



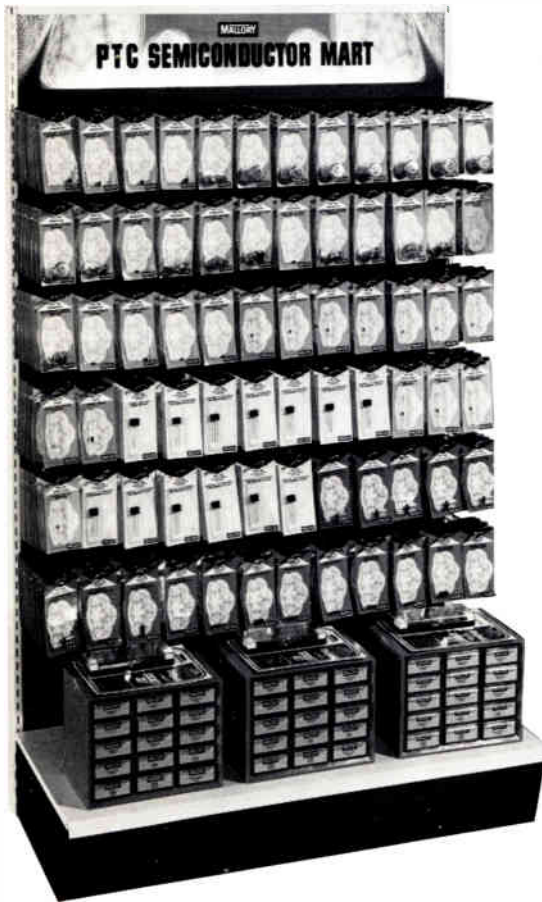
# Electronic Servicing.



**1973 scope roundup page 22**

**New HV regulators  
Servicing solid-state video  
Triggered scopes better?**

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February 1973 □ Volume 23, No. 2

# Electronic Servicing®

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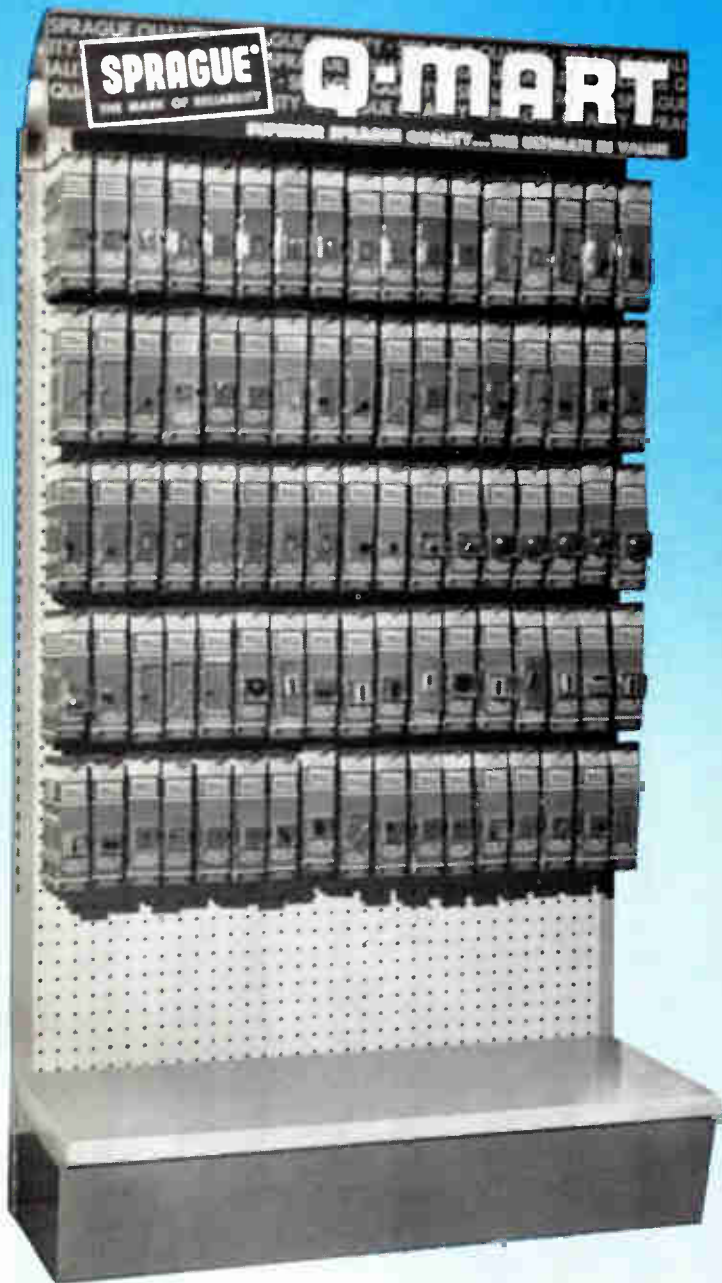
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February, 1973/ELECTRONIC SERVICING 3

# electronic scanner

news of the industry

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Zenith has just announced their new system of AC voltage regulation which permits operation at line voltages between 70 and 140. The system, called Power Sentry, consists of a saturable-reactor circuit using a special power transformer and one oil-filled capacitor to tune a secondary winding. There are no adjustments for the circuit. Voltages between 85 and 140 show no visible change of picture quality, and most individual chassis still have a full raster at 70 volts. One of the important advantages claimed for the circuit is that line transients (especially dangerous to solid-state components) are suppressed completely. The Power Sentry is now used in all Titan 210 series color receivers.

A new RCA TV-camera tube having two "eyes", or targets, is expected to improve the performance of single-tube color TV cameras. The type C23244 BIVICON tube was designed by RCA originally for the HoloTape system in which color pictures are generated from two-frame holographic or photographic films with the b-w projected onto one target, and the color projected onto the other. It is said the registry between b-w and color is excellent because the two electron beams are deflected by one deflection and focus system.

Would you believe a four-cell six-volt battery that is less than one-eighth-inch thick and only slightly larger than a playing card? According to Frederick Port, president of ESB Incorporated, the battery was developed by ESB's Ray-O-Vac Division for use in the Polaroid SX-70 Land camera. To be more precise, one battery is an integral part of each film pack, and it is used to power the film ejection motor, the electronic shutter/exposure system and the flash bar. This makes certain the camera always has a fresh battery. Other uses for thousands of special-type batteries are in mini-calculators and electric watches.

An experiment has explored possible uses for side-by-side TV pictures. No, it's not for watching two different football games simultaneously! According to the *Wall Street Journal*, stations WNEW and public-broadcasting WNET tried a program called "Two's Better Than One", in which the two screens showed different aspects of the same scene. A basketball was bounced from Bob in one screen to Ray in the other. And a rubber-tipped arrow shot from the right screen struck someone viewed in the left screen. While the experimental program was termed a fascinating flop, the two-screen technique holds great promise for certain dramatic scenes, or for sports where a close-up and a long-shot could be broadcast for the viewer to choose the one to be watched.

Emerson and DuMont brands are being discontinued by the National Union Electric Corporation, as reported in *Home Furnishings Daily* and *Radio & Television Weekly*. Also terminated is the contract under which Admiral supplied home-entertainment products to Emerson during 1971 and 1972. Emerson will continue to manufacture and market their line of room air conditioners called Quiet Kool.

*(Continued on page 6)*

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 1703 LAMAR AVE., Memphis, Tennessee 38114 ..... TEL: 901-278-4484  
**TEXAS** ..... 11540 GARLAND RD., Dallas, Texas 75228 ..... TEL: 214-327-8413  
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**WATCH US GROW**

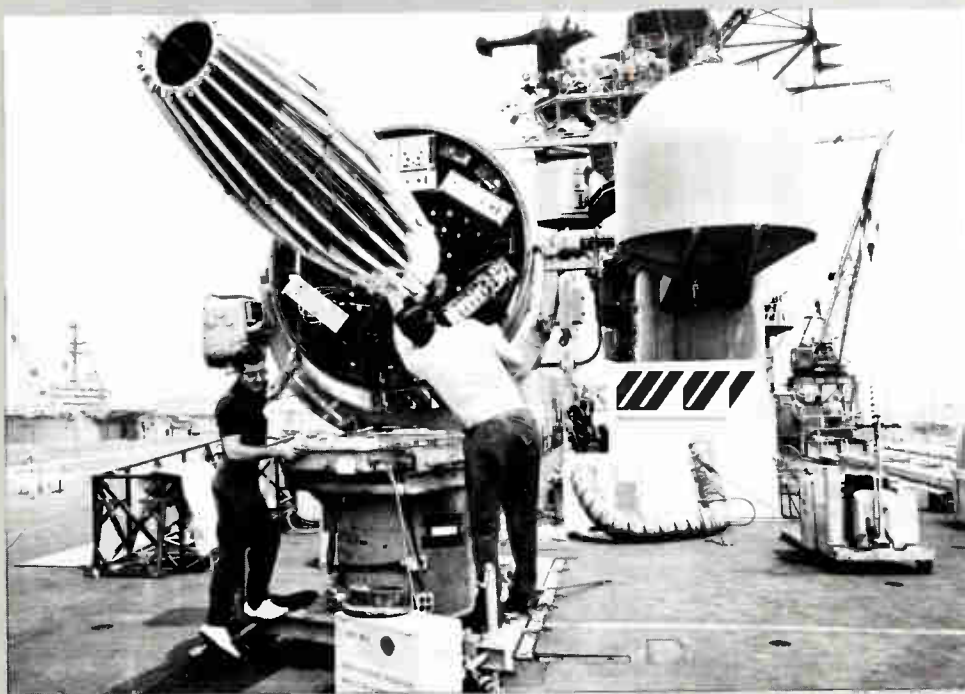
For More Details Circle (6) on Reply Card

The BBB is offering a free booklet of tips for selecting a shop to give good TV servicing, according to Home Furnishings Daily. The booklet, entitled "How To Get Good Television Service" is available in English and Spanish from the Better Business Bureau of Metropolitan New York, Inc. It is said the booklet advises the worst way is to choose a shop in random fashion, perhaps because of location. Conversely, the best way is to look in the Yellow Pages under the brand name of the TV set, or call the distributor for a recommendation.

"Touch-and-Cook" electric ranges by Frigidaire have been previewed, according to Home Furnishings Daily. The controls are programmed by touch, and have a digital-readout panel. For example, the cook might touch the part of the panel marked "start time", then 400 for starting at 4 PM. Next, a touch of the panel marked "oven" and the temperature desired, such as 350 degrees. Finally, a touch on 700 for the stopping time of 7 PM. The touch panel is of smooth tempered glass, and IC's and solid-state components are used in the circuit. Not stated is the type of readout system. When not in use indicating the stove functions, the digital readout shows the correct time.

Less X-ray exposure claimed by use of a new magnetic video disc which replaces the conventional film. As described in Radio & Television Weekly, the magnetic disc recorder designed by Arvin industries can reduce the exposure of both patient and doctor to X-ray radiation by about 50 percent or more. Immediate availability of the picture by the instant replay feature saves time and inconvenience. List price of the Discassette Recorder is \$4,000. It uses a flexible magnetic disc selling for \$25.

Live TV coverage of the splash-down and capsule-recovery of Apollo 17 was transmitted by a Western Union International satellite ground station model WUI-1. In the picture, technicians are shown on board the aircraft-carrier USS Ticonderoga preparing the ground station. The 15-foot parabolic antenna is mounted on a gyro-stabilized platform to accurately track the satellite regardless of ship movements. □





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The B&K Precision Model 281. A solid-state, lab-quality portable instrument that measures AC/DC voltage, current and resistance.

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Model 281 readings are faster and more accurate than analog-type meters. Unlike hard-to-see needle indicators, you can read the large, illuminated numerals—including the decimal point—from a distance.

Featured are 26 ranges: five DC voltage, 100mV to 1000V, with 1% accuracy and 10 megohms input impedance; five AC voltage, 100mV to 1000V RMS, five DC current, 100 $\mu$  A to 1A; five AC current, 100 $\mu$  A to 1A; and six resistance, 10 ohms to 10 megohms.

With built-in protection, the 281 can't be harmed by overload. And for safety's sake, it has a three-line AC grounded cord.

Everything about the 281 says expensive—except the price.

Call your B&K distributor.

Or write Dynascan Corporation.

Very good equipment  
at a very good price. **B&K**

# \$169<sup>95</sup>

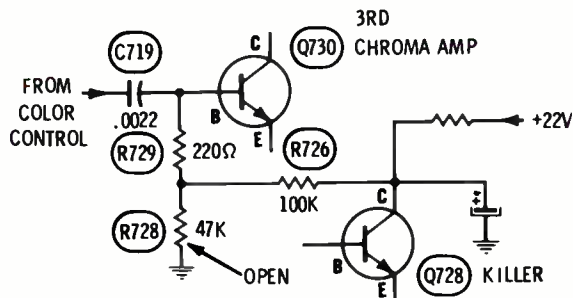


Product of Dynascan Corporation, 1801 West Belle Plaine Avenue, Chicago, Illinois 60613

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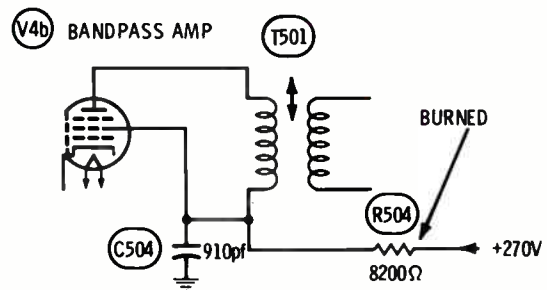
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Chassis—Silvertone 528.4347 and similar  
PHOTOFACT—1278 POM



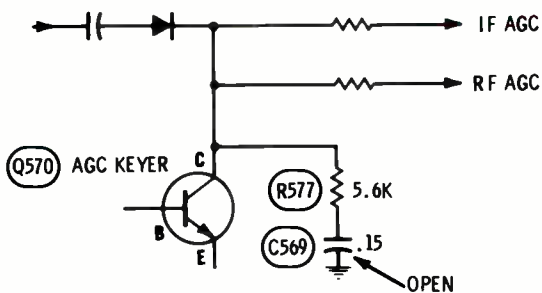
**Symptom**—Excessive color and reddish tint  
**Cure**—Check R728, and replace if open or increased in value

Chassis—General Electric C-1  
PHOTOFACT—1100-2



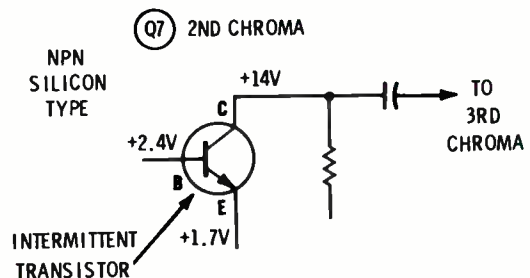
**Symptom**—Intermittent or no color  
**Cure**—Check for R504 burned by lead touching transformer shield

Chassis—Silvertone 528.4347 and similar  
PHOTOFACT—1278 POM



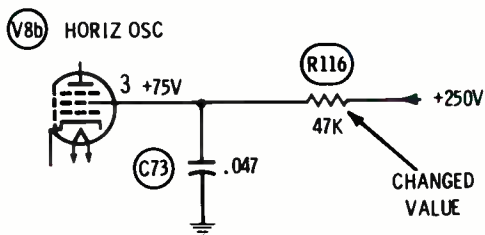
**Symptom**—Several horizontal bars in picture  
**Cure**—Check C569, and replace if open

Chassis—Zenith 16Z7C19Z  
PHOTOFACT—1105-3



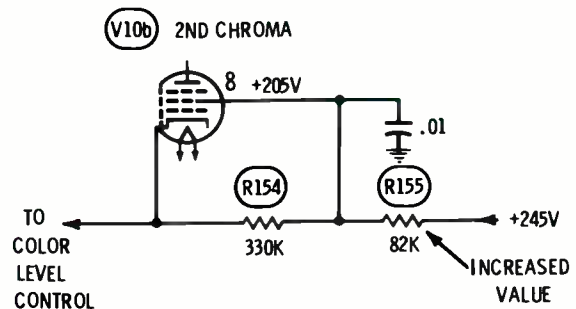
**Symptom**—Poor quality and intermittent color  
**Cure**—Check for an intermittent Q7 2nd chroma amplifier transistor

Chassis—Coronado TV2 6618A  
PHOTOFACT—1001-1



**Symptom**—Low HV and insufficient drive from horiz oscillator  
**Cure**—Check R116, and replace if changed in value

Chassis—Zenith 23XC38  
PHOTOFACT—863-3



**Symptom**—Weak color  
**Cure**—Check R155, and replace if increased in value



## Our ECG 102A transistor replaces...

To Be Replaced	ECG Replacement	To Be Replaced	ECG Replacement
11B33	102A	MA393L	102A
11B54	102A	MA393G	102A
11B55	102A	MA393R	102A
11B56	102A	MA815	102A
11B75	102A	MA881	102A
11B75C			
11B77	102A	MA882	102A
11B77B	102A	MA883	102A
11B77C	102A	MA884	102A
11B156	102A	MA885	102A
	102A	MA886	102A
11B156C			
11B171	102A	MA887	102A
11B172	102A	MA888	102A
11B175	102A	MA889	102A
11B176	102A	MA890	102A
	102A	MA891	102A
11B178			
11B186	102A	MA892	102A
11B187	102A	MA893	102A
11B263	102A	MA894	102A
11B270	102A	MA895	102A
	102A	MA896	102A

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Waltham, Mass. 02154*

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# readers' exchange

Need a not-available schematic? Need an obsolete part? Have an unusual service problem and want help? Send information and full mailing address to ELECTRONIC SERVICING. Other ES readers should send replies with their offer of help direct to the writer. We reserve the right to edit and print all letters sent to this column. Let us help one another.

**Needed:** Service data for model 440 TV/radio/phono combination made by Victor Company of Japan, Ltd.

Mr. Gene Nichols  
1910 Harvey Road  
Seminole, Oklahoma 74868

**Needed:** Schematic and service information for an old model Sears Silvertone radio model 6134, chassis number 101.510.

Rex C. James  
Route 9  
Sevierville, Tennessee 37862

**Needed:** An updated roll chart for a Superior tube tester model TV12.

Reverend Charles Johnson  
23 Payne Place  
Canonsburg, Pennsylvania 15317

**Needed:** Schematic for a Concert stereo model B60082.

James Knoble  
Knoble's TV  
Box 96 Hite Street  
Kingmont, West Virginia 26578

**Needed:** Power transformer for an old Precision oscilloscope series ES-500A.

Edward E. Smith  
5425 South 52nd Street  
Omaha, Nebraska 68117

**Needed:** A schematic and operating instructions for a Precision Model E-400 Sweep Generator.

James R. Burke  
9113 Doris Dr.  
Friendly, Maryland 20022

**Needed:** Schematic and operating instructions for Hammarlund Model HQ-105-TR transreceiver.

Steve Koplinka  
29 Osprey Avenue  
Riverhead, New York 11901

**Needed:** An audio output transformer part number H-10515993 for a model BA-75 Harmon-Kardon Galaxy 75 amplifier. Will pay any reasonable price for a new or used transformer.

Mike Bocz  
Mike's TV 303 Third Street  
Marysville, California 95901

**Needed:** Schematic for a "Rocket" model 8-HL b-w TV manufactured by Egawadenki Kenkyusho, Tokyo, Japan.

Gustavo Diaz  
92-12 88th Avenue  
Woodhaven, N.Y.C., New York 11421

**Needed:** A case for a B&K model 375 VTVM. Condition of internal parts of no concern. Original case was damaged by fire, and Dynascan has no replacements.

Garay's Radio and TV  
RD 2 Crosse Road  
Amherst, Ohio 44001

**Needed:** A flyback transformer part number 493V003MOS for a Westinghouse b-w TV model HZIT101A.

Joseph J. Mehalko  
324 4th St.  
Blakely Olyphant, Pa. 18447

**Needed:** Schematic diagram and service manual for a Candle Transistor Micro Television Receiver model MT-150.

B. L. Roberts  
829 E. Mustang  
Crowley, Texas 76036

**Needed:** The complete address of Electro Technic Products, Chicago 40, Illinois, in order to obtain a part for a high-frequency generator model BD-10 which checks picture tubes for air leaks.

C. Medina  
Atlas TV Service  
1025 Venice Blvd.  
Los Angeles, California 90015

**Needed:** A Flyback Transformer No. WF90 or TWF90 for a Setchell Carlson X162 TV chassis.

Stanley Peterson  
1111 18th Street South  
Wisconsin Rapids, Wis. 54494

**Needed:** Service data for Precise scope model 300.

Lymburner Electric Company, Inc.  
37 Cottage Street  
Bar Harbor, Maine 04609

**Needed:** Service information for the Robosonics Record-O-Phone, Model 100. We have received no reply from their old address.

W. M. Walsh  
Speedway Radio  
307 West 19th St.  
Austin, Texas 78701

**Needed:** Schematic and operating manual for a Precision scope model ES-500A.

Jack Goins  
Route 5  
Rogersville, Tennessee 37857

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Edward J. Caffé  
7519 S. Morgen St.  
Chicago, Ill. 60620

# Everytime we introduce a new product, you become more important.

New products mean more business. Not only for us, but for you. Independent service technicians. Once a product leaves our hands, it's in yours. Along with our reputation for making quality electronics. And for standing behind them. That's why you're so important to us. You help us maintain our good name. Product after product. Year after year.

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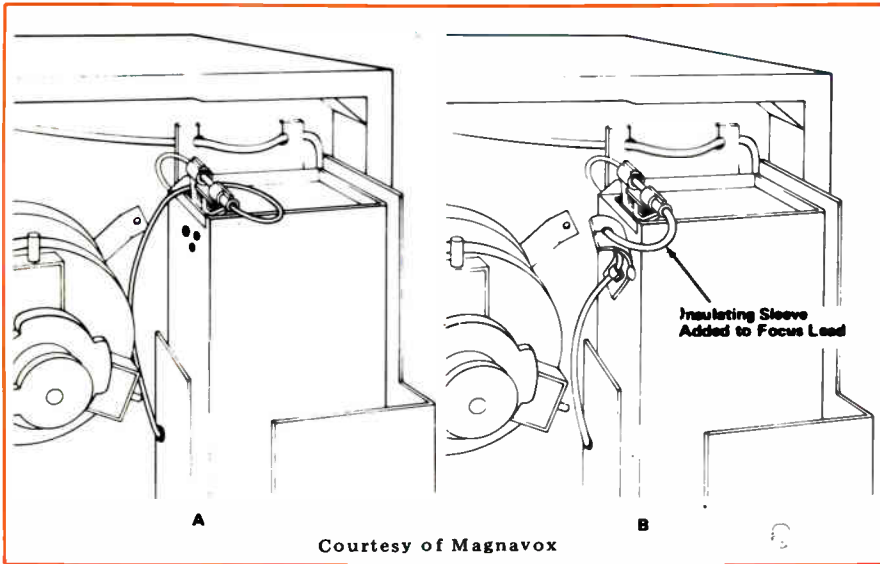
**Panasonic.**  
just slightly ahead of our time

Panasonic Service Division, 10-16 44th Drive, Long Island City, N.Y. 11101

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# service bulletin

a digest of info from manufacturers

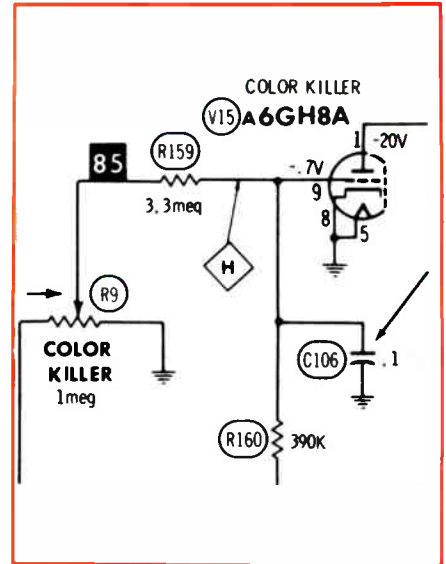


Courtesy of Magnavox

## Modification Of Focus Rectifier Lead Dress Magnavox T939 Color TV Chassis

Lead dress of the focus rectifier socket should be inspected in each T939 chassis serviced. In some versions, the socket is mounted on top of the HV cage, as shown in illustration "A". Arcing might occur between the lead wire and the HV cage or the yoke bracket.

Install Kit number 171282-1 obtainable from your Magnavox District Parts Center, as shown in Illustration "B", to eliminate any possibility of arcs.

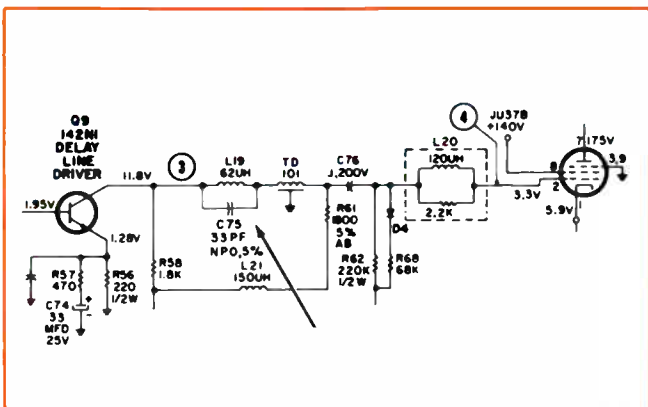


## Loss of color

Admiral G11, G13, H10, H12, K15 and K16 color TV chassis

A loss of color in these receivers (because the killer is biasing the bandpass amplifier to cutoff) might be caused by leakage in the .1-mfd capacitor from the grid (pin 9) of the color killer tube to ground.

Replace the capacitor with one having a higher voltage rating.

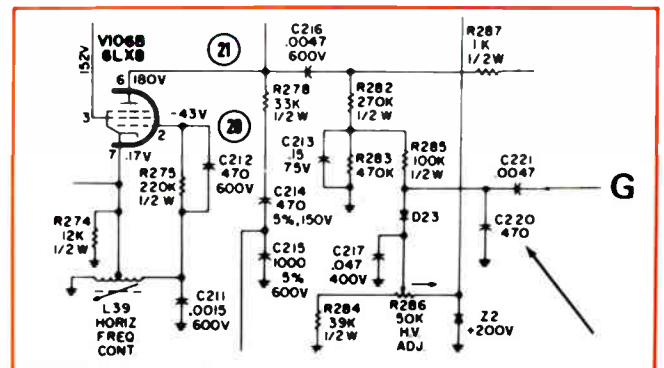


Courtesy of Magnavox

## Beat Pattern Magnavox T952 Chassis

Early production T952 chassis did not have C75 (33 pf) paralleled across L19 in the delay line circuit.

If a beat pattern can be seen, add the capacitor as shown in the schematic.



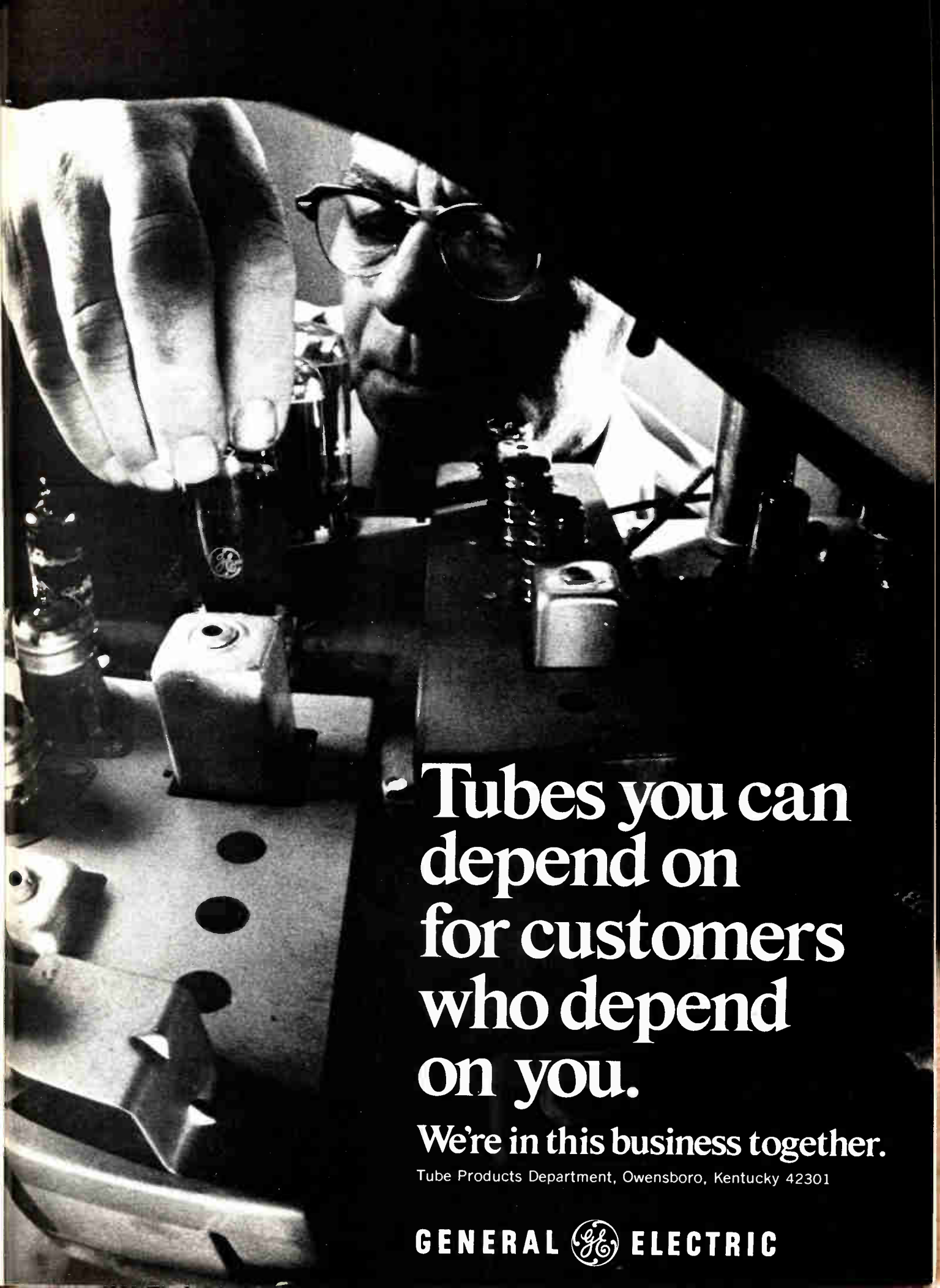
Courtesy of Magnavox

## Removal of Capacitor Magnavox T952 Color TV Chassis

Some versions of the T952 chassis included C220 (470 pf) which was connected from ground to the junction of C221, R285 and D23 in the horizontal oscillator circuit.

Remove any of these capacitors from the chassis you are servicing. The removal reduces the dissipation of the horizontal-output tube. □





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# Are triggered-sweep scopes really better?

By Carl Babcoke

*Triggered-sweep and dual-trace features are the "in" thing about new scopes this year. According to your letters, many of you are puzzled about which type is better for servicing color sets. Here are some of the answers and some little-known, but important, uses for DC and dual-trace functions.*

Most articles about scopes mention that triggered-sweep models have DC coupling, extending high-frequency response, and better locking compared to recurrent-sweep versions. But that's misleading. Although these improvements are usually found in triggered scopes, DC coupling and wider bandwidth are not essential for triggered-sweep operation. Many good recurrent scopes have DC coupling and more-than-adequate bandwidth.

No, the one distinctive advantage of triggered-sweep operation is stability of locking. The explanations and scope waveforms that follow should clarify the "what kind" and "how much" questions about the stable locking of triggered-sweep scopes.

## Locking Recurrent Sweep

In scopes using recurrent sweep, the horizontal sweep operates continuously whether or not there is a waveform to be viewed. A sample of the amplified input signal is used as sync to lock the sweep frequency.

It is not customary to view just one cycle of waveform on the scope

screen. For one reason, the part of the sweep cycle used for retrace removes a small portion of the waveform. Instead, the sweep is operated at one-half, one-third, or one-fourth of the signal frequency to produce two, three, or four cycles of the waveform.

Let's follow the sequence of waveforms shown in Figure 1 to learn something important about locking recurring-sweep scopes. Assume that we have adjusted the controls to lock a single sine wave (Figure 1A). Next, we turn the variable-frequency knob in the direction giving a lower sweep frequency. At first there is just a blur (Figure 1B). That's normal. Then the picture stops moving, and we expect to see two sine waves. Unfortunately, there are two separate waveforms, each having sine waves (Figure 1C). This might be okay for looking at sine waves, but imagine the mishmash if they were complex video waveforms! Turn the knob again and the blur is back (Figure 1D). Finally after more knob turning, the movement of the waveform stops and the screen shows two cycles of sine wave (Figure 1E).

In other words, if we turn the variable-frequency knob attempting to change the number of cycles of waveform on the screen, we must lock the sweep separately for each one. This is easy enough for sine waves which lock readily, but much more difficult and exasperating with video waveforms.

Notice that the action is the locking of multiples of the sweep and the signal frequencies. The key word is

"frequency". To obtain a valid comparison, we must try the same locking sequence with a triggered-sweep scope.

## Locking Triggered Sweep

Except in the "auto" mode, there is no horizontal sweep unless a waveform starts (or triggers) it. Thus the name. A certain polarity and amplitude of voltage is selected by the locking controls. When this exact voltage occurs in the waveform being observed, it triggers the start of the horizontal sweep. Once started, the sweep continues for a period of time determined by the RC time constant of the sweep/time controls. At the end of the time, the sweep stops and waits for the next identical triggering voltage to arrive and start it again. Of course, when viewing repetitive waveforms, the sweep appears to us to be repetitive. Let's examine how this operates.

Assume that we have adjusted the controls of a triggered-sweep scope to obtain one sine wave, as shown in Figure 2A. Next, we turn the variable/time control in the direction which gives a sweep of longer time duration. The sine wave appears to squeeze together showing part of another cycle until about 1-1/4 (Figure 2B) then 1-3/4 sine waves appear (Figure 2C). Additional adjustment of the control finally produces 2 complete sine waves (Figure 2D). The important point is that the waveform doesn't jump out of lock, but just smoothly pulls more sine waves into view.

What's more, the waveform remains locked when radical movements of the

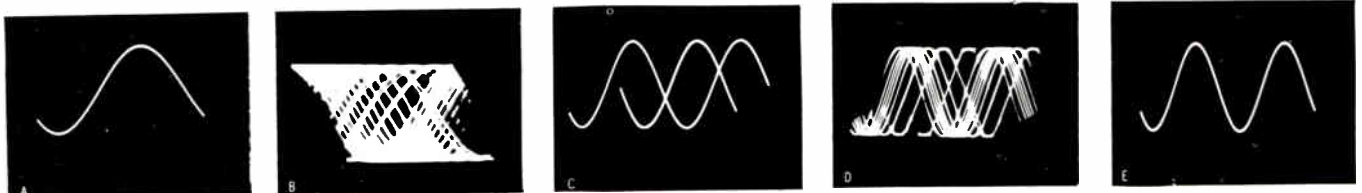
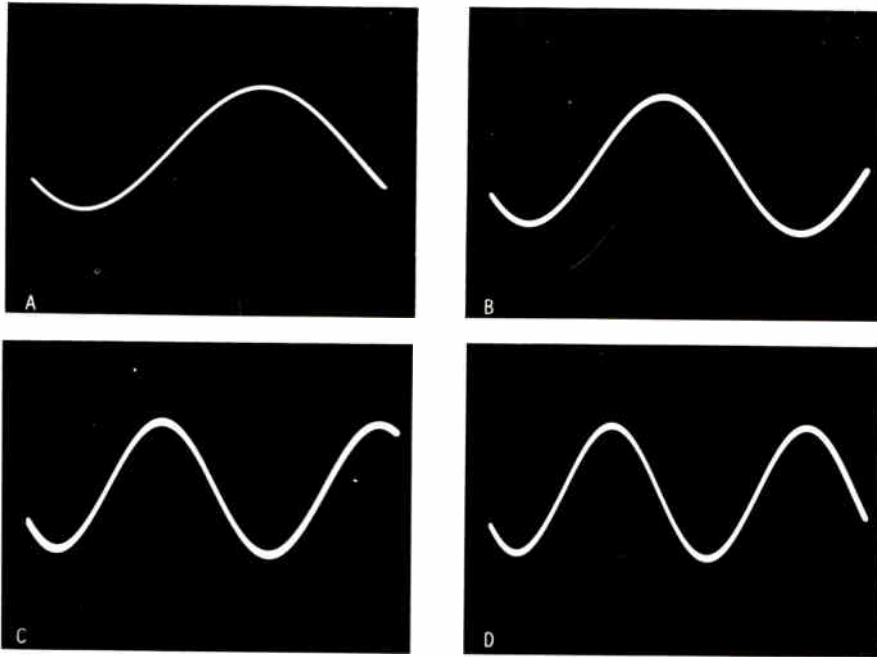
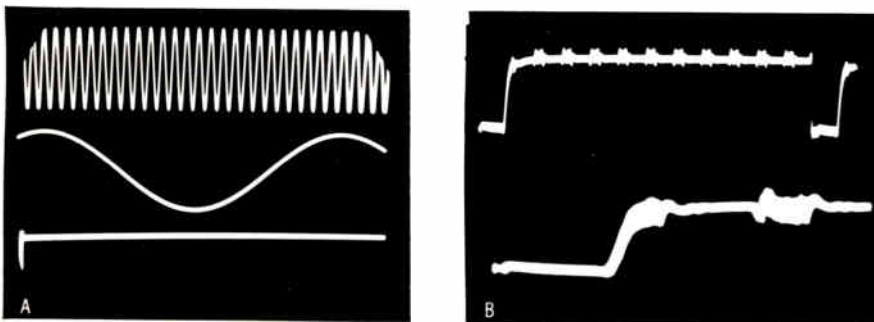


Fig. 1 The sequence of waveforms obtained when changing a recurrent-type sweep scope from a locked single sine wave to two cycles of sine wave. (A) Adjustment of the scope controls has locked one cycle of sine wave. (B) Slight rotation of the variable-frequency control pulls the waveform out of lock and it becomes a fast-moving

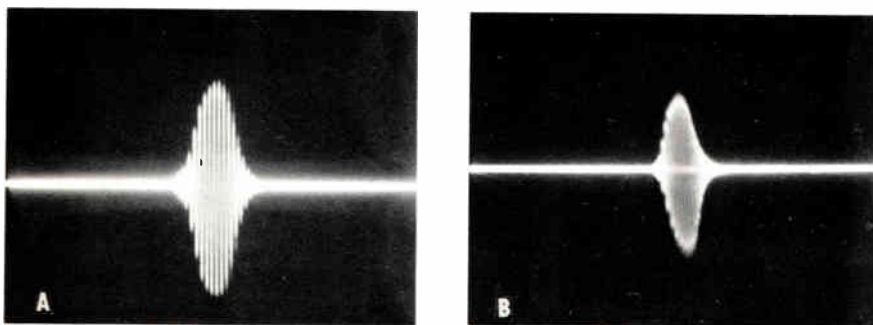
blur. (C) More rotation stops the waveform, but is two separate waveforms, not one as we wanted. This is false locking. (D) Again, adjustment produces a meaningless out-of-lock blur. (E) Finally, the two cycles of sine wave are locked.



**Fig. 2** Changing a triggered-sweep scope from one cycle of waveform to two is easy and fast. (A) Adjustment of the scope controls has locked one cycle of sine wave. (B) Slight rotation of the variable/TIME/CM control appears to contract the waveform so about 1-1/4 cycles are visible. (C) More rotation contracts the waveform so nearly 2 cycles are shown. (D) Two cycles are obtained merely by stopping the adjustment. More than two cycles can be obtained just as easily, without losing locking.



**Fig. 3** After a waveform is locked by the triggered sweep to the desired voltage, almost any number of cycles or portions of a cycle can be obtained without loss of locking. (A) In this case the sweep was locked to the center waveform. Then the TIME/CM switch was turned for a longer sweep time giving about two dozen cycles (upper waveform). Finally the TIME/CM switch was turned for a very-short sweep time, which showed such a small percentage of one cycle that the trace (bottom waveform) appears to be a straight line. (B) The upper waveform is one complete cycle of a chroma signal from a color bar generator. Decreasing the sweep time widens the waveform until only the chroma for one color bar is on the screen (lower waveform).



time/CM switch show a fraction of one, or dozens of cycles.

Think of it this way: triggered sweep merely freezes a slice of time for our inspection. It's all the same to the scope whether there is 1/10th waveform or a dozen visible on the screen, as illustrated in Figure 3. Recurrent sweep can never show less than one complete waveform.

#### Viewing part of a waveform

One of the important advantages of triggered sweep is the ability to enlarge just a portion of one cycle of a waveform (see the color-bar waveforms in Figure 3).

In addition, most triggered-sweep scopes have a 5X switch which widens the horizontal-sweep width. This, and operation of the centering control, makes possible the examination of very small portions of any waveform. Some of the more spectacular waveform photos we have published during the past couple of years were made possible by these expanding techniques. Perhaps you remember the serrated pulses in video and sync, or the color burst where you could count the individual cycles.

When the 5X switch widens the scan, there is a large loss of brightness of the waveform. It might interest you to know that some of those photographs were exposed for 10 or 12 seconds. That speaks well of the ability of the scope to hold perfectly steady under those exacting circumstances.

Often waveforms that seem completely motionless when viewed the usual way will show a fuzziness when expanded either by a short-time-sweep or by the 5X feature. The cause is a failure of all the waveforms to appear at the same position horizontally. Under these poor conditions, triggered scopes outperform the recurring ones. The two waveforms of Figure 4 are the

**Fig. 4** Triggered sweep has better accuracy in starting each sweep at the same time. The waveform is less fuzzy because each of the repetitive waveforms occurs at the same point on the screen. (A) Color burst at the output of a burst keyer is sharp and steady when viewed on a triggered-sweep scope. (B) This is the steadiest, sharpest burst waveform obtainable from a good-quality recurrent-sweep scope.



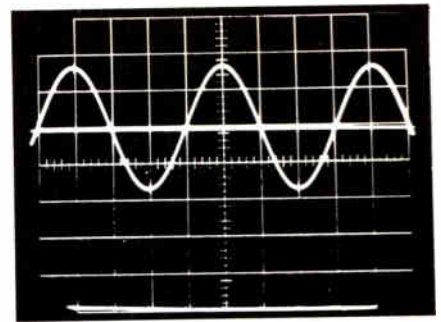
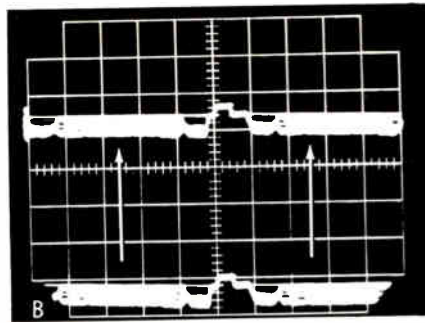
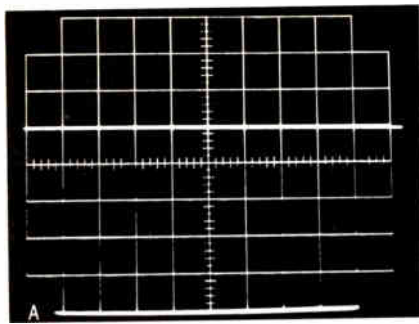


Fig. 5 When DC coupling is used, DC voltages can be measured by vertical change of scanning-line or waveform position. The calibration for DC is the same as for AC p-p. (A) To measure DC which has no AC waveform, adjust the vertical-centering control so the horizontal line is at the bottom graticule marking, when the probe is not connected to the circuit. Then touch the probe to the voltage and count the number of centimeter squares the line moves. (B) When both AC and DC are present, switch to AC coupling and position the waveform so a certain portion of it is in line with a graticule marking. Then switch to DC coupling and count the number of centimeters the waveform has moved. In this case, the waveform was 45 volts p-p, and it was riding on a DC voltage of +260.

Fig. 6 The average DC voltage when the AC waveform is symmetrical can be measured from the zero line to the vertical midpoint of the waveform. Because the scope was set for 50V/CM, the sine wave is 180 volts p-p, and the average DC is 250 volts.

best ones I could obtain of color burst using both types of scopes.

#### Tighter locking

One of the pleasant surprises you should receive, when first trying to lock a triggered scope, is the firmness with which the waveform snaps into lock. Of course, it's necessary to adjust two controls, but often this is true of the recurring types, also.

We can't use waveforms to show you this increased tightness of locking; you must experience it for yourself.

#### Long-term stability

Another performance characteristic of scopes that we can't illustrate is the long-term frequency stability of the horizontal sweep. Look at it this way: the oscillator of recurrent-sweep

scopes are usually blocked-oscillator or multivibrator types, which change frequency even more from amplitude changes than from the drift of components. Remember that a slight drift of frequency will cause a loss of locking. But with triggered scopes the frequency is determined by the signal, not the oscillator.

As a test, I once locked six scopes of mixed recurring and triggered types to the same waveform, then watched them for a period of several hours for any loss of locking. On the average, the triggered ones held locking much longer.

#### DC Coupling

Many of the new model scopes (even recurrent-trace models, and especially solid-state types) have DC coupling of

(Continued on page 18)

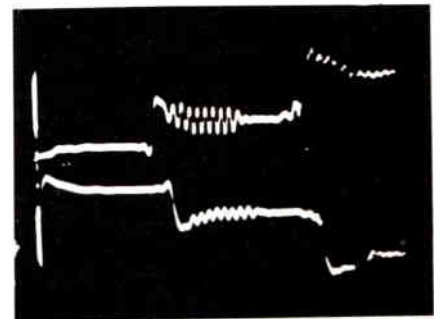


Fig. 7 Dual trace waveforms can show the effect of delay lines. The signal at the input of the delay line is shown in the upper waveform, while the lower one is the output signal. The video waveform has been expanded about six times by using a horizontal sweep of 1-microsecond-per-centimeter, and the lower waveform has been inverted by the scope.

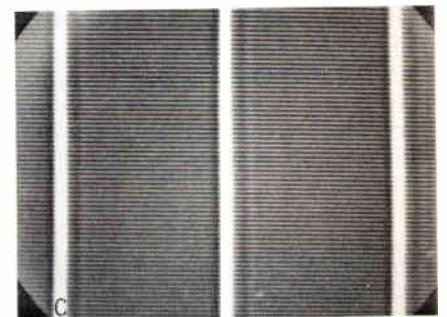
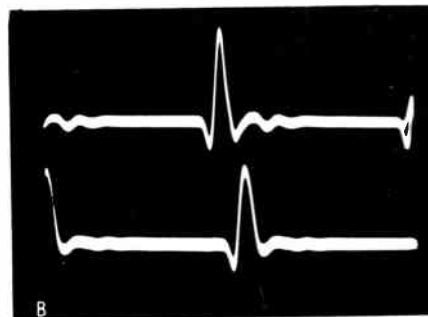
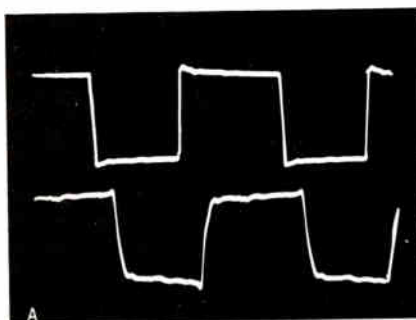


Fig. 8 Delay lines can be tested by square waves or the vertical-lines pattern of a color-bar generator. The delay line circuit here is normal. (A) Square waves of 200 KHz pass through the delay line with only a slight change of waveform, but the output signal (lower waveform) has been moved to the right by the time delay. (B) A more convenient source of signal for testing delay lines is to use the video from a vertical-lines pattern, or crosshatch. The triggered sweep has expanded

the waveform until only two cycles are shown, and the time delay is easily seen. The lower waveform is the output signal from the delay line, and positive-going portion produces white on the screen of the TV picture tube. Compare this waveform with actual lines on the screen, shown in (C). (C) This picture taken from the screen of the picture tube shows the pre-shoot, post-shoot and other ringing effects the same as the scope waveform in (B).

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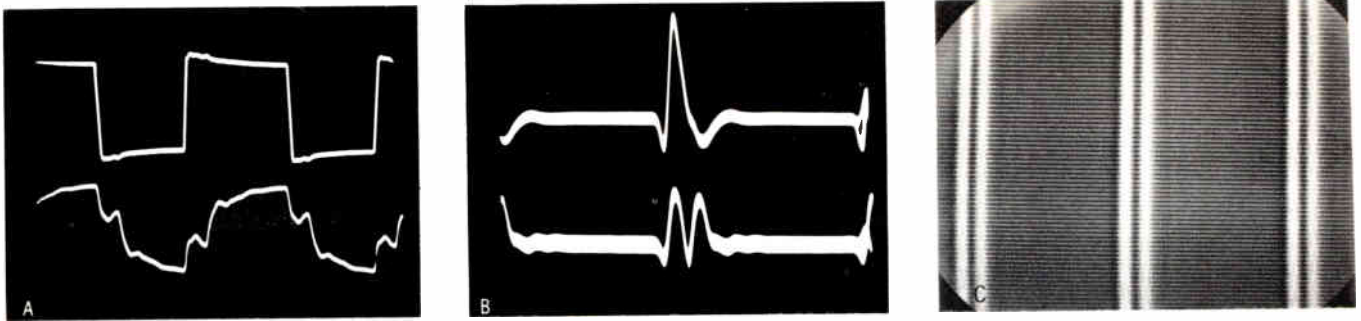


Fig. 9 Square waves and the vertical-lines pattern show the effects of an open ground circuit of the delay line. (A) The output signal (lower waveform) shows ringing of both the rising and falling edges of the square wave. However, the effect on the visible TV picture is shown

more accurately by the vertical-lines pulses. (B) Two pulses of nearly equal amplitude are produced by the open ground. Notice that the first pulse (lower waveform) is not delayed. (C) Two vertical lines for each normal one line are visible on the screen because of this defect.

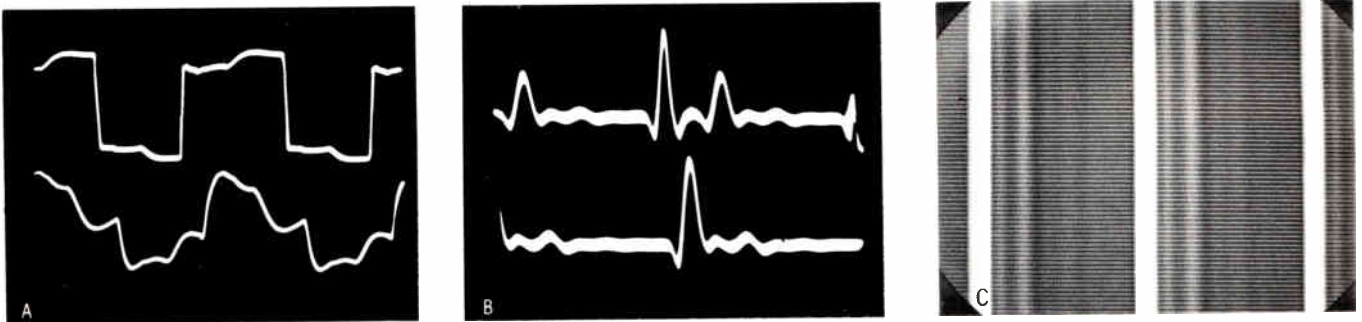


Fig. 10 An open load resistor at the output of the delay line produces ringing which resembles ghosts. (A) Both the input (upper waveform) and the output (lower waveform) signal are affected by the open load resistor which causes standing waves. Although, square waves don't show the effect on the TV picture as accurately as the pulses of the

vertical-lines signal do. (B) The time delay is not affected by the open resistor, but both the input (upper) and output (lower) waveforms show extra ringing. And the output ringing corresponds exactly to the ghosts on the screen in (C). (C) The effect of ghosts is produced on the picture tube when the output load of the delay line is open.

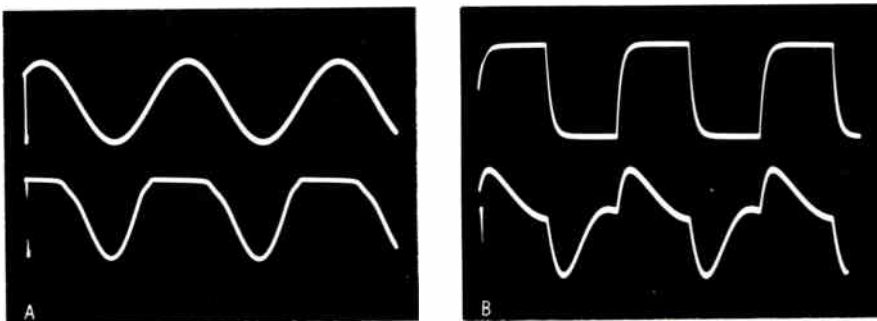


Fig. 11 Dual-trace waveforms taken from the two channels of a stereo machine help locate the stage where distortion or a change of frequency response occurs. Sine waves show frequency response, and both can indicate any amplitude difference. (A) Distortion because of wrong bias is shown in the lower waveform, and can be compared easily with the undistorted signal of the other channel (upper waveform). (B) Attenuation of both high and low frequencies is shown by the lower waveform, compared to the normal one (upper waveform).

the vertical amplifier stages.

Of course, this extends the low-frequency response, but even more important it makes possible the measurement of DC voltages. It is a convenience to be able to measure together the AC signal amplitude and the DC component.

Remember that the calibration of voltage per graticule marking is exactly the same for DC as for peak-to-peak voltages.

#### Measuring DC by the shift

One method of measuring DC voltages is to compare the position of the horizontal line with and without the DC voltage. Then multiply the number of calibration marks it moved by the vertical-sensitivity factor.

For example in Figure 5A, the VOLTS/CM position was selected to cover the anticipated amount of voltage. Next, the vertical centering was used to move the horizontal line to the bottom line of the graticule. Then, the

probe was applied to the DC voltage (without AC waveform). The line moved upward five centimeters, which was multiplied by the sensitivity factor of 10 volts/CM to give a reading of 50 volts DC. Very simple.

There are a couple of precautions. Don't forget to include the attenuation factor of the probe. In this example, the VOLTS/CM was set to 1 volt and the low-capacitance probe was used giving a loss of 10 times. So

(Continued on page 20)



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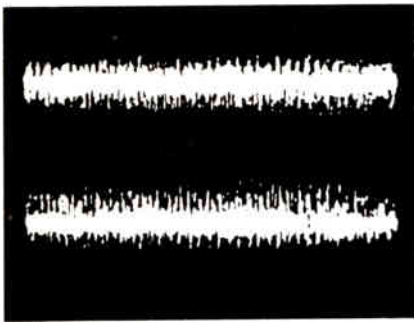


Fig. 12 Test for an intermittent in an audio stage by looking at the input signal on one scope channel and the output signal on the other trace of the dual-trace function. If you can hear the intermittent stop the volume, but there is no change of either trace, the defect is following this stage. If both traces lose amplitude at the same time, the trouble is before the stage. If the input waveform remains, but the amplitude decreases at the output, the defect is in the stage.

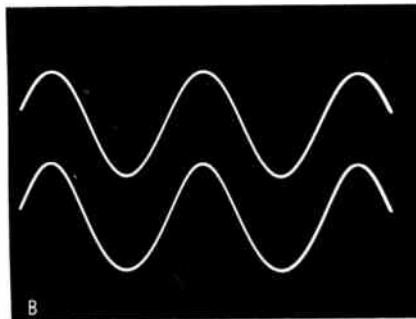
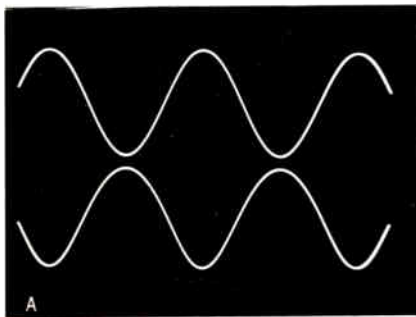


Fig. 13 Small amounts of distortion are difficult to determine from visual analysis of sine waves. The lower waveform has 3-percent distortion in both examples. (A) The input and output (lower) waveforms appear to be nearly identical. (B) Even after inversion of the lower waveform by the scope, the two waveforms are nearly the same.

the total sensitivity factor was 10 volts/CM.

Make certain the vertical gain is correctly calibrated. Some of the new scopes are stable enough and have internal factory adjustments so it is only necessary to turn the variable VOLTS/CM knob completely clockwise, and the calibration mark-

ings at each position of the VOLTS/CM switch are correct. In addition, many scopes have a calibration waveform for testing the accuracy of calibration.

One more precaution. The DC balance of some individual scopes might change when other VOLTS/CM ranges are selected. Therefore, the calibration (if any) should be done first, then the position of the VOLTS/CM switch selected **before** the line is adjusted to the graticule marking you intend to use as the zero-voltage reference.

Simultaneous measurements of AC and DC voltages can be made in nearly the same way as pure DC (Figure 5B). Switch to AC-coupling, and use the vertical centering control to position a selected part of the waveform so it lines up with a graticule marking. Use a graticule line near the bottom for positive voltages, or a line near the top if the voltage is negative. Then, switch from AC- to DC-coupling and measure how many graticule markings (centimeter squares) the selected part of the waveform moved. Multiply the number of graticule markings by the total sensitivity factor (from the VOLTS/CM switch and the probe attenuation) to obtain the DC voltage. The p-p measurement of the waveform is made in the usual way by noticing the height relative to the number of graticule markings.

#### Average-DC voltage measurements

The previous methods of measuring DC involved two separate steps. Under certain conditions, both the AC and DC components of a signal can be measured in one operation.

If the waveform is symmetrical from top to bottom (sine, sawtooth or square waves), the average DC voltage (the same as measured by a DC meter) is exactly in the vertical center of the waveform.

In the example of Figure 6, the sensitivity factor was 50V/CM, the sine wave measured 180 volts p-p and the DC voltage from the zero line to the center of the sine wave was 250 volts.

Incidentally, a rough approximation of the DC component of video waveforms can be obtained by estimating the half-way point between the sync tips and the white-producing video level. The DC voltage is the number of graticule marks between the one-half point and the zero line.

#### Dual-Trace Operation

Dual-trace and dual-beam scopes can show two separate waveforms, but with the same horizontal sweep and locking. We won't discuss dual-beam scopes very much, because they are usually much more expensive, and not many models are offered for sale. They use a special scope tube that has two guns and two sets of vertical deflection plates. The two vertical channels have separate vertical gain and centering controls.

Dual-trace scopes are somewhat similar, except a conventional scope tube is used and the beam is internally switched to simulate two separate beams. Two methods are employed to divide the one beam so it is used for two waveforms. One is to switch between the channels so that one horizontal trace has the centering and waveform of channel 1, while the next trace has the centering and waveform of channel 2. This is called "alternate" scanning.

The other method is called "chopping", and in this mode the two channels are switched alternately in and out at a rate between 100 KHz and 150 KHz. Some scopes give you a choice of these modes; others have chopping only. Either mode is satisfactory for TV servicing.

#### Advantages of dual-trace operation

If you have never used a dual-trace scope, you probably believe it would be of little value to you. At first, I thought that, too. But the more I have used one the more uses I find for it.

There are two general advantages: the relative phase of the waveforms in two different circuits can be measured easily; and simultaneous comparisons can be made of the waveforms in two channels.

#### Testing Delay Lines

Delay lines used in color receivers can be tested for the correct amount of time delay by using dual-trace scope operation and one of several different test signals.

#### Testing delay lines with video

Video waveforms from the TV stations are always available without adding equipment or making modifications.

The upper waveform of Figure 7 is the video at the input of the delay line, and the signal at the output of the delay line is shown by the bottom waveform. To make the amount of

delay easier to see, the bottom waveform has been inverted in the scope.

If the graticule markings had been included in the picture, we easily could have calculated the exact delay expressed microseconds. The horizontal sweep TIME/CM was set for 1 microsecond-per-centimeter, so the required delay of about .7 microsecond should have moved the lower waveform .7 of the width of one graticule square. Notice that the sweep was triggered by the left edge of the horizontal sync pulse, as shown in the upper waveform.

This type of waveform expansion is made possible by the ability of the triggered sweep to move the beam across the screen very rapidly, then wait until started again by the same point of the next cycle of the waveform. Only the part of the waveform immediately following the triggering point will be visible. Another method is used if the desired portion of the waveform occurs later in the cycle, as discussed previously.

#### Testing with vertical bars or square waves

The delaying time of a delay line also can be tested by using a high-frequency square wave, or by the video from the vertical-bar pattern of a color-bar generator.

Figures 8, 9 and 10 show square waves and vertical crosshatch lines after they have passed through a normal delay line, through a delay line whose ground return is open, and through a line without the correct termination impedance.

Also included are comparisons of the video waveform of the vertical-lines pattern and the appearance of the vertical lines on the screen of the TV picture tube. Notice that a wrong load for the delay line causes "ghosts", while an open ground of the delay line produces a double image with no delay of the first line. A shorted delay line would merely eliminate the delay so the waveforms at both ends would arrive at the same time. These tests will uncover nearly any kind of delay line defect.

#### Facts behind the tests

When ordinary video was used to test the action of delay lines, the repetition rate of the video signal was 15,734 Hz. If the complete cycle of video had been shown, the difference in the arrival time of the two wave-

(Continued on page 50)

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The new Heathkit IB-1100 adds up to one of the best bargains you can buy in a 5-digit, -30 MHz counter. This easy-to-assemble kit gives you: Solid-state digital circuitry for non-blinking readout. Dependable cold-cathode display tubes. Custom designed time base for  $\pm 3$  ppm accuracy from  $+22^\circ$  to  $+37^\circ$  C. Diode-protected J-Fet for improved triggering over inputs from 100 mV to 150 V rms. 1 megohm input, shunted by 20 pF, for minimal loading. kHz/MHz switch and over-range lamp. You can have yours together in approximately seven hours, and at this low price that's time well spent. Kit IB-1100, 6 lbs.

The IB-1102 is the finest Heathkit Counter you can buy and build. Design features include a temperature compensated crystal oscillator clock for  $\pm 1$  ppm stability from  $+10^\circ$  to  $+40^\circ$  C.; high impedance FET input circuit for minimum loading; automatic triggering level for hands-off operation. Sensitivity is 50 mV to 100 MHz and 125 mV above 100 MHz. The full 8-digit cold-cathode display, overrange lamp, gate lamp and two range indicator lamps make the IB-1102 one of the easiest reading counters around. Kit IB-1102, 12 lbs.

Heathkit IB-1101 gives you maximum capability in the medium-price range. The all solid-state circuitry accepts inputs from less than 50 mV to 140 V rms, depending on frequency. The full five-digit cold-cathode readout can be expanded to eight digit capability using the overrange circuitry. Other features include 1 megohm input impedance and low input capacitance; custom designed time base crystal for accuracy better than  $\pm 3$  ppm from  $17^\circ$  to  $32^\circ$  C. Compare performance and price with the competition. Then order your Heathkit IB-1101. Kit IB-1101, 8 lbs.

The Heathkit IB-102 Scaler is a two-evening kit that extends the range of virtually any counter to 175 MHz. In most cases you'll get improved sensitivity too. The solid-state circuitry divides input frequencies from 2 MHz to 175 MHz with the scaled output fed to any compatible frequency counter with a 1 megohm input. There is front panel switching of 10:1 or 100:1 scale ratios, plus 1:1 straight-thru counting. Resolution is down to 10 Hz with a counter having a 1 second time base. The Heathkit IB-102 is the economical way to add 175 MHz capability to your service bench. Kit IB-102, 8 lbs.



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HEATH COMPANY, Dept. 25-2  
Benton Harbor, Michigan 49022

Enclosed is \$ \_\_\_\_\_, plus shipping.

Please send model(s) \_\_\_\_\_

Please send FREE Heathkit Catalog.

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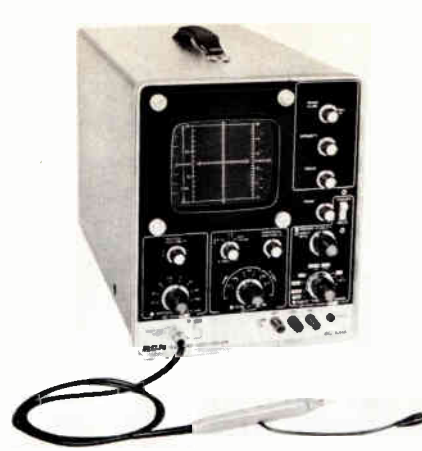
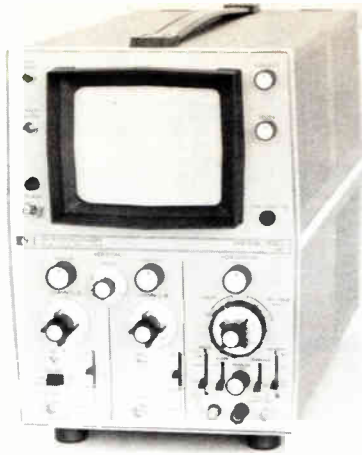
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TE-273

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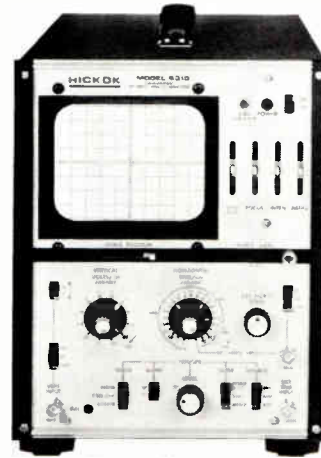


Model 1217A scope by Hewlett-Packard (perhaps not a familiar name because they build expensive and precision equipment) has all the standard features of good triggered-sweep models plus a "beam finder", and a polarity inverter for one channel.



Change from triggered to recurrent sweep by a flip of a switch with the model WO-535A RCA scope. Other features are AC or DC operation and preset vertical and horizontal positions.

Triggered sweep for the budget-minded, might be a good description of this hybrid-type scope model TO-50 by Lectrotech, which has all the standard features.



Sliding switches and controls gives this Hickok model 5310 triggered-sweep scope a new look.

The top of the B&K line is Model 1470 featuring triggered sweep, dual trace, polarity inverter for channel 2, and a host of other features.



Wide-band vector function is an extra with the Leader model LBO-505 triggered-sweep, dual-trace scope which also has a X10 magnifier, and a polarity inverter for channel 2.

## 1973 scope roundup

Shopping for a new scope today can be a puzzling and frustrating experience. Not because you can't find the features you need, but because there is such a flood of good prices and excellent features.

The first big choice you must make is about sweep. Most manufacturers offer both recurrent-sweep and triggered-sweep models. Generally speaking, triggered sweep provides better locking of the waveform, but the instrument sells for a higher price.

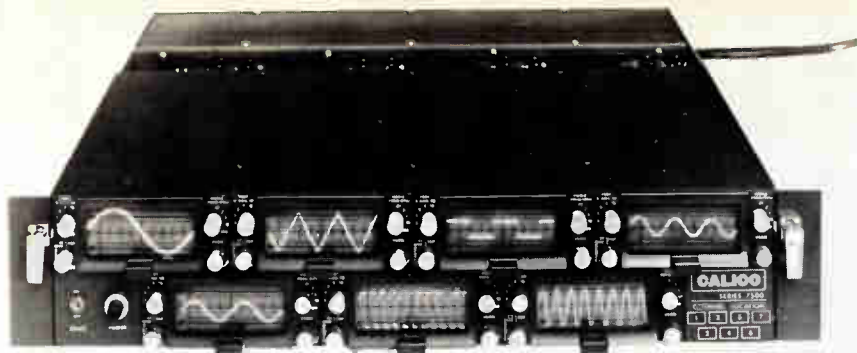
Next, you must decide whether or not dual-trace waveforms will be important enough to you to justify the added expense. Other articles in this issue present the information you need to decide about triggered-sweep and dual-trace features.

In the charts that follow, we are listing the factual specifications for most of the service-type scopes. If you find one whose features and price interest you, make arrangements to examine one at your local distributor.

Perhaps the distributor would give you a demonstration, or furnish the name of another technician who has recently purchased the same model scope, so you could try out the performance for yourself.

### Solid State

Solid state has permitted some reduction of cabinet size, although the size of the CRT tube and the number of panel controls limits the amount of miniaturization. It's easier to find



Seven separate scopes mounted in one small 3-1/2 inch rack panel are offered in the Series 7500 by California Instruments Company. Although these scopes are primarily intended for biomedical research or real-time data monitoring, you might buy one and become the only shop in the world that could monitor seven points of an intermittent TV!

Brand	Model No.	CRT Size	Tube	Solid-State Hybrid	Vertical Sensitivity	Vertical Frequency Response	Vertical Rise Time	AC Coupling AC/DC	Horizontal Sweep Frequency Ranges	Horizontal Amp Frequency Response	Triggered Sweep	Recurrent Sweep	Dual Trace Expanded Sweep	Calibration Waveform	Price
B&K	1440	5"		X	16.6 mv/cm	DC to 10 MHz	35 ns	X	5 Hz to 500 KHz	DC to 800 KHz	X	No	Yes	Yes	\$299.95
B&K	1450B	5"		X	25 mv/in	5 Hz to 5 MHz	120 ns	X	5 Hz to 500 KHz	2 Hz to 750 KHz	X	No	No	No	\$299.95
B&K	1460	5"		X	10 mv/cm	DC to 10 MHz	35 ns	X	.5 us/cm to .5 s/cm	DC to 800 KHz	X		Yes	Yes	\$399.95
B&K	1465	5"		X	16.6 mv/cm	DC to 10 MHz	35 ns	X	1 us/cm to 20 ms/cm	DC to 800 KHz	X		Yes	Yes	\$359.95
B&K	1470	5"		X	10 mv/cm	DC to 10 MHz	35 ns	X	1 us/cm to .5 s/cm	DC to 800 KHz	X	X	Yes	Yes	\$499.95
California Instruments	7500	1" x 3"		X	50 mv/in	DC to 10 MHz	40 ns	X	10 Hz to 100 KHz	10 Hz to 10 MHz	X	Yes	No	No	\$2795.00
California Instruments	7502	1" x 3"		X	200 mv/in	DC to 10 MHz	40 ns	X	10 us/div to 100 ms/div	1 Hz to 1 MHz	X	X	Yes	No	\$2945.00
EICO	TR410	5"		X	10 mv/cm	DC to 10 MHz	35 ns	X	.5 us/cm to .5 s/cm	DC to 1 MHz	X		Yes	Yes	\$379.95
EICO	427	5"	X		10 mv/cm	DC to 500 KHz	700 ns	X	10 Hz to 100 KHz	2 Hz to 450 KHz	X	No	Yes	Yes	\$109.95 Kit \$149.95 Wired
EICO	435	3"	X		50 mv/cm	DC to 4.5 MHz	80 ns	X	10 Hz to 100 KHz	1 Hz to 500 KHz	X	No	Yes	Yes	\$129.95 Kit \$179.95 Wired
EICO	460	5"	X		33 mv/cm	DC to 4.5 MHz	80 ns	X	10 Hz to 100 KHz	1 Hz to 400 KHz	X	No	Yes	Yes	\$109.95 Kit \$159.95 Wired
EICO	465	5"	X		34 mv/cm	DC to 8 MHz	60 ns	X	10 Hz to 100 KHz	DC to 1 MHz	X	No	Yes	Yes	\$179.95 Kit \$249.95 Wired
Heath	10-17	3"	X		30 mv/div	5 Hz to 5 MHz	75 ns	X	20 Hz to 200 KHz	2 Hz to 300 KHz	X	No	No	No	\$82.50 Kit
Heath	10-102	5"		X	30 mv/cm	DC to 5 MHz	80 ns	X	10 Hz to 500 KHz	DC to 1 MHz	X	No	Yes	Yes	\$119.95 Kit \$179.95 Wired

Triggered sweep in a kit you build yourself is offered by Heath. Their model IO-103K has all the standard features, and response to 10 MHz.



space for a good scope around the bench.

Solid-state scopes show a waveform slightly sooner and operate cooler than tube models. Also, there seems to be less drift of gain and centering in solid-state models, although, we would not advise you to make this a deciding factor in your choice of models.

Brand	Model No.	CRT Size	Tube	Solid-State Hybrid	Vertical Sensitivity	Vertical Frequency Response	Vertical Rise Time	AC Coupling	AC/DC	Horizontal Sweep Frequency Ranges	Horizontal Amp Frequency Response	Triggered Sweep	Recurrent Sweep	Dual Trace	Expanded Sweep	Calibration Waveform	Price
Heath	IO-103	5"	X		50 mv/cm	DC to 10 MHz	50 ns	X		100 ns/cm to 100 ms/cm	DC to 500 KHz	X			Yes	Yes	\$229.95 Kit
Heath	IO-105	5"	X		50 mv/cm	DC to 15 MHz	24 ns	X		.2 ms/cm to 100 ms/cm	DC to 100 KHz	X		X	Yes	No	\$399.95 Wired
Heath	EU-70A	8x10 cm	X		50 mv/cm	DC to 15 MHz	24 ns	X		.2 ms/cm to 100 ms/cm	DC to 100 KHz	X		X	Yes	No	\$595.00 Wired
Hewlett-Packard	1200 A/B	5"	X		.1 mv/div	DC to 500 KHz	700 ns	X		1 us/div to 5 s/div	DC to 300 KHz	X		X	Yes	Yes	\$1050.00
Hewlett-Packard	1217 A/B	5"	X		5 mv/div	DC to 7 MHz	50 ns	X		1 us/div to 5 s/div	DC to 300 KHz	X		X	Yes	Yes	\$1175.00
Hickok	5310	8x10 cm	X		10 mv/cm	DC to 10 MHz	50 ns	X		.5 us/cm to .2 s/cm	DC to 1 MHz	X			Yes	No	\$425.00
Kikusui	553	5"		X	10 mv/cm	DC to 7 MHz	50 ns	X		1 us/cm to 1 s/cm	2 Hz to 200 KHz	X		X	Yes	Yes	NA
Kikusui	555G	5"		X	.02 v/cm	DC to 7 MHz	50 ns	X		1 us/cm to 1 s/cm	2 Hz to 200 KHz	X			Yes	Yes	NA
Kikusui	557A	5"		X	20 mv/cm	DC to 5 MHz	100 ns	X		10 Hz to 100 KHz	2 Hz to 500 KHz		X		No	Yes	NA
Leader	LBO-505	5"	X		10 mv/cm	DC to 15 MHz	35 ns	X		1 us/cm to .5 s/cm	DC to 200 KHz	X		X	Yes	Yes	\$559.95
Leader	LBO-501	5"		X	20 mv/cm	DC to 10 MHz	35 ns	X		1 us/cm to .2 s/cm	DC to 200 KHz	X			Yes	Yes	\$389.95
Leader	LBO-54B	5"		X	10 mv/cm	DC to 10 MHz	35 ns	X		1 Hz to 200 KHz	DC to 500 KHz		X		No	Yes	\$284.95
Leader	LBO-301	3"	X		10 mv/div	DC to 7 MHz	70 ns	X		1 us/div to .2 s/div	DC to 200 KHz	X			Yes	Yes	\$374.95



# TO A PRO, TIME IS MONEY

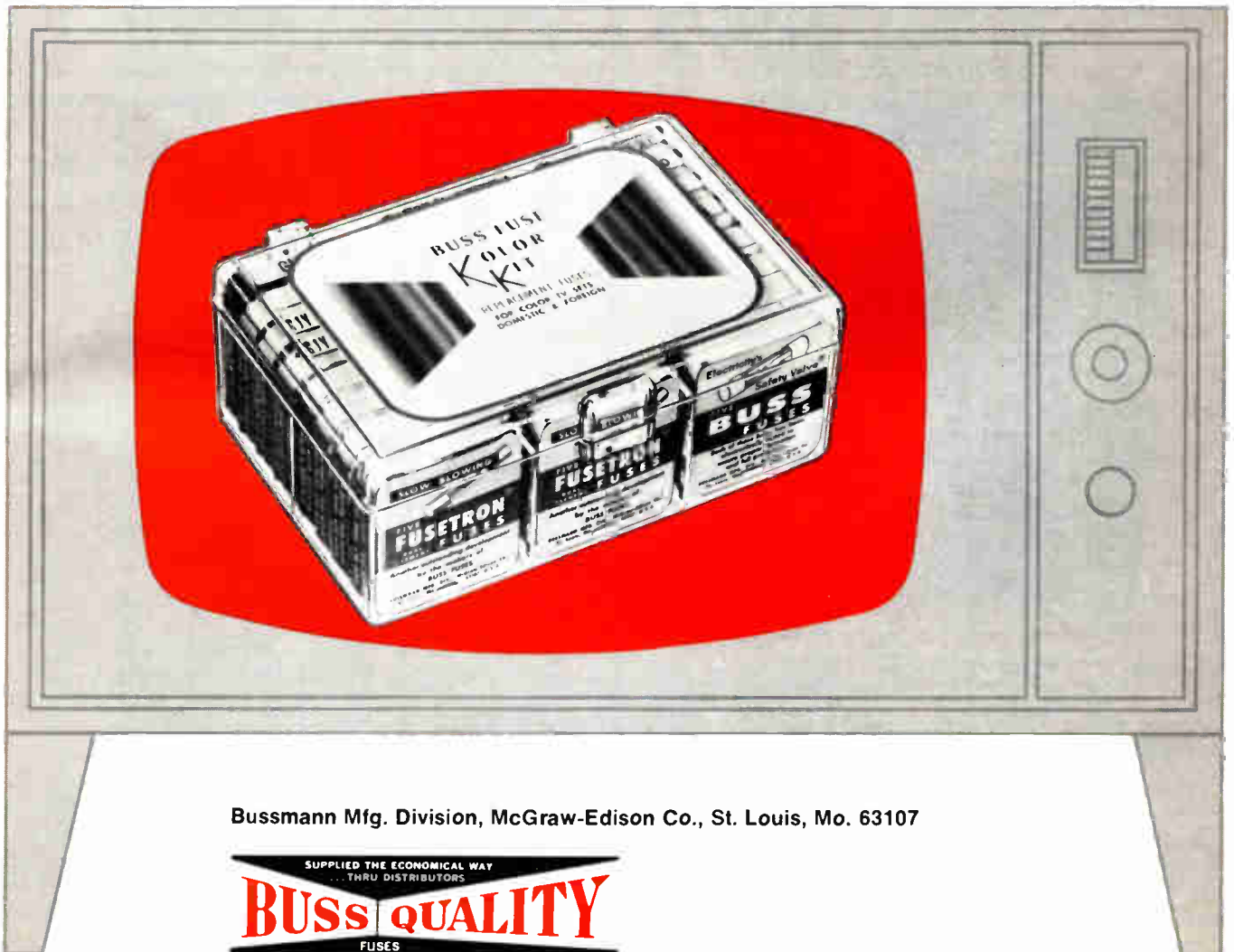
So take time to read about the BUSS® Kolor Kit of replacement fuses

The mark of a professional Certified Electronic Technician is efficiency. He's got the ability to locate a problem quickly, repair it quickly, and get on to the next job.

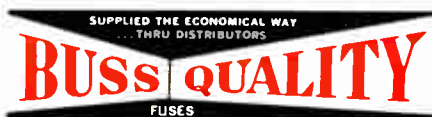
One of his secrets is that he always has the part he needs when he needs it. That's where the BUSS Kolor Kit of replacement fuses for domestic and foreign TVs comes in.

The Kolor Kit comes in two sizes, the No. 140 Kolor Kit containing 120 fuses, and the No. 240 Deluxe Kolor Kit containing 240 fuses plus four sets of twin clips. With a BUSS Kolor Kit in your tube caddy, you'll always have the fuse you need when you need it. Ideal for servicing both color and black and white TV's.

BUSS Kolor Kits are available from your local BUSS Distributor.



Bussmann Mfg. Division, McGraw-Edison Co., St. Louis, Mo. 63107



This seven-pound portable model PS-900 Vu-Data scope operates up to 5 hours from the internal rechargeable batteries, has triggered sweep and vertical response from DC to 20 MHz.



Brand	Model No.	CRT Size	Tube	Solid-State	Hybrid	Vertical Sensitivity	Vertical Frequency Response	Vertical Rise Time	AC Coupling	AC/DC	Horizontal Sweep Frequency Ranges	Horizontal Amp Frequency Response	Triggered Sweep	Recurrent Sweep	Dual Trace	Expanded Sweep	Calibration Waveform	Price	
Leader	L80-328	3"			X	10 mv/cm	DC to 7 MHz	70 ns	X		10 Hz to 200 KHz	DC to 400 KHz	X				Yes	\$209.95	
Leader	L80-310	3"		X		20 mv/cm	DC to 1 MHz	350 ns	X		10 Hz to 100 KHz	DC to 250 KHz	X				No	\$169.95	
Lectrotech	TO-50	5"			X	20 mv/div	DC to 10 MHz	35 ns	X		.2 us/cm to 20 ms/div	DC to 1 MHz	X			Yes	Yes	\$339.50	
Lectrotech	TO-60	5"		X		5 mv/div	DC to 10 MHz	35 ns	X		.2 us/div to 20 ms/div	DC to 1 MHz	X	X	Yes	Yes	Yes	\$449.50	
Marconi	2204	8x10 cm		X		2 mv/cm	DC to 18 MHz	19 ns	X		.2 us/cm to 1 s/cm	DC to 2 MHz	X	X	Yes	Yes	Yes	\$995.00	
Raytheon	CDU-150	8x10 cm				5 mv/cm	DC to 35 MHz	10 ns	X		.1 us/cm to 1 s/cm	NA	X	X	Yes	Yes	Yes	\$1495.00	
RCA	WO-33A	3"	X			10 mv/inch	3 Hz to 5.5 MHz	100 ns	X		15 Hz to 75 KHz	3.5 Hz to 350 KHz	X		Yes	Yes	Yes	\$180.00	
RCA	WO-505A	5"		X		5.9 mv/cm	DC to 10 MHz	35 ns	X		10 HZ to 1 MHz	3.5 Hz to 2 MHz	X		Yes	Yes	Yes	\$299.00	
RCA	WO-535A	5"		X		5.9 mv/cm	DC to 10 MHz	35 ns	X		10 Hz to 1 MHz	3.5 Hz to 2 MHz	X	X	Yes	Yes	Yes	\$329.00	
Sencore	PS148	5"	X			17 mv/inch	10 Hz to 5 MHz	NA	X		5 Hz to 500 KHz	5 Hz to 400 KHz	X		No	No	No	\$269.50	
Sencore	PS163	5"		X		5 mv/cm	DC to 8 MHz	40 ns	X		.1 us/cm to .1 s/cm	DC to 7 MHz	X	X	X	Yes	Yes	Yes	\$595.00
Telequipment	D54	5"		X		10 mv/cm	DC to 10 MHz	35 ns	X		.2 us/cm to 2 s/cm	DC to 1 MHz	X	X	Yes	Yes	Yes	\$595.00	
VU-Data (battery operated)	PS900	1" x 2½"		X		10 mv/div	DC to 20 MHz	18 ns	X		1 us/div to 100 ms/div		X		No	No	No	\$595.00	

## Prices

Scopes of all price ranges from a kit priced under \$80 to a special-purpose scope priced at nearly \$3,000 are included in the charts that follow. Although the manufacturers of laboratory and scientific scopes offer many dozens of different models with plug-in modules, response to the gigacycles, and other expensive options, we have included only a few of the models which would be useful in service work.

## Abbreviations

Because of some restrictions about the typesetting, we are using these abbreviations in the charts:

us	microseconds
cm	centimeters
div	division
mv	millivolts
ns	nanoseconds
s	seconds

## List of Manufacturers

A list of manufacturers and their addresses is included following the charts for your use if you want to ask them for additional information. □

B&K, Dynascan Corporation  
1801 W. Belle Plaine Avenue  
Chicago, Illinois 60613

California Instruments Company  
5150 Convoy Street  
San Diego, California 92111

EICO Electronic Instrument Co., Inc.  
283 Malta Street  
Brooklyn, New York 11207

Heath Company  
Benton Harbor, Michigan 49022

Hewlett-Packard Company  
1501 Page Mill Road  
Palo Alto, California 94304

Hickok Electronic Instrument  
10514 Dupont Avenue  
Cleveland, Ohio 44108

Kikusui Electronics Corp.  
Miida Electronics Division  
866 Second Avenue  
New York, New York 10017

Leader Instruments Corporation  
37-27 Twenty-Seventh Street  
Long Island City, New York 11101

Lectrotech, Inc.  
5810 N. Western Avenue  
Chicago, Illinois 60659

Marconi Instruments  
111 Cedar Lane  
Englewood, New Jersey 07631

RCA Corporation  
415 So. 5th Street  
Harrison, New Jersey 07029

H. M. Electronics Inc. (Raytheon)  
10975 San Diego Mission Road  
San Diego, California 92108

Sencore, Inc.  
3200 Sencore Drive  
Sioux Falls, South Dakota 57107

Tektronix, Inc. (Telequipment)  
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Beaverton, Oregon 97005

Vu-Data Corporation  
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San Diego, California 92111

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<input type="checkbox"/> 6FQ7	5 for \$3.25	<input type="checkbox"/> 8FQ7	5 for \$3.25
<input type="checkbox"/> 1G3	5 for \$4.35	<input type="checkbox"/> 6BZ6	5 for \$3.40
<input type="checkbox"/> 6EA8	5 for \$4.30	<input type="checkbox"/> 6HA5	5 for \$4.20
<input type="checkbox"/> 6GJ7	5 for \$3.10	<input type="checkbox"/> 12GN7	5 for \$5.90
<input type="checkbox"/> 1Y2	5 for \$2.55	<input type="checkbox"/> 2AV2	5 for \$3.45
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<input type="checkbox"/> SK3041-HEP245 (list \$4.20 ea.)	5 for \$4.20

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<input type="checkbox"/> EQUIV. ASTATIC 142	\$2.
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EK-357

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# A practical inventory control system



By Robert G. Amick

Here is the simplified inventory control plan promised last month. Every shop, regardless of size, needs inventory control.

A good inventory-control system can give you these benefits:

- organized, efficient storage;
- assurance of adequate stocks, while avoiding overstocks and losses because of obsolescence;
- control over quantities when ordering, based on past rates of usage rather than on guesswork; and
- all of the previous advantages without too much paperwork and record-keeping.

The system to be described fulfills these requirements.

## Organizing Storage Of Parts

Adequate shelf space is essential, and we recommend the use of steel shelving. It's strong, permanent, won't warp or split, and can be adapted to almost any storage plan. Of course, the

price when new is fairly expensive, but it should never need replacement. Or, you probably can find some good buys in used steel shelving by investigating the market.

## Sizes of shelving

You should make a study to determine how much space is needed for small parts (resistors and capacitors), medium-sized parts (flybacks, yokes, etc.) and very large parts (such as picture tubes). Units of shelving usually are three feet long and either 12 or 18 inches deep. For small parts, the 12-inch units spaced about 7 or 8 inches between shelves are adequate. For medium-sized items, use the 12-inch units with 10 to 12 inches between shelves. Most large parts (except some picture tubes) fit well on the 18-inch units spaced about 18 or 20 inches between shelves.

## Parts bins

If price is not important, you can buy steel parts bins which are made to go with the shelving. Or, of course, you can use bread pans, shoe boxes or cardboard cartons. In any event, all of the smaller items should be in bins to prevent accidental mixing with other parts and to make identifying and finding them easy.

Cartoned tubes look neat enough, and the numbers are readable when

stacked on a shelf. But, there are many possibilities that the tubes will get moved around out of position, or the stack might topple and become mixed with other tubes. If you use bins, you can be certain the different numbers will be kept separate.

## Bin Identification

Each section of shelves should be given a letter designation, each shelf in that section a number, and each bin on each shelf a number. Thus, A-45 means shelf section "A", fourth shelf, and fifth bin. Remember always to number down or up, left or right the same in all cases.

Then group together similar kinds of parts. All resistors on the same shelf, etc.

## Keep All Parts In The Stockroom

It is vital for good organization that you start a firm policy of storing all parts (except the rotating stock in each truck) in the stockroom. The benchmen should be discouraged from keeping individual stock items on the bench. If you permit exceptions to this rule, the usual result is that most of your stock ends up on the benches in a disorganized mess.

Stock in the service trucks should be restricted to the items used most frequently.

ORDER QTY		PART DESCRIPTION		BIN NUMBER	
RESERVES		SUPPLIER		COST	
DATE	QTY	REMARKS	DATE	QTY	REMARKS

Fig. 1 A sample control ticket. The item description should list the part name, value, and the supplier's part number.

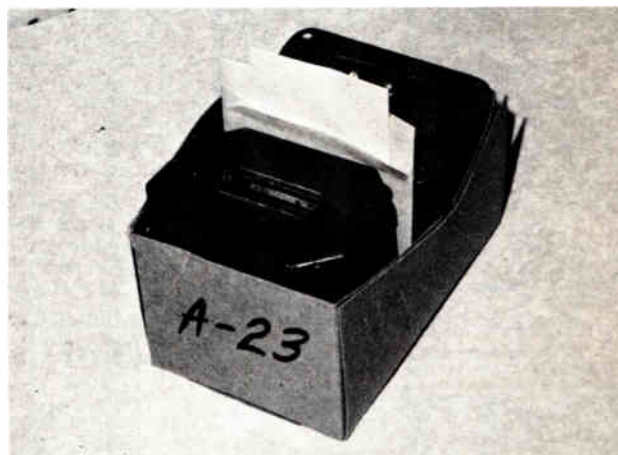


Fig. 2 One method of arranging bins for small parts with the control ticket placed in a holder to keep it visible and to separate the working from the reserve stocks.

Only the items in your stockroom and those regularly charged to the trucks can be under your efficient control. It is imperative that you know what you have and where it is at all times.

### Controlled Stocking

You need enough parts on hand to avoid delays because of being out of stock. But, you certainly don't want so many of each kind that they become obsolete before they can be used. Also, standard parts that never become obsolete should not be overstocked because they tie up too much capital.

To solve these stocking problems, you need accurately to know:

- the rate of use,
- the time lag between order and delivery, and
- any changes in the rate of use.

This knowledge can be obtained only from the records that you keep.

### Control tickets

The first step in setting up an inventory-control system is to have printed a sufficient supply of control tickets (see Figure 1). Order one card for each different item you carry, plus an extra 50 percent for future additions or replacements. Control tickets do get lost or worn out. Have the tickets printed on 3X5- or 4X6-inch card stock.

One control ticket goes to each bin,

and remains there so long as there is more than a reserve quantity. When the count gets down to the reserve stock, the ticket should be pulled and placed in the "Parts To Be Ordered" box. From this, your parts man knows what's needed.

Ideally, each employee who removes a part from a bin should notice if the count is down to the reserve level. But if this doesn't work satisfactorily, you should appoint one person to make frequent checks and pull the tickets when needed. Don't permit the system to bog down so that the reserve stock is used up before a new order is placed. In a busy shop these control checks should be made daily. In any case, they should be made frequently.

After the ordering data has been copied from the ticket, the control ticket can be placed in the "Orders Pending" box until the parts are received.

All orders received should be checked against the purchase order, instead of the control ticket. Make sure the order was filled correctly. Then enter the date and quantity sent to stock on the control tickets when both the parts and the tickets are placed in the bins. That way mistakes because of back-orders or damaged items returned for credit will not upset the accuracy of the count.

You will notice that this system makes it easy to place a new parts order in the bins. The parts and the control tickets are together, and the

tickets tell the exact bin number.

The wholesale cost prices on the tickets can simplify and speed your annual audit of inventory.

These last two advantages are bonuses obtained from using this type of inventory control.

### Getting Started With The System

The most disliked part of setting up an inventory-control system is getting started by making up the control tickets, each having the supplier, cost and bin number. By checking your purchase orders for the past year, you can approximate the reserve level and ordering quantities. Otherwise, wait until next year and then determine these figures from the control tickets.

The time lag between order and delivery (plus any time lost before the order and after the delivery) relative to the rate of usage should determine the reserve-stock level, because it's intended to keep the work going until the new order arrives. Of course, a reserve stock isn't very important for parts ordered from a local source where delivery might be made the next day. But it becomes more important on orders from distant sources which might not arrive for several weeks.

At first you probably will be forced to work from "guesstimates", but these will fall into line as the system begins to work. However, when setting quantities without records, it's a good

PART I MASTER-CONTROL BOOK					
BIN NUMBER	PART DESCRIPTION	SUPPLIER DATA	ORDER QTY	RESERVE STOCK	WHOLESALE COST

PART II MASTER-CONTROL BOOK					
PART NUMBER OR DESCRIPTION	BIN NUMBER	SUPPLIER DATA	ORDER QTY	RESERVE STOCK	WHOLESALE COST

Fig. 3 Part 1 of the Master-Control Book primarily lists the parts by bin number, while part 2 first lists the supplier's or manufacturer's stock or part number.

idea to be conservative.

### Suggestions For Bins

Figure 2 shows a bin with stock and a control ticket. In this illustration, one transformer is working stock and is stored in front of the ticket (which is held in place by a folded envelope stapled into position), and the other is reserve stock stored behind the ticket.

When you use the working stock and pull the ticket for ordering, move the reserve stock up front where it will be used next.

### A Master-Control Book

If you have followed our previous suggestions, you now have an organized storage, a control-ticket system and high hopes. That's fine! But you haven't yet run into some of the pesky little problems that can arise.

Suppose a ticket is lost? Or you need to find a part and know only the manufacturer's part number? For problems such as these, you need a guidebook added to the system. It's called a Master-Control Book.

A master-control book is a type of

directory. One section lists all the parts by bin number, showing what's in each bin. Another section lists the parts by part numbers, and shows which bins they are in. That's as far as it needs to go, but it can be extended to cover any other additional functions you might want.

Sample pages from each section are shown in Figure 3. Only the directory function is served by these simple pages. If you want or need additional records, you could add columns to summarize control-ticket entries beside each item. Of course, the data is on the bin tickets, so don't do it unless you have a definite need.

### Tips For Operating The System

The following systematic procedures are very important and should be carefully followed:

1. Designate one person to be responsible for stock control. He should regularly and systematically make the control checks, handle incoming orders, stock the parts shelves, and keep up the ticket entries.
2. You should tell all other em-

ployees in your business about the system and enlist their help in making it work.

3. You should limit withdrawals of parts for use in the truck stock to reasonable amounts, and discourage the benchmen from keeping any stock items at the bench.

4. Keep your records up to date. Make periodic adjustments in the order quantities and reserve stocks. Add other parts as new models appear by setting up tickets and bin assignments when you first order the new parts. When they arrive, they'll already be in the system.

5. Periodically verify the data about the supplier on the ticket. Is the price the same? What about the delivery schedule?

6. Use the data which is on the control tickets to determine your turnover, and to speed completion of the annual inventory.

7. Be flexible and receptive to system additions or changes which might help the system work for you. Just try to look ahead to avoid some of the approaches that develop into dead-ends. □

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# Servicing two new high-voltage regulators

By Bruce Anderson

*A third generation of high-voltage regulators is becoming popular. Writer/technician Anderson explains how the circuits operate and how to service them.*

## DC HV-Shunt Regulation

For years the only method of high-voltage regulation used the familiar 6BK4 tube in simple circuits based on the one shown in Figure 1A. When the high-voltage current of the picture tube was decreased, the regulator tube was forced to dissipate more HV current. This meant that the total HV current drain remained substantially constant at all times. And constant current provides a constant DC voltage.

In this circuit, as in others which followed it, the amount of high voltage was not sensed directly. HV-bleeder networks are expensive and prone to defects. Instead, B-boost was used as an indicator, because when HV current changes, both high voltage and B-boost rise and fall in step.

## Grid Regulation

One of the first non-6BK4 circuits was the "grid" regulator (Figure 1B). This method of regulating high voltage has been used in large numbers of color receivers, and remains popular with hybrid sets which have tube-type horizontal deflection. There are many minor variations of the circuit, but all do essentially the same things.

High voltage and horizontal sweep power are regulated by adjusting the maximum amount of plate current flowing through the horizontal-output tube. This maximum is determined by the instantaneous grid voltage.

High-voltage pulses and pulses from windings of the flyback transformer track with nearly the same percentage of amplitude change when HV current varies. So, pulses from an auxiliary winding of the flyback are rectified to produce a negative DC voltage which rises and falls in step with the AC high voltage. To improve the efficiency of

regulation, a positive "bucking" voltage is added, and this causes the negative-DC voltage to vary more than does the change of pulse amplitude.

After the negative voltage is filtered, it is applied to the control grid of the horizontal output tube. In operation, when the picture tube draws less current, the high voltage goes up, the amplitude of flyback pulses increases, more negative voltage is produced by pulse rectification, and the resulting excessive grid bias reduces the maximum plate current of the output tube. Less plate current means that a lower wattage is available for deflection and high voltage. This reduces the flyback pulses (and the high voltage) nearly to the amplitude obtained just before the picture tube drew less current. Of course, an increase of CRT current reverses all of these circuit actions.

## AC-Shunt Regulation

As one answer to the possibility of 6BK4's emitting X-rays, pulse regulators (Figure 1C) were developed.

Again, regulation is accomplished by arranging for a constant load. However, this one is a constant AC load across the flyback transformer. Loading of the regulator tube is controlled by variations of the B-boost voltage which determines the amount of current drawn from the tips of the pulses.

The percentage of regulation is satisfactory, although it is not so good as that obtained from DC-shunt regulation. The reason for this difference is found in the voltage drop across the HV rectifier tube.

## Problems Of Regulating Solid-State HV

Sufficient solid-state power for good deflection and high voltage is difficult to obtain at reasonable cost. Transistors which can handle the large amounts of power required, and also withstand safely the high-amplitude flyback pulses, are expensive. Therefore, it is undesirable to "waste" any energy by the use of shunt regulators.

What's more, it is not practical to

regulate the AC or DC voltages applied to the base of an output transistor, because the transistor function is not so much amplification as it is switching. There just isn't any effective point to connect a control bias.

## Power-Supply Regulation

Surprisingly, regulation of the sweep and high voltage in many of the newer all-solid-state color receivers is by regulation of the supply voltage for the horizontal output stage. At first you might not see how supply regulation also regulates the high voltage. Certain important facts about solid-state devices help make this clear.

### Internal voltage drops

Vacuum-tube dampers, output tubes, and high-voltage rectifiers all have fairly high internal resistances. So the voltage drops across them increase significantly when the load current increases. By comparison, transistors and solid-state diodes have much lower internal voltage drops which change very little with increased current.

### Circuit impedances

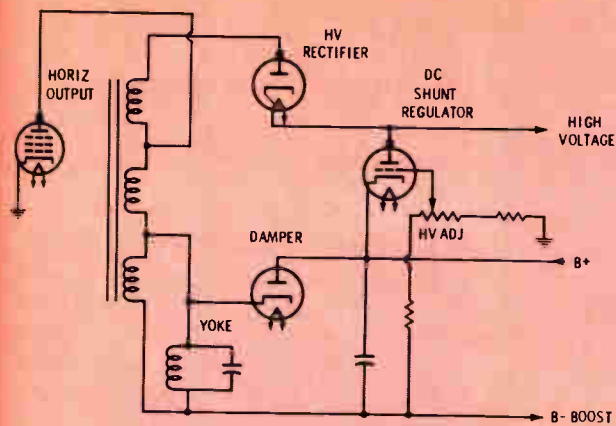
Retraces of the beam across the face of the picture tube, and the high-voltage pulses occurring at that time, are powered by ringing of the inductances and capacitances in the sweep circuit. That's true of both tube and solid-state circuits.

However, in tube-type horizontal sweep circuits, capacitances and inductances are arranged in parallel. Parallel-tuned circuits are essentially high-impedance devices which show a decrease of signal amplitude when their loads become heavier.

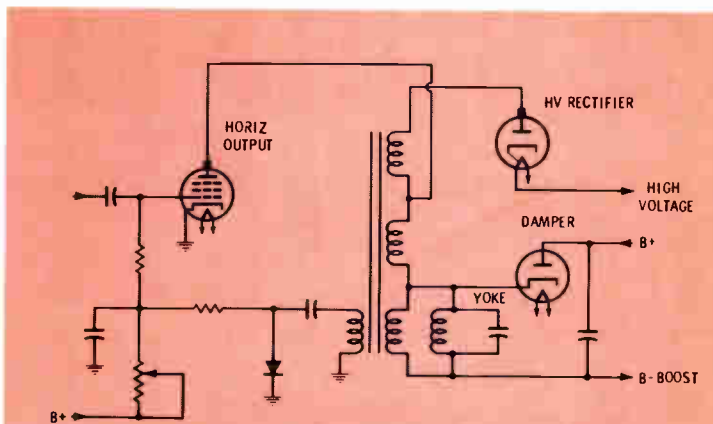
In contrast, ringing of solid-state horizontal sweep is by means of inductances and capacitances in series. Series-tuned circuits have their lowest impedance at the resonant frequency, and are relatively unaffected by load changes.

### Efficiency versus aging

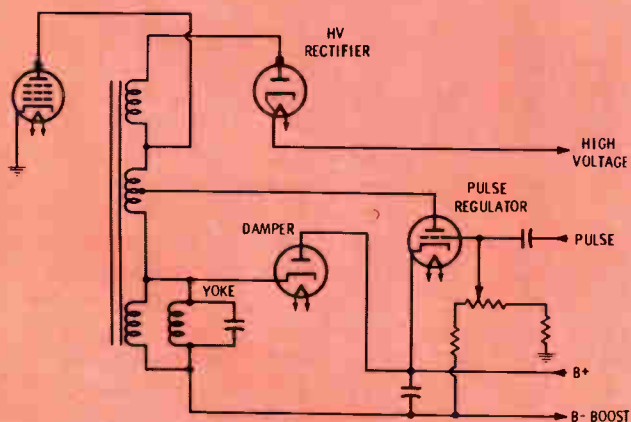
Solid-state components don't



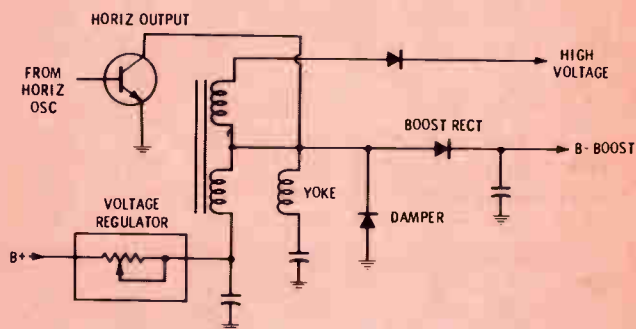
(A) HV DC-shunt regulator.



(B) "Grid-voltage" regulator.



(C) AC-shunt regulator.



(D) Power-supply regulator.

Fig. 1 Simplified schematics of four basic types of high-voltage regulators.

weaken or develop increased internal resistance from aging or usage, but vacuum tubes do. Consequently, there is a need in tube sets for regulator circuits which compensate for any gradual decrease of the high voltage.

#### Supply current variation with loading

Changes of high-voltage current bring corresponding changes in the current of the output transistor. The more current drawn by the picture tube, the more current is needed by the output transistor. Without regulation of the supply voltage for the output transistor, this would cause a decrease of high voltage when the picture is brighter. In the absence of other types of high-voltage regulation, regulation of the supply voltage is essential.

In short, the philosophy behind the need for a supply regulator is: "Regu-

late the supply voltage, and the high voltage will take care of itself".

#### Basic Supply Regulation

Moderately-good regulation can be obtained from a very simple circuit (Figure 2). Essentially, the circuit is an emitter follower. The base forward bias is clamped by the zener, and the transistor attempts to maintain the emitter at the same voltage (less the base/emitter voltage drop).

Assume that the load on the emitter circuit is moderate enough to permit +119.3 volts there when the zener holds the base at +120 volts. Increased current drain on the regulated supply decreases the emitter/ground voltage. This represents an increase of base/emitter forward bias, the transistor becomes a lower resistance between collector and emitter, and the emitter

voltage increases nearly to the original value.

If the current drain decreases, the emitter voltage rises, the forward bias is decreased, the resistance of the collector/emitter path increases and the emitter voltage is nearly restored. As in all automatic circuits, control is never perfect; some variation of output voltage must be expected.

#### Requirements For Regulating Horizontal Supply Voltage

The simple circuit just described is not adequate for regulating the horizontal sweep and high-voltage circuits of a color receiver. For example, the supply current might vary between 200 ma and 500 ma as the brightness level is changed. Assuming a transistor beta of 100, the base current would swing between 2 ma and 5 ma. This would require a rather high-wattage



zener regulator. An amplifier between the zener and the control transistor is desirable. Two advantages result: The zener can be operated virtually unloaded, which reduces voltage variations, and the additional gain adds to the accuracy of control.

### A Magnavox Regulator

Figure 3 shows the complete regulator circuit used in the Magnavox T979 all-solid-state chassis.

Z1 zener and R4 control supply a stable voltage that is adjustable from +100 to +123 volts to the base of Q1, the driver transistor. The emitter of Q1 must maintain itself .7 volt less positive than the base voltage, and it is connected to the base of Q201. In turn the emitter of Q201 must maintain a voltage just .7 volt less than its base voltage. Overall, the emitter of Q201 should be 1.4 volts less positive than the base of Q1, or between +98.6 and +121.6 volts.

Nominally, the regulated supply voltage is rated +115 volts, but in practice it is adjusted by R4 to produce the desired high voltage of 25.5 KV.

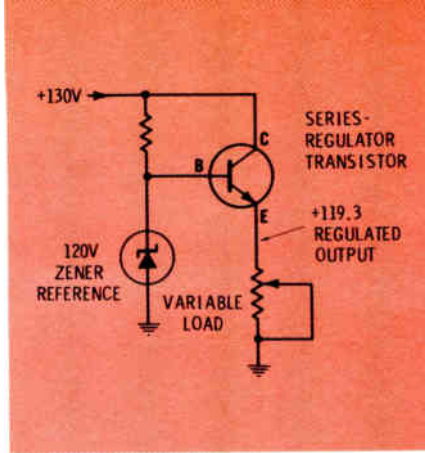


Fig. 2 A basic series-type power-supply regulator.

### Troubleshooting the regulator

If the high-voltage and deflection systems fail, first you should determine whether the regulator or the deflection system is at fault. The easy way is to disconnect the load from the emitter of Q201 and replace it with a dummy load, such as a 500-ohm 50-watt resistor. If the regulator delivers the rated voltage to the dummy load, it is okay, and the problem must be in the deflection circuit. If it doesn't deliver the proper voltage, the regulator circuit must be defective.

Chances are a defective regulator circuit either will have an output of zero volts or an uncontrollable output of about +130 volts. An open in either transistor will result in little or no output voltage.

Leakage through C209A causes different symptoms than an equivalent leakage in an unregulated supply. The regulator circuit takes out most of the ripple, so it's unlikely a moderate amount of C209A leakage would increase the ripple. Also, the leakage just acts as a heavier load on the supply, and this will be compensated for so long as Q201 doesn't fail because of overload. If you find the transistor is defective, better check C209A for leakage before replacing the transistor.

The main filters which remove ripple are C1 and C208A. Check them if the complaint is hum in the power supply.

A shorted or leaky zener will reduce the output voltage to nearly zero. An open zener would allow the base of Q1 to rise to such a high voltage that Q201 would saturate and produce an unregulated excessively-high supply voltage.

### A New RCA Regulator

The recently-introduced RCA CTC60 all-solid-state chassis has a supply regulator (Figure 4) with some

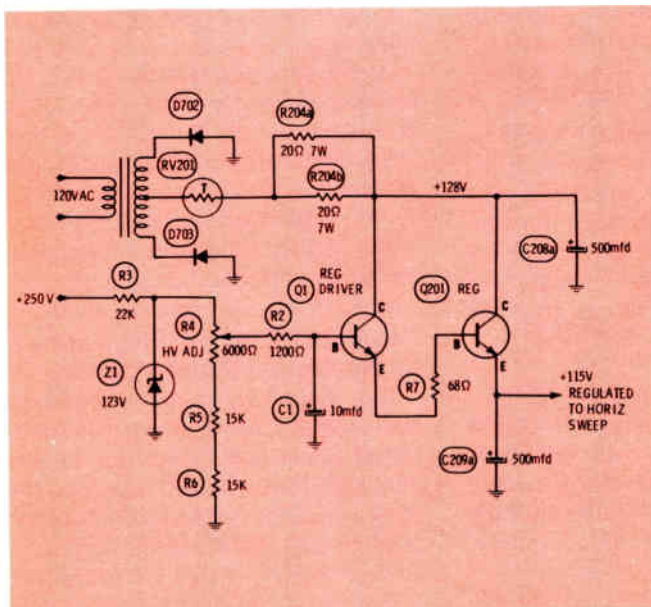


Fig. 3 A schematic of the regulator in Magnavox T979 chassis.

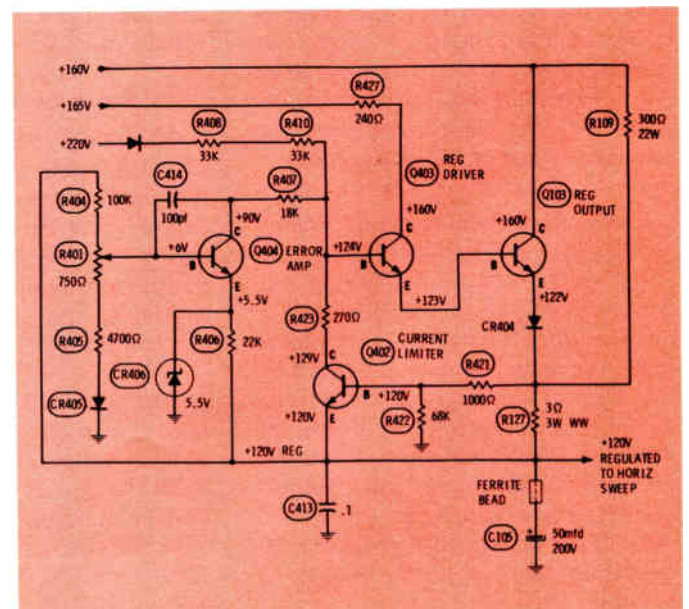
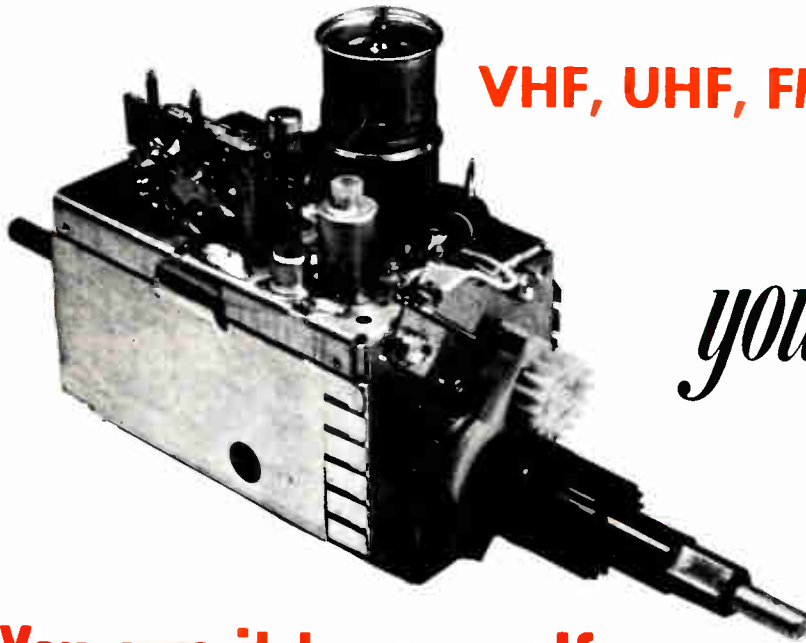


Fig. 4 Complete schematic of the current-limiting regulator used in RCA CTC60 chassis.

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similarities to the Magnavox circuit. But there are at least two major differences.

Q404, the error amplifier, is operated as a voltage amplifier which has the control voltage taken from the collector, and the emitter voltage is stabilized by a zener. Amplification of the transistor permits the use of a zener of only 5.5 volts. This system is a closed-loop type.

A sample of the +120 volts regulated supply is adjusted by R401 and fed to the base of Q404. The collector is partially coupled to the base of Q403, an emitter follower which drives the base of Q103, the regulator output.

Ignoring the current-limiter transistor, let's follow a typical regulating action. Assume the brightness is increased, and this increases the current through the horizontal output transistor and reduces the +120 volt supply. In turn, the base of Q404 becomes less positive, causing the collector to be more positive, then the base and emitter of Q403 and the base of Q103 become more positive. The more-positive voltage at the base of Q103 is increased forward bias, so Q103 becomes a lower-value resistance and raises the voltage at its emitter. As a result, the +120-volt supply changes very little.

**Current limiting feature**

One unique feature of the RCA circuit is the current-limiting function. The supply current cannot exceed 400 milliamperes even with a dead short across the output.

Here's how it operates. Normally Q402 is biased to cutoff by the small voltage drop across R127 and has no effect on the regulation. But suppose the load current attempts to exceed the design maximum. The increased voltage drop across R127 forward biases the base of Q402. When Q402 conducts, its collector current (by way of R423) reduces the base voltage of Q402 and the base voltage of Q103 which reduces the output voltage by increasing the collector/emitter resistance.

If the overcurrent is severe enough,

Q103 is biased to zero collector current. Even so, some current to supply the output still flows through R109, which parallels Q103, but only slightly over 400 mills can flow even if the output is shorted. In effect, the system changes from a constant-voltage to a constant-current supply.

**Troubleshooting the RCA regulator**

As mentioned previously for the Magnavox regulator, one of the first steps is to test the regulator on a dummy load such as a 500-ohm 50-watt resistor. An output voltage of around +120 volts is proof the regulator is okay.

An overload in the deflection system should "switch" the regulator into the constant-current mode causing the output voltage to be low. Conversely, an open Q103 regulator transistor (or an open CR404) also will greatly reduce the output voltage.

If the output of the regulator can be adjusted by R401 (even if a wrong voltage is obtained) the transistors probably are good. A shorted CR405 would raise the output voltage somewhat, but adjustment of R401 would restore it to normal. In that case, the receiver would operate okay, but the high voltage might fluctuate with temperature.

A shorted zener would force the output away down, and an open one would cause just the opposite: an excessively-high voltage.

If the output voltage is adjustable, but cannot be adjusted to a voltage between +115 and +120 volts, check for an off-tolerance resistor.

**Summary**

Although the power supply regulator circuits are more complicated than 6BK4-type high voltage regulators, servicing them is not difficult. For one thing, the voltages are not dangerous and can be measured safely. Also, the type of interdependence between DC or AC shunt regulators and the sweep circuit can be avoided with the power supply regulators just by testing the regulators separately using a dummy load. □



# A new look at transistor substitution for auto radios



By Joseph J. Carr, CET

*The subject of transistor substitution is one that has been written and talked about to the point of exhaustion. Even so, serious problems continue to appear. The tips given here are limited to solid-state replacements in car-radio and tape products.*

## Exact replacements

The easiest way of obtaining a replacement solid-state device that will install easily and operate correctly is to order it from the original manufacturer or one of his distributors. As we are all painfully aware, this is not always possible or practical.

## Industry-standard numbers

If the defective transistor has a standard "2N" number, just obtain a replacement having the same number, and disregard the brand of the replacement. Unfortunately, few Original Equipment Manufacturers (OEM) transistors are marked with these standard numbers. Most often they have a code

number that is meaningless to anyone except the manufacturer.

## Crossover guides

Crossover guides would seem to be a nearly-perfect source of replacement numbers. They should be used whenever possible. But many are the gremlins that can pop up unexpectedly. Theoretically, the cross-matching has all been done in advance, probably by the use of an infallible computer. When we follow those recommendations, however, we often find some suggested replacements that have insufficient power or voltage rating, too narrow a bandwidth, a different physical shape causing space problems, or wrong mounting dimensions requiring modification of the chassis. Many of these discrepancies occur because the crossovers are compiled from printed lists. It's an open secret that the recommended substitutions seldom are actually tried in any kind of equipment.

My policy is to return, along with a

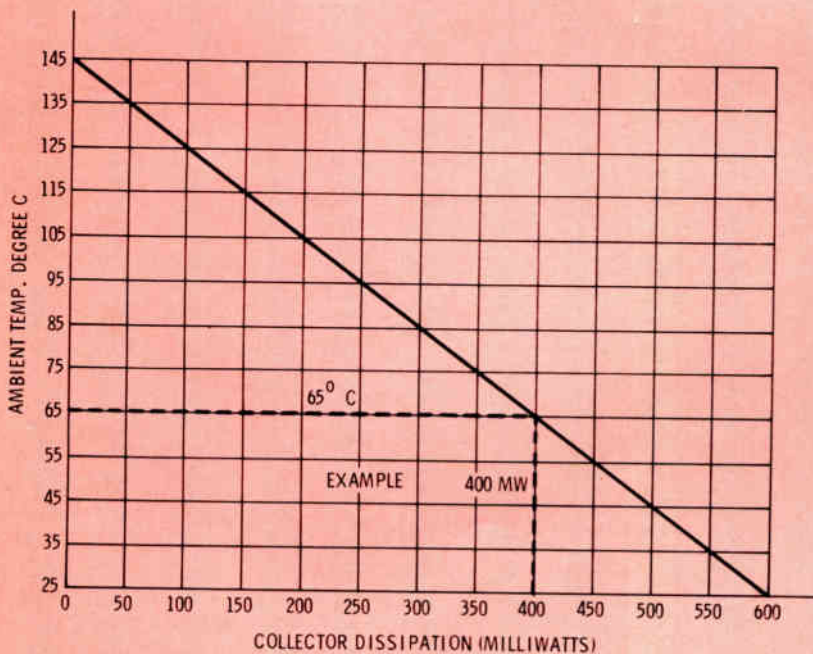


Fig. 1 One example of the derating of transistor wattage necessary when the temperature is increased above normal.

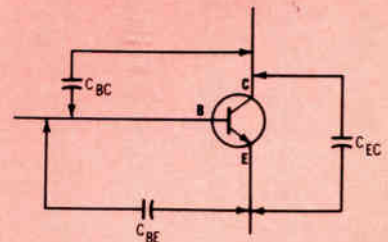


Fig. 2 Different junction capacitances and Miller effect can cause a replacement transistor to have low gain at high frequencies.

note of explanation, any crossover transistors that would require major reworking of the chassis or rewiring of the circuit. If everyone did this, the manufacturers might take the hint.

Another problem has nothing to do with electrical specifications, but rather with identification. Most manufacturers of consumer-electronic products use their own "house numbers" on solid-state components. Usually, this practice causes no problems.

But, what about the possibility that each of two manufacturers accidentally might assign the same designation to two completely dissimilar devices? It's not likely a crossover guide would solve this problem.

I remember one case in which I needed a replacement for a Delco DS-25. Now, the DS-25 has been used for about ten years as the RF amplifier, converter, and IF amplifier replacement in most Delco car radios. Unfortunately, a small hi-fi manufacturer also used the DS-25 designation for a medium-power PNP

germanium power transistor in a TO-3 case. One crossover guide I consulted at that time listed the TO-3 type without noting it was not a Delco type, even though it was listed among other Delco "DS" types.

Another example of poor crossovers involves the replacements often listed for the popular Japanese transistor type 2SB492. Many of the crossover guides list replacements that will dissipate safely only a few hundred milliwatts, although in many circuits the transistor is called on to dissipate several watts. Such underrated replacements usually burn out within a few minutes.

Failure of a 2SB492 often ruins the secondary winding of the driver transformer. Better check it before applying power after installing a new transistor.

Some of the "replacements" for the 2SB492 make the problems worse because they are physically different. In most sets, the original 2SB492 is mounted to a special flanged heat sink

accepting only TO-5 type transistors. I advise you to hold out for a replacement that mounts correctly without modifications.

### Mobile problems

Up to this point, the problems of obtaining suitable replacements for transistors in auto products have been identical with those for home-type machines. But there is one special problem that is unique to mobile equipment: environmental heat.

For example, one manufacturer became concerned about the excessive amount of failures in one of his first all-solid-state car radio models, and decided to investigate the possibility that heat was a factor. He asked his plant employees to leave their car doors unlocked for one day. During that day of 90-degree weather, his engineers measured the temperatures inside many closed cars. They were surprised to find the average reading was 160-degrees Fahrenheit, although a few peaked at 180 degrees!

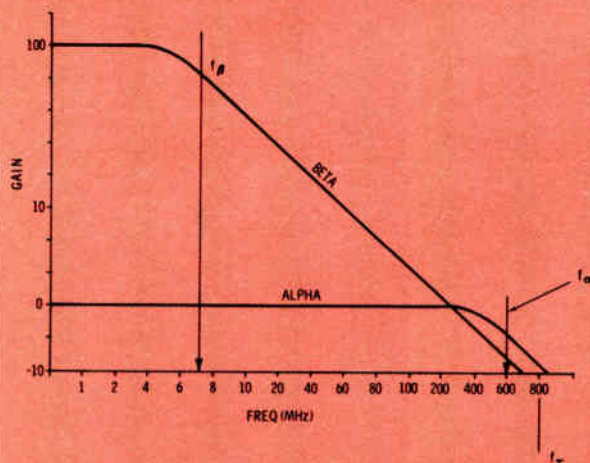


Fig. 3 Frequency cutoff of transistor alpha (grounded base operation) occurs at a much higher frequency than transistor beta (grounded emitter operation).

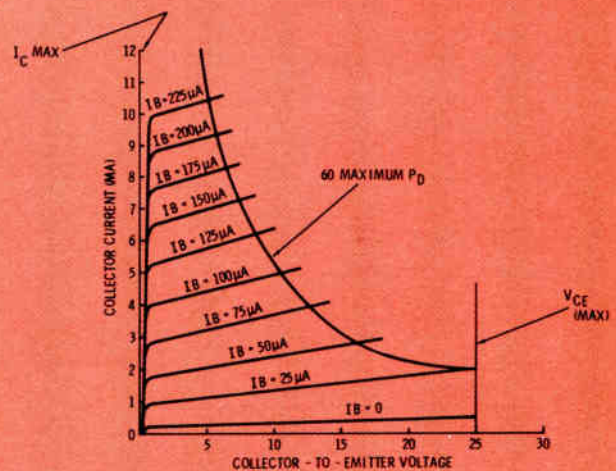


Fig. 4 Transistors cannot safely withstand both maximum voltage and maximum current. At low collector currents, the collector voltage can be maximum; when the collector current is maximum, the voltage must be low.

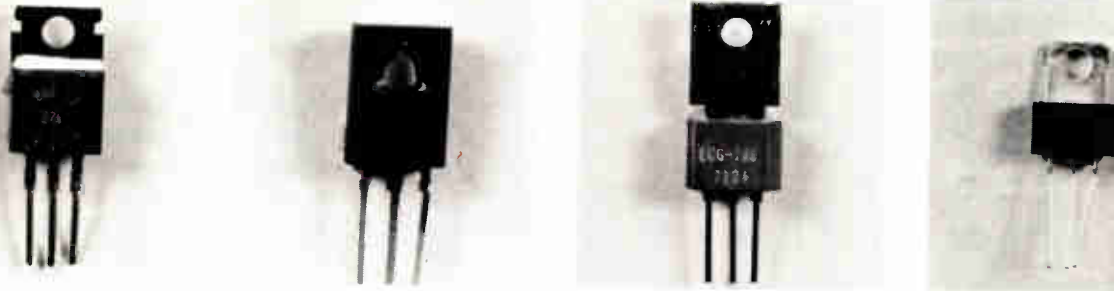


Fig. 5 Four examples of crossovers for each other and for T0-3 and T0-66 types. Obviously, some custom fitting must be done to mount them.

### Derating the specs

The power ratings of transistors usually are specified at room temperature, perhaps 25-degrees Centigrade (77-degrees Fahrenheit). If transistors are to be used at higher temperatures, the maximum wattage must be reduced to prevent extra failures which could occur even when all the electronic specifications are fulfilled.

A curve typical of those used for derating is shown in Figure 1. Notice that a transistor having a rating of 600 milliwatts at 25 degrees, can safely dissipate only 300 milliwatts at 85 degrees (185-degrees Fahrenheit).

This explains why a transistor that is operating slightly below its maximum wattage rating could be destroyed by using it in a hot car. Watch for such hazards, especially if you attempt to use the "five-for-a-buck" bargain replacements.

### Beyond crossmatching

Often the numbers on a bad transistor seem meaningless. There is no way to crossmatch. And you can't locate an EOM replacement.

The next step is to find a universal replacement from one of the many convenient sources. You must become an electronic detective and find out these things about the defective transistor:

- Is it a silicon or germanium type?
- Is it of PNP or NPN polarity?
- What frequencies must it amplify?
- What are the power requirements?
- Are there any special mechanical requirements?

After you have answered those questions, you can make a satisfactory selection from most any brand of universal replacements.

### Silicon or germanium

Silicon transistor junctions measure higher resistances than do germanium ones. In fact, silicon transistors usually read open on all measurements except base/emitter and base/collector forward polarity. If even one junction remains intact, you can tell which material it is.

Forward bias voltages for stages other than oscillators, sync amplifiers, AGC keyers and burst amplifiers should be around .2 volt for germanium and .7 volt for silicon types. Check the schematic to see if accurate base and emitter voltages are given.

### PNP or NPN

When the collector voltage is more positive than the emitter, the transistor is a NPN type; and if the collector is more negative than the emitter, the transistor is a PNP type. Most schematics give these voltage readings. On the other hand, you can measure collector/emitter voltages, that are accurate enough for this purpose, right in the circuit in most cases.

If even one junction of the defective transistor is intact, you can determine the polarity by using an ohmmeter. If you obtain a normal diode-type reading with the positive ohmmeter lead on the base and the negative lead on collector or emitter, it is a NPN type. If you must reverse the leads to obtain a diode reading, the transistor is a PNP type.

### Frequency response

Suppose you have installed a universal replacement and it doesn't amplify. According to the DC voltages, it's drawing current, and it doesn't

heat excessively, but it just fails to operate.

Chances are, the transistor has a bandwidth that is too narrow, and so the amplification is insufficient.

As you know, there is no easy way of measuring the frequency response of transistors. Worse yet, the manufacturers can't seem to agree on the correct method of rating the frequency response. In fact, I have seen examples of three different methods all in the same crossover guide!

Probably that's the reason you can install a transistor rated simply as "50 MHz" and yet find it won't properly amplify the signal in a 10.7-MHz IF system of a FM radio. Of course, the manufacturer didn't lie, but he might have misled you by using a rating system that didn't fit the circuit.

As shown in Figure 2, one factor is the capacitances between the junctions. Another, not shown, is the thickness of the base region and the time it takes for the majority carriers to cross the base region. If the capacitances of the replacement are too far out of tolerance, the gain will be reduced at high frequencies.

In addition there is the Miller effect which is the effective capacitance produced by internal feedback from the output signal back to the input. A small difference of internal capacitance can create a larger change of effective capacitance because of the Miller effect.

### Alpha and beta

Transistor alpha is the ratio of the collector current to the emitter current, and can never exceed 1. Beta is the ratio of collector current to base current.



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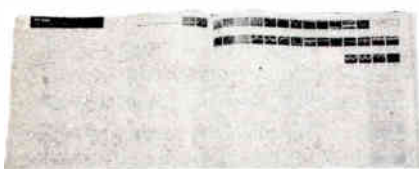
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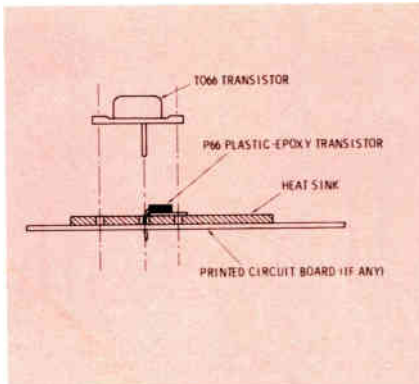


Fig. 6 A P-66 type plastic-case transistor can be used to replace the TO-66 type by inserting the pins into the socket and fastening the body by one mounting screw. Use an extra piece of metal for a heat sink, if the transistor is mounted to a PC board. Don't bend the leads where they emerge from the transistor case.

The frequency cutoff point is greatly different for these two kinds of ratings, as illustrated in Figure 3. A manufacturer who rates his transistors by the common-base method might correctly list them as having a far wider response than is possible by the common-emitter method. Of course, the common-base rating can provide you with a no-gain 10.7-MHz IF stage.

### Gain-bandwidth product

Another misleading method of rating frequency response is the gain-bandwidth product method. It is defined as the frequency at which the common-emitter gain drops to unity. For an example, let's assume a transistor with a low-frequency (1000 Hz) beta of 50 and a gain-bandwidth product of 50 MHz. The gain-bandwidth product equals the beta times the common-emitter cutoff frequency, so the common-emitter cutoff frequency is found to be only 1 MHz. That's why you can act on some of the short-form specs and still obtain a dud that won't amplify.

### Analyzing Maximum Ratings

Care must be used in analyzing the manufacturer's maximum voltage and current ratings. Just because a transistor is listed for certain maximum collector voltage and current doesn't

mean it always can operate safely at those levels. The graph of Figure 4 shows that the transistor can safely stand either high current or high voltage, but not both at the same time. Maximum wattage, the product of both voltage and current, must not be exceeded.

A transistor, whose maximum voltage and current ratings seem to indicate a dissipation of 30 watts, should be operated at about 10 watts to prevent overload and early failure.

### Mechanical Problems

Problems of physical size, connecting leads, and methods of mounting some substitute transistors are equally as vexing as those of finding suitable electrical characteristics.

Figure 5 pictures four types of plastic transistor cases which are listed as crossovers for each other and for the TO-3 and TO-66 types. In some cases, substitution will be easy. In others, for example the Motorola tape players made for Ford, the substitution is too difficult to attempt. Better obtain one with the proper case style.

Don't bend the leads to either side during installation of this type because the connections might break internally.

Make sure the mounting screws are tight, and that a generous amount of silicone grease is used between the transistor and the mounting surface.

### TO-66 replacement

In many cases, a Japanese-made TO-66 transistor can be replaced by a plastic type (see Figure 6). Use a heat sink and mount the plastic transistor by one screw. Bend the leads and insert them into the socket.

### Summary

The locating of suitable replacement transistors for car radio and tape units has the same problems and answers as that for home units, except for the ambient temperature.

Equipment used in automobiles must operate correctly without excessive failures over a temperature range from below zero to over 100-degrees Fahrenheit. Generally speaking, higher-wattage replacements should be used because of the derating necessary from the high temperatures. □

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# New ways of servicing solid-state video

By Robert L. Goodman

*Servicing video circuits has become increasingly difficult because of pre-CRT matrixing, multiple direct-coupled stages, and solid-state components. Here are some tested new ways of solving these new problems.*

Pre-CRT matrixing and solid-state components are two new developments found in the video circuits of late-model color receivers. In fact, the use of pre-CRT matrixing was initiated because of the expense and power limitation of transistors.

All color receivers manufactured in the period between the 1955 RCA and the first Motorola Quasar supplied chroma signals to the three grids of the picture tube, and video signals to the three cathodes. Thus, matrixing (or mixing) of the video and chroma signals was accomplished in the electron stream of the picture tube. This type of CRT matrixing was simple and effective. However, it did require four amplifiers, each capable of supplying high-amplitude video signals.

Transistorized amplifiers, capable of furnishing the large signals necessary to drive a color picture tube, are expensive. By matrixing the three chroma signals with the video-luminance signal to produce three color/video signals, one high-level amplifier stage can be eliminated. That's the reason most all-solid-state color receivers feature pre-CRT matrixing using three color/video amplifiers that drive either the three control grids or the three cathodes of the color picture tube.

Another design trend is toward more video stages, all direct coupled. No tube chassis uses more than three video stages. But, several RCA solid-state chassis use five stages, and the Zenith 25CC55 (which will be analyzed in the following paragraphs) has four stages.

## One Zenith Video Circuit

A block diagram of the complete video circuit of the Zenith 25CC55 color chassis is shown in Figure 1. Notice that two of the four video stages are emitter followers having no gain.

Before you start troubleshooting video stages, it's important that you know into which stages the Automatic Brightness Limiter (ABL) and blanking signals are injected. In this case, the ABL control voltage is applied to the base circuit of Q203, the 2nd video amplifier transistor, and both vertical and horizontal blanking signals are injected at the emitter circuit of the same transistor. ABL conditions change the DC voltages which affect the brightness, and blanking signals affect the video waveforms.

## Chroma amplification

Figure 2 shows the video circuit of the Zenith 25CC55, less only the 1st-video emitter follower and the blue and green video output stages.

Using the red video channel as an example of the three chroma/video amplifiers, you'll find that the R-Y signal coming from the demodulator IC is amplified only by one transistor, Q206. Because the signal input is to the base and the output is taken from the collector, the transistor gives both gain and phase inversion. The voltage gain, however, is limited to about 20 by the unbypassed emitter circuit where the video signal enters.

Amplitude of the chroma/video signal is adjusted by the red-drive control before the signal reaches the red cathode of the picture tube. This adjustment is needed to trim up any differences of transistor gain, and to match the efficiency of the red phosphor in the picture tube. In practice, the three drive controls (red, blue and green) are used to track the high-

lights of a b-w picture. The 18-pf capacitor across the drive control maintains good high-frequency response when the control is set for maximum attenuation.

## Video amplification

The video detector output is a negative-going signal which passes through the 1st-video emitter-follower transistor with little amplitude change, and with no change of polarity. The purpose of this stage is to serve as an impedance-matching device to prevent loading of the video detector by the low-impedance base circuit of the 2nd-video amplifier.

Both AC and DC couplings are used between the 1st-video amplifier and the contrast control. The AC part of the signal is coupled through C201, a non-polarized capacitor. It is a non-polarized type because, without a station tuned in, the DC voltage from the 1st-video stage is more positive than that at the contrast control. But when a strong station signal is received, this voltage relationship can reverse.

Coupling of the DC part of the video signal is through the 15K resistor, R201. About 25-percent DC coupling is provided by the parts values. Any more than that, say 100 percent, would make the picture too dark when the video level goes high. From the contrast control to the picture tube, the coupling is 100 percent.

For the moment, let's ignore the connection between the contrast control and the ABL circuit.

At the base of the 2nd-video amplifier, the signal is negative-going. Therefore, it is positive-going at the collector, the same as at the base of Q204, the 3rd video amplifier emitter follower.

Emitter followers don't invert the

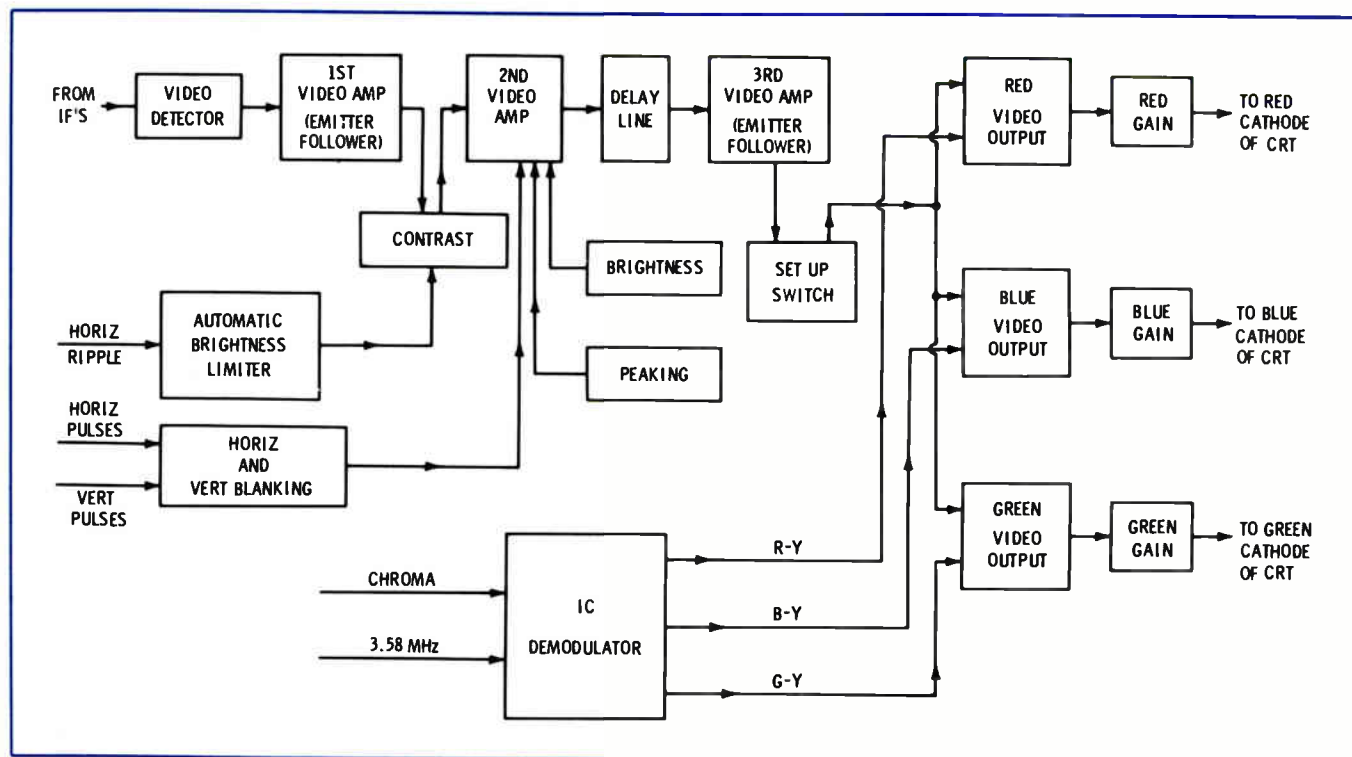


Fig. 1 Block diagram of the Zenith 25CC55 video circuit.

phase, so the signal remains positive-going at the emitter of Q204, and is positive-going at the emitter of Q206, the red video output transistor.

Now, when an input signal is applied to the emitter, the circuit is called a grounded-base amplifier. The transistor amplifies, but there is no phase inversion. Because the emitter video signal is positive-going, the amplified signal at the collector is also positive-going, and it is applied to the red cathode of the picture tube. A more positive voltage at the cathode reduces the brightness, and that is the correct condition needed to produce a normal picture.

With the polarities of all of the video stages checked out, we need to back-track and discuss some of the important details that were omitted.

#### Automatic brightness level (ABL)

The basic principle used to sense the amount of high-voltage current is that the ripple of any power supply increases with a heavier load. In this case, the ripple of the focus supply obtained from the HV-tripler assembly is the ABL control signal which is

adjusted for amplitude by the ABL control and applied to the base of the ABL transistor, Q201. Note that Q201 has no fixed DC forward bias.

When the picture tube current is 1.5 milliamperes, or less, the amplitude of ripple voltage reaching the base of Q201 is not sufficient to cause collector conduction. But when higher brightness is called for, the increased forward bias ripple at the base causes collector current. The collector current reduces the DC voltage at the contrast control and at the base of Q203, the 2nd video amplifier transistor.

As we observed before, a decrease of the base voltage of Q203 produces a darker picture. Therefore, the CRT current and picture brightness are both decreased. This prevents damage to the picture tube and also helps the HV regulation by reducing excessive current.

The zener diode CR226, not shown on the schematic, prevents any excessive voltage at the base of Q201 in case of arcs in the picture tube.

#### Brightness and peaking circuits

Picture peaking is accomplished by

increasing the high-frequency response of the 2nd video-amplifier stage. Emitter resistor R213 of Q203 is unbypassed. This decreases (by degeneration) the gain at all frequencies. When the peaking control, R218, is turned to maximum, C207 bypasses the emitter resistor. Because this is an efficient bypass only at high frequencies, the degeneration is cancelled and provides extra gain at the high-frequency end of the video response.

Brightness of the picture is changed by variations of the positive DC voltage at the same emitter. In addition to the normal voltage drop across R213 because of the emitter current, a variable positive voltage from the brightness control also enters via R216. To give increased brightness, a less positive emitter voltage produces a less positive voltage at the cathode of the picture tube.

#### Blanking signals

Vertical and horizontal pulse waveforms from the sweep circuits are applied to the emitter circuit of Q203, the 2nd-video-amplifier transistor.



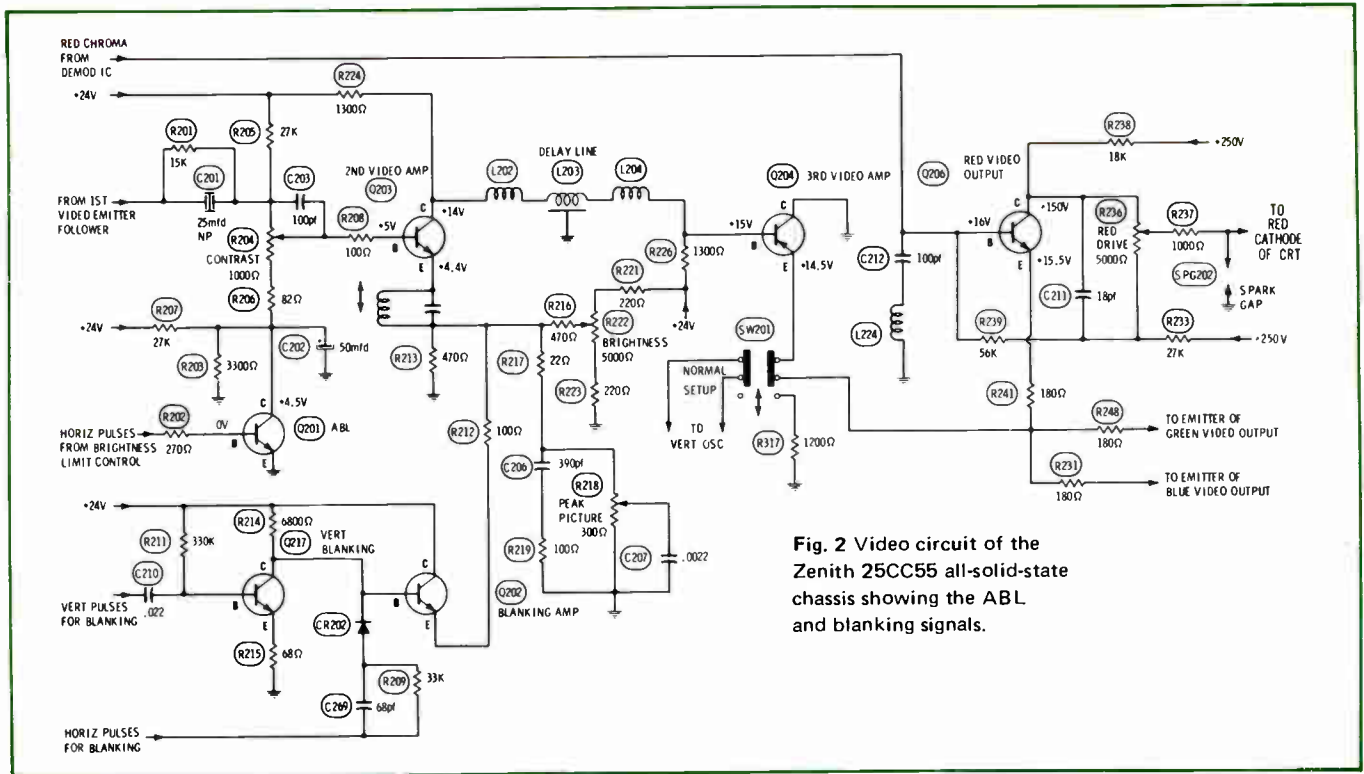


Fig. 2 Video circuit of the Zenith 25CC55 all-solid-state chassis showing the ABL and blanking signals.

However, the pulses are not applied directly, but through Q217, the vertical blanking transistor, and through Q202, the blanking amplifier.

Negative-going vertical pulses are applied to Q217 for inversion and amplification. The positive-going output pulses are direct coupled to the base of Q202. In addition, positive-going horizontal pulses are fed to the base through an RC filter and a diode. The diode, CR202, prevents weakening of the vertical pulses because of leakage through the RC filter (R209 and C269). Except when the tips of the horizontal pulses exceed the voltage at the base of Q202, the diode is reverse biased and an open circuit. These combined positive-going vertical and horizontal blanking pulses appear without inversion at the emitter of Q202, and are applied through R212 to the emitter circuit of Q203, the 2nd video amplifier.

Because there is no polarity inversion of signals applied to an emitter, the blanking signals at the emitter of Q203 appear amplified but not phase inverted at the collector. Also at the collector is the positive-going video signal, produced by the video signal at the base.

Addition of these blanking signals

changes the appearances of the video waveforms from this point on to the picture tube. As shown in Figure 3, the blanking pulses are much wider and of greater amplitude than the blanking pulses they replace.

There is no inversion of the blanking pulses following this stage. So, the blanking is positive-going at the cathodes of the picture tube and reduces the brightness during the pulse times.

#### Delay line

Since the bandwidth of the video channel is always wider than that of the chroma channel, a delay line is included in one of the video-amplifier stages. If there were no delay line, the chroma part of the picture would be about .4 inch to the right of the b-w on the screen of a 23-inch picture tube.

The amount of time delay can be tested by use of a square-wave generator set for 200-KHz and a dual-trace triggered-sweep scope with the sweep set for about 2 microseconds. The typical waveforms shown in Figure 4 indicate a delay of about .7 microseconds.

Of course, low-frequency video is slowed just as much as is the high fre-

quency by the delay line. But, the requirement is for the scope to show a very short slice of time, and the repetitive frequency then is chosen to provide several cycles. A 2-microsecond display of a 60-Hz sine wave starting at the zero line would be only a very slightly-sloped line.

#### Loading

To prevent standing waves and the "ghosts" they can cause, both the input and output terminals of the delay line must be loaded by the characteristic impedance. In the circuit of Figure 2, the delay line is loaded by R224 and by R226.

#### Normal/service switch

One of the aids for rapid tracking of the b-w picture is the use of the normal/service switch, SW201. When the switch is slid to the service position, a fixed bias is supplied to the emitter returns of the red, blue, and green video-output transistors. This bias is nearly enough to cut off the transistors, and is done to increase the positive voltage at the cathodes of the picture tube so the brightness of the horizontal line will be moderate when the switch is operated to stop the vertical sweep.

### Another delay-line circuit

Two important items of information should be known before you try to troubleshoot the delay line circuit (Figure 5) used in the RCA CTC40 and other all-solid-state RCA color sets.

First, loading of the delay line is not the usual voltage loading, but is current loading. There are no load resistors from the delay line to ground (or other common point). Instead, R350 loads the input and R362 loads the output of the delay line because they are in series with the signal and the delay line.

Although an unbalanced loading seems to be indicated by the dissimilar resistance values, the loading is correct because other circuit resistances add to complete the loading and make the input and output loading resistances equal. The impedance of the 1st-video amplifier adds to R350, and the input impedance of the 2nd-video amplifier adds to R362. Of course, R350 and R362 cause a large loss of signal voltage, but the loss is of little importance because the circuit primarily amplifies current.

When you trace the delay-line circuit using a scope, expect very little drop of signal across L316, L303 and the delay line. But, there will be a reduction of about 2-to-1 across R350 and more than 10-to-1 across R362.

In fact, when you first test the emitter signal of the 2nd-video amplifier, you probably will think the signal is missing. That small signal amplitude is the second unique difference about

this particular circuit.

When a signal is injected at the emitter of a grounded-base amplifier, the input impedance is very low. Visualize a 50-ohm resistor wired from emitter to ground, and you will understand the reason for the small amplitude. The gain of the transistor, however, is extremely high, so there is a large non-inverted video signal at the collector.

### Troubleshooting Solid-State Video Circuits

Circuit conditions in the video-amplifier stages determine these things:

- dim or excessively-bright pictures. Extreme cases of either condition can cause a complete loss of raster;
- the amount of contrast;
- the degree of picture sharpness;
- retrace lines; and
- the quality and amplitude of sync pulses which are sent on to the AGC and sync stages.

Because of the direct-coupling between all of the video stages, a defect causing a reduction of contrast or a blurring of sharpness is almost certain to cause a much more noticeable symptom of a large change of brightness range. For that reason, we will concentrate most on brightness problems.

### Defects that affect brightness

Either extremely-low or excessively-high brightness can cause a loss of the

raster. Low brightness biases off the raster, although the high voltage and other CRT voltages are normal. High brightness might cause blooming so severe that it kills the high voltage and thus eliminates the raster. Between these extremes are the cases in which the rasters can be seen, although they have the wrong brightness range.

### Use the normal/service switch

Let's assume that there is no raster, although the picture tube does have normal high voltage and focus voltage. Refer to the schematic in Figure 2.

Slide the normal/service switch to the service position. Then notice if the screen shows a gray horizontal line, or if a line of any color can be obtained by turning up the screen controls. No horizontal line indicates that the screen voltages or bias voltages of the picture tube are wrong. Voltage tests using a VTVM or FET meter quickly will determine the circuit in which the trouble is located.

If a horizontal line is obtained with the switch in the service position, but there is no raster in the normal position, the defect is not in the red, blue or green video output stages, but in one of the three preceding video stages.

### Tracing the video stages

AC waveforms and their DC levels in the video stages can be measured simultaneously by use of the DC scope function.

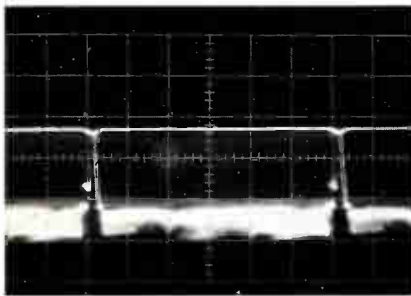


Fig. 3 The video waveforms are changed by the addition of blanking signals. Left; Appearance of the video and blanking with the scope set to view the vertical fields. Right; The horizontal blanking pulses have nearly three times the normal amplitude.

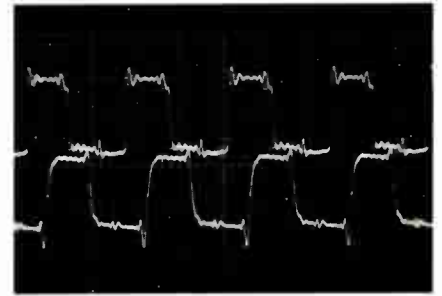
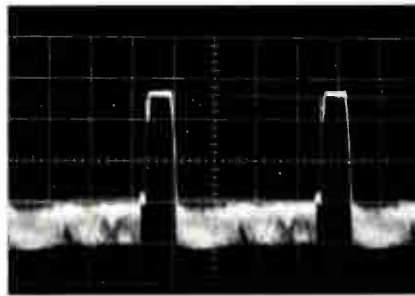


Fig. 4 Dual-trace scope waveforms show the .7 microsecond time constant of the delay line. The top trace is the input, and the bottom trace is the output of the delay line. Frequency of the square-wave generator was about 200 KHz and the triggered sweep was set for 2 microseconds.

The waveforms of Figure 6 show the base and collector signals of one stage. First, the scope is adjusted for 2-volts p-p per centimeter (each graticule square), DC coupling of the vertical amplifier, and the zero line (moved by the vertical centering control) at the bottom line of the graticule. In the lower waveform taken from the base, a square wave of about 1.2 volt is riding on the forward bias of +2.2 volts DC. The collector (top waveform) has a 2.5 volt p-p square wave and a DC voltage of +8.8 volts.

There are two different methods of measuring the DC component of an AC/DC combination of voltages. If the

waveform is symmetrical (sine, square, triangular or sawtooth) the average voltage line is exactly in the vertical center. Just measure from this point to the zero line.

However, when the waveform is pulses or other non-symmetrical shapes, change the AC/DC switch from one mode to the other and notice the number of graticule markings the waveform moves.

#### One use for dual-trace scopes

A dual-trace or dual-beam scope can be very helpful in troubleshooting video stages. For example, the ability to see the waveforms present at two

points of the circuit (see Figure 7) makes possible an accurate comparison showing any changes of the waveforms.

Also, such a test is ideal for showing the stage where an intermittent originates.

#### Brightness changes because of transistor defects

It is very helpful to know in advance what effect various transistor defects might have on the brightness level.

For example, a collector/emitter short or excessive base forward bias of Q201, the ABL transistor) decreases the brightness. An open collector/

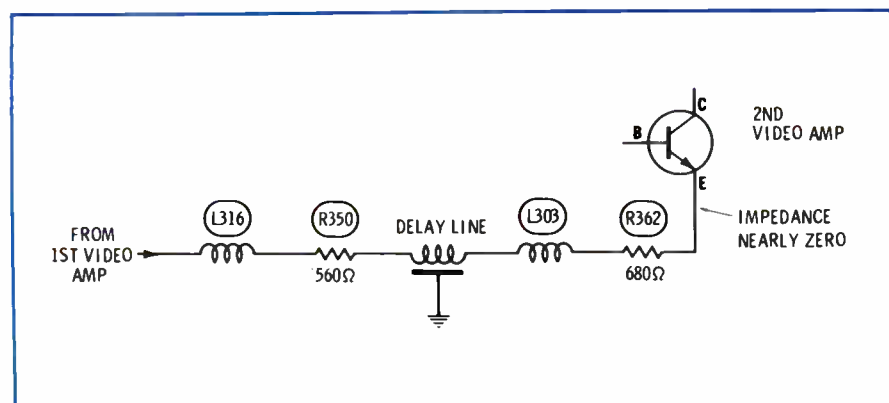


Fig. 5 Current-loaded delay-line circuit used in the RCA CTC40 chassis.

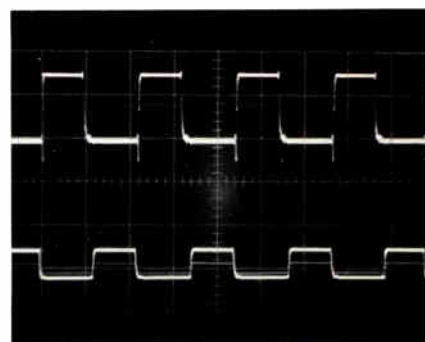


Fig. 6 DC voltages can be measured simultaneously with the p-p waveform by using the DC function of the scope.

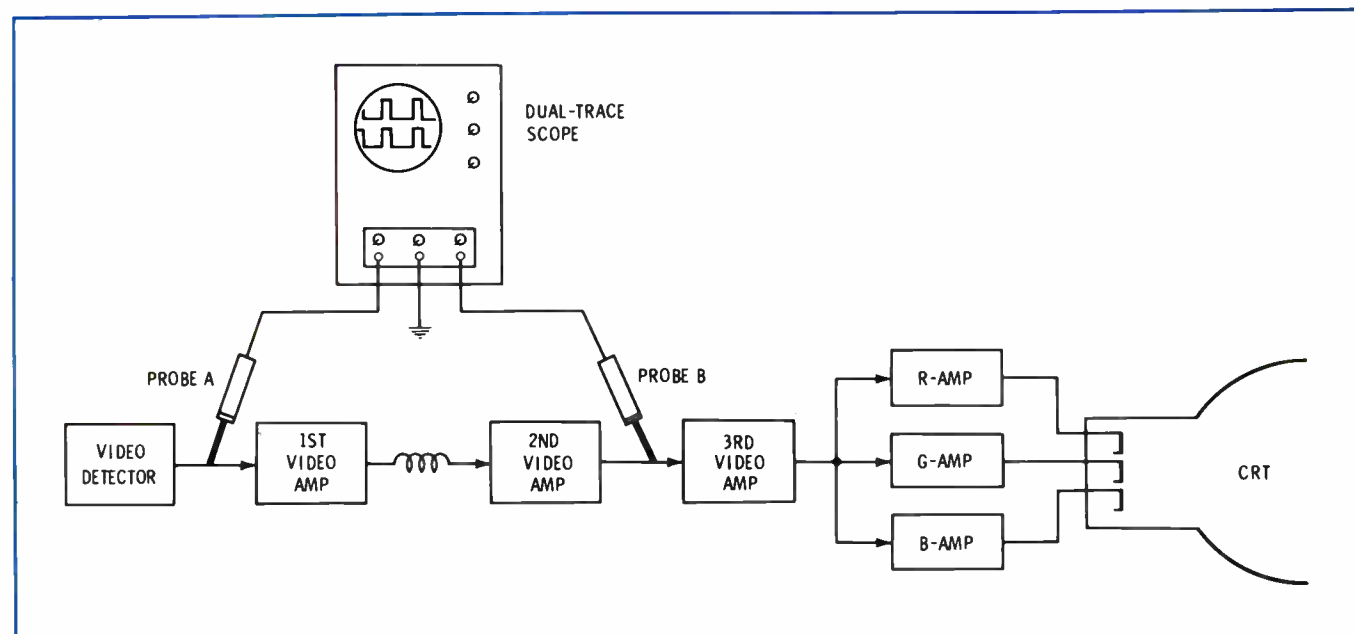


Fig. 7 A dual-trace scope is the ideal instrument to use in finding the stage which has an intermittent.



emitter junction or no base bias eliminates any automatic reduction of excessive brightness.

A shorted collector/emitter junction of Q217 or a shorted C210 causes vertical retrace lines but does not affect the brightness. An open collector/emitter or open R211 increases the brightness.

An open element or base/emitter short of Q203 decreases the brightness, probably eliminating the raster. A collector/emitter short or an open R203 will increase the brightness, and possibly cause blooming.

A collector/emitter short in Q204 tremendously increases the brightness causing loss of high voltage. Conversely, a blacked-out raster results from an open junction in Q204.

### Changes Of B-W Screen Color

Shorts, opens or leakages in the red, blue or green video-output transistors seldom change the brightness alone. They are much more likely to eliminate one or two colors or to produce a changed gray-scale tracking of the b-w screen color.

For example, a shorted collector/emitter junction of Q206 (the red video output transistor) or a large increase in the positive voltage at the base (from the demodulator IC) makes the red gun draw saturation current. At the same time, the other two output transistors are biased to cutoff and the blue and green guns produce no color. Either the screen would be a solid red without video, or the excessive drain would kill the high voltage and eliminate the raster.

On the other hand, an open collector/emitter junction in Q206, or a loss of the positive base voltage from the demodulator, would eliminate all red from the raster and from the color picture. Blue and green should operate normally.

Similar defects of the blue and green video-output transistors give the same symptoms, except the affected colors are reversed.

In all of these cases, check the DC voltage at the three cathodes of the picture tube. They should measure within 20 volts of each other. Usually just one will be excessively high or low, and this indicates the defective channel. □

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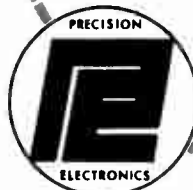


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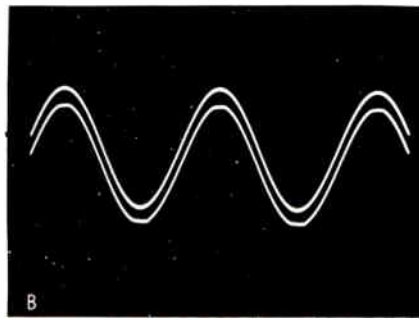
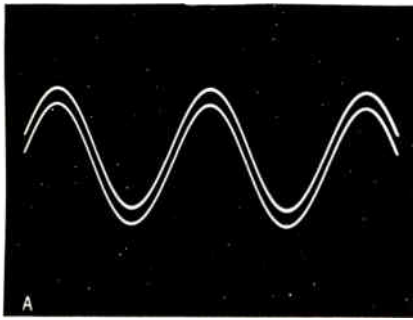


Fig. 14 Sliding the waveforms together closely makes it easier to spot any differences. (A) Both waveforms here are undistorted, and are given just for comparison. (B) The lower waveform shows a slight amount of clipping at both peaks. Clipping shows more clearly when the waveforms are separated very slightly, while other types of distortion are seen more easily by overlapping the waveforms.

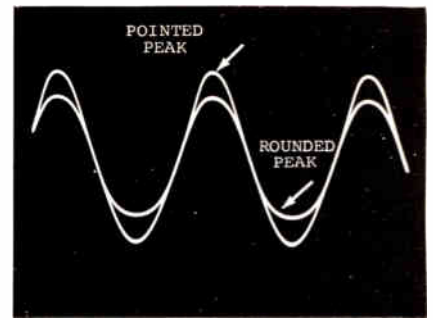


Fig. 16 A distortion of 8 percent, when it is mainly second and other even harmonics, shows as a large and unmistakable difference in waveform.

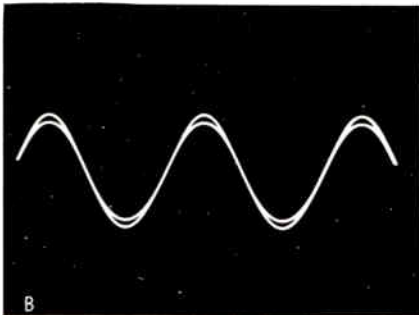
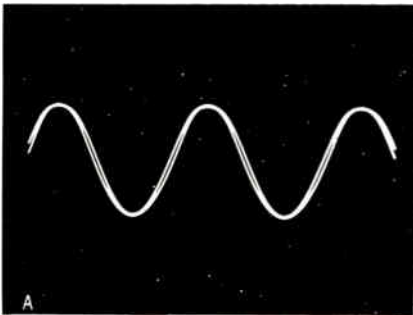


Fig. 15 Adjust the controls of the scope so both waveforms have the same height, as shown in (A) and merge them at the tips of the peaks. Notice that the difference between the waveforms is not very noticeable. After using one of the vertical-centering controls to make the waveforms merge at the zero line in the center (B), the differences in waveshape caused by only 3-percent distortion can readily be seen.

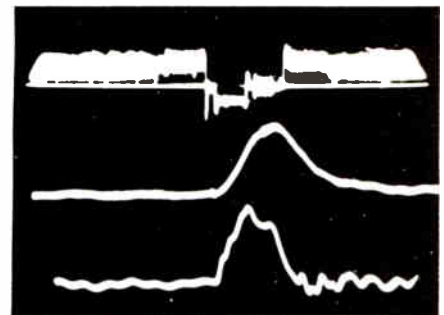


Fig. 17 This triple-exposure picture is repeated from a previous article. It shows the phase relationships of the horizontal sweep pulse (lower waveform) to the pulse at the burst keyer (center waveform) after the phase was delayed normally by an RC filter, and to the burst component of the video (upper waveform). A wrong delayed phase of the enabling pulse would weaken or eliminate the color locking.

(Continued from page 21)

forms would not have been noticeable. One cycle of video at the horizontal rate takes about 63 microseconds. The waveform of Figure 7 occupied 10 microseconds total (1 microsecond-per-centimeter times 10 centimeters); therefore the waveform was expanded about 6 times. By use of this much expansion, the .7 centimeter displacement of the burst, or of the trailing edge of the sync pulse, easily could be seen.

The 200-KHz square waves of Figure 8 require 5 microseconds per cycle, and there are two cycles on the screen. Therefore, 10 microseconds were required to scan the complete waveform. This is the same amount of time used for the video signal in the previous example.

Repetition rate of the vertical-lines signal was 189 KHz, so the conditions are nearly the same as for the square waves.

The point is this: to show the required delay of .7 microseconds, the scope sweep must be adjusted for a very short scan time, then the

waveform must show a definite and easily identified area that can serve to show the displacement of the two waveforms. All three of these signals fulfill the requirement.

### Checking One Stereo Channel Against The Other

One of the good breaks a technician gets when checking stereo machines is the possibility of comparing the defective channel against the other which is working okay.

Sine waves fed to both channels will show any large amount of distortion (Figure 11A). On the other hand, square waves (Figure 11B) would not show any clipping distortion, but definitely would indicate any changes of frequency response.

### Dual-Trace Spots Intermittent Stages

Using both channels of a dual-trace scope cuts in half the required testing time for finding an intermittent video or audio amplifier stage. Just attach one probe to the input and the other

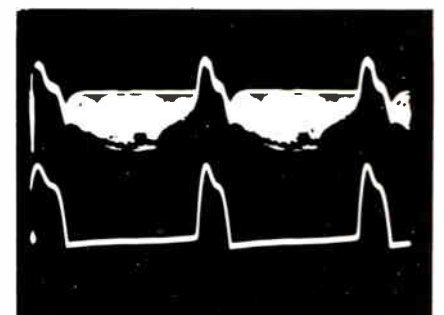


Fig. 18 The phase of the video relative to the horizontal pulses at the AGC keyer must be the same for the AGC action to be normal. A change of phase of either signal would weaken the amount of AGC.

to the output of the stage to be tested. Adjust the vertical gain controls so the two waveforms are about the same height, and wait for the intermittent to happen. If the amplitude of both waveforms changes, the intermittent is

ahead of this stage. If neither waveform changes during the intermittent, the trouble is behind the stage which is under test.

When checking audio stages, use the normal station audio, and adjust the scope sweep for a very slow scan so individual cycles of the audio can be seen. This is illustrated in Figure 12. However, the long photographic exposure has increased the apparent number of cycles.

### Using Dual-Trace To Identify Distortion

One of the most well-known uses for scopes always has been to show distortion of sine waves. Unfortunately, only large amounts of distortion (perhaps 10 percent and higher) can be identified positively by a visual analysis of a single waveform. See Figure 13.

Dual-trace waveforms enable us to approximately measure sine wave distortion down to below 2 percent! However, you should use a method we developed in our **ELECTRONIC SERVICING** laboratory.

### Merge the waveforms

By merging the two in-phase waveforms, we can easily see small differences between the sine wave from the generator and the distorted sine wave at the output of the stage or amplifier system under test.

Figure 14A shows two undistorted sine waves moved vertically close together. Placing one waveform on top of the other magnifies any slight discrepancies as we will show later. However, a merely-close positioning is more effective for identifying any clipping of either one or both of the peaks (see Figure 14B). Incidentally, the distortion of the clipped waveform was caused by the loading of the AC function of a p-p reading VTVM when applied to the plate of a tube-type amplifier, and it measured only about .4 percent. This appears to be an insignificant amount, but the sharp corners of the clipping indicate that the distortion products are mainly high-order harmonics, which would be much more noticeable to the ear in listening tests than to a scope or meter. In addition, such clipping would cause intermodulation distortion products generated by the

unwanted mixing of individual notes of music.

### Merging which way?

It makes a big difference which way the merging is done. For example, if we merge by adjusting the gain of the two scope channels so the peak-to-peak amplitude of the undistorted generator sine waves equals that of the distorted sine waves, as shown in Figure 15A, a distortion of 3 percent is barely noticeable near the zero center points.

But if this step is done first, and then the centering of one trace is moved so the two waveforms merge perfectly at the center zero line, about twice the amount of difference can be seen (Figure 15B).

The appearance of 8-percent distortion produced by excessive signal input to a triode audio amplifier is shown in Figure 16. This type of distortion is mainly second harmonic as evidenced by the sharper tip of the positive-going peak, and the rounded tip of the negative-going peak. Although the reading obtained by a distortion meter from this signal is many times higher than the small .4 percent example caused by clipping, the audible effects of the clipping will be greater. It's very helpful that this method of finding distortion will show up both types.

### Dual-Trace Tests Phasing

Several circuits in a color receiver can be checked for the relative phase of two signals. Vertical and horizontal retrace blanking is one example. If component failure has changed the phase of the blanking relative to the sweep retrace, the blanking will be ineffective.

Another example (Figure 17 repeated from a previous article) is the phasing of the horizontal enabling pulse relative to the color burst. If the two have a different arrival time, there will be weak or no color locking, even when the amplitudes of both signals are normal.

A decrease of AGC action could be caused by a change of relative phase between the video signal and the horizontal pulse applied to the AGC keyer tube or transistor (Figure 18). □

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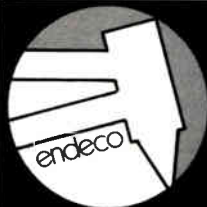


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## test equipment report

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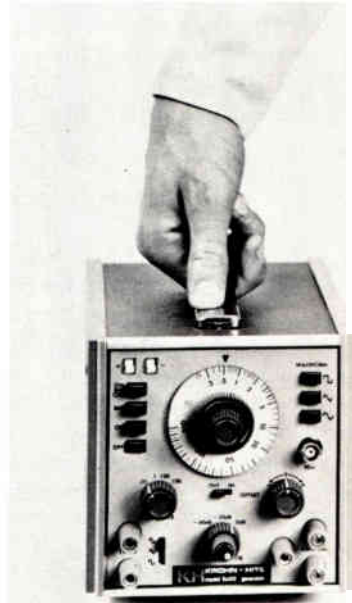
### Portable Function Generator

Product: Model 5600 by Krohn-Hite Corp.

**Features:** The portable function generator provides sine, square and triangle waveforms in a frequency range from 0.002 Hz to 2 MHz, with a frequency accuracy of  $\pm 5\%$  of reading for the entire 1000:1 tuning range of the dial. Output is controlled by a three-position attenuator and amplitude vernier, providing both a 50-ohm single ended with 15 volts p-p, and a 600-ohm balanced output with 30 volts p-p. Model 5600 converts to a portable unit by using two rechargeable nickel-cadmium batteries.

**Size and Weight:** The generator measures 5-1/2 X 5-1/4 X 10 inches and weighs 7 pounds.

**Price:** Model 5600 is priced at \$395, plus \$70 for the portable battery kit.



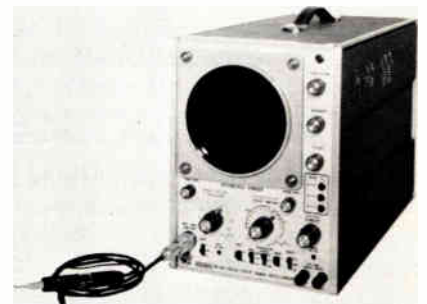
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### Triggered-Sweep Oscilloscope

Product: Model TR-410 oscilloscope by EICO Electronic Instrument Co., Inc.

**Features:** The TR-410 is designed for TV servicing, lab work, production testing, and vocational instruction with features such as 10-MHz bandwidth, sweep that automatically locks in with complex TV signals, solid-state design with protected FET input stage, and a single probe for converting from direct to 10:1 low-capacity operation. It has a 3-way operation: standard 120-volt line, low 100-volt, and 220-230 volts; all 50 and 60 Hz. There are three calibration voltages: 2, 5, and 10. Horizontal and vertical DC balance controls are adjustable and there is a

selection of AC or DC modes of amplification. A gating signal is available at a jack to enable the user to synchronize other equipment to the trace on the scope.



**Price:** EICO Model TR-410 oscilloscope is listed at \$379.95, wired only.

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## audio systems report

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**Needle Merchandiser**  
Product: Model CND Needle Merchandiser by the Duotone Co.



**Features:** The new sales unit has a front panel which shows 25 of Duotone's most popular needles for instant identification. Holding over 400 needles on three slide-out trays, the merchandiser is equipped with lock and key. The side-panels are of walnut-grain. The unit is available as a counter type or, if desired, with a floor stand.

**Price:** It is offered to dealers at no charge with a \$500 needle order.

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### P. A. Amplifiers

**Product:** Power-Plus 120 P. A. Amplifier by the Fanon/Courier Corp.

**Features:** The pictured model is included in the Power-Plus line of professional P. A. amplifiers. The five basic models in the line range in RMS power output from 15 watts up to 120 watts, and include a 35-watt combination AM/FM background-music receiver and paging amplifier. Power-Plus 120 and 65 models include VU meters while Models 15, 35 and 35T

### Portable Field-Strength Meter

**Product:** Field Strength Meter FSM-4 by Blonder-Tongue Laboratories.

**Features:** The FSM-4 has separate VHF and UHF tuners, providing continuous coverage from 54 to 216 MHz and from 470 to 890 MHz, with accurate signal readings in dBmV and microvolts from 10 to 100,000 made on a large-scale taut-band suspension meter. The meter is calibrated to read average signal strength and the entire unit operates on four standard 9-volt batteries. Accuracy of readings in the VHF band are  $\pm 3$  dB while UHF readings are accurate to within  $\pm 4$  dB. The portability of the meter makes it useful for reading signal strength measurements at the "top of the mast".



**Size and Weight:** The FSM-4 measures 9 X 6-1/2 X 4 inches in its carrying case. It weighs 4 pounds, 6 ounces.

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### AC Current/Voltage Tester

**Product:** Model 300C "Clamp-On" Current Tester by EICO Electronic Instrument Co., Inc.

**Features:** To measure current, the operator snaps the trigger-actuated "Clamp-On" insulated jaws around a single conductor of the circuit under test. To measure voltage and resistance, the user plugs in the safety test leads. The rotary scale reveals one range at a time, with reading accuracy of  $\pm 3\%$ . The pointer lock "freezes" readings enabling both "memorizing", and measuring in darkness to read later in light. It comes complete with battery, leads, and carrying case.

**Specifications:** Measurement ranges are: AC Amps: 0-6, 15, 60, 150, 300; AC Volts: 0-150, 300, 600; Ohms: 0-1,000 (mid-scale 30 ohms).

**Size and Weight:** Model 300C measures 2-5/8 X 7-1/2 X 1-1/2 inches, and weighs 2 pounds.



**Price:** Model 300C "Clamp-On" Current Tester sells for \$49.95 (wired only).

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### Digital Voltmeter

**Product:** Model PM2441 by Test & Measuring Instruments Inc.

**Features:** The PM2441 can be used either as a separate digital voltmeter for precision bench measurements with either manual or automatic ranging or as part of a fully-automated or remote-controlled measuring system. Input impedance is  $10^9$  ohms on the three mid-range scales,  $10^8$  ohms on the lowest (20mV) scale, and  $10^7$  ohms on the 200 and 1000 volt scales. The resolution of the PM2441 is four digits plus one over-range digit; maximum scale reading is 19999. The maximum response time in auto-ranging is 1.5 seconds. For system applications, the PM2441 may be controlled by BCD signals from TTL level up to 50 volts.

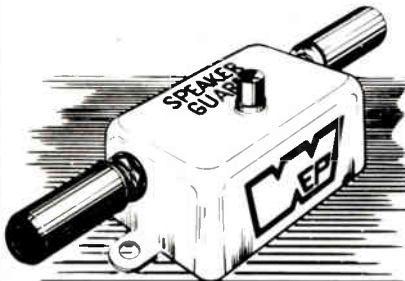


**Price:** Model PM2441 sells for \$1890.

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# SPEAKER GUARD

**PROTECTS SPEAKER  
AND AMPLIFIER**



An overload in wattage of amplifier output activates circuit breaker and prevents damage. Reset circuit breaker and make sure you use correct values of Speaker Guard.

**18 DIFFERENT VALUES**

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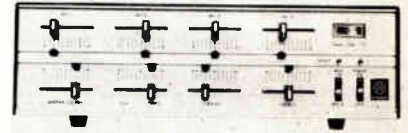
**WORKMAN**

Subsidiary of IEM TECHNOLOGY, INC.  
BOX 3828 SARASOTA, FLA. 33578

*Electronic*  
PRODUCTS, INC.

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(combined tuner and amplifier) come equipped for 12 VDC use. Outputs for the new amplifiers are 4, 8, or 16 ohm as well as 25 and 70 volt balanced or unbalanced line. The integrated circuitry uses modular preamp and driver circuits. Safety circuits and thermal cutouts protect equipment from shorts. Also, featured are a priority page, hi-lo impedance microphone channels, slide controls and memory markers.



For More Details Circle (51) on Reply Card

## Cassette Tape

**Product:** Toyota C-60L Cassette by Electronic Homes Company.

**Features:** C-60L is a low-noise tape with a calendered finish, flanged guide rollers, and pin construction for accuracy in head tracking. The cassette housing is made of a high-impact plastic Philips-style hinged box which is factory-sealed. The units are assembled in the U. S. A. The Toyota cassette provides 60 minutes of playing time at 1-7/8 IPS (2 X 30 minutes).

**Price:** C-60L cassette sells for \$.89.

For More Details Circle (52) on Reply Card

## Audio Cable

**Product:** Stereo cable Model 44-359 by The Weltron Company.

**Features:** Model 44-359 is 12 feet long with a 3-wire connector cable. It has a standard 3-way phone plug to a standard 3-way in-line jack. It is designed for use as a headphone and stereo speaker extension cable for tape recorders, receivers or 8-track and cassette tape players.

**Price:** Suggested list price of Model 44-359 is \$3.08. □

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# SPRAY AWAY THE RACKET.



Squeak. Whine. Whirr. Pssst! Silence. Quietrol did it again. Silenced those moving T.V. parts, with one squirt from the handy spray pack. Cleaned away dirt, dust, and crud. Without damaging anything... in any black and white or color set. Silence is golden. So is Quietrol.

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COMPANY

Spartanburg, South Carolina

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54 ELECTRONIC SERVICING/February, 1973

## productreport

for further information on any of the following items, circle the associated number on the reader service card.

## Pocket Calculator Kit

**Product:** Pocket calculator kit by ARIES Kits Inc.

**Features:** The AR-420K calculator has an LED display of eight seven-segment digits. Features include automatic zero suppression, automatic "overload" indicator, and a floating decimal point. It is useful for raising numbers to powers, calculating inverse numbers, and extracting square roots. Four size-AA alkaline cells are provided with the kit. Also available is a Battery Charger Kit complete with nickel-cadmium cells.

**Size and Weight:** The dimensions of the pocket calculator kit are 1-3/4 inches X 2-7/8 inches X 4-3/4 inches. The finished calculator weighs 9-1/2 ounces and shipping weight of the kit is 1-1/4 pounds.



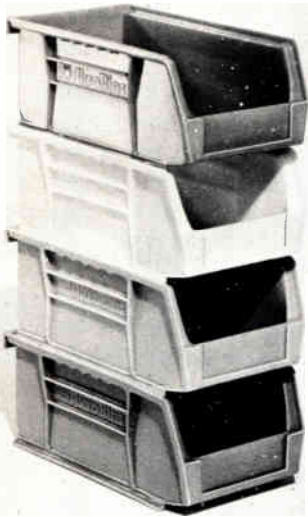
**Prices:** The cost of the AR-420K Pocket Calculator Kit is \$75.00. The Battery Charger Kit sells for \$17.50.

For More Details Circle (54) on Reply Card



### Storage Bins

**Product:** AkroBins by Akro-Mils Division of Myer Industries, Inc.



**Features:** These self-stacking storage bins are molded of heavy-duty polyethylene and are available in four colors for parts coding. Besides stacking, Akro-Bins may be suspended from most straight-rail or perforated-panel hanging systems and fit into standard industrial shelving. A slot is located under each bin for holding pre-punched data-process inventory and reorder cards.

**Sizes:** AkroBins come in five sizes ranging in inches from 3-7/16 X 4-3/4 X 2-13/16 to 14-3/4 X 14 X 6-3/4.

**Prices:** The prices of AkroBins depend on size and range from \$.45 to \$5.00 each.

**For More Details Circle (55) on Reply Card**

### Remotely-Controlled Light

**Product:** Sonic-Raylite remote-controlled light by Signal Science, Inc.

**Features:** Sonic-Raylite is used as a garage or door light for the porch or walkway. It consists of an all-aluminum, weather-proof receiver box and socket plus a convenient pocket-size remote control hand unit. Each socket powers a lamp up to 150 watts. The unit may be controlled from the owner's car from distances up to 75 feet. It requires no special skills for installation.

**Price:** The Sonic-Raylite retails for \$19.95. Additional outlets are available at \$7.50 each. An extra outlet with a 30-foot cord sells for \$10.00.

**For More Details Circle (56) on Reply Card**

### Tech Spray Markets Adhesive

**Product:** Eastman 910 Adhesive by Tech Spray, Inc.

**Features:** The adhesive features high strength and rapid bonding of rubber, metals, plastics, ceramics, glass and phenolics, such as wafer switches, drive belts, and ferrite cores. It sets fast with no mixing or heating and is clear when dry.

**For More Details Circle (57) on Reply Card**

### Mobile Charging Assembly

**Product:** Charging adapter assembly No. 7585 for cordless soldering irons by Wahl Clipper Corp.

**Features:** The No. 7585 charger assembly plugs into the lighter outlet of any cars having a standard 12-volt electrical system and charges the battery of any "Iso-Tip" cordless soldering iron while the vehicle is in motion. This assembly can be purchased separately or as part of the "Iso-Tip" kit No. 7565 which includes a cordless iron, a small tip, and the auto-charger plug assembly.

**Price:** The auto-charger plug assembly No. 7585 sells for \$4.95.

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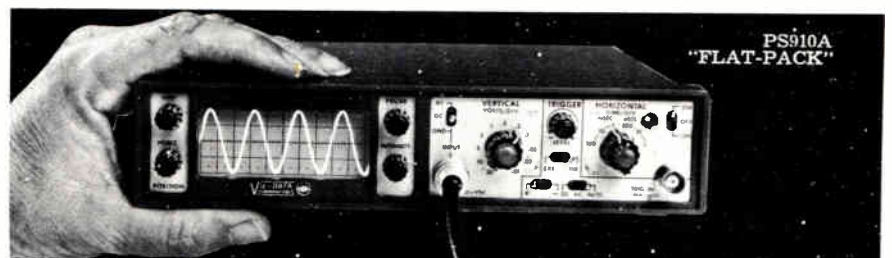


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## antenna systems report

*Features and/or specifications listed are obtained from manufacturers' reports. For more information about any product listed, circle the associated number on the reader service card in this issue.*

### TV Antenna-Rotator Repair Tool

**Product:** Finco Model 5245 Tenna-Clamp Rotator and Antenna Repair Mount by the Finney Company.

**Features:** The Finney Company Mount makes it possible to keep an antenna in position of the roof while the rotator is removed for repair or replacement. The antenna and mast can be removed from the rotator, placed in Tenna-Clamp's receiver flange, and locked in place. Next, the rotator is removed for repair or replacement while the antenna remains on the roof. Tenna-Clamp can hold the antenna in position indefinitely, if necessary. Also, repairs to the antenna itself can be made safely and conveniently utilizing the bracket arrangement which allows the antenna to be placed in a horizontal position while it is being repaired.

**Price:** \$19.50.

For More Details Circle (59) on Reply Card

### MATV Amplifier

**Product:** The pictured model is included in the "G" series of solid-state broad-band MATV distribution amplifiers for UHF-VHF-FM reception. The "G" series features two outputs; separate VHF and UHF inputs, switchable to a single all-channel input; two separate and adjustable FM traps; double-diode lightning protection; and separate VHF and UHF gain controls. Solid-state military-quality printed circuit boards, transistors and components are standard.

**Specifications:** Model UVF-2540 is engineered for 30 to 96 TV set outlets, with 25dB minimum gain and +40 dBmV rated output; Model UVF-3545, for up to 128 TV set outlets, featuring 25 dB minimum gain and



+45 dBmV rated output; and Model UVF-4554 for more than 450 TV set outlets, with 45dB minimum gain and +54 dBmV rated output.

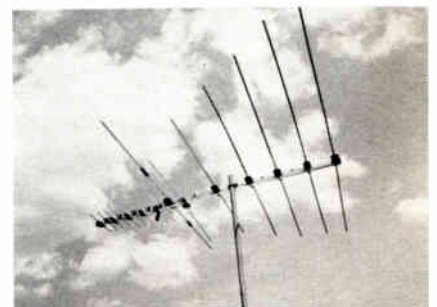
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### Color TV Antennas

**Product:** Color Whiz TV antenna Model CW80 by JFD Electronics Corp.

**Features:** The VHF/UHF/FM CW80 is one in a new series of eight Color Whiz 82 TV antennas. These models utilize cross-phased dual-band elements that deliver the gain, directivity, and front-to-back ratio of antennas up to 20% larger in size. Elements slip into receiving position with minimum effort, yet are retained rigidly in place by means of the bracket mechanism. The director section features new flat planar construction which results in a larger signal-gathering area. A VHF/UHF signal splitter is included

with each antenna. The Color Whiz 82 line ranges from local-type antennas to fringe antenna designs.



**Prices:** Prices of the Color Whiz 82 line range from \$8.60 to \$49.95.

For More Details Circle (61) on Reply Card

PHOTOFACT BULLETIN lists new PHOTOFACT coverage issued during the last month for new TV chassis.

<b>BRADFORD</b>	
1071C33 (WTG-78626) .....	1299-1
<b>GENERAL ELECTRIC</b>	
TR115RTX-2(CH. R-2) .....	1292-1
<b>JVC</b>	
7500 .....	1292-2
7310, 7510 .....	1298-1
<b>PANASONIC</b>	
TR-005, TR-005C .....	1290-3
CT-771, TY-702 .....	1294-1
<b>PENNCREST</b>	
2870A (855-0725) .....	1292-3
1412 .....	1293-2
<b>MAGNAVOX</b>	
Chassis T966-01-LA thru T966-06-LA .....	1298-2
<b>MOTOROLA</b>	
Chassis TS-938, ATS-938, YTS-938, YATS-938 .....	1299-2
<b>PHILCO-FORD</b>	
Chassis 2CY80, 2CY80A .....	1297-1
<b>SINGER</b>	
HE-8040 .....	1296-1
<b>TRUETONE</b>	
MIC4219A-27 (2DC4219) .....	1293-3
EIS3920C-86 .....	1296-2
MIC3220A-27 (2DC3220) .....	1297-2
<b>WARDS AIRLINE</b>	
GGV-12813A .....	1295-3
GAI-12653A .....	1298-3
<b>XAM</b>	
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1872 .....	1297-3
16BW73 .....	1299-3
<b>ZENITH</b>	
Chassis 19DC22 .....	1296-3



Covers: •IF •CHROMA •VSM •CHANNELS 2 thru 13  
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## SMG-39 sweeper generator

A precision sweeper with quality and features found only in lab instruments. The SMG-39 utilizes post injection crystal controlled intensity or pulse markers for a sharp jitter free display. The SMG-39 features four independent bias supplies. VFO (variable frequency oscillator) provides an additional calibrated marker between 39-49 MHz. Unique marker display enables accurate marker positioning for faster receiver alignment. VFO facility provides an additional marker for protection against obsolescence, may also be used for spot alignment. All solid state with glass epoxy circuit boards. Complete with all cables and pads.

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## SMG-12 VHF-UHF sweeper generator

The SMG-12: Checks alignment of Tuner RF Amplifier and RF-IF overall response. Sweeps all channels 2 thru 13 and 14 thru 83 when used with the SMG-39 or other brand sweep generators. SMG-12 converts an IF sweeping signal to each of the 12 VHF channels with crystal controlled stability. The 45.75 MHz (Picture), 42.17 MHz (Chroma) and 41.25 MHz (Sound) IF markers are also converted to correspond to the picture, chroma and sound carrier frequencies of each of the TV channels. No additional marker source is required.

**SMG/UHF Balanced Detector.** Displays the alignment curves of a passive type UHF tuner when used in conjunction with the SMG-39 or equivalent generator. Display includes crystal accurate picture, chroma and sound markers.



SMG-12 complete with SMG/UHF and all cables. .Net **249.50**

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February, 1973/ELECTRONIC SERVICING 57



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## The MARKETPLACE

This classified section is available to electronic technicians and owners or managers of service shops who have for sale surplus supplies and equipment or who are seeking employment or recruiting employees

**Advertising Rates**  
in the Classified Section are

- 25 cents per word (minimum \$3 00)
- "Blind" ads \$2 00 additional
- All letters capitalized 35 cents per word

Each ad insertion must be accompanied by a check for the full cost of the ad

**Deadline for acceptance** is 30 days prior to the date of the issue in which the ad is to be published.

This classified section is not open to the regular paid product advertising of manufacturers

### EDUCATION INSTRUCTION

**REPAIR TV TUNERS**—High Earnings. Complete Course Details, 12 Repair Tricks. Many Plans, Two Lessons, all for \$1. Refundable. Frank Bocek, Box 3235 Enterprise, Redding, Calif. 96001. 1-73-4t

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**TV & RADIO TUBES 36c EA.!!** Free color catalog. Cornell, 4221 University, San Diego, California 92105 9-72-6t

**USE YOUR SCOPE** (any model, no rewiring) to test transistors in/out circuit. Simple instructions \$1.00. Schek Technical Services, 8101 Schrider St., Silver Spring, Maryland 20910. 2-73-6t

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**UNUSUAL SURPLUS** electronics and parts catalog, thousands of items. \$1. ETCO, Dept. ES, Box 741, Montreal, Canada. 2-73-10-t

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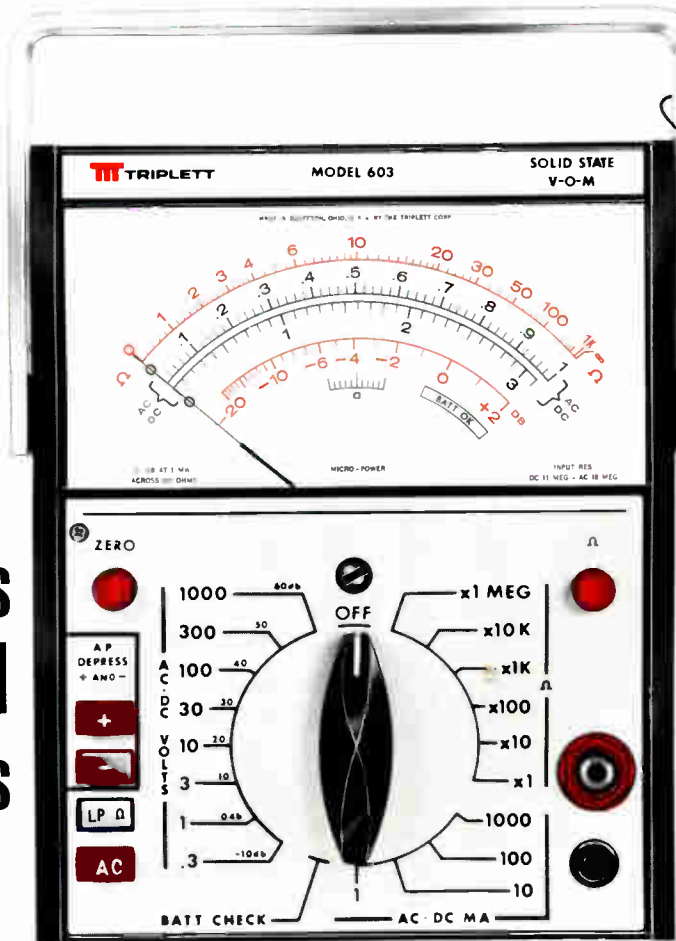


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