of the grid-drive waveform at the top-right. During retrace, the leakage inductance of the transformer/yoke (L) and the various capacitances (C) act as a resonant circuit that rings at about 40 kHz when excited by the rapid discharge of the energy stored in the magnetic field. The first half-cycle of ringing reverses the direction of current in the yoke, causing the yoke current to rapidly decrease to zero. As the yoke current decreases, the energy of the magnetic field charges the circuit capacitance (C) so that the peak of 5000 volts is attained when the yoke current reaches zero at the middle of the screen—shown in center waveform. When the flyback pulse passes the peak, the electron beam is rapidly deflected past center to the left side of the screen—shown by the retrace current waveform at bottom-right.

At the end of the first half-cycle, when the ringing voltage starts to go negative, the damper is biased into conduction and the left side of the screen is scanned by recovering energy from the yoke/transformer, thus recharging the capacitors in the B-Boost/efficiency circuit.

The block at the upper-left shows the effect of damper conduction on the ringing waveform. First, the positive-going half-cycle produces retrace. Second, when the damper conducts, the circuit is loaded so that it no longer rings, as shown by the dotted area in the waveform.

Left Side Scan

The action of damper-tube conduction is shown in Figure-9. As illustrated, the horizontal-output tube is cut off and the ringing voltage has driven the damper-tube cathode negative, causing it to conduct and load the horizontal-output transformer/yoke so that the remaining stored energy in the yoke/transformer recharges the B-Boost capacitors via the conducting damper tube. This B-Boost circuit charging current is also the linear yoke current that scans the electron beam from the left side of the screen to the center.

The simplified schematic of Figure-10 illustrates the circuit operation during the damper-controlled portion of scan. The damper tube is shown as a closed switch that creates a loop circuit containing the horizontal-output transformer/yoke inductance, the damper, and the B-Boost capacitor. This simplified circuit clearly shows how the remaining stored energy in the transformer/yoke inductance is recovered by the B-Boost/efficiency circuit during damper conduction.

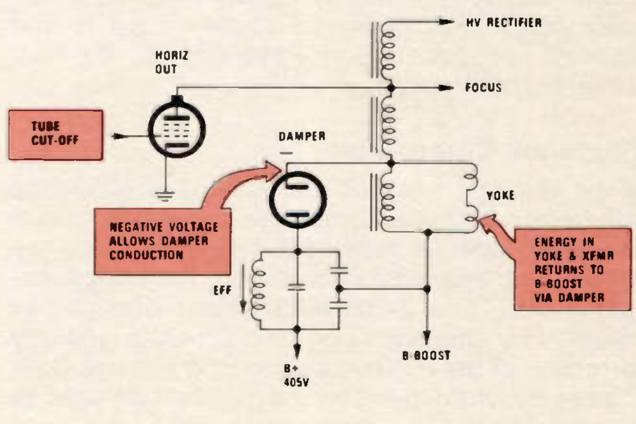

Figure 9—Damper Conducts (Left Side)

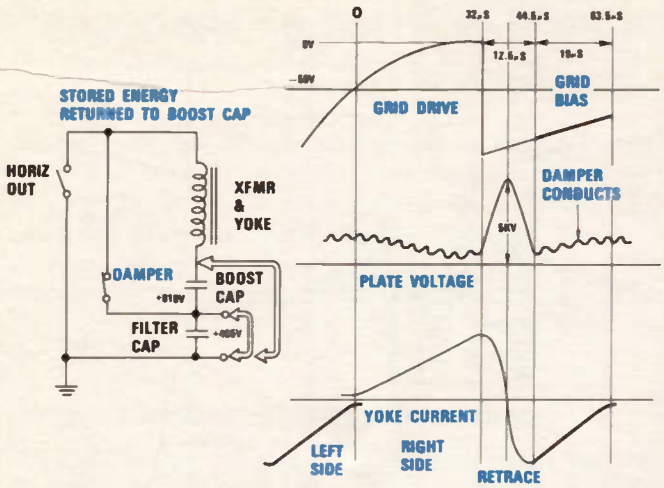

Figure 10—Left-Side Scan Action

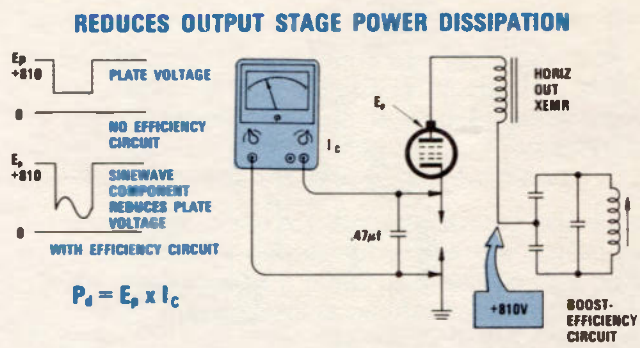

Figure 11—Efficiency Coil Reduces Power Dissipation

The waveforms at the right indicate conditions occurring in an actual circuit. The top waveform (grid bias) reveals that the horizontal-output grid signal remains more negative than the cutoff voltage to assure that the tube is nonconducting. The center waveform shows the ringing action that produces the retrace pulse when the output tube is cut off. The bottom waveform depicts the rapid yoke-current reversal that produces retrace.

B-Boost Generation

Up to now it has been assumed, for simplification, that the B-Boost circuit supplies power to the horizontal-output circuit. Actually all power is supplied by the 405V B+ supply, and excess energy that is not required to overcome circuit losses (high-voltage generation and coil resistive losses) is returned to the B-Boost/efficiency circuit as charging current for the B-Boost capacitors. The series connected B-Boost and B+ circuitry furnish higher than B+ voltage to operate the horizontal-output circuit. When the receiver is first turned "on," there is obviously no boost voltage. At this time, plate voltage for the horizontal-output tube is supplied from +405 volts via the conducting damper. As the circuit begins to operate, the boost capacitor is charged by the previously described action until a potential of about +405 volts appears across this capacitor to be added to the 405 volts B+, resulting in +810 volts for the horizontal-output tube plate.

Efficiency Coil Action

So far the text has not discussed the efficiency coil because, theoretically, the horizontal-output circuit will operate without it. When an efficiency coil is used, improved operation of the horizontal-output tube and decreased power dissipation results. The efficiency coil also provides linearity correction of the horizontal-scanning current. Both of these actions depend on the tuned efficiency-coil circuit modifying the horizontal-output tube plate voltage and the deflection-yoke current.

Reduced Power Dissipation

The reduced horizontal-output stage power dissipation results from allowing the efficiency circuit to add a sinewave component to the B-Boost voltage supplied to the horizontal-output tube plate. Recall that the power dissipated by the horizontal-output tube is equal to its plate voltage (when conducting) multiplied by the RMS plate current. The first example at the upper left of Figure-11 indicates that when the horizontal-output tube conducts, the plate voltage drops from +810 volts to approximately +100 volts, and a cathode-plate current that has an average value of approximately 225 mA results. The second example at the lower-left illustrates a circuit that includes an efficiency coil. In this case, when the horizontal-output tube is driven "on," the plate voltage initially drops to about +100 volts; but, the added sinewave component reduces the plate voltage to approximately +30 volts, resulting in reduced power dissipation in the horizontal-output tube. Although a radical change in cathode current will not result when the efficiency coil is misadjusted, minimum cathode current indicates minimum horizontal-output stage power dissipation and maximum efficiency.

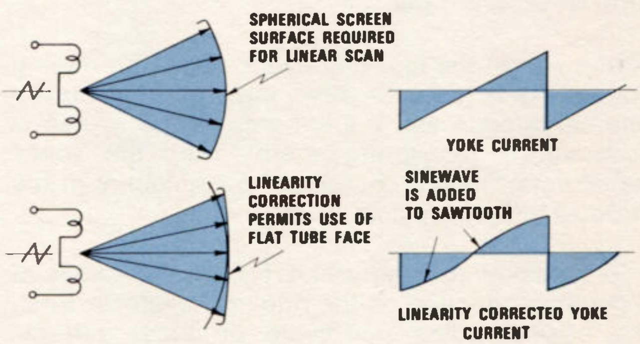

Figure 12—Efficiency Coil Improves Horizontal Linearity

Linearity Correction

The efficiency coil also functions to improve horizontal linearity. Although the horizontal sweep system will operate without linearity correction circuitry, the resulting linear (sawtooth) yoke current must scan a spherical screen surface in order to display an undistorted picture. Obviously, the picture tube does not have a screen of this type; therefore, it is necessary to modify the scanning current applied to the yoke so that a linear scan is produced.

The example at the left of Figure-12 illustrates that a picture produced by a linear sawtooth current would be stretched out of proportion at the left and right sides of the screen. In order to display an undistorted picture, it is necessary to reduce the deflection current at the left and right sides of the screen sufficiently to counteract the stretch that occurs when the beam scans the non-spherical screen. The linearity corrected yoke current at the bottom right illustrates the action occurring when the sinewave component is added to the sawtooth yoke current. Notice at the beginning of the waveform (left side of the screen) the deflection current and consequently the horizontal scan is reduced by the amount necessary to provide linearity correction at the left side of the screen. Past center, as the scan continues, increasing correction is added to the yoke current so that an undistorted picture results.

Multivibrators

Continued from Page 3

occurs, the drop in Q1 collector voltage removes base bias from Q2 and it goes to cutoff. Now, capacitor C1 charges through the collector/emitter circuit of Q1, until the voltage on C1 (junction of R3 and C1) becomes high enough to forward bias the base of Q2. (Capacitor C1, along with its associated resistances, constitutes an R-C network whose time constant determines the width of the output pulse.) At this time, Q2 turns "on" and its collector voltage drops. The turn-on of Q2 removes the base bias on Q1 and it goes to cutoff. The circuit has now returned to the starting, "at rest," condition. The resulting output pulse is shown in Figure-13. The uniform width (duration) and voltage of the pulse produced by the monostable multivibrator makes it very useful in pulse shaping or delaying applications.

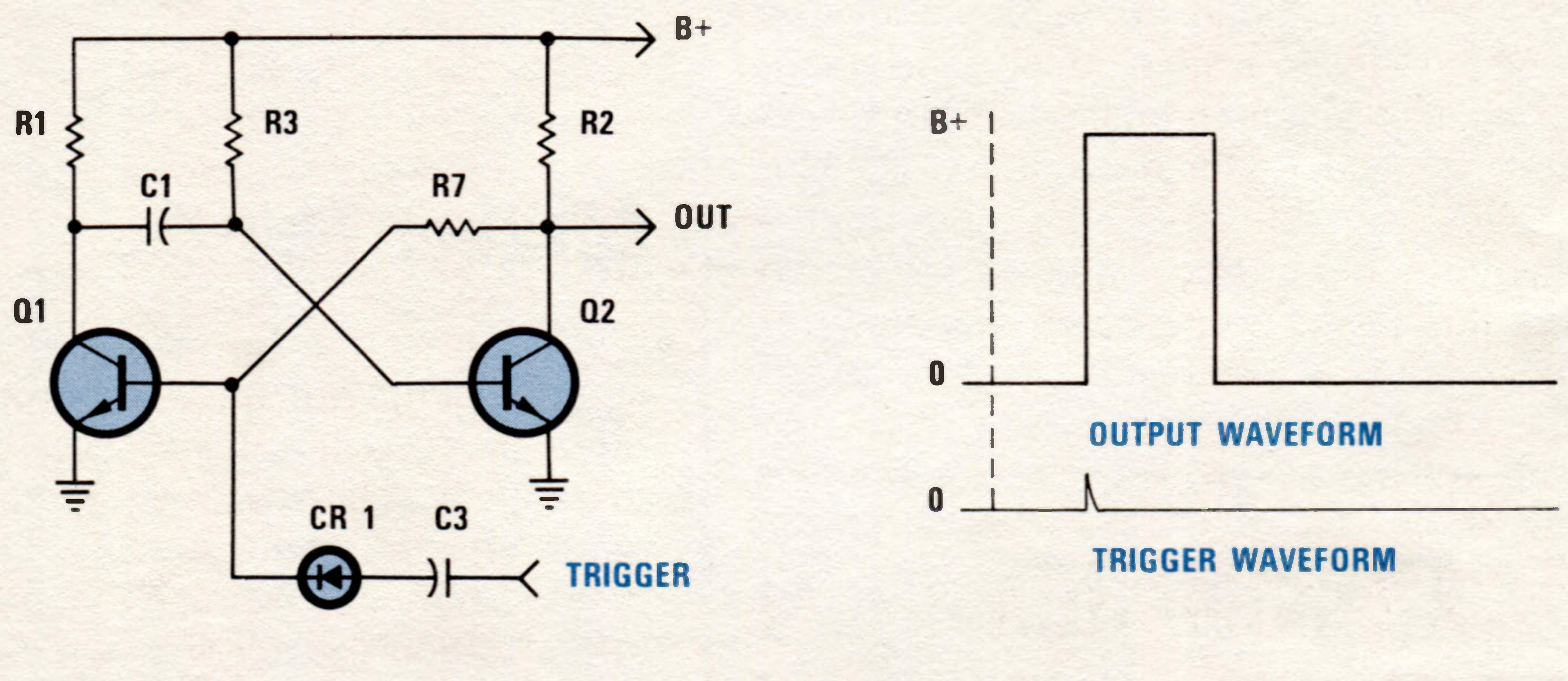

Figure 13—Monostable (One-Shot) Multivibrator

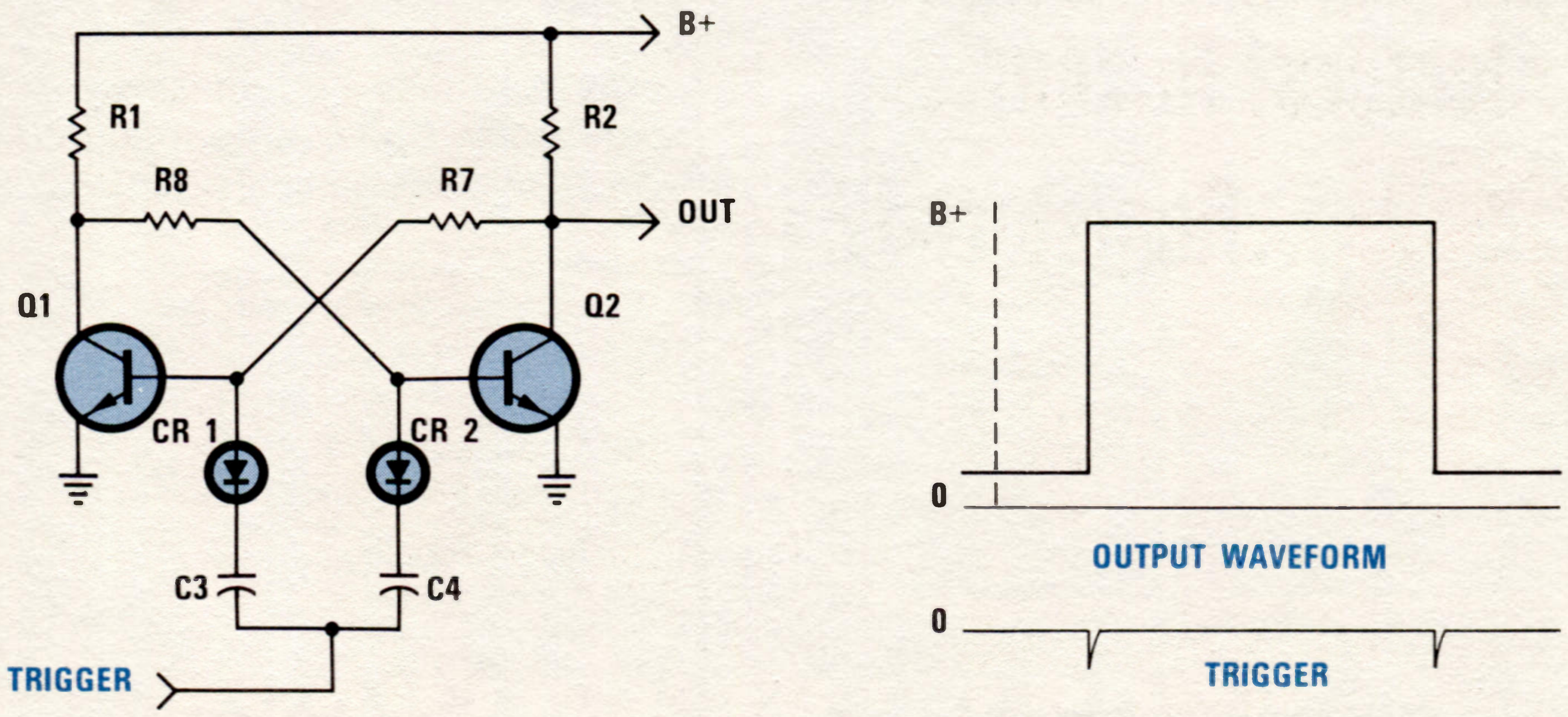

Figure 14—Bistable Multivibrator (Flip-Flop)

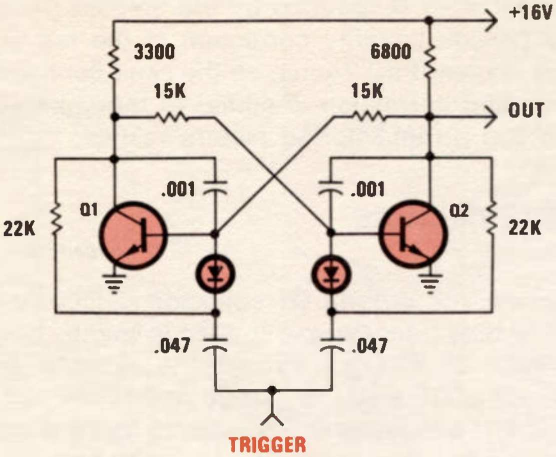

Figure 15—Flip-Flop Used in CTC 53XR Remote

Bistable Multivibrator

Figure-14 shows a bistable multivibrator. Again, note the similarity to the previous two multivibrator types. In this configuration, capacitor C1 is replaced with R8—R3 is not necessary.

When B+ is applied to this circuit, either one of the transistors will conduct depending on circuit values. This, in turn removes base bias from the other transistor, assuring that it will remain cutoff. If Q2 is assumed to be conducting and Q1 is "off," the state of conduction can be reversed by the application of a negative trigger pulse. The negative pulse is applied simultaneously to both bases via capacitors C3 and C4, and diodes CR 1 and CR 2. The diodes serve to "steer" the trigger pulse to the **conducting** transistor, while at the same time prevent the bases from being coupled together as they would if CR 1 and CR 2 were not used.

A little study reveals that the trigger pulse drives both bases negative, and this means that the transistor that is conducting (Q2) is driven to cutoff and its collector voltage rises to B+. Thus Q1 can turn "on" and the conduction condition has been reversed.

As can be seen in Figure-14, one positive output pulse results for every two input trigger pulses. Thus, the flip-flop finds widespread use as a divide-by-two counter. One example of the flip-flop's application in RCA Consumer Electronics products is the remote **ON/OFF/VOLUME** control system used in certain CTC 53 remote-control instruments. One of the two flip-flops used in the CTC 53XR remote-control system is shown in Figure-15. Notice that the collector resistor of the first transistor is smaller than the second in order to satisfy the output requirements, and the 15K feedback resistors are the same. Capacitors (.001 μF) couple each transistor collector to base to provide negative AC feedback to improve random noise immunity. The 22K resistors to the cathode of each diode back-bias the diodes to prevent base-to-base cross-coupling and ensure proper triggering.

Speaker Phasing

All internal and external speakers in a television or stereo instrument must be properly connected in order to have "in-phase" sound outputs. Similarly the speakers in each system must be phased with each other. Incorrect connections may be evidenced by loss of bass, or a "hole in the middle effect" when listening to a monophonic recording from a point midway betwen the two speaker systems.

Always make certain speaker systems are phased correctly. Speaker connection diagrams are shown in RCA Consumer Electronics Service Data.

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