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Electronic Servicing®

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About the cover John D. Liljestrand Jr. is using modern test equipment to troubleshoot an older color TV receiver.

Application to Mail at Controlled Circulation Postage is pending at Shawnee Mission, KS, and at additional offices. Published monthly at 9221 Quivira Road, Overland Park, Kansas 66212 by Intertec Publishing Corp., 9221 Quivira Road, Overland Park, Kansas 66212. Send Form 3579 to 9221 Quivira Road, P.O. Box 12901, Overland Park, Kansas 66212.


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ELECTRONIC SERVICING (ISSN 0013-497X) (with which is combined PF Reporter) is published monthly by Intertec Publishing Corp., 9221 Quivira Road, Overland Park, KS 66212.

ELECTRONIC SERVICING is edited for technicians who repair home-entertainment electronic equipment (such as TV, radio, tape, stereo and record players) and for industrial technicians who repair defective production-line merchandise, test equipment, or industrial controls in factories.

Subscription prices to qualified subscribers: 1 year—$10, 2 years—$16, 3 years—$20, in the USA and its possessions. All other foreign countries: 1 year—$13, 2 years—$22. Subscription prices to all others: 1 year—$25, 2 years—$50, in the USA and its possessions. All other foreign countries: 1 year—$34, 2 years—$68. Single copy price $2.25; back copies $3.00. Adjustment necessitated by subscription termination to single copy rate. Allow 6 to 8 weeks delivery for change of address. Allow 6 to 8 weeks for new subscriptions.

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news of the industry

All locally available Magnavox "Magnavision" videodisc players were sold within a half hour after they first were introduced last December 15th in Atlanta, GA. The three dealers had a total of only 37 machines for sale, while the demand was estimated at 2000. Some customers camped near the stores to be first in line at opening time, and inquiries came from Paris, New York and Acapulco. One store was said to have sold more than 100 units, most to be delivered during January and February. About 1000 videodiscs also were sold. Magnavox has selected the Seattle-Tacoma area as the next test market. The videodiscs resemble conventional phonograph records, but without the grooves. A laser beam in the player reflects light from the spiral tracks that are made up of many microscopic pits or indentations. The reflected laser light is received by a photo cell, and from it comes the three FM carriers that are processed and demodulated to produce one composite video signal and two separate sound signals. The beam is kept centered on the correct "groove" by a complex servo mechanism that moves the automatic tracking mirror. Retail price of the Magnavision player $695, and the DiscoVision discs are priced between $5.95 and $15.95 according to the playing time.

Quasar Electronics has been divided into two separate companies. Matsushita Industrial Company will perform the engineering and manufacturing of Quasar TVs and other products. At a later date, it is expected to begin building Panasonic TVs also. Quasar Company is to sell and service Quasar products through the present system of distributors and dealers.

About 447 CB transmitters and linear amplifiers were seized by the FCC in a December raid at the Brewer Labs of Porter, OK. The seizure is said to be part of the FCC's continuing effort to eliminate illegal CB linear amplifiers that cause many kinds of interference.

Sylvania has added five TVs, two stereos and a color video recorder with optional color camera to the 1979 line. The three consoles feature Automatic Sharpness Control (ASC) circuitry. An electronic digital clock and timer in the 4-hour video recorder can be set in advance to record TV programs. The recorder lists for $1075, and $849.95 is the suggested price of the color video camera with built-in microphone.

In January, Quasar announced a portable videocassette recorder weighing less than 20 pounds and operating from an internal sealed rechargeable battery. Another VCR (model VH5100) is said to be the first with a remote control channel-change feature. Quasar also demonstrated a film-to-tape conversion system for transferring movie film or color slides to videotape. Top of the 4-model line of microwave ovens is the Quasar model with Insta-Matic Cooking (model MQ6600).

RCA is said to be rushing the introduction of its SelectaVision VideoDisc. The project had been sidelined in 1977, but now is expected to have a marketing schedule later this year. The RCA videodisc has a groove to guide the pickup head, which operates by capacitance changes. Retail price of the disc players is expected to be around $400.

A single-electron-gun color picture tube should be introduced by Panasonic next fall. The first model will have a 4-½-inch screen, but larger sizes up to 10 inches are expected soon. Another new product is a line of batteries only 1/300th-inch thick which are designed to be used in calculators, watches and cameras. Retail price of each battery is expected to be about $1. For industrial uses, Matsushita has introduced a color TV transmitting and receiving system using 1,125 scanning lines.

Industry predictions for 1979 include both good and bad news. Sales of color TVs are expected to decrease, but increased volume of video products, microwave ovens and home computers should more than compensate.

Major winner of the Sylvania "Tab Terrific" sweepstakes is James Kessler, a TV service dealer of Mt. Vernon, OH. He received a first prize of 5000 program tabs.

Versatility: Here's why B&K-PRECISION's new DMMs offer more

Selecting a DMM isn't simply a matter of looking for the highest accuracy. It's a more complex process of deciding what features and performance characteristics you need, to do as many different jobs as you're likely to encounter. In short, versatility is just as important as accuracy!

The new 2830 digital multimeter from B&K-PRECISION has all the popular features you'd expect to find on a 3½ digit lab DMM, but it also offers some very uncommon features. Because a DMM may be used under poor lighting conditions or in a very bright environment, the 2830 uses bright, high-efficiency 0.43" high LED digits. The readability of this premium display is unmatched by other readout devices.

The 2830 is also one of the very few DMM's available with a 10 ohms range, capable of .01 ohm resolution. This range offers the user accurate resistance measurement of switch and point contacts, or motor or coil condition. AC and DC current measurement capability extends from 100 nA to 20 amps without the need for external plug-in shunts. For voltage measurement, the 2830 can resolve as little as 100 μV. For maximum versatility in resistance measurement, selectable high-/low-power ohms permits resistance measurement with or without forward biasing semiconductor junctions.

The unit is housed in an attractive rugged cabinet which features a combination tilt stand/handle. Options include a battery pack for field use and a carrying case.

B&K-PRECISION's 2810 DMM offers many of the features of the 2830 but in a more compact package and at a substantially lower price. Features include 100 μV, .01 ohm resolution; high-/low-power ohms; autozeroing; high immunity to RF interference and complete portability.

Free DMM Selection Guide

A new B&K-PRECISION DMM selection guide is now available. This full-color brochure details features, applications and specifications. It also includes details of a new probe that turns any DMM into a digital thermometer. Send for your free copy today!

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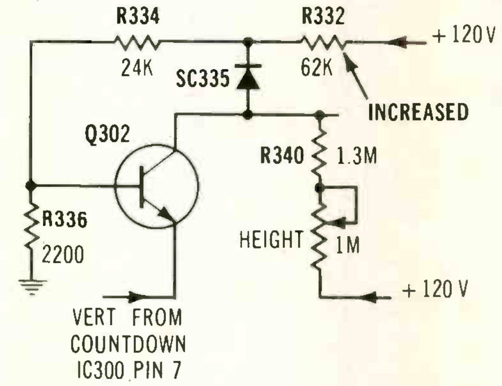
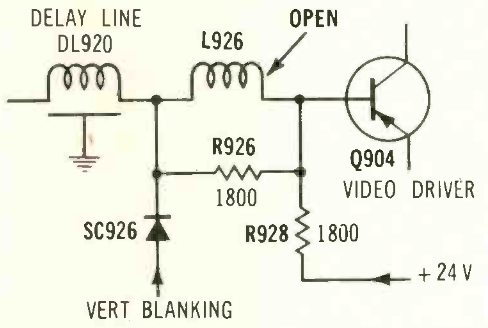
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Sylvania E03/E04/E05
PHOTOFACT—1414-3, 1425-3, 1420-2



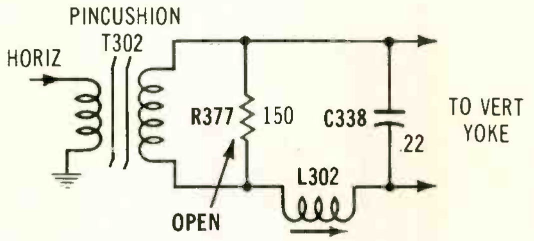
Symptom—Insufficient vertical height
Cure—Check R332, and replace it if increased

Chassis—Sylvania E06
PHOTOFACT—1432-3



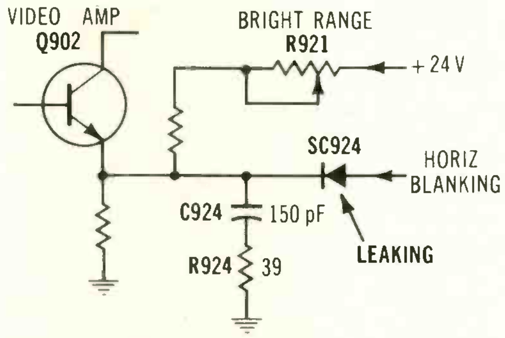
Symptom—Low contrast
Cure—Check coil L926, and replace it if open

Chassis—Sylvania E02
PHOTOFACT—1324-3



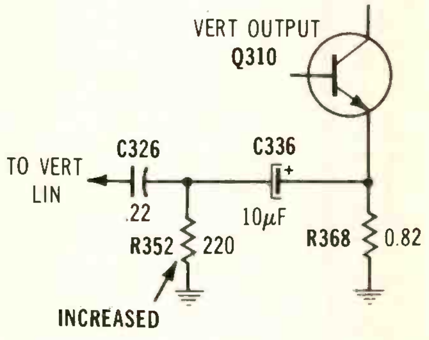
Symptom—Vertical linearity stretched at the center
Cure—Check R377, and replace it if open

Chassis—Sylvania E08
PHOTOFACT—1481-2



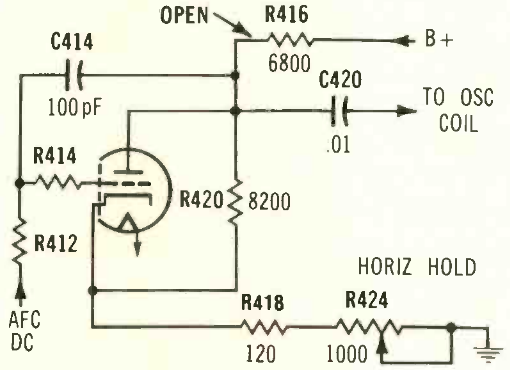
Symptom—Horizontal tearing which is changed by brightness
Cure—Check diode SC924, and replace it if leaking or erratic

Chassis—Sylvania E03/E04/E05
PHOTOFACT—1414-3, 1425-3, 1420-2



Symptom—Slightly insufficient height
Cure—Check resistor R352, and replace it if increased.

Chassis—Sylvania D16
PHOTOFACT—1178-3



Symptom—Horizontal hold can't change horiz frequency
Cure—Check R416, and replace it if open

reader's exchange

There is no charge for a listing in *Reader's Exchange*, but we reserve the right to edit all copy. If you can help with a request, write directly to the reader, not to **Electronic Servicing**.

Needed: TV field strength meter. Prefer Sencore or Jerrold. *L.C. McCall, P.O. Box 158, Hiawassee, GA 30546.*

Needed: Used test equipment for TV and audio equipment. Also, will sell early Photofacts and old radio tubes. *Vision Electronics, 7226 Taft, Hollywood, FL 33024.*

Needed: A copy of *Repairing Home Audio System* by E. Ecklund. *Bob Kramer, 539 South Stat, Aurora, IL 60505.*

Needed: Technicians interested in not-for-pay participation for the design of a super-small personal walkie-talkie for repeater operation. Send self-addressed envelope to: *Smith, 8636 Grand, River Grove, IL 60171.*

For Sale: Rider's manual abridged I-V, VI through XIX, no indexes; PA manual number 1; RCA Victor service books: Volume 1 (1923-1937), Volume 2 (1938-1942); Stromberg Carson service notes circa 1950. All in mint condition, prices negotiable. You pay freight. *Walter J. Blair, 35 Arroyo Way, San Francisco, CA 94127.*

Needed: Owner's manual with schematic for Supreme Electronics set tester, model 504-B. Also, owner's manual and schematic for EMC (Electronic Measurement Corp.) RF/AF crystal-marker/TV-bar generator, model 700. Will buy, or copy and return. *John Brovzakis, RD2 Box 602B, Charleroi, PA 15022.*

For Sale or Trade: Tubes: old, antique, oddball, hard-to-find types. *Troch's, 290 Main Street, Spotswood, NJ 08884.*

Needed: Deflection Yoke part 361285-1 (T-D74-U) for Magnavox TV chassis T922-01-AA. *Harry K. Murphy, 1230 St. Antoine, Florissant, MO 63031.*

For Sale or Trade: Tennelec Memoryscan model MS-1, $125; EICO 380 color generator, $45; Paco Z-80 signal tracer, $25; Precision 10-54 tube and set tester, $15. *Norman Round, 29 Elmwood Road, Methuen, MA 01844.*

For Sale: Color or monochrome picture tube rebuilder, never used, complete with supplies and duds, cost $5500. Will sell for $1500 or best offer. *Eugene Faber, 1112 W. 31st South, Wichita, KS 67217.*

For Sale: Sweep tubes at 25 cents each; small tubes at 10 cents each. New tubes in cartons. You pay freight. *W.E. Papy, 913 E. 22 Street, Hialeah, FL 33013.*

Needed: Help from someone who specializes in repair of photoflash units. I have a Singer Graflex 500 Strobematic but don't have much test equipment. *Elmer L. Mosley, 720 Poplar Street, Keneva, WV 25530.*

For Sale: RCA WO-33B 3-inch scope with manual and probes, excellent condition, $125; Sencore CG-22 color/bar generator, as is, $10. Also, about 200 Clarostat controls with switches and shafts; best offer. *Mark Hughes, Route 2, Box 271, Kings Mountain, NC 28086.*

Needed: Convergence-yoke assembly part 94D303-5S for Admiral color TV chassis 4H10. *Leslie Welch, 616 Valencia Drive, Belleville, IL 62223.*

For Trade: Good used color picture tubes. I need 16VACP22 and 400BNB22. I have 155P22, 16CYP22, 19GYP22, 19HCP22, and 19HYP22. Send for list of B&W CRTs I have and need. *Gordon Handy, Jr., 300 Vienna Drive #214, Palm Springs, FL 33460.*

Needed: Antique Marconi-Deforest wireless gear and literature for my collection. Also, Atwater Kent, breadboard parts, crystal sets, catalogs and literature for them. Will pay best prices. *A&M In-The-Home TV Care, 84 West Muriel, Orlando, FL 32806.*

For Sale or Trade: Sylvania model 500 sweep generator, new in carton, $65; Philco VTVM with 9-inch meter for panel mounting, with instruction manual, $35; Rider's TV manuals volumes 1 through 26, with index, $135; Black & Decker ½-inch electric drill, $20; and a 7-inch Ram 88 circular saw, $25. *M. Seligsohn, 1455-55th Street, Brooklyn, NY 11219.*

Needed: Schematic of AM/FM-stereo with 8-track tape chassis number 0640 made by Mayfair Sound Products. Or address of Mayfair. *Terry Stremcha, Dakota, MN 55925.*

For Sale: B&K-Precision model 1077B television Analyst, like new, $295; and the following Heathkit instruments: model IT-5230 CRT tester/rejuvenator, $100; model IM-17 VOM, $10; model IT-18 transistor tester, $10, model 4110 frequency counter, $180, and model 5218 VTVM, $25. *Eugene Maples, P.O. Box 503, Flippen, GA 30215.*

For Sale: Heath IG-18 sine-square audio generator, $85; Heath IG-37 stereo generator, $70; Heath IM-48 audio analyzer, $35; Heath IM-58 distortion meter, $35; Heath IB-1100 frequency counter, $100; IB-102 frequency scaler for above, $90; Continental res/cap bridge, DM-3, $75; Continental Design-Mate circuit designer with 5 V supply, $70; EICO model 369 RF sweep generator w/probes, $35; EICO model 680 transistor tester, $45; EICO model 214 VTVM, collectors item, works good, $60; B&K model 801 capacitor Analyst, $90; B&K model 260 3-digit VOM,

Reader's exchange

$55; Leader LSG-14 signal generator, $50; Military AN/USM-34 multimeter with RF probe, $30; Ballantine model 301A ac VTVM, $50; and TS-497/URR signal generator, 10-400 MHz, $125. Will ship prepaid upon receipt of certified check. *Electronic Service Company, 1412 Mayfield Ave., Morgantown, WV 26505.*

For Sale: Precision E200C signal-marking generator; EICO 368 sweep/marker generator; EICO 460 scope; Heath IO-57A post/marker sweep generator, almost new; Heath IO-101 vectorscope, new, factory calibrated; Heath IG-18 sine/square generator, factory calibrated, almost new. All equipment with manuals and leads. *Robert J. Sheehan, 89 Strattford Ave., Pittsfield, MA 01201.*

Needed: Schematic and parts list for a Fada radio, model 260. Will buy, or copy and return. *Raymond Friend, 236 W. Pearl Street, Butler, PA 16001.*

For Sale: Obsolete tubes. Send your list of needs. Also, home built transistor tester by Zenering, $15. *Elmwood TV, 13G Market Square, Newington, CT 06111.*

Needed: Power transformer Sylvania part 55-23915-1. *A.R. Pumphrey, 15109 Copter Lane, Lockport, IL 60441.*

Needed: Volume control with on/off switch (4 meg tapped at 2 meg) part RRC226 for GE radio/phono

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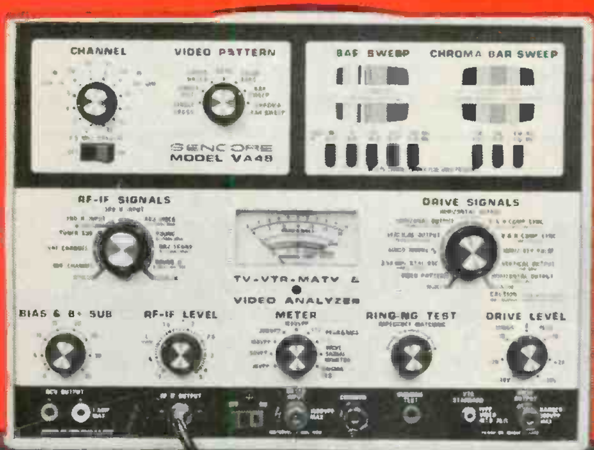

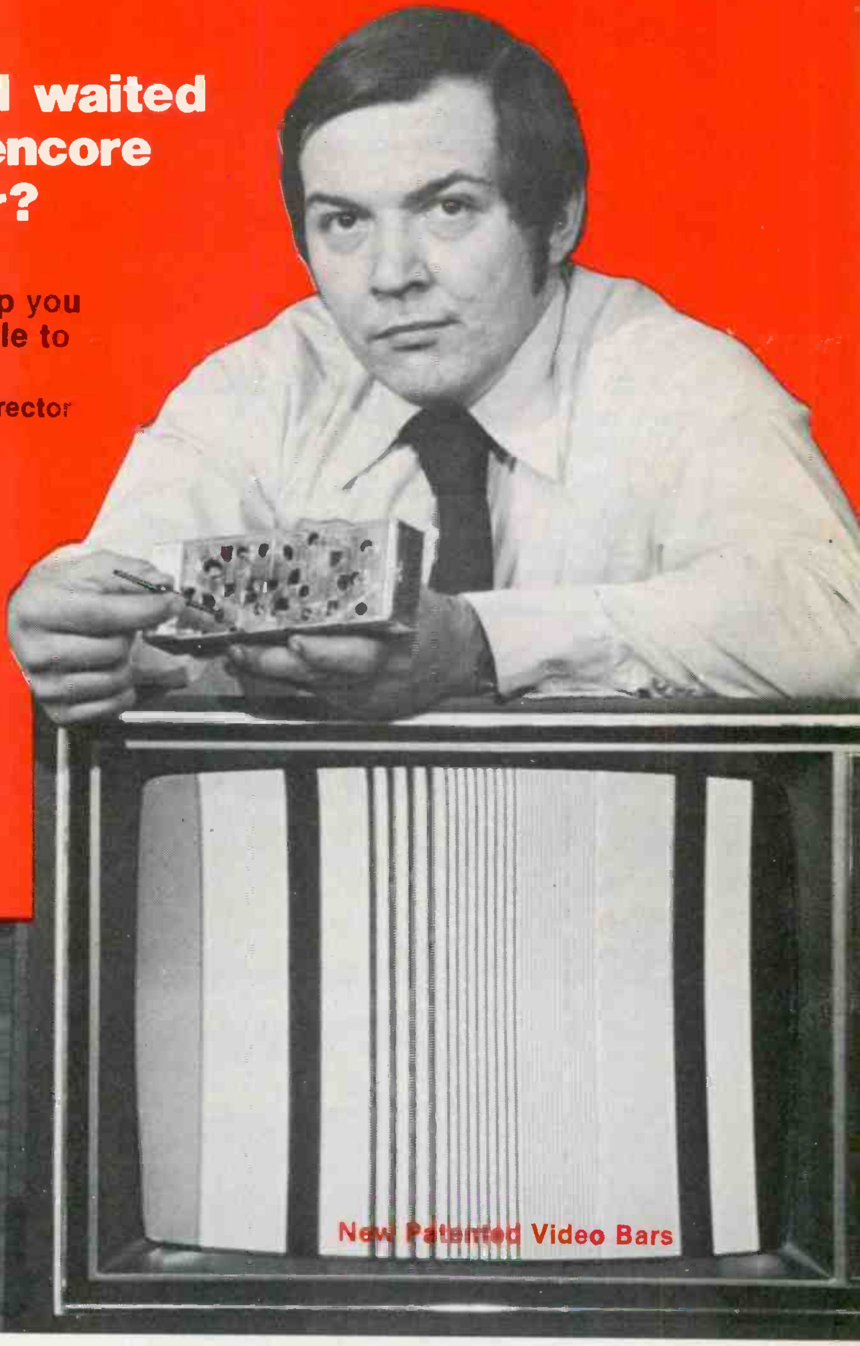

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model 440. Must be in good working condition; quote price. *Vernon Oester, Box 243, Garrett, PA 15542.*

Needed: B&K-Precision 1077B analyst and 467 CRT restorer/analyzer. *W. Kohler, 1441 Carol Lane, Deerfield, IL 60015.*

For Sale: Most Photofact folders before number 800. *Mrs. B. Lawrence, RD-1, Delta, PA 17314.*

For Sale: Sencore TR151 transistor checker, with papers, excellent condition, best offer. *B. Longwood, 56 N. Broadway, Yonkers, NY 10701.*

For Sale: Model 23A Hickok Cardamatic tube tester; B&K-Precision 700 tube tester; Millen grid-dip meter with 1 coil; RCA WV-98B VTVM; General Radio wave meter; B.R. noise detector; 50-MHz frequency counter; and miscellaneous tubes. Trade for B&K-Precision model 415 sweep/marker. *Allan V. Eisenhaur, 9 Rachel Carson Lane, Centerville, ME 02632.*

Needed: Schematic for a B&K-Precision 360 VOM. *K.E. Lee, Route 1, Box 44, Big Rock, VA 24603.*

For Sale or Trade: Rider's radio & TV manuals. Also, 01A, 5Z3, 6J6, 011A, 112A, UX200, 199, U864, 120, 2A3, 25B8, VR150, 19T8, 71A, 117L3, 117M7 and 83 tubes for old radios. *G.C. Goodwin, c/o Odd Fellows Nursing Home, Mattoon, IL 60960.*

For Sale: Photofacts 173 to 419, old shop manuals, radios, record players and early-model TVs, *PF Reporter* and **Electronic Servicing** from 1967 to 1978, *Radio-Electronics* from 1971 to July 1978, many old books, used yokes, hundreds of good used tubes and old test equipment. Make an offer. *Ray Otto, 205 Lake, Menasha, WI 54952.*

For Sale: Two file cabinets full of older Photofacts, $350. *F. Swartz, 2050 Espanola, San Pablo, CA 94806.*

For Sale: Some copies of *Radio News* dated 1939, 1940 and 1941. *Harold Homes, 1687 Greenwood Road, Alger, MI 48610.*

For Sale: New Heath IG-57A, $135; IG-28, $75; IG-18, $75; and Sencore FC45, $300. All with manual and leads. *Bill Becktold, 7429 Frederick St., Omaha, NE 68124.*

For Sale: B&K-Precision 1801 frequency counter, B&K 1403A scope, B&K servicemaster and Hickok 256 40-channel CB RF generator. All CB equipment used just a few hours, in cartons with all probes and manuals. Cost was $950, sell for $700 or best offer. *Michael Harlinski, 180 Cherokee Drive, Springfield, MA 01109.*

Needed: Schematic for a Galaxy V transceiver. Will buy, or copy and return. *Steve Stein, 10 Rainbow Drive, Humbolt, IA 50548.*

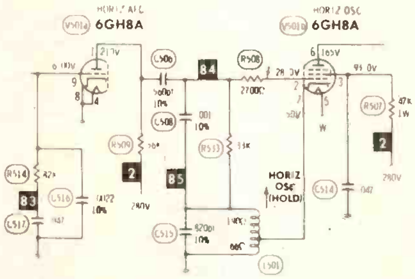
Needed: Operating manual for a model 610A Hickok signal generator. *J. Di Franco, 518 Glenmere, Neptune, NJ 07753.*

For Sale: Volumes 7, 10, 11, 12, 13, 14, 15, 16 and 17 of Rider's radio troubleshooters manuals with indexes. Also, numerous technical books, some now out of print. Write for a list. *Macario Garnica Balbuina, Libertad #2208 Ote., Col. Moderna, Monterrey, Nuevo Leon., Mexico.* □

troubleshooting tips

Loss of horizontal locking
Truetone WEG2887A17
(Photofact 1160-2)

Adjustment of the horizontal-hold coil could bring the horizontal to zero beat, but there was no locking. Usually, a new duo-diode phase detector will cure this symptom. However, neither a replacement duo-diode nor a new oscillator tube helped the operation.



After the TV was brought to the shop, I checked the oscillator and phase-detector voltages. No dc voltage was measured at the plate of V501A (the AFC tube) and R509 checked open. Additional resistance measurements proved R514 and R533 were about 35% low, while R507 measured only about 5K.

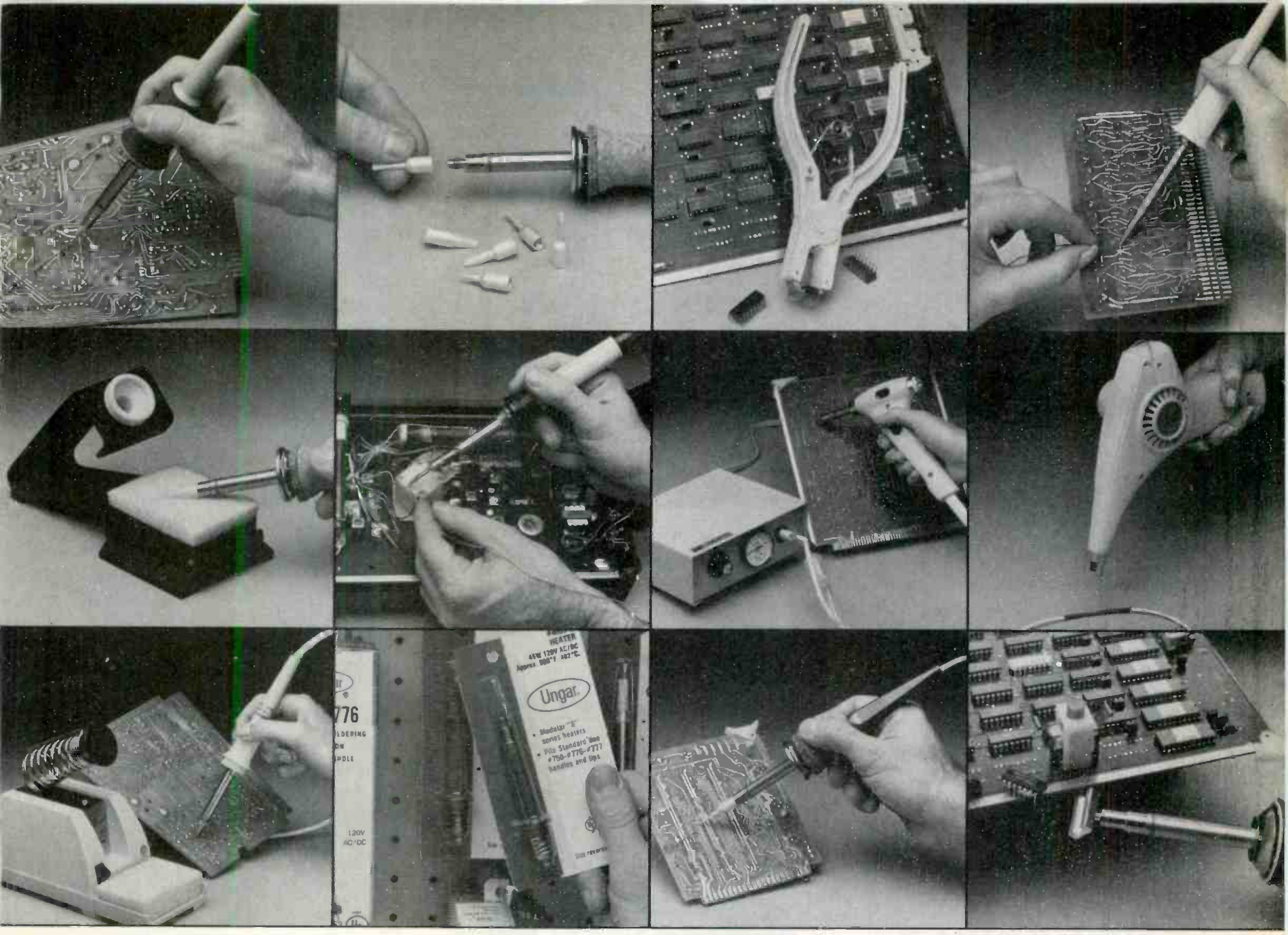
Replacement of these four resistors restored correct operation. Notice that Singer model HE-8060 S-1280 and Coronado model TV2-6634 S-1157 have the same circuit. Check these resistors first, if no locking or loose locking is the complaint with those models.

Charlie Jackson
Buckner, Illinois

Smoked, no volume
Acme 8-track tape player
(no Photofact)

This nearly-new tape player had smoked and gone dead, according to the customer. I connected my bench power supply and test speakers, then inserted a tape. There was no sound or smoke and the supply meter showed zero current drain. The fuse in the in-line holder was a 30-ampere automotive type and it was blown.

I removed the case and saw



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Circle (12) on Reply Card

Troubleshooting tips

charred wires that connected the power socket to the on/off switch and to the track-changing solenoid. Something had drawn a lot of current. Because I had no schematic and couldn't be sure of where the wiring connected on the board, I set the current-limiting feature of my power supply for 2 A with a dead short. When I touched the positive lead to the solenoid, the supply voltage dropped to nearly zero and the current was 2 A. This indicated a dead short. A B+ wire ran from the solenoid to the PC board. I disconnected the wire at the board and touched my positive supply lead to the wire. It was shorted to ground.

After checking the wiring, I found the motor was fed by power from the circuit board, so I disconnected the motor's B+ lead. This time when I applied power to the previous point, the current drain was less than 50 mA, and I could hear the normal background noise coming from the test speakers. *Touching the supply probe to the motor wire proved the motor was shorted.*

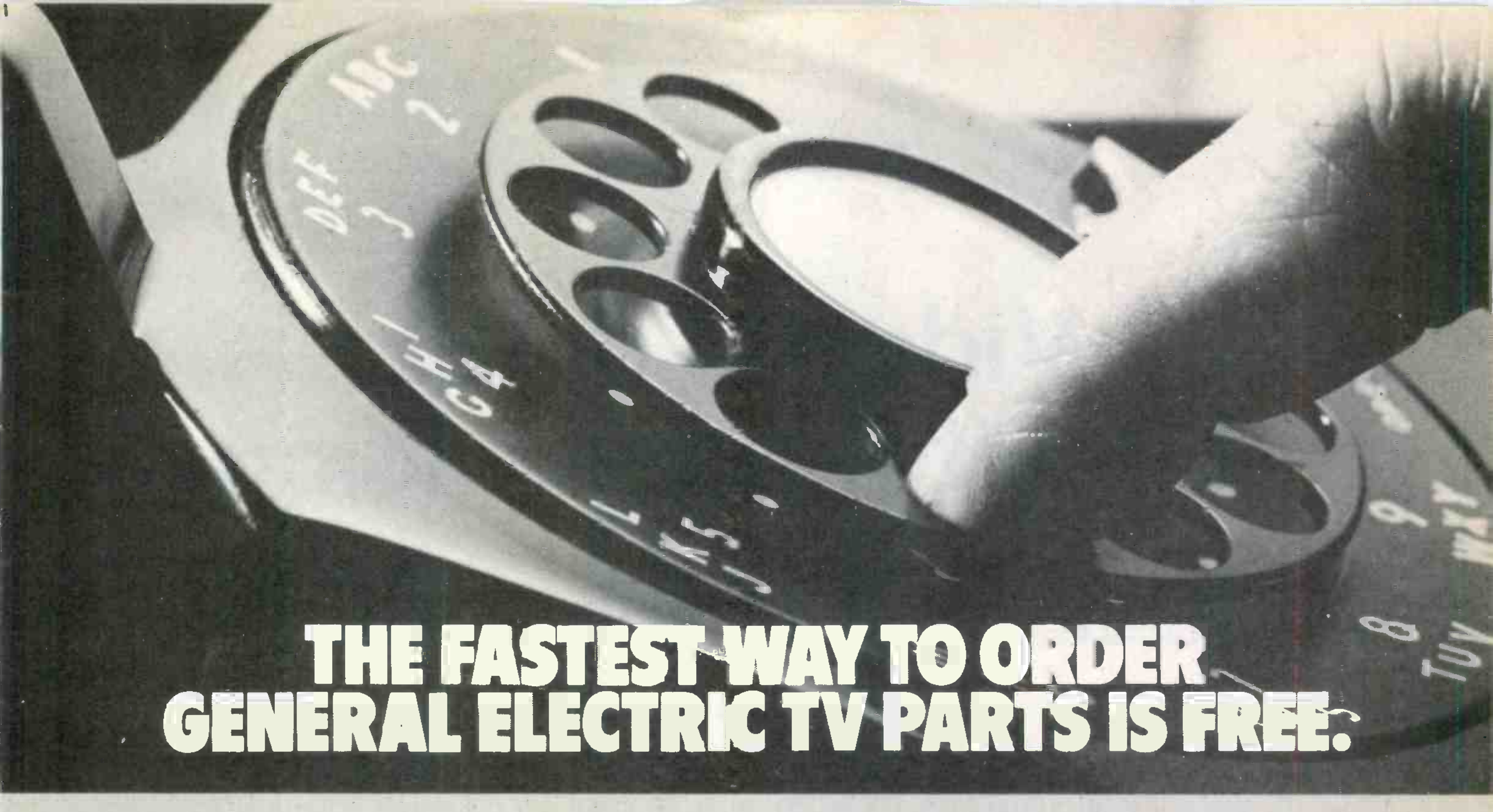
Thinking the motor had a jammed rotor, I began to remove it by taking out three Phillips-head screws. When I lifted out the motor, I noticed that the B+ lead had been pinched against the case, causing a dead short to ground. I applied power to the motor. It rotated, and the drain was less than 100 mA.

Apparently the wire had been pinched during installation at the factory. Installation of new wires to replace the burned ones plus taping and rerouting of the motor's B+ wire completed the repair.

Never before have I had a motor lead pinched, but I have found wires of dial lamps in CB radios pinched before. Of course, the fuse blew each time.

To minimize the cost of fuses blown during troubleshooting and to allow faster troubleshooting without danger of ruining more components, I usually set my bench power supply for a certain maximum current. It is quicker and more accurate than using an ohmmeter.

Mark Hughes
Kings Mountain, NC



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GENERAL ELECTRIC

Video and ABL circuits and servicing

Servicing GE 13" color TV, part 6

By Gill Grieshaber, CET

Video circuits

Some technicians believe video circuits are simple, and that they are included only to provide sufficient contrast. Perhaps this was true in tube-type black-and-white receivers, but certainly it's not the case with modern solid-state color receivers.

For example, the General Electric AA chassis has a total of seven transistorized stages between the video preamplifier and the picture tube. In addition to amplification of the video signal, these stages also remove the 3.58-MHz color signals, allow the adjustment of brightness and contrast, have vertical and horizontal blanking inserted, and are connected to the Automatic-Brightness Limiter (ABL) circuits.

Correct clamping to the proper black level is provided by a combination of direct coupling and dc restoration.

Defects in these video stages are more likely to affect the brightness than the contrast. Also, troubleshooting is more difficult with direct-coupled stages. Therefore, modern video stages are *very* important, and we urge you to study them before you are forced to repair them.

Figure 1 shows the general area of the video and ABL circuits in the GE AA chassis, while Figure 2 and Figure 3 have arrows to show

Figure 1 A white arrow marks the approximate location of the video and automatic-brightness-limiter circuits in the General Electric AA chassis.

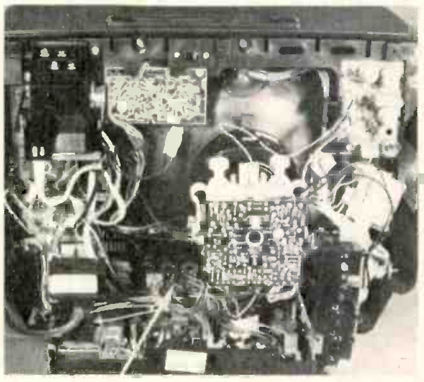
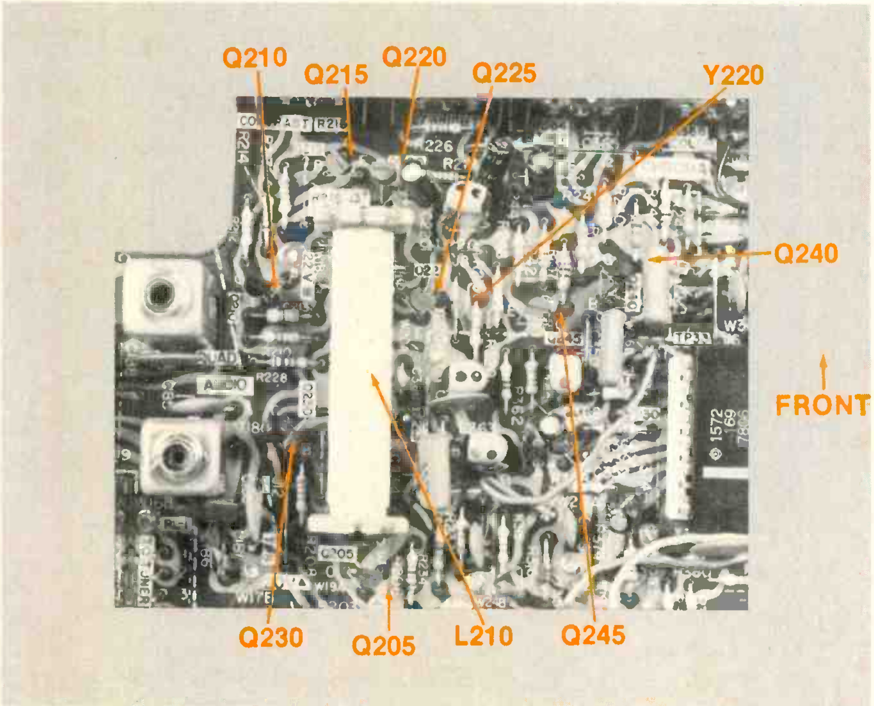


Figure 2 Major video and ABL components are identified by arrows.



transistor and diode locations on the main module and on the module that includes the picture-tube socket.

Analysis of video circuits

A schematic of the first five video stages is given in Figure 4, and Figure 5 has the corresponding waveforms.

When the receiver is tuned to any TV station, both the video amplitude and the dc voltages vary constantly according to the picture content. These are large changes, and they prevent correct readings of both peak-to-peak and dc voltages. Therefore, to eliminate these variables during waveform photos and voltage measurements, a gray-quad pattern was used from an ATC-10 American Technology generator.

Q205 operation

Except for two items, the Q205 second-video stage is ordinary. First, the emitter resistor is not bypassed, and the collector load resistances together are low, about 1300Ω. Because of these conditions, the base-to-collector gain is less than 2 (see Figure 4).

Also, between the emitter resistor and ground is a tuned circuit (L214 and C214) that resonates at about 3.58 MHz. Any emitter signal is subtracted from the base signal. Therefore, any signal at L214/C214 reduces the gain of the transistor. In other words, the L214/C214 tuned circuit is a trap that reduces the Q205 gain around the 3.58-MHz frequency. This action is shown by the color-bar waveforms of Figure 6. L214 is not adjustable.

Delay line

L210 provides the usual time delay of the luminance signal so it is in register with the chroma signal at the picture tube.

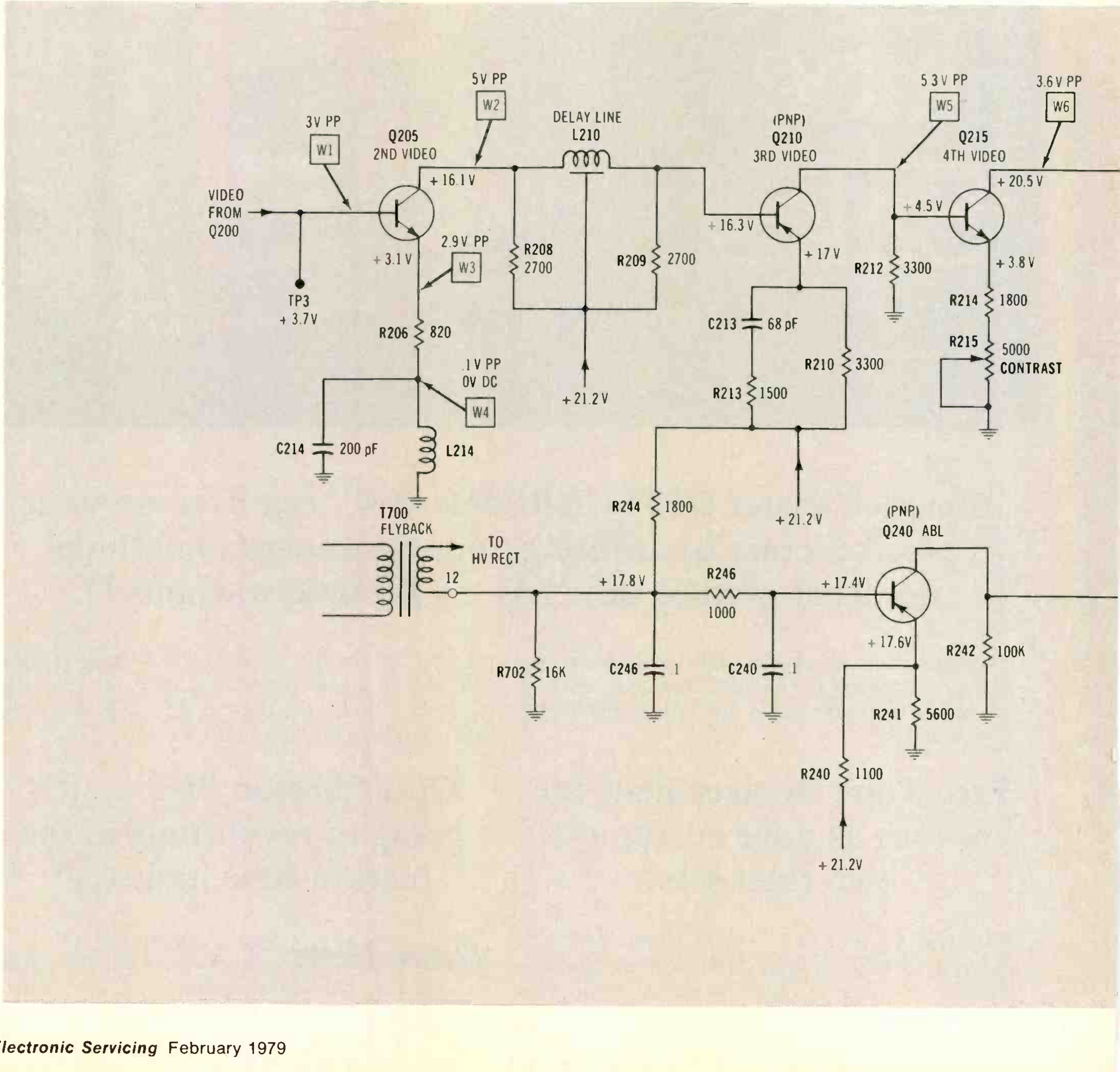
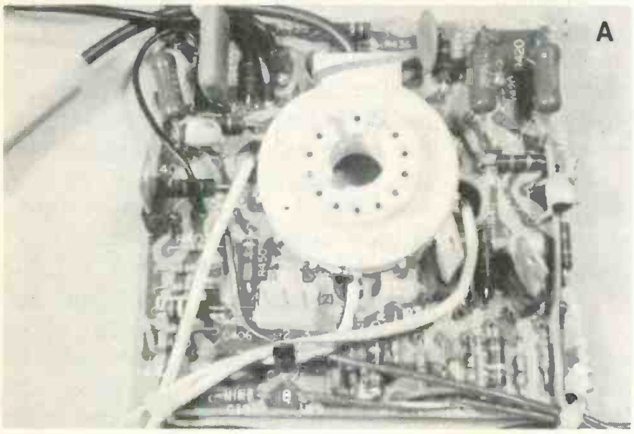
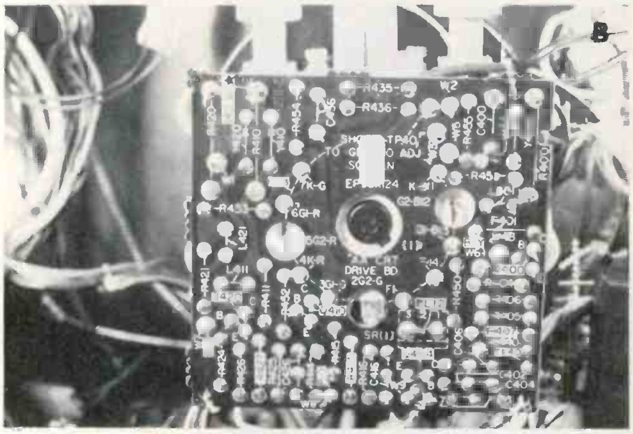
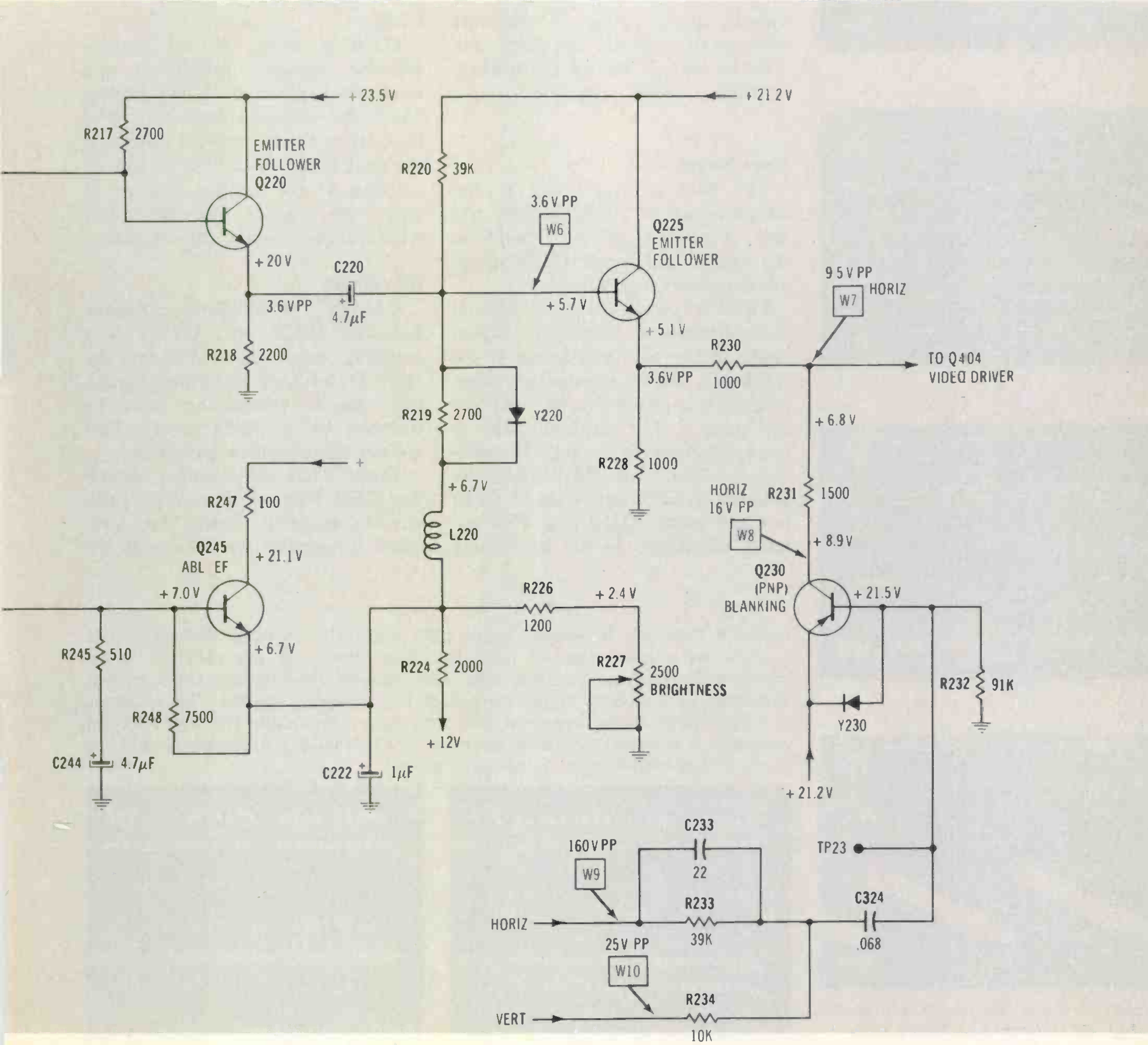


Figure 3 Three color matrixing power transistors and one video driver transistor with associated components are mounted on the picture tube socket module. All connections are made through polarized plugs and sockets so the assembly can be removed or replaced easily. Picture A is the front side which has the components, and picture B shows the wiring side as viewed from the rear of the TV.







General Electric

For troubleshooting, remember that an open delay line eliminates all video in downstream stages and also produces a black raster.

An open of the common L210 connection (that is tied to B+) will cause severe ringing which resembles ghosts. Also, an open R208 or R209 will cause the same ringing, because of improper termination at the input or output of the line.

Test for a defective delay line by removing the component, turning down the color control, and connecting a short piece of wire between the collector of Q205 and the base of Q210. The picture should have normal sharpness but without any ringing. If this test removes the ringing, the delay line must be bad, or one of the loading resistors is out of tolerance.

Three stages

The next natural break in the circuit occurs at C220, the first and only coupling capacitor. Therefore, the Q210, Q215 and Q220 stages are explained together.

Q210 is connected as a normal common-emitter amplifier (signal enters at the base and leaves at the collector). This provides a phase reversal (see waveforms W2 and W5 in Figure 5). The emitter resistor is bypassed partially to high frequencies by C213, while R213 limits the amount of HF boost. Gain of Q210 is about unity. Q210 is a PNP-polarity transistor, so the B+ enters at the emitter and exits at the collector where it becomes the base bias and signal for Q215.

Q215 functions as a common-emitter amplifier. However, its gain usually is less than unity because of the large unbypassed resistance in the emitter circuit. A part of this resistance is the contrast control. Higher resistances decrease the gain, and lower resistance adjustments increase the Q215 gain by the principle of degeneration (current feedback). Of course, adjustments of the R215 contrast control change the collector voltage (and the base voltage of Q220, the next stage), but this does not change the actual picture brightness because of C220.

Q220 is wired as an emitter follower (signal is applied to the base and is taken from the emitter while the collecter has only B+) that drives the dc-restorer circuit in the next stage. Both the dc and ac voltages at the emitter change in step with picture variations and with contrast-control adjustments.

DC restorer

C220 is the coupling capacitor between Q220 and Q225. Any coupling capacitor eliminates the vital dc level of the video signal, but the dc relationship can be restored by a diode circuit that clamps the waveform properly.

Diode Y220 and coupling capacitor C220 form a shunt-type peak reading rectifier circuit that produces a negative dc voltage at the

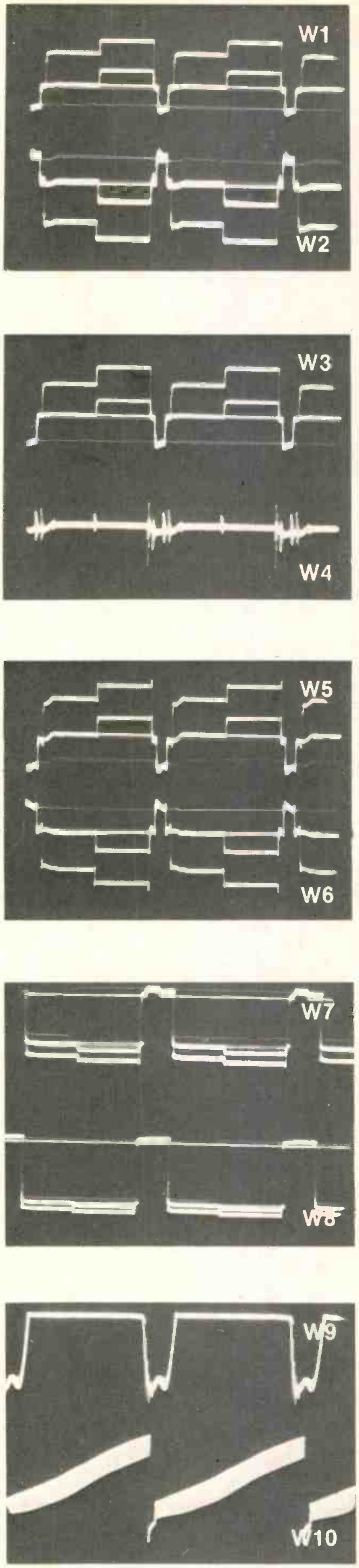
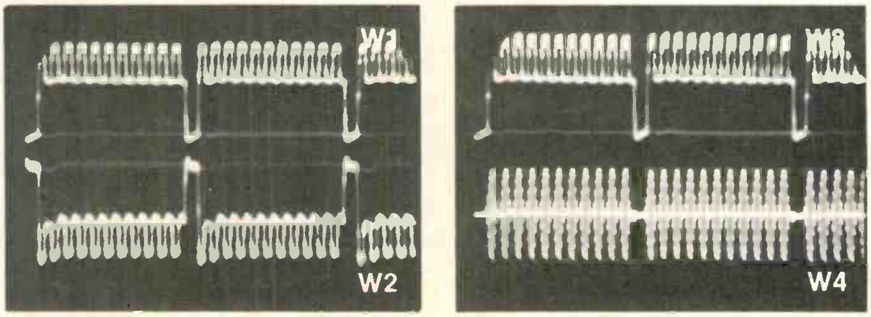


Figure 5 These waveforms are keyed to the "W" numbers in Figure 4.

Figure 6 Color-bar waveforms prove L214 and C214 (in Q205 emitter circuit) function as a tuned trap to minimize color signals at the collector. Base waveform (W1) has sync pulses, black bars between the color bars and a normal amplitude of 3.58-MHz signal on top of the color-bar spaces. The collector waveform (W2) shows inversion and less color amplitude. The W3 (emitter) waveform is identical to that of the base. W4 (L214/C214 trap) shows only the 11 color bars without sync or blanking pulses.



Y220 anode when the video signal is rectified. The junction of C220 and Y220 is connected to the base of Q225. Therefore, when the video signal there has increased amplitude, the base becomes less positive (which makes the picture brighter, as we shall see). Conversely, a reduced video level allows the base to become more positive, and the overall picture is less bright. (This prevents a gray background during low-contrast dramatic scenes when the background *should* be jet black.)

Notice that the *true* brightness of the picture is not changed, because *the diode clamps the shoulder of each blanking pulse to the dc voltage* that's present at the cathode of Y220. This operation should be clarified by the waveforms of Figure 7.

Defective Y220

When the video amplitude is normal and Y220 is not defective, the anode of Y220 measures about 0.8 V less positive than its cathode (from the clamping rectification). If the same dc voltage is measured at *both* ends of Y220, the diode is open or shorted. Therefore, *either an open or a short reduces the brightness* by eliminating that 0.8 V of opposing voltage. Other symptoms, however, are different.

An open Y220 probably smears the picture sharpness slightly, but the difference is not noticeable. The loss of brightness is the main symptom.

A severe degradation of picture quality occurs when diode Y220 is shorted, in addition to the large reduction of brightness. In this case, L220 is the only load for the signal coming through C220, so overpeaking and waveform distortion occurs. Figure 8 shows a waveform and a TV picture for normal operation plus (for comparison) another waveform and TV picture when Y220 was shorted. The TV picture when the diode was shorted is difficult to describe. One of the effects resembles white compression. But another shows smears along the trailing edges.

Q225 emitter follower

Q225 is connected as an emitter follower whose high-impedance input does not interfere with the C220/Y220 dc restorer operation, and whose low-impedance output from the emitter is adequate for supplying the video-driver stage.

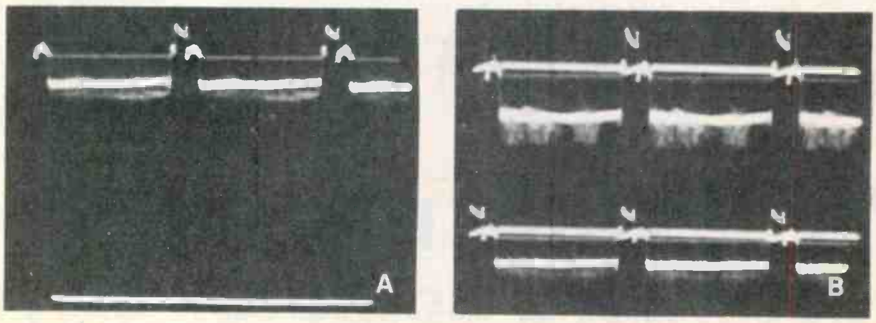
Input to Q225 consists of the video that comes through C220 and the sum of the Y220 rectified voltage plus the dc voltages from the brightness control and the ABL circuit.

Output of Q225 is video mixed with a dc voltage that varies with brightness-control adjustments (which don't change the video amplitude).

At the output of decoupling resistor R230, the blanking signals from Q230 are added before the combined video and blanking is sent to Q404.

Figure 8 A serious picture degradation occurs when diode Y220 shorts. In A, the top trace is the normal generator video at the Y220 anode. Lower trace shows the distortion caused by a shorted Y220. TV picture B is a normal one, while picture C shows the same TV picture after Y220 was shorted. There is a compression of most shades of brightness plus a trailing smear and the picture was much darker.

Figure 7 Video coming through C220 is clamped by diode Y220 to a selected dc level. Waveform A (at the Y220 anode) shows the relative positions of video and the zero-voltage line. Clamping by diode Y220 occurs at the blanking shoulders. The line at the blanking shoulders in the top trace of B marks the dc voltage supplied to the Y220 cathode. After the video level was reduced (bottom waveform of B), the blanking shoulders still were clamped to the dc voltage. Therefore, the blanking shoulders remained at the selected dc voltage although the video amplitude changed. This holds the cut-off point of the picture tube at the same fixed dc voltage (regardless of video changes) in exactly the same way as if dc coupling had been used through all of the video stages.



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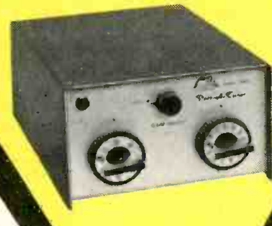

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Blanking

Horizontal-sweep pulses and vertical-sweep waveforms are both fed to the base of Q230 through C324. In addition to operating as a coupling capacitor, C324 has a value that removes the tilt from the vertical waveform. (If this diagonal line between vertical pulses is not leveled, the top of the picture would be brighter than the bottom.) R232 applies a small forward bias to the PNP transistor, while the negative-going peaks of both horizontal and vertical signals produce B/E current (and thus amplification). The positive peaks are conducted through Y230 to prevent peak-reading base rectification, which could produce a positive base voltage that would allow only the tips of the input waveform to be amplified. (Therefore, an open Y230 would cause insufficient blanking, with visible retrace lines. And a shorted Y230 would eliminate all blanking.)

The negative-going sweep signals are inverted in Q230, and the positive-going collector signals are sent through R231 to join the video at the output of R230. Then both blanking and video go to the base of Q404, which is on the module that includes the picture-tube socket.

Notice that a negative-going signal (such as a reduced dc voltage) at the junction of R230 and R231 *increases* the picture brightness. **And an increased dc positive voltage or a positive-going video signal** (see W7 in Figure 5) **at R230/R231 decreases the picture brightness.** Therefore, *the positive-going tips of the blanking signals at R230/R231 will reduce the brightness* (blank the picture tube).

Keep these statements in mind when you measure dc voltages during troubleshooting.

Next, the ABL circuit will be analyzed before the remainder of the video circuit is discussed.

TESTPOINT	LOW BRIGHT	NORMAL BRIGHT	HIGH BRIGHT
Q240 base	19.4	18.2	17.8
Q240 emitter	18.3	17.9	17.7
Q240 coll	7.5	6.3	7.2
Q245 emitter	8.1	6.8	6.5
Q225 base	7.1	5.9	5.7
Q404 base	6.8	6.9	6.7
Q420 coll	138	110	102
Q400 coll	138	113	108
Q410 coll	137	110	104

Table 1 These key dc voltages were measured at different brightness levels.

Automatic-brightness limiter

High-voltage current from the picture-tube guns travels through the video-output transistors to ground. From ground, this current flows through resistor R702 (see Figure 4) to the low end of the HV-rectifier winding of the flyback. Therefore, the flyback end of R702 will have a *negative* voltage that varies directly with the picture-tube brightness.

Well, it would be negative except for a positive voltage brought from the +21.2-V source through R244. After this bucking positive voltage is added, *the dc voltage at R702 becomes less positive with increased brightness.* Variations of the positive voltage are used to operate the automatic-brightness-level (ABL) circuit.

C246, R246 and C240 filter the horizontal ripple from the R702 dc voltage before it is applied to the base of Q240, a PNP-polarity transistor. Voltage divider R240/R241 applies a positive voltage to the Q240 emitter. This voltage is approximately equal to the base voltage. Therefore, Q240 does not have enough forward bias to conduct when the picture-tube current is not excessive. In other words, over the normal brightness range, Q240 is cut off and does nothing. Q240 drives Q245, so Q245 also does not conduct, and the dc voltage applied to Y220 and the Q225 base voltage is not changed. *The ABL circuit does not operate at any normal brightness.*

If the brightness becomes excessive for any reason, the Q240 base voltage becomes less positive, and Q240 conducts, thus increasing the positive voltage at the Q245 base. In turn, Q245 conducts and brings some of the positive collector voltage to the emitter, where it increases the dc positive voltage at the base of Q225. As stated before, a higher dc voltage here reduces the brightness.

Therefore, the ABL circuit works to cancel most excessive brightness. The figures in Table 1 should make the operation more clear.

One factor is not accounted for in the dc voltages. The filter at the Q240 base removes the horizontal ripple, but it does not eliminate the low-frequency 60-Hz ripple that is produced by the alternate high and low picture-tube currents that occur during vertical trace and retrace. These waveforms are forward bias for Q240, and they cause conduction that does not seem to be justified according to the dc voltages alone.

Video and chroma matrixing

At the neck of the picture tube is a combination CRT socket and module that contains one video-driver transistor and three color power amplifier transistors that

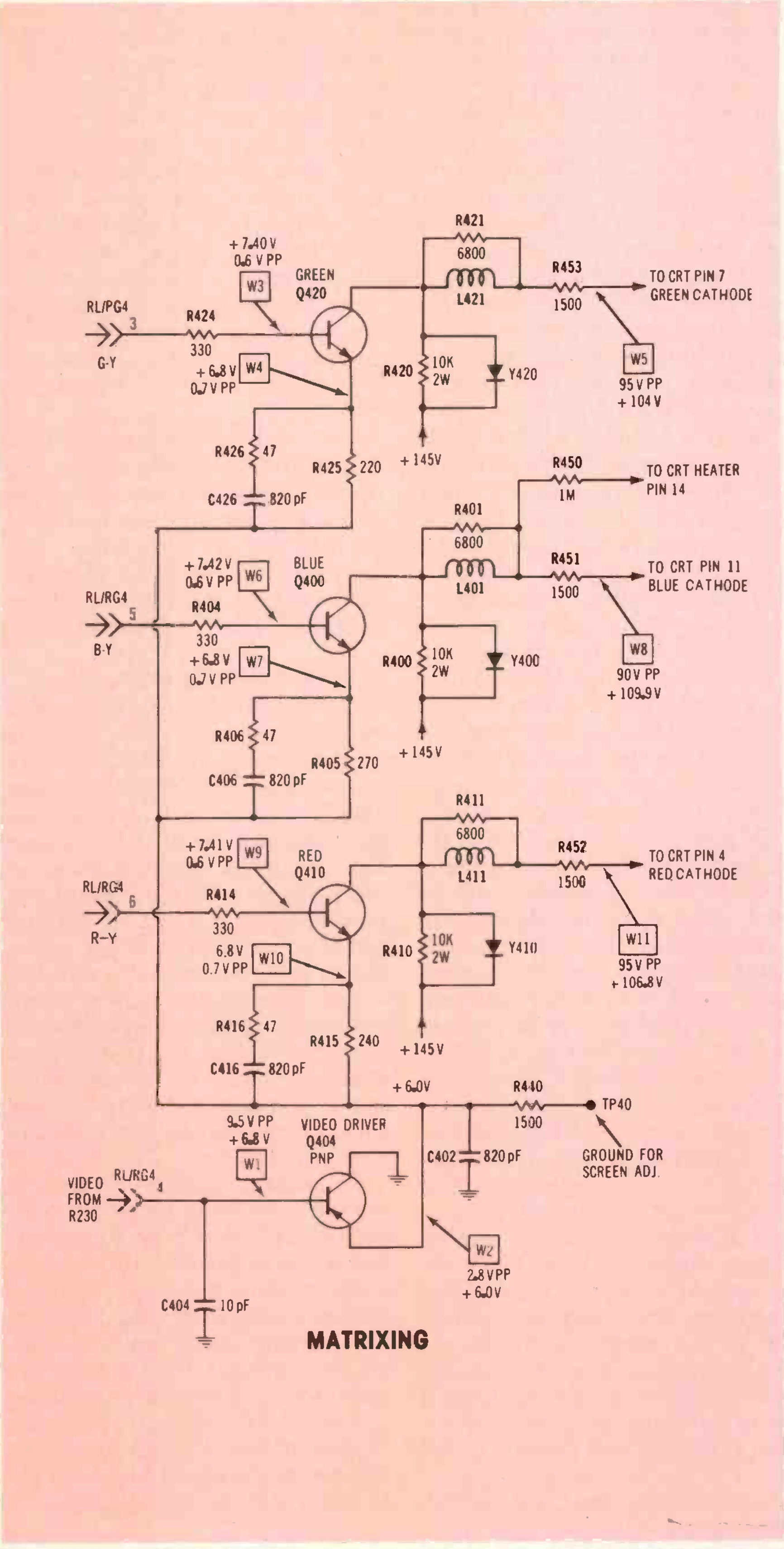


Figure 9 Luminance video and demodulated chroma signals are matrixed inside Q420, Q400 and Q410. Chroma signals are applied to the bases, and luminance signals are applied to the emitters. These four transistors are mounted on the CRT-socket module of Figure 3. Voltages and waveforms were measured during reception of a generator B&W signal, therefore, no chroma signals were there.

drive the three picture-tube cathodes. Figure 9 gives the entire schematic, and Figure 10 shows the luminance waveforms when video is supplied by a generator.

Q404 operates as another emitter follower. Video from the emitter goes through R425, R405 and R415 to the emitters of the three color-output transistors. Neither common-base amplifiers (where the signal enters at the emitter and exits at the collector) nor emitter followers invert the polarity. Therefore, the video (plus blanking) is positive-going through these stages and at the CRT cathodes. Of course, a positive signal to a CRT cathode decreases the brightness of that gun, so the polarity at the CRT is correct.

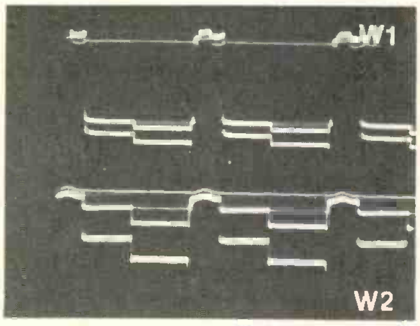
Matrixing of the G-Y, R-Y and B-Y demodulated chroma signals with the luminance occurs inside Q420, Q400 and Q410. These chroma signals enter at each base (so the collector polarity is inverted), the luminance signal enters at each emitter (this signal is not inverted), and the combined color and luminance signals come out at the collectors.

Chroma waveforms for these same stages are very different. They will be shown and explained next month.

One unusual characteristic of this type of matrixing is that the chroma signal appears at the base, the emitter, and the collector of these color transistors. Signal is found at the emitters because they are not bypassed. In the same way, the luminance signal can be scoped at base, emitter and collector of each color amplifier. When the luminance is fed to the emitter, some of the waveform appears at the base because it isn't bypassed and there is *conduction* between emitter and base at all times. These waveforms can be very confusing unless you know the facts. A luminance signal fed to a tube cathode does *not* appear at the unbypassed grid. This is one of the many differences between transistor and tube circuits.

Troubleshooting

Video-circuit troubles might include insufficient contrast, smeared pictures, excessive brightness, dark



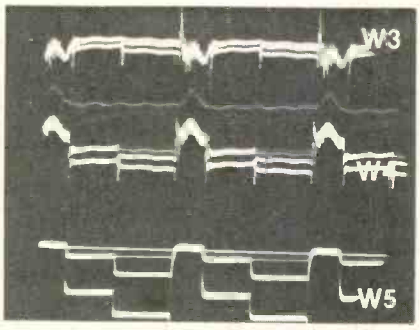
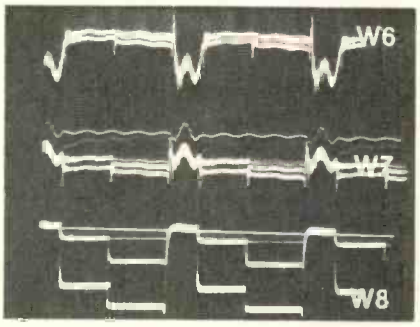
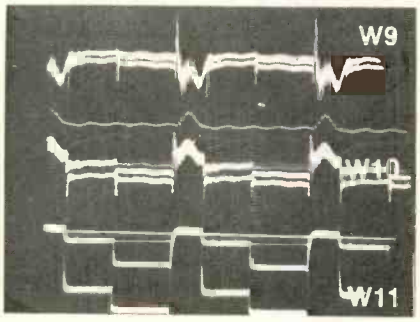


Figure 10 These waveforms were made when a video generator supplied the signal. The W numbers correspond to those of the Figure 9 schematic.





or blanked-out pictures, or wrong raster colors (bad gray scale). Probably the most common symptom will be wrong brightness.

In general, video troubleshooting should be done in sections. Q205, Q210, Q215 and Q220 comprise the first section. Preliminary analysis should be done as though these four stages were just one. Check input and output signals first. *If your scope shows the proper waveform at the Q220 emitter* (and if the dc voltage there is within tolerance), *probably this section of four stages is working correctly.*

Here's a valuable tip: **No defect in this section of the video circuit can eliminate the raster.** That's assuming the defect doesn't affect a power supply which is common to other circuits. Defects here can eliminate the video, weaken it or degrade it. And a loss of video will darken the raster. For example, if a blob of solder shorts the Q215 base to ground, the downstream dc voltages will change drastically, but C220 isolates the disturbance. You can turn up the brightness control slightly and obtain a blank raster.

By contrast, serious defects in the last section of the video circuit from Q225 to the picture-tube cathodes often cause excessive brightness or a dark picture. The driver transistor (Q404) is the only one that theoretically could reduce the contrast. However, Q404 is an emitter follower, and they seldom have defects that reduce the output signal. The next stage has three power transistors that drive the CRT cathodes, and a defect in just one would change the B&W screen color more than it would the contrast.

If a defect reduces the +145-V supply (scan rectified from the horizontal sweep) for the color amplifiers, the raster and picture will be too bright. Sometimes the brightness is so great it kills the high voltage. A C/E short in Q404 driver transistor also causes tremendous brightness and possible loss of HV.

On the other hand, an open in Q404 would bias all three color amplifiers (Q420, Q400 and Q410) to cut off. They in turn would apply an increased positive voltage to the CRT cathodes, and no raster could be seen.

TP40

At the lower corner of the module containing the CRT socket is test point TP40, which is used during the gray-scale adjustments. There is no service/normal switch. Therefore, the brightness and contrast controls are turned down completely, TP40 is grounded and the three CRT screen controls are adjusted for a dim gray raster. Then the contrast and brightness are turned up to normal and a touchup made on the screen controls (if the B&W picture has a tint).

This test point can be used during troubleshooting. If you can follow the sequence for setting the screen controls and are successful in obtaining a dim raster, this proves that any problem of a dim or blacked-out picture is caused by the Q404, Q225, or Q230 stages.

Servicing direct-coupled stages

Analyzing direct-coupled stages is quite difficult, and most methods have some snares and dangers because the signal and dc voltages of each stage depend on conditions of upstream stages. Even simple tests (such as shorting base to emitter to turn off a transistor) can produce severe overloads on transistors that are several stages downstream from the one being tested.

You can substitute for wrong voltages by applying power from an adjustable-voltage supply through a limiting resistor to a bad stage. But this must be done with care while monitoring the effect on the stages that follow.

DC voltage analysis perhaps is the safest and most simple method. *At least this should be done first.* Most transistor defects are shorts or opens, so write down the measured voltages and then use logic to decide which defects might account for the readings. Then remove the transistor or other component for out-of-circuit testing. The AA chassis GE has all video transistors soldered to the circuit board, so try to be accurate in your diagnosis.

Next month

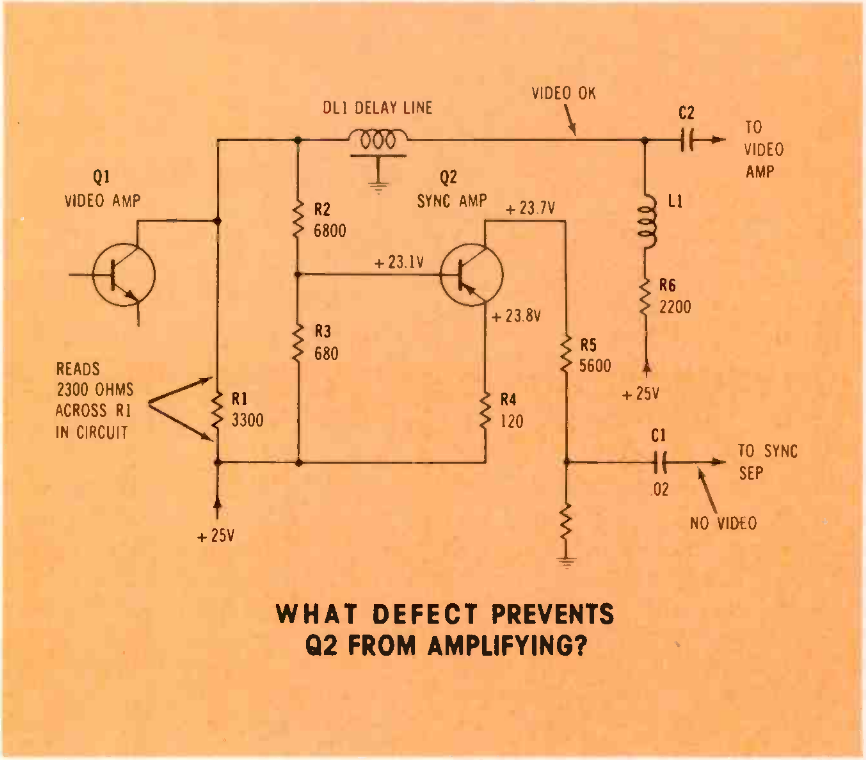
Chroma circuits of the AA-chassis General Electric, including the Color Monitor, will be discussed next month. □

Quick TV Tips

Case of the disappearing sync

By Wayne Lemons, CET

This is a case history that baffled two good technicians for about an hour. All important clues are given here. Can you solve it faster than they did?



Symptoms

Both horizontal and vertical sync disappeared intermittently in this Admiral TV receiver. Scope waveforms isolated the intermittent signal to the output of sync amplifier Q2 (see the partial schematic). No loss of sync occurred in the video channel, and the picture suffered no apparent change.

Although the problem was very erratic, the TV sometimes would remain without sync for several minutes. Therefore, we were able to measure all dc voltages and look at the scope waveforms.

Actually, the waveforms of Q2 were not helpful. Q2 was saturated (collector and emitter voltages checked about the same) and didn't amplify. But, the big question was this: **Why was Q2 saturated?**

No defective parts?

Each resistor shown in the schematic was unsoldered at one end and individually tested for resistance. Unfortunately, all were within a 5% tolerance. Q1 was not defective, it had the correct bias and was amplifying normally. Q2 checked okay, and a new transistor operated in the same intermittent way.

Bias and video for the Q2 base were supplied by a voltage divider that paralleled the Q1 collector load resistor. Therefore, we reasoned that the defect must be in that area. An in-circuit resistance test across resistor R1 gave a reading of about 2300 Ω. This seemed about right since the 3300-Ω R1 was paralleled by about 7500Ω from the series-connected R2 and R3.

All information necessary for us (and you) to identify the bad component has been given. Think about the problem before you read the answer.

The solution

An in-circuit reading of 2300 Ω across R1 should have been enough for us (and you) to find the one intermittent component. Notice that not only is R1 paralleled by the sum of R2 and R3, but also R1 is paralleled by R6 (through the delay line and L1). The reading should have been about 1100 Ω.

The delay line must have had continuity constantly, since a picture was on the screen. Also, all resistors had been checked out-of-circuit. Therefore, *either L1 was intermittently open, or R6 had a bad soldering joint* that was opening the L1 circuit. **L1 was opening erratically!**

When L1 opened, the Q1 collector load resistance went up from about 1100Ω to about 2300Ω, thus increasing the voltage drop across R1. In turn, Q2 was biased into saturation and loss of gain by the larger R1 voltage.

Comments

Looking back after the problem was corrected, we remembered that the picture showed some "ghosts" which are typical for an incorrectly-terminated delay line. But of course, we were looking for a sync trouble, and intended to check the ghosts later.

Could you have found the defect in less time than we did? □

Typical Radio Repairs

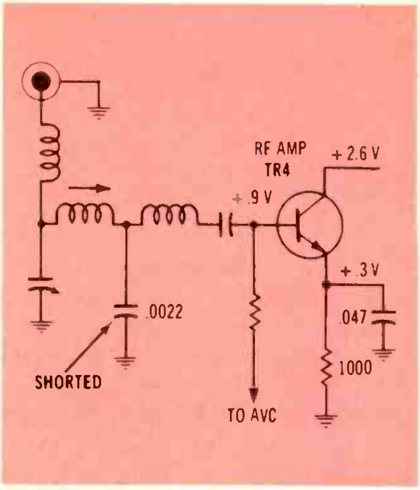


Figure 1 Audiovox model AMF-15 had no AM-band operation.

By Homer Davidson

Although no single article can describe all possible defects in car radios and tape players, these case histories should help you solve many similar problems in other models. Also, suggestions are given for troubleshooting tests and general methods.

Solid-state auto radios are not very difficult to repair. Some circuits are in cramped corners, and there are some accessibility problems. Also, many machines will require removal of dust and dirt before you can see the components. Other problems should be no more severe than those in home radios.

The following case histories should help you anticipate some of the typical troubles.

Dead AM reception

No sound could be heard on either the FM or AM bands. Voltage measurements around the power section of the circuit board revealed that no voltage was reaching any circuits. While tracing the supply voltage from the on/off switch to the filter capacitors, I found an open in the printed wiring.

The open wiring was bridged by a piece of hookup wire soldered over the printed wire. The FM radio operated on all the usual stations, but the AM function was completely dead.

Now, the IF transistors are common to both AM and FM, so it was obvious that the problem must be around the AM input stages, such as the RF or oscillator.

An in-circuit test of RF transistor TR4 showed a beta reading without any opens. Voltage readings, too, were quite normal. But when any of the transistor leads was touched, strong local radio stations could be heard. Obviously, the defect was in the RF stage.

A generator signal was injected at the base when the radio was tuned to 1400 kHz and the gain seemed to be normal. The same signal applied to the input jack could not be heard. The signal was injected in turn to each end of the .01 coupling capacitor, and it gave normal volume.

The defect had to be between the input jack and the .01 coupling capacitor (Figure 1). Ohmmeter tests of the few components found that the .0022 bypass capacitor was shorted. A new capacitor restored correct AM sensitivity.

Motorboating and oscillating

A mixture of oscillations and motorboating was the complaint against the model 706A Dodge radio.

Most complaints of this nature are caused by open filters or bypass capacitors. Occasionally, bad transistors or improper alignment will do the same.

All filter and bypass capacitors were paralleled in turn by another capacitor of a larger value, but the problems continued.

Generally, transistor testing and voltage measurements are not effective for locating components that produce oscillations. The squealing could be heard as the radio was tuned across each station, so we suspected a bad converter bypass capacitor.

However, in making the tests, the meter probe was touched to the emitter of the RF transistor (Figure 2) and the radio played weakly but without oscillations.

The .01 emitter bypass capacitor was replaced, and the performance was very good.

Intermittently weak reception

When the American Motors

model 2HT1413, radio became intermittent, only two local stations could be heard at all. However, the radio would rapidly alternate between normal sensitivity and this weak condition.

Because there was no overload of local stations during the weak periods, we assumed the problem was in the RF stage. Very low dc voltage was measured at the base of Q1 (Figure 3) and none at the emitter. These readings indicated that Q1 was not conducting.

However, an in-circuit test of Q1 showed a good beta reading and no opens. Sometimes an intermittent transistor will "pop" on when a transistor tester is connected, so we always make additional tests. The suspected transistor was replaced with a universal SK3018. Unfortunately, within minutes, the intermittent began again.

After several unsuccessful tests, we measured the resistance of all transistor leads to ground. Such tests generally are not accurate with the transistor still connected. But this test showed about 200 Ω from emitter to ground and only about 3 Ω from base to ground.

We replaced the 47-μF base-return bypass capacitor and the intermittent was cured.

One local station

Only the local 540-kHz radio station could be heard at the low end of the dial, and nothing (not even noise or static) was received above about 700 kHz.

When only the low end stations can be received, we usually find the converter transistor is not oscillating over the entire band. In this case, a replacement converter transistor didn't solve the problem.

Analysis of the dc voltages showed a supply voltage of slightly above 6 V (it should have been 12 V or higher). And the small bench-mounted power supply was running hot and buzzing. We suspected the audio power-output transistor, which has its mounting screw located inside the dial assembly. After we unsoldered the transistor leads, the supply voltage rose to the normal 12 V.

Before the power transistor could be removed, it was necessary to remove four plastic inserts from the dial assembly. To remove each insert, take out the round center core and then pry out the plastic insert. Next, remove two metal screws that hold the metal dial assembly. The mounting screw for the transistor now is accessible.

After the output transistor was removed from the small circuit board (see photo in Figure 4), a leakage test verified that the transistor had nearly a dead short. A universal SK3041 was used to replace it.

Before you solder the new leads, make sure the flat side of the transistor is opposite the lead wires. Then, doublecheck the wiring. Yellow wire goes to the emitter, the blue wire to collector and the green wire to the base. After the transistor and small circuit board are fastened into position, a drop of silicone-rubber cement should be

Figure 2 Motorboating and oscillations ruined reception of the model 706A Dodge radio.

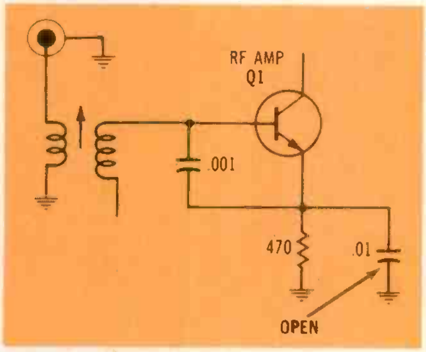


Figure 3 Intermittently, the model 2HT1413 American Motors radio would become very weak. Only two stations could be heard.

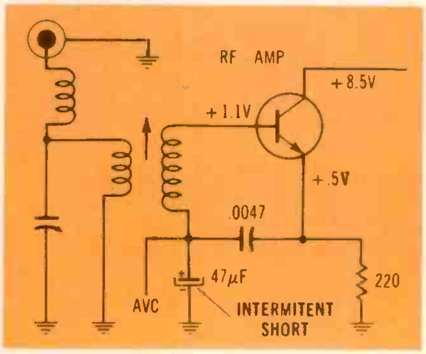
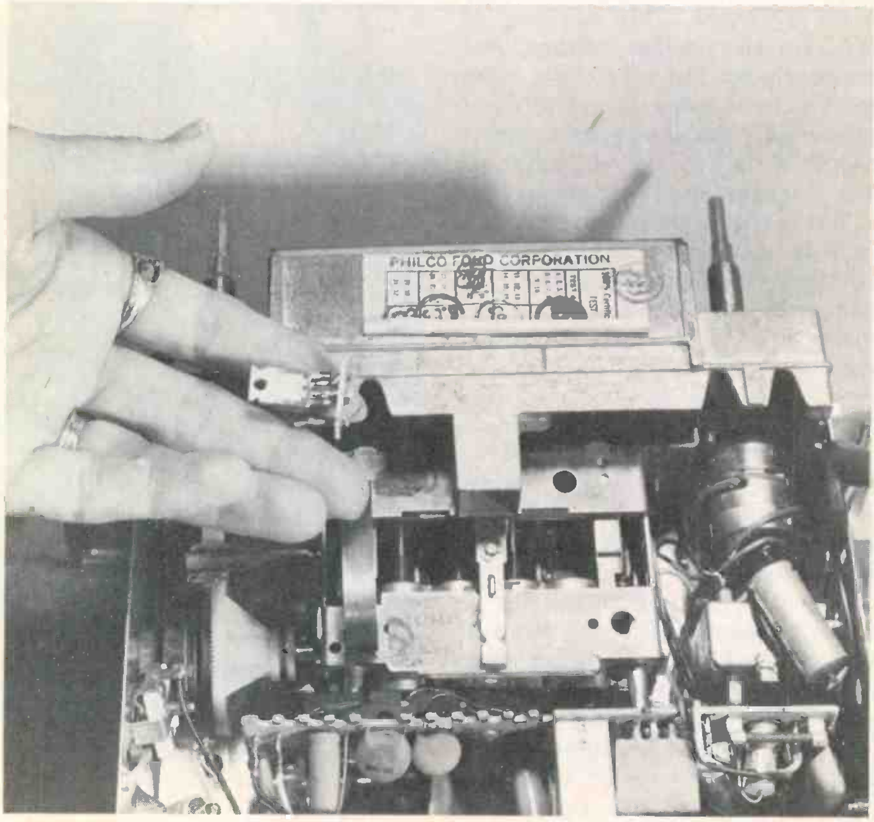


Figure 4 Excessive current drain in the Philco-Ford model DOAA-18806 indicated a shorted output transistor. In this model, part of the dial assembly must be removed to gain access to it.



added to prevent the board from turning.

Severe noise

A model CYM62 Motorola had very noisy reception, and occasionally the audio would stop for a short time.

Generally, such noise is caused by bad transistors, worn volume controls, leaky IF transformers, and leaky RF or oscillator padder capacitors. And sometimes a defective ceramic capacitor or noisy resistor in the audio stages can produce a similar noise. Of course, audio noises can be heard all the time, but RF and IF noises vary in loudness with the volume control settings. Thus, the volume control divides the radio for test purposes. In this case, the noise originated before the volume control.

One shortcut for finding noisy transistors is to short the base to its emitter. Do this to each stage. If the B/E short stops the noise, the noise source probably is in some stage upstream. By using this method, we traced the noise to the converter stage.

Sometimes the circuit where the problem originates will show a fluctuation of dc voltage when the noise is loudest. This was true of the converter emitter voltage, and we concluded the defect was close by (Figure 5). Because nearly all of the supply voltage appears across the oscillator padder capacitor, it was suspected of erratic leakage.

When the capacitor was disconnected, a varying high-resistance reading was obtained across the terminals. Installation and adjustment of a new padder solved the noise problem.

Low audio gain

Only one radio station could be heard, and it had weak volume. These symptoms in a model 986846 Delco might make you suspect an RF, converter, or IF problem. This suspicion was strengthened by a normal amount of buzz, when a screwdriver blade and finger were touched to the center lug of the volume control.

Using a noise generator, the signal was traced to the second-IF transistor. When the signal was applied to the base, the sound was very weak, but it was loud when touched to the collector. An in-circuit transistor test indicated the transistor was open, and the installation of a replacement restored the proper volume and number of stations.

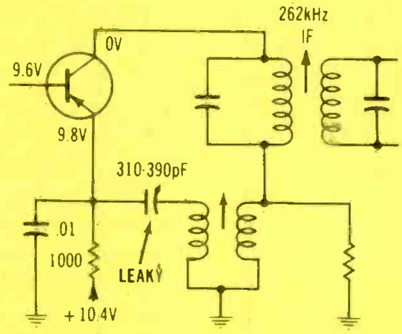


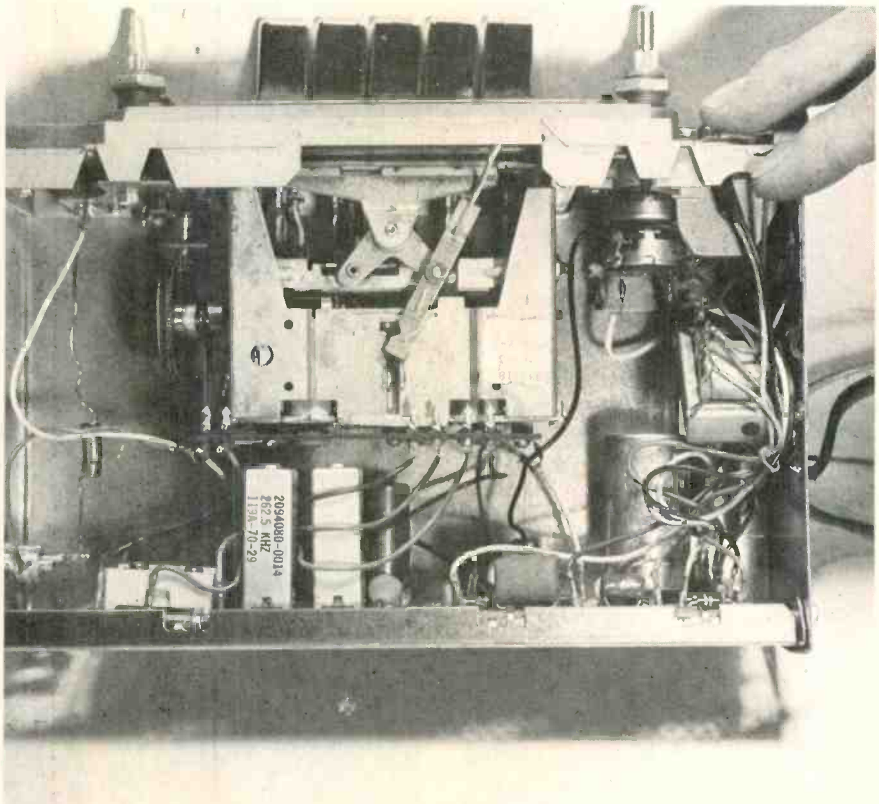
Figure 5 Severe noise in a CYM-62 Motorola was traced to a leaky padder capacitor.

Broken volume control

The complaints against the Craig model 3521 radio and cassette player were no sound and a loose volume control.

A visual examination showed the frame of the volume control was firmly attached to the radio, but both volume controls and the switch were pushed backwards so they rotated with the shaft. This improper movement had broken the power lead from the on/off switch.

Figure 6 Both volume controls and the switch were pushed back out of position, and several wires were broken in the Craig model 3521 radio.



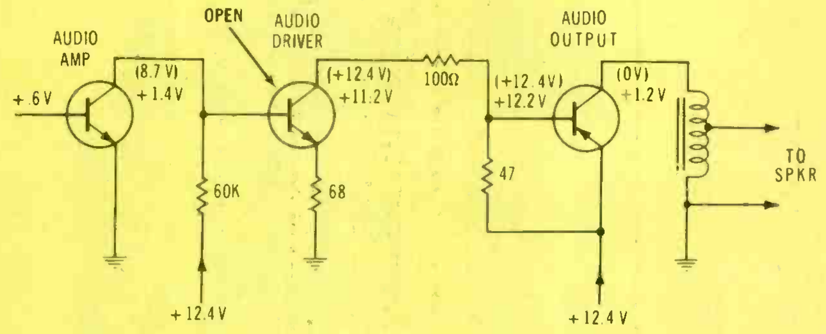
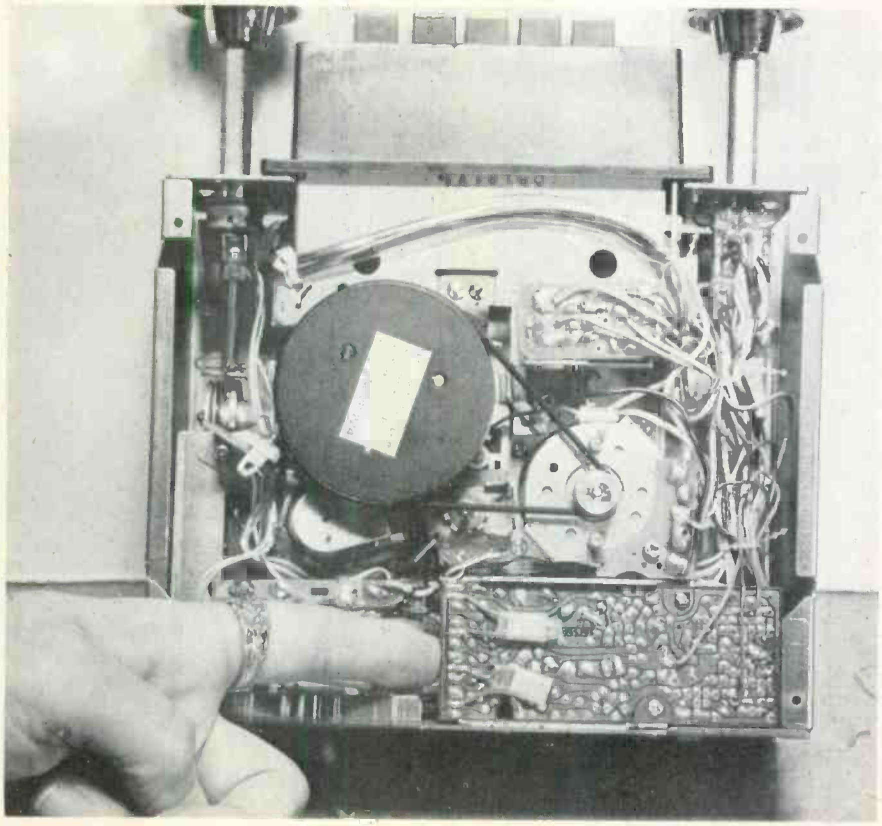


Figure 7 No click or thump could be heard when this inoperative Motorola TM7A was turned on. Usually a power problem or a dead output transistor is responsible.

The customer was ready to start his vacation and there was no time to order the special control assembly. Therefore, the control was fastened together (with spots of solder strengthening the tabs), the power wire and ground leads were resoldered, and the radio worked fine except for the noisy volume controls (Figure 6). We ordered the volume-control assembly for installation after his vacation.

Some noisy volume and tone controls can be restored by squirting tuner spray inside and then rotating the shaft several times. Other controls either don't become quiet or the noise elimination lasts only a short time. So, it's best to consider cleaning as a temporary remedy that might last until a new control can be obtained.

Figure 8 A poorly-soldered joint produced one weak stereo audio channel in a Sanyo FT872.



No sound

When this Motorola model TM7A was brought in, no station could be received and no click was heard when the radio first was turned on. (If the output stage is operating, most radios will have a thump or click.) With these symptoms, the output transistor usually is dead. We replaced it, but there was no change (Figure 7).

An audio tone was injected at the volume control, but not a sound came from the speaker. Next, dc voltage readings were taken in the audio system. The emitter voltage was zero, the base had 8.7 V, and the collector measured the same as the 14.2 V supply. There was no C/E current, and yet the forward bias was 8.7 V. Obviously, the B/E junction was open. This was verified by an in-circuit transistor test, and a new transistor restored the good performance.

One weak channel

One channel of the Sanyo FT872 was very weak, but there was no distortion. In this combination radio and Stereo-8 player, the audio stages are on a separate circuit board, as shown in Figure 8.

Where two identical stereo channels are used, a very effective troubleshooting technique is to compare the voltages and signal level of the bad channel against the good one. Therefore, a signal from an audio generator was injected at each stage of both amplifiers, starting with the output and working upstream. Source of the weak signal was found between the first and second audio transistor.

When the signal was injected at the input side of the 10-μF coupling capacitor, the sound usually was weak, but at times it snapped back to normal volume. At first, we thought the capacitor was intermittent, but a loose soldering joint was found at one end of the capacitor during the start of disconnecting it.

A good soldering joint stopped the intermittent and brought back proper gain to the weak channel.

Intermittent transistor

At first, we suspected an IC audio amplifier in the model CKL-4019 Automatic radio. However, voltage checks and other tests changed our suspicion to the audio output transistor (see Figure 9). When the meter probe was touched to the transistor leads, several times the sound would begin. There was no noise and no stations when the radio was malfunctioning.

When the sound was not working, the collector voltage was zero, the base voltage was 10 V and the emitter measured 12.8 (the supply voltage). These voltages indicate no transistor current and an open junction. Replacement of the intermittent output transistor with an SK3041 transistor cured the problem.

Both stereo channels dead

Both channels of the model KID-565 Kraco radio and tape player were dead. This is unusual. Usually the two channels have different symptoms, even if both have problems. Of course, power-supply defects can kill both channels at the same time.

In this case, the audio power ICs of both channels were nearly shorted (Figure 10) and required replacement. Shorted speaker wires might have caused the ICs to fail.

Before you remove any ICs, check for mounting arrows or identification numbers. It's difficult to determine the right position otherwise.

Loud shrieking noises

Radio stations could be tuned in; however, volume of the sound was

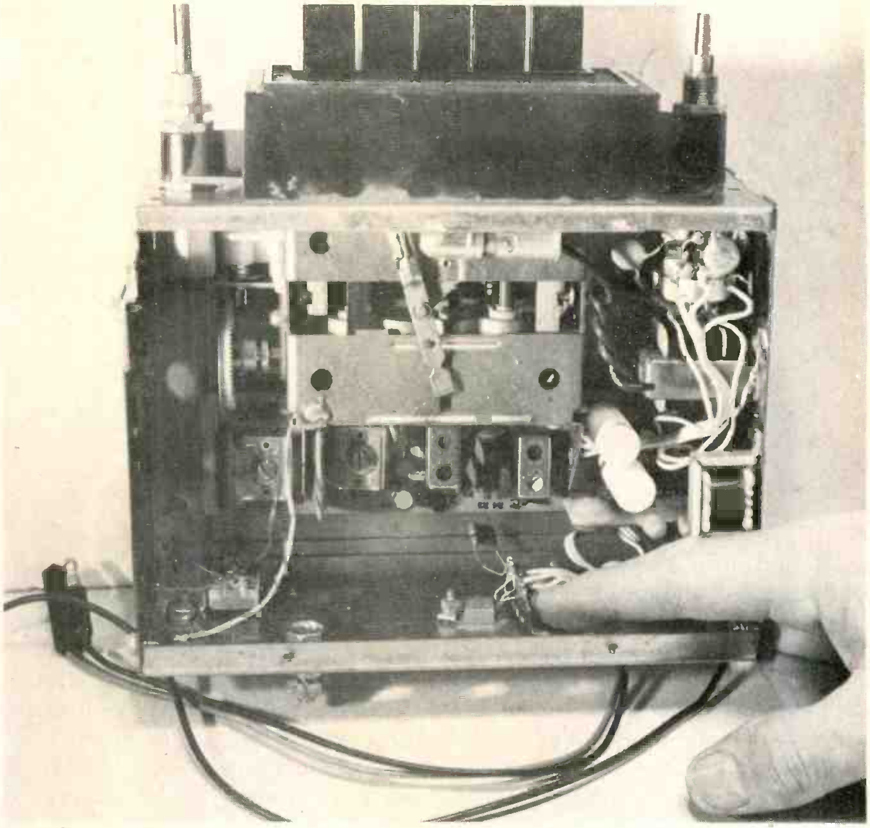
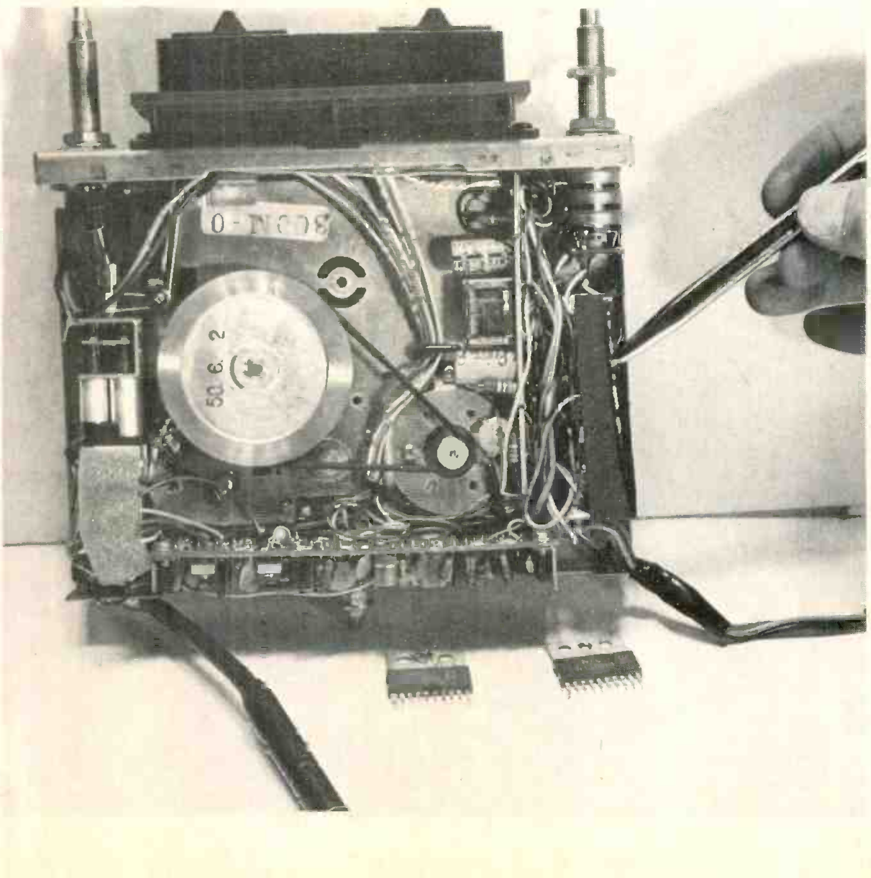


Figure 9 This model CKL-4019 Automatic radio had intermittent volume.

Figure 10 Both stereo channels of the Kraco model KID-565 were dead; an unusual symptom, except for power-supply problems.



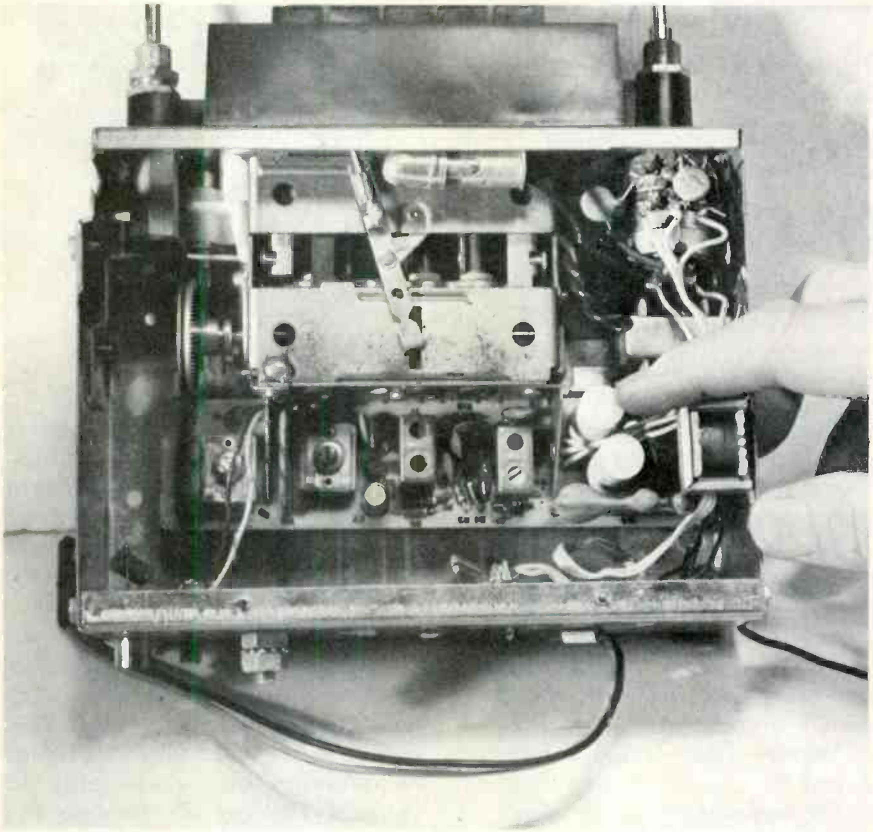


Figure 11 An ear-splitting shriek was the symptom of the 7985773 Delco radio. Filter capacitors often cause this trouble.

not changed by the controls. But the most obvious symptom of the model 7985773 Delco was the ear-splitting shrieking noise.

Noises of this kind often are caused by open filter capacitors (shown in Figure 11). Test for the possibility by shunting a 1000-μF 16-V capacitor across each filter in turn. If the test capacitor stops the shrieking noise, the capacitor it was paralleling at the moment is the open one.

Sometimes several capacitors are located in one container. If just one section is open, it's best to replace the entire assembly.

One filter capacitor was replaced and all abnormal noises were gone.

Motorboating

When the volume control of the Delco model 01BP2 was advanced, the sound would develop a fast variation of volume (often called motorboating). Also, the dc voltages at the filter capacitors would vary in step with the motorboating.

Each filter was shunted by a test capacitor. Paralleling the test capacitor across one certain filter capacitor stopped the motorboating (Figure 12). This was in a multiple-capacitor can, so the whole assembly was replaced. All motorboating was eliminated.

Comments

As you can understand from these actual case histories, not many auto-radio repairs are difficult. As always, intermittent problems bring additional complications. But, the techniques of signal injection and dc-voltage analysis usually can pinpoint the stage that has the trouble.

Some defects are more likely to occur than others. Capacitors often become intermittent; resistors seldom do. And symptoms vary according to the circuit having the defect. You can save hours by knowing these facts.

Before you install the covers after a repair, check the pilot lamps and replace them if necessary. Use window spray to clean out any dirt or grease from the dial assembly. Adjust all pushbuttons correctly for local radio stations. These chores require very little time, but they will impress the customers with your helpful attitude. □

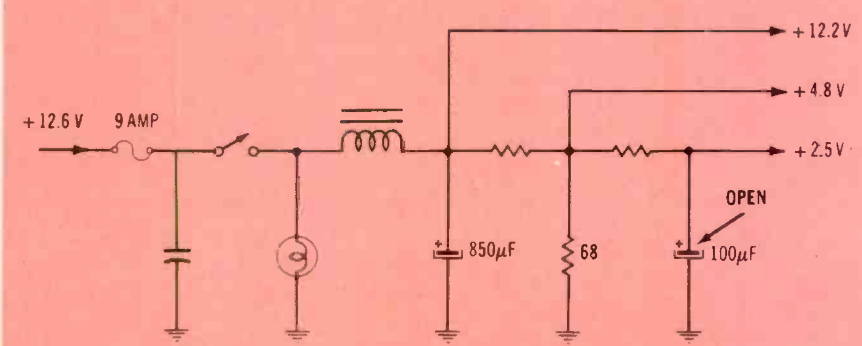


Figure 12 Motorboating commonly is caused by open filters. This was true of the model 01BP2 Delco radio. Several capacitors were in one can, so the can was replaced, rather than just the one bad section.

Sam Wilson's Technical Notebook

COUNTER GLITCHES

Your comments or questions are welcome. Please give us permission to quote from your letters. Write to Sam at:

J.A. "Sam" Wilson
c/o Electronic Servicing
P.O. Box 12901
Overland Park, Kansas 66212

By J.A. "Sam" Wilson

In the December Technical Notebook, I discussed three capacitor questions that are difficult for technicians to answer. My theory is that problems arise because they are not taught how capacitors actually work. Instead, they are taught from incomplete models.

Keep in mind that this is *my* theory. Here, as with other controversial subjects I discuss in Technical Notebook, **Electronic Servicing** allows me to present my ideas. If you disagree, then your quarrel is with me, and not with the magazine.

Question of the uncharged capacitor

A schematic for the last capacitor question of the series is shown in Figure 1. (I don't call it a circuit, but an arrangement, because a circuit has a complete path for current flow. A capacitor does not.)

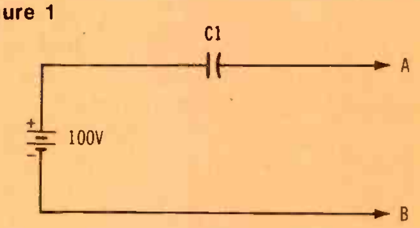
Question: What is the voltage between points A and B, if capacitor C1 is uncharged?

Answer: There is 100 V between A and B.

The reasoning is quite simple. If the capacitor is uncharged, it can't have any voltage across its terminals. Therefore, the *same* voltage is at each of the capacitor terminals. In other words, **the voltage between A and B is identical to the battery voltage.** These last two statements are true because of the zero voltage across the capacitor.

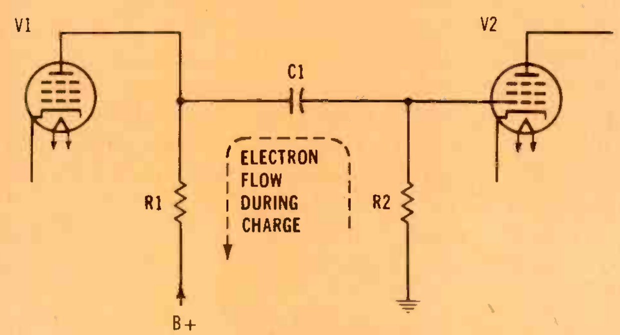
This question was used in an early version of the CET test, and it brought me more mail than any other question in any test. Why should this simple arrangement of components be so difficult to analyze? Perhaps it's because the usual capacitor model places excessive emphasis on the thought that

Figure 1



WHEN CAPACITOR IS UNCHARGED, WHAT VOLTAGE IS BETWEEN A AND B?

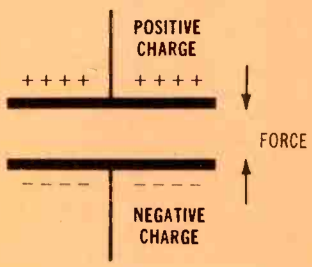
Figure 2



WHAT DOES C1 DO?

Figure 2 C1 is called a coupling or blocking capacitor. What does it actually do?

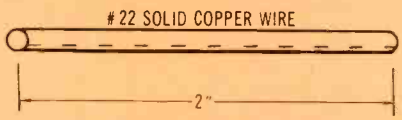
Figure 3



UNLIKE CHARGES ATTRACT

Figure 3 A charged capacitor has opposite charges at the plates. These attract; therefore, work is required to move the plates apart. This work accounts for the increased voltage that occurs when the plates are separated more widely.

Figure 4



HOW MUCH CAPACITANCE?

capacitors will pass ac but not dc voltages.

The circuit often used to demonstrate this idea is shown in Figure 2. Capacitor C1 sometimes is called a blocking or (more often) coupling capacitor. Its purpose often is described this way: **the capacitor allows the ac signal to pass from V1 to V2, but prevents the V1 positive plate voltage from reaching the grid of V2.**

The explanation is not wrong, but it omits the initial charging that occurs when the circuit first is energized. A dotted arrow shows the electron path for the charging current. After the capacitor becomes charged, the dc voltage across resistor R2 has dropped to zero volts. The dc voltage across the capacitor then is equal to the B+ minus the voltage drop across R1.

Notice the similarity between the schematics of Figure 1 and Figure 2. In both cases, the capacitor is connected to a positive voltage. However, in Figure 1, the capacitor is uncharged, so the output dc voltage equals the supply voltage. In Figure 2, the capacitor is charged, and its output voltage is zero volts.

Just as soon as a conventional voltmeter (which draws current from the tested circuit) is connected between points A and B in Figure 1, the capacitor begins to charge. Eventually, the dc output voltage will become zero volts when the capacitor reaches full charge. However, that is not a consideration in the question, **because the capacitor is described as being uncharged.**

In a future issue, I'll present some comments from readers about this capacitor series.

More comments about work

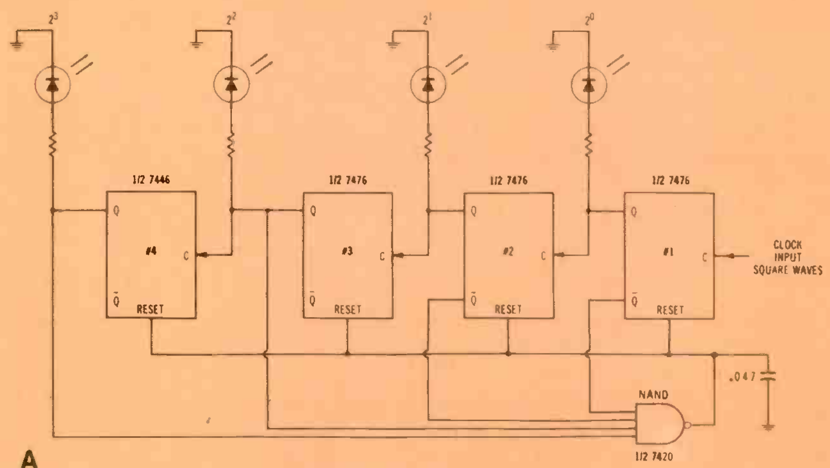
One reader (who didn't give permission for his name to be mentioned) asked me to give additional information about the increase of voltage across a charged capacitor when the plates are moved apart. He asked why the voltage went up when the plates are moved farther apart but not when they are allowed to move toward each other.

The answer is found in this statement: Voltage is a unit of work. That is, work equals force multiplied by distance. When a capacitor is charged, one of the plates is positive and the other is negative (see Figure 3). Like charges repel and unlike charges attract. Therefore, the plates of a charged capacitor are attracted to each other. To move those plates apart, **you must exert force through a distance.**

Since the plates are attracted to each other, they will move toward each other without the need for an external force. So, it's not necessary to expend work on the system to move the plates nearer together.

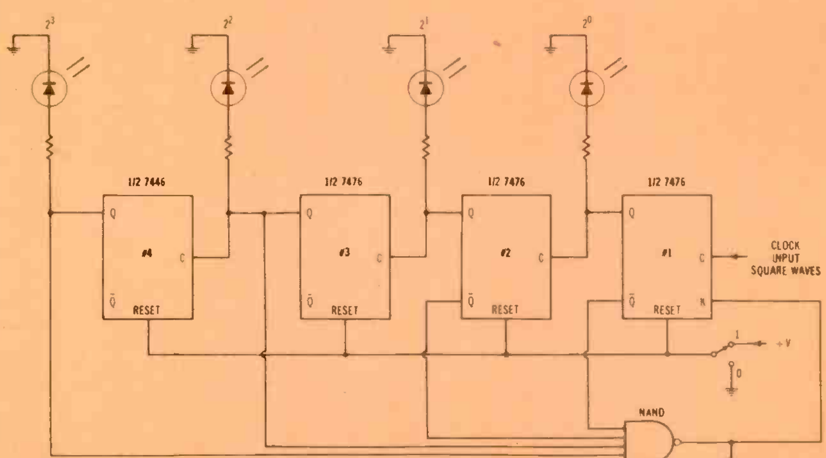
When the plates are moved apart, energy is stored, and this energy is given up when the plates are returned to their original position.

Figure 5 These are corrected schematics from the October, 1978 Industrial Electronics article in **Electronic Servicing**. The A schematic was Figure 1 on page 32; B was Figure 2 on page 33; C was Figure 3 on page 36; D is the binary counts of this Figure 5C; and E was Figure 4 on page 36. The capacitor added to all schematics cures an unexpected glitch.



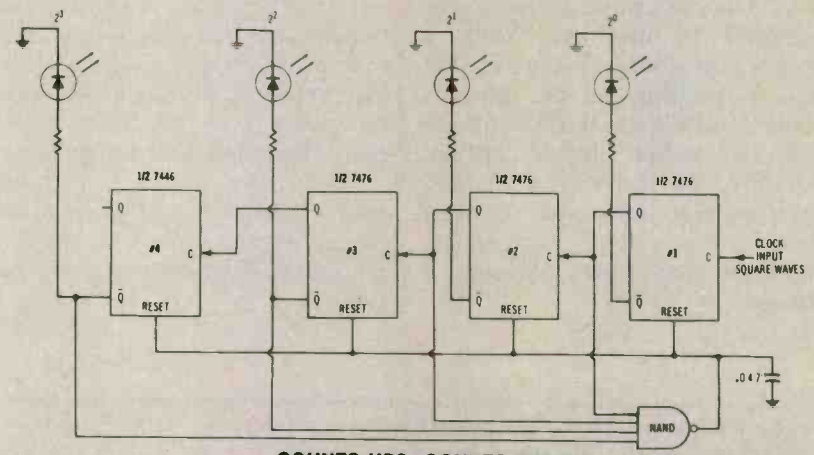
A

HOMEWORK SOLUTION COUNT TO 11 AND RESET



B

COUNT TO 12 AND STOP



COUNTS UP? COUNTS DOWN? CONSTRUCT FOR EXPERIMENT 3

C

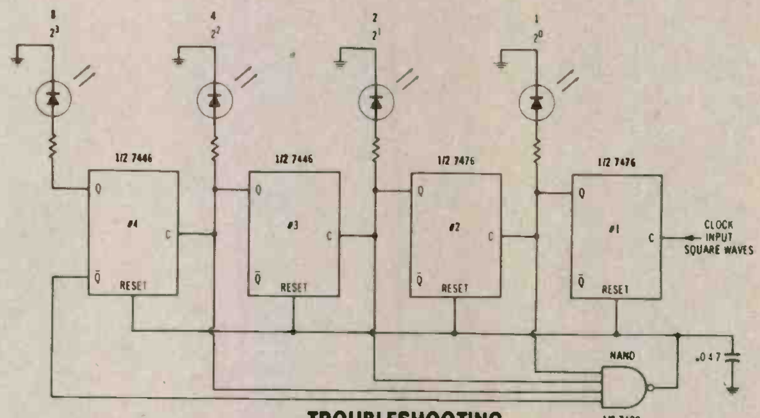
COUNT	Q	$\bar{Q}$	READOUT	DECIMAL	NAND IN	NAND OUT
0	0000	1111	1111	15	1100	1
1	0001	1110	1110	14	1101	1
2	0010	1101	1101	13	1110	1
3	0011	1100	1100	12	1111	0
0	0000	1111	1111	15	1100	1

LAST COUNT DISPLAYED

RESETS TO 1111 READOUT

OPERATION OF FIGURE 5C CIRCUIT

D



TROUBLESHOOTING QUESTION 1

E

Technical notebook

Please, no phone calls

I try to answer all letters sent by readers. Sometimes there's a long delay because I have a busy schedule. But I do answer eventually.

However, I don't have a telephone. (I'm waiting to see if they catch on.) So, when people call the ISCET/NESDA office, the magazine, or my place of work, they waste their time and money. I never return phone calls because it's too much trouble to find a pay phone.

Please write to me; don't call.

A strange capacitor

I just can't resist one more capacitor question. At the beginning, I must explain that I don't know of any practical application for the answer.

Question: What is the capacitance of the piece of wire in Figure 4? The answer is given at the end.

Glitch...that old demon

Many readers have written about the first four illustrations in the October, 1978 Industrial Electronics article (pages 32, 33, and 36). Those illustrations and the accompanying text had too many errors to blame on the typesetters (our usual excuse). (Three of the schematics had NOR symbols when the gate plainly was labelled as a NAND. In Figure 3, the NAND inputs were wired incorrectly. Also, the Figure 8 caption should have referred to Figure 4, not 3.) **Corrected schematics are in Figure 5.**

However, even after several readers recognized the mistakes and correctly wired the counters, wrong counts were obtained.

With ripple counters, each flip flop is switched in sequence. The first switches the second, the second switches the third and so on. These counters are programmed to stop or repeat the count when all four NAND inputs receive logic 1 signals (highs). At that time, the NAND output should go low and stop the count.

Figure 6 shows the NAND input waveforms for the October Figure 1. The area of interest is the tiny slice of time between the 7 count and the 8 count. This point is marked by an arrow. Notice that signals from the first, second and fourth flip flops are changing to highs, while the signal from the third flip flop is switching to a low.

If these four waveforms switched at the same instant, there would be no problem. However, if the third flip flop signal has the slightest delay in dropping to zero, all four NAND inputs will have logic ones for a very short time before the correct states are established. This brief transient condition produces at the NAND output a glitch that's similar to the narrow negative pulse of Figure 7. Unfortunately, the glitch resets the four flip flops to zero before the counter reaches the programmed count of eleven.

A simple fix

The glitch can be eliminated by the addition of a 0.047 microfarad capacitor connected from the NAND output to ground, as shown in Figure 8 and the corrected schematics of Figure 5. The capacitor stores the narrow glitch but the value is too small to affect the correct NAND output logic states. With the capacitor added, the counters work as intended.

Now, I don't recommend adding capacitors to solve glitch problems, unless there is no other solution. For example, a 2-input NAND could be used to switch only two adjacent flip flops. This greatly reduces the effects of time delays.

Another design solution is to use a synchronous counter. I'll discuss that type next month.

Answer to wire capacitor

A straight piece of solid wire has an infinitely-large capacitance! Remember that moving the capacitor plates nearer together increases the capacitance. This is proved by the following equation for capacitance:

$$C = k \frac{NA}{d}$$

In this case, k is the dielectric constant, N is the number of paralleled plates, A is the area of each plate, and d is the distance between the plates.

Therefore, if the distance between plates is reduced to zero, the capacitance becomes infinitely large. Figure 9 shows how such a capacitor can be made from wire.

As I wrote earlier, I don't know of any practical use for this curious type of capacitor. Do you? □

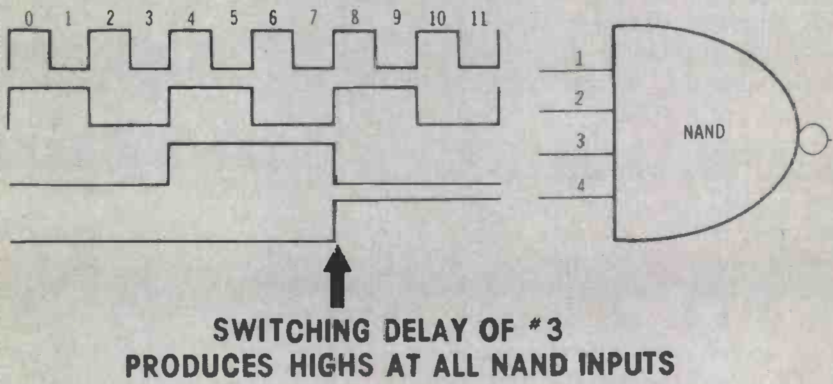


Figure 6 If the third flip flop signal is slow in dropping to zero at the beginning of the eighth count, all NAND inputs will have highs for a very brief time. However, this is long enough to produce a negative-going glitch at the NAND output, and it stops the count prematurely.

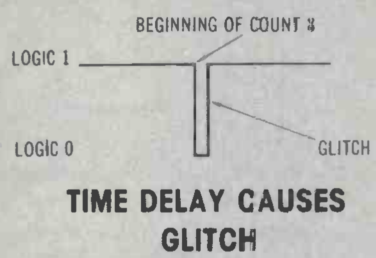


Figure 7 A time delay in the third flip flop can cause a glitch at the NAND output. The glitch resets the counters before the programmed number.

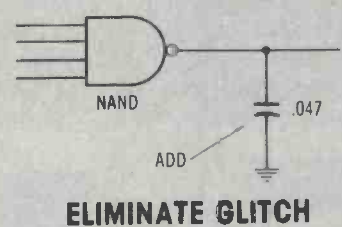


Figure 8 A 0.047 capacitor added to the NAND output removes the glitch.

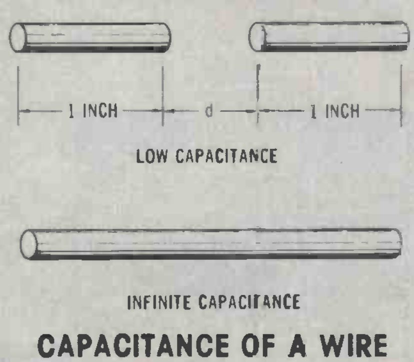


Figure 9 Sam says this lower wire has infinite capacitance.

Just a bad tuner

His RCA color TV that was purchased recently in the States would not receive one of the two local Bermuda channels unless he forced the channel knob to stay a bit to one side of the number, reported one customer.

I informed him that corroded contacts inside the tuner probably were causing the intermittent, and that such defects are rare in new TVs. Because the receiver was in warranty, I advised him to have the tuner sent to the selling dealer.

He agreed with my suggestion, and I removed the tuner. I took the precautions of making a pictorial diagram of the wires and connections before I removed them, and then clipped off the leads to the UHF switch (sometimes the switch will melt if the iron is too hot during the unsoldering).

About five weeks later, the tuner came back, and I installed it in the TV. Both local stations were received in good fashion, and I was about to replace the back screws before delivering it to the customer when I noticed that the picture was too narrow. About 1-inch of black showed at the right and about ½-inch at the left.

When did it become narrow?

Had the picture been narrow before I worked on it? Could I have caused the problem? Was my line voltage low? These were some of the thoughts that flashed through my mind.

Difficult analysis of a narrow picture

By Frank Wolff, CET

With skill, perseverance and several good tips from **Electronic Servicing** articles, this technician was able to find several obscure defects in one TV receiver.

First, I checked my shop line voltage, and it measured a volt or so above 120. The line voltage was okay. I called the customer who reported that the picture had been narrow since he bought it, but the picture was excellent and the narrow picture had not bothered him. Well, it bothered me!

No schematic

Again, I removed the cabinet back and carefully examined the chassis for a width pot or a width connector wire. Neither were found, but I did locate a width switch, which I started to slide. Then I saw the precautionary notice to turn off the power before changing the switch position. I followed instructions, but the switch must have been in the "wide" position before, because the picture was more narrow now. I turned off the power and moved the switch back to the original position.

I was beginning to worry because I had no replacement parts for this model. If I were forced to order parts (which require five weeks to arrive) and then found I had diagnosed wrong, the customer would be more than unhappy. This called for careful and accurate troubleshooting before any components were ordered.

To make the situation worse, the RCA had a CTC78 chassis but my Photofacts stopped with the 1976 models. I was not familiar with this type of horizontal-output circuit.

The latest Howard W. Sams *Color TV Field-Service Guide* on my bookshelf was volume 5. It covered RCAs only to CTC66, and I spent some time looking for similar chassis layouts before settling on a

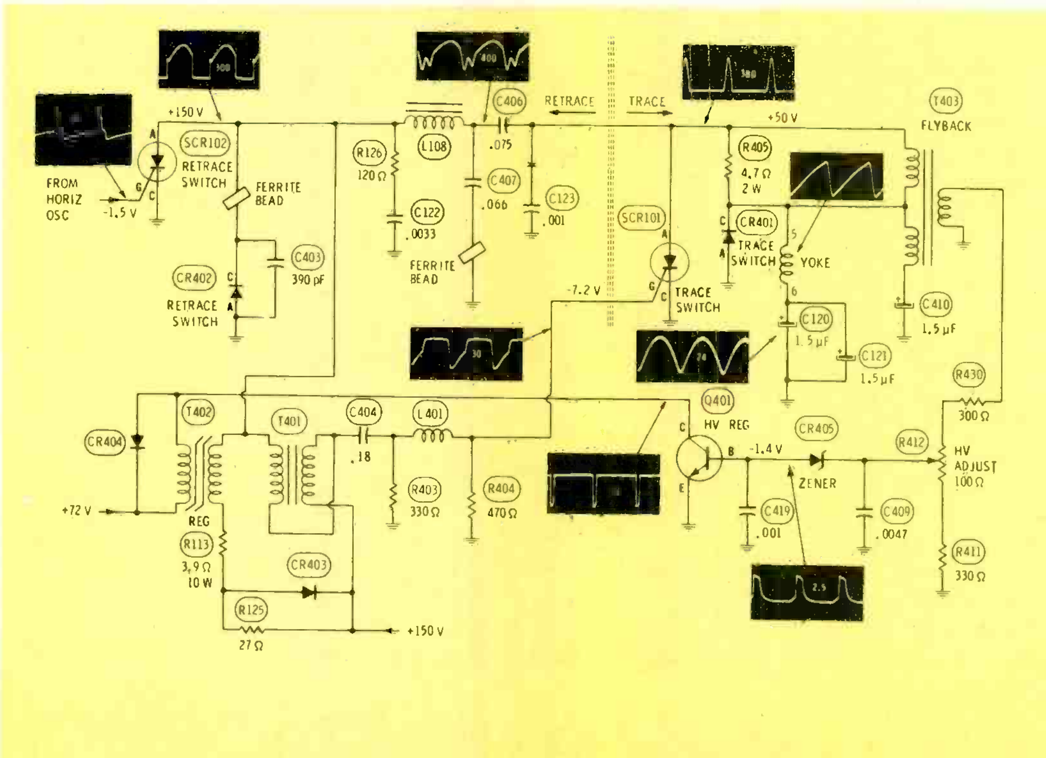


Figure 1 This horizontal-sweep schematic of the RCA CTC58 color TV is similar to the one repaired by the technician.

CTC58. It had SCRs for horizontal outputs, and this reminded me of a series about that model in the January, February, March and April 1976 issues of **Electronic Servicing.** I was glad now that I had saved all of the old issues.

Suggestions from Electronic Servicing

After a long review of the articles, and fortified by several cups of coffee, I returned to the receiver with renewed confidence.

As the first step, I shorted TP1 to TP2 to find out if the over-voltage protection circuit would operate to throw the horizontal out of lock. It didn't. I grounded TP2 to see if the protection circuit was loading down the horizontal sweep. Again, there was no change.

A suggestion in the April article stated that certain shorts or overloads at some flyback taps will narrow the picture without causing non-linearity or foldover. I decided to remove one circuit at a time from the flyback. Any circuit that gave more width when disconnected must have the overload. Lifting one wire from the board disconnected the top/bottom pincushion circuit, but the width did not improve. Other flyback connections appeared to be very difficult to remove, and I decided to come back to that test later.

I suspected that a yoke problem might narrow the raster, but the raster showed no distortion, and I decided to test other things.

During the tests, I noticed that the picture widened to almost normal width at low brightness, and then narrowed as the brightness was increased. This pointed to poor regulation. The March article stated that an open C407 causes poor regulation (see Figure 1). This seemed to be a good suggestion. However, an open C407 produces wrinkles in the SCR101 anode waveform. There were no abnormal wrinkles, so C407 probably was not open.

I was surprised to measure only 15 kV of high voltage. Usually low HV causes out-of-focus or dark pictures, but that was not true here. As I adjusted the HV control from end to end the HV varied only about 1 kV, and could not be adjusted above 16.5 kV even with a dark picture. Also, pulses at the Q401 regulator collector changed very little as the pot was adjusted. These symptoms appeared to point to a regulator problem.

Finally, I remembered the suggestion that grounding the base of Q401 would eliminate the HV regulation (which with a normal TV would activate the protective circuit). When I grounded the base, the HV shot up to 30 kV, and the HV protective circuit promptly forced the oscillator far out of frequency. Next, I grounded the base of Q402, the over-voltage protective transistor, and was relieved to obtain a bright and very wide picture. This was proof the narrow width was produced by excessive HV regulation, and that the protective circuit was operating normally.

Where in the regulator?

The test proved even more: the defect was not in the collector circuit of Q401 but was located at the base, the emitter or the circuits that supplied them. With the base ungrounded, the emitter and collector dc voltages were about right. Suspicion now was directed to the base.

Perhaps too much amplitude of horizontal pulses was reaching the base. To prove or disprove this theory, I paralleled R411 with a 100-Ω resistor which would permit less amplitude from the variable control (Figure 2). With the grounds removed from Q401 and Q402, the picture had full width and good brightness, while the HV control could vary the HV from 20 kV to 25 kV. Eureka! But, changing a resistor value is not a cure.

Perhaps the HV control or one of the resistors was out of tolerance. After I removed the pot from the circuit, it and the two associated resistors (R430 and R411) tested within tolerance. Another component must be bad.

Only one part remained to be tested. I removed zener diode CR405 and discovered the usual forward resistance *but an abnormal 5K reading with reversed polarity.* The reverse resistance should be almost infinity. There could be not doubt, CR405 was defective.

Unfortunately, I didn't have a 13-V zener in my stock, but I did have two 6.3-V zeners which I connected in series. After installing the zeners and reconnecting the other components, I was rewarded with a normal picture. I adjusted the HV to 24.5 kV with a dark picture, and measured a drop to only 23.5 kV at high brightness. The regulation was operating as designed.

Test it

If you would like to duplicate this problem, connect a 5 K resistor in series with a 0.5 M control, and parallel them across CR405 in a TV that is working okay. Adjust the pot and notice the width change at low-resistance settings.

Comments

As soon as Photofact 1628-2 was available, I obtained one and use it now when repairing this same CTC78 color TV. Also, I thank Gill Grieshaber and **Electronic Servicing** for helping me with this difficult repair.

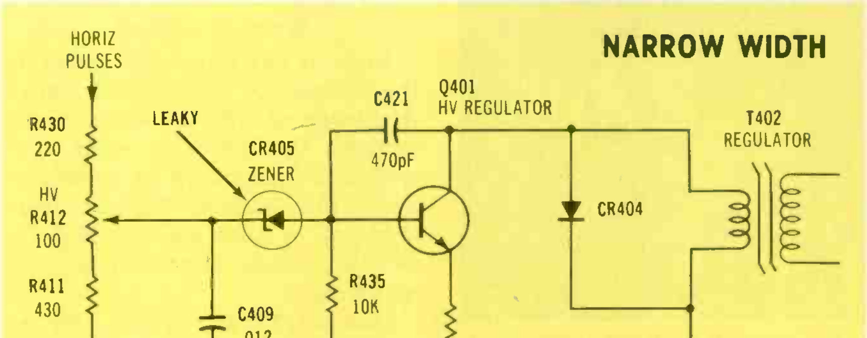


Figure 2 The narrow picture was caused by excessive HV-regulator operation. CR405 leakage forced Q401 to conduct too much saturation current through regulation transformer T402.

MATV gain versus noise

Most MATV systems are designed for adequate signal level at each TV tap-off. However, many of them have too much snow in the picture. On the other hand, *any MATV system that has excellent signal-to-noise ratio will automatically have sufficient signal level to each TV.* Use these suggestions to minimize snow in the systems you design or repair.

By James E. Kluge, technical editor, Winegard Company

These pictures illustrate three signal-to-noise ratios. The top picture has no perceptible snow for a S/N of about 45 dB. Some snow at about 29 dB is shown by the center picture, while an unacceptable 22 dB S/N is pictured at the bottom.

Excessive snow in a TV picture displeases any viewer. It is even more intolerable if the *same* amount of snow is present after going to great trouble and expense for an elaborate *Master Antenna for TV* (MATV) system.

Unfortunately, such discouragements are not rare. Sometimes the snow is stronger following installation of a new MATV system. What went wrong? The preamplifier is rated for more than enough gain, and other parts were selected with care. Of course, there could be a defect in the preamplifier, or the downlead might have an open in it. In many cases, however, *several important MATV principles were violated* in the design specifications.

Minimum snow can be obtained only by following several important steps. The signal-to-noise ratio is all-important. Total gain is secondary. Because very little has been written about the subject, the basic principles, calculations and system designs that are imperative for obtaining the best signal-to-noise ratio will be discussed here.

What is noise?

Noise is any signal that exists in the absence of the desired signal. According to that definition, noise includes the black or white dots and lines from motor or power-line arcs, the picture flashes from lightning or auto ignition, and the swirling lines from CB or FM interference.

However, for this article, only the wide-bandwidth "white" or "pink" noises produced by various noise mechanisms in diodes and transistors, and by the thermal agitation of electrons flowing through resistances are being considered. These noises cover almost all frequencies, appearing in TV pictures as snow, and in the sound as a constant hissing or frying.

Facts about noise

A few abbreviations used in explaining or calculating noise problems are signal (S), noise (N) signal-to-noise ratio (S/N) and noise figure (NF). Before they are discussed, here are some fundamental concepts:

- An antenna in an electromagnetic field produces a signal voltage, but it does not generate any appreciable noise.
- Thermal noise is added to the signal by the resistive termination at the input of a preamp, or at the end of the downlead.
- A 75-Ω -impedance antenna has a theoretical noise voltage (across the 75-Ω termination resistor) of -59.1 dBmv (or 1.11 μV). In like fashion, noise at the 300-Ω termination resistor of a 300-Ω antenna has a minimum of -47.1 dBmv (or 4.44 μV). (Because of the impedance ratio, both noise and signal in 300-Ω circuits are four times those in 75-Ω wiring.)
- **Signal-to-noise ratio** equals the signal power present divided by the noise power. A marginal-quality TV picture can be obtained with 25 dB, while excellent quality requires about 45 dB S/N.
- **Noise figure** of an amplifier is the amount of noise that's added to the signal by the amplifier. S/N in dB at the amplifier input minus the S/N in dB at the amplifier output equals the noise figure (NF).
- The signal-to-noise ratio of any MATV system always is best at the antenna terminals before any preamplifier or downlead. In other

words, the S/N *cannot* be improved following the antenna. Therefore:

the best way to improve the S/N is to use an antenna that has higher gain.

- Everything done to the signal *after* it leaves the antenna degrades the signal-to-noise ratio by attenuating the signal or adding noise. This is true of the downlead, amps or preamps, splitters and attenuators. If you use good techniques, however, the degradation can be minimized.
- The NF of passive devices (such as splitters, downlead, filters and matching pads) is equal to the power-damping factor. For example, a 6-dB (4-to-1) attenuator has a power gain of 0.25, and a power-damping factor of 4, which in turn gives a NF of 4.

In general terms, there are two steps for obtaining a high S/N at each receiver of a MATV system. First, achieve a high S/N at the antenna. And then minimize the addition of noise by maintaining a sufficient signal level at each point of the system.

Antenna S/N

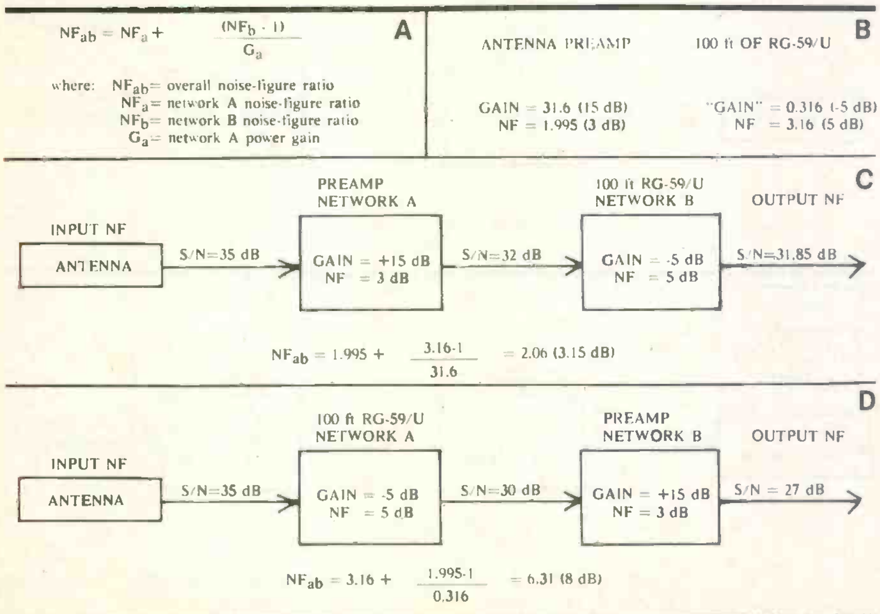
One limitation of the maximum output signal from an antenna is the strength of the signal that surrounds the antenna. Thus, the maximum signal level that's available depends on the transmitter power, frequency, distance from the station, weather conditions, antenna height and any obstructions in the line-of-sight signal path. Only the last two conditions are controllable. The antenna can be moved horizontally to a more-favorable location, and a signal-strength meter can be used during tests at different heights to find the one giving the strongest signal.

Gain is determined partially by the size and physical configuration of an antenna. Although no one can judge gain merely by looking at an antenna, it's true that larger antennas generally produce more gain than smaller ones do.

Noise from an antenna and its loading resistance can't be reduced. Therefore, to obtain an adequate S/N at the antenna, it's imperative that a large enough antenna be placed in a favorable location.

What is an adequate S/N? As mentioned previously, a S/N of 45 dB at the TV tuner will provide an excellent picture without noticeable snow. However, it's advisable to start with about 60 dB at the antenna to allow leeway for the reduction of S/N that always occurs before the signal reaches the TV.

Figure 1 Placing a low-noise preamp between antenna and coax can give a better S/N than placing it between coax and the TV receiver. (A) This is the formula for calculating the total noise figure from two cascaded networks; (B) gives the gain and noise ratio of each network; (C) is the circuit and calculation of S/N with the preamp ahead of the coax; and (D) is the same but with the coax before the preamp. The (C) wiring provides 4.85 dB improvement over the (D) circuit.



MATV gain vs. noise

About 35 dB at the antenna (followed by minimum degradation of the S/N) is the bottom limit for satisfactory operation. Any less signal or excessive degradation of the S/N will produce pictures that are barely watchable.

An important question is this: how can the S/N degradation be held to a minimum?

First amp limits S/N

Both practical experience and the formula (for computing the NF of cascaded stages) prove that the overall noise figure of the MATV system depends primarily on the noise figure of the first amplifying stage. Nothing can remove noise after it is added to the signal; signal and noise together are amplified by the same amount.

Therefore, when selecting an antenna preamplifier, *choose one that has the lowest noise in preference to one having high gain.*

Of course, if the NF of the following network (downlead, filter or splitter) is very high, you might require a preamp having high gain *in addition* to a low NF. (Remember, however, that high-gain amplifiers usually overload at lower input levels than lower-gain ones do. So, don't select a high-gain preamp unless the additional gain actually is needed.)

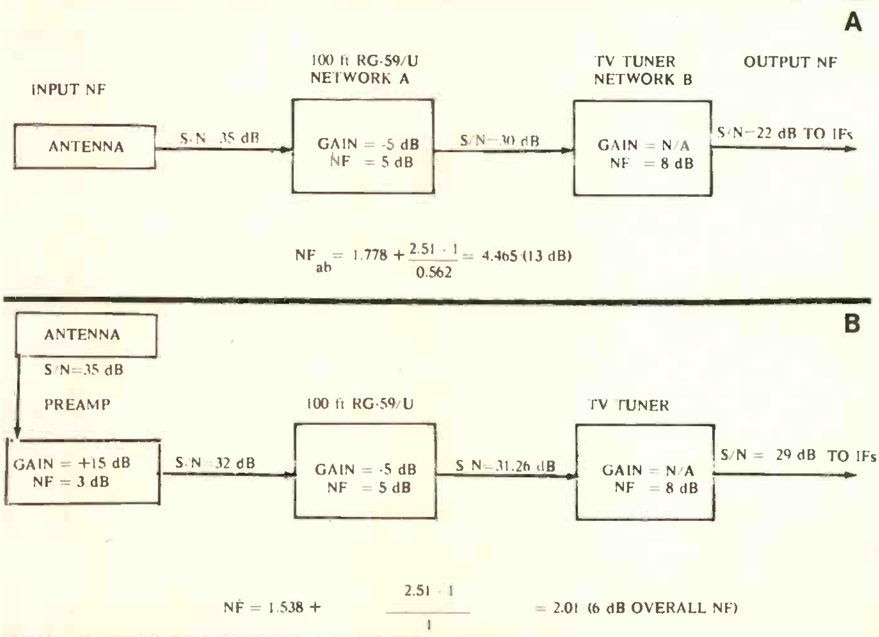
Two examples

A typical installation calculated both with the preamp ahead of the coax loss and with the coax loss in front of the preamp (Figure 1) will help clarify the principle. Placing the preamp *ahead* of the coax loss improved the S/N by 4.85 dB compared to the reverse.

Figure 2 shows the same kind of calculations for a MATV system with an antenna and 100 ft of RG-59/U coax which fed the signal to a TV tuner. The first amplifier of the system was the tuner RF amplifier and mixer which have a poor 8 DB NF. Therefore, the 5 dB NF of the coax and the 8 dB NF of the tuner are added together to produce an overall NF of 13 dB.

After the preamplifier was added to give low-noise gain before the coax loss, it becomes the first amplifier. Therefore, the noise figures calculated according to the formula, producing a total NF of only 6 dB (which is less than the 8 dB of the TV tuner when used alone).

Figure 2 A preamplifier between the antenna and the coaxial cable can reduce the S/N below that of the TV tuner alone. (A) The MATV system with antenna, coaxial cable, and the tuner of the TV provides an unacceptable 22 dB S/N, while at (B) a low-noise preamp reduced the noise figure to only 6 dB and gave a passable 29 dB S/N.



Preamp requirements

Any preamp that is included to prevent severe degradation of the NF because of heavy signal losses must have a very-low noise figure, of course. In addition, it needs gain which can be calculated by the following formula:

Gain equals total losses in decibels plus 6 dB plus the noise figure in decibels.

It is easy to see why the preamp must make up for the losses, but *that would only keep the NF the same as it was originally if the preamp had no noise.* Therefore, to compensate for the preamp NF and provide a cushion for variations, the other two figures must be included.

For example, if the coax losses are 5 dB and the NF of a widely-used preamp is 3 dB, then the required preamp gain = 5 + 6 + 3 or 14 dB. This matches the specs of the preamp, so it would be suitable. On the other hand, another preamp with a gain of 15 dB and a NF of 6.4 dB would calculate this way: 5 + 6 + 6.4 = 17.4. The preamp would not be suitable because it lacked 2.4 dB of having enough gain. (In some applications, the higher NF also might make it unsuitable.)

Summary

Everything in a MATV system (except the antenna) adds noise to the signal either directly or indirectly. Preamplifiers and other amplifiers with transistors add their internal noise to the signal as it passes through.

Passive devices (downlead, splitters, filters and tap-offs) don't generate noise themselves. However, they always are followed by active devices (amplifiers or TV tuners) that have a fixed noise level which *comparatively* becomes worse when the input signal is reduced by upstream passive devices. That's why passive components have a NF rating.

These are the steps for reducing noise and snow *as much as possible* in MATV systems:

• Obtain all possible signal from the antenna. Choose an antenna that has more gain than the amount needed to supply only one TV located at the antenna. Select the antenna location and orientation with care, always trying to obtain maximum signal level with minimum ghosts and noise. Remember: *the antenna is the only part of any MATV system that does not add any snow.* Any antenna improvement is all "gain" without tradeoffs. Examine the picture on a portable TV connected near the antenna, and be certain there is more than enough signal. The signal-to-noise ratio never will be better than it is here.

• At the headend location (or where the splitter of a small system will be located), again view the signal coming from the downlead. If the snow is worse than it was at the antenna, add an antenna-mounted low-noise preamplifier in front of the coaxial downlead. Determine the gain needed by the formula:

Gain =losses in dBs plus 6 dB plus NF of preamp in dBs

• If an amplifier or a preamplifier is needed to compensate for the downlead or other distribution losses (thus preventing a drop of S/N), select one having a very low noise figure. *The S/N for the downstream signal depends mainly on the NF of the first transistor stage in the first amplifier.* This stage is second in importance only to the antenna for minimizing snow.

• At the antenna (or the antenna-mounted preamp) output, measure the carrier strength of the weakest usable channel. Then, at all points downstream, *never* allow the signal to fall below 6 dB above this reading. This will preserve the signal-to-noise ratio. Otherwise, the first active device following the weak signal will degrade the S/N. If the loss that reduces the signal below the reference-plus 6 dB point is in a long run of coaxial cable, then add amplifiers at intervals to prevent excessive signal loss before the next amplification.

• At each TV receiver of the system, the minimum level (with some snow) should be 1000 μV (0 dBmV). Of course, higher signal levels (up to 10,000 μV, or +20 dBmV) are desirable. However, don't confuse signal level with signal-to-noise ratio. A 10,000 μV signal with a poor signal-to-noise ratio still has excessive snow (not snow from the TV, but snow from the MATV system).

Follow these few principles and all of your MATV installations should provide minimum snow that will please your customers. □

test equipment

Portable DMM

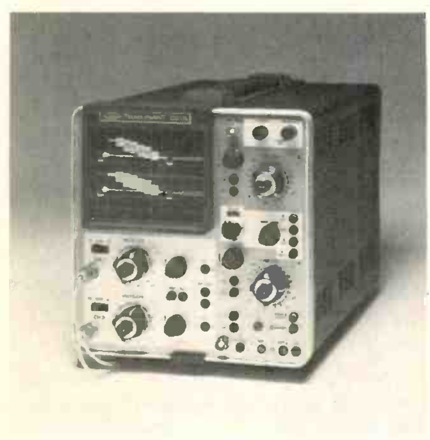
Model LX-303 from **Hickok** is a pocket-sized battery-operated digital multimeter with a 3-½ digit LCD display. Auto-polarity, auto-zeroing and automatic overrange are provided. Accuracy of dc volts is ±0.5% of reading ±0.5% of full-scale reading. Battery life is more than 200 hours from a single 9-V alkaline battery. Several accessories are available, such as an ac adapter, vinyl carrying case, dc-current shunt, 40 kV dc probe and an X10 dcv adapter that slips over the probe.

Model LX-303 sells for $74.95.

Circle (30) on Reply Card

Dual-trace delayed-sweep scope

One unique feature of the model D67A **Telequipment** scope is "mixed" sweep, with one sweep rate scanning the picture over part of the screen and another sweep rate working across the rest of the screen. This delayed sweep can be adjusted according to need. Dual-trace operation permits viewing of two waveforms simultaneously by either alternate or chopped mode. Conventional horizontal sweep times can be selected between 40 ns and 2 s per graticule division. A sync separator is built-in to provide stable TV vertical and horizontal displays.



Maximum sensitivity of each vertical channel is 10 mV, and minimum sensitivity is 50 V per division. Bandwidth is from dc to above 15 MHz.

Price of the D67 Telequipment is $1325. (Telequipment is a subsidiary of Tektronix.)

Circle (31) on Reply Card

Small frequency counter

Continental Specialties offers the MAX-550 frequency counter which covers the 1-kHz to 550-MHz range with 1 kHz resolution on the 6-digit display. A carrying case, cables and alternate power sources are optional accessories.

MAX-550 sells for less than $150.

Circle (32) on Reply Card

Portable VOM

Meter protection and a mirrored scale are two features of the **Mura** model NH-63 VOM multitester. Sensitivity of the six dc ranges is 20,000 ohms-per-volt, and it is 10,000 Ω/V for the four ac ranges. In addition,

three resistance ranges and two dc current ranges are provided.

The suggested price is $25.50.

Circle (33) on Reply Card

Dual-triggering scope

A new feature of the model 1032A **Ballantine Laboratories** scope is independent triggering of the dual-trace channels. Each channel has its own trigger circuit, and an electronic switch selects the trigger of the channel that's being displayed. This allows non-synchronous waveforms to be viewed simultaneously. The CRT of the dc-to-20 MHz instrument has an advanced mono-accelerator design which is said to provide high brightness and a small spot diameter on the 8 cm x 10 cm screen. Twelve vertical ranges cover sensitivities between 5 mV and 20 V/cm division. Calibrated horizontal sweep times are between 0.5 and 1 µs per division plus an X10 magnifier.

Model 1032A sells for $895.

Circle (34) on Reply Card

Function generator

Continental Specialties offers model 2001 function generator which has outputs of sine, triangle, square or TTL-square waveforms that can be swept over a 10:1 to 100:1 range.

Repetition frequency is selected by a vernier dial and five pushbuttons and cover 1 Hz to 100 kHz in five ranges.

Sine, square and triangle waveform output signals can be varied over a 40 dB range, with a maximum level of 10 V peak-to-peak. The TTL output can drive 10 TTL loads with rise and fall times of better than 25 ns. Sine waves are said to have less than 2% distortion.

User price of model 2001 is $124.95.

Circle (35) on Reply Card

Tiny DMM

Heuer has announced a micro-miniaturized digital multimeter, DMM 2000, for field-service measurements.

The instrument has a 3-digit LCD readout, providing four measuring ranges for each mode: DC up to 1000V and AC up to 700V, AC and DC current up to 2A, and resistance up to 20 M ohm, with a typical accuracy of 0.5% on DC ranges.

Two technical features of the multimeter are its true RMS (root mean square) measurement of AC ranges and shielding against RF. Up to 100 hour battery life is provided for the Dmm 2000 by four 1.5V watch batteries.

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the marketplace

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