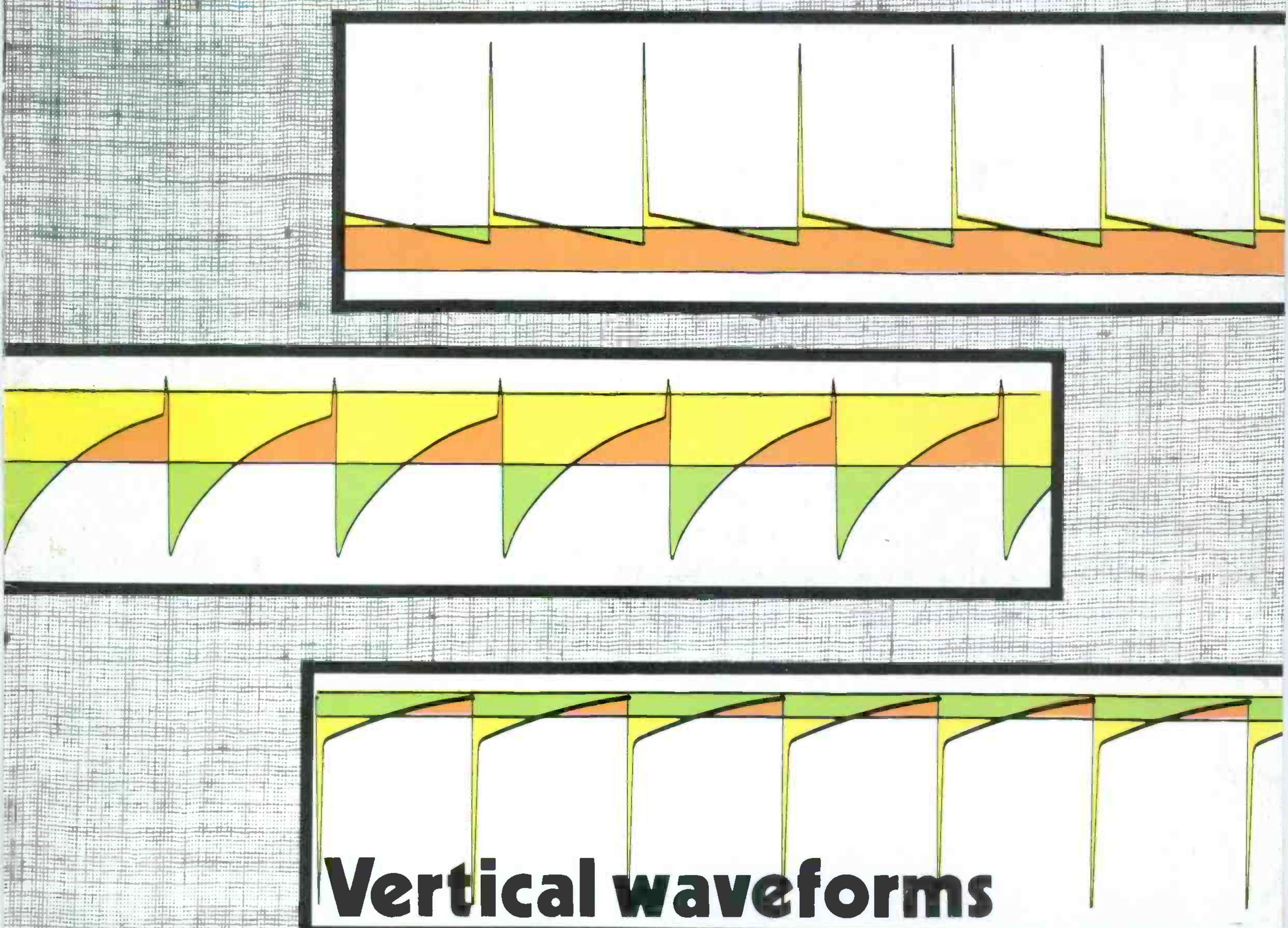
July 1979 ☐ $2.25

Electronic Servicing

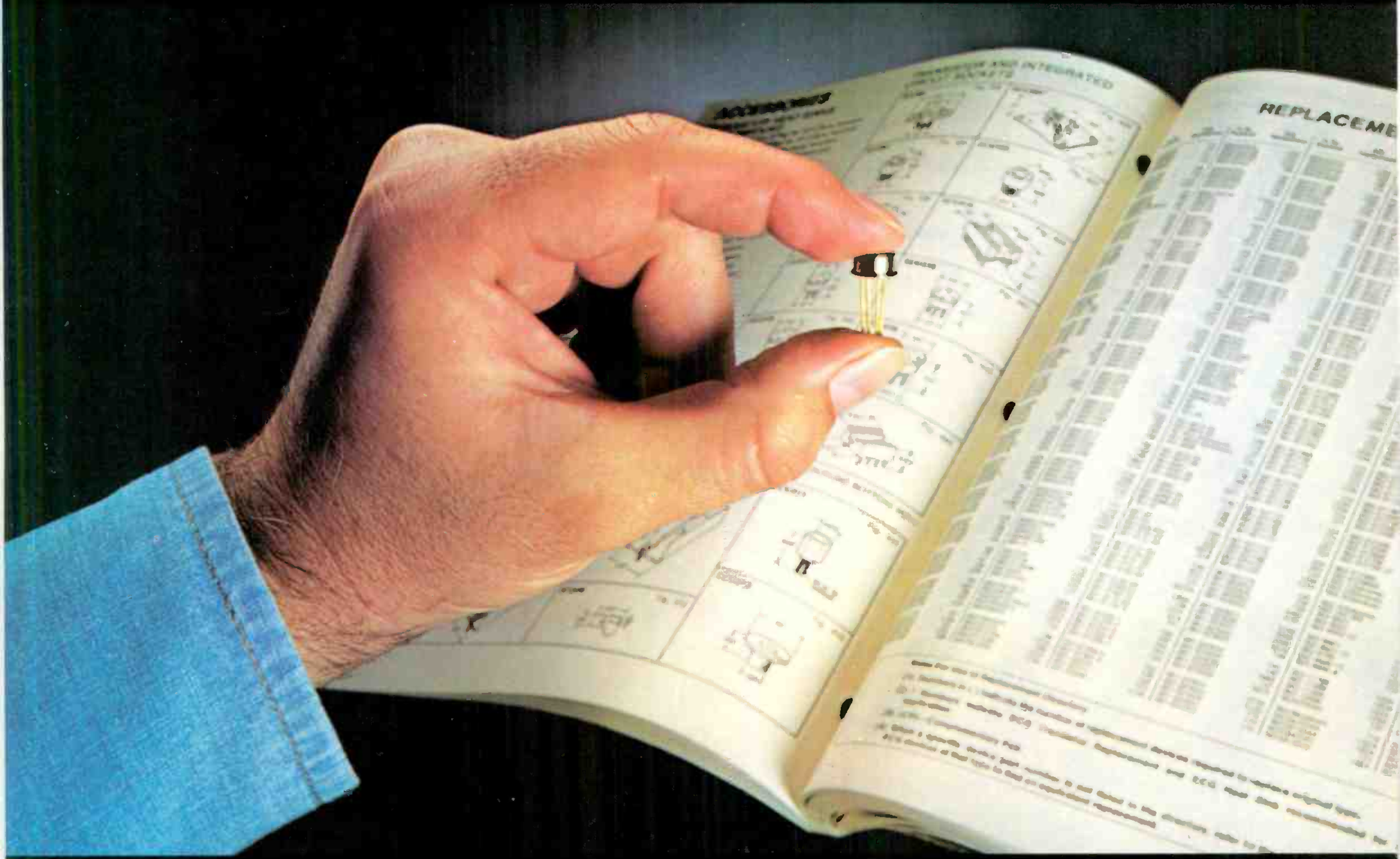
1980 TV preview

Repairing intermittents



Vertical waveforms

SYLVANIA HELPS SOLVE GE AND RCA'S PROBLEMS.



No one knows better than Sylvania that the show must go on. So when a faulty semiconductor in any brand of home entertainment product turns into a showstopper, it's Sylvania to the rescue. Our ECG® semiconductor guide is the most used, and useful, guide in the industry. It makes it easy to replace any ailing performer with an ECG semiconductor that will get the show back on the road.

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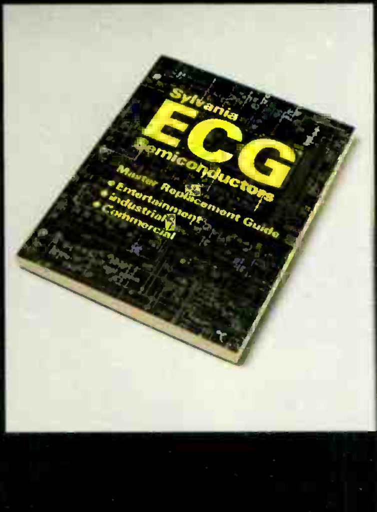

SYLVANIA | GTE

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Electronic Servicing

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EDITORIAL
Bill Rhodes, *Editorial Director*
Carl Babcoke, *Editor*
Cindy Nelson, *Managing Editor*
Joan Jackson, *Editorial Assistant*

ART
Dudley Rose, *Art Director*
Linda Franzblau, *Graphic Designer*

CIRCULATION
John C. Arnst, *Director*
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ADMINISTRATION
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INTERTEC PUBLISHING CORP.

In August

Electronic Servicing

A unique method of curing unwanted RF carrier interference, electronic medical equipment repairs, plus more on the microprocessor series. Waveforms part 3 shows replacements in scan-rectified power supplies. Plus, the introduction of Electronic Servicing's new MRO industrial electronic servicing section.

July, 1979 □
Volume 29, No. 7

Electronic Servicing®

14 **A second look at waveforms, Part 2**
Gill Grieshaber

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Jack Webster

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Robert L. Goodman

These examples and technical tips can help solve intermittent problems.

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Wayne Lemons

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About the cover

The graphic design of vertical-sweep waveforms is by Linda Franzblau with photography by Carl Babcoke.

electronic scanner

news of the industry

First annual convention of the **Electronics Technicians Association-International** (ETA-I) is scheduled for August 3 through 5 at the Bingeman Park Convention Center in Kitchener, Ontario, Canada. Technical seminars, leadership sessions, business-management school, certification workshops, business meeting and election of officers are part of the activities. For more information, contact: ETA-I, Dept. ES, 7046 Doris Drive, Indianapolis, IN 46224. The phone number is (317) 241-7783.

The Marriott Hotel in Tucson, AZ was chosen for the national annual convention of the **National Electronic Service Dealers Association** (NESDA) and the **International Society of Certified Electronic Technicians** (ISCET), and the state convention of the **Arizona State Electronics Association** August 13 through 18. In addition to association business sessions and the election of officers, other items on the agenda include business management and new technology schools, the Electronics Roundup trade show, CET tests, manufacturer/service forum, technical seminars, Hall of Fame awards and council meetings. Recreational activities include a day in Old Tucson (courtesy of RCA), a trip to Nogales, Mexico courtesy of Hiser Publications and a golf tourney. For information write to: NESDA, Dept. ES, 2708 West Berry Street, Fort Worth, TX 76109, phone number, (817) 921-9061.

National Association of Television & Electronic Servicers of America [NATESA] has scheduled its national convention at the Carson Inn of Nordic Hills, Itasca, IL August 23 through 26. Many events are scheduled in addition to the association business. These include profit-producing seminars, contacts with key industry people, a certification test, technology trends and reports on industry problems and solutions. Carson Inn has a large golf course, indoor swimming and many other recreational activities. The NATESA awards banquet with floor show is one of the highlights. Write to NATESA at 5809 South Troy, Dept. ES, Chicago, IL 60629, or call (312) 476-6363.

US factory sales of electronic equipment, systems and components totalled $64.9 billion in 1978, representing an increase of nearly 15% over the previous year, according to the *1979 Electronic Market Data Book*, released by the Electronic Industries Association. The other major electronic industries also showed growth in 1978 with sales of consumer electronics increasing nearly 15%, electronic components 14% and communications equipment 12%. Employment in the electronic industries grew by 9% in 1978, to more than 1.3 million workers. This growth rate was almost double the increase in overall US employment.

The 1979 International Summer Consumer Electronics Show, June 3-6, featured a record 938 exhibitors and established a new high attendance of 60,824. The CES is sponsored and produced by the Electronic Industries Association Consumer Electronics Group. The CES Design and Engineering Exhibition showcased nearly 100 products selected by a panel of judges as among the most innovative of the year. Additional CES special exhibits included the CES Retail Services Center where retailers met with finance companies, store layout experts, freight forwarding and other retailer service suppliers.

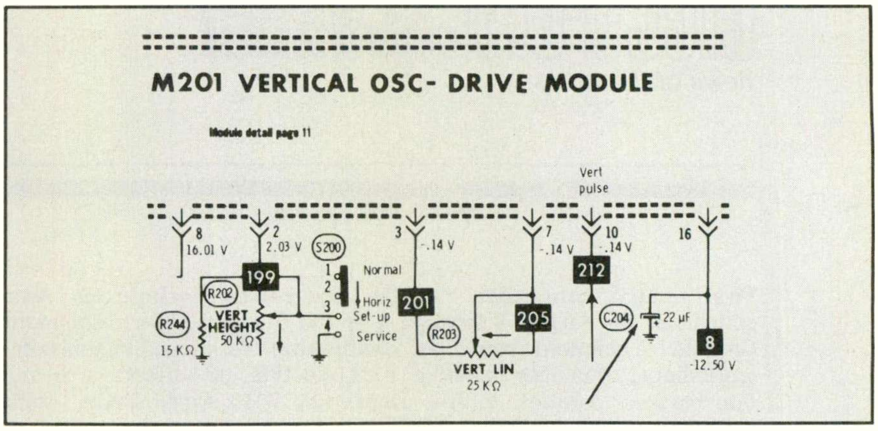
troubleshooting tips

Insufficient height
Magnavox T987
(Photofact 1411-2)

According to the customer, the trouble started with a small line across the top of the screen and increased until the picture only had about 1/3 height. The linearity was stretched at the top, and the linearity control adjustment had little effect.

All transistors on the vertical module checked normal, as did the output transistors. However, dc voltages at the output transistors were wrong.

Because many electrolytics had caused trouble lately, I decided to check those in the vertical circuit.



Paralleling C203 made no change, but a new 20 μF across C204 restored the height. After the capacitor was replaced and the height and linearity controls adjusted, the vertical sweep was entirely normal.

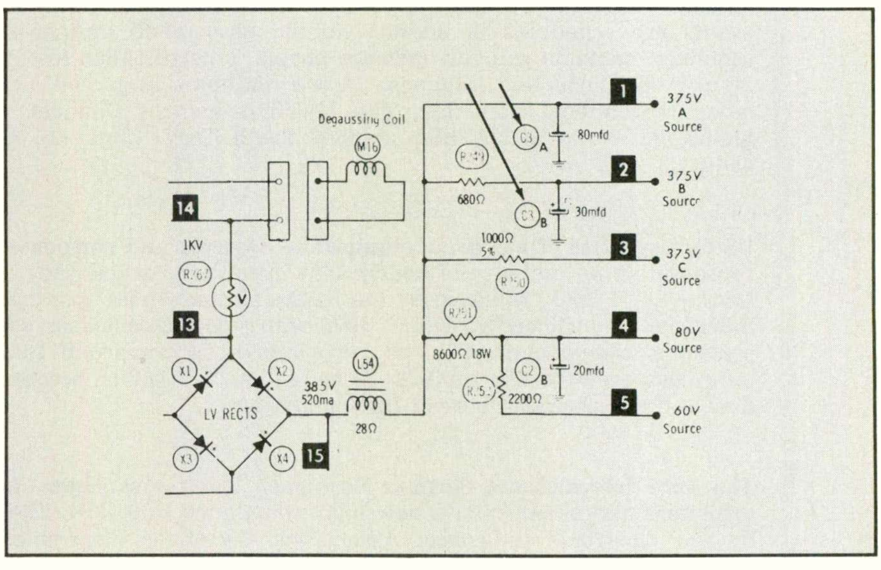
Richard Serrano
Madera, CA

Tinted raster
RCA CTC38XA
(Photofact 1092-3)

When the color control was turned down completely to remove the color, the raster had a green tint on one side and a purple tint on the other half. Further, when the color killer was rotated CCW, the unwanted color was gone. Of course, no color was possible then even after the color control was turned up again.

The problem seemed to be on the chroma circuit board, and that area was tested first. But after several hours of work, no defects had been found.

Finally, I noticed some slight bending and weaving that moved up through the picture. This suggested filter problems, and peak-to-peak scope readings were taken at all can filters. C2 and C3 checked alright, but the C3 ripple was too high. Some dried electrolyte was noticed around the terminal. Although I didn't believe the bad filter could be responsible for the color shading, I decided to replace it. To my surprise, the shading was gone from the raster.



George M. Marechek, Jr.
Cheverly, MD

Editor's Note: The CTC38 color killer biases all three -Y amplifiers to cut off. They receive voltage from C3 and the +375-V supply, and thus amplified the hum while they conducted. However, when they were cut off, the hum was not amplified and could not reach the picture tube.

Intermittent oscillator RCA CTC38
(Photofact 1092-2)

Only the horizontal-output tube had been bad. This was the easiest repair of the day (or so I thought). No complaint or comments were on the repair order. But then a lack of raster was obvious.

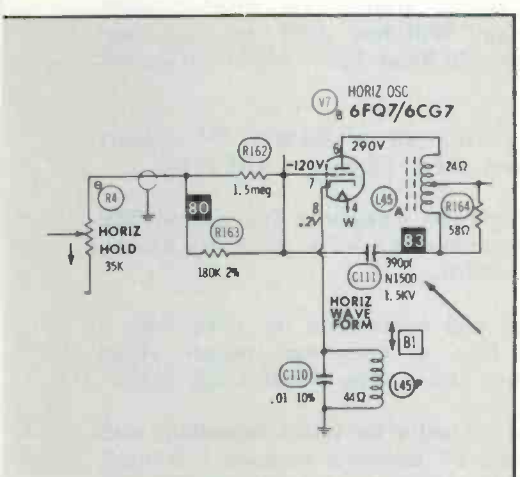
Next morning the bench power was on only a couple of minutes before I realized the easy repair job was not showing a picture. Also, the smell of a hot tube was noticeable. By the time I could shut off the TV, the output tube was ruined. I replaced the output tube, watching carefully for a red plate or any sign of trouble. Nothing appeared but a normal picture.

Jarring the horizontal-oscillator components or heating and cooling them didn't affect the operation. All day it played.

Before the power was applied to this TV the next day, I connected a scope to the output grid and watched for a red tube as the power cord was plugged in. The scope showed no grid drive and the ouput plate began to glow redly. *There was no output from the horizontal oscillator.*

To prevent the destruction of more output tubes, I connected the scope with test leads to the output grid with the tube removed and then turned the power on and off at intervals. Only one try in twenty showed no horizontal drive. I removed the oscillator tube (output still was out of socket) and plugged it into the socket at intervals. This procedure caused a loss of oscillation every time. Finally, a careful cooling of one component at a time identified the 390 pF grid capacitor (C111) as the culprit. It was a disc negative temperature coefficient ceramic that showed a crack around the edge, and a new replacement solved the intermittent problem.

Roger Redden
Beaver, WV



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: Good used 490BLB22 color picture tube and 19VAR B&W picture tube. For sale or trade: 510CTB22 color and old B&W 24CP/TP/QP/XP picture tubes. *Mike's Repair Services, P.O. Box 217, Aberdeen Proving Grounds, MD 21005.*

Needed: One new 16BXP4 picture tube. For sale or trade: model 465 B&K-Precision CRT tester and VoltOhmyst Senior RCA VTVM. Both in good condition. *W. Hitchcock, Route #3, Birch Tree, MO.*

Needed: Schematic and service data for a model 52 Crosley radio and a Clough-Brengle model 225 tube tester. Also, dates of manufacture? *Raymond Friend, 236 West Pearl, Butler, PA 16001.*

For Sale: Complete set of Rider's TV manuals with index. Also, Rider's radio manuals less one volume, test equipment, and old tubes. *Westfield Radio, P.O. Box 367, Westfield NJ 07090.*

For Sale: New Sencore SM158 sweep generator, $195; Sencore BE156 power supply, $19; and Heath IG28, $70. All with leads and manuals. *Don Brentlinger, 4822 Sparks Avenue, San Diego, CA 92110.*

Needed: Used FM 2-way-radio course by MTI. *John Webb, Route 2, Gibson, GA 30810.*

For Sale: Heathkit model IO-12 scope with leads and manual, like new, $75; and 300 seldom-used tubes, $1 each plus postage. Send SASE for list. *J. R. Blundin, 151 West 3rd, Mt. Carmel, PA 17851.*

For Sale: B&K-Precision model 415 sweep/marker, $375; B&K 501 curve tracer, $125; Leader LB-501 scope, $150; Leader FET VOM, $45. All B&K in top condition; all prices plus shipping. *Milton Obuch, 1308 N. 4th Sayre, OK 73662.*

Needed: Manual and schematic for model ST55MX Paco FM-stereo receiver. Will buy, or copy and return. *Paul Ciarelli, 17 Pebble Lane, Levittown, NY 11756.*

For Sale: Lampkin 107C service monitor, like new, $2850; RCA WT-524 transistor checker, $120; B&K-Precision 1474 30-MHz dual-trace scope with probes, $700; Heathkit IB-1103 frequency counter, $225; Betamax jig kit, $225; Panosonic jig kit, $100; EICO flyback tester, $40; Heathkit IG-5237 stereo generator, $70; Heathkit SG-18 audio generator, $65; Heathkit 1D-5252 audio load, $25; EKTAL 220 viewer, $90; 3M model 149 copier, $70. *Manning Jeter, 1029 East Fairview Avenue, Montgomery, AL 36106.*

Needed: UHF sweep generator covering 470 MHz to 600 MHz. *John Morgan, 3008 Ozark Road, Chattanooga, TN 37415.*

For Sale: Lampkin Micrometer frequency meter type 105-B, $150. *Arnold Kading, Box 285, Hackensack, MN 56452.*

Needed: Tube caddies and tube stock. Send prices and tube numbers. *Mark McDonald, 2-1610 East Cliff Drive #12, Santa Cruz, CA 95062.*

For Sale or Trade: Extra Rider's manuals and textbooks for the 1940s and earlier. *Lawrence Beitman, Box 46, Highland Park, IL 60035.*

Needed: Complete tuner-control panel with face plate and knobs (mounted on front of cabinet) for model GP634L RCA console TV. *Bob Vellines, Jr., 1228 East Ridge Road, Gary, IN 46409.*

Needed: Service and parts manuals for model 636 Jackson tube checker and EICO model 955 capacitor tester. Also, want Rider's radio manuals volumes 1 through 5 (unabridged) and 19 through 23; have other Rider's to sell or trade. *Stan Lopes, 1201 Monument Boulevard #74, Concord, CA 94520.*

Needed: Schematic for a model 125565 old Zenith radio. It has 12 tubes, 2 short-wave bands and broadcast band. *Holme Radio, 602 North 11th Avenue, Lake Worth, FL 33460.*

For Sale: Kenwood combined SM-220 station monitor and BS-8 pan display, new in original box, $370; also a More-Gain multiband 10/80-meter dipole antenna, $45. *William Shevtchuk, One Lois Lane, Clifton, NJ 07014.*

Needed: Good used triggered dual-trace scope, such as Telequipment, Sencore, etc. *John Martin, 105 Fernwood Avenue, Weirton, WV 26062.*

Needed: Schematic and service data for a model 12-8300 Webcor stereo system. Or need present address for Webcor. Will buy data, or copy and return. *Real Lausier, 30 River View, Madawaska, ME 04756.*

Needed: Photofact 78-7 for a GE-800 TV. *Albert Pecaites, 4048 Wesxt 161st, Cleveland, OH 44135.*

Needed: Receiving-tube adapters for model 658 Jackson deluxe tube tester. *Bob's TV, 1822 Sun Valley, Jefferson City, MO 65101.*

Needed: Schematic and parts data for a Hy-Gain 8 model 3108. Will buy, or copy and return. *Allen Fryou, 3735 Fairmont Drive, New Orleans, LA 70122.*

For Sale: Philco 9-inch meter for panel mounting, with manual, $30; Rider's TV manuals volumes 1 through 26, with index, $130; Measurement Labs model 78B signal generator, $35; Sylvania model 500 TV sweep generator, new in original carton, $70; 7-inch Ram-88 circular saw, $20; Black & Decker ½-inch drill with geared drive, $20. *M. Seligsohm, 1455 55th Street, Brooklyn, NY 11219.*

Needed: Operating manuals for Hickok Traceometer model 156, Sprague Telomike model TO-4, and Meissner signal tracer. *James Humphrey, 1006 East 28, Los Angeles, CA 90011.*

For Sale: Triplett 601 FET VOM, $100; Hewlett-Packard 330D distortion analyzer, $225; H-P 200CD wide-range audio oscillator, $125; H-P 410B VTVM, $125; H-P 5382A 225-MHz frequency counter, $325; Monsanto 1106A counter plug-in unit, $120; Tektronix plug-ins "T" $175, "82" $325, "CA" $125, "H" $75, "N" $125; Tektronix P6008 probes, four for $60 each; Ballantine 310A ac VTVM, $60; Unico 202 explosive-vapor detector, $75. All units are in good-to-excellent condition. *Ronald Zimmerman, 10836 4-Mile Road, Franksville, WI 53126.*

Needed: AM/FM/OFF function switch, part 2006441-61 for model 40L43-19 Arvin AM/FM/cassette receiver. *Kenneth Stuckwisch, RR #4, Seymour, IN 47274.*

Needed: Schematic for a G110 Electronic Music Corporation (EMC) guitar amplifier. *Gordon's Electronique, 3760 Provost, Lachine, Quebec H8T 1L7.*

Needed: Frequency counter with minimum of 6 digits and 30 MHz. Also, need grid-dip meter, such as Heath or EICO. State price and condition. *Caswell Davis, Jr., 601 Delmar Apt. 2, San Antonio, TX 78210.*

For Sale: Model 567 EICO multimeter with leads and manual, good working order and calibrated, $25; Heathkit IM-1210 2½-digit (Bell & Howell) digital multimeter with probes and manual, $30; Sanwa model V-50 multimeter, good working order, $10. All prices plus shipping. *Donald Young, 1037 South Park Drive, Brookfield, OH 44403.*

Needed: Service data for model 2020P Shell Electronics stereo amplifier, model FM-15 Transitronics FM tuner. Will buy, or copy and return. *T. Earl, 1317 Kingston Drive, Yukon, OK 73099.*

For Sale: B&K-Precision 1040 Servicemaster and 1640 power supply, and Hickok 380X frequency counter. CB equipment is three years old and in excellent condition. Write for price. *LeRoy Barnes, 229 Watson, Camden, TN 38320.*

For Sale: Used electronic courses. NRI complete audio/TV course with 48 lesson texts, 10 reference texts but no training kits; Heathkit EE-3102 AC/electronics course with EE-3103 semiconductor devices, EE-3104 electronic circuits, ET-3100 basic trainer and

Readers' exchange

with all parts; Heathkit EE-3401 microprocessor course, ET-3400 microcomputer trainer, partial EE-3201 digital techniques with parts but no ET-3200 trainer. Offered only for each complete course series; best offer. *Red Bull Electronics, 4807 Fifteenth Avenue S.E., Lacy, WA 98503.*

Needed: Complete exact tuner replacement for model PL17F32B Admiral portable TV. VHF tuner number is 94E163-1D, using 2CY5 and 5CGB8. *John Lefko, 18 Dali Court, Fairfield, CA 94533.*

Needed: Model 1077B Analyst with manual and accessories. *Clarence Gillow, 608 Black Drive, Prescott, AZ 86301.*

For Sale: Heathkit LO-101 vectorscope; Heathkit IT-7400 digital IC tester; Conar 255 triggered scope with 3 probes; Conar 214 transistor tester; Conar 311 R/C tester; Conar 202 frequency counter; Conar 212 TVOM with HV probe; EICO 270 DMM with ac adapter. All in good operating condition for 50% of original kit cost. *Red Bull Electronics, P.O. Box 2531, Olympia, WA 98507.*

For Sale: Heathkit square-wave generator, $15. *D. Pollock, 178 Pinckney Road, Little Silver, NJ 07739.*

Needed: Power transformer for model M-1537 Philco stereo; part number 325-0127-1. *W. B. Jones, P.O. Box 354, Carnesville, GA 30521.*

For Sale: Heathkit model 8T-5230 CRT tester/rejuvenator, hardly used, $115; Heathkit DVM model IM-2202, $125; Weston model 1250 frequency counter to 55 MHz, $105; RCA model WA-504B audio generator, $80; Photofacts 1 through 800 in cabinets, $350. *Ash Lakhiani, 48 Route 10, East Hanover, NJ 07936.*

Needed: Original 2SA290, 2SA289 and 2SA288 transistors for a VHF model TV6U Singer TV tuner, or address where they can be purchased. *Theodore Anderson, 435 E. 105 Street, New York, NY 10029.*

For Sale: Rider's early volume 1, 1919 to 1927, $15; complete index for Rider's volumes 1 to 23, 270 pages, $15; RCA 1922-1932 service data, 200 pages, $15; and Rider's radio volumes 10, 11, 12 and 13, $15 each. *Antique Radio Shop, 3403 Broadway, Long Beach, CA 90803.*

Needed: Information where the field coil of an antique radio can be rewound. *C. S. Wood, 50 Brixham Road, Eliot, NE 03903.*

For Sale: Model 510 B&K-Precision transistor tester with probes and manual, almost new, $75; 34 issues of **Electronic World** to December, 1971, $10 plus shipping costs. *Aurie Antilla, 4066 Mt. Everest Boulevard, San Diego, CA 92111.*

For Sale: A 25-year accumulation of tubes, parts, PF Reporter and **Electronic Servicing.** Send self-addressed envelope with list of needs. *C. E. Combs TV, Route 2 Box 184-C, Crawfordville, GA 30831.*

For Sale: All issues of PF Reporter/**Electronic Servicing** from 1951, in good condition, best offer plus shipping; also, other publications and older Photofacts; many radio and TV tubes. Write for details. *Frank Zablocki, Box 531 Ferry Road, North Haven, Sag Harbor, NY 11963.*

Needed: Copy of AR-96 auto-radio Photofact (now out of print): will buy. *C. G. Howard, 70 Richards Road, Columbus, OH 43214.*

For Sale: *Radio Electronics* from 1946 to 1974; Service 1946 to 1958; *Electronic Technician* from 1955 to 1977 (no schematics). You pay shipping; make offer. *Joseph Kouril, 71 Morton, Brentwood, NY 11717.*

Needed: One model 375 B&K VTVM, working or not. State price and condition. Charles Ruffner, 4032 Paseo Grande, Tucson, AZ 85711.

For Sale: 500 old-type tubes in original boxes, reasonable price. Send for list of tube numbers. *Delman TV, 651 East Park Avenue, Long Beach, NY 11561.*

Needed: Rubber drive rim for Presto 16-inch transcription turntable. *Grant Canfield, 1600 Mokulua Drive, Kailua, HI 96734.*

For Sale: Model 500 Sylvania TV sweep generator, new in carton, $60; Rider's TV manuals, volumes 1 through 26, $120; Rider's Radio manuals, volumes 16 and 17, $10 each; Philco VTVM for panel mount, with 9 inch meter and manual, $25; model 78B Measurement Lab signal generator, $25; assorted text books. Send for list. Prices do not include shipping. *M. Seligsohn, 1455 55th Street, Brooklyn, NY 11219.*

For Sale or Trade: Miscellaneous antique radios including National Radio & TV model Apex 36; also some old tubes. Need Rider's volume 23 and any index for Rider's 1-15 or 16-23. *Barry Evans, 11115 East 50th Street, Kansas City, MO 64133.*

Needed: Schematic or specs of a B+ dropping resistor for model MS6-FM AM/FM intercom. *Paul Wojcik, 207 North 18th, Barrington, IL 60010.*

Needed: Model 1070 B&K-Precision Dyna-sweep circuit analyzer. *J. D. McKissack, 1740 23rd Avenue North, Nashville, TN 37208.*

Trade: Will trade a model 415 B&K-Precision sweep/marker generator for a B&K model 1077B TV Analyst in good condition. *Virgil Collins, Sam's TV, Mammoth Street at Beatrice, Thayer, MO 65791.*

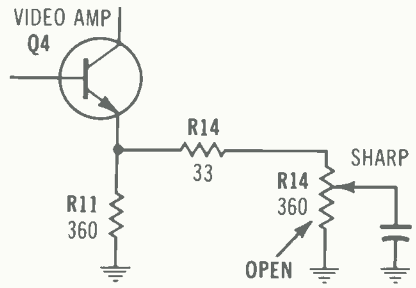
For Sale: Heath SG-18A sine/square generator, factory wired; model 415 B&K-Precision sweep/marker generator; Sencore FE-21 FET meter; Sprague TO-6A Telohmike capacitor analyzer; Sencore PR-47 UHF prescaler and NE-206 noise eliminator; B&K-Precision model 747B tube tester. All in excellent condition and operation. Sell any or all for best offers. *Christian TV & Audio, 6916 Silver Star Road, Orlando, FL 32808.*

For Sale: PF Reporter from November 1959 to August 1967 (less 1965) plus a few later issues. Send stamped self-addressed envelope for price and details. *Cheri's TV, 1300 15th Street, Wyandotte, MI 48192.* □

symcure

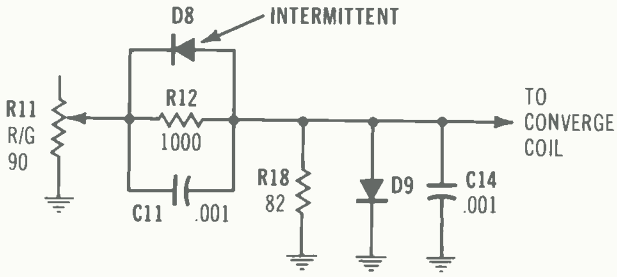
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Magnavox T995
PHOTOFACT—1815-1



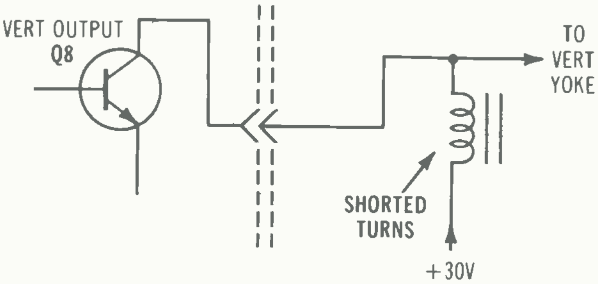
Symptom—Good sound and bright raster without much video
Cure—Check R14 sharpness control, and replace it if open

Chassis—Magnavox T995
PHOTOFACT—1815-1



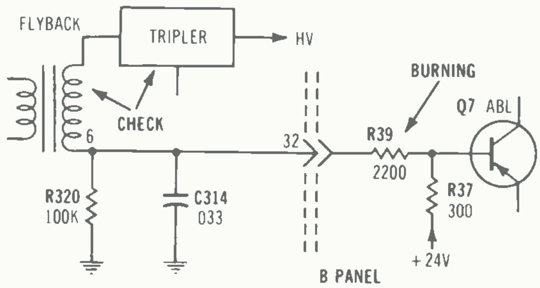
Symptom—Intermittent convergence
Cure—Replace diode D8 on convergence panel; also check diodes D5 and D6 on the mother panel.

Chassis—Magnavox T995
PHOTOFACT—1815-1



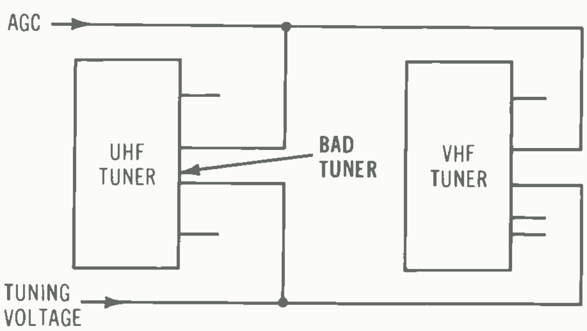
Symptom—Foldover near center of vertical sweep
Cure—L1 vertical choke might have shorted turns; replace it

Chassis—Magnavox T989
PHOTOFACT—1418-2



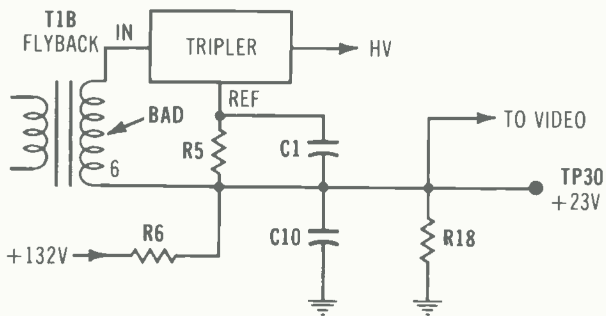
Symptom—No HV and R39 on B panel is burning
Cure—Check regulator transistor, HV tripler and flyback; Replace any that are defective

Chassis—Magnavox T995 with Touch-Tune
PHOTOFACT—1815-1



Symptom—VHF stations drift slowly off channel
Cure—Check for tuning voltage leakage inside UHF tuner

Chassis—Magnavox T995
PHOTOFACT—1815-1

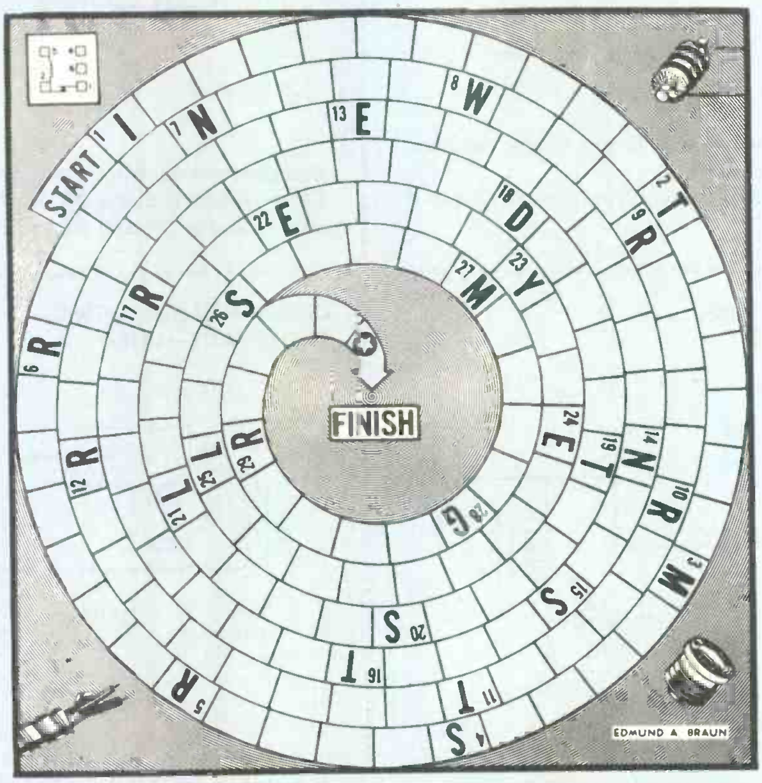


Symptom—Dark picture but good high voltage, and voltage at TP30 is low
Cure—Replace the flyback as a test

Electronic Roulette

by Edmund A. Braun

'Round and 'round she goes, where you are stopped, nobody knows! That's the whole shebang on this Pinwheel Puzzle based on Electronics. The last letter of each word is the first letter of the next word. Each correct answer is worth 4 points, a perfect score is 116. It should prove quite easy except perhaps for someone who thinks "sensor" is someone who eliminates the X-rated words, or believes "vacuum" is where the Pope lives! So pick up your pencil and get a high score. Ready? Then GO!!



1 Starting and stopping periodically.
2 Metallic element used in high-reliability capacitors.
3 Machines that convert electric energy into mechanical energy.
4 Set of plates in a variable capacitor that remain in a fixed position.
5 In TV, a circuit generally using a diode tube which automatically supplies bias voltage to picture tube grid.
6 In a circle, the angle included within an arc equal to radius of the circle.
7 Pertaining to a disc used for scanning areas of an image in correct sequence for a mechanical TV system.
8 Unit of magnetic flux.
9 Unmodulated pattern on a kinescope face.
10 This uses a pawl to prevent reversal of motion.
11 Converts energy from one form to another.
12 Opposition offered by magnetic substance to magnetic flux.
13 Decorative metal wood, or other material around knobs, etc.
14 Radio or TV program dealing with current events.
15 An abnormal connection of relatively low resistance between two points of a circuit.
16 Non-vacuum electronic device similar in use to an electron tube.
17 Converted from ac to dc.
18 Used to hold indexed rotary switches firmly in selected position.
19 Used to adjust receivers to frequency of sender.
20 Sign or letter used to designate something else.
21 Authority granted by the FCC for broadcasting
22 Capacity for performing work.
23 Coils on a picture tube.
24 Pertaining to a closed curve in the form of a symmetrical oval.
25 An optical device which focuses light by refraction.
26 Thin metal vane which has been perforated with an appropriate wave pattern.
27 Muffling or deadening a sound.
28 Material introduced into a vacuum tube during manufacture for greater evacuation.
29 The movable plates of a variable capacitor.

The easiest part of this puzzle is to find the solution on page 41.

people in the news

Terry Banks, general manager of PTS-Indianapolis has been named PTS Electronics' "Man of the Month." Jack Craig, right, PTS regional manager, presented the award to Banks who has been with the firm for six years.

Recent Developments in Arc Suppression for Picture Tubes, co-authored by James W. Schwartz and Mark Fogelson of Zenith Radio Corporation, has been selected the best paper of the 1978 Chicago Fall Conference on Consumer Electronics. The paper reviews past developments in picture tube arc suppression systems and describes a new system, invented and patented by James W. Schwartz, et al.

William L. Thomas, Gary Sgrignoli and Walter S. Ciciora, also of Zenith, took second place honors for their paper, *A Tutorial on Ghost Cancelling in Television Systems*.

George A. Scherer has been promoted to chief engineer, RF Products at Blonder-Tongue Laboratories. Scherer joined the company in 1961.

Thomas R. Shepherd has been appointed senior vice president and general manager of GTE Entertainment Products Group. Shepherd, who succeeds Frank R. Lann, will continue to be located at group headquarters in Batavia, NY.

Robert G. Lynch has been appointed vice president-marketing for the Products Group of GTE. Lynch succeeds Thomas H. Cashin.

The formation of the Sylvania Circuit Products Division has been announced by Roger W. Slinkman, senior vice president-components for GTE Consumer Electronics. The new division, formerly known as the Sylvania Circuit Module Operation, will be headed by Abdulgafoor M. Serang, who has been named vice president and general manager.

Csaba Geczi has been appointed general manager of the Antennas and Accessories Division of Channel Master. Geczi, who has been with the company for eight years, will oversee the major portion of Channel Master's production facilities in Ellenville, NY.

Ervin Kuczogi has been appointed general manager of Chroma Tube, Channel Master's plant for color replacement tube manufacturing in White Mills, PA. Kuczogi was chief CRT engineer at Chroma for six years.

Robert Hynes has been named national sales manager for Philips Test & Measuring Instruments. Hynes has been with PTMI since 1974, and most recently served as eastern sales manager.

Paul F. Bugielski has been promoted to product manager-microphones and circuitry products, Shure Brothers. Bugielski will have responsibility for new product market planning and management, and technical field sales support for the company's microphone and circuitry product groups.

Vaco Products has announced the appointment of David O'Brien as western regional sales manager. O'Brien will be responsible for all sales and rep activity in a 13-state area. O'Brien will be headquartered at Vaco's Western Distribution Center in Gardena, CA.

Harry A. Sanders, electronics program instructor at Clover Park Vocational-Technical Institute in Washington State, has written a 2-page technical report concerning the two types of quadrature detector circuits which are found in most tube-type television receivers. Sanders compiled the report when the textbook he was using failed to provide information that the students needed. □

A second look at waveforms, part 2

By Gill Grieshaber, CET

Many previous explanations about TV vertical-sweep theory are totally wrong. Correct operation is covered in detail here along with the necessity for certain waveforms, how to analyze vertical waveforms and several tips for servicing vertical sweep circuits.

Most explanations of the vertical-output stage in a tube-powered TV receiver describe the main function as power amplification for driving the yoke. This amplification is thought to be moderately linear with only a small amount of distortion introduced intentionally to cancel yoke and transformer distortion.

That explanation appears to be verified by the Figure 1 waveforms. Obviously the plate waveform of the lower trace is an inverted and amplified image of the top trace grid waveform.

Misapplied theory

The circuit operation *seems* to be logical and correct, but that is *not* how the circuit works. Any troubleshooting based on this false theory will produce incorrect results. Those statements will be proved by many facts.

Wrong signal amplitudes

One warning sign is the large signal amplitudes that do not match the dc voltages. For example, it's impossible for any class A or class AB tube amplifier stage to handle an input of 470 V peak-to-peak with a grid/cathode bias of only -50 V.

To produce large output signals without excessive distortion, linear audio amplifiers must position the center of the input waveform at the optimum bias point. Also, the peak-to-peak input amplitude cannot exceed the bias. If the amplitude exceeds the bias, the grid draws current, clipping distortion occurs and dc voltage is generated.

For example, if the large input signal of Figure 1 was applied to a single tube operated with class AB bias, the tube could not handle the 235 peak volts above and the 235 peak volts below the nominal -50 V of grid/cathode bias. Instead, grid current would flow, thus clamping the positive peak and producing about -235 V of bias. However, that is not happening in the vertical-output stage as proved by the lack of a high negative voltage. The same dc voltage is present at each end of the grid resistor.

According to these facts it is *impossible* for the vertical-output tube to amplify the total pulse/sawtooth amplitude that is applied to the grid.

Instead, a positive voltage from the linearity control moves the bias voltage point so it crosses the grid waveform at about the center of the sawtooth portion. This allows a balanced swing of *sawtooth* signal voltage around the bias point. At the sawtooth negative peak tip, the output-tube current must be zero; therefore, the pulse amplitude cannot affect the plate current.

Plate amplitude is limited

Signal amplitudes at the plates of vertical-amplifier tubes range between 800 VPP and 1500 VPP. Such large voltages cannot be produced by amplification.

Without ringing or resonance no amplifier can produce an output signal of higher peak-to-peak voltage than the power supply dc voltage. When a tube is cut off by bias, the plate voltage rises to the supply voltage level. If a tube could be saturated completely, the plate voltage would be zero. Therefore, the maximum range of signal voltages is between the supply voltage and zero.

A vertical amplifier with +255 V between plate and cathode (as in the CTC10) never can have more than 255 VPP of amplified signal at the plate. The plate sawtooth has an amplitude of 90 VPP, which is well within the tube's capability. The other 1300 VPP of pulse amplitude is generated by ringing of the output transformer and the deflection yoke.

Before the true output operation is explained, consider another case of misapplied theory.

Correct yoke waveform?

Many TV textbooks and home-study courses have made the statements and shown the drawings of Figure 2. The usual rationale to explain the pulse/sawtooth waveform of the vertical yoke is as follows:

(A) When the voltage sawtooth

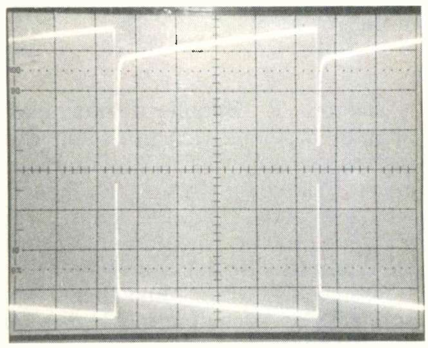
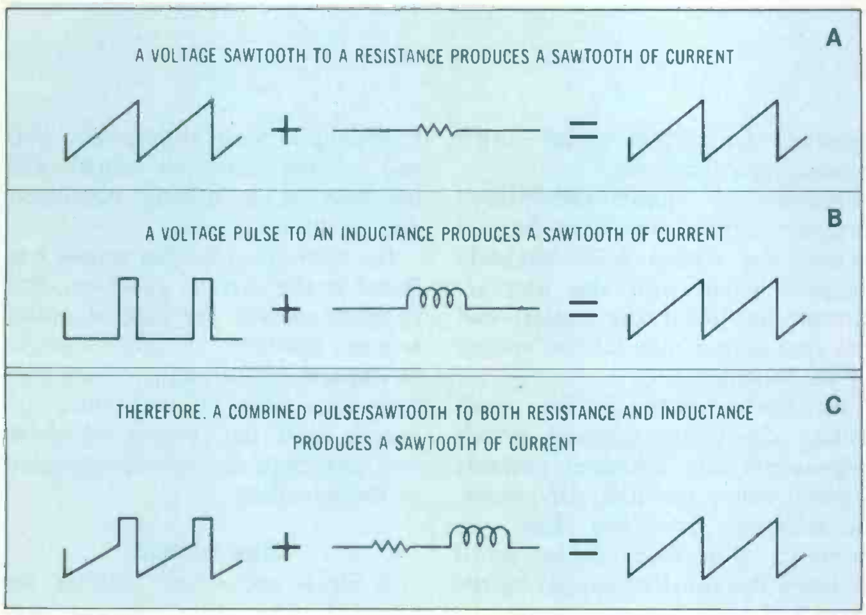


Figure 1 Similarity of the vertical-output grid waveform (top trace) and the output plate waveform (bottom trace) appears to verify that only linear amplification with inversion has occurred.



True? or False?

Figure 2 This is the explanation given most often in textbooks for the combination sawtooth/pulse waveform at the vertical yoke. However, it is wrong. Yoke inductance is not sufficient to produce a sawtooth at that pulse repetition frequency. Instead, the sawtooth part of the waveform produces the deflection.

waveform is applied across a pure resistance, a sawtooth of current flows through the resistance.

(B) A voltage pulse produces a sawtooth of current when it is applied to a pure inductance (one without any dc resistance).

(C) Therefore, the vertical winding of a TV deflection yoke should be supplied with a voltage waveform that combines the correct proportions of sawtooth (for the resistance) and pulse (for the inductance).

Statement A is completely correct. Statement B is correct if a proper match is made between pulse repetition rate and the inductance. But the summary in statement C is wrong. Actually, the vertical yoke is supplied with a sawtooth of *current*, then the pulse amplitude is developed by yoke ringing from the sudden cessation of current.

Tube produces sawtooth only

Any plate signal produced by amplification will be present in the plate/cathode current. To show current variations, a 3.3Ω resistor was added between the 6EM7 cathode and the other components (Figure 3). The resistance is too small to affect the normal operation, but the current produces a voltage drop, and a scope con-

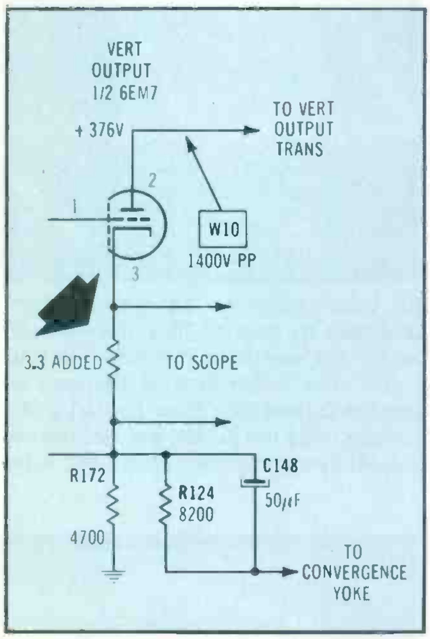


Figure 3 A 3.3Ω resistor was added to the output cathode circuit. A scope connected across the resistor showed the waveform of plate/cathode current. No pulse amplitude appeared in the waveform.

nected across the extra resistor shows the waveform of cathode-to-plate current.

Top waveform in Figure 4A is the 470 VPP combination pulse and sawtooth between grid and cathode of the 6EM7 tube. For the bottom waveform, the scope gain was increased until the 90 VPP of the sawtooth filled about half of the scope screen. A zero-voltage line was added by the scope.

An analysis of Figure 4A lower waveform reveals that the instantaneous grid/cathode bias varies from about -90 V at the start of vertical deflection (left part of the sawtooth) to just a few volts more negative than zero. Although the precise cutoff bias voltage of the tube is not generally know, it seems definite that none of the pulse will affect the plate current, since all of the pulse is more negative than the cutoff bias where the current is zero. Increasing the negative bias beyond the cutoff point can't produce *less* than zero.

Figure 4B shows the plate/cathode current waveform (scoped across the added 3.3Ω cathode resistor) along with the average-current line (near the center) and the zero-current line (at the bottom of the waveform).

At the zero-current line, each falling edge of the sawtooth (which represents the retrace) extends slightly below the line. Of course, no tube can draw less than zero current; therefore, these small negative tips must be caused by the large grid pulse feeding through the grid/cathode capacitance.

The current waveform clearly shows that zero current flows at the beginning of vertical deflection (left end of the sawtooth slope) and increases at a slightly non-linear rate to the maximum.

No trace of amplified pulses was found in the current waveform. But to make certain the lack of pulses was not produced by critical height or linearity adjustments, those controls were adjusted over their full ranges while the current waveform was observed. No pulses appeared in the waveform.

Yoke current

It does not seem possible for vertical tube plate current that varies between zero and positive to produce yoke current that *must* vary from negative to positive with

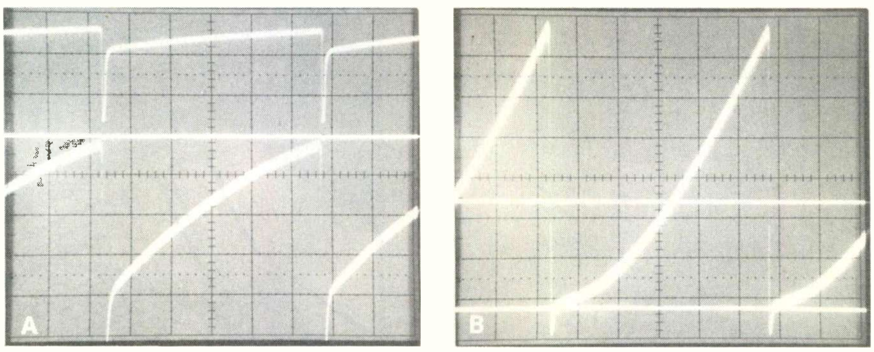


Figure 4 Top waveform of picture A is the usual waveform between grid and cathode. Lower trace is the same signal expanded by gain of 20 V/div and with a zero-voltage line added by the scope. During the sawtooth the instantaneous grid voltage went from about -93 to about -3 V. The B waveform is the cathode current across the 3.3Ω resistor with an average-current line (near center) and a zero-current line added by the scope. The small negative pulses are not caused by plate/cathode current because control adjustments did not change the pulse amplitude.

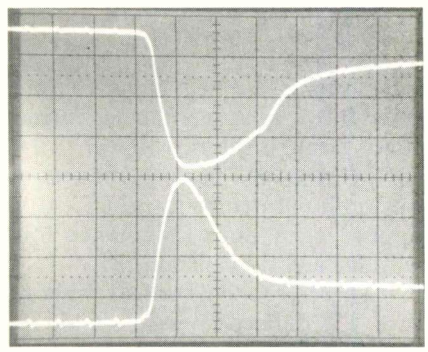


Figure 5 When the waveforms were expanded horizontally by the Tektronix model T935A scope, the grid pulse at the top was wider than the plate pulse (bottom trace). This difference indicates the output pulse was not produced by simple amplification.

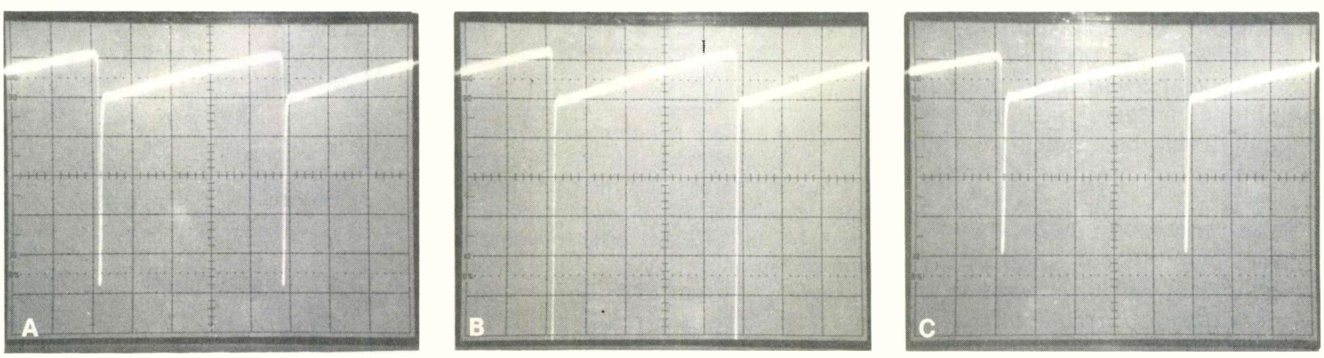


Figure 6 Control adjustments changed the pulse amplitude but not the sawtooth amplitude. Picture A shows the normal output-plate waveform when the picture had normal height and good linearity. When the height control was turned fully clockwise and the linearity control was adjusted for the same total height as before, the waveform (B) showed unchanged sawtooth amplitude but increased pulse height. The raster was compressed at the top. For waveform C the linearity control was rotated fully CCW and the height control was adjusted for a total picture height that equalled A. The linearity was spread at the top. Therefore, total height (disregarding nonlinearity) is determined by the sawtooth amplitude and not the pulse height.

zero in the center during both trace and retrace. But the two are compatible because the tube current does not drive the yoke directly. Instead either a capacitor or a coupling transformer removes the dc. The sawtooth yoke current is symmetrical. Therefore, in the absence of dc, the zero-current line is exactly in the center.

Effects of controls

At the vertical-output grid, height-control variations changed the amplitudes of both the pulse and sawtooth sections. Adjustments of the linearity control (which changes the grid/cathode bias) moved the zero-voltage line nearer or farther away (less or more negative bias) from the tip of the sawtooth. When the adjustment tried to move the line below the tip (positive grid bias), the sawtooth tip was clipped because of grid-current loading, and the clipping caused bottom foldover on the TV screen.

Wider/narrower pulses

More evidence is found in Figure 5 waveforms where the grid and plate pulses have been expanded by the scope. The grid waveform is much wider, indicating that it originated as a square-tipped pulse. By contrast, the plate pulse has a sharp tip and the general look of a pulse formed by highly-damped ringing.

Pulses versus height

One of the handicaps of believing incorrect basic theory is that often the wrong parameters are measured, leading to confusion and errors. That can happen if a technician judges the amount of vertical deflection by the amplitude of the *total* waveform, which is composed mostly of pulses. The fallacy of judging sweep by pulse amplitude is illustrated by the next few waveforms.

Figure 6A shows the normal output plate waveform for a full raster having good linearity. The B and C waveforms have different kinds of poor linearity, but they also have the same raster height as A.

Remembering that all three TV rasters had the same total height, carefully examine the sawtooth amplitude and the pulse amplitude in each of the three scope waveforms. The three sets of pulses have drastically different amplitudes, but the sawtooth amplitudes are the same for all three waveforms.

Therefore, *the sawtooth amplitude of the vertical yoke waveform determines the raster height on a TV screen.* Pulse amplitude in the combination waveform has no particular significance except that each model has a certain normal amplitude.

60-Hz injection test—A quick test for multivibrator vertical-sweep circuits is to connect a 0.1 capacitor between the 6 V heater voltage and the oscillator grid or the output

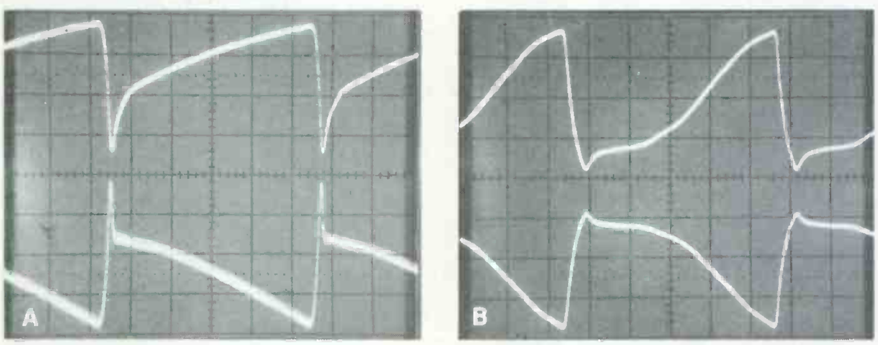


Figure 7 Picture A shows the output tube grid waveform at top and the plate waveform (bottom trace) when a 60-Hz sine wave was injected at the oscillator grid. Controls were adjusted for full height with fair linearity on the TV screen. Picture B top trace is the grid waveform and the bottom trace is the plate waveform when 60 Hz was injected at the output grid. Height was about 5 inches, but the linearity was severely stretched at the top of the TV raster. These waveforms reinforce the statement that the sawtooth (not the pulse) determines the height.

grid. Normal TVs show some height then, although the linearity is not good and the picture rolls steadily downhill during color programs.

Waveforms for the CTC10 when the sine wave was injected at the oscillator grid are shown in Figure 7. Top trace of Figure 7A is the output-grid waveform while the plate waveform is shown by the bottom trace. Controls were adjusted to obtain full height with fair linearity. Notice that the pulses are small.

In Figure 7B when the sine wave was injected at the output grid, the top trace is the output grid waveform, and the bottom trace is the output plate waveform. The TV picture had a 5-inch height with poor linearity. No pulses are present in either waveform, again proving that pulses are not required for vertical deflection.

Although a 60-Hz sine wave was injected in both tests as a substitute for an oscillator signal, no trace of a sine wave was found at the output plate. Rectification by the first grid it reached changed the sine wave into wide and distorted pulses that were further modified by the wave-shape R/C filters into approximations of the correct output plate waveforms.

Solid-state proof

The output waveforms of solid-state vertical systems usually have small pulse amplitude and larger sawtooth amplitude. Some circuits have diodes to clip the pulses (strong pulses can ruin transistors) while others have pulse clipping as a hidden byproduct.

All these items of proof emphasize that the pulses are not essential. In tube circuits, they produce faster retrace, and the high amplitudes are tolerated because they are harmless. The design of solid-state circuits deliberately minimizes the pulses. In all cases, it is the sawtooth part of the waveform that causes vertical deflection.

Waveform exceptions

After a thorough study about the distortions of a square wave as it

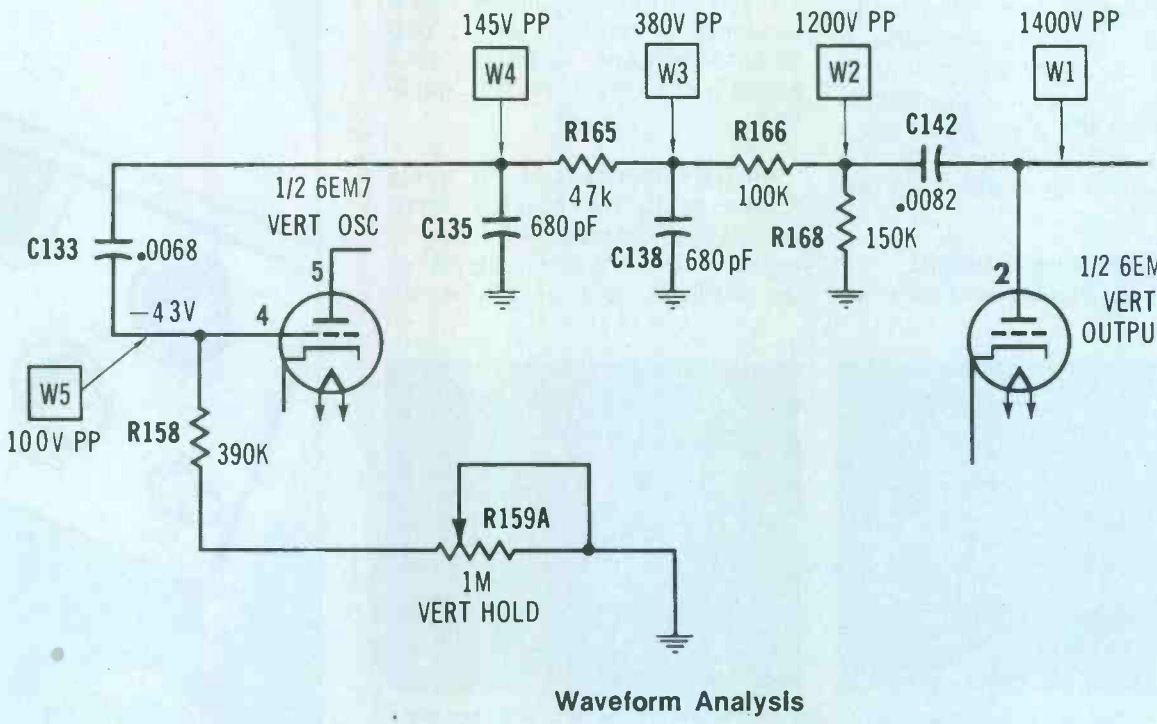


Figure 8 These are the component values and peak-to-peak signal voltages measured in the positive-feedback path of an old RCA CTC10.

passes through various resistance/capacitance filters, a technician should be able to follow a schematic and know approximately what the waveshape should be at each point.

However, there are exceptions that complicate the analysis because of multiple paths or the unexpected conduction of a diode. Some examples will be shown in the waveform analysis of vertical sweep.

Vertical-feedback waveforms

As previous discussions have settled questions about the proper output waveform at the vertical-output tube in an RCA CTC10 chassis, the remainder of that sweep circuit will be analyzed, with the emphasis placed on unique waveforms.

Figure 8 shows the positive-feedback path from the plate of the 6EM6 output tube to the oscillator grid. (Of course, both stages make up the multivibrator oscillator. But those labels are easier to keep straight.) The corresponding waveforms are in Figure 9.

W1 waveform has been analyzed before as consisting of sawteeth and pulses.

Capacitor C142 and resistor R168 form a high-pass (low-frequency cut) filter. Therefore, the W2 waveform is similar to W1 except the sawtooth tilt has been removed and the amplitude is slightly lower.

The tilt should be removed at W2 to prevent a problem further downstream. Before the pulse waveform reaches the oscillator, the amplitude must be reduced and all horizontal-sweep pulses removed by low-pass filters. Both are done by the R166/C138 and R165/C135 filters, that incidentally reduce the pulse amplitude more than the sawtooth amplitude. Unless the sawtooth tilt is removed before the low-pass filters, it will be excessive at the oscillator. Those pulses don't contribute any deflection, but they are used for oscillator feedback.

W3 shows the reduced amplitude and the rounded corners produced by the R166/C138 low-pass filter. Those effects are more pronounced following the R165/C135 filter. Notice that the sawtooth tilt is more prominent as the pulse amplitude is reduced.

None of these previous waveforms needed zero or average lines. However, those lines will be valuable in analyzing W5.

Knowledge gained from square-wave analysis predicts that the W5 waveform *should* be identical to W4, with the possible exceptions of less sawtooth tilt and the addition of some dc voltages from the grid current. But the W5 waveform seems to be totally different from W4. Common sense cannot explain why it is different.

Oscillator-grid waveform

Positive-going W4 pulse passes through C133 and causes diode-type conduction between grid and cathode. This clamps the positive tip of the waveform to zero volts. (Remember, it was started last month that clamping a positive peak produced negative voltage.) Therefore, the trailing edge of the pulse plunges to about -93 V. Follow this series of actions in W5 of Figure 9.

The trailing edge of the pulse in W5 ends at about -93 V. At the grid (after the waveform has passed through C133), it seems logical that the base line between pulses will be flat, because C133 should have removed the sawtooth tilt. However, C133 is too small to hold the charge without loss for the amount of time between pulses. So, C133 discharges through R158 and R159A at a rate that follows the text-book voltage-discharge curve (except it is inverted since the charge is negative.)

C133 continues to discharge to a less-negative voltage. At about -16 V, the oscillator barely begins to draw some plate current. If left to itself, the circuit will oscillate shortly afterward, because the oscillator current drives the output, and its pulse in turn drives the oscillator grid. At this time, however, the vertical sync arrives and it forces

Waveforms

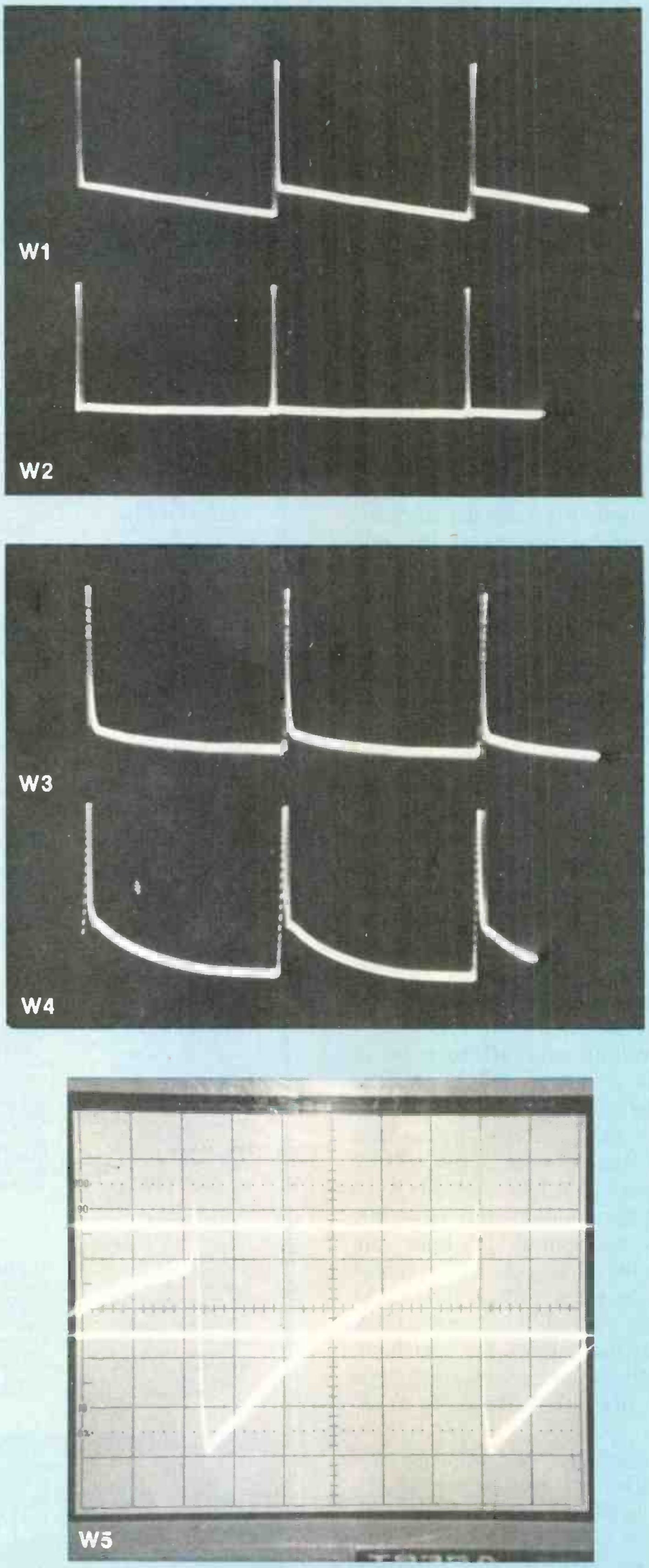


Figure 9 Numbers of these waveforms correspond to Figure 8 schematic. The Tektronix scope has added a zero-voltage line near the top and the average-voltage line near the center of the W5 waveform.

the output tube into conduction a bit sooner. That starts the regenerative effect. A less-negative oscillator grid allows more plate current which reduces the grid voltage of the output tube. In turn, the reduced grid bias increases the output plate voltage, and it is coupled through the positive feedback loop to the oscillator grid where the rising pulse triggers the oscillator into conduction. This entire regenerative cycle occurs too fast to be seen on the scope, but it ends with a large positive pulse that is applied through C133 to the oscillator grid. In fact, the waveform W5 shows that the pulse travels to about +7 V before the grid current clips it. That accounts for the 45 V difference between W4 and W5.

Next, the grid/cathode current clamps the waveform again; the pulse trailing edge goes negative and the slow C133 discharge allows it to drift toward zero volts. This is slightly more than one vertical cycle.

Locking

Two conditions must be met for the vertical circuit to lock properly. The R/C time constant (C133 and R158/R159A) at the oscillator grid versus the maximum negative charge in C133 must be adjusted to cause the oscillator to operate slightly slower than the 59.95-Hz field rate. Then the sync starts the cycle at the right time for correct locking.

C133 has a fixed capacitance, but the resistance of the R/C circuit is adjustable. This ability to adjust the time constant is necessary because *a different pulse amplitude reaching C133 will change the discharge time and thus the operating frequency.* Therefore, even a change of picture height varies the free-running frequency.

For example, if the picture is locked and then the height is increased moderately, the negative C133 charge is increased and (if the locking is not tight) the vertical will roll upward very rapidly.

Zero and average lines—The top line in W5 is the zero-voltage line.

Only those pulse amplitudes slightly above and below the line are in the bias range that can cause oscillator plate current. Therefore, all of W5 waveform is more negative than cutoff bias except the positive pulse that causes conduction. In turn, the tube conduction produces negative-going pulses (which cannot be scoped directly) at the plate.

The line near the center of waveform W5 is the average-voltage line. It was stated last month that the peak voltage between the zero and average lines equals the dc voltage as measured by a meter. Both the scope and a dc meter gave readings of -43 V.

This -43 V of grid bias is not an absolute voltage. It varies with height changes and with adjustments of the vertical-hold control. In fact, the voltage can be bent a few volts either way by moving the hold control within the limit of the lock-in point. But if the voltage varies because of capacitor leakage, resistor drift or other variables, the vertical-sweep frequency will change and locking will be lost.

Waveforms without grid loading

C142 was disconnected from the tube, and while the TV power was off, positive-going narrow pulses from a VIZ generator were connected to C142 in an attempt to duplicate the normal sweep waveforms (W2, W3, W4 and W5). The experiment was not successful. The waveforms changed according to square-wave theory, but they didn't match the actual ones.

Finally, a *separate* positive-feedback network was breadboarded. The values of C142, R168, R166, C138, R165, C135, C133 and R158/R159A were measured and wired together. The vertical sweep was working normally, and the extra network was connected only to output plate and to ground. All of the W1B through W5B waveforms were measured and photographed (see Figure 10). No tube or transistor was connected to the W5B waveform.

Of course, W1B is identical to

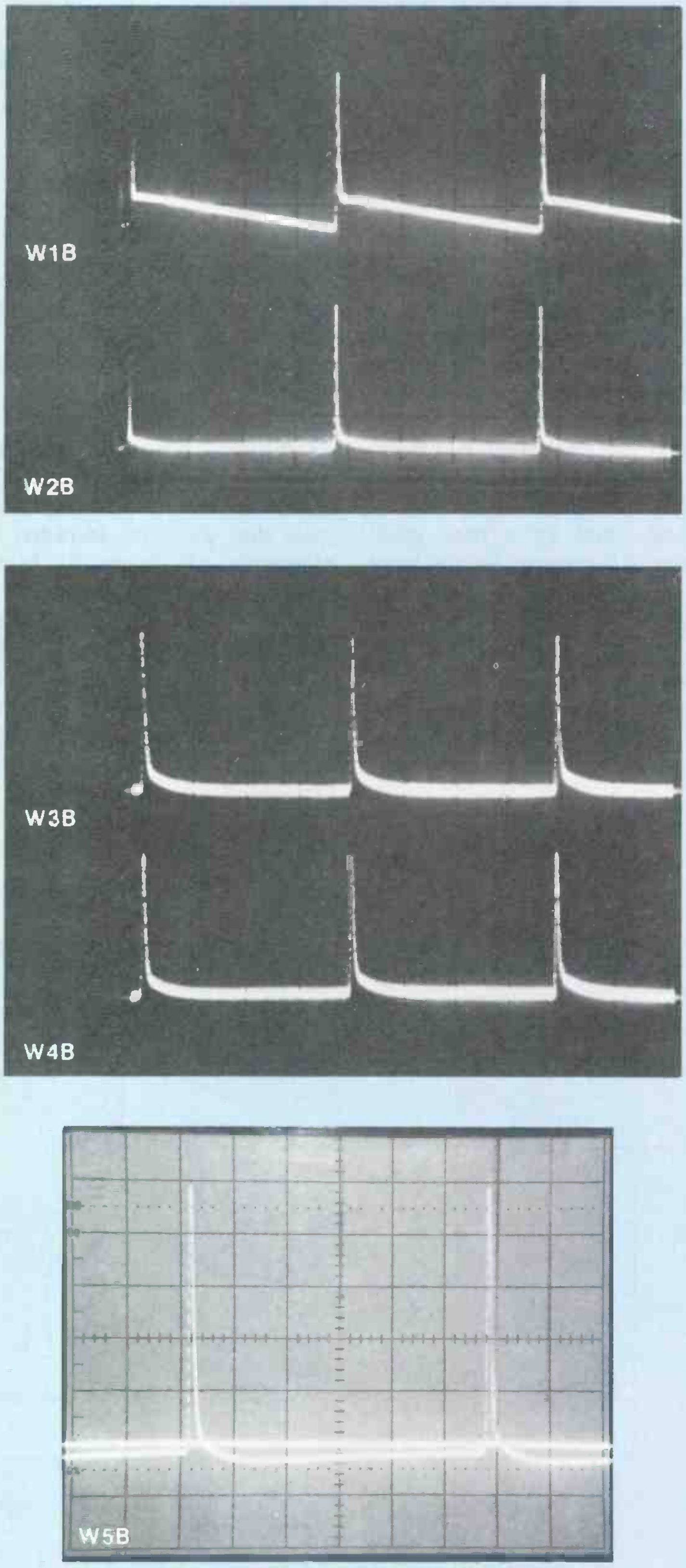


Figure 10 To determine how the Figure 9 waveforms would change if the oscillator grid current was removed, a separate positive-feedback path was constructed without any diode at C133. These waveforms follow square-wave theory for such filters, thus proving that oscillator grid current produces the unique W5 grid waveform.

the original W1. Other waveforms showed only a slight rounding of the edges, and the pulse amplitudes were much higher than the actual ones. The sawtooth tilt was smaller by comparison with the larger pulses. But the important waveform was W5B. It was virtually identical with the original W4.

Could the lack of a tube grid/cathode at W5 account for the huge change of waveform? A diode was connected at W5B as a substitute for the oscillator tube, and the new W5B waveform was identical with the original W5. All other waveforms then were identical to their counterparts, including the amplitude.

Therefore, all deviations from the waveforms predicted by square-wave theory were caused by grid/cathode current of the oscillator tube!

Oscillator/amplifier waveforms

Figure 11 shows the RCA CTC10 oscillator and power-amplifier circuits that were not included in the schematic of Figure 8. Matching waveforms are in Figure 12.

The W5 waveform in Figure 12 was described previously in Figure 9, where the zero line proved that only the small positive tip provides the low bias necessary for a flow of plate current. The pulse-shaped bias should produce a larger negative-going pulse at the plate. A 100 Ω resistor was added between cathode and ground, and the W6 waveform scoped across it verified the narrow pulse of current.

However, the W7 plate waveform does not show the predicted pulses. Instead, the waveform is a combination of pulses and sawteeth. What component or circuit action added the sawteeth?

Creating sawtooth waveforms—A combination of pulses and sawteeth can be obtained as shown in Figure 13 by connecting a resistor and a capacitor in series from the V107A oscillator plate to ground.

To visualize this action the

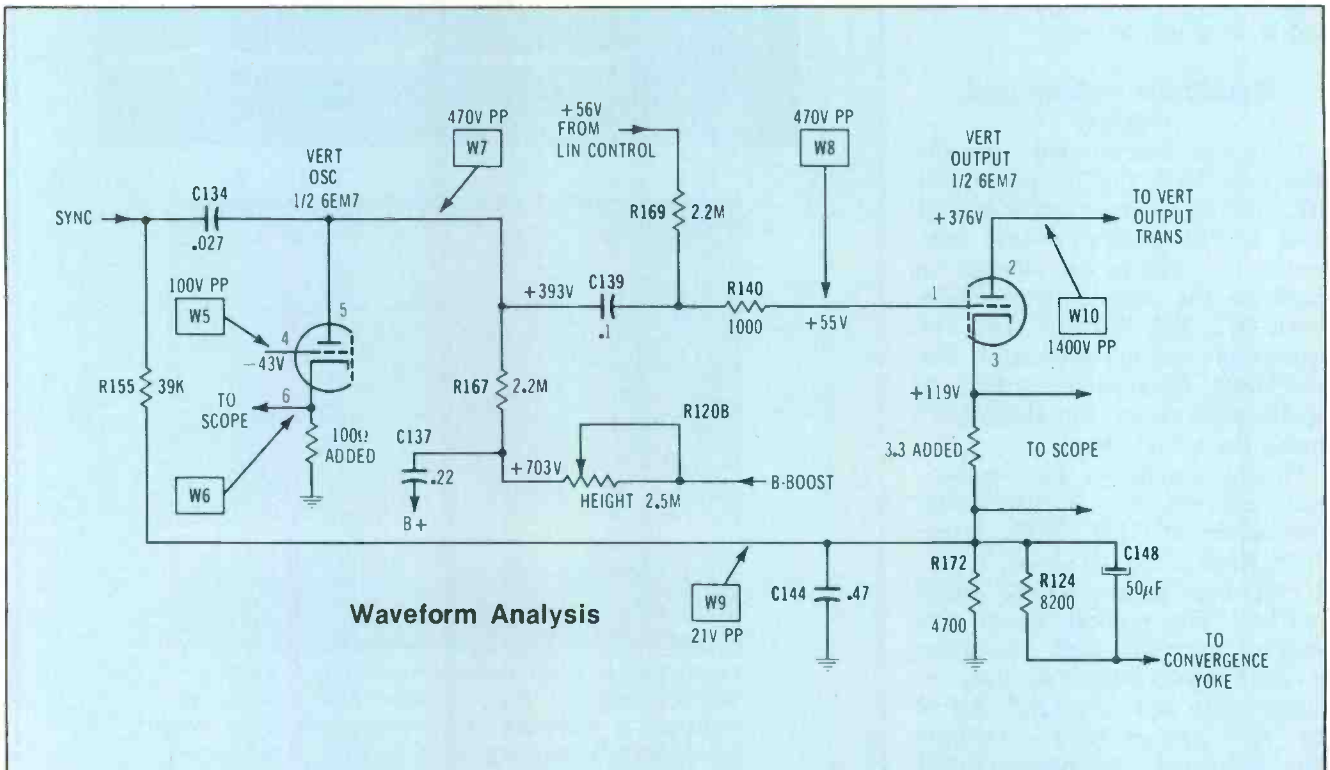


Figure 11 This schematic completes the Figure 8 schematic and shows the RCA CTC10 amplifying path. Waveform W5 is the same in both diagrams. Two resistors have been added to permit viewing of oscillator and output-cathode current waveforms. Corresponding waveforms are in Figure 12.

easiest way, imagine that C134 capacitor is shorted which leaves only R155 from plate to ground. The dc and signal levels are greatly reduced, but the waveform shows negative-going pulses and nothing else.

Next, imagine that R155 is shorted but C134 is okay. C134 is connected from plate to ground, and the pulses are integrated into sawteeth.

Therefore, when both the resistor and capacitor are in the circuit, the waveform is a combination of both pulses and sawteeth. Larger resistor values increase the pulse amplitude, and a larger capacitance decreases the sawtooth amplitude. These values can be varied to obtain the desired pulse/sawtooth ratio.

The actual Figure 11 circuit adds one more function. Filtered vertical sync is injected between C134 and R155, thus the R/C filter does two functions. Negative-going sync enters through C134 to reduce the oscillator plate voltage and control the locking.

Height adjustment—The gain of an audio tube is increased when the plate-load resistance is increased. Gain of an oscillator (pulse amplifier) is *not* changed by the plate resistor, but other factors determine the output amplitude as the resistance is varied. In vertical circuits, for example, a larger total resistance from B-boost to oscillator plate decreases the pulse/sawtooth waveform amplitude. And a smaller resistance increases the amplitude.

Figure 14 explains the separate actions for pulses and sawteeth.

More waveforms

Waveform W8 (output grid) in Figure 12 is identical to the W7 waveform at the oscillator plate. Any difference indicates a defect. C139 coupling capacitor and R169 output grid resistor both have large values, and such a long R/C time

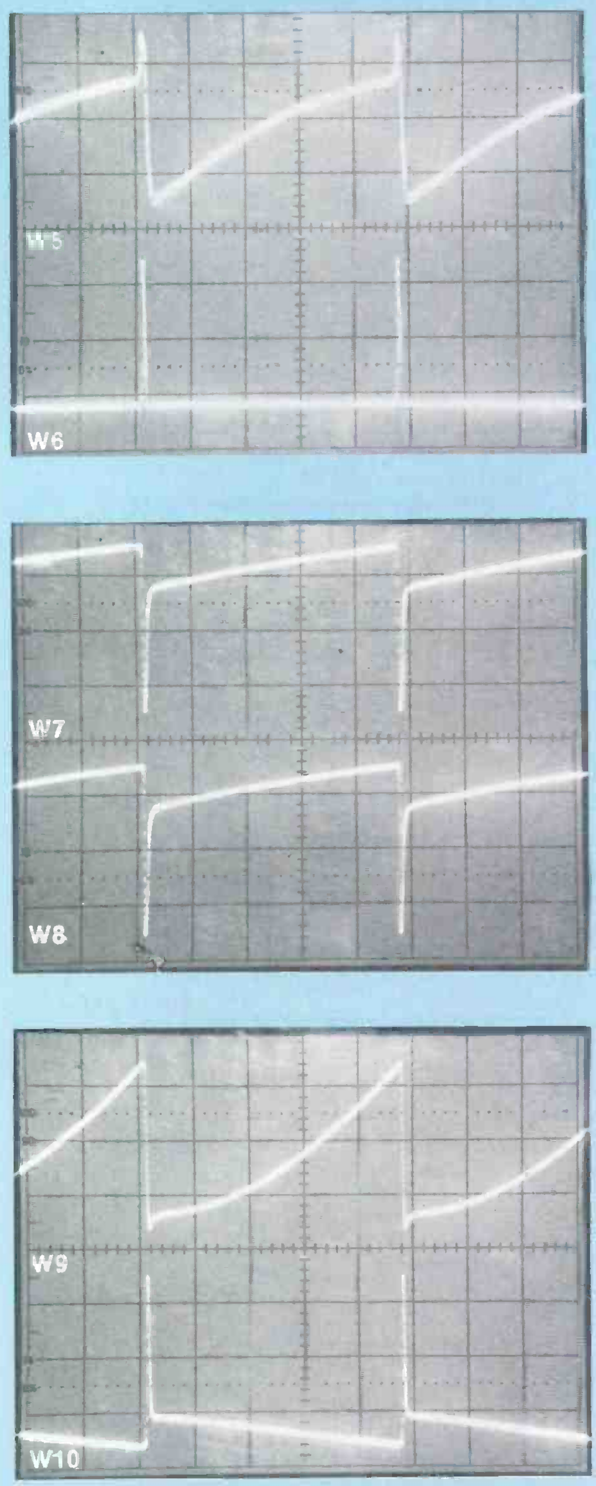
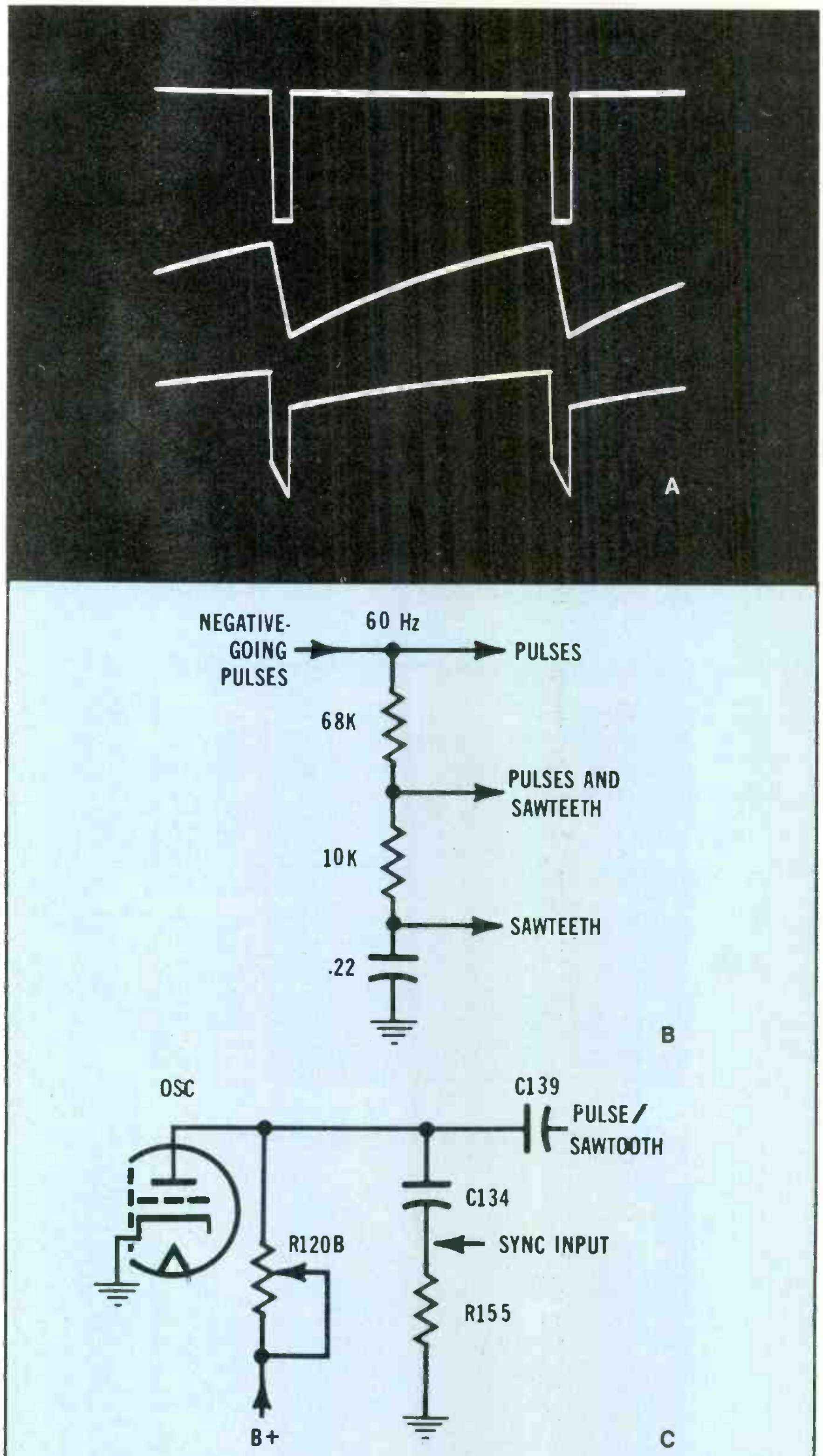


Figure 12 These are the waveforms of Figure 11 schematic.



Combined Pulses and Sawteeth

Figure 13 (A) Negative-going pulses (top trace) from VIZ model WR-549A can be changed into sawteeth (center trace) and combination pulse and sawteeth (bottom trace) by the B schematic. (C) The CTC10 schematic does about the same as the previous circuit. However, some of the components are hidden. In effect, the pulse enters at the cathode, with the plate resistance representing the 68K resistor of B, while the 10K resistor and the .22 μF capacitor take the place of R155 and C134. Therefore, the pulses appear in the cathode current but cannot be scoped anywhere else.

constant passes the pulse/sawtooth signal to the grid without tilt or any other significant change.

Bias of the output tube is determined by the amplitude of the grid waveform versus the positive voltage at the grid. This positive voltage comes from the linearity control, and it moves the grid/cathode zero-voltage line nearer or farther from the positive tip of the sawtooth. These factors determine the flow of output-tube current at the beginning of deflection (top of TV raster).

Incidentally, don't rotate the linearity control any more clockwise than *barely* enough to provide good linearly at the top of the picture. As the grid-to-ground positive voltage rises, the cathode dc voltage rises almost in step. Notice that the cathode-to-ground voltage effectively subtracts from the B+ supply. Therefore, an excessive linearity setting prevents full deflection at the raster bottom. For a TV that won't quite fill the screen, back off the linearity and increase the height-control setting.

Cathode waveform W9 is almost identical to the cathode-current waveform of Figure 4B. That's because most of the cathode bypassing by C148 is through the convergence-circuit resistance. Waveform W10 is the output-tube plate waveform which has been analyzed before.

Tips for servicing vertical sweep

Multivibrator-type vertical-sweep circuits have caused many problems for technicians over the years. Because of the closed loop, the symptoms have been confusing. A bad waveform at one point probably ruined the waveforms at others. Defects that would have reduced the height alone (if the circuit only amplified) also caused a wrong frequency with severe loss of locking. On the other hand, a large change of frequency often reduced the height.

Observant technicians have noticed that linearity and height adjustments often varied the vertical frequency sufficiently to cause a loss of locking. Also, they noticed that defective components far removed from the hold control produced severe frequency errors that were impossible to correct with the hold control.

Many of these puzzling cases can be explained by a clear understanding of the charging and discharging of the R/C time-constant that is mostly at the oscillator grid circuit. Any defect of those components changes the operating frequency.

The amplitude of the pulse that charges the time-constant capacitor (C133 in Figure 8) is very critical. In the previous discussion, it was assumed that the postive-feedback pulse originated at the input end of C133. That's only approximately correct. This amplitude is determined by the pulse voltage at the output plate plus all of the components between there and C133.

For example, an open C135 increases the pulse amplitude at C133, which increases the C133 charge. That higher negative voltage requires longer to leak away, so the vertical frequency is reduced (picture flips upward rapidly). If C138 has a leakage of 100K, the pulse downstream at C133 is reduced to about half amplitude. The negative voltage is lower, the frequency is higher and the picture rolls down.

Further complications arise because all the positive-feedback components are in series with the input side of C133 during the discharge part of the cycle. Where can C133 discharge to if R168 is open? R165, R166 and R168 all affect the discharge time. That's why a shorted C142 changes the frequency so drastically; it has the effect of shorting out the 150K resistance of R168.

Heat changes

One of the typical vertical problems is a slow downward movement of the picture after the receiver is thoroughly warmed. A leaky C133 that's sensitive to heat is a likely suspect. Heat it slightly with a soldering iron and then cool it with canned coolant as a test. Don't use an oridinary disc ceramic as a replacement.

Check the positive feedback

Normal amplitude reduction in the positive feedback loop of most vertical multivibrators occurs in several *gradual* steps. This fact can be the basis for a fast test of the feedback loop, if there is some picture height. Any large amplitude reduction indicates a defect at that point or in a component just upstream.

One prime suspect is any capristor (combination capacitor and resistor). Many have been troublemakers. Replace them with separate components of the same values.

These quick checks plus an understanding of the true circuit operation should make vertical-circuit repairs much easier.

Editor's Note: Similar combinations of updated circuit theory and practical tips should be helpful when applied to other electronic subjects. Send your comments or questions to:

Carl Babcoke
Electronic Servicing
P.O. Box 12901
Overland Park, KS 66212 □

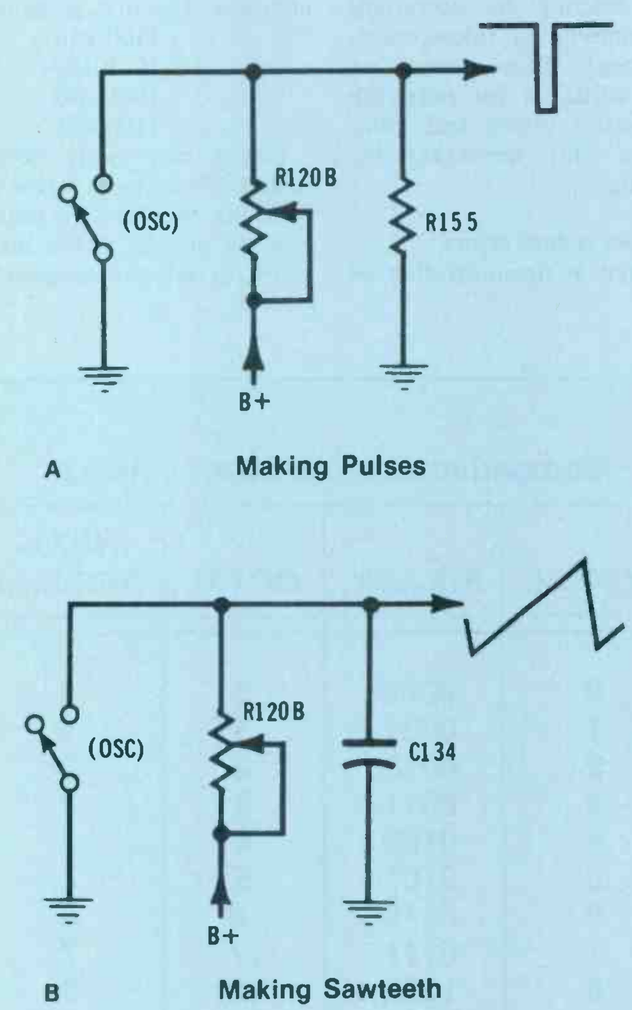
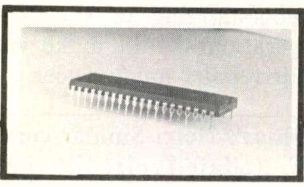


Figure 14 Variations of R12OB height control's resistance affects the amplitudes of both sawteeth and pulses, but the operation is different. (A) Negative pulses are formed by oscillator tube conduction. When the tube does not conduct (switch open), the positive voltage between pulses is determined by the R12OB/R155 ratio. Larger R12OB resistance reduces the maximum positive voltage. (B) Sawtooth amplitude is determined by the time constant of R12OB and C134. When the resistance of R12OB is increased, C134 cannot charge to the previous higher voltage before the next cycle begins with tube conduction which discharges the capacitor. Therefore, the amplitude is smaller.



Digital numbering systems

By Jack Webster

Any combination of numbering systems can be used with microprocessors. Therefore, digital technicians must know the basic facts about each system, and be able to convert from one to another. Methods are given here.

Various number codes are employed to describe the operations and programming of microprocessor equipment. These codes are extremely valuable for reducing human operator errors and minimizing the time necessary for programming.

Codes reduce errors

As a practical demonstration of codes, copy the next two series of numbers. The first series is:

11001010
10110100
10011010
11000101

Errors can easily occur when writing these long series of numbers. But those 8-digit binary numbers are typical of the instructions given to microprocessors. Many microprocessors use 8-bit numbers in groups of one, two or three bytes.

Comparisons of number systems

DECIMAL	BINARY	OCTAL	HEXA-DECIMAL
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

Write these numbers and check them for mistakes:

2B
20
F1
96

Two letters or numbers are much easier to handle accurately than the previous 8-digit bytes. The last examples are in hexadecimal code, and each represents a complete 8-bit byte.

If a keyboard is used to program a microprocessor for a certain job, *hexadecimal* code numbers are typed. However, internal circuits convert those hex code letters and numbers into 8-bit binary bytes that are sent to the microprocessor.

Also, the *octal code* frequently is employed in microprocessor operation. Each three-octal digit represents an 8-bit byte. These are examples of octal numbers:

142
056
101
110

The last two numbers could be mistaken for binary code, so it is obvious that some confusion can occur when the type of code is not known.

Radix

When there is danger of wrong identification of codes, the number is marked with its *radix*. The radix of a numbering system is the *number of symbols* required to write any number in the system. For example, ten symbols are used in the decimal system, so it has a radix of 10. The binary system has a radix of 2, the octal system radix is 8, and the hexadecimal radix is 16.

The radix is written as a subscript beside the number when identification is desired to prevent confusion and errors. The following are examples of the number 11 as written in four systems:

- Binary 11_2 (equals decimal 3);
- Octal 11_8 (equals decimal 9);
- Decimal 11_{10} (equals decimal 11); and
- Hexadecimal 11_{16} (equals decimal 17).

A comparison of the first sixteen numbers in each system is provided in Table 1. These are the numbering systems most often encountered in microprocessor instructions.

Converting one system to another

Octal and hexadecimal numbers are more convenient for human operators, but a microprocessor can accept only binary numbers. Therefore, it is necessary to convert the numbers of one system to those of another.

Procedures for number conversions are very simple and easy to remember. Examples of 8-bit numbers will be used since they are the most common in microprocessors.

Binary to octal

Divide the binary number into groups of three digits, starting at the right and ending at the left. If the last group at the left does not have three digits, add zeros to complete the three. (This does not change the value of either the binary or octal number, but it simplifies the calculation.)

Here is a sample calculation:

number to be converted	11011110
groups of three digits	011 011 110
octal value from table	3 3 6

Therefore, 11011110_2 equals 336_8.

Binary to hexadecimal

This procedure is similar to the previous conversion to octal, except the binary numbers are separated into groups of four digits.

number to be converted	11011110
groups of four digits	1101 1110
hexa value from table	D E

Therefore, 11011110_2 equals DE_{16}.

The same binary number was used for both examples. So, the results can be stated as: $11011110_2 = 336_8 = DE_{16}$.

Octal to binary

The binary-to-octal conversion that was explained before is reversed here.

number to be converted	143
change each to binary	001 100 011
combine but drop left zero	01100011

Therefore, 143_8 equals 01100011_2.

Hexadecimal to binary

Essentially this is the reverse of the binary-to-hexadecimal conversion.

number to be converted	4C
change to 4-digit binaries	0100 1100
combine into 8-digits	01001100

Therefore, $4C_{16}$ equals 01001100_2.

Other codes

Studies of other number codes will be necessary as the microprocessor course continues. □

Review

All signals inside a microprocessor (and signals into or out of it) must be in digital form (highs and lows). Each Binary digIT is called a *bit*, and a group of bits is called a *byte*. Many microprocessor bytes have eight bits.

Microprocessor memories are of two types. Read-Only-Memory (ROM) ICs have the digital information permanently stored inside. This data can be retrieved as often as needed, but it can't be changed or erased. Random-Access-Memory (RAM) ICs are the read/write type that can accept data for storage. The data can be retrieved as needed, or new data can be stored to replace previous data.

Most of the explanations have been about RAMs because they have nothing stored until data is programmed into them. This important extra step must be understood.

Highlights of 1980 products

These are summaries of 1980 TV, audio and videocassette product lines listed according to manufacturers.

General Electric

Highlights of the 1980 General Electric line include a simplified and improved VIR Broadcast-Controlled Color system, the new 19-inch EC (Energy Conscious) chassis, crystal-controlled all-channel tuners, microprocessor-controlled infra-red remote controls and a four-hour VHS videocassette recorder.

Three types of Quartz tuning are offered. Model ET82 tunes in all VHF and UHF channels with three revolutions of one knob. Rotary switches manually select proper inputs of the programmable divider in the phase-locked loop (PLL) which is the same for the three systems. Model MMP82 has a random-access manual pushbutton keyboard. MP82 also has microprocessor-controlled tuners plus all-channel programmable remote control. Either random-access or automatic scan of programmed channels may be selected. The remote can be customer programmed for up to 20 channels. Because of the phase-locked loop, there is no need for any manual or automatic fine tuning. Channels are indicated by digital readouts.

Color Monitor II operates when the VIR switch is on but the station has no VIR signal. It provides skin-color and saturation stabilization without adversely affecting other hues.

All 19-inch GE color receivers are equipped with the EC chassis. Five circuit boards are mounted vertically on the metal frame to allow air flow around the components, and the cabinet air vents are larger. This 28-kV chassis uses about 100 W compared to 143 W for the previous model. Total reduction of interior temperature is about 18 F, which is said to double the reliability.

Count-down circuits provide vertical and horizontal signals without hold controls. High-voltage diodes are mounted inside the high-voltage transformer for increased reliability. Visible 920-kHz picture beats are minimized by a synchronous product detector.

A new 19-inch picture tube has 90 degree deflection and unitized guns. Focus voltage is 8.5 kV, and auto-convergence eliminates most adjustments.

One important feature of GE's 4-hour programmable VHS videocassette recorder is the pushbutton 12-channel electronic tuning. The programming allows recording of five TV programs on different channels for each of seven days. Also, the recorder has a built-in electronic timer, tape counter with memory and a remote pause.

In addition to the full line of picture tube sizes and cabinets, General Electric offers the Widescreen-1000 projection TV with an internal screen that has more than three times the area of a 25-inch picture.

Hitachi

Eleven color and one monochrome TV receivers were displayed at the Consumer Electronic Show (CES). Model CK-200 is a 5-inch portable color TV that operates from line voltage or 12 Vdc. The electronic tuning has two buttons (one up and one down) for the station search tuning.

Model CT-989 is a 19-inch color receiver with remote, random-access station selection in addition to search, VIR color control and wood cabinet. Other models are in 13-inch and 15-inch screen sizes. Model I-62 is a 9-inch monochrome portable receiver.

A stereo portable combination is model TRK 8181H that features programming. A Digital Random-Program Selector counts the times between selections when nothing is recorded. Using these as references, this circuit allows the user to select musical numbers out of sequence by fast forward or rewind to the desired spot. Two tweeters with two woofers, two volume meters, microphone mixing and digital readout of the program in progress are other features.

Model TH-6100H is a pocket-sized AM radio with a slide-rule dial and an LED for tuning indicator.

Magnavox

Increased use of electronic tuning and improved sound quality are two general features of the 1980 Magnavox line. Loudness controls that boost both low and high frequencies at low sound levels and increased audio power are changes made for all 19-inch and 25-inch models. A voice/music switch is included in all 25-inch Star and Touch-Tune models, except those having separate amplifiers.

The high-resolution comb filter that provides wider video bandwidth is included in 76% of the new TVs.

In the 5000 series are eight Star tuning systems and 14 10-button Touch-Tune models. All have remote controls.

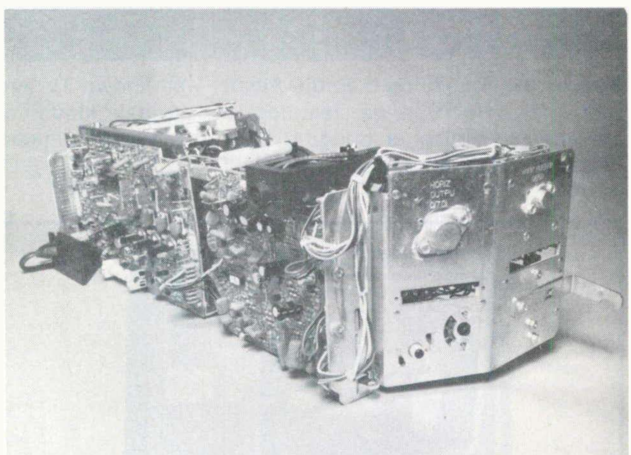
Non-remote series 4800 25-inch color receivers feature 10-button electronic tuning with large LED digital readouts and horizontal key address. Single-knob electronic tuning is available in five other 25-inch models. Four new 19-inch models with remotes and Touch-Tune Videomatic are available.

Nine models have been added to Magnavox's modular audio line.

A total of 24 home video games is offered now after the addition of 7 new games for Odyssey 2.

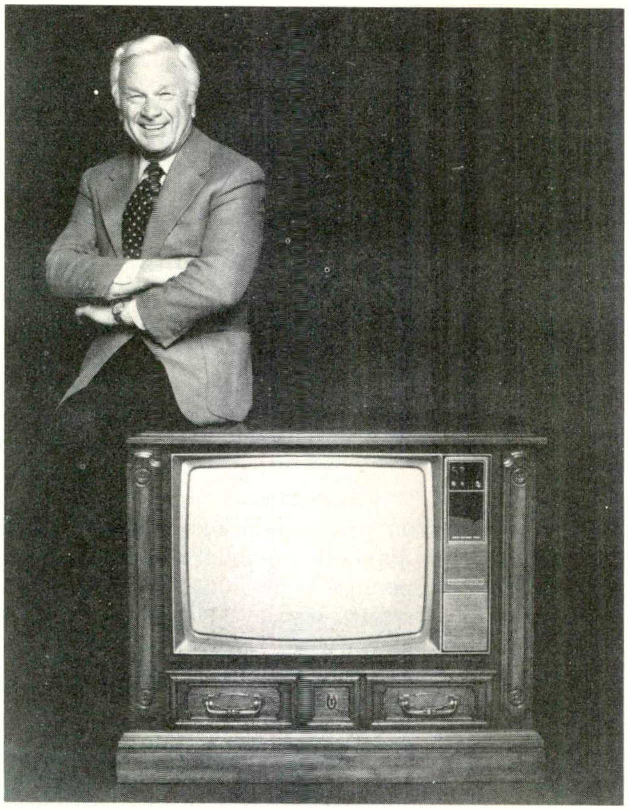
Panasonic

Only one electron gun is required in the 4.5-inch picture tube of Panasonic model CT-1010 color portable which operates from nine "D" batteries. Instead of a shadow mask, stripes of special phosphors on the screen emit ultraviolet light that is detected and processed to control the beam landing.

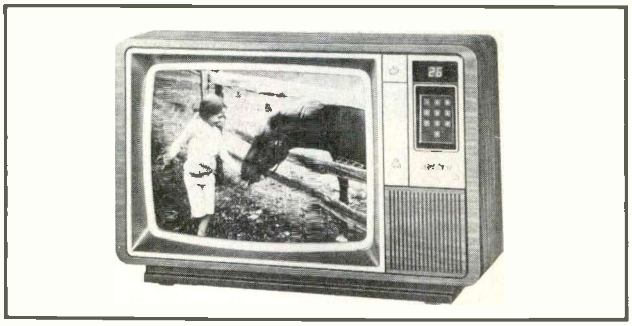


The General Electric Energy-Conscious (EC) chassis is designed for cooler operation with a metal frame and vertically mounted circuit boards for improved air circulation. Average ac power is 100 W.

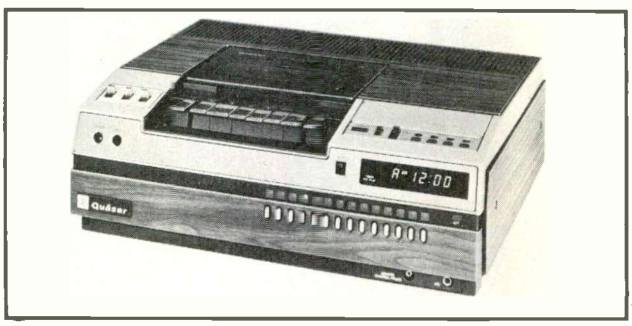
General Electric's 4-hour programmable VHS videocassette recorder permits recording of five programs at different times on five days during one week. The user follows the reminder lights for step-by-step programming.



Spokesman for Philco is Eddie Albert, well-known TV and film star. He will be featured in several kinds of advertising. Philco is bringing back the former slogan, "Famous for quality the world over."



Quasar model WT5966RW 19-inch table model color TV features Compu-Matic touch tuning, which is a crystal-controlled PLL circuit. An LED readout shows the channel numbers.



Pushbutton selection of TV channels, a digital clock and programming of six recording hours up to seven days in advance are a few features of model VH5150 Quasar videocassette recorder. One channel can be viewed while another is being recorded.

1980 Highlights

According to Panasonic, the TV is smaller and uses 40% less power than previous color portables.

Included in all consoles and five portables is Color-Pilot, an active circuit that adjusts color and tint according to the incoming program and a preselected standard.

All consoles feature ColorPilot, Panalock AFT, video sensor, Panabrite Control, lighted channel indicator, CATV antenna connector, and a 100 degree in-line tripotential picture tube.

Panasonic also has added 26 models to the present radio and tape recorder lines.

Philco

The 1980 line of Philco Color TVs offers 17 new models in 25-inch, 21-inch, and 19-inch screen sizes in console and table versions. Three models feature remote tuning. Five 25-inch models have Color-Rite automatic picture control; two have five-button remote control.

Three models feature Philco ACT (Auto-lock Channel Tuning), Super Black Matrix picture tube, lighted channel indicators and vinyl/wood cabinets. Four 25-inch consoles have an electronic single-knob VHF/UHF tuning system.

Six Philco stereos, including two studio sound centers, one compact (with both cassette and 8-track tape decks) and three consoles were introduced at the recent convention.

Philco's monochrome TV line includes 10 models in screen sizes from 9-inches to 19-inches.

Quasar

Additional models with Compu-Matic direct-access touch tuning highlight the new 1980 Quasar line that includes 35 models ranging from 13-inch to 25-inch sizes. Three small-screen models were introduced, including a new 15-inch with remote.

The Dyna-Module chassis is used in all models, and Dynacolor (Quasar's automatic picture-control system) is included in all but one. Audio Spectrum Sound with three speakers is employed in 10 models. The Compu-Matic microprocessor-controlled electronic tuning system now is contained in 14 models. No pre-programming is required for any area of the country. Quasar also offers a full line of monochrome portable receivers, including many portables and models with built-in radios.

Two new six-hour VHS videocassette machines feature tape economy. Model VH5020 allows six hours of recording to be programmed up to seven days in advance. Model VH5200 is a *portable* player/recorder that operates from 120-V line power, 12 Vdc in car or boat or from internal rechargeable batteries. Also offered are three color cameras with prices ranging between $660 and $960.

Insta-Matic cooking with Quasar microwave ovens is accomplished with a sensor and a microprocessor which determine the correct cooking power and the required time. Insta-Matic Frozen Foods allows the defrosting and cooking of frozen foods in one step. Insta-Matic Temperature cooks foods to the desired degree of doneness using only one control.

RCA

RCA has announced three major developments as part of the company's 25th anniversary line of color TV receivers. A color receiver that can be pre-programmed to select channels and turn on and off over a period of seven days is one advancement. Video sharpness is improved by a comb filter using a charge-coupled device (CCD). This Dynamic Detail Processor system is said to provide 330-line resolution instead of the former 260 lines. The Dual-Dimension Sound system processes monophonic audio to achieve a simulated stereo sound from the TV.

In the new line, the ColorTrak models total 29, and the XL-100 line has 16 models ranging from 13-inch to 25-inch sizes. Three of the 25-inch XL-100 have a single-knob 20-position SignaLock varactor tuning system.

Sanyo

Many of the 1980 Sanyo color TVs have Surface Acoustic Wave filters (SAW) which replace the IF coils. Phase-detector circuitry and one IC are said to improve the color fidelity. Several models feature electronic tuning with or without remote. One 19-inch color TV (model 91C41) is to be retailed at only $339.95.

The portable audio line has been expanded with new radios, cassette decks and carry-along systems that include radio, cassette and TV. An AM/FM clock radio and monochrome TV has a 2.5-inch picture. The cabinet has 2"x5"x1" dimensions.

Sony

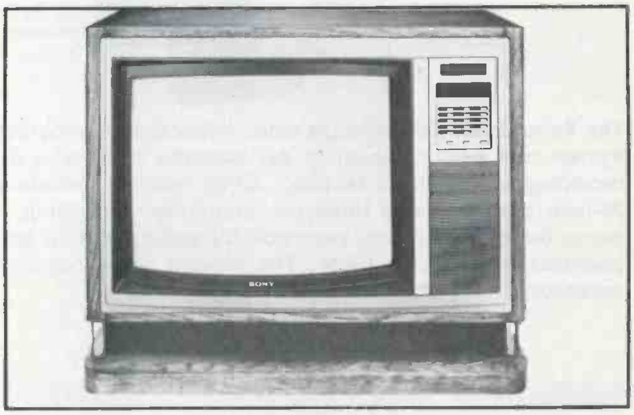
Ten Sony color TVs are introduced for 1980. The three consoles have 26-inch Trinitron single-gun picture tubes, the largest size available (341 square inches versus 315 square inches for 25-inch sizes). Some features include the Alpha chassis, which has fewer components using less current to operate cooler, Velocity Modulation design of the picture tube to give better corner-to-corner sharpness, automatic or semi-automatic channel presetting, Lumisponder light sensor that changes brightness and contrast according to the room lighting, fluorescent digital clock and channel indicator (some models) and the Express Commander infrared remote-control system.

Sylvania

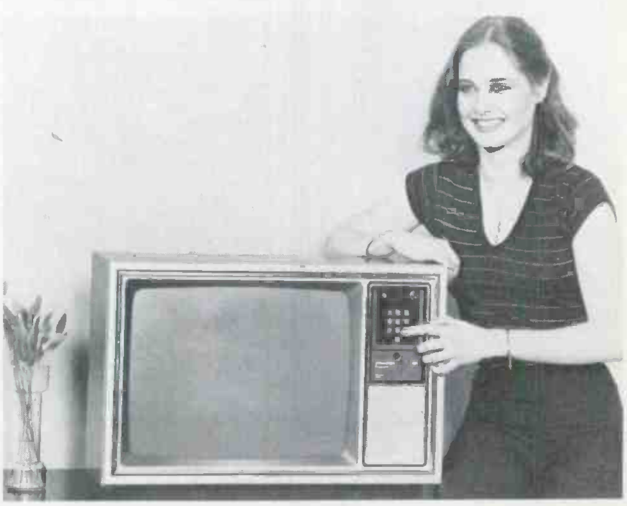
Supersound is featured in three of the 32 new Sylvania color TV sets. Supersound provides high-fidelity audio with a separate amplifier having bass and treble controls, a high filter switch and a two-way speaker system with a 3-inch tweeter plus a 6-inch woofer.

Other features of the line include Automatic

RCA model GC702 25-inch color console has ChanneLock electronic tuning (PLL type with crystal control), pushbutton channel selector with LED readout of channels and the Automatic ColorTrak System of color processing.



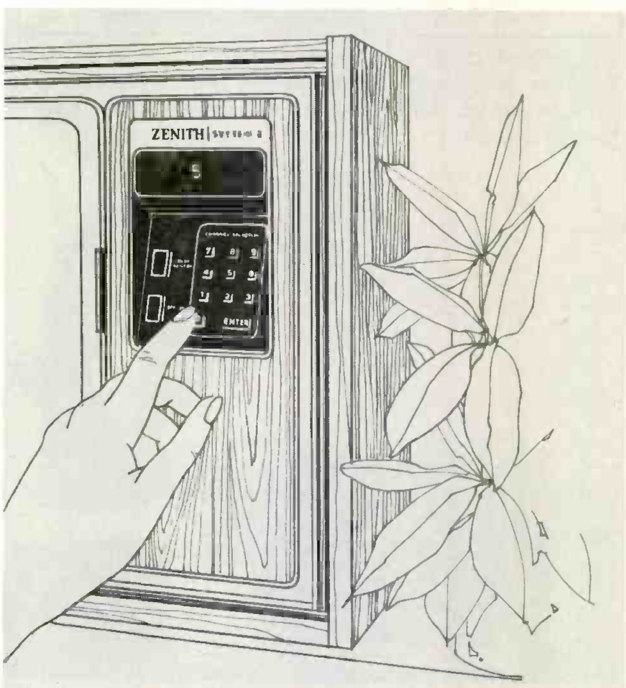
The largest direct-view color picture is on the 26-inch Trinitron single-gun picture tube. This KV-2643R Sony console has the Alpha chassis and the 14-button Express Tuning system.



Sylvania Superset 19-inch color portable features push-button channel selection, GT-Matic with ASC, GT-300 chassis, black-matrix picture tube, room-light monitor and LED channel readout.

1980 Highlights

The Sylvania VC4000 portable color videocassette recorder system has 4-hour capability per cassette with separate recording and playback sections. Other features include a 24-hour programmable timer for unattended recording, a pause button for editing, provision for audio dubbing and pushbutton electronic tuner. The camera is an optional accessory.



The new Zenith Keyboard Touch-Command channel selector is microprocessor controlled for 105 TV channels without setup or fine tuning. No converter is required to receive special cable channels.

Sharpness Control (ASC), GT-Matic color system, Automatic Fine-tuning Control (AFC) and Permatint.

Superset 25-inch models include two table models and 12 consoles. Five have remote controls and all have GT-Matic with ASC, GT-400 chassis, Dark-Lite 50 black-matrix picture tubes, electronic channel selectors, room-light monitors, 6-inch oval speakers and Cable-Set cable connectors. Seven Superset-Plus consoles have the previously listed features plus Computer Controller with VIR signal correction and a larger speaker.

Model MQ9014GY 5-inch monochrome television has internal AM/FM radios, a telescoping antenna, and operates from nine "D" cells or a rechargeable battery pack. Six consoles and five compact audio systems also are in the new line.

Four hours of video recording are possible with the VC4000 color videocassette recorder. This *portable* machine has separate recording and playback sections, a pause button, an internal VHF/UHF electronic tuner and a 24-hour programmable timer that turns the recorder on and off for unattended video recording. A battery pack is supplied.

Zenith

Microprocessor control makes possible the Touch-Command tuning system that provides random and direct-access to all VHF and UHF channels plus 23 cable frequencies without the need for any customer setups. Both on-the-set and remote versions are available.

Models in the Royal-Sound series have a built-in auxiliary 10-W amplifier plus two woofers and two tweeters.

Electronic Power Sentry provides electronic voltage regulation that replaces the magnetic/transformer regulation used before. Color sentry includes five electronic circuits that together automatically produce a pleasing color picture. System 3 modular chassis is teamed with a 100 degree picture tube having in-line EFL electron guns.

Five hours of video recording are possible with the Video Director and L-830 tape cassette. Speed-Search function of the remote control permits a viewing of unwanted recorded material at about ten times normal speed in both forward and reverse modes. Thus sports replays are possible. Stop Action freezes the tape on one frame for a still picture. The "Weekend" Automatic Timer allows the timer to begin recording automatically up to three days in the future. Touch-Command electronic tuning is pre-tuned for each desired station. A pushbutton gives direct access to any programmed channel. Another unusual feature is the switch for Pulse Code Modulation (PCM) which allows the recording of audio with the least noise of any system. A separate decoder is required for PCM audio playback. □

Techniques for repairing intermittents

By Robert L. Goodman, CET

Repairs of intermittent conditions can be made easier by these examples and technical tips from an experienced technician.

Most electronic technicians detest trying to locate the causes of intermittent troubles in the equipment they service. Troubleshooting symptoms of erratic operation can be trying and it demands the utmost in knowledge and testing skills.

The proper choice of testing methods plus factual records of similar defects and their solutions can be very helpful. That is the purpose of these case histories about known repetitive failures and unique problems.

It doesn't always start

If the sound and picture began operation when the TV was turned on, it would continue working until turned off. But perhaps the next time power was applied, there would be no sound, no raster, an unlighted dial lamp and no voltage in several dc power sources.

In this General Electric YA chassis, most of the dc-voltage supplies are produced by scan rectification of horizontal-sweep power. Even the channel-selector lamp is powered by horizontal sweep.

The usual cause of failure to start at turn-on is a horizontal oscillator that doesn't oscillate. One module contains the entire circuit and it can be replaced to test for that possibility.

Horizontal oscillator—The module can be repaired if desired. Figure 1 shows the oscillator and multivibrator circuits. Dc voltage from the phase detector varies the bias of Q550; and the Miller Effect capacitance change operates to vary the oscillator frequency as needed for horizontal locking. Q550 parallels the oscillator coil, L550.

The Q555 transistor operates in a modified Hartley oscillator, with the collector and base coupling capacitor connected to out-of-phase ends of the tapped oscillator coil. This type of oscillator has more than enough feedback and therefore, should start dependably. If it does not, some component probably has a marginal defect. A weak oscillator will tend to be erratic about starting.

One handy measure of oscillation strength is the base-to-emitter voltage. Photofact 1496-1 shows base and emitter voltages that calculate to -0.9 V of bias. For an NPN transistor, this is reverse bias. Stronger oscillation would increase the negative bias (decrease the positive voltage at the base) and weaker oscillation reverses that action.

Check the oscillator and multivibrator stages with a scope when the TV is working normally. Then when it fails to start up, check the same points again, noticing where the signal stops.

The components that cause erratic starting most often are the Q550 and Q555 transistors, C556 and L550. Be alert for bad solder connections and hairline cracks in the circuit board.

Monostable multivibrator—Transistors Q560 and Q570 comprise the monostable multivibrator of Figure 1. That kind of multivibrator does not oscillate. One of the two possible states is stable and the other is not. When Q560 is triggered by an oscillator pulse at the base, the multivibrator goes through one cycle and then stops until triggered again. The value of a monostable multivibrator (sometimes called a Schmitt Trigger) is in the precise pulse widths that can be obtained.

For proper operation of the horizontal-output stage, the width of pulses at the base of the Q920 horizontal buffer must not vary by more than 10% from the standard. Picture width and horizontal linearity can be inadequate and the horizontal-output transistor can fail often if the pulse width is wrong.

Intermittent operation is caused usually by Q560, Q570, diode Y560, capacitor C562 and the L570 choke.

Intermittent height

The partial schematic in Figure 2 is typical of the vertical-sweep circuit in many of the older Zeniths (this one is chassis 16Z7C17 of Photofact 1105-3).

Many intermittent problems can

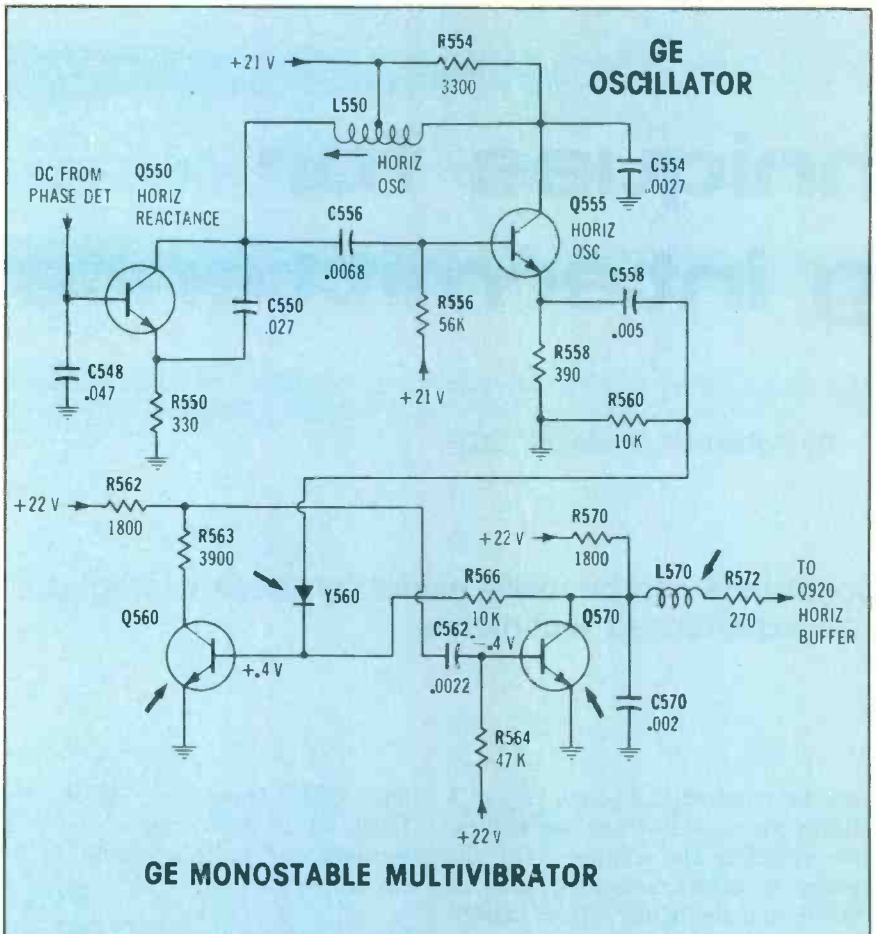


Figure 1 The horizontal oscillator in the GE YA chassis is followed by a monostable multivibrator which provides a constant pulse width to drive the horizontal-buffer transistor.

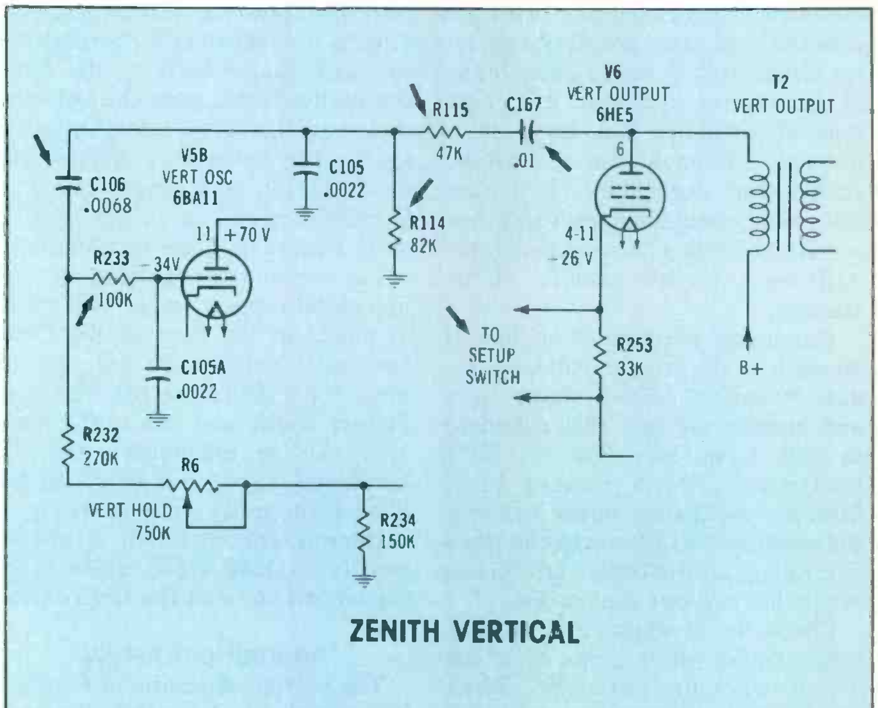


Figure 2 Components in the positive-feedback loop of the Zenith tube-type vertical-sweep circuit cause many of the intermittent problems. Those marked with arrows are the first suspects.

Intermittents

be traced to the setup switch, which eliminates the vertical sweep at one position by opening the short across R253, the cathode resistor. Picture bending and shaded rasters sometimes are caused by leakage in the same switch. Both video and some vertical waveforms are routed through the various sections. Test for an open switch by shorting across R253.

Other intermittent conditions originate in components of the positive-feedback network. R115 has

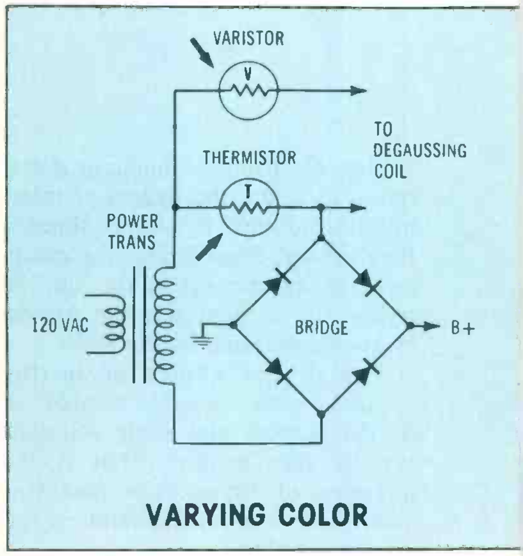


Figure 3 Symmetrical ac current of the main full-wave bridge is used for automatic degaussing. At turn-on, the thermistor has about 120Ω of resistance. A large voltage drop is produced by the capacitor-charging current. This higher voltage causes a low resistance in the varistor which passes a strong current to the degaussing coil. The thermistor wattage produces internal heat which forces the resistance to decrease. This decreases the thermistor voltage drop and lower voltage is applied to the varistor. The lower voltage increases the varistor's resistance, which reduces the degaussing current. These conditions continue until the thermistor is nearly a dead short and the high varistor resistance blocks the degaussing current. The varistor, the thermistor and any of the bridge diodes can cause wrong or intermittent degaussing.

produced many cases of wrong frequency or intermittent height. It should be replaced with one of higher wattage. Other suspects include C167, R114, C106 and R233.

Signal-injection tests—Problems in the positive-feedback network can be proven by testing the oscillator and output stages as plain amplifiers. Follow this sequence of tests:

- Disconnect the R114 end of C106.
- If some sort of picture height remains on the picture tube screen, the vertical-sweep circuit has a parasitic oscillation in the absence of the positive-feedback pulses. (Normal circuits have no height.) Check filter capacitors, components from oscillator plate to output grid, diodes around the oscillator cathode and the 15K resistor at pin 9.
- Assemble two clip leads and a 0.1 μF capacitor for injection tests.
- Connect this test capacitor from the 6.3 V heater supply to plate (pin 6) of the output tube, while watching the raster.
- If the plate has dc voltage and the yoke and output transformer are alright, the horizontal line (from the lack of vertical) should move downward and back to the center in a fast blink. A very small amount of deflection should be seen.
- Move the capacitor lead to the vertical output grid pin 2. About 3 to 5 inches of vertical height should be seen if all downstream components are good. Linearity will be poor.
- With the test capacitor moved to the oscillator plate (pin 11) the height should be identical to the previous test. If not, the coupling capacitor is bad.
- Connect the test capacitor to the pin 10 oscillator grid. If the tubes and amplifying components of both stages are not defective, the picture should have almost full height (perhaps with poor linearity).
- Move the test capacitor to the disconnected end of C106. The height should be slightly less than during the previous step.

If the last step provided almost full height, the amplifier path of the vertical circuit has been checked and found to be alright. Therefore the problem of lack of height must be in the positive-feedback path.

Intermittent purity

At random periods the color hues would vary. An intermittent in the automatic degaussing circuit was suspected. A test with only the red gun turned on verified the diagnosis. The degaussing was going into and out of operation.

The Figure 3 circuit is typical of many, particularly RCA's. An intermittently open individual diode in the bridge or a defective thermistor is the likely cause of the erratic degaussing. These thermistors operate at a high temperature and often crack or develop a loose lead wire.

Also, check the Figure 3 circuit etched wiring for erratic connections.

Zaps output transistors

A General Electric color TV (YA chassis) occasionally would blow the horizontal-output transistor when the power first was applied. An intermittent arc was suspected, since the performance was normal at all other times.

The difficulty with testing for such arcs is that a large number of expensive output transistors can be ruined during the unsuccessful tests.

One partial solution is to reduce the input line voltage by means of a variable transformer set for about 75 or 80 V. Or a 100 W light bulb can be temporarily connected in series with one side of the line voltage. The bulb gives a visual indication of current. When there is no overload, the bulb is lit with partial brilliance. If an overload occurs, the brightness goes to maximum.

After the bulb is connected, watch specific areas of the horizontal-sweep circuit and around the picture tube. Look for arcs or smoke each time the power is applied.

If the defect can't be located

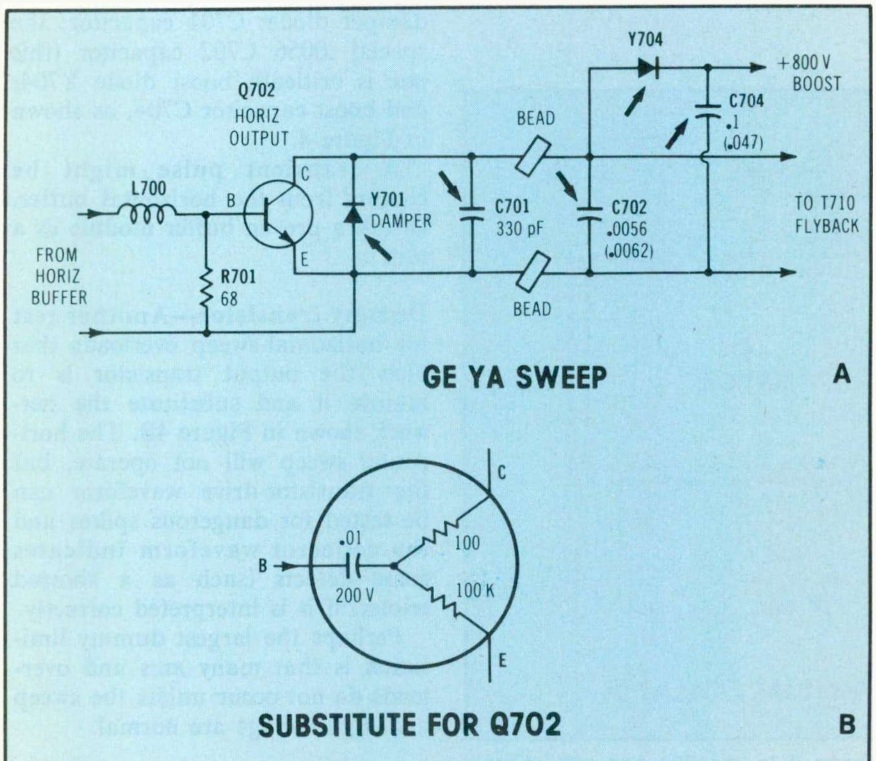


Figure 4 Those components marked with arrows are likely to have arcs that can ruin the horizontal-output transistor.

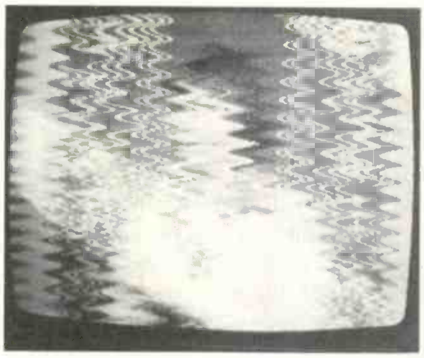


Figure 5 This "E" chassis Zenith intermittently showed a frequency "hunting" pattern on the screen.

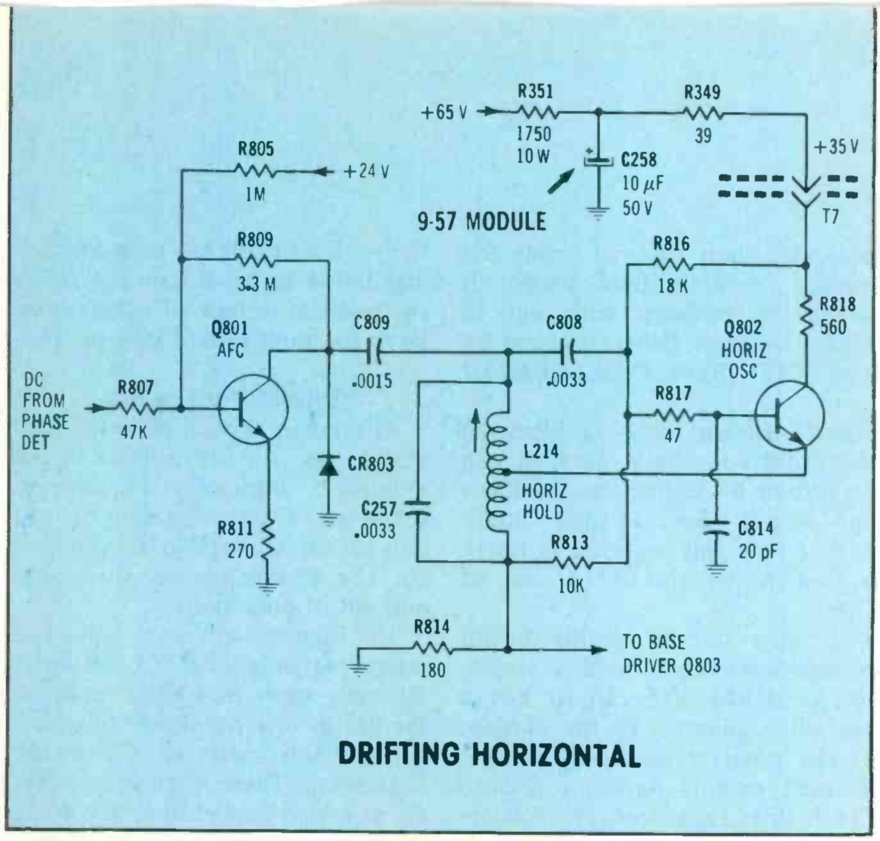


Figure 6 Drifting horizontal frequency in the Zenith 25DC57 was caused by an intermittently open capacitor (C258) that was mounted externally to the module.

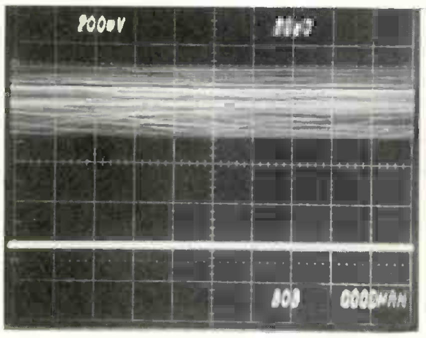


Figure 7 When C258 of Figure 6 was open, the B+ at terminal T7 had the large amount of hash shown by the top trace. After a new capacitor was installed, the ripple and hash were gone (bottom trace).

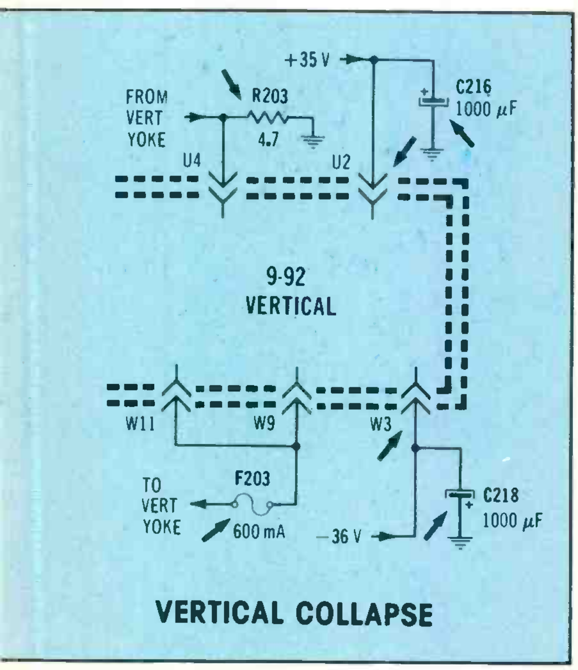


Figure 8 In the "E" and "F" chassis Zenith TVs, these are the points and components to check for sources of intermittent height.

Intermittents

within a reasonable length of time, replace these components: Y701 damper diode; C701 capacitor; the special .0056 C702 capacitor (this one is critical); boost diode Y704; and boost capacitor C704, as shown in Figure 4.

A transient pulse might be coming from the horizontal buffer. Install a proven buffer module as a test.

Dummy transistor—Another test for horizontal-sweep overloads that blow the output transistor is to remove it and substitute the network shown in Figure 4B. The horizontal sweep will not operate, but the transistor-drive waveform can be tested for dangerous spikes and the collector waveform indicates some defects (such as a shorted tripler) if it is interpreted correctly.

Perhaps the largest dummy limitation is that many arcs and overloads do not occur unless the sweep and high voltage are normal.

Slowly drifting horizontal

If the horizontal hold of the 25DC57 Zenith was adjusted for good locking when it was first turned on, the picture gradually drifted into the slanted lines of wrong oscillator frequency. Or if the hold was adjusted correctly after it was warm, the horizontal was out-of-lock next time power was applied.

At other times, the picture would have a violent "hunting" pattern (see Figure 5) that resulted from overcorrection of the frequency error. These various symptoms were intermittent and at other times the operation was normal.

The AFC and oscillator circuits were on the 9-57 module; therefore, the module was replaced. However, the troubles continued erratically.

The search was widened to include the B+ sources and the horizontal components not on the module (schematic in Figure 6). Nothing wrong was found until module terminal T7 was scoped. Hash was present there (top waveform of Figure 7) at times. When the problem disappeared on its own, the hash was gone, as shown by the lower scope trace.

Paralleling a new 10 μF capacitor

across C258 stopped the problem, and it was soldered into place after the old one was removed. There was no horizontal drift following the capacitor replacement.

Causes of similar horizontal drift have been traced to the L214 oscillator coil (which also is the hold control) or to C257, the .0033 μF tuning capacitor for the oscillator coil.

Intermittent vertical sweep

A picture that collapsed to a narrow horizontal line was a problem that occurred several times in various chassis of the "E" and "F" Zenith color receivers. Sometimes the line then would black out because of the safety circuit action that applies cutoff bias to the picture tube whenever there is no vertical sweep. The 0.6 A vertical fuse also might blow.

Vertical sweep in these modular TVs requires one -35 V supply and one +35 V supply. Figure 8 shows the yoke terminals and dc supply terminals of the vertical module.

Either bad filter capacitors or intermittent opens at the U2 and W3 pins can cause these intermittent symptoms. Carefully check the back side of the chassis where terminals are inserted, and resolder any suspicious-looking joints.

Scope the +35 V and -35 V supplies at U2 and W3 for excessive ripple or hash. If abnormal amplitudes are found, check for an open C216 or C218 filter capacitor.

If the filters or the terminals become intermittent for very long, the ripple and hash will ruin the yoke or blow the 0.6 A fuse. Sometimes one of the power output transistors is damaged also.

General tips

The only difference between a regular defect and intermittent trouble is that the intermittent problem has symptoms only at certain times. If the intermittent can be made to malfunction constantly, the cause can be found by conventional methods.

Some intermittent problems can be triggered by vibration, shock or temperature changes. Therefore, they all should be tried in an attempt to control the intermittent.

These are some techniques to try:

- Use a variable line-voltage transformer to supply 10 V above or 10 V below the rating. Experiment to determine if there is a critical voltage.
- Flex the circuit boards and their connectors. If moving the entire board promotes some disturbance, check, clean or tighten the plug-in springs and connectors.
- Tap gently at specific components on the suspected module. Pry with a non-metallic rod or screwdriver.
- Heat the suspected area with an infra-red lamp or heated blower. Don't use excessive heat; it's not necessary and it might cause damage.
- Canned coolant should be sprayed carefully and selectively on components in the suspected area. Vary the amount of cooling; often only a small decrease of temperature is best.
- After the problem area has been pinpointed, use a strong light and a magnifier to locate small cracks in solder connections or board wiring. A crack that can't be seen with the unaided eye can open a circuit or cause an intermittent connection. A circular crack around a pin or an eyelet is the source of many erratic problems. After the joint is soldered and repaired, look at it again with the magnifier. Some joints do not tin properly, and extra care must be used.

Use any or all of these techniques to control the beginning or ending of the intermittent period. After the symptoms can be controlled, the actual defect can be found with no more than the usual trouble. □

A meter that lied

By Wayne Lemons, CET

A dim, narrow, out-of-focus and unstable picture was on the TV receiver screen. During some initial tests, the technician noticed the tube cathodes didn't seem to glow as brightly as usual. The tube heaters were series-connected and the 21LU8 socket was easy to reach, so the tech measured the ac voltage across those heater pins. About 22 volts ac was the VOM reading.

As that was a normal reading, he went on to other tests. After some time, the technician decided to check the heater voltage a second time. This time the meter indicated zero volts. The meter was not defective or intermittent; it measured the line voltage correctly and was not erratic.

After a few minutes of perplexity over the TV problem and the mysterious meter readings, the technician thought of the answer to both.

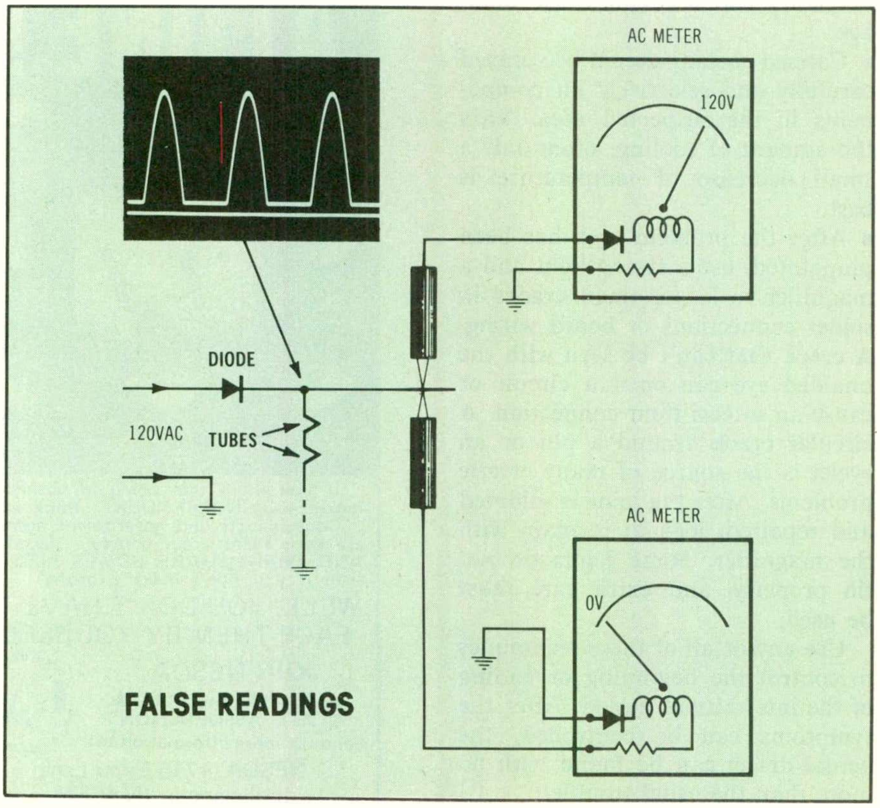
DC versus AC

This TV had an instant-on circuit which, when the power was switched off, connected a diode in series with the tube heaters to keep them warm at half voltage. Therefore, all heaters were to be supplied with *ac voltage* when the power switch was on, or with half-wave unfiltered *dc voltage* during power-off operation.

When he first measured the heater voltage, the tech (correctly) used the ac-voltage function because the power was turned on. In that VOM, a single series-connected diode rectifies the ac by passing only one peak, and the range resistor is chosen so the meter accurately reads the RMS value of the ac voltages.

A double on/off switch was used in this TV model. When turned on, one section applied ac to the low-voltage power supply. The other section shorted across the heater diode to restore proper heater voltage.

The diode-shorting section was open, therefore, the TV had normal B+ voltages but only half the usual heater voltage. The original TV symptoms were caused by the low heater voltage, not by weak tubes.



FALSE READINGS

Meter polarity

The diagram shows both possible connections for testing the heater voltage at the diode cathode. With the leads connected as shown by the top VOM, both diodes had the same polarity, and the current path was not changed significantly. Normally, the meter operated only from the positive peak of any ac voltage. Therefore, it provided the same reading for the positive half-wave dc as it did for ac.

When the technician reversed the meter leads (which is permissible with ac), the two diodes (see bottom VOM diagram) had opposing polarities, thus opening the current path and giving a zero reading.

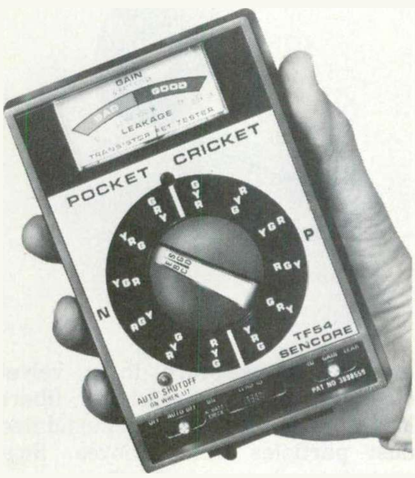
Other readings

There are possibilities for wrong readings with other meters or conditions. If the tech had used the VOM jack that adds a coupling capacitor (for checking ac in an ac/dc mixture), both polarities of meter probes would have provided low readings of the half-wave dc heater voltage. Also, a VTVM would have given a low reading of the half-wave dc voltage, regardless of the polarity. □

test equipment report

Pocket Cricket

Sencore has introduced a pocket-sized transistor tester. Battery-operated, the Pocket Cricket is designed to check nearly all transistors and



FETs either in or out of circuit.

An automatic circuit turns the instrument off after 10 minutes of use to save batteries. The unit can be ac-operated on the bench with an optional PA208 power adapter.

Circle (20) on Reply Card

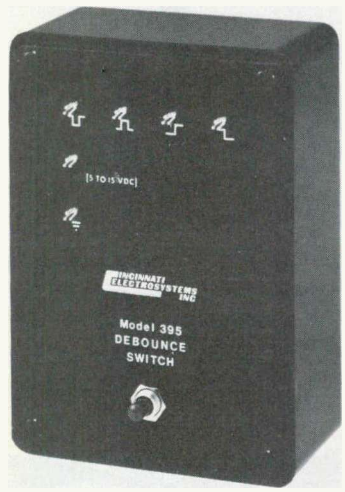
Benchtop DMM

A 3½-digit benchtop digital multimeter can measure ac or dc currents up to 20 A. Model 1351 from **Data Precision** has 0.1% basic accuracy. Featuring 34 ranges, it can measure dc volts from ± 100 μV to 1200 V, ac volts from 100 μV to 1000 V RMS and resistance from 100 MΩ to 20 MΩ with either high or low voltage. Measurements are displayed on a 0.43-inch LED display. Model 1351 is complete with test leads and spare fuse and is priced at $199.

Circle (21) on Reply Card

Debounce switch

Cincinnati Electrosystems' model 395 Debounce Switch provides a method for clocking logic circuits



without contact bounce. A push-button switch generates a choice of a positive or negative 10 μs pulse or a level change.

The instrument is priced at $7.95.

Circle (22) on Reply Card

Digital multimeter

Model LM-353 3½-digit digital Volksmeter from **Non-Linear Systems** is packaged in a 1.9"x2.7"x4" plastic case. Basic functions include ac and dc volts, ohms, and ac and dc mA. Full-scale ranges are 1, 10, 100 and 1000 V, 1, 10, 100, 1000

and 10,000 kΩ and 1, 10, 100 and 1000 mA.

Low-power ohms provide in-circuit tests of resistive components. The unit utilizes an LCD display. Replaceable AAA size batteries allow up to 100 hours of operation. The LM-353 sells for $149.50.

Circle (23) on Reply Card

Solution to:

Electronic Roulette

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productreport

Short form catalog

A condensed catalog describing a line of instrumentation for measurement, analysis and/or recording of power-system parameters is available from **Dranetz Engineering Laboratories.** Each product section lists features, gives a comprehensive description of the instrument and plug-ins and includes a photograph. Detailed specifications are also listed.

Circle (35) on Reply Card

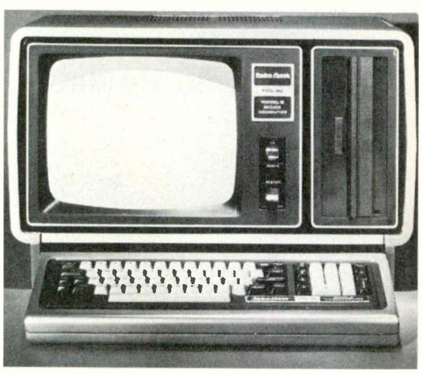
Replacement parts

Over 65 hard-to-find IC audio amplifiers have been stocked at **GE** authorized distributors as replacements for such popular types as AN 214, TA7205P, UPC1025H and HA-1306.

Circle (36) on Reply Card

Microcomputer systems

Radio Shack has introduced the TRS-80 Model II, microcomputer system. Software is available for general ledger, accounts receivable,

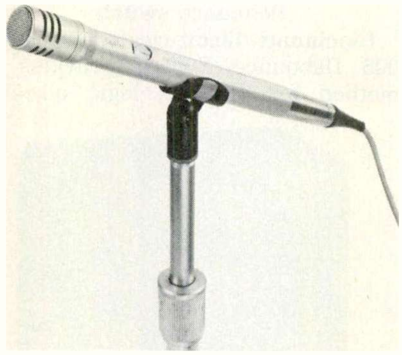


inventory control, mailing list management and payroll. Model II has a built-in 12-inch high-resolution video monitor that displays 24 lines of 80 normal characters or 40 expanded characters.

Circle (37) on Reply Card

Condenser microphone

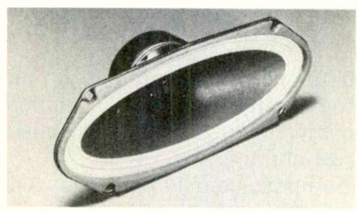
Shure Brothers' model SM81 cardioid condenser microphone features flat frequency response, good signal-to-noise ratio and smooth cardioid pattern at all frequencies. In addition, the electronics section has low total harmonic and intermodulation distortion. The SM81



also features a 3-position low-frequency response switch located on the microphone case.

User net price is $225.

Circle (38) on Reply Card



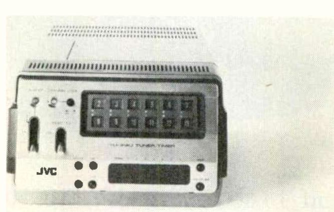
Woofer

Acoustic Fiber Sound Systems has introduced the Model 0006, 4"x10" woofer. The unit offers 50-5000 Hz frequency response with 30W power handling capability.

Circle (39) on Reply Card

Tuner/timer for VCRs

The TU-41AU tuner/timer from **US JVC** is designed to give owners of portable VCR units the capability of recording television programming at a predesignated time within an eight day period. The unit has a built-in electronic digital timer for precise



scheduling, a channel lock button to prevent accidental channel change during recording and a 12-button electronic tuner. It can receive channels 2 through 13 on VHF, and channels 14 through 83 on UHF.

Circle (40) on Reply Card

Record cleaner

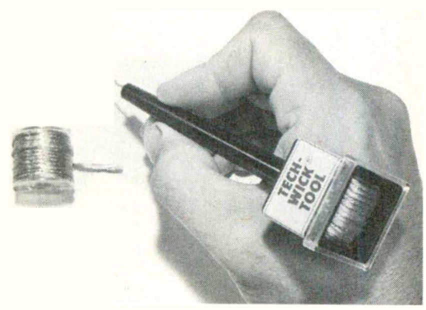
Record Sweep from **Robin Industries** incorporates a quick-fill covered reservoir which feeds metered

amounts of moisture to a velvet cleaning surface. Individual fibers loosen and pick up accumulated dust particles from grooves. Suggested retail price is $3.35.

Circle (41) on Reply Card

Desoldering tool

A desoldering tool that is refillable is available from **Tech-Wick Tool.** A transparent plastic cap snaps off for reloading, and each



refill contains approximately 20 ft of pure copper stranded wick. The tool sells for $7.50, which includes a refill in any of three sizes.

Circle (42) on Reply Card

Portable radio

Zenith's Trans-Oceanic R-7000 portable radio has 12-bands consisting of seven shortwave bands covering all used frequencies from 1.8 MHz to 30 MHz, AM broadcasting band, FM broadcasting band, long-wave FAA weather band, aircraft communications band and public service band. The radio is priced at $379.95. □

Circle (43) on Reply Card

catalogs literature

New England Business Service offers an 80-page full-color (3039) catalog describing more than 300 business forms, service tickets, repair tags, and many other items to improve the image and efficiency of businesses.

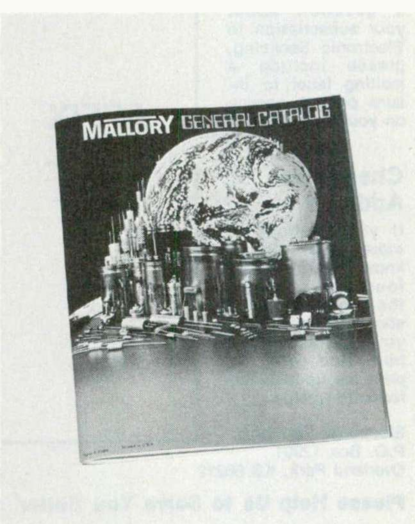
Circle (24) on Reply Card

ORA Electronics has available a *1979 Winter Catalog* featuring hundreds of replacement parts including ICs, transistors, FETs, electrolytic capacitors, tool kits, hardware packs and test cassettes that help in repairs of Japanese and eastern electronic products.

Circle (25) on Reply Card

Heath Company has available a 96-page catalog describing kits for color TVs, hi-fi components, digital clocks, personal computers, test equipment and many accessories. One new item is a 35-MHz dual-trace delayed-sweep scope.

Circle (26) on Reply Card



Mallory—A 112-page general catalog presents thousands of electronic components. Featured are additions to existing lines as well as new products not previously available from Mallory.

Circle (29) on Reply Card

General Electric—A new and expanded 416-page edition of the General Electric *Replacement Semiconductors Guide* features expanded coverage of both the PRO and MRO lines and provides an indexed listing of GE replacement entertainment semiconductors. Cross reference is made to various OEM as well as universal replacement by JEDEC numbers.

Circle (30) on Reply Card

Simpson—A 60-page, 4-color catalog lists the complete Simpson Electric Company line of stock analog and digital panel meters, meter relays, controllers and test instruments. Catalog 4900 includes Simpson's model 463 compact liquid crystal digital multimeter and the #00758 universal temperature adapter probe.

Circle (31) on Reply Card

Quam-Nichols—12-page Catalog '79 lists 150 different speakers. The catalog also includes updated listings of general purpose, automotive, music instrument, communications, high fidelity and commercial sound speakers.

Circle (32) on Reply Card

ITT Components offers a 33-page capacitor catalog that includes rating charts, performance curves, and application notes for each series of solid-tantalum capacitors.

Circle (33) on Reply Card

Association of Audio-Visual Technicians—*The Annotated Directory of Parts and Services for Audio-Visual Equipment*, lists the sources of parts and services for more than 1,000 brands of audio-visual equipment. The equipment is listed by brand names and sources of parts and present distributors are listed. Price of the directory is $20 plus $2 postage and handling, if payment does not accompany the order. □

Circle (34) on Reply Card

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