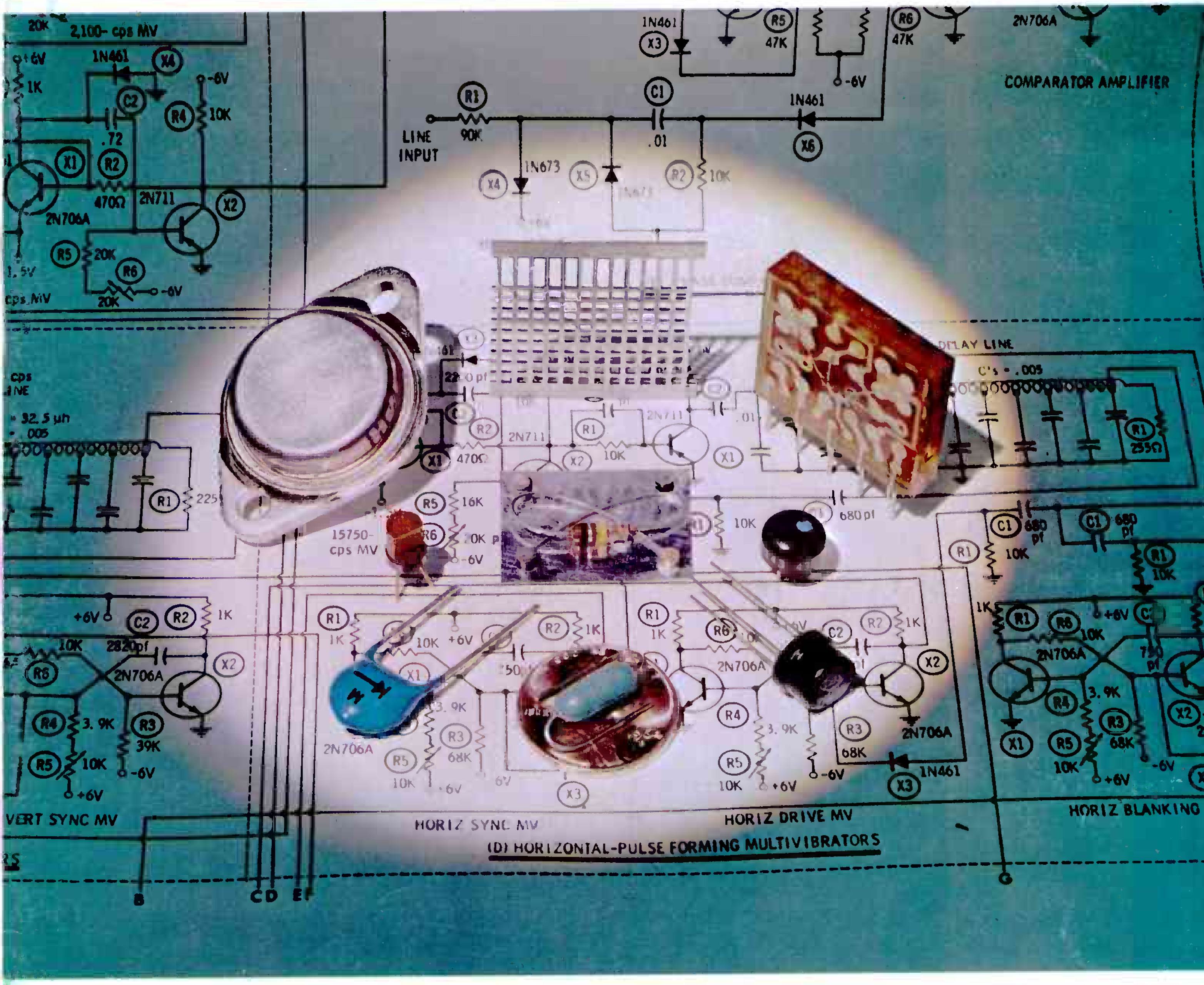
September, 1977 □ 75 cents

Electronic Servicing

A HOWARD W. SAMS PUBLICATION



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September, 1977 ☐ Volume 27, No. 9

Electronic Servicing®

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About the cover—Our cover reminds us that parts and circuits continue to change. Photo courtesy of Howard W. Sams & Company.

DEPARTMENTS

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Electronic Servicing

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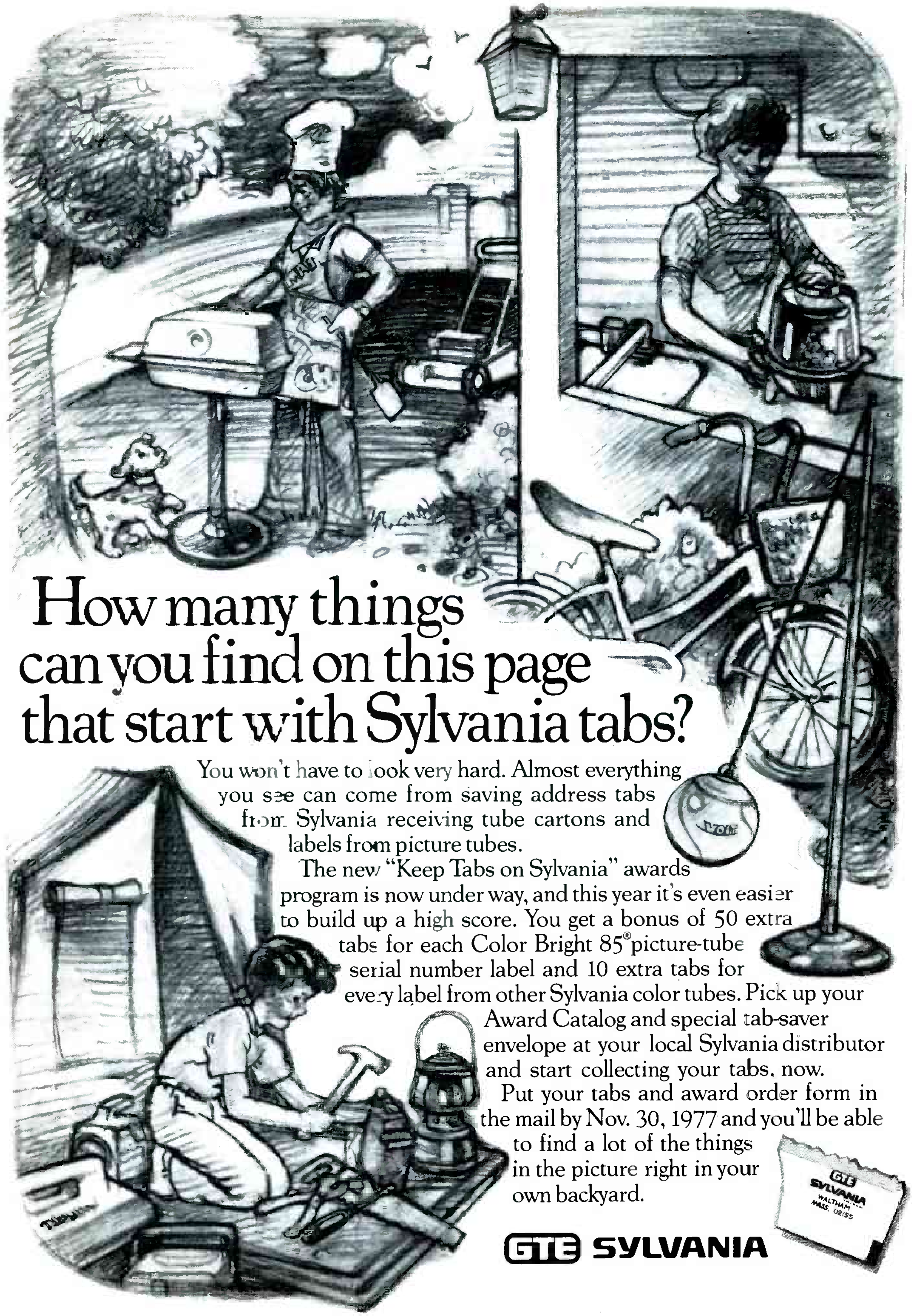
How many things can you find on this page that start with Sylvania tabs?
You won't have to look very hard. Almost everything you see can come from saving address tabs from Sylvania receiving tube cartons and labels from picture tubes.
The new "Keep Tabs on Sylvania" awards program is now under way, and this year it's even easier to build up a high score. You get a bonus of 50 extra tabs for each Color Bright 85® picture-tube serial number label and 10 extra tabs for every label from other Sylvania color tubes. Pick up your Award Catalog and special tab-saver envelope at your local Sylvania distributor and start collecting your tabs, now.
Put your tabs and award order form in the mail by Nov. 30, 1977 and you'll be able to find a lot of the things in the picture right in your own backyard.
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electronicscanner

news of the industry

The U.S. Court of Customs and Patent Appeals has reversed a lower court ruling requiring the government to impose countervailing duties on imported Japanese electronic products. The court, by a three-to-two vote, said that rebates issued by the Japanese government on certain exported electronic items do not constitute a "bounty or grant" under the U.S. countervailing duty law. *Electronic News* reports that Zenith plans to take the case to the U.S. Supreme Court. Even if the Supreme Court agrees to hear the case, however, a final ruling is not expected before next spring.

Several Japanese firms are planning to introduce microprocessor-controlled microwave ovens in the U.S., *Retailing Home Furnishings* reports. Matsushita Electric Industrial Co., Mitsubishi Electric Corp., and Sharp Corp. have already announced plans to enter the U.S. market, with Hitachi, Ltd., Tokyo Shibaura Electric Co., and Sanyo Electric Co. expected to follow. Prices on the ovens will range from $300 to $600 for deluxe ovens using microprocessors.

TV dealers report that gross profits on color consoles increased by 2% in 1976 over 1975, according to a Cost of Doing Business survey conducted by the National Appliance Radio-Electronics Dealers Association. According to the survey, the biggest gain in television sales was in color consoles, which rose from 23% to 25%. Color portables increased from 22.1% to 23.7%, while monochrome portables moved from 22.9% to 24.1%.

A new telephone communication system using light beams instead of electricity has been inaugurated in Great Britain. Telephone calls on the new system travel via laser light over hair-thin fibers of glass, replacing traditional metal cables. The system was designed and installed by Standard Telephones and Cables, the major British telecommunications company of International Telephone and Telegraph Corporation (ITT).

The Phoenix branch of PTS Electronics, Inc. recently moved to a new facility at 2916 West McDowell Road. In addition to tuner repair, PTS-Phoenix offers module rebuilding/exchange; purchases dud modules; maintains a complete inventory of tuners, tuner parts and modules; and offers a full line of tuner test instruments and accessories.

More than 75% of fatal and non-fatal shocks are directly related to eight consumer products through failure, repairs and installation, a Consumer Product Safety Commission study concludes. *Retailing Home Furnishings* reports that, according to the study, power tools, light fixtures and lamps, televisions and radios, pumps, heating systems, appliance and extension cords, antennas contacting power lines, and installed wiring are the major causes of these accidents. The study also says that 50% of all fatal shocks are due to failure of products while in use, although 21% of the electrocutions might have been prevented by safety features.

continued on page 6

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For More Details Circle (7) on Reply Card

continued from page 4

Home videocassette recorders (HVCRs) will have large mass-market sales if prices drop below about $800, predicted 100 department and specialty stores. The results of a survey were published by *Retailing Home Furnishings.* Sony, Zenith, RCA, and Quasar were mentioned as the favorite brands.

Two states, Virginia and Connecticut, have passed legislation banning the use by motorists of speed-radar warning devices. This year, nearly one million drivers are expected to buy the small microwave receivers. The units monitor highway-speed radar, and beep and flash warnings with increasing tempo as a speed trap is approached.

Appliance-TV dealers blame rising operating costs as the primary reason for declining gross sales margins, a *Retailing Home Furnishings'* report concludes. The National Appliance and Radio-Electronics Dealers Association (NARDA) recently released a survey of more than 1800 retailers which showed that gross margins in 1976 were 2.6 points behind 1975 levels.

The Commission on Postal Service has recommended that the U.S. Postal Service begin utilizing electronic communications in the delivery of mail, Electronic News has reported. The commission said the Postal Service should begin using electronic communications immediately to be more competitive in the business-user market, and decide within two years if it should adopt a complete electronic message service. Eighty percent of first-class mail today is business-related, but according to a recent study by Arthur D. Little Inc., 23 percent of first-class mail will be diverted to electronic communications by 1985.

"Caruso—A Legendary Performer" (RCA CRMI-1749) has been named top classical music album of 1976 by the Audio Excellence Record Awards, a new critics poll. The album is a collection of the great opera singer Enrico Caruso's performances restored by computer from noisy discs made in the early 1900s. The system involved converting the voice and music from the original Caruso discs into computer signals. The material was then sonically improved and re-recorded.

General Electric now will accept the NARDA-developed warranty claim form for all GE television in-warranty service claims, it has been announced by "Dutch" Meyer, manager of product services. "We fully support the goal of minimizing the number of different television warranty claim forms the independent service technician must currently deal with," Meyer stated.

A video recording unit will be included in the GTE Sylvania line this fall. Robert O'Neil, vice president-marketing for consumer-electronic products, said an agreement had been reached with the Matsushita Company of Japan to use its four-hour VHS (video home system).

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Course EE-3101 .... 39.95

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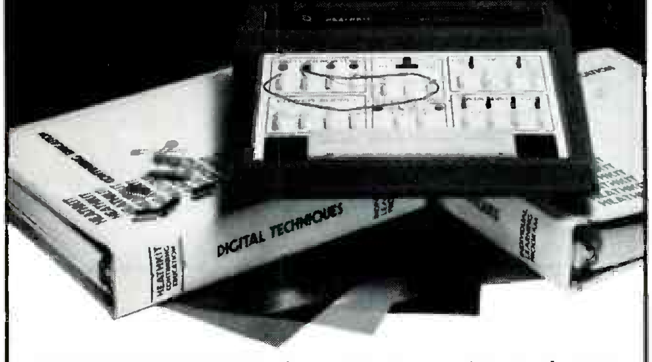

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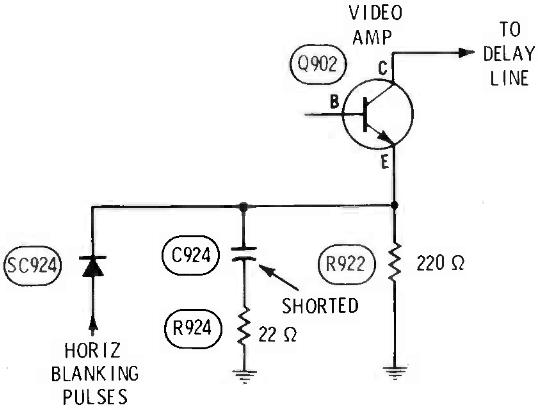
Electronic Servicing ED-105A

symcure

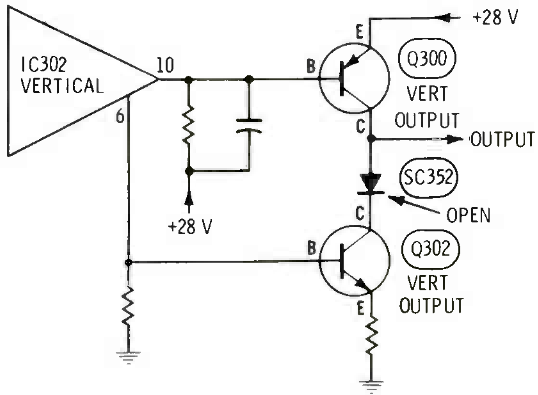
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Sylvania E21
PHOTOFACT—1587-1



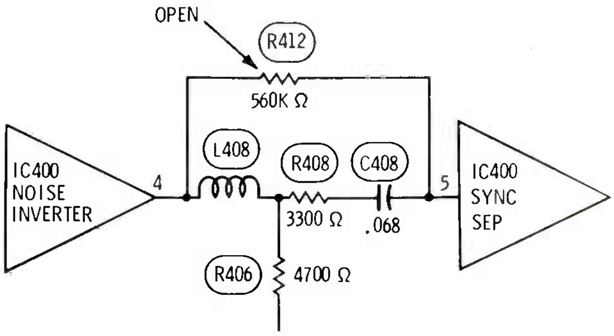
Symptom—Too bright, and no control
Cure—Check C924, and replace it if shorted

Chassis—Sylvania E08
PHOTOFACT—1481-2



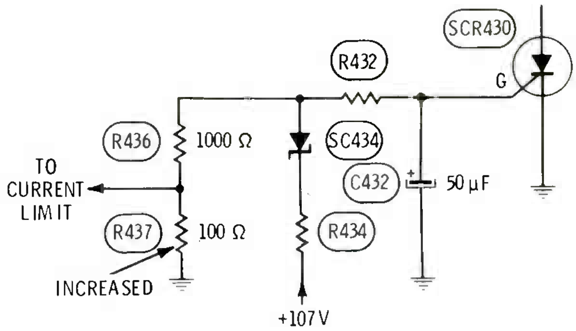
Symptom—No vertical sweep
Cure—Check diode SC352, and replace it if open

Chassis—Sylvania E21
PHOTOFACT—1587-1



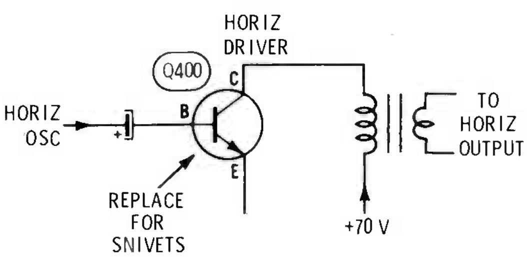
Symptom—Vertical does not lock
Cure—Check R412, and replace it if open or increased

Chassis—Sylvania E08
PHOTOFACT—1481-2



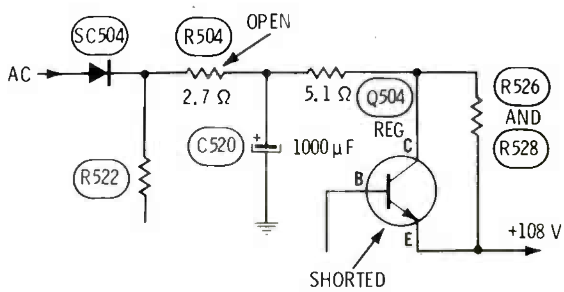
Symptom—Repeated operation of "shut-off"
Cure—Check R437, and replace it if increased in value

Chassis—Sylvania E21
PHOTOFACT—1587-1



Symptom—Snivets on low channels
Cure—Replace transistor Q400, and check snivets again

Chassis—Sylvania E08
PHOTOFACT—1481-2



Symptom—No sound, no picture, no raster
Cure—Check for open R504 and shorted Q504 regulator transistor

troubleshooting tips

Poor degaussing
Any color set with automatic degaussing

My favorite method of testing the degaussing action of a color set is to disconnect the degaussing coil while the power is turned off. Then, turn on the power, and connect the coil, while watching for the characteristic swirl of colors on the face of the picture tube.

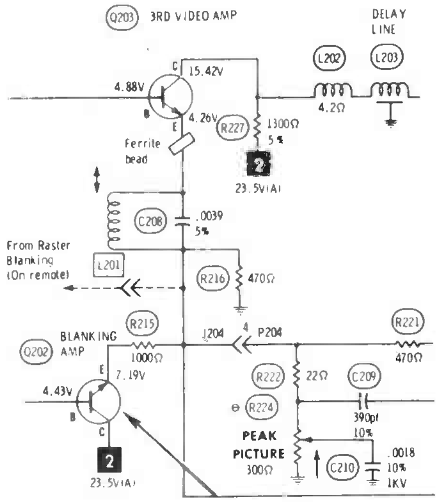
Usually, this swirl of colors is not seen, because it is over before the screen lights up. Some older models had pushbuttons mounted on the front panel for the users to operate. That was a good idea, and the swirl was a pretty effect to watch.

John Brocco
Tomah, Wisconsin

Dark picture
Zenith 25EC58
(Photofact 1370-2)

The contrast control worked okay, but the picture could not be adjusted bright enough for a good picture. However, the line intensity with the service position of the setup switch was normal.

The Q207 collector voltage was +200 volts, which



is too high. In the service position, it dropped to a normal +180. This led me to check the waveform at

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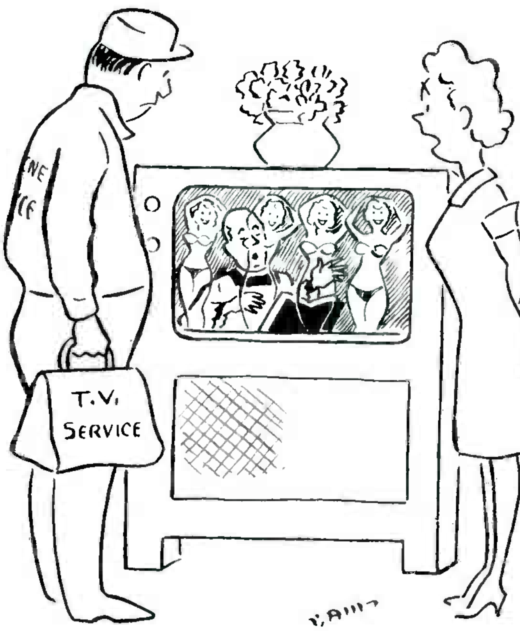


"Do you suppose it could be two stations?"

troubleshooting tips

continued from page 13

the base of Q204, but it was in tolerance, about 10 volts PP.

Voltage and resistance measurements were taken around Q201 and Q202, but without success. Since they were in sockets, I removed them for testing.

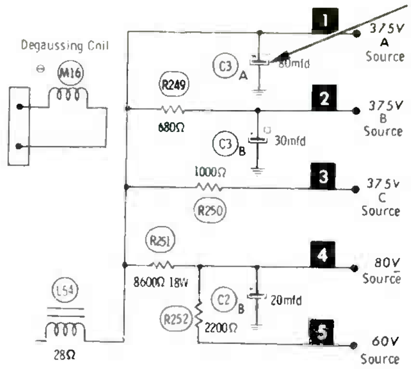
Q202, the blanking amplifier, was shorted. In my parts box, I found a 2N2369, which proved to be a satisfactory substitute, bringing all functions back to normal.

This set was repaired without pulling the chassis; I removed the bottom metal cover to provide room for the tests.

Al Potter
Parlin, New Jersey

No raster
RCA CTC38XT
(Photofact 1000-3)

Audio was okay, but there was no high voltage or raster, and the breaker would trip after a couple of minutes. Plate current of the 6LQ6 was excessive, but the flyback was not heating. New horizontal-sweep tubes only made the breaker trip sooner.



The boost voltage was low, and so was the drive to the grid of the 6LQ6 horizontal-output tube. No problem was found in the horizontal oscillator circuit. The frequency checked within tolerance, according to calibrated scope. (I have had similar symptoms when the frequency was double the correct value.)

Next, I disconnected one at a time all loads from the flyback, such as the yoke, capacitors, and focus coil. But, there was no improvement.

I was tempted to change the flyback, but the symptoms did not check with all of the other cases.

After much worry, I remembered that the filter capacitor for the B+ supply of the horizontal had not been checked. Although, I didn't understand why this should increase the 6LQ6 current, I tested it, finding C3A was open. Operation was fine, after the can was replaced.

John Huff
Stockton, California

*Send in **your** helpful tips—we pay!*

reader's exchange

Needed: Service and operation manual for Solar Exam-Eter, Model CF. Will buy, or copy and return. *Allan Morains, 13451 Oak Park Blvd., Oak Park, Michigan 48237.*

For Sale: Heathkit IO-4540 scope, new, $120. Will sell in kit form or assembled. *Charles Okulicz, 326 High Street, New Britain, Connecticut 06051.*

Needed: Power transformer (7034) for York clock radio, Model DCR92. *Garrison TV, 1010 Mitchell Ave., Waterloo, Iowa 50702.*

Needed: Instruction manual for Seco Model 500, two-way-radio test set (combination crystal checker, RF signal, and field-strength meter). Will buy, or pay for photo-copy, postage & handling. *G.P.R. Christensen Repair, Peever, South Dakota 57257.*

For Sale: Heathkit 5" scope Model 10-12, also Eico Model 369 TV/FM post-injection sweep/marker. With manuals; used but good; $250 for both. *George Lengbridge, 9858 Hawley Road, El Cajon, California 92021.*

Needed: Power transformer (part 32-10006-3) for Philco Model M-1666WA AM/FM radio. Send price. *John Iannelli, 1501 Saunders Cres., Ann Arbor, Michigan 98103.*

For Sale: PF Reporter and Electronic Servicing from 1953 to present, most copies. Entire set, 24 years, $100 plus shipping. *Roy Berthold, 66 Reid Ave., Port Washington, New York 11050.*

Needed: Tube chart, schematic and/or operating manual for Instrument Design Model T31 tube tester. Will copy and return and pay charges. *Elbert Barnes Jr., 902 East 58th Street, Tacoma, Washington 98404.*

Needed: RCA Victor Service Data bound volumes for 1949, 1951, 1952. Write with condition and price. *Carleton Sarver, 256 West 88th Street, New York, New York 10024.*

Needed: Lectrotech V5 Vectorscope in good operating condition, with service and operating manuals. Please state age, price, and condition. *Raymond Lohman, 99 Burton Ave., Hasbrouck Heights, New Jersey 07604*

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reader's exchange

continued from page 15

Needed: Schematic for antique radio, Truetone Model 0935, RPC Chicago, serial A-278440. Will buy, or copy and return. *K. R. Beerwinkle, 1215 King Arthur, College Station, Texas 77840.*

Needed: for Rem Cathode-Recovery Unit and CRT Tester: Transformer T-61382; black sealed disc module; and schematic. *Active TV, 14547 South Halsted, Harvey, Illinois 60426.*

Needed: Schematic for an old Hallicrafter Model SX-28A radio receiver. Will copy and return. *R. C. Spence, 2407 Brooklyn, Parkersburg, West Virginia 26101.*

Trade: Precision RF generator, Model E200-C (in working order) for Heath RF generator, Model IG-102. *St. Mary's Electronic Club., c/o Rev. Henry Preneta, R.D. 3, Parker, Pennsylvania 16049.*

Needed: One 60-Hz motor pulley for a Sony turntable Model PS-110. Also, GE Transistor Manual, 7th edition. *William B. David, 209 Fir Avenue, Montgomery, Minnesota 56069.*

Needed: Tuner VHF switch control knob for a Philco B&W television, Model UN-3532-BE, chassis 15125. *Paul Capito, 637 West 21st Street, Erie, Pennsylvania 16502.*

For Sale: Rider's radio manuals, volumes 1 through 20. Best offer. *Robert Beck, 14 Adams Street, Farmingdale, New York 11735.*

Wanted: Correspondence with electronic technician with experience in picture-tube rebuilding and equipment. *George Kopteros, P.O. Box 75, Kayetsou 40, Mytilene, Greece.*

Needed: Schematic and tube-location for Supreme Model 561 AF/RF signal generator. Will buy, or copy and return. *R. A. Heiman, 6320 Edgerton Way, Carmichael, California 95608.*

Needed: Heath IG-72 audio generator and bottom-of-line Heath scope. Good condition desired. *Bob Kramer, 539 S. State Street, Aurora, Illinois 60505.*

Needed: CRT Number 150JB4 (6") for Singer TV6U (Sony). State price. *Paul Abelquist, 3344 Prince of Wales Court, Virginia Beach, Virginia 23452.*

Needed: Service manual for a JFD Electronics Model 600 mini camera. *Allan Eisenhaur, 9 Leonard Road, Hyannis, Massachusetts 02601.*

For Sale: Triplett TV/FM sweep/marker generator Model 3434, without manual; $50 plus shipping. *Lyle Ralston, 14½ North Broadway, Watertown, South Dakota 57201.*

Needed: One Roberts 400CX or AKAI 355 tape recorder for parts only. Transport and electronics, if possible. *Ronald Singleton, 193 Albany Ave., Brooklyn, New York 11213.*

Needed: Service information and schematic for a U.S.L. (United Scientific Laboratories) Contact 23 CB transceiver, Model CB 7000. Will buy, or copy and return. *Pontek Technical Services, 4993 S. Hollister Road, Route 2, Ovid, Michigan 48866.*

Needed: Schematic, manual or any other information for a DuMont Model 208 scope. Will buy, or copy and return. *Al Cameron, Route 3, Box 93, Samson, Alabama 36477.*

For Sale: Rider's radio manuals, volumes 1-14, individual volumes in fair condition. Will accept fair offer to include postage or will ship by freight. *Lawrence Beitman, 1760 Balsam Road, Highland Park, Illinois 60035.*

Needed: Rider's radio manuals, volumes 1-8. State price and condition. *Troch's Television, 290 Main Street, Spotswood, New Jersey 08884.*

For Sale: Heathkit post-marker/sweep generator, complete, $175; Gonset Comm II 2-meter 12V/115V with extras, $75; B&K-Precision Model 700 tube tester, $125. *Allan Eisenhaur, 9 Leonard Road, Hyannis, Massachusetts 02601.*

Needed: Schematic/service manual or copies for telephone-answering cassette recorder Mark II, manufactured by Craft Electronics. Will buy. *V. R. Silva, 2451 Church Lane, San Pablo, California 94806.*

For Sale or Trade: Allied SX-190 short-wave radio receiver, $160 plus shipping. Also, Kenwood QR-666 receiver (150 KHz/540 KHz to 30 MHz), good condition, $195 plus shipping. Have several military surplus receivers for sale, or trade for test gear. *Bill Coleman, Jr., Coleman Electronics, P.O. Box 1601, Rocky Mount, North Carolina 27801.*

Needed: Used B&K TV Analyst or a signal generator for VHF. *Bill Coleman, Jr., Coleman Electronics, P.O. Box 1601, Rocky Mount, North Carolina 27801.*

Needed: Schematic and/or assembly manual for Lafayette Genometer kit 38-1001, model 156, manufactured by Accurate Instrument Company. Will buy, or copy and return. *William E. Schaefer, 1136 Limekiln Pike, Ambler, Pennsylvania 19002.*

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reader's exchange

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Needed: New or used VU meter for an AKAI M-7, Roberts part #88-66. Not available through normal channels. *Dean Rivard, Rivard Radio and TV Service, 410 W. College, Burkburnett, Texas 76354.*

Needed: Manufacturer's name for a model X-260 dual-channel scope. (Name plate has been removed.) *Thomas J. D'Ambrosia, Madison TV Service, 146 W. Madison Avenue, Clifton Heights, Pennsylvania 19018.*

Needed: Service information for Recordio (Wilcox-Gay) model 230, chassis 78W. *William F. Clark, 7401 Jewel Lane, Indianapolis, Indiana 46250.*

Needed: Schematic for Radio City Products VTVM model 665A, serial number 917 (unit has megohm insulation test and a capacitance test). Will copy and return. *Steve Wright, Audio Rivington, 5 Rivington Street, New York, New York 10002.*

Needed: Up to four T-155 impedance-matching transformers for Bogen MXM. Please quote price to: *Director of Special Services Department, Building 154, Naval Training Center, Great Lakes, Illinois 60088.*

For Sale: B&K model 465 picture-tube tester and rejuvenator, excellent condition, $60 or best offer. *Jack Burgess, P.O. Box 124, West Blocton, Alabama 35184.*

Needed: Schematic for Acoustech V stereo amplifier (Acoustic Technology Laboratories). *Tim Ritter, 6830 Marshall Road, Upper Darby, Pennsylvania 19082.*

Needed: Schematic for Crosley model 66CT radio. Will buy, or copy and return. *Edward Skrobiszewski, 2445 S. Marilyn Drive, Perry, Utah 84302.*

Needed: 8-inch speaker with 1400-ohm field coil and output transformer (primary 350 ohms DC center-tapped, and secondary 0.09 ohms DC) for an old Philco radio model 14. *L. S. Speckin, 4840 Weiss Road, Saginaw, Michigan 48603.*

For Sale: Sideband generator, 90-110 MHz, new with manual, $80. Also, have some test equipment (mostly army surplus). Write for information. *William Lackey, 304 Curtis Avenue, Point Pleasant Beach, New Jersey 08742.*

Needed: Hickok model 189 Tracemeter; also one 1B85 geiger-counter tube. *ARO Electronic Service, 735 Mills Street, Kalamazoo, Michigan 49001.*

Needed: Schematic and parts list for Magnavox AM-FM record player, model 1ST278R. *Jesse Chaves, 9768 Michaels Way, Ellicott City, Maryland 21043.*

Needed: Schematic and/or service manual for Telfunken Gavotte 55 radio chassis 11611. Will buy, or copy and return. *Duane Ballew, 15216 State Road #16, Gig Harbor, Washington 98335.*

Needed: Schematic and parts list for Western Auto model DC-4850 auto radio. Material no longer available from manufacturer or Sams. *Charles Prater, Edna, Kentucky 41419.*

Needed: Sams MHF manuals, numbers 12, 23, 30, 36, 41, 44. State price and condition. (These are no longer available from Sams.) *Elmer Blush, Blush Electronics, 627 Main Street, Olean, New York 14760.*

Needed: Instruction book and schematic for Feiler signal-tracer analyzer model TS-2. Will buy, or copy and return. *George Maruscik, 2016 S. Etting Street, Philadelphia, Pennsylvania 19145.*

Needed: Schematic for a model 6800 National guitar amplifier. Will buy a copy. *Kenneth McCabe, McCabe Electronics Service, 1237 Ottawa Avenue, Ottawa, Illinois 61350.*

For Sale: Complete Bell & Howell home entertainment course, including color TV. Texts plus scope with probes, digital multimeter, design console, and all tests and answers for $295. *R. Bruce Stevenson, 105 N. 21st Street, Vincennes, Indiana 47591.*

For Sale: Sencore TF-151 transistor tester, $50; Precision model 220 marker/adder, $25; Heath electronic switch, $35; Heath linearity-pattern generator model LP-1, $25; VTVM, $10. *Charles B. Cerates, 10420 Wise Road, Auburn, California 95603.*

Needed: B&K-Precision model 415 sweep generator and American Technology model ATC-10 dot-bar generator. *Rich Roman, Action TV & Radio, 1180 Los Altos Avenue, Los Altos, California 94022.*

For Sale: RCA high-sensitivity AC VTVM model WV-76, $35; RCA Dynamic transistor/FET tester, model WT-524A, $100; RCA Quicktracer transistor checker, model WC-528, $10; RCA color/B&W picture tube tester, model WT-509A, $75; RCA transistor-radio Dynamic Demonstrator, model WE-93A, $20; Conar R-C tester, model 311, $25; Hickok Dynamic mutual conductance tube tester, model 6000A, $30; Eico signal tracer model 147A, $40; Simpson VTVM model 311 with RF and HV probes, $75; Sencore Electrolytics substitution box; 4 to 350 uf at 450 VDC, $15; Heathkit VTVM signal generator and oscilloscope applications, with manuals, models 1-2-3 $10 each, or 3 for $30. *William Shevtchuk, One, Lois Avenue, Clifton, New Jersey 07014.*

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

A "Tough-Dog" Vertical Problem

By Walter P. Weaver

Probably every TV technician has fond memories (or nightmares) about repairs that were exceptionally difficult. However, it would be hard to top this true story. Read it, and sympathize with the writer.

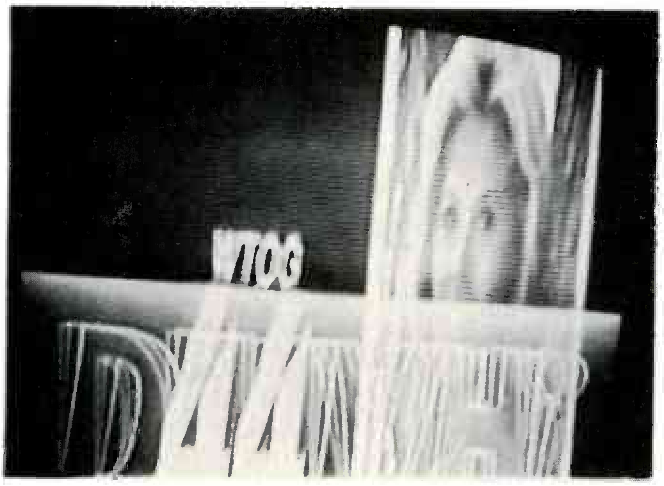


Figure 1 Severe non-linearity with bottom foldover is shown by this picture of part of the TV screen.

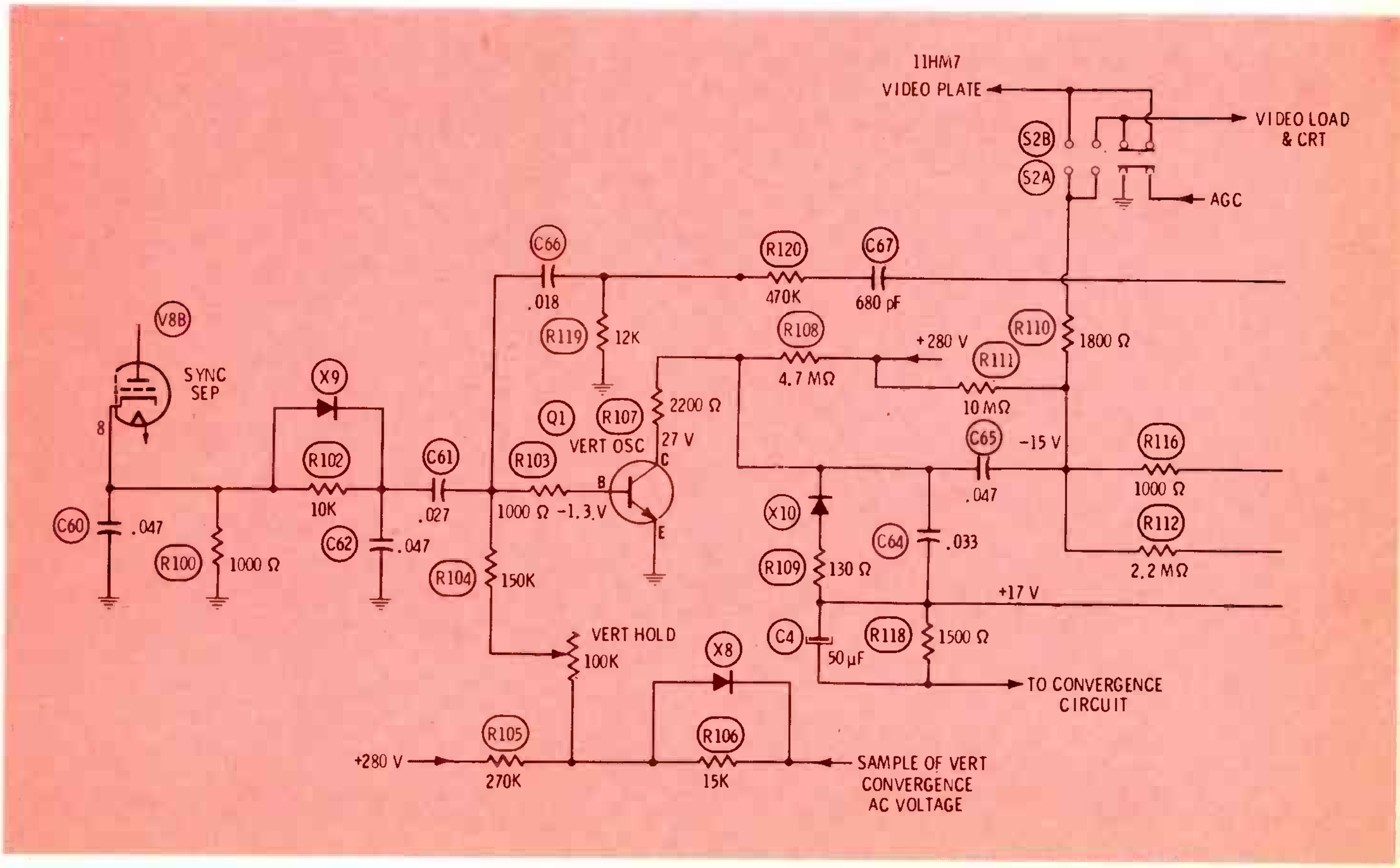
Confidence Before The Battle

The customer's voice on the phone said her television picture was upside down and half-way up the screen. I mentally translated those symptoms to mean: "vertical foldover," and wrote it on the service order.

As I pulled Photofact 1077-2 for the RCA CTC36 chassis, I thought of many sure-fire foldover corrections. My confidence was undisturbed, for I had solved other similar problems on this same chassis, and didn't anticipate any serious difficulties.

Symptoms and home tests

After the TV was turned on in the home, severe bottom foldover appeared on the screen (Figure 1).



By carefully adjusting the height and linearity controls, I could obtain fair linearity. However, this could not be considered as a satisfactory solution, because the slightest movement of either control brought back poor linearity, and the locking also was too soft.

"Try simple things first," I reminded myself, as I removed the back and replaced the 12JQ6 vertical-output tube. There was no improvement.

The next suspect was C4 (Figure 2). This capacitor (or the equivalent in other brands and models) is noted for reducing the height, and afterwards the best adjustments of height and linearity controls can achieve only poor linearity and fair height. Unfortunately, paralleling a new 50-microfarad tubular capacitor across C4 caused no noticeable change of either height of linearity.

An analysis of the DC voltages of both multivibrator stages was in order at this point. Several voltage readings (such as Q1 collector, and control grid, cathode and pin 6 of the 12JQ6) were excessively high. However, these voltages didn't point to anything specific, because with multivibrators it's very difficult to know if a wrong reading is the *cause* of the problem of is the *effect* of it.

Resistance checks of the height and vertical linearity controls (plus the resistors around them), and the collector resistors of Q1 were normal. Q1 tested okay in-circuit.

Other vertical tests are too complex to be done in the customer's home, so the TV was brought back to my shop.

Scope and replacement tests

On my test bench, the scope showed distorted waveforms everywhere in the vertical circuit (Figure 3). Of course, this is similar to the problem of interpreting DC voltages in closed loops. Often all conditions are wrong, and nothing points to a definite defect.

Adding to the confusion, the picture intermittently jumped from foldover to a normal picture, and occasionally had only a horizontal line. The added symptoms pointed toward a loose connection of the wiring or inside a component. However, moving and tapping on all parts in the vertical-sweep section could not stop or start the problem.

My usual infallible logic indicated the defect should be in the output stage, so I checked the resistors and replaced the capacitors (including R121, C68, and the linearity control) between plate and control grid. Again, there was no improvement.

By this time my confidence was beginning to fray around the edges, and I took time out to work on another (easier) repair.

Control leakages?

While away from this "dog," I remembered several cases of leakage between the element of a variable control and the case or shaft, which are grounded. I decided to substitute temporarily the height, linearity, and hold controls. Unfortunately, the height control, linearity control, and the blue-screen control are all PC components in a single package. So, considerable time was required to open the important paths and substitute external controls. The results were a big nothing!

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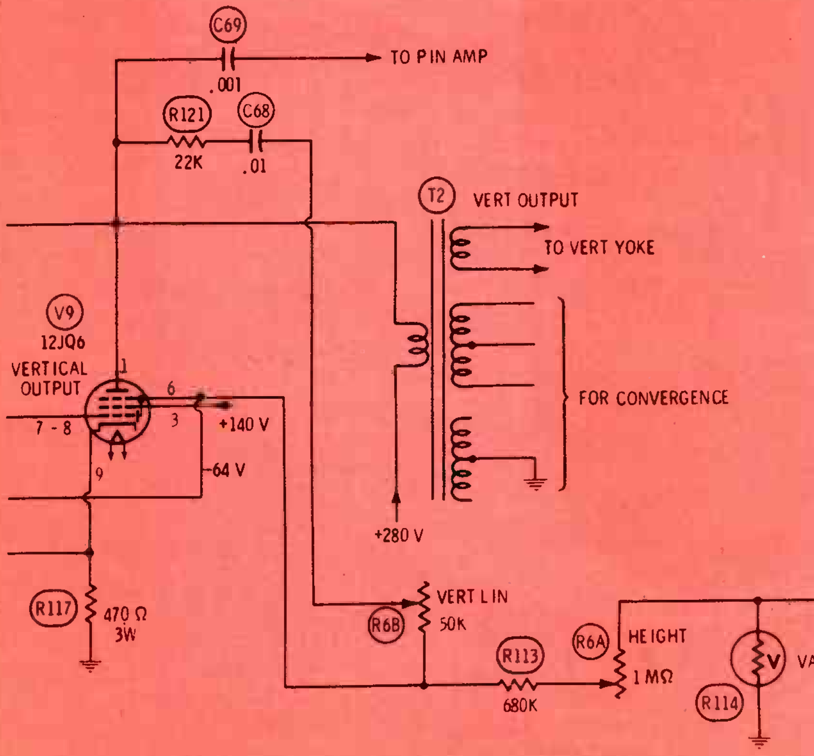

Figure 2 The component that caused a simple repair to become a "tough dog" is in this schematic of the RCA CTC36 vertical sweep. Two unusual features are the transistor oscillator and the diode inside the output tube. Otherwise, the circuit is a conventional multivibrator type of oscillator.

Non-linearity

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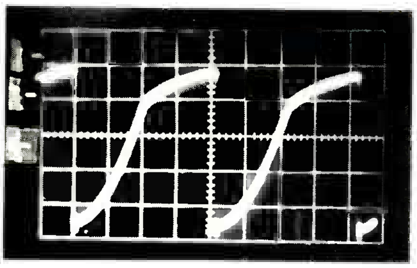

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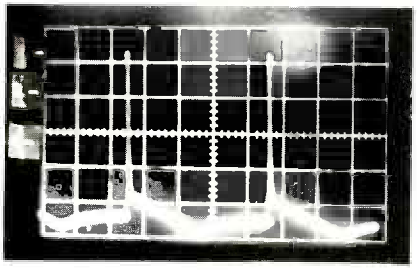

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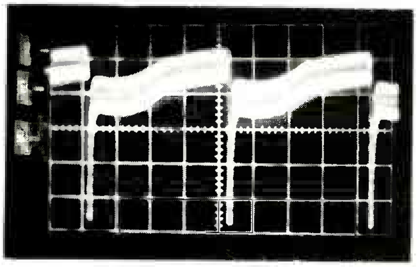


C

Figure 3 These are the distorted waveforms found before the repair. (A) The sawtooth at the grid of the output tube is flattened. (B) The plate waveform of the output tube also shows the wrong tilt that indicates foldover. (C) Even the waveform at the diode inside the 12JQ6 output tube is badly distorted.

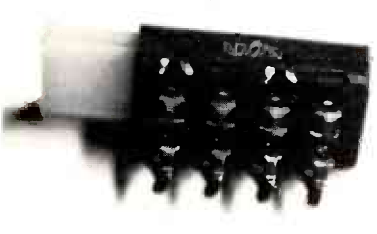


Figure 4 Service/normal/raster switches, such as this one, can cause many kinds of unexpected intermittents and non-linearities of vertical sweep. For a foolproof test, disconnect the wire going back to the vertical circuit. Restoration of normal height and linearity is proof that the trouble originated in the switch.

What about varistor R114? Ohmmeter tests of varistors usually are futile, but I substituted R114 with a resistance-substitution box and tried all values from 50K to 10M. None of the values helped the poor linearity; therefore, the varistor couldn't be defective.

Cooling tests

Perhaps coupling capacitor C65 was leaking positive voltage to the 12JQ6 grid. I frosted it with cooling spray, and finally replaced it. Neither test proved anything.

While I had the can of coolant in my hand, I cooled all of the capacitors of the vertical-sweep circuit. I tested diode X10 and finally tried a new one. None of these tests improved the foldover.

Next, my attention focused on the positive-feedback loop from the output plate to the base of Q1. Logic told me a defect here would affect the frequency and locking more than the linearity, but I was beginning to panic. Anyway, the components of the loop do have some waveshaping effects. Again, the resistors were checked and the capacitors were replaced—you guessed it!—without any change of symptoms or hint of a bad component.

No more suspects

By now I had wasted so much time the job would require a ticket written with red ink, and the vertical components were almost all checked. Nothing much remained but the board, wiring, and the connections.

Leakage tests were made, copper paths were examined, and soldering was checked and reheated. All were okay; but, the linearity remained bad.

What about the output transformer, deflection yoke, and pincushion circuit? Ringing, ohmmeter, and shorts tests found nothing wrong; all components were okay.

Zero Confidence

My confidence now was sliding toward a minus rating. Somewhere, I must have made a serious mistake or overlooked something important. Yet, I had checked all components. Or had I? *For the first time, I noticed on the schematic the normal/service/raster switch.*

As shown in Figure 2, the switch opens part of the AGC circuit to kill the RF and IF gain for a blank raster, disconnects the video amplifier from the CRT cathodes and shorts the 12JQ6 grid circuit to ground through R110 in the service (line) position.

Switches sometimes develop leakage internally. Could that cause foldover? It was the *last* component of the circuit, and that alone called for testing. Also, it was not with the other vertical components, which would eliminate most effects of mechanical movement.

With the first whiff of coolant on the switch, the picture rolled, jumped, and then began to drift into normal height and linearity. Some tuner cleaner sprayed into the switch appeared to cure the problem. But to make sure, I replaced the switch (see Figure 4).

Comments

At this point, I was not at all proud of myself, although I eventually had found the source of the problem. I knew what to do, in general, but blew it when I panicked and abandoned my logical methods.

No, the answer to this and other technical problems is a complete knowledge of how the circuit works. Equally essential is a large application of logic, based on the knowledge of circuit actions. The knowledge requires hard and continuous study that goes hand-in-hand with practical experience. The logic comes by the discipline of mind and habits.

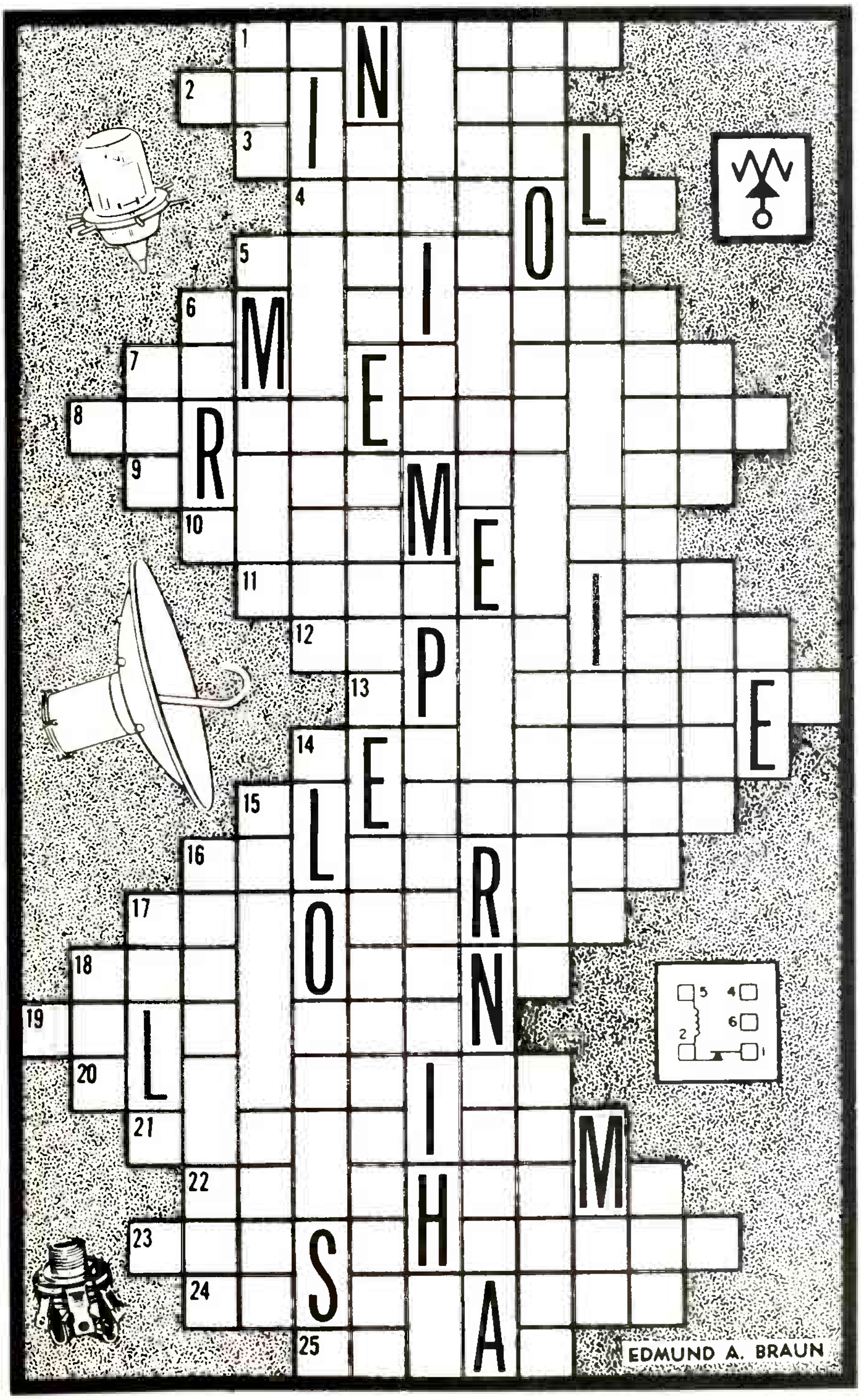
Most of the things I did were correct. It's smart to "play the percentages," which means to remember which components have caused the same problem in the past. Also, doing the simple things first is good, provided you don't stop when stronger measures are necessary. But, real electronic competence lies beyond these elementary methods.

My infallible hindsight tells me that my worst mistake was failing to follow logic based on knowledge, even though it is not exactly logical to expect vertical foldover from a service switch. Nevertheless, I did allow myself to weaken and follow false paths after the problem escaped my first efforts. In the service business, wasting time is the unpardonable sin. □

SHOCKING!

by Edmund A. Braun

Now that you have a few minutes to spare, have fun solving this Just-across-word Puzzle based on electronic terminology. Each word is connected to the word above and below by one or more letters but only one is usually shown as a clue. Each correct answer is worth 4 points; a perfect score is 100. If you're a novice and miss a few, don't worry; you'll have added a few words to your vocabulary. It should be quite easy to get a high rating except for someone who thinks that "clockwise" refers to someone who can tell time, or that "Kelvin bridge" spans the Kelvin River! So put on your thinking cap and GO!



1. The current carrying part of a relay that opens or closes a circuit.
2. Pertaining to a circuit that is etched instead of wired.
3. Type of wire splice.
4. Receiver cabinet that stands on the floor.
5. Greek letter to denote dielectric constant, permittivity.
6. Self-saturating type of magnetic amplifier.
7. Electronic circuit for altering frequency response of an amplifier.
8. Having dielectric properties similar to those of iron compounds.
9. Equipment used to generate, amplify and modulate an RF carrier signal.
10. Instrument to measure active power in an electrical circuit.
11. Invisible force which attracts ferrous metals.
12. Device for receiving and storing an electric charge; a condenser.
13. Breakdown of the air between two electrical conductors.
14. One million megacycles.
15. Either terminal of an electric source.
16. A lie detector.
17. Formerly a micromicrofarad.
18. Interception and rebroadcast of beacon signals.
19. Computer-memory tube capable of storing 256 binary digits for rapid access.
20. Direction in which the hands of a timepiece rotate.
21. The exponent of the power to which a fixed number must be raised to produce a given number.
22. The use of radio-frequency fields to produce heating in body tissues.
23. Fuse containing a spring which completes an auxiliary circuit when blown.
24. High resistance device to prevent current flow.
25. Time required for a signal to pass through a device or conductor.

We know you wouldn't sneak a peek so we'll tell you frankly the solution's on page 70.

Dangerous Questions for Job Interviews

By Lipman G. Feld, B.S., J.D.

The questions you ask applicants during job interviews can get you into serious trouble, if they are in violation of the anti-discrimination laws. Here are specific examples of proper versus unacceptable pre-employment questions.

Thousands of businessmen have found to their sorrow that the questions asked of prospective employees during interviews no longer are a private matter between two people. March 25, 1972 was the dividing line, for on that date President Nixon signed into law the "Equal Employment Opportunity Act Of 1972." The law touched off a flurry of lawsuits, and the repercussions continue.

Don't believe that you are immune from prosecution because your business is small and there are few employees. It's true that the federal government is not supposed to handle cases against businesses having fewer than 15 employees. However, the various state "Fair Employment Commissions" also are active in filing for alleged violations.

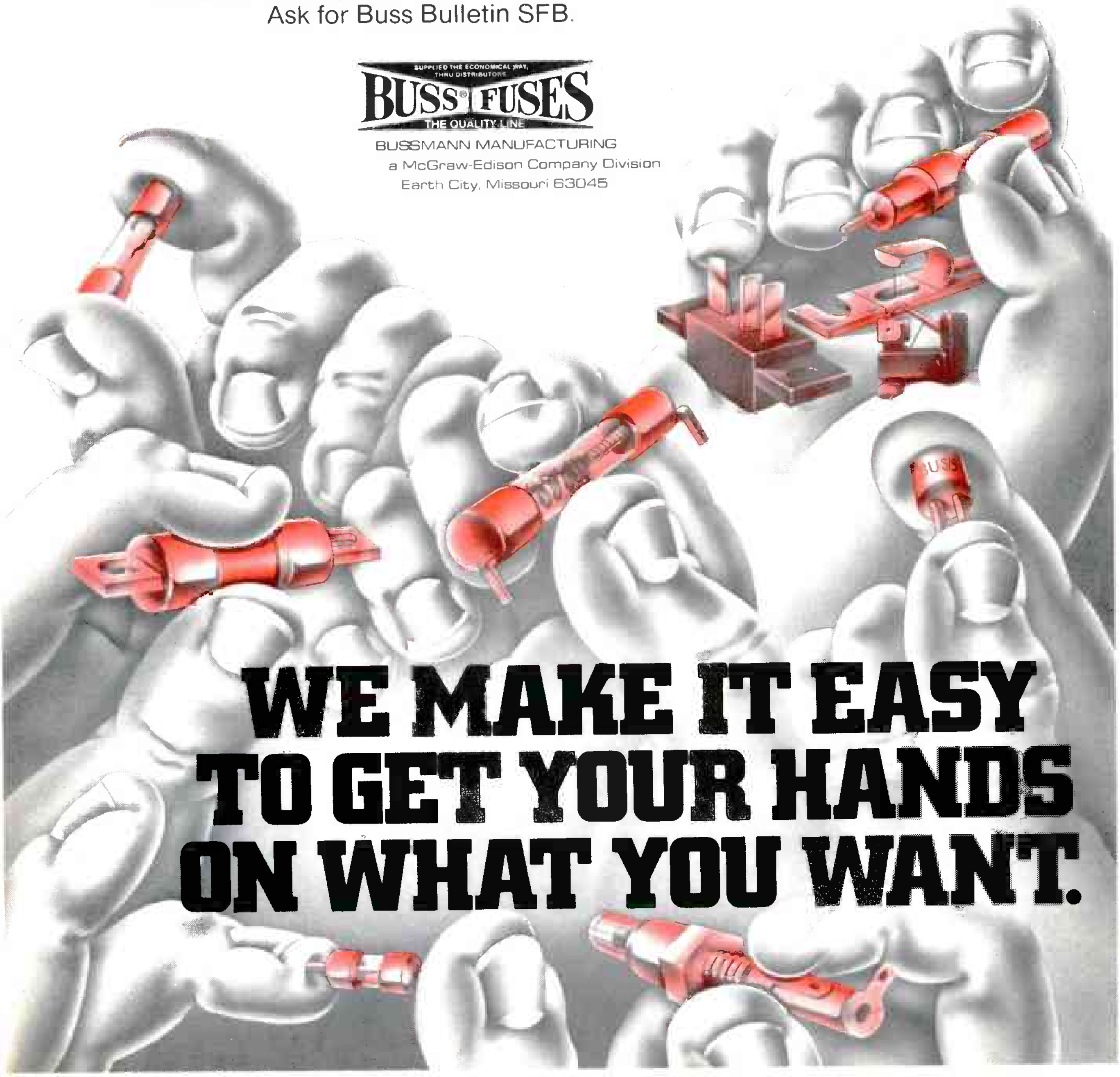
Specifically prohibited is discrimination in employment because of race, color, religion, sex, or national origin. Details of the laws are listed elsewhere.

Enforcement of the laws can be condensed into these sentences: *If you ask a wrong question of a qualified applicant, and then fail to hire him or her, the applicant might make a claim of discrimina-*

continued on page 28

BUSS ELECTRONIC FUSES.

Nearly every type of fuse and fuse holder you need to protect electronic circuits and devices you can get from us, easy. For example, Buss® Semiconductor Fuses; 700 volts, with extremely low I²t and Ip let-thru values. TRON® Rectifier Fuses, ½ to 1,000 amps, up to 600 volts. Fusetron® dual-element time-delay fuses. Buss quick-acting glass tube fuses. Buss signal-indicating, alarm-activating fuses. TRON sub-miniature pigtail fuses. Buss sub-miniature GMW fuses. Buss telecommunications fuses. Buss military fuses. And Buss fuse holders and fuse blocks. Get your hands on exactly what you want. Write us now. Ask for Buss Bulletin SFB.



Dangerous Questions

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tion against you. Even if you were to win in court, the triumph would cost you much time and money.

Most cases of complaint seem to involve women who are fighting for economic equality. Running a close second are cases with black or brown males. Others involve Italians, Poles, Jews, Greeks, or others in second-generation or third-generation American ethnic groups. These same trends are found in both federal and state actions.

Avoid, Don't Fight

It's easy to avoid breaking the laws on discrimination, if you follow a few guidelines. Some general and specific suggestions are mentioned here.

First, remember that using the precise word is important, and another can be substituted without taking away your right as an employer. For example, when placing want ads, don't use the word "man," or any other similar word which suggests a preference for a person of just one sex. In other words, *don't advertise for an "office girl" or a "service man."* Instead, think of terms such as "office assistant" or "technician."

The Only Defense

One of the few legal defenses against a practice that has discriminatory effects is to plead "business necessity or job-relatedness." The practice must be proved necessary to the safe and efficient operation of the business, and that no alternative of less discrimination is available. This concept has been narrowly defined by the courts.

Of course, for jobs requiring technical knowledge, it certainly is proper to ask about past technical experience or for a demonstration of present technical competence under the necessity of job-relatedness.

Arrest Records

Because members of some minority groups are arrested more often than are whites (in proportion to their percentage of the population), any questions about arrests must be handled with care.

Both the courts and the U.S. Equal Employment Commission have held that a conviction for a felony or a misdemeanor does not by itself lawfully constitute an absolute bar to employment. An employer must give fair consideration to the relationship between a specific conviction and the applicant's fitness for the particular job.

These decisions indicate that conviction records should not be cause for rejection unless their number, nature, and recentness would cause the applicant to be unsuitable for the position. If inquiries about convictions are made, they should be accompanied by a statement that a conviction record will not necessarily be a bar to employment.

Other Discriminations

Employers should not reject applicants who have less-than-honorable discharges from military service.

Discrimination because of age, for persons between the ages of 40 and 65 years, is prohibited; therefore, be careful of questions about age.

Any consideration of citizenship that has the purpose or effect of discriminating against persons of a particular national origin is illegal, in most cases.

A study of the examples of acceptable and unacceptable questions (that follow) should clarify other specific cases of discrimination.

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U.S. Laws Concerning Discrimination

- Title VII of the Civil Rights Act of 1964, as amended by the Equal Employment Opportunity Act of 1972, prohibits discrimination because of race, color, religion, sex, or national origin for any term, condition, or privilege of employment. It is enforced by the U.S. Equal Employment Opportunity Commission for businesses having 15 or more employees.

- The Equal Pay Act of 1963 requires all employers that are subject to the Fair Labor Standards Act (FLSA administered by Wage and Hour Division of the Department of Labor) to provide equal pay for men and women who perform similar work. (Women are doing electronic servicing.)

- The Age Discrimination in Employment Act of 1967, also administered by Wage and Hour, prohibits employers from discrimination against persons 40 to 65, in any area of employment because of age.

- All of these laws have rules, regulations, and guidelines, which are not always clearly defined, but they are strictly enforced. Many have been defined only as the result of lawsuits.

- State and local laws which are designed to eliminate discrimination in employment are known as "Fair Employment Practice Laws" (FEP), and these do apply to any electronic-service business, even those with one or two employees.

A product inspired by space technology

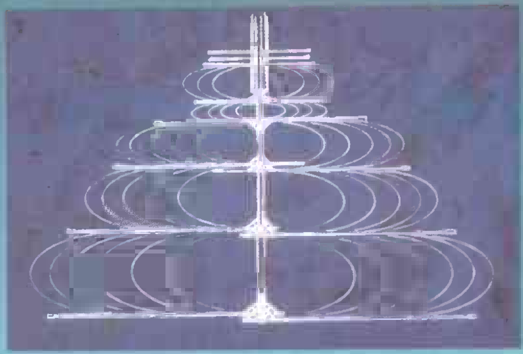
RCA Permacolor Outdoor TV Antennas... designed to provide the best possible picture in the home.

Permacolor is a product of the RCA Distributor and Special Products Antenna Engineering Laboratory, a specialized facility dedicated to the engineering and development of antenna technology. Permacolor . . . designed by the same corporation which developed the microwave antenna used on the Apollo lunar landing missions.

The Permacolor line is a complete line with advanced engineering features that offer the best possible reception in almost any area, from deep fringe to metropolitan locations. The line consists of: 10 UHF-VHF/FM all band combo models, 7 VHF/FM models, 5 UHF models, an FM only model, and a selection of 75 ohm and 300 ohm antenna kits; plus the amazing Mini-State — the first true miniaturized rotating antenna system.

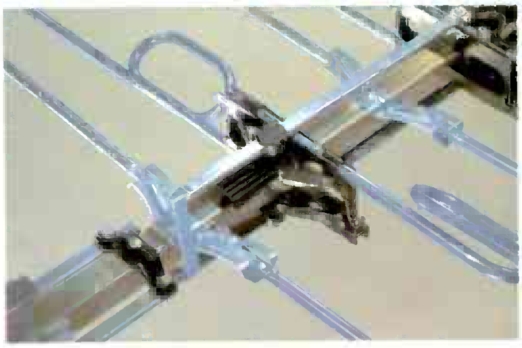
Permacolor is the first antenna with solid, permanent connections from elements to feed line. The first antenna with pivoting, polypropylene insulators. And, the first antenna with a weather-resistant blue and gold vinyl finish.

Remember. . .Permacolor Antennas are the only outdoor TV antennas that are designed, engineered, and manufactured by RCA — a world leader in electronics.

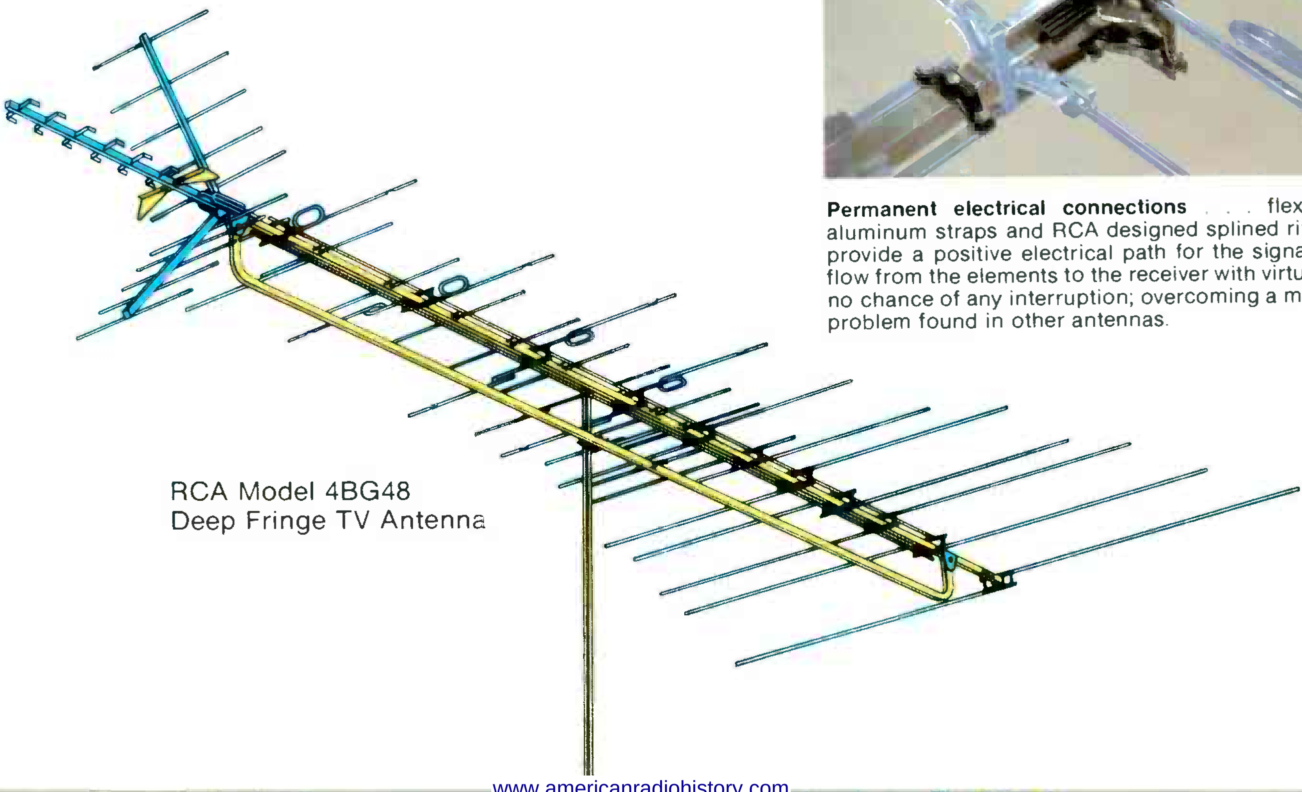


Perma-tuned circuits . . . an original RCA development. Arrangement of elements forming tuned circuits results in full-range, all-channel reception which is maintained throughout the life of the antenna by means of solidly riveted connections of flexible aluminum between elements and feed lines.

Polypropylene insulators . . . an extremely low loss material that resists weathering for peak performance and long life. Entire insulator pivots and snaps into place. Holds its element over a span of almost 6 inches, for great strength.

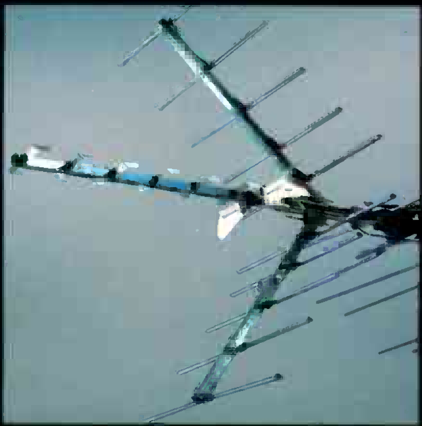


Permanent electrical connections . . . flexible aluminum straps and RCA designed splined rivets provide a positive electrical path for the signal to flow from the elements to the receiver with virtually no chance of any interruption; overcoming a major problem found in other antennas.

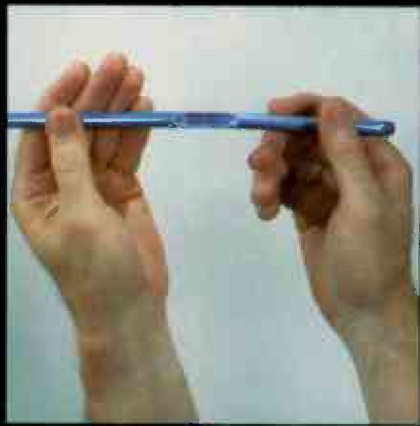


RCA Model 4BG48
Deep Fringe TV Antenna

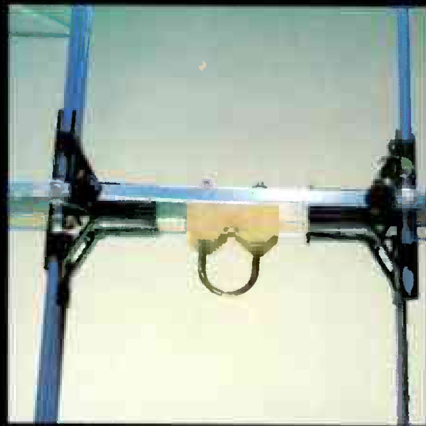
RCA Permacolor Outdoor TV Antennas... so advanced you'll never be satisfied with anything less.



Combination bowtie and corner reflector on UHF-VHF/FM models result in full-range, no compromise, all-channel reception.

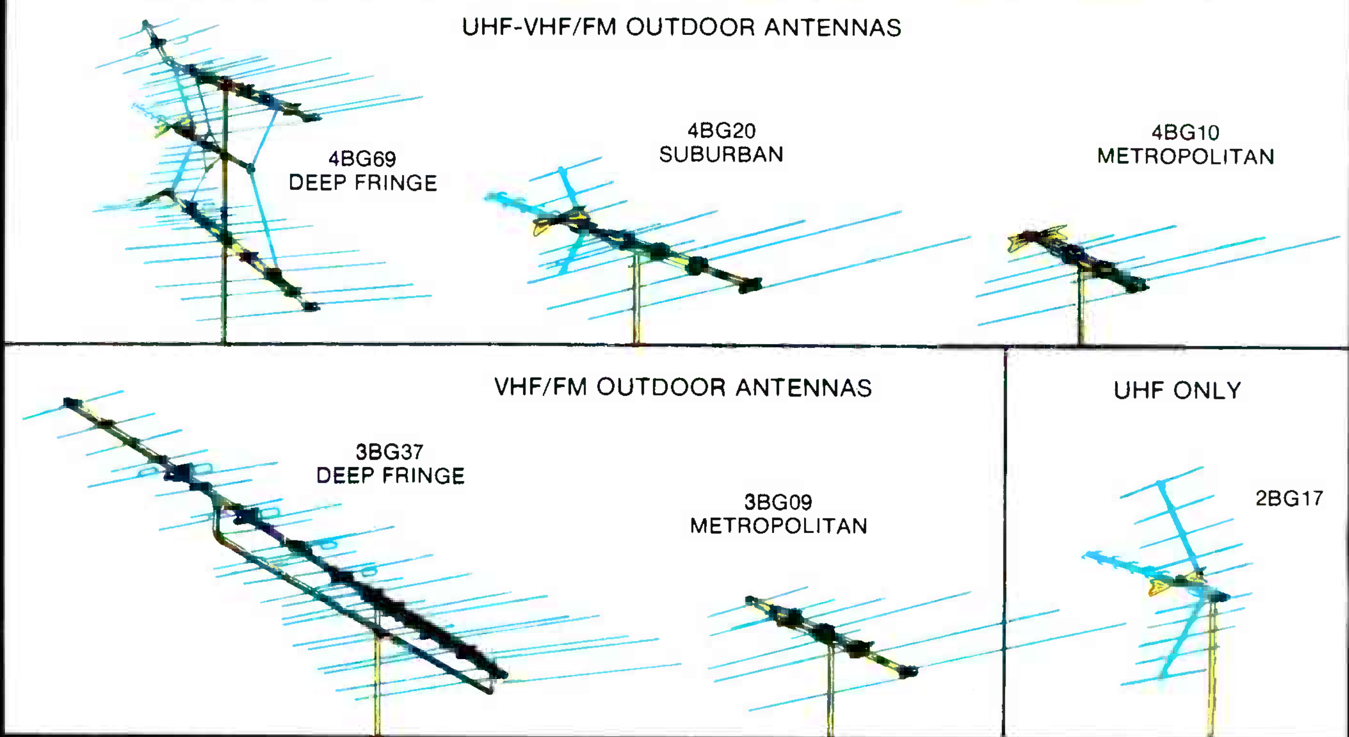


Break-off elements . . . allow you to control FM broadcast reception to suit local conditions. UHF response can be extended to bring in channels 70 to 83 if desired.



V-shaped mast clamps . . . double set of teeth bites into mast, prevents antenna from slipping, and keeps it aimed in the proper direction. Antenna is preassembled, elements unfold with ease and lock into place.

A few of the Permacolor Antenna models available:



RCA Antenna Mounting Kit

Some models are also available with a kit that includes everything needed for a normal installation — perfect for do-it-yourselfers.

A complete line of quality RCA accessories — including rotators, reception aids, and installation hardware is available.

RCA Permacolor Outdoor Antennas — your TV picture will show you the difference.

RCA Permacolor

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DISCRIMINATION—Acceptable and Unacceptable Pre-Employment Inquiries

Subject	Acceptable Pre-Employment Inquiries	Unacceptable Pre-Employment Inquiries
NAME	"Have you worked in this business under a different name?" Maiden name of a married woman applicant?	Former name of applicant whose name has been changed by court order or otherwise? "Your name sounds Spanish, are you from Puerto Rico?"
ADDRESS OR DURATION OF RESIDENCE	Applicant's place of residence? Place and duration of previous residences in the United States? How long applicant has been resident of this State or City?	"How long have you lived in the United States?" "What kind of accent is that?"
BIRTHPLACE	"Can you, after employment, submit a birth certificate or other proof of U.S. citizenship or age?"	Birthplace of applicant? "There must be some reason you won't tell me where you were born." Birthplace of applicant's parents, spouse or other relatives? Requirement that applicant submit a birth certificate, naturalization or baptismal record *prior* to employment.
AGE	"Can you, after employment, submit a work permit if under eighteen?" "Are you over eighteen years of age?" "If hired, can you furnish proof of age?" Or, statement that hiring is subject to verification that applicant meets legal requirements.	Questions which tend to identify applicants 40 to 64 years of age. "Don't you think this job is too hard on an old man like you? At your age you could fall down and really hurt yourself."
RELATIVES	Names of applicant's relatives already employed by this organization? Name and address of parent or guardian if applicant is a minor?	Marital status or number of dependents? "How do I know you will be able to get a baby sitter?" Name or address of relative, spouse or children of adult applicant? "With whom do you reside?" "Do you live with your parents?"
NOTICE IN CASE OF EMERGENCY	Name and address of *person* to be notified in case of accident or emergency?	"Give me the names of two relatives." Name and address of *relative* to be notified in case of accident or emergency?

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DISCRIMINATION—Acceptable and Unacceptable Pre-Employment Inquiries

Subject	Acceptable Pre-Employment Inquiries	Unacceptable Pre-Employment Inquiries
ORGANIZATIONS	Organizations, clubs, professional societies, or other associations of which applicant is a member, excluding any names the character of which indicate the race, religious creed, color, national origin, or ancestry of its members?	"List all organizations, clubs, societies, and lodges to which you belong."
REFERENCES	"By whom were you referred for a position here?"	Requirement of submission of a religious reference, such as name of a minister.
PHYSICAL CONDITION	"Do you have any physical condition which may limit your ability to perform the job applied for?" (You describe the nature of the job.) Statement by employer that offer may be made contingent on passing a physical examination.	"Do you have any physical disabilities?" (Some states have laws protecting the handicapped.) Questions on general medical condition. Inquiries as to receipt of Workers' Compensation.
RELIGIOUS	It is best to make no comment about religion.	Applicant's religious denomination or affiliation, church, parish, pastor, or religious holidays observed? "Do you attend religious services or a house of worship?" Applicant may not be told "This is a (...Catholic/Protestant/Jewish/atheist/etc.) organization."
WORK DAYS AND SHIFTS	Statement by employer of regular days, hours or shift to be worked.	"A woman like you couldn't work the long hours we men work each day."
RACE OR COLOR	General distinguishing characteristics such as scar?	"You look pretty dark to me?" Complexion, color of skin, or other questions directly or indirectly indicating race or color.
PHOTOGRAPH	Statement that photograph may be required after employment.	Requirement that applicant affix a photograph to his application form even if you really do it for identification. Request applicant, at his option, to submit photograph. Requirement of photograph after interview but before hiring.

DISCRIMINATION—Acceptable and Unacceptable Pre-Employment Inquiries

Subject	Acceptable Pre-Employment Inquiries	Unacceptable Pre-Employment Inquiries
EDUCATION	Applicant's academic, vocational, or professional education; schools attended?	Date last attended high school? (Viewed as an anti-Black question.)
CITIZENSHIP	"If you are not a U.S. citizen, have you the legal right to remain permanently in the U.S.? Do you intend to remain permanently in the U.S.?" Statement by employer that if hired, applicant may be required to submit proof of citizenship.	"Are you a U.S. citizen? This place is 100% American." Whether applicant or his parents or spouse are naturalized or native-born United States citizens? Date when applicant or parents or spouse acquired U.S. citizenship? Requirement that applicant produce his naturalization papers or first papers.
NATIONAL ORIGIN OR ANCESTRY	Languages applicant reads, speaks or writes fluently?	Applicant's nationality, lineage, ancestry, national origin, descent or parentage? Date of arrival in United States or port of entry; how long a resident? Nationality of applicant's parents or spouse; maiden name of aplicant's wife or mother? Language commonly used by applicant? ("What is your mother tongue?") How applicant acquired ability to read, write or speak a foreign language?
EXPERIENCE	Applicant's work experience? Applicant's military experience in armed forces of United States, in a state militia (U.S.), or in a particular branch of U.S. armed forces?	Applicant's military experience (general)? Type of military discharge? Draft Dodger?
CHARACTER	"Have you ever been convicted of any crime?" If so, when, where, and disposition of case? (Even this question has gotten some individual employers into trouble.)	"Have you ever been arrested?"
MISCELLANEOUS	Notice to applicant that any mis-statements or omissions of material facts in his application may be cause for dismissal.	Any inquiry that is not job-related or necessary for determining an applicant's eligibility for employment.

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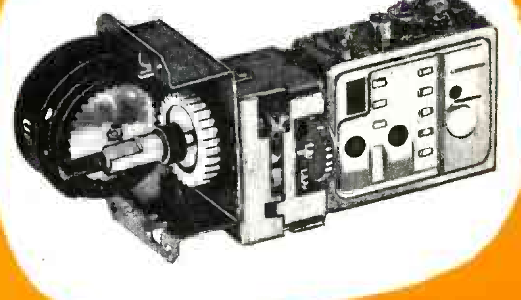

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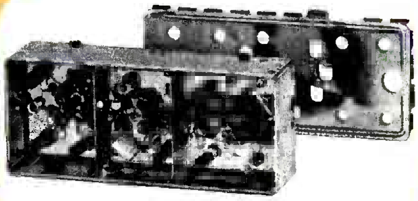

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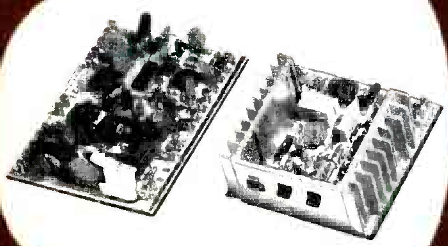

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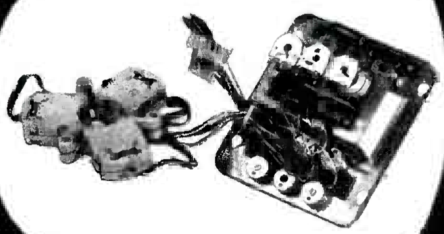

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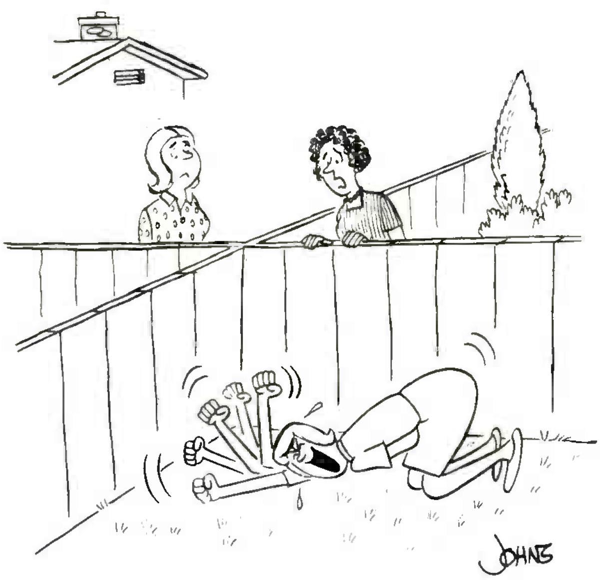
"He's from the police
and he wants to know about your sign."

"Thank goodness! The last of 28 screws."



"All I said was, it must be nice
being married to a service repairman
and have your appliances
working great all the time.

"I had a successful TV business
until I decided not to sell or service
any foreign made TV set."

Troubleshooting 4-Channel Auto Tape Players, Part 2

By Homer L. Davidson

Practical methods are given for signal tracing to find the sources of hum, noise, low volume, or intermittent gain. Also, solutions are offered for solving mechanical and electronic problems of wrong tape speed.

What Gain Per Stage?

Although most audio transistors are capable of large voltage gains (perhaps as high as 2,000), it's seldom we find such high gain in tape machines. There are several reasons for this. Probably the designers deliberately select circuits and values that provide less than maximum voltage gains in order to achieve other desirable characteristics.

The following conditions must all be fulfilled before any transistor can produce its maximum voltage gain:

- The forward bias must be optimum for that individual transistor, as it is used in the circuit. The bias giving maximum gain is very critical, often requiring a bias-adjustment control. Sometimes a bias change of only 0.05 volts will reduce the gain to near unity; either an increase or a decrease will reduce the gain;
- Collector impedance must be very

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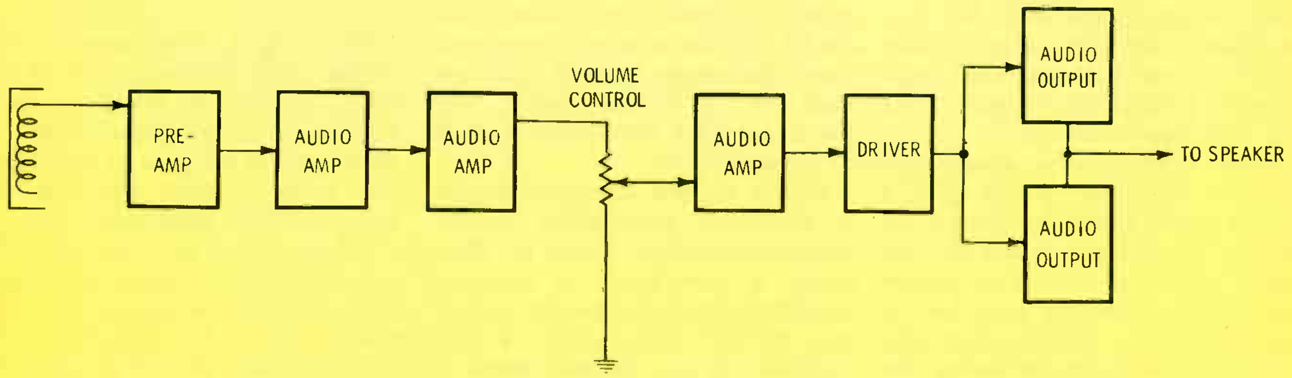

Figure 7 Although signal injection and signal tracing can be done in any stage, most stereo amplifiers divided naturally at the volume control. Inject an audio tone at the volume control and trace each stage to the speaker. Or, inject a small-level tone at the input of the preamplifier and trace it through the stages to the volume control. An excellent alternate is to apply the tone through separate isolation capacitors to the same point of two stereo amplifiers. Check voltages and audio levels between the bad channel and another which is normal.

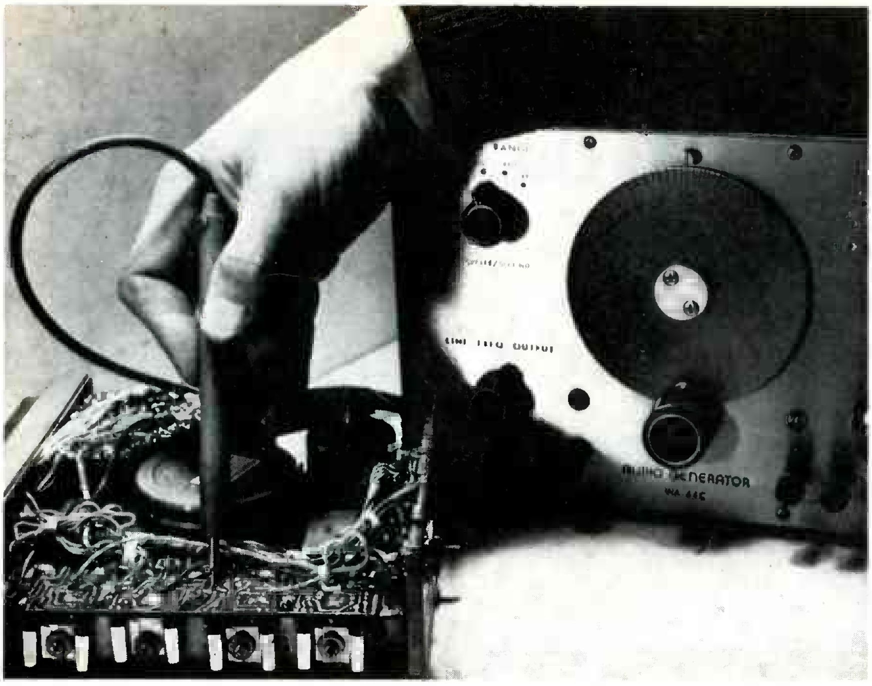

Figure 8 Sine waves from an audio generator are best for signal-injection and signal-tracing tests. Use an isolation probe, or connect a capacitor in series with the hot lead.

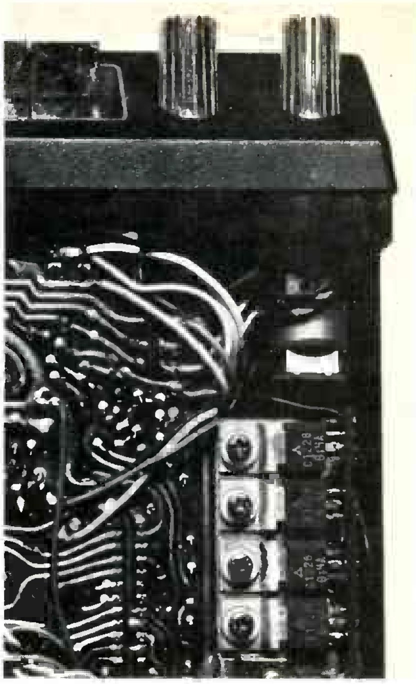

Figure 9 Transistors of this type often develop intermittent operation that originates with the leads. Therefore, move the transistor leads around, using a plastic or insulated tool, and be alert for intermittents.

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high (above 50K ohms, for example), and that includes the load or the input to the next stage;

- Several volts of C/E voltage must be present;
- No negative feedback or degeneration is permitted.

As you can imagine, a circuit with all of those features is not practical. Stabilizing networks minimize most drift, and eliminate the need for adjustable bias, but they do reduce the gain. Few circuits permit a high collector load. And negative feedback is imperative for low noise and distortion.

Also, many audio stages are emitter followers, which give a power gain while providing an output level that's equal to the input. (Emitter followers—where the signal enters the base and is taken from the emitter—that feed very low impedances are susceptible to a *loss* of gain. The output might be from 10% to 50% of the input.) Notice that the output transistors of Figures 6A and 6B are emitter followers, having unity gain (input and output AC signals are equal), while the NPN transistor of Figure 6C is a special case that has the unity gain of an emitter follower. Therefore, stage gain might measure between -10 dB and+10 dB.

Signal tracing

One highly-effective method of finding which stage has the defect is to inject an audio signal—usually a sine wave from an audio generator—and measure the signal levels in the following stages.

Figure 7 shows the block diagram of a typical tape channel. The circuit divides naturally into two parts: the stages between the tape head and the volume control; and the stages from the volume control to the speaker.

Decide whether to inject the tone at the head preamplifier or the volume control (see Figure 8). Then apply a sine wave of suitable amplitude through separate capacitors to the *same* point of two channels. As you use your scope to follow the signals downstream, check the levels and waveforms of the bad channel against those of the normal channel. This gives you a valuable built-in standard.

Without a normal stereo channel to serve as a guide, you would be forced to guesstimate the gain of each stage. After some practice, you can examine the circuit and arrive at a ballpark figure for gain. However, the comparison against a normal channel is easier, faster, and more accurate.

Suppose one certain audio stage of the faulty channel showed a slight loss of gain, compared to a gain of about 20 for the comparison stage of the good channel. Unquestionably, the low-gain stage has a dectect in it.

Next step is to measure the DC voltages and the resistances of the stage, followed by transistor tests, both in-circuit and out-of-circuit. In most cases of low gain or distortion, this series of tests will find the defect within a short time.

Of course, multiple direct-coupled stages introduce many possible traps for the unwary. Even so, analysis of the DC voltages usually can pinpoint the origin of the problem.

Hum and noise

Transistors can't cause hum; tubes are notorious for generating hum. In addition, auto stereo amplifiers operate from the +12-volt car battery, thus eliminating the possibility of filter hum. It's almost impossible for these units to have conventional hum.

However, auto tape units are more susceptible to various kinds of noises than are the home models.

The playback head is magnetic, and it can act as a pickup coil for ignition noise or the popping sound of opening and closing light switches. Even so, such noises are not problems very often.

The most likely noises come from transistors and resistors, which can generate either impulse popping noises or "pink" noise that sounds the same as an FM receiver without an input signal (a rushing, hissing sound).

Such frying or hissing noises can start at any time. Unbypassed resistors—such as emitter resistors—in the preamplifier stages can become noisy, perhaps from aging. Transistors, too, sometimes begin intermittent or continuous noise.

Often the noisy transistors and resistors will respond to the hot-and-cold treatment. Either heat the entire chassis slightly, or wait until the noise starts, then carefully spray each suspected resistor or transistor with canned coolant. A sudden change of noise might indicate the bad component.

With resistors and transistors, a *slight* change of temperature usually is sufficient to vary the noise level; don't overdo the heating and cooling. Also, use the small tubing that comes with the spray can to direct the coolant to just one component at a time; otherwise the results will be confusing or erroneous.

The same temperature cycling can identify a surprising number of intermittent transistors. Usually, the intermittent occurs after the ambient temperature has reached normal operation; therefore, a small spray of coolant often restores the correct performance.

Watch those leads

TO-22-type output transistors (and similar ones), as shown in Figure 9, are prone to intermittents that start and stop from movements of the leads. This is particularly a problem where the leads have a 90° bend before reaching the chassis or a socket.

Move the leads around by using a plastic screwdriver or alignment tool. Any transistors that change volume or distortion during the manipulations should be replaced. (Don't forget to use silicone grease where mica insulators are used between chassis and transistor.)

General Speed Problems

Regardless of brand or model, tape players in autos frequently exhibit these symptoms:

- The tape speed slows down after a few minutes of playing;
- The music plays too fast;
- Wow or flutter can be heard with the music;
- The music sounds "flat," or the customer believes the music is playing too slow; or
- The tape doesn't move.

These problems all originate in the motor or the mechanism that moves the tape. Often the customer's complaint must be interpreted. For example, a complaint of the

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Figure 10 (Top) Remove the flywheel and capstan shaft assembly before you clean out the old grease and apply fresh lubrication to the bearing shaft.

Figure 11 (Top right) Holding the flywheel should stop the motor. If it does not, the belt might be loose or defective.

Figure 12 (Right) Fast tape speed can be caused by a belt that rides too high on the motor pulley and the flywheel, as shown.

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machine running slow, or making the music sound "flat," usually is *not* caused by an error of the *average* tape speed. Instead, *the speed is varying;* and this changes the pitch of the musical notes, sometimes "sharp" and sometimes "flat."

Slow variations of tape speed are called "wow," while "flutter" either is a rapid speed change or a fast change of volume (amplitude).

Check the lubrication

Many cases of slow tape speed, or slowing down after a few minutes, are caused by old dried-out oil and grease, perhaps in the bearings (Figure 10). Therefore, fresh lubrication is required for proper analysis, as well as for good maintenance. However, to minimize call-backs, you should locate the bearing that's causing the problem, before you do a complete lube job.

At the other extreme, excessive oiling can produce problems of slow speed. For example, a rubber belt or rubber-tired wheel will slip after oil or grease reaches the surface. **DO NOT use too much oil and grease.** In fact, do not touch the rubber. You might have gotten oil from tools or the tape mechanism on your fingers. And even skin oils can cause slippage.

Use a clean cloth dipped in alcohol to clean oil and grease from rubber parts, or to remove caked lubrication from shafts and bearings.

Don't try to free a flywheel/capstan (that is "frozen" or turns hard) by merely oiling it from the outside. Such "fixes" are only temporary at best. Instead, remove the flywheel/capstan assembly, and clean both the shaft and the bearing with alcohol. Use a cotton swab dipped in alcohol to clean inside the bearings, and to remove oxide and tape scraps from around the capstan bearing.

Just before reassembly, place one drop of #20 machine oil on the bearing area of the capstan shaft. During the insertion of the shaft, make certain the oil doesn't run onto the drive area of the shaft.

Remember: **either too little or too much lubrication can cause serious speed problems.**

Simple tests

The cause of wrong or erratic tape speed often can be located by a visual inspection of the mechanism. This is called "eyeballing." You can find most bad belts by looking for cracks or oil on the inside surface.

Loose or stretched drive belts can

be found by turning on the power and using fingers to stop the flywheel (Figure 11). Notice whether or not the motor stalls from the load. It should stop, if the belt has sufficient friction and the proper tension. If the motor continues to rotate, replace the belt.

Check the flywheel rim and the motor drive pulley for a shiny surface indicating slippage of the belt.

Remove the belt and try to spin the flywheel; it should spin freely. Then rock the flywheel back and forth to check for worn capstan bearings. If there is any sign of bearing wear, replace both the bearings and the flywheel/shaft assembly.

A cartridge that's wound too tight can slow down the speed, or cause wow and flutter problems. Try several cartridges to determine whether or not the symptom is caused by the questionable cartridge.

Electric or electronic defects

Cases of excessive tape speed are rare, but possible. If the motor has an internal governor, it probably is the cause of very-high speed. Replacement of the motor is the only solution.

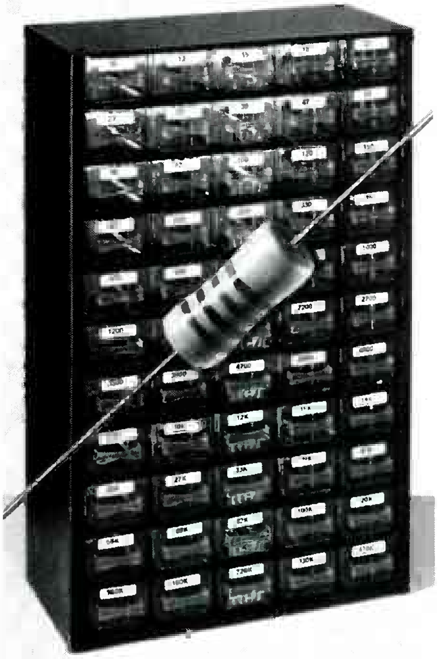
However, some machines have a voltage-regulator circuit for the motor, and too much voltage to the motor produces excessive tape speed. Check the voltage against the schematic figures.

Also, a simple mechanical defect, such as a belt that rides too high on a motor pulley, can cause fast tape speed (see Figure 12).

Comments

Treat all transistorized equipment with cautious respect. Certain kinds of intermittent shorts during tests that are made carelessly can ruin several transistors. If you want to inject a sine wave from a generator, turn off all power to the tape unit, **connect the generator through an isolation capacitor** to the point, and *then* turn on the tape-player power.

To avoid disastrous shorts, use the same care when you measure voltages. If the board has no convenient point for the test, solder a small length of bus wire to the copper wiring, and connect the meter lead or test equipment to it. □



The Basics of Industrial Electronics, Part 3

By J. A. "Sam" Wilson, CET

Passive transducers undergo a change of resistance, capacitance, or inductance when the energy level being sensed changes. For example, we learned that most thermistors have a decrease of resistance when their temperature increases. Other passive transducers are described this month.

Many transducers used in industrial-electronic devices vary their resistance in response to a change of the energy being monitored. Here's how they work.

Changing The Resistance

One or more of the following conditions must change before the resistance of a conductor or a semiconductor can be varied:

- **Cross-sectional area.** Lower resistance requires a larger cross-sectional area of the material.
- **Length.** Longer paths for the charge carriers increase the resistance.
- **Temperature.** PTC materials increase resistance with an increase of temperature, while NTC materials decrease resistance with an increase of temperature.
- **Type of material.** Individual formulas for conductors and semiconductors produce materials having different resistances.

Notice, as we discuss some examples of resistor transducers, which of these four conditions is changed.

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At the left, a Hall-effect transducer senses rotation of the vanes. The sensor at the right shows the two halves, with a powerful magnet on one side and an IC on the other. The vanes block most of the magnetism when they are between the halves. Hall-effect sensors can detect very slow counts (where magnetic devices are useless); that is their main advantage. This unit is rated from zero to 100,000 counts per second. (Courtesy of the Micro Switch Division of Honeywell.)

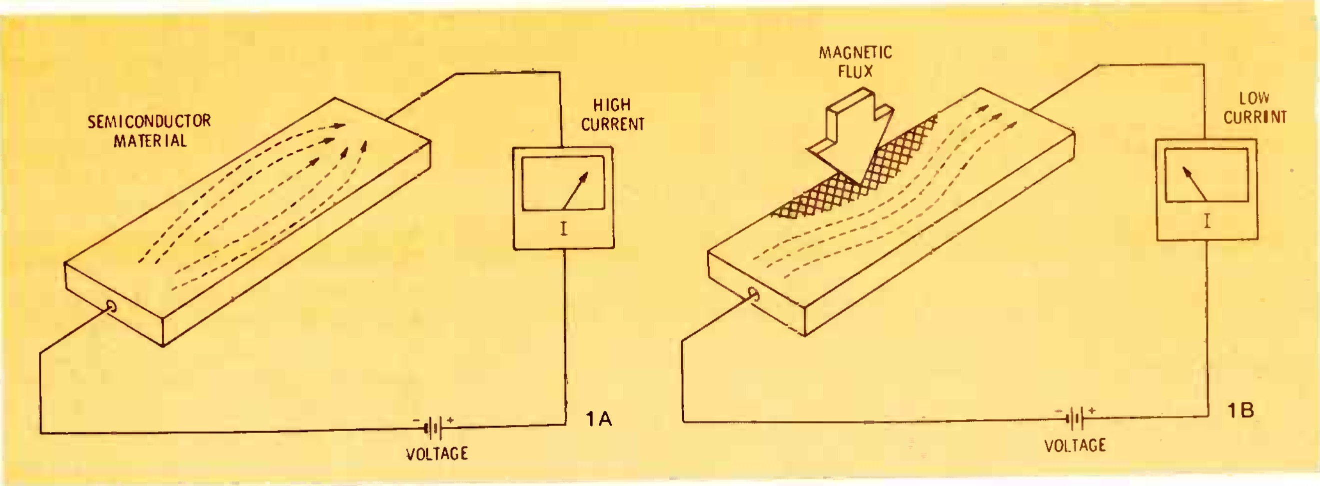

Figure 1 DC voltage applied to a slab of semiconductor material (A) causes paths of the charge carriers (electrons) to be distributed evenly throughout. (B) When a magnetic flux is applied to one edge, the charge-carrier paths are reduced near the flux and are bent around the area. This is the magnetoresistive effect.

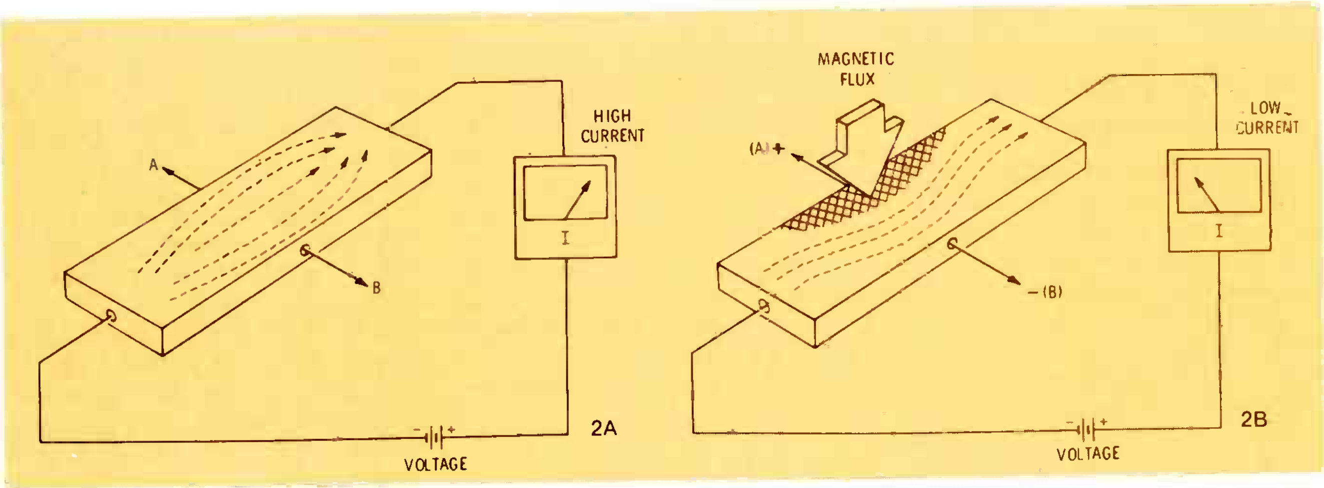

Figure 2 (A) Without flux, electrodes at A and B receive no voltage when the semiconductor passes current. As in Figure 1, the current paths are distributed evenly. (B) When a magnetic flux is applied to one edge of the slab, a voltage is developed between the electrodes; A is positive and B is negative. **This is the Hall effect, and it is used extensively in industrial transducers.**

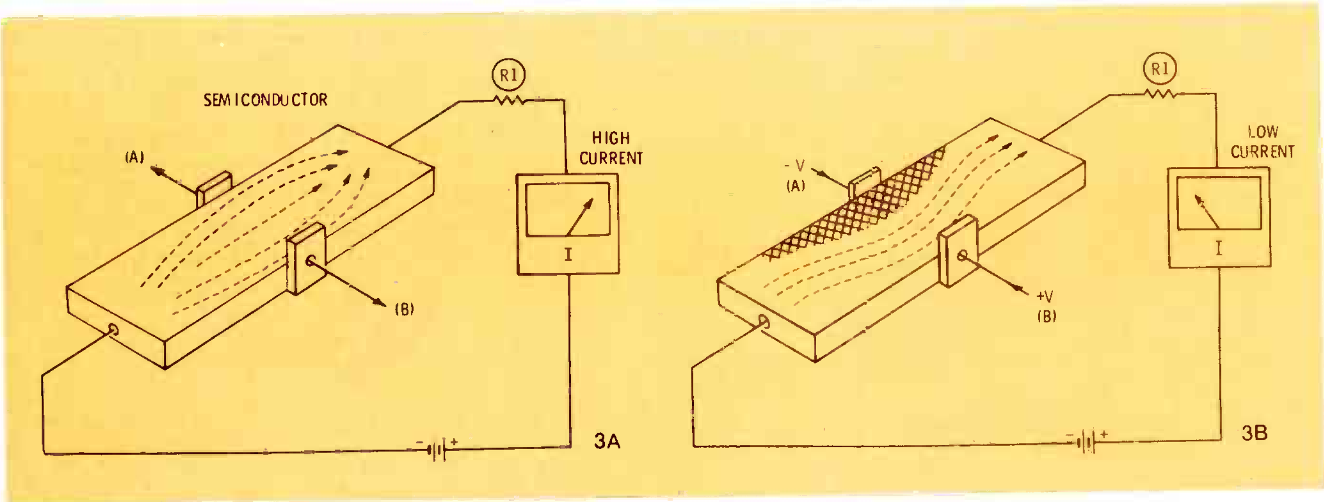

Figure 3 (A) Insulated plates mounted at the edges of the semiconductor slab don't affect the current paths when no voltage is applied to them. (B) Voltage connected to the plates decreases the number of current paths near the negative plate thus reducing the current. This is the field effect, which is the basis for Field-Effect Transistors (FETs).

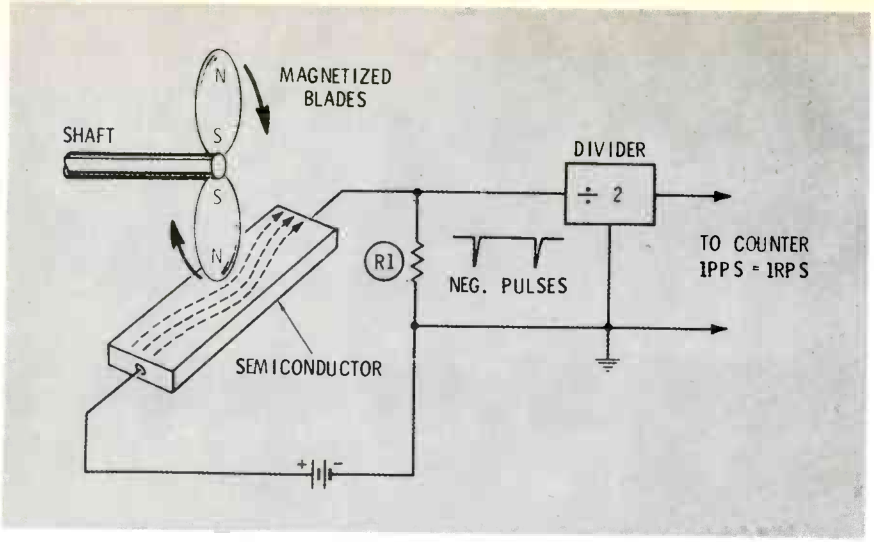

Figure 4 Rotating magnets reduce the semiconductor current as they pass. Negative-going pulses of voltage are produced across the load resistor R1. A divider equal to the number of magnets makes the output signal directly indicate the shaft rotation per second.

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Cross-Sectional Variations

Physically changing the cross-sectional area to obtain a variable resistance usually is not possible or desirable. But, the same effect can be produced electronically.

For example, Figure 1 shows a slab of semiconductor material that's connected across a source of voltage. Arrows show typical paths of the charge carriers (Figure 1A), and you will notice that they are spread evenly across the material. (These charge carriers are electrons.)

However, when a magnetic flux passes through the slab (Figure 1B), the paths of the charge carriers move to the outside, around the flux. The result is less current, because the resistance has been increased by a reduction of the *effective* cross-sectional area. Stronger magnetic flux minimizes the current even more.

This is called the **magnetoresistive effect.**

The Hall Effect

The setup of equipment in Figure 2 is similar to that for demonstrating the magnetoresistive effect. However, two extra terminals (A and B) have been added to the semiconductor material.

In Figure 2A, when current is passed through the semiconductor, no voltage is developed at A or B.

But the addition of a magnetic flux at the edge of the semiconductor (Figure 2B) warps the paths of the charge carriers, with few around A and many around B. Therefore, terminal B measures negative in respect to terminal A. In other words, a voltage is generated when flux is present. That characteristic makes it an "active" transducer.

This phenomena is called the "Hall" effect, and it's interesting to know that it was first discovered in 1879, although modern semiconductor techniques are required to make practical use of it.

Hall generators are used extensively as sensors for the measurement of magnetic field strength, and as sensors of shaft rotation or for counting in industrial electronic systems.

The Field Effect

Another important principle called the "field" effect needs an explanation at this point.

In the absence of an electric field between terminals A and B of the semiconductor slab in Figure 3A, the electron-current paths are evenly distributed, and the current is maximum.

When a positive voltage is connected to B and the negative end to A, the electron-current paths are concentrated around B and they

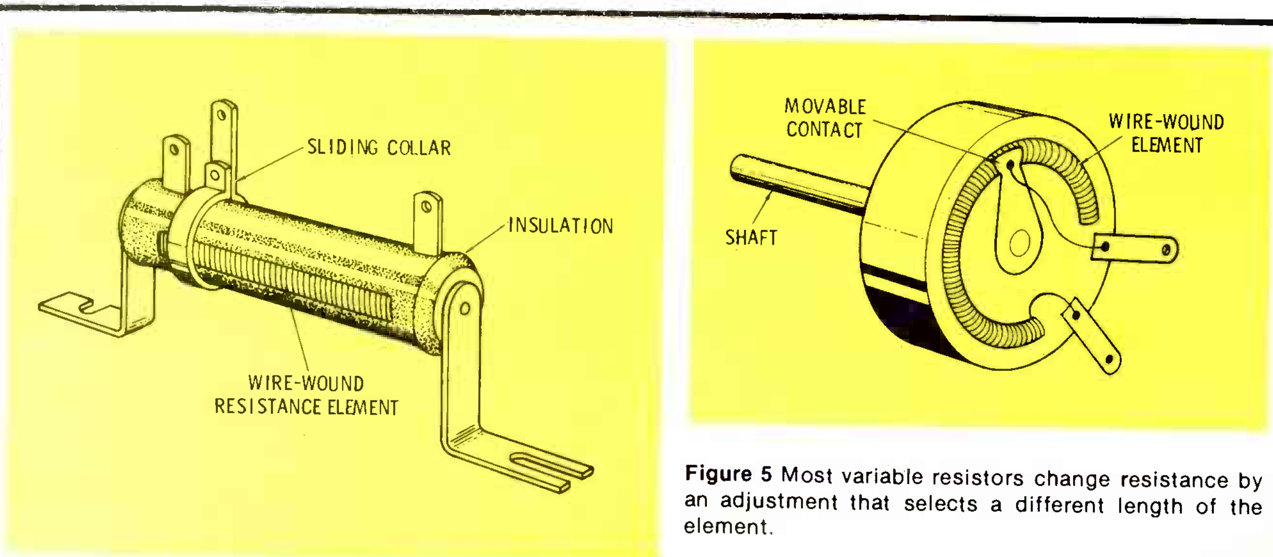

Figure 5 Most variable resistors change resistance by an adjustment that selects a different length of the element.

avoid the area around A. Therefore, the semiconductor current is reduced.

Experienced TV technicians will recognize the principle behind Figure 1 as being similar to magnetic deflection of a picture tube, while the electrostatic deflection of a scope tube is illustrated by Figure 3.

And, of course, this also is the way Field-Effect Transistors (FETs) operate.

Speed Measurements

The speed of shaft rotation can be measured by the magnetoresistive effect, as shown in Figure 4. Both fan blades are magnetized (or two bar magnets are used for other applications). Every time a blade passes close by the semiconductor slab, the current is reduced. Therefore, negative-going pulses are developed across load resistor R1.

When a divide-by-two circuit is added to the output pulses, the pulses-per-second equal the shaft revolutions-per-second. (A four-bladed fan, or four magnets, would require a divide-by-four circuit.)

Varying The Length Of Current Path

Most variable resistors (potentiometers, rheostats, or variable voltage-dividers as shown in Figure 5) are designed to change the resistance by a variation of the *length* of the resistive element.

Measuring lateral position or thickness

Lateral position of an object can be monitored by connecting a rotary rheostat with rack-and-

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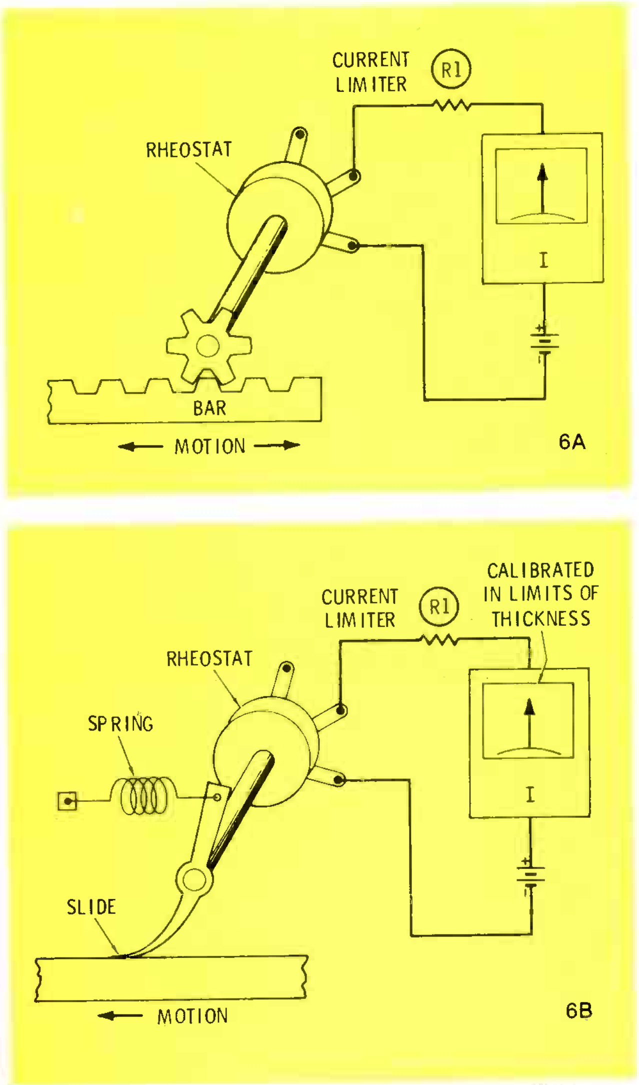
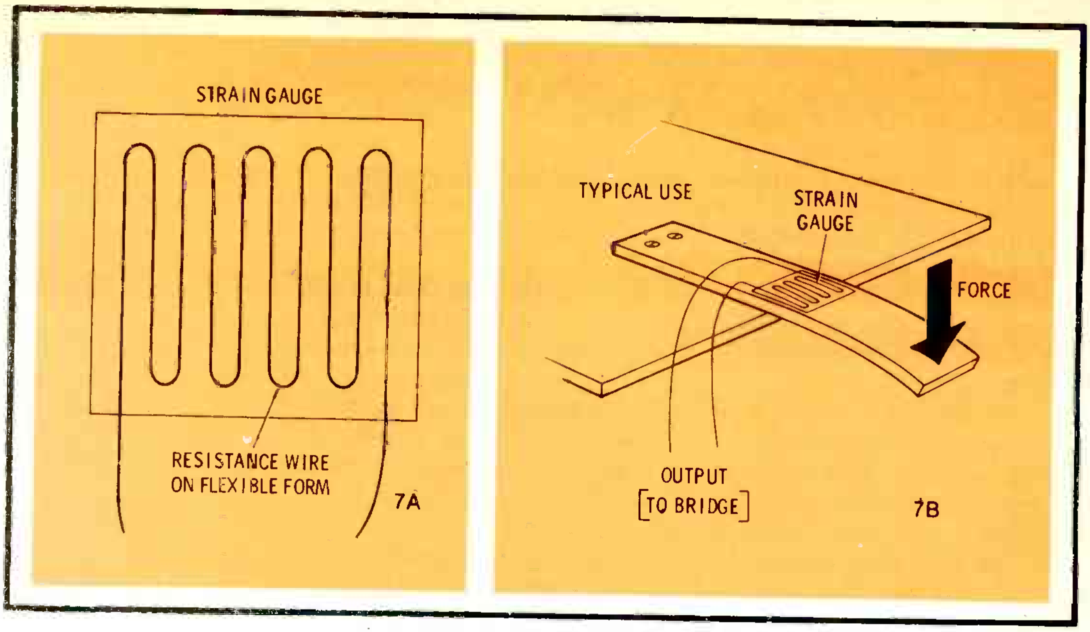


Figure 6 Rheostats and potentiometers can be attached to metal linkages so the lateral position (A) or the thickness (B) of a moving object can be read from the meter.

Figure 7 Resistance of a strain gauge changes when the device is bent. (A) shows how the wire is applied to the paper backing, and (B) gives one application whereby the strain gauge senses the bending of the beam.



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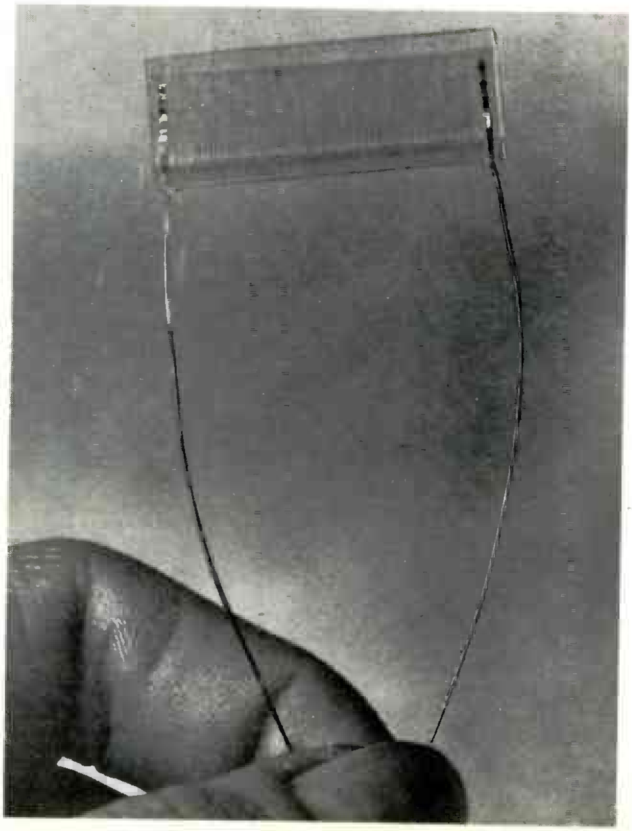
pinion gears (see Figure 6A). The motion of the bar turns the shaft of the control (thus varying the length of the resistive element), and the resulting current is read on the meter. This circuit works best with slow-speed movements. Also, it has memory, so stoppage of the bar movement is indicated.

Calibration of the meter scale shows the desired position plus any permissible deviation, and the meter can be mounted separate from the machinery to provide remote readings.

Figure 6B illustrates one method of monitoring the thickness of a moving object (such as lumber or insulation for homes). A slider bracket attaches to the shaft of a rotary potentiometer or rheostat, and a spring holds the slider against the plate or moving object. In this case, increased thickness causes more resistance and a lower reading on the meter. The meter scale can be marked in inches or with high and low tolerance readings.



Although this sensor has the appearance of a strain gauge, it actually is a nickel-iron-wire temperature sensor that's designed to be embedded inside a heated aircraft window. (Courtesy of Minco Products)

Strain Gauges

When force is applied to a solid mass, bending or deformation occurs. **Stress is the force that's applied to a physical body, and strain is the resulting change of shape.**

Therefore, a **strain gauge** is used to measure the deformation that results from stress. A typical strain gauge is illustrated in Figure 7.

Small-diameter resistance wire is fastened securely to a non-rigid backing material, such as paper or plastic. When the device is bent or twisted, the length of the wire is increased, and the stretching of the wire makes it thinner (reduces the cross-sectional area). Both of these effects increase the resistance. (This change is not large compared to that of thermistors or varistors, and usually requires amplification or use in a bridge circuit to increase the sensitivity.)

Although Figure 7 shows the strain gauge measuring the bending of a beam that's under stress, the bending of any material can be detected.

Resistance Versus Temperature

Thermistors are resistive transducers that undergo a relatively-large change of resistance when its temperature is varied. This was discussed at length previously. One of the applications was an alarm that signalled when a tank was empty. Although the schematic was similar to Figure 8, the principles are different. Last month, the self-heating effect of a thermistor changed according to whether or not it was in the liquid. Conductivity of the liquid was not a factor. Compare that with the next description.

Transducers That Change Material

A simple example of a sensor that utilizes a change of material is shown in Figure 8. In this case, the liquid in the tank has a low electrical resistance. At normal liquid depths, the A and B electrodes are separated by air, a good insulator. When the liquid is overfilled and rises above the electrodes, the conductive liquid completes the circuit and activates the alarm relay. The normally-open pair of relay points are used for this kind of alarm.

For an empty-tank alarm, the electrodes are placed at the bottom. When the tank is full, the electrodes are in the liquid, thus activating the relay all of the time. A low level of liquid exposes the electrodes to the air, the relay opens and lights the warning through the normally-closed points.

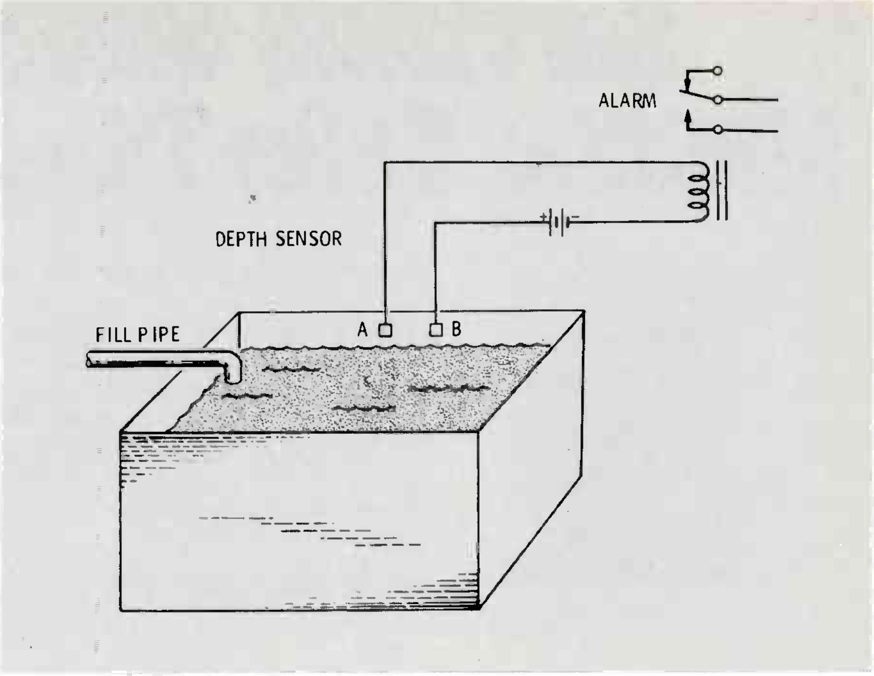


Figure 8 Some sensors depend on a change of material for a signal. In this example, the liquid readily passes electrical power, and the circuit can be arranged to show overfilling or an empty tank. When the electrodes are in air, the relay has no power. Then, when they are immersed in the conductive liquid, the relay coil is energized.

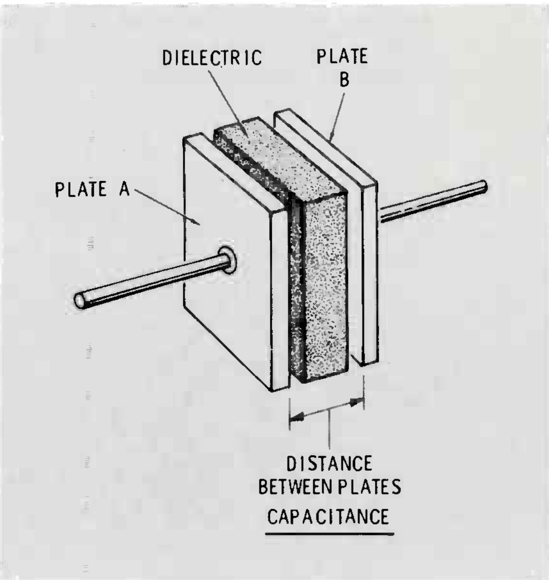


Figure 9 The factors that determine capacitance are shown here.

Capacitor Parameters

A capacitor stores energy. Physically, it consists of two conductors that are separated by insulation (usually called **dielectric**), as illustrated in Figure 9.

The capacitance (or capacity) is a measure of how much energy a certain capacitor can store. These three factors determine the amount of capacitance:

- the areas of the plates that face each other. Larger areas produce increased capacitance;
- the distance between the plates. The capacitance is inversely proportional to the distance between the plates. In other words, the capacitance is decreased by a wider separation of the plates; and
- the type of material that's used for the dielectric. The "dielectric constant" rates various materials relative to a vacuum.

It is important for us to understand that the energy of a capacitor is stored in the dielectric, and a vacuum is a poor storage unit; most materials are much better. Thus, the dielectric constant predicts how much more energy the various materials can store compared to a vacuum.

The equation for capacitance is: Capacitance equals the plate area divided by the distance, times the dielectric constant (K).

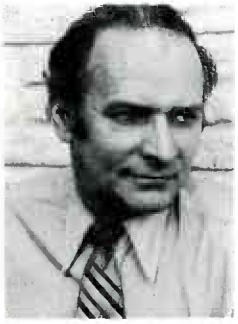
Capacitance transducers must vary either the plate area, the distance between plates, or the material of the dielectric.

Next Month

Capacitive transducers and some of their typical applications will be the main topic next month. □

Servicing Magnavox Modular Color TV, Part 4

By Gill Grieshaber, CET



In the IF stages of the Magnavox T995, MOSFETs are the amplifiers, while discrete transistors handle the AGC and sync-separation functions. The Videomatic module has special variable gain-reductions of the video and chroma signals that allow them to track contrast and brightness adjustments. A unique circuit in the low-level video module clamps the top of the blanking pulse of the composite video to the DC voltage selected by the brightness control. These are some of the interesting details of the IF and video stages.

Signal Processing

Paths of the various signals in a Magnavox T995 chassis are shown in Figure 1. Most of these signals are connected in conventional fashion, although the stages are assigned to the various modules by a layout that is unique to this one model. We'll show you where the important test points are, and what signals and levels to expect there, so you can service the T995 efficiently.

Tuners And The IF Module

The Videomatic *digital* tuner-control system includes two varactor-type tuners, but this system will not be described yet. So, we will skip over the tuners, and start

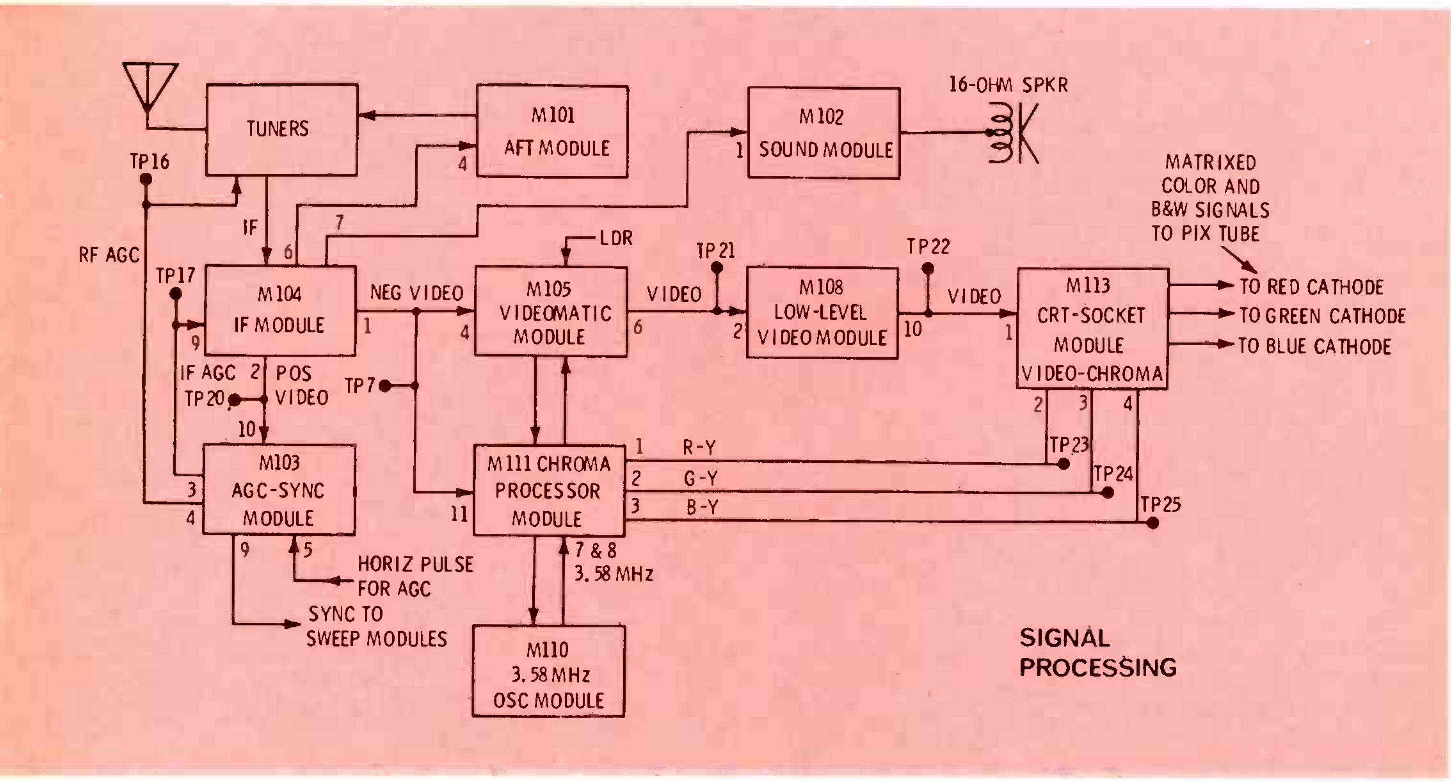


Figure 1 Paths of the IF, video, and chroma signals in the Magnavox T995 color receiver are shown in this block diagram.

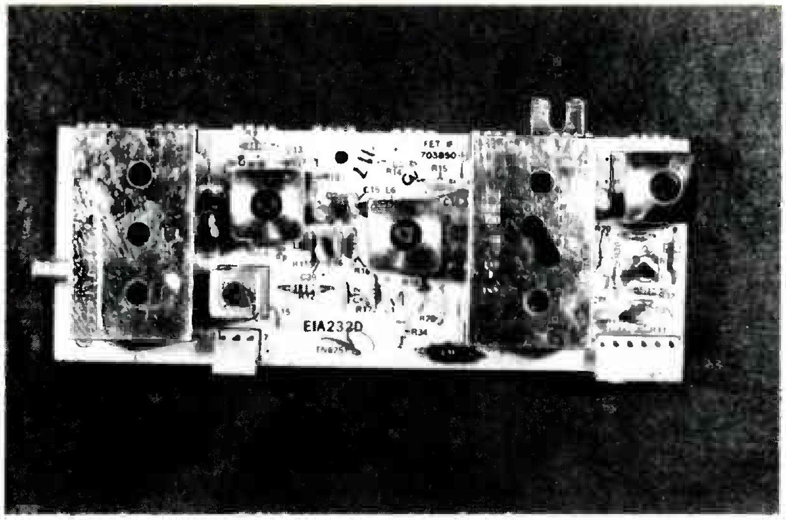


Figure 2 Shields cover only parts of the M104 IF module, so voltages and signals can be measured easily at the video transistor and two of the dual-gate MOSFETs. Therefore, these modules either can be repaired or exchanged.

with the M104 video-IF module (see Figure 2). Three dual-gate MOSFETs and one bipolar transistor are used. The video and sound-IF detectors are separate, with the sound-detector signal picked off before the 41.25-MHz sound trap that's in the output of the third-IF stage.

Q4, the bipolar video transistor of Figure 3, is driven from the video-detector (through the 4.5-MHz trap), and the output is a positive-going video signal for use by the AGC/sync circuits on the M103 module, plus a negative-going video signal that supplies the video circuit (module M105) and the chroma bandpass (module M111). These two signals have the usual composite-video waveforms.

The photograph in Figure 4 shows the approximate locations of the modules described this month.

RF And IF AGC Circuits

On the M103 AGC/sync module (see Figure 5) are the noise-gate, AGC-keyer, and sync separator stages; the complete schematic is in Figure 6.

Diode D7 clamps the IF AGC voltage to the DC voltage from R21 and R22. When the IF AGC attempts to rise above the +4 volts produced by the R21/R22 voltage divider, the diode conducts. Therefore, the IF AGC can exceed +4 volts only by the 0.7-volt drop across the diode.

In the same way, diode D1 clamps the RF AGC voltage so it can't rise above the +10 volts supplied by R4 and R5.

The "detector-level" control (R11) sets the emitter DC voltage (bias) of Q1, the AGC keyer. Therefore, this control affects contrast and overload in exactly the same way as did the AGC controls in old tube-equipped sets.

Although the "RF-AGC delay" control (R7) actually determines the amount of DC AGC voltage that's applied to the IF MOSFETs, the effect is to vary the RF AGC voltage. Therefore, R7 determines the amount of snow in TV signals of moderate level.

For your guidance during AGC troubleshooting, Figure 6 shows the RF and IF AGC voltage actually obtained from no signal and three signal strengths. Good accuracy of these various signal levels was possible by using the gray-quad pattern from an American Technology model ATC-10, which has a 0-to-9 calibrated knob for the channel 3 output level. Refer to these voltages when you question the AGC operation of a Magnavox T995.

Noise gate

Zener diode Z1 maintains the emitter of Q2 (noise gate) at a constant DC voltage, and the base resistor (R14) returns to the emitter. Therefore, Q2 has no DC forward bias and can't amplify until the AC base signal exceeds +0.6 volt. In addition, diode D4 normally is reverse biased, and this prevents any video signal from reaching the base of Q2. So, when the picture has no noise pulses, Q2 does nothing.

If the video signal has large amplitude noise peaks, these peaks can forward bias D4 and reach the base of Q2, where they act as forward bias. During those peaks, Q2 amplifies the pulses, and inverts the phase. These inverted pulses are added to the video (that has the original noise pulses) at the output of R17. There the two polarities of noise pulses cancel, leaving the video without noise.

This noise cancellation removes the pulses from the video sent to the AGC (preventing loss of contrast during heavy noise) and to the sync separator (preventing vertical roll from bursts of noise). However, the noise pulses remain in the video signal which is sent to the chroma and video modules, and they can be seen on the screen as black dots or short lines.

AGC keyer

The emitter DC voltage of Q1, the AGC-keyer transistor, is adjusted and stabilized by the voltage divider that includes R11, which is labelled "detector level." Amplitude of the video signal that reaches the base of Q1, therefore, determines the bias and the conduction of Q1, which acts as a variable resistor in series with D3, thus controlling the rectification of D3. Positive horizontal pulses (Figure 7) pass

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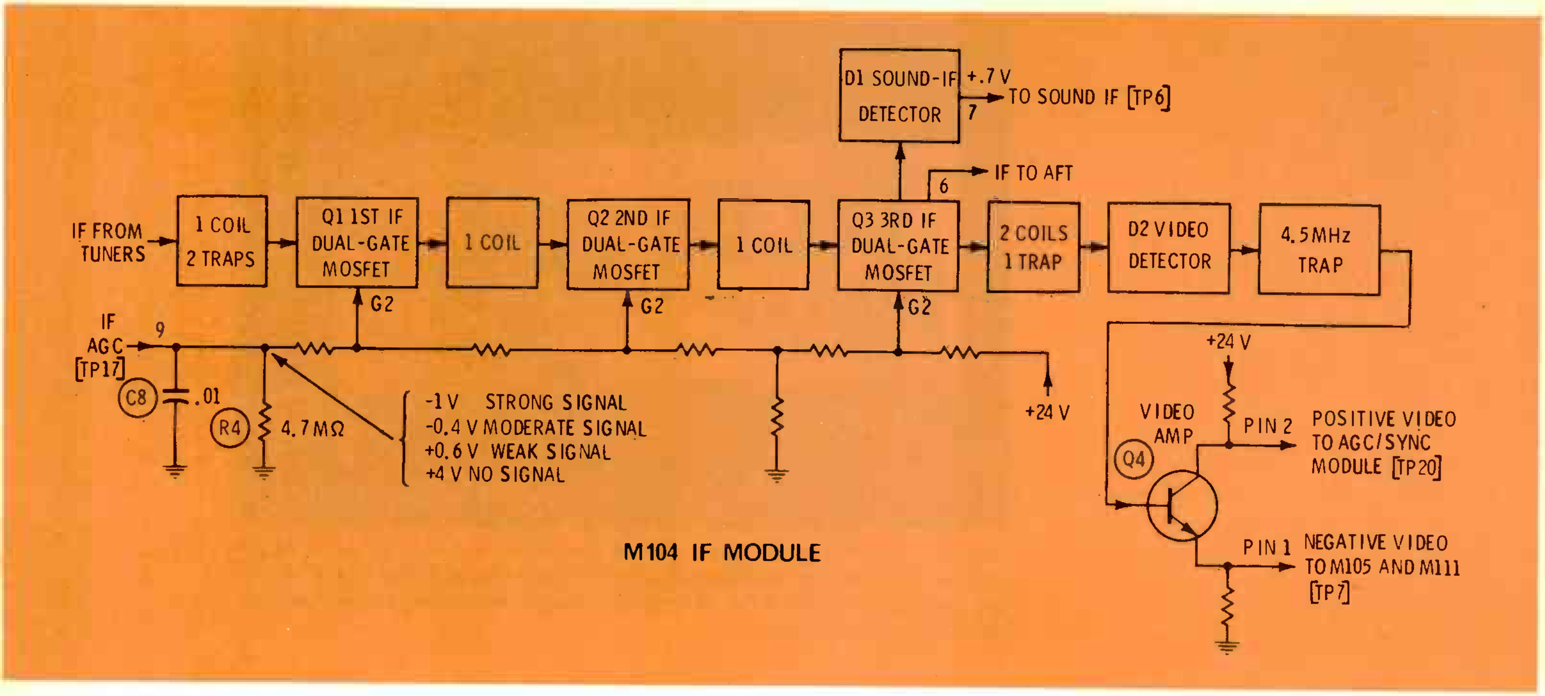

Figure 3 A block diagram of the M104 IF module shows a conventional array of circuits. Input and output pin numbers are given, plus typical AGC voltages produced by various signal levels.

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through C9 to the anode of D3. Rectification of the pulses makes the D3 anode negative, and produces a positive voltage at D3 cathode (which also is the Q1 collector).

For example, if a stronger TV carrier increases the video level, Q1 conducts more, making the collector less positive, and producing a higher negative voltage at the D3 anode. The voltage divider, consisting of R6, R7, and R8, mixes the variable negative with a fixed amount of positive voltage, in a ratio determined by the setting of R7. Usually the IF AGC voltage is slightly positive, becoming slightly negative only from a very strong station signal. The first and second MOSFETs in the IF module receive the AGC voltage from R7.

We previously described the action of R22, R21, and D7, which prevents the IF AGC from becoming more positive than about +4 volts.

RF AGC

The varying negative DC voltage from the anode of D3 goes through R2 and is mixed with a fixed positive voltage from R1, producing an RF AGC voltage that always is positive. Instead of a negative voltage that becomes more negative as the result of an increase of signal strength, the RF AGC voltage now is a positive voltage that becomes

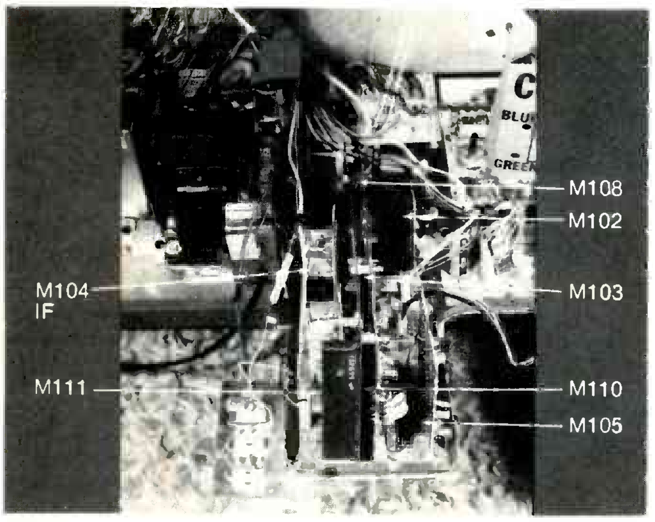

Figure 4 Locations of the signal-processing modules are indicated by arrows. These modules are all on the left half of the chassis.

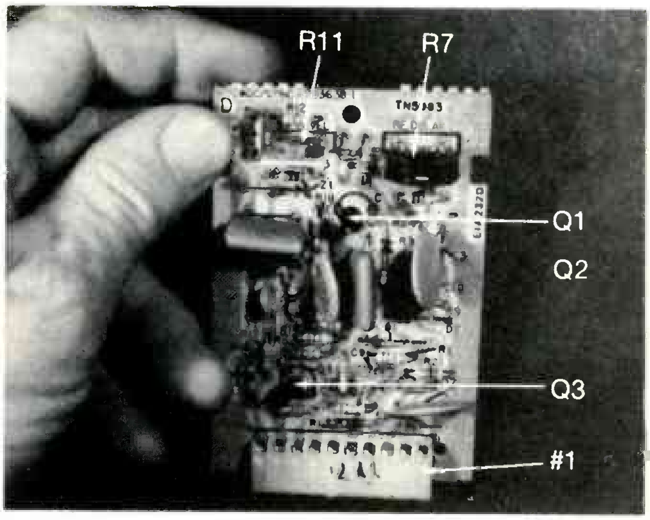

Figure 5 Controls and transistors of the M103 AGC/sync module are pointed out.

less positive when the signal strength increases.

Of course, a weaker TV signal reverses all of these voltages, thus increasing the gain of the RF stage.

Separating The Sync

The sync-separator stage has a single circuit, and it functions very well. Although R19 brings in some positive forward bias for the base of Q3, the base never *measures* positive. The base/emitter junction operates as a diode to rectify the video brought in through C7 and C8. (The base is equivalent to the anode of a diode, and the emitter acts as a diode cathode.) Therefore, the shunt rectification develops a voltage that is negative (as averaged by a DC meter). When the TV is tuned to an unused channel, the "diode" rectifies the snow, and the base remains slightly negative.

Shunt-rectifier circuits draw current only at the tip of the waveform. The base waveform is positive-going video. Therefore, base current (also, forward bias and amplification) occur *only* during the horizontal and vertical sync pulses. So, the output at the collector of Q3 consists of negative-going sync pulses (Figure 8).

Videomatic Switches

Although the Videomatic switch board usually is next on a block diagram, I will not discuss it at this time. Its function is to switch in the AFT, the LDR (for sensing room illumination), and either the manual or the preset color controls. However, neither the video nor chroma signals pass through it, so it will be covered later.

Videomatic Module

Processing of the video and chroma signals takes place in the M105 Videomatic module (see the partial schematic of Figure 9). Although some amplification occurs (the video channel has a gain of about 2; slightly more on the Videomatic function), the gain is almost incidental. Instead, a secondary control of the contrast and color levels is the main action that's desired. This is not a large control of contrast and color saturation, but both levels are varied by small amounts to make the chroma level track with contrast changes,

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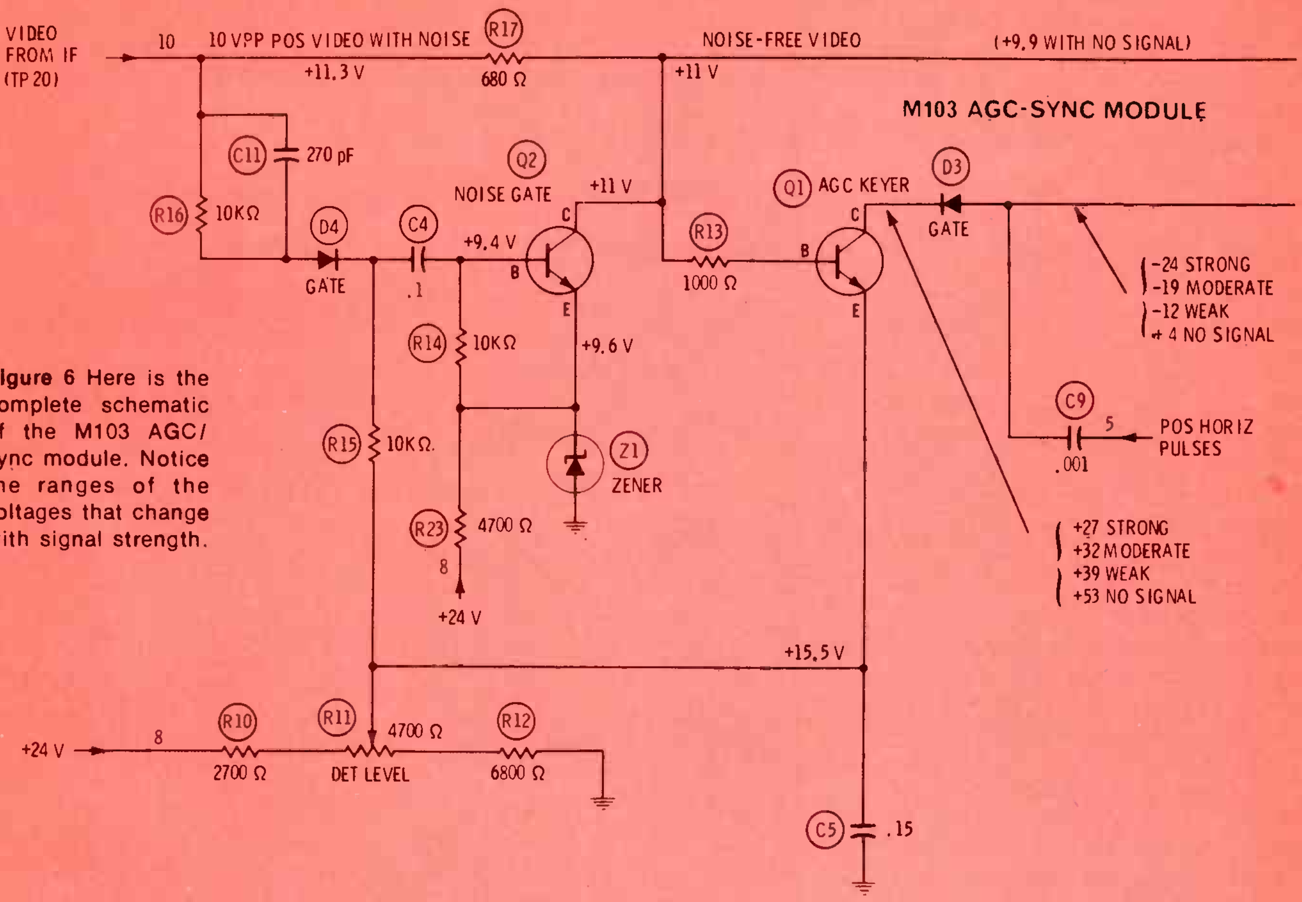

Figure 6 Here is the complete schematic of the M103 AGC/sync module. Notice the ranges of the voltages that change with signal strength.

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and to allow the Light-Dependent Resistor (LDR) to control the contrast according to the room lighting.

In summary, the Videomatic feature selects preset color, contrast, brightness, tint, and AFT, and slightly varies the chroma and video gains to provide better tracking.

As shown by the waveforms of Figure 10, both the input and output video signals are very similar in shape and amplitude, except for a high-frequency boost (from the Q2 emitter-bypass capacitor) that gives about four times the usual burst amplitude.

LDR operation

During Videomatic operation, the LDR determines the DC base voltage of Q1, and the output voltage from the emitter in turn varies the video gain by changing the DC voltage at pin 2 of IC1. The video-output level approximately doubles when the LDR illumination is changed from no light to the beam from a flashlight. Covering the LDR when the room has average brightness reduces the contrast a noticeable amount.

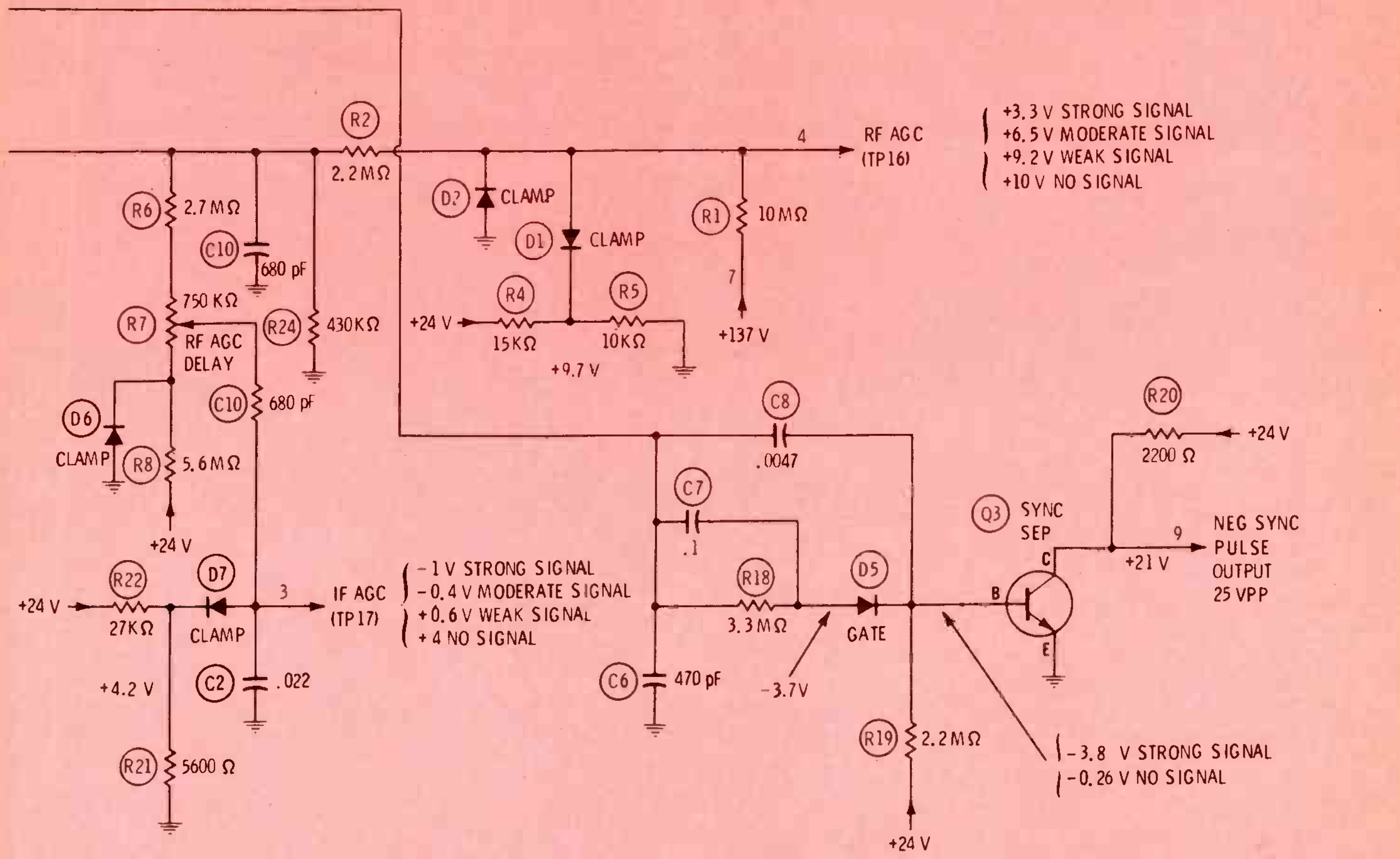
Chroma control

The gain of the chroma channel is varied in *two* ways; therefore, the circuitry (Figure 9) is more complex than that of the video channel. One kind of control is produced by applying a DC voltage from the contrast control to pins 6 and 10 of IC1.

One of the chroma modules (which will be covered next month) has the principal Automatic-Chroma Control (ACC) that operates according to the amplitude of the burst. Module M105 has an auxiliary ACC circuit that attenuates the chroma output when the input amplitude increases. **The entire chroma signal (not the burst alone) operates this ACC.**

R46 and diode D5 comprise a variable voltage divider. The diode does not rectify, because it is operated at a forward bias that forces D5 to have an intermediate forward resistance (rather than the usual on/off switching). The diode takes the place of the lower leg of a resistive voltage divider. Therefore, a higher forward bias gives a lower resistance and a lower output-signal amplitude. The anode of D5 is bypassed to ground by C11; so, it is a "ground" for the chroma signal, while the DC control signal is applied there. Here's how this extra ACC circuit works:

- Transistor Q3 amplifies the Q5



chroma output, and the collector signal goes to a voltage-doubler rectifier (C7, D1, D2, and C9). The negative DC output voltage is applied to the base of Q4;

- Q4 has no forward bias, except the negative voltage from the doubler;
- An increased chroma output produces more negative forward bias at the base of Q4; therefore, Q4 conducts more, bringing additional positive DC voltage from Q4 emitter to its collector, where it goes to the anode of D5;
- A higher positive voltage at the anode of D5 reduces the anode-to-cathode resistance, which in turn decreases the chroma level at the output of R46; and
- Diodes D7 and D8 are clamps which prevent the D5 anode voltage from exceeding about +1.2 volts.

Of course, during times when the chroma level is low, D5 has less forward bias, acts as an open circuit, and the full chroma signal goes through R46 to the base of Q5.

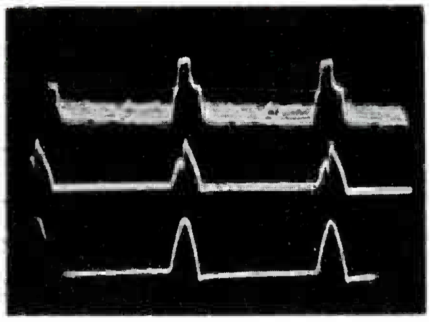


Figure 7 Top waveform is the 8-VPP video signal at the base of AGC keyer Q1 on the M103 module. At the center appears the slightly-distorted pulses at the collector of Q1 (16-VPP), and the 85-VPP pulses at the bottom are found at the anode of D3, the AGC-keying diode. All waveforms were taken while a strong station was being received.

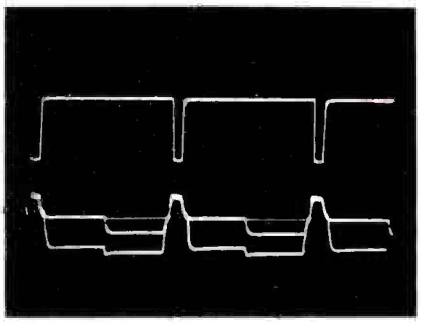


Figure 8 These are the sync-separator waveforms of the M103 module (when the signal was supplied by a model ATC-10 American Technology pattern generator). Bottom trace shows the 9-VPP base input at Q3, while the 25-VPP negative-going sync pulses from the collector are shown at the top.

Early M105 modules blanked the burst by applying positive horizontal pulses to diode D3. When the positive pulses reached the

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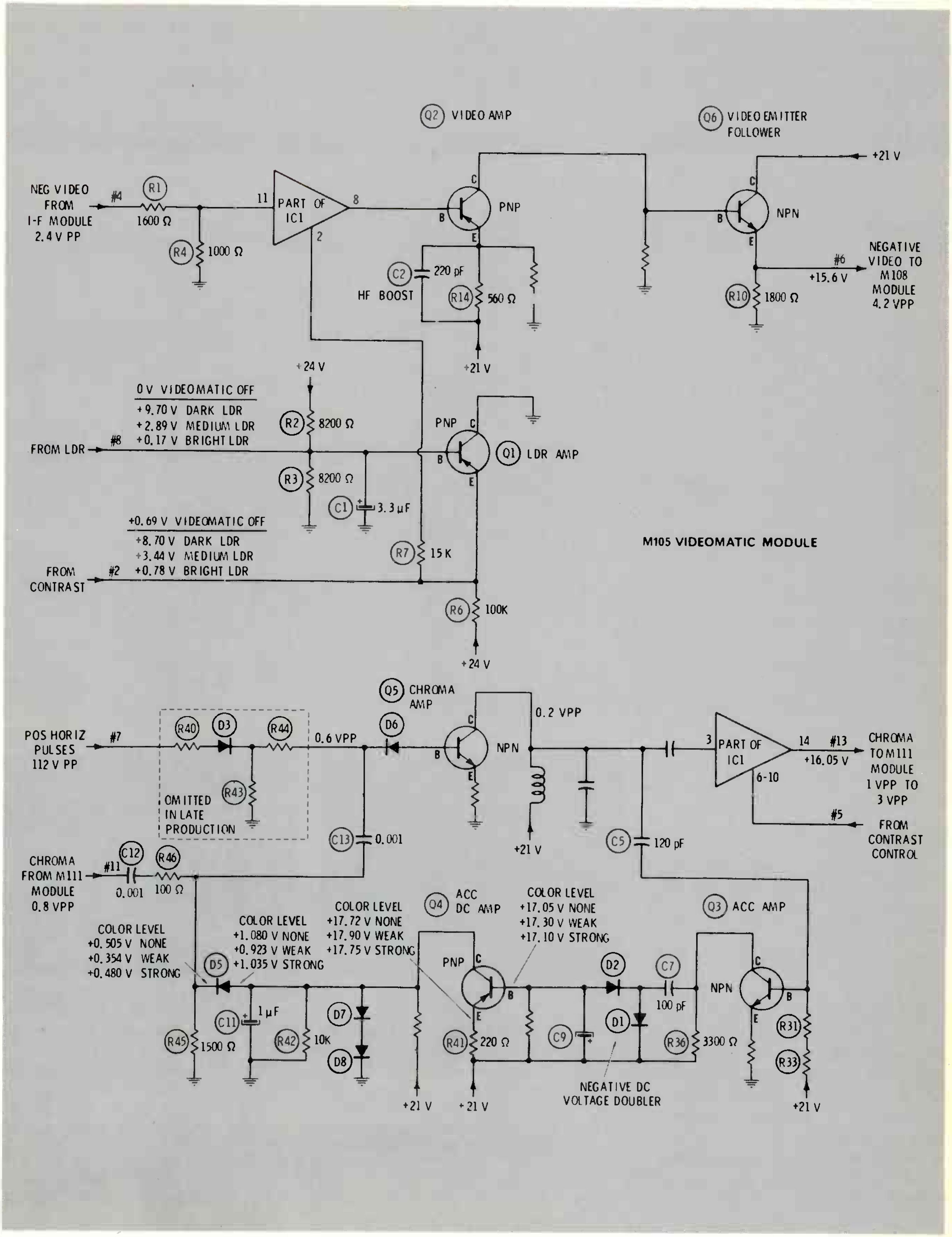

Figure 9 This is the complete schematic of the M105 Videomatic module, which varies the contrast according to the brightness of the room lighting, changes the chroma level in step with variations of the contrast control, and provides a secondary ACC that's controlled by the overall chroma level (not just the burst). Accurate DC voltages are shown for the LDR operation at various light levels, and for the auxiliary ACC action.

cathode of D6, they reverse-biased D6, which opened to prevent the chroma signal from passing through to the base of Q5.

Later-production modules omit D3 and the components inside the dotted lines, although the pulses still appear at connector pin 7. I noticed this change first when the output chroma waveforms showed the burst present with the other bar pulses.

Figure 11 shows the increase of output chroma amplitude when the TV is operated in a dark room, and then a flashlight is turned on the LDR.

M108 Low-Level Module

The video signal receives more amplification and processing in the M108 low-level-video module (see Figure 12 for the early-production schematic). Several interesting features are found here.

In addition to the delay line, the module also includes part of the brightness-limiter wiring, plus a unique circuit that clamps the blanking pulse (of the composite video) to the DC voltage from the brightness control. This clamping circuit will be described in detail.

Delay line and service switch

Both the delay line and the service switch are conventional circuits, requiring little explanation. However, you should notice that R25 (the resistor that matches the input of the delay line to prevent standing waves) and R4 (the resistor that matches the output) act as voltage dividers, reducing the delay-line output to half of the amplitude of the input at pin #2.

Brightness limiter

Part of the brightness-limiter circuit was explained along with the horizontal-sweep operation. Beam current of the picture tube is sensed by the negative voltage it causes at the "low" side of the HV tripler. This voltage partially cancels the positive voltage at the base of Q6.

The remainder of the explanation will be made later, along with details of production changes in the new modules.

Back-porch clamp

Perhaps the most interesting new circuit of the Magnavox video stages (see Figure 12) is the one that clamps the top of the blanking pedestal (composite video) to the DC voltages that come from adjustments of the brightness control.

Now, the blanking pedestal *should* be the part of the video waveform that would be seen as perfect black on the TV screen. In

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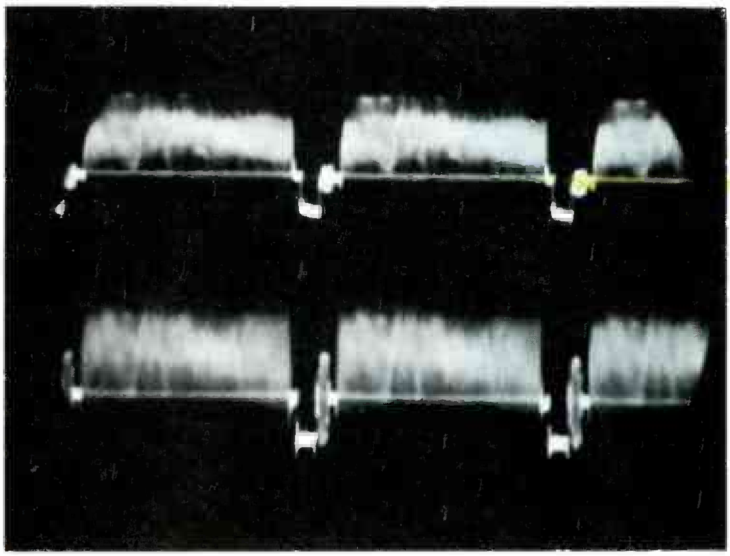

Figure 10 The 4.2-VPP video output waveform (#6) of the M105 Videomatic module (bottom trace) is similar to the 2.4-VPP input (#4, shown by the top trace), except for the high-frequency boost that quadruples the burst amplitude.

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other words, the picture-tube conduction *barely* should reach zero current during both porches of the blanking pedestal, or for video having the same black level.

If CRT is not cut off completely, but some current flows during the blanking time, the areas of the picture that should be jet black will appear as dark gray. But, if current cutoff occurs from video of less black level than the pedestal, the dark gray areas will be black. Either too little or too much cut off produces a poor picture.

When you balance the contrast and brightness adjustments for a pleasing picture, you are setting the CRT cutoff for this optimum point. However, problems of proper balance can arise when automatic brightness or contrast circuits are used. One example is the LDR cell in the Magnavox that adjusts the CRT contrast according to the amount of illumination in the room.

Conventional capacitive coupling in the video permits the black level to vary excessively with contrast or other amplitude changes. Therefore, many TV models have either a DC-restorer or direct-coupled video stages between the video detector and the picture tube to preserve the correct black level.

Magnavox has taken a different approach by including one coupling capacitor followed by a circuit that clamps the blanking pedestal of the video to the DC voltage from the brightness control. After the brightness control is set properly, variations of video amplitude have no effect on the black-level point.

Back-Porch Clamp

Figure 12 gives the automatic-black-level circuit provided in the early M108 modules. The operation is as follows:

- Positive-going horizontal-sweep pulses are given a delay of phase by R1 and C1, which comprise a low-pass integration filter;
- D4 rectifies the sawtooth delayed-phase waveform, and passes only the tips of the signal;
- A small-value coupling capacitor (C2) removes the low-frequency hash and passes narrow positive-going pulses to the base of Q1, the pulse clipper/amplifier. Q1 has no bias except the positive pulses; therefore, the output at the collector consists of negative-going narrow pulses;
- Q2 supplies both polarities of these narrow pulses through capacitors to diodes D1 and D2;
- A DC voltage, having a value determined by adjustment of the brightness control, is brought to the diodes through R9 and R10;
- These narrow pulses have been delayed so they occur during the time the back porch of the blanking pedestal is at the base of Q3;

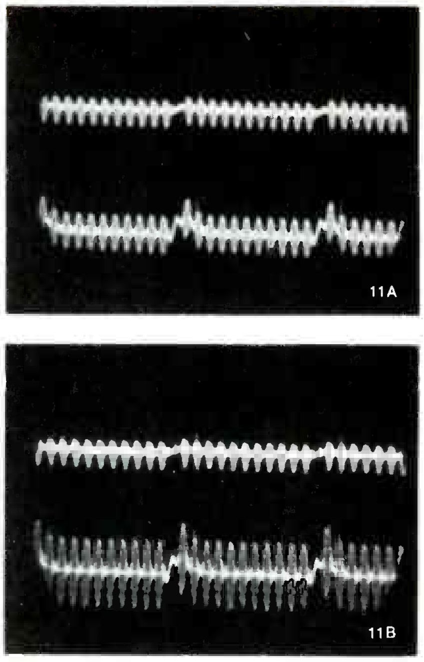
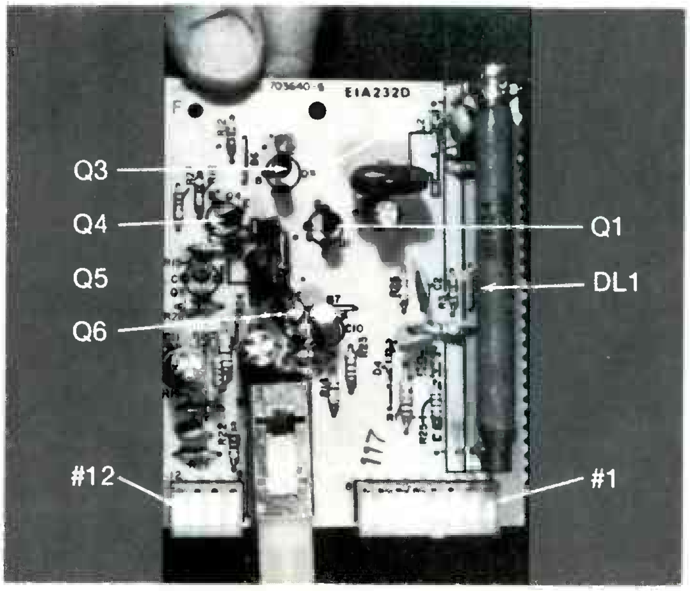


Figure 11 The top trace of (A) is the 0.8-VPP chroma input of M105 at #11, and below it is the 1.2-VPP output at #13, when the Videomatic is off. Turning on the Videomatic activates the LDR, and the output chroma level (bottom trace of B) goes up about 2-VPP amplitude, for normal room brightness.

- Therefore, **during the back-porch time, the DC voltage from the brightness control passes through R9 and D1** (or R10 and D2) **and goes on to the base circuit of Q3, where it charges coupling capacitor C3 to the brightness-control voltage.** Power from the brightness control flows through *either* diode, depending on the polarity of the voltage between C3 and the brightness control. The charge in C3 supplies the base current for Q3, so the voltage drops slowly between the new chargings that occur during each rear porch; and
- This replenished DC voltage in C3 maintains the correct black level (regardless of contrast changes) at the picture tube, because of the direct-coupled stages between those points.



Arrows point to the major components on the M108 module.

Other Video Stages

Q3 is an emitter follower that drives the base of Q4, which is a normal common-emitter type of amplifier, except for the ABL connection to the emitter. The collector of Q4 drives Q5; and the output from the emitter goes

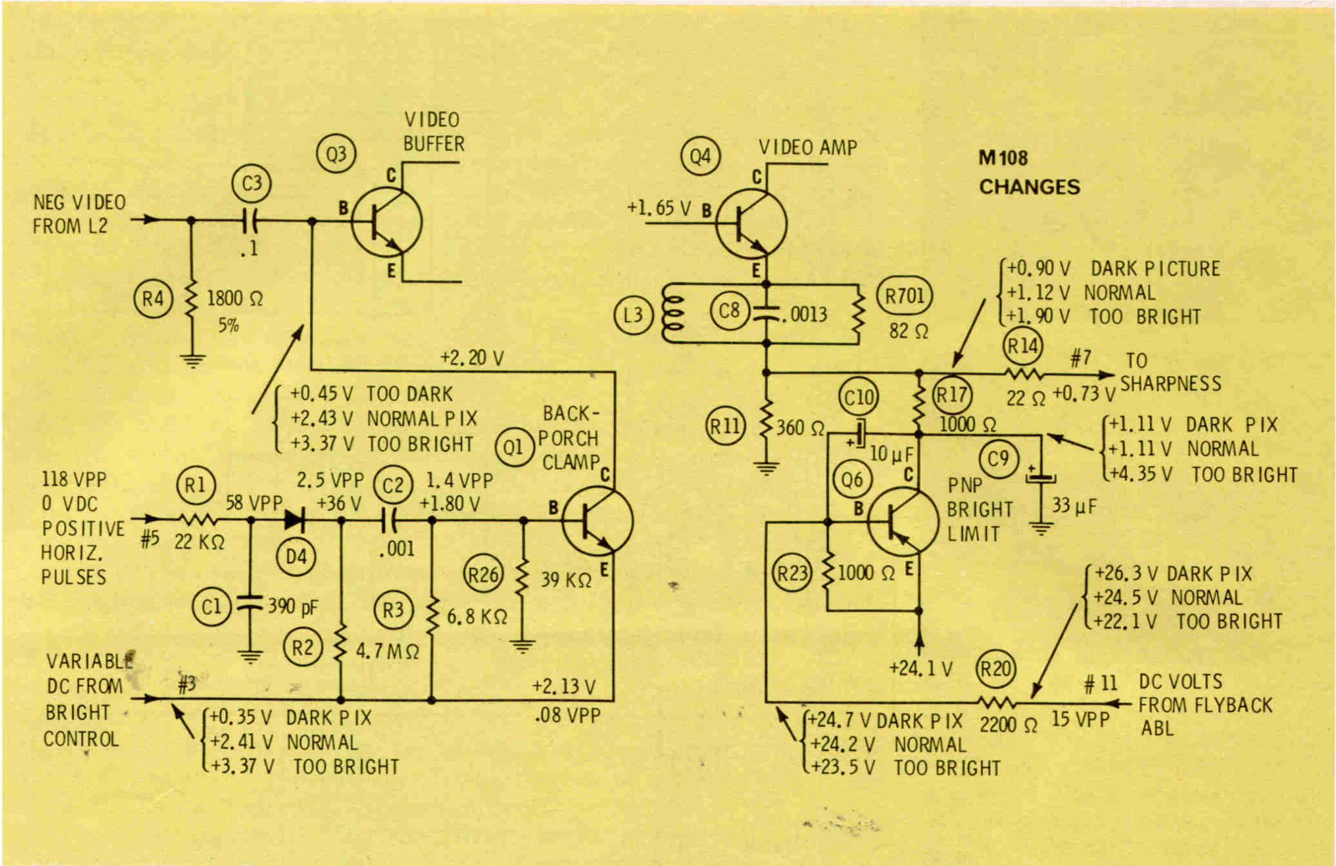


Figure 13 In new-production M108 modules, the narrow positive-going phase-delayed pulses at the base of Q1 force Q1 to become a short circuit between collector and emitter. Therefore, the DC voltage from the brightness control reaches the base of Q3 during the back-porch of each video waveform. The brightness-limiter circuit, including Q6, increases the positive voltage at CRT cathodes, when the CRT current becomes excessive (thus reducing the brightness). This is accomplished by increasing the Q4 emitter voltage.

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emitter of Q1 is connected to the collector of Q1 (also to C3 and the base of Q3).

C3 is charged completely during these pulses, to the same voltage that comes from the brightness control, and the large capacity allows only a small voltage drop (the base current for Q3 comes from C3) before it is replenished by the next pulse.

Q1 is an open circuit, except during the pulses, so it can't have any effect on the video signal that also is at the collector. Q2 is not used in the new circuit.

The advantage of establishing the bias of Q3 *only* during the time of the back porch of the blanking pedestal is that **the back porch retains the same DC voltage** (and the same black level at the picture tube) **regardless of any changes of contrast** (video level).

The voltages of Figure 13 for black picture, normal brightness, and excessive brightness, plus the waveforms of Figure 15 prove this explanation of the black-level clamp operation is correct.

Output waveform

Video at the output (pin #10) of M108 module should be (and is) positive-going. However, a glance at the waveform there (Figure 16) almost would convince you that theory is wrong, and Q4 did *not* invert the phase.

The unexpected appearance of *negative* blanking along with *positive* video is produced by a horizontal-blanking circuit that's external to the module.

Automatic Brightness Limiter operation

Figure 13 lists the DC voltages in the ABL and Q4 stages for black raster, normal color bars, and excessive brightness. (Operation of the ABL in early-production M108 modules is similar.) Notice that PNP-type Q6 is reverse biased for normal and black rasters. Only when the brightness and CRT beam current are excessive does Q6 have forward bias.

The DC voltage at ABL input (pin #11) is modified by a negative DC voltage coming from the "cold" end of the HV tripler. Higher beam current produces more negative voltage, which decreases the positive voltage at pin #11 and the base of Q6.

During times of excessive picture-tube current, Q6 has forward bias, and it conducts. Some of the +24-volt supply at the emitter of Q6 comes through the C/E junction to make the collector more positive. The collector is connected to the emitter return of Q4, so this emitter also becomes more positive. We know from the voltages of the Q1 and Q3 stages that a higher voltage to the base of Q3 produces in-

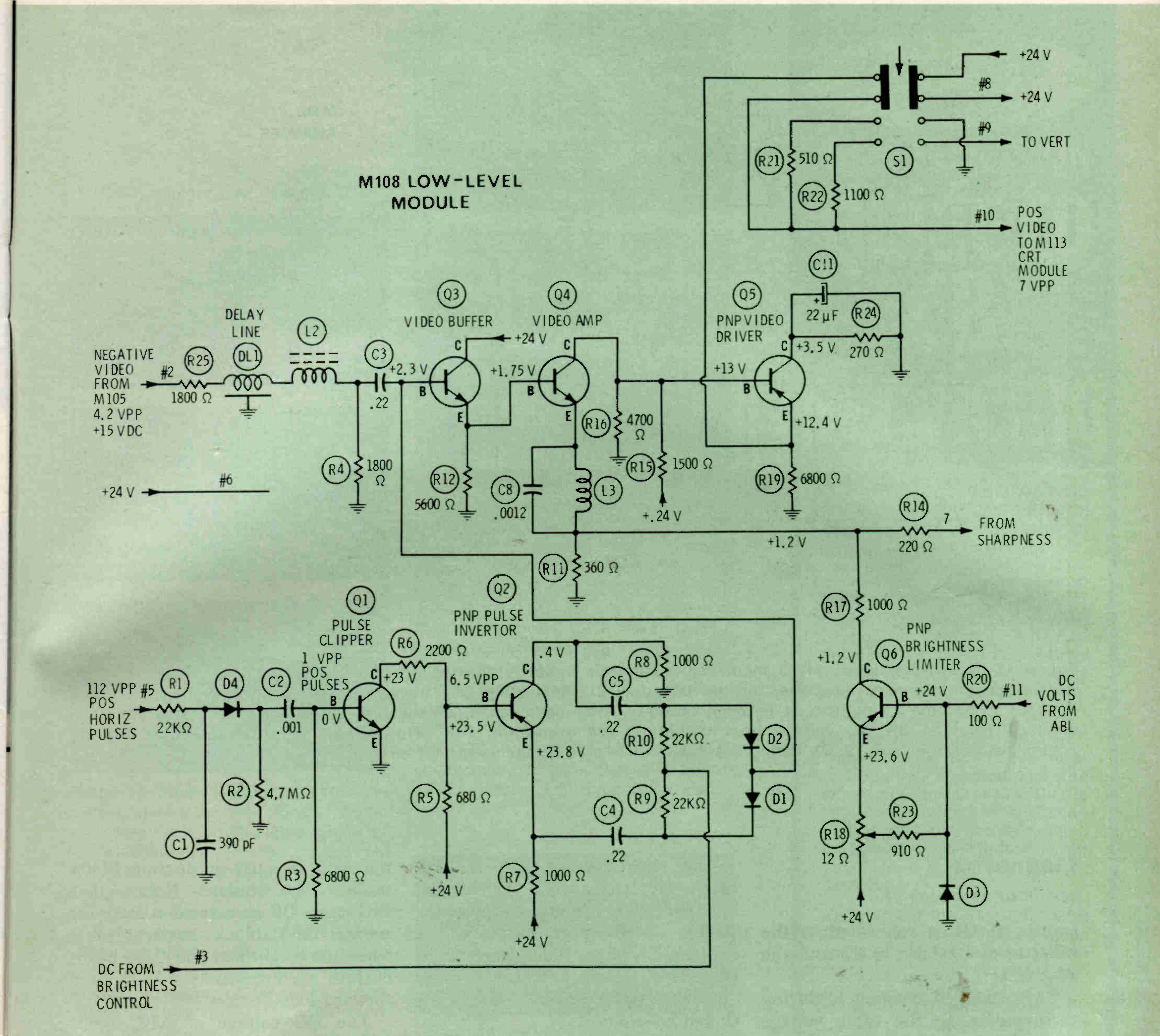

Figure 12 Early-production Magnavox M108 low-level video modules had this schematic. (Figure 13 gives the changes in brightness-limiter and black-level circuits.) Q1 amplifies clipped and narrowed horizontal pulses that have been delayed in phase so they arrive during the back-porch time. The DC voltage from the brightness control (#3) goes through either D1 or D2 during the time of each horizontal pulse and on to the base of Q3. Therefore, the black-level of the video waveform (the back-porch of the blanking pedestal) is clamped to the brightness-control voltage.

through the service switch to the M113 CRT RBG module.

New M108 Circuits

New-production M108 low-level video modules incorporate radical changes of the back-porch black-level clamp circuit, and the ABL stage has some minor changes (see Figure 13).

New black-level clamp

The pulse-delaying and wave-form-changing components ahead of Q1 in the new black-level circuit are nearly the same as shown in the original circuit of Figure 12. Narrow positive-going pulses (Figure 14) are applied to the base of Q1. Forward bias from R3 and R26 is not sufficient to make Q1 conduct. Therefore, Q1 conducts only during the positive base pulses.

However, **Q1 is NOT an amplifier.** Instead, it operates only as an on/off switch. Each base pulse forces the C/E junction to become a virtual short circuit. **Therefore, for the duration of each pulse, the brightness-control voltage from the**

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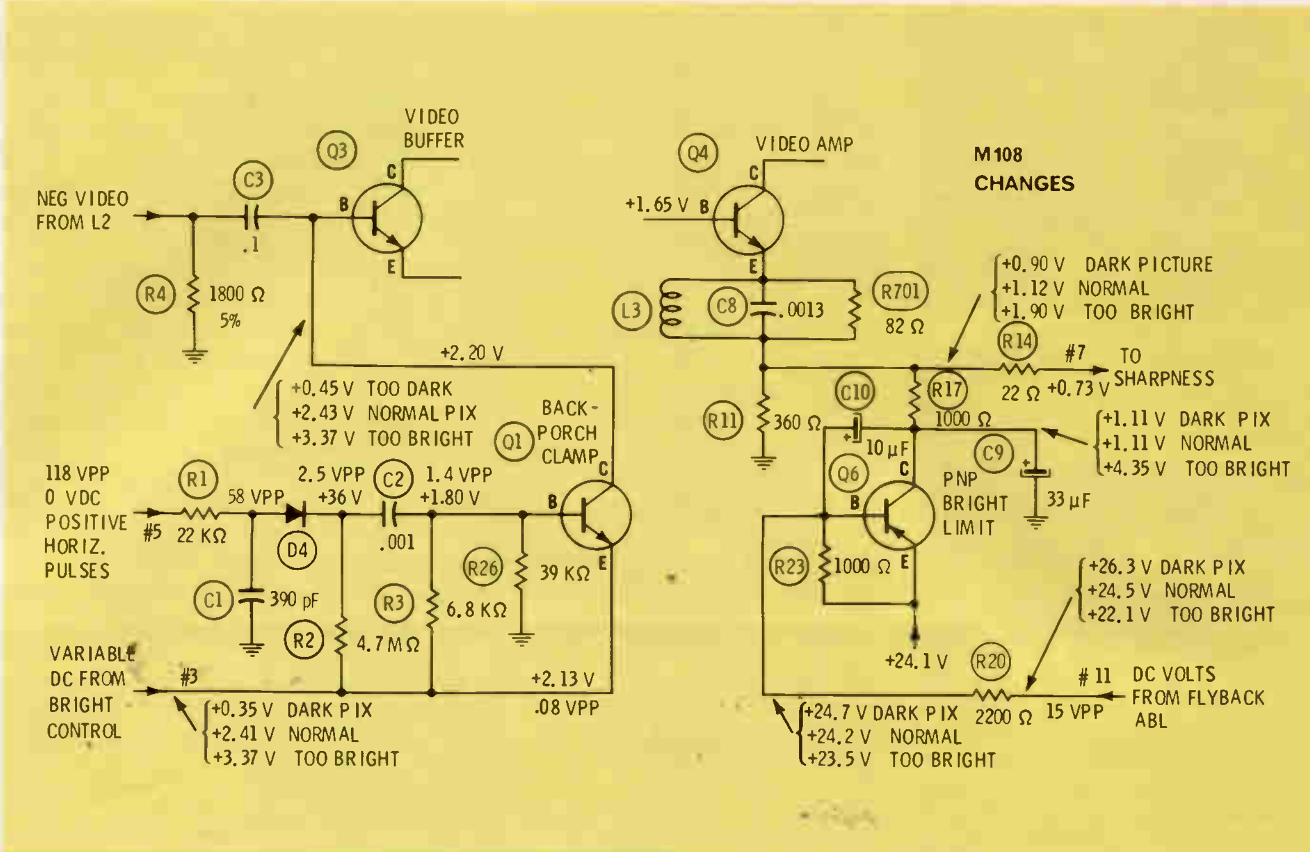

Figure 13 In new-production M108 modules, the narrow positive-going phase-delayed pulses at the base of Q1 force Q1 to become a short circuit between collector and emitter. Therefore, the DC voltage from the brightness control reaches the base of Q3 during the back-porch of each video waveform. The brightness-limiter circuit, including Q6, increases the positive voltage at CRT cathodes, when the CRT current becomes excessive (thus reducing the brightness). This is accomplished by increasing the Q4 emitter voltage.

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emitter of Q1 is connected to the collector of Q1 (also to C3 and the base of Q3).

C3 is charged completely during these pulses, to the same voltage that comes from the brightness control, and the large capacity allows only a small voltage drop (the base current for Q3 comes from C3) before it is replenished by the next pulse.

Q1 is an open circuit, except during the pulses, so it can't have any effect on the video signal that also is at the collector. Q2 is not used in the new circuit.

The advantage of establishing the bias of Q3 *only* during the time of the back porch of the blanking pedestal is that **the back porch retains the same DC voltage** (and the same black level at the picture tube) **regardless of any changes of contrast** (video level).

The voltages of Figure 13 for black picture, normal brightness, and excessive brightness, plus the waveforms of Figure 15 prove this explanation of the black-level clamp operation is correct.

Output waveform

Video at the output (pin #10) of M108 module should be (and is) positive-going. However, a glance at the waveform there (Figure 16) almost would convince you that theory is wrong, and Q4 did *not* invert the phase.

The unexpected appearance of *negative* blanking along with *positive* video is produced by a horizontal-blanking circuit that's external to the module.

Automatic Brightness Limiter operation

Figure 13 lists the DC voltages in the ABL and Q4 stages for black raster, normal color bars, and excessive brightness. (Operation of the ABL in early-production M108 modules is similar.) Notice that PNP-type Q6 is reverse biased for normal and black rasters. Only when the brightness and CRT beam current are excessive does Q6 have forward bias.

The DC voltage at ABL input (pin #11) is modified by a negative DC voltage coming from the "cold" end of the HV tripler. Higher beam current produces more negative voltage, which decreases the positive voltage at pin #11 and the base of Q6.

During times of excessive picture-tube current, Q6 has forward bias, and it conducts. Some of the +24-volt supply at the emitter of Q6 comes through the C/E junction to make the collector more positive. The collector is connected to the emitter return of Q4, so this emitter also becomes more positive. We know from the voltages of the Q1 and Q3 stages that a higher voltage to the base of Q3 produces in-

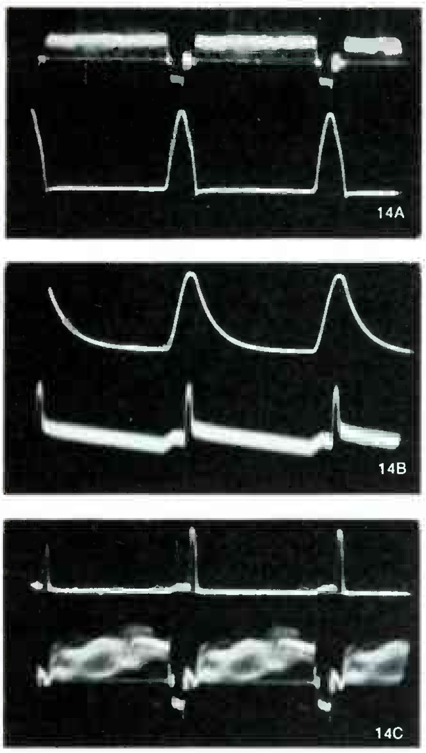

Figure 14 These waveforms show the correct phases of the signals in the black-level back-porch clamp circuit of the M108 module. The top trace of (A) is the normal video signal, while the bottom trace shows the horizontal-sweep pulses that enter the module at #5. After integration by R1/C1, the phase has been delayed and the shape approaches a sawtooth (top trace of B). At the output of D4, only narrow pulses (bottom trace of B) and some ripple can be seen. (C) This dual-trace photo contrasts the narrow delayed pulses at the base of Q1 with the video that appears at the collector (bottom trace). Q1 does not amplify, so no negative pulses are added to the video.

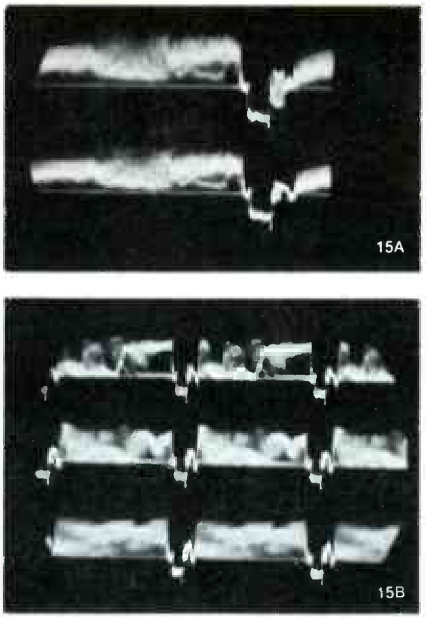

Figure 15 (A) shows expanded views of the input video (top trace) and the video at the collector of Q1 and the base of Q3 (below). Only a small discontinuity shows on the back porch, where the brightness DC voltage is switched in to charge C3. These waveforms were made from a late-production M108 module. (B) shows the video at the base of Q3 with a black raster (top), normal brightness (center trace), and excessive brightness (trace at the bottom). The DC voltage at the base of Q3 was nearly equal to that from the brightness control for all three conditions.

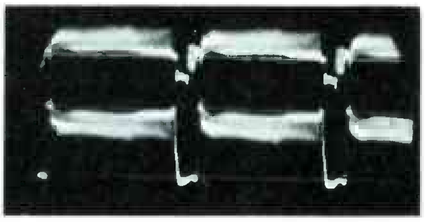

Figure 16 Horizontal blanking that's external to the M108 module changes the output waveform in a peculiar way. Top trace is the negative-going video input to M108, and **below is the positive-going video,** but with **negative blanking pulses.**

creased CRT brightness. Q3 is an emitter follower, so more forward bias of Q4 also gives increased brightness.

A more-positive emitter has the same action as a less-positive base. Therefore, the higher Q4 emitter voltage reduces the brightness of the picture and decreases the CRT current. Without the ABL, the brightness could be turned too high, causing damage to CRT and other components.

Next Month

Chroma processing and demodulation, plus the matrixing of B&W and color signals will be explained for the Magnavox T995 next month. □

Emerson-to-Thordarson Parts Cross Reference

Independent manufacturers and distributors make available many hard-to-find components for the repair of TV and stereo machines. This Thordarson Meissner cross reference of Emerson parts is one good example.

EMERSON #	THORDARSON #
72A185-5	17-1072
72A216-5	20-1057
72A251-2	17-3422
72A251-8	17-3419
72A287-3	20-1051
72A287-4	20-1051
72A296-7	17-3404
72A301-2	17-1073
72A308-1	17-5015
72A308-2	17-3414
72A314-2	17-1048
72A316-8	20-1079
72A325-3	17-6038
72A327-1	17-6039
72A357-1	17-6050
72A359-1	17-3405
72A361-1	20-1077
72A362-1	17-6051
72A363-1	17-6052
72A364-1	17-6071
72A373-1	HS 28
73A5-40	19-4201
73A5-62	19-3125
73A31-11	19-1001
73A46-21	19-3060
73A55-10	19-6022
73A55-12	19-3125
73A55-15	19-2027
73A55-17	19-3660
73A55-18	19-2013
73A55-26	19-3125
73A55-27	19-1008
73A55-29	19-3060
73A55-31	19-2005
73A55-37	19-1000
73C55-38	19-7068
73A55-40	19-2022
73A55-41	19-6033
73C55-46	19-6033
73A90-2	19-2033
73A125-1	19-1001
73A125-3	19-1008
73A125-4	19-2017
73A126-1/-2	19-7047
73A360-1	17-3409
74A18-45	26C78
74C18-45	26C78
74A18-60	26C77
74D18-60	26C77
74A18-62	26C77
74C18-62	26C77
74A18-63	26C77
74D18-63	26C77
74A27-4	26C80
74B27-4	26C80
74A30-1	26C80
74C30-1/D	26C80
74A30-5	26C77
74C30-5-H	26C77
74A31-1	26C78
74B31-1	26C78
79D33-112	22S86
79A106-5	26S86
79D106-5	26S86

EMERSON #	THORDARSON #
79A124-5	24S83
79A131-2	26S86
79D131-2F	26S86
79A134-2	26S86
79D134-2G	26S86
79A134-3	26S91
79D134-3-H	26S91
79A138-4	FLY 421
79D138-6	FLY 422
79D138-14	FLY 421
79A140-1	FLY 386
79D140-1D	FLY 386
79A141-1	24S89
79B141-1	24S89
79A142-1	24S51
79D142-3	24S51
79A142-5	24S60
79D142-5	24S60
79A146-2	FLY 444
79A146-3/C	FLY 444
79D146-3/G	FLY 444
79A153-1/-2	26S96
79D153-2/-5	26S96
79A154-1	FLY 385
94D255-1/2/3	Y 229
94A/B268-4	HS 7
94A277-2	HS 48
94C277-2	WC 53
94D302-6/5	Y 229
94D302-16	Y 229
94A304-1/-2	Y 138
94A304-5	Y 117
-11	Y 131
94A304-8/-10	Y 117
94A305-7	WC 62
94D305-7	WC 62
94A/D305-8	WC 58
94A305-9	WC 59
94D305-9	WC 59
94A/D377-1	Y 131
94A/D377-2	Y 131
94D377-3	Y 109
94A/D377-4	Y 216[14]
94A377-5/-6	Y 117
94D377-7/-9	Y 109[1]
94A377-8	Y 216[14]
-11/-12	Y 120
94D379-1/2/3	Y 193[14]
94A/D379-4	Y 147
94A/D379-5/-6	Y 193[9]
94D379-8/-9	Y 186[9]
94D379-12	Y 239
94D379-13	Y 193[9]
94A405-1/-2	Y 148
135C14	26C81
135P37	21F09
135A61	24S06
150A17	24S53
700A814-8	Y 229
700C814-3/-5	Y 229
700C1089-6	Y 229
-29	Y 229
750C1089-2	Y 88
-12/-13	Y 229

EMERSON #	THORDARSON #
022027	19-3125
022029	19-3180
022033	19-2028
180076	26C43
180281/85/418	24S53
180330/332	24S53
208027	FC 1
270081	17-3495
353017	Y 245[14]
358123	WC 45
358134	WC 41
424028	26C81
453117	24S64
701515	19-1001
702104-1	17-1063
703046-1/2/6	Y 150
704020	19-3001
705002/09	19-1003
705014	19-6022
705016	19-1003
705020	19-3001
705021	19-1005
705023	19-1001
705024	19-1004
705025	17-1007
705031	19-1000
705040	19-1003
705041	19-1001
705047	19-1008
705049	19-1001
705050	19-1008
705058	19-1009
705065	19-1005
705067	19-4214
705079	19-3036
705120	17-3400[1]
707214	Y 10
708002	17-1013
708003/04	WC 14
708008	17-1013[1]
708014	19-6022
708017	17-3496
708018	17-3496
708019	WC 15
708021	WC 16
708023	FC 3
708027	FC 1
708030	Y 3
708031	17-3496
708031B	17-3496
708032	20-1004
708032-1	17-3495
708036	Y 3
708037	WC 14
708039	FLY 5[3]
708041	FC 1
708043	Y 13
708051	WC 11
708052	WC 14
708053	WC 27
708054	WC 17
708055	WC 14
708056	WC 18
708058	WC 22

Service notes giving wiring or mounting deviations are listed after the cross references.

EMERSON #	THORDARSON #
708062	17-3494
708064	Y 13[8]
708066	WC 22
708068	WC 22
708071	17-3496
708073	Y 13
708082	WC 11
708082-1	WC 11
708090	19-3075
708091	19-1920
708092	19-1921
708093	19-3036
708094	19-3125
708095	19-3180
708096	19-3075
708097	17-3400
708099	19-1923
708100	19-4251
708108	19-4060
708109	19-3250
708111	19-4840
708112	19-1921
708114	19-1923
708115	19-3660
708116	19-5100
708117	Y 13
708122	Y 6
708130	Y 3
708130-L	Y 3
708130-R	Y 3
708131	Y 13
708135	Y 13
708137	Y 10[5]
708141	FC 1
708144	Y 68
708150	Y 13
708151	17-3496
708156	WC 22
708158	HS 8
708162	Y 10[5]
708163	Y 10[5]
708164	20-1004
708165	Y 10[5]
708174	Y 16[5]
708175	17-3496
708176	Y 18[5]
708180	HS 8
708209	19-1003
708210	17-3496
708211	Y 18[5]
708212	Y 18[5]
708213	20-1049
708214	Y 10[5]
708226	WC 23
708228	WC 18
708232	Y 61[8]
708241	17-6013
708243	19-3500
708247	19-4950
708248	19-3036
708249	WC 23
708255	HS 5
708265	17-6013
708269	Y 61[8]

EMERSON #	THORDARSON #
708270	Y 10[5]
708271	19-1003
708272/A	19-3300
708273	19-4400
708274	19-3660
708275	HS 21
708276	20-1053
708279/A	19-3500
708288	Y 49
708312	19-1005
708313	Y 61
708321	Y 10[5]
708322	Y 61
708330	Y 62
708332	Y 61
708334	Y 53[5]
708336	19-4950
708432	WC 14
708344/48	Y 62
708346A	19-3100
708351	19-4400
708352	Y 68
708353	Y 60
708357/58	19-3660
708359	Y 65
708367	Y 53[8]
708370	19-4201
708373	Y 60
708379/A/B	Y 53[8]
708381	Y 60
708382	Y 68
708392	Y 53
708393	Y 65
708394	WC 18
708401	19-3180
708402/403	Y 62[5]
708405	19-3275
708406	19-3093
708407	Y 61
708415	Y 105[8]
708416	WC 18
708424	FC 7
708425	19-3075
708426	19-2028
708427	20-1058
708429	19-3036
708431	19-3660
708432	20-1057
708434	HS 23
708436	WC 41
708437	WC 38
708438	17-6028
708439	17-6022
708440	19-1005
708441	19-1035
708442	19-3060
708443	19-3125
708444	WC 36
708448	Y 107
708451	Y 105[3]
708452	Y 105[5]
708456	WC 45
708461	FC 6
708462	WC 37

EMERSON #	THORDARSON #
708463	Y 245
708464	WC 53
708465	WC 45
708468	WC 54
708475	19-1008
708476	Y 116
708479	Y 116
708481	Y 105[8]
708493	19-3125
708496	Y 116
708506	Y 116
708512	19-3125
708514	Y 147
708516	Y 147
708517	19-2023
708518	19-3060
708521	19-7047
708522	19-7068
708523	19-1003
708524	19-2026
708526	19-7047
708529	WC 44
708531	19-3300
708532/A	Y 105[8]
708534	Y 144
708538	19-4216
708539	Y 147
708549	Y 147
716037	HS 3[3]
716052	HS 7
716052-A	HS 7
716073	HS 7
716074	HS 5
716083	HS 7
716084	HS 8
716102	HS 20
716103	HS 29
716117	HS 7
716121/A	HS 11
716136A	HS 11
716148	HS 25
716149	HS 26
716151	HS 27
716163	HS 7
716177	HS 7
720013	17-1043
720017	17-1012
720024	16-3487
720025	16-3487
720026	16-6770
720027	17-1011
720031	16-6758
720032	16-6758
720033	16-6758
720042	17-1006
720043	17-1006
720044	17-1005
720056	19-1021
720067	16-3487
720073	17-1003
720075	16-6758
720076	16-6770
720081	17-3495
720081-A	17-3495

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Service notes giving wiring or mounting deviations are listed after the cross references.

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EMERSON #	THORDARSON #
720084	16-6758
720085	16-6770
720089	17-1064
720091	17-1005
720092	17-3495
720093	17-1004
720096	17-1063
720097	17-3400
720098	17-1064
720103	17-1026
720105	17-1006
720106	17-1069
720108	17-1004
720109	17-1003
720125	16-6770
720126	16-3487
720127	17-1067
720128	17-1067
720129	17-1069
720131	17-1063
720133	17-1069
720135	17-3495
720139	17-1070
720141	17-3495
720142	17-5001
720146	17-3495
720147	17-5001
720148	17-4523
720149	20-1049
720151	19-1020
720154	20-1049
720155	17-5004
720156	17-5001
720157	17-3495
720166	20-1049
720175	17-4523
720178	17-3495
720181	17-4522
720182	17-3495
720185	17-3495
720187	17-6758
720198	17-4522
720199	17-4522
720201	17-5004
720204	17-4522
720213	17-4522
720215	17-5038
720216	17-4523
720221	17-1024
720226	17-4522
720229	19-6012
720231	17-4523
720238	17-4523
720241	17-4522
720243	17-1027
720246	17-3495
720247	17-4523
720259-2/-3	16-6780
720259-4	16-6780
720289	17-4504
720294	16-6780
720295	16-6780
720297/A	17-1072
720298	17-1028
720299	20-1054
720315	20-1079

EMERSON #	THORDARSON #
720317	20-1080
720318	17-3418
720322	17-1052
720336	20-1054
720337	17-1052
720364/A	17-3489
720393	16-6786
720394	16-6787
720404	20-1054
720445	17-3418
720447	17-1036
720448	17-1029
720449	17-1097
720451	17-5015
720452	20-1079
720453	20-1080
720454	17-3418
720455	17-3418
720466	16-6780
720467	16-3490
720469	20-1052
720471	17-1052
720472	20-1050
720474	17-3418
720475	17-3419
720476	17-3414
720477	17-3420
720478	17-6031
720479	17-6032
720481	17-6033
720486	17-1052
720512	17-1114
720513	17-1052
720514	17-3419
720515	17-6017
720516	17-6023
720517	17-6020
720518	17-3420
720540	17-3418
720541	17-5015
720558	20-1052
720563	17-6054
720566	17-5027
720570	17-6061
720575	17-6062
720579	17-6065
720580	17-6063
720582	17-6062
720583	17-6064
720589	20-1079
730002	22R05[1]
730005	26R00[1]
730018	24R94
730022	26R21
730023	26R95
730024	26F65
730026	26R95
730029	26R95
730031	26R95
730032	26R88
730037	26R88
730039	26R88
730041	26R79
730043	26R88
730044	26R88
730046	26R79

EMERSON #	THORDARSON #
730051	21F09
730052	26R88[1]
730054	21F09
730060	26R113
730061	26R113
730062	26R113
730064/65	26R113
730074	26R47
730078	26R116
730079	26R47
730094	26R116
730108/111	26R116
730109	26R120
730113	26R113
730114	26R116
730118	26R150
730120	26R150
730126	26R106
730129	26R150
730149	26R152
730152	21F09
734004	22S56
734018	26S49
734028	24S60
734044	24S50
734051	26S49
734052	24S50
734058	24S50
734058-1	24S50
734063	24S50A[1]
734064	24S50A
734074	26S49
734082	24S50[1]
734084	26S48
734088	24S48
734099	24S51[1]
734103	24S48
734104	24S53
734107	24S53
734122	26S58
734123	24S51
734126	24S64
734130	24S48[1]
734134	24S64
734139	24S53
734144	24S53[1]
734146	24S48[1]
734161	24S53[2]
734162	24S51[2]
734163	24S64[2]
734168	24S48
734172	24S48
734176	24S48
734178	24S53
734181	24S64[1]
734188	26S58[1]
734195	26S53
734202	26S49
734205	24S48
734212	24S64
734215	26S53
734221	22S86[1]
734223	24S61
734225	24S53
734226	24S53
734228	24S53

Service notes giving wiring or mounting deviations are listed after the cross references.

EMERSON #	THORDARSON #
734248	24S06
735151	FLY 5017
737002	26C42
737003	20C49[1]
737011	20C49[1]
737012	20C64
737015	20C49[1]
737016	26C44
737017	26C41
737018	26C93
737019/23	26C80
737027	26C77
737028	26C78
737031	26C80
737033	26C77
737036	26C77
737037	26C78
737038	26C77
737039	26C77
737043	26C77
737044	26C77
737047	26C77
737048	26C79
737049	26C81
737056	26C77
737057	26C81
737058	26C79
737059	26C81
738000	FLY 1
738003	WC 14
738004	24A88
738005	24A90
738008	24A89
738009	FLY 1
738010	24S86
738010-1	24S86
738011	26S53[1]
738012	FLY 1
728013	FLY 1
738014	FLY 4
738015	FLY 1
738016	24S86
738017	24S86
738019	HVO 50
738020	24A89
738022	24A89
738023	24A89
738024	FLY 4
738026	26S51[1]
738026A	26S51[1]
738027	26S51[1]
738028	FLY 1
738029	26S52
738029-2	26S52
738030	24A88
738031	24A89
738032	26S53
738032-A	26S53
738033	26S53
738034	FLY 46
738035	HS 3
738037	HS 8
738039	FLY 5
738042	24A89
738044	26S57

EMERSON #	THORDARSON #
738047	FLY 2
738048	FLY 2
738048A	FLY 2
738050	26S22
738052	26S57
738053/51	FLY 2
738054	26S22
738059	26S57[1]
738060	FLY 8
738065	HS 8
738066	26S24
738067/74	FLY 13
738068	FLY 13
738069	FLY 13[3]
738070	26S73
738071	HS 8
738073	FLY 13
738075	FLY 13
738076	26S24
738078	FLY 202
738079	FLY 160
738080	26S51
738081	26S51
738082	FLY 13
738083	FLY 13
738084	FLY 160
738085	FLY 13
738086	FLY 13
738087	FLY 202
738090	26A04
738091	FLY 89
738094	FLY 160
738095	FLY 160
738096	FLY 89
738097	26S51
738098	26S51
738099	FLY 89
738100	FLY 89
738102	26S72
738103	FLY 141
738105	26S72
738106	FLY 142
738107	FLY 142
738108	26S72
738109	FLY 141
738110	26S72
738111	FLY 142
738119	FLY 143
738121	26S72
738122	FLY 143
738124	26S72
738126	26S85
738127	26S71[1]
738128/29	FLY 143
738134	26S12
738137	26S85
738138/A	FLY 230[8]
738139	26S72[1]
738140	FLY 143
738142/145	FLY 228
738147	26S72
738150	26S72
738152	26S85
738153	26S72
738154	FLY 229

EMERSON #	THORDARSON #
738155	FLY 231
738156	26S72
738158	HS 8
738159	26S72
738160	FLY 230
738161	26S85
738162	FLY 231
738163	FLY 229[3]
738168	FLY 150
738169	FLY 232
738170	26S70
738171	26S72
738177	FLY 231
738180	26S75
738182	26S72
738186/88	FLY 258
738189	26S72
738190	FLY 292
738191	FLY 292
738192	FLY 293
738193	26S85
738195/A	FLY 277
738196	26S86
738197	FLY 294
738202A	FLY 295
738203	26S33
738206	FLY 293
738210	FLY 293[3]
738213	FLY 295
738214	FLY 277
738222A/M	FLY 324
738223	FLY 277
738415	Y 105[8]
739000	FLY 1
750033	16-6758
906186-501/ -502/-503/ -504/-507	Y 245
962159	15-1082
970013	20-1051
970014	19-1008
970015	17-3414
970016	Y 229
970116	Y 229
970241	19-1005
970243	19-1001
970244	19-1004
970383	20-1051
970485	22S86
970706	19-2012
970800	Y 229
970842	19-3275
970844	19-2032
970845	19-1008
970998	FLY 422
971423	Y 109
972026	Y 210
972133	Y 210
981289	26C81
981292	WC 53
981294	19-1008
981295	19-7068
981296	19-2028
981297	19-2024
981300	26S64

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Service notes giving wiring or mounting deviations are listed after the cross references.

Emerson-to-Thordarson

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EMERSON #	THORDARSON #
981328	Y 245[14]
981368	WC 41
981369	WC 45
981387	19-1008
981388	19-1008
981389	19-7047
981398	19-2014
981400	19-3330
981401	20-1058
981404	17-3418
981891	Y 122
981920	26C81
981921	20C47
981924	FLY 443
981927	19-2016
981938	26S49
981981	17-3419
981985	20-1057
981989	19-7068
981991	19-2024
981992	19-3180
981993	19-3500
981996	19-2014
981997	19-1006
981998	19-2001
982023	19-2034
982024	19-7068
982046	19-2033
983746	17-3405
983754	19-6033
983755	19-2027
983756	19-3660
983757	19-2026
983758	20-1055
983760	Y 123[9]
983762	22S61
983764	26C79
983952	19-1008
983955	Y 122
983957	FLY 443
983972	17-3415
983976	20-1057
983979	19-1006
983981	19-7047
983982	19-2023
983992	19-1002
986588	16-9035
986590	14-9021
986591	16-9033
986592	16-9034
986696	16-9030
986697	16-9031
986698	16-9032
986701	16-9028
986704	16-9026
986705	16-9027
027-033200	Y 148
032-003000	26C78
033-014300	26S96
033-016200/D	FLY 385
750C1089-6	Y 229
950C1089-12	Y 229
AT2916	24S53
B515-215	FLY 5017
BH-2401	17-5023
BH-2402	17-3423

EMERSON #	THORDARSON #
BH-2404	20-1062
BH 2429	19-1002
BH 3012	20-1055
BH 5003	26C79
BH 8000	26S30
BH 9002	HS 12
BH 9040	Y 123[9]
F 103	FLY 443
F 122	FLY 443
R77842	19-4073
R100037	26S48
R100131	19-3125
R101819	19-3036
R102134	26C81
R102201	19-3060
R103037	19-3375
R103137	19-3355
R105065	WC 41
R105066	WC 42
R105195	26C81
R105196	WC 35
R105213	17-6018
R105214	17-6019
R105216	17-6011
R105294	17-3417
R105295	20-1057
R106383	20-1050
R107290	17-3402
R107837	17-6012
R109171	19-1008
R109180	WC 43
R109221	FLY 28T
R109237	HS 8
R109251	HS 32
R109252	17-3418
R109253	17-3419
R109254	17-3414
R109257	19-3600
R109261	20-1052

EMERSON #	THORDARSON #
R109262	17-1083
R109263	26S86
R109264	FC 7
R109286	26R150
R109457	Y 107
R109826	19-3060
R109838	19-3093
R109840	19-3060
R109845	Y 107
R109850	26S86
R112820	FLY 273
R112821	26S86
R112822	26S48
R112829	26C81
R112845	26R150
R112866	HS 23
R112869	17-6031
R112870	17-1083
R112871	17-3420
R112872	17-6028
R112873	17-6032
R112874	17-6022
R112875	WC 36
R112877	17-6033
R112879	17-3414
R113382	FLY 277
R113383	26R150
R113388	19-3600
R113390	26S86
R113394	WC 44
R113547	17-3419
R113640	FC 7
T79C124-5-1	24S83
T 125-020039	22S22
T-B25	26C81
T-B30	20C47
T-D81A-UC-25	Y 122
T-D81C-UC-25	Y 122
T-V111	26S49

Service Notes

1. Mounting of replacement is different.
2. Peaking coil requires use of an original-value resistor in parallel.
3. Terminal numbers are different.
4. Reverse yellow and black leads.
5. Might require removal or addition of some ringing components.
6. Add a jumper between terminals 1 and 3.
7. Connect windings in series, and use as autoformer.
8. Leads are different. Connect as in original circuit.
9. Cut off plug, and connect as the original.
10. Use original mounting bracket.
11. Splice leads, if necessary.
12. Use original plug.
13. Lead colors are not the same as original.
14. Change terminal or plug leads to correspond with original.
15. Remove or add jumper as required by original.

Service notes giving wiring or mounting deviations are listed after the cross references.

photofact bulletin

"Let's see if I got your problem straight. It starts out as snow, but as the set warms up, it changes to a light rain?"

Reports from the test lab

Each report about an item of electronic test equipment is based on examination and operation of the device in the ELECTRONIC SERVICING laboratory. Personal observations about the performance, and details of new and useful features are spotlighted, along with tips about using the equipment for best results.

By Carl Babcoke

Bandwidth Test

Perhaps the most unique of many innovations in the model 530 semiconductor tester from B&K-Precision (Figure 1) is the test giving the frequency where the gain of bipolar transistors is one (unity). Details will be given later.

Other Features

Three separate basic semiconductor tests are provided. First, there are in-circuit or out-of-circuit tests of lead identification, good/bad condition, and polarity. Sharing the socket and input jacks, but nothing else, are out-of-circuit metered measurements of leakage and gain. The bandwidth test (previously mentioned) has its own sockets, switch, and meter.

In-Circuit Tests

Along the right edge of the front panel are located the controls for the go/no-go in-circuit tests (see Figure 2). At the bottom are the on/off switches for power and speaker, with the 3-pin transistor socket and three banana jacks for connecting the transistors mounted just above. At the top are the polarity LEDs, the lead-selection lever switch, and the window for the lead colors. Bipolar transistors, FETs, and SCRs can be tested.

Here is the sequence of tests:

- Connect the device by the socket or with leads in the banana plugs;
- Select the "HI" position of the drive switch;
- Turn on the power and slide the lever switch through the six possible combinations of leads;
- With bipolar transistors, usually two positions will light one of the LEDs (an audio tone sounds when either LED is lighted, unless turned off);
- The LEDs are labeled NPN and PNP, and the lighted one indicates the polarity; when lighted, either LED proves the transistor is good;
- Change the drive switch to "LO." Only one LED now should light;

Figure 1 Model 530 semiconductor tester from B&K-Precision checks solid-state devices in three separate ways. Operation is rapid and positive, without ambiguous readings.

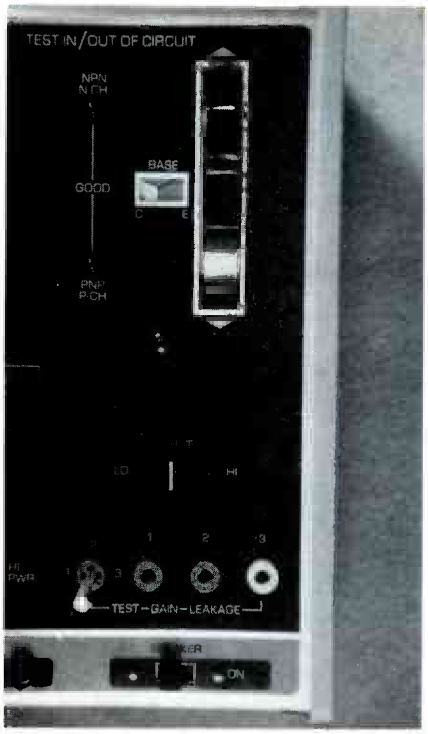

Figure 2 Controls for the in-circuit/out-of-circuit good/bad and lead-identification tests are located at the extreme right.

Figure 3 In the center of the panel are found the controls and meter for out-of-circuit leakage and gain measurements.

• The window beside the lever switch indicates the color code of the transistor elements (it's not necessary to use standard coding, just leave the transistor connected, and proceed with the other tests).

Tests for SCRs, diodes, and FETs are similar, but the terminology is different. Some devices that resemble transistors (such as triacs, diacs, and multiple diodes) cannot be tested. Refer to the instruction book for these.

Base and collector are fed coded pulses (which are different for "HI" and "LO" drive). Logic circuits sample the times when the transistor draws current, and this allows the identification of PNP or NPN.

Also, the pulses make the test nearly immune from errors caused by in-circuit loads. Factory specs call for valid good/bad indications down to 10 ohms or 15 microfarad with "HI" drive, and down to 1.5K ohms or 0.3 microfarad in "LO" drive. Several tests using resistor-sub boxes seemed to verify these limits.

Leakage And Gain

Near the center of the panel (Figure 3) are the controls for the out-of-circuit measurements of leakage and gain. The device remains connected as it was for the previous in-circuit tests.

One precaution, first set the NPN-PNP switch according to the results of the in-circuit tests. Otherwise, these next measurements will give no readings or wrong readings.

Press down the "PUSH TO TEST" button, adjust the "VOLTS" variable control to the test voltage desired and read the leakage on the meter that's just above. Current limiting is provided to prevent damage to the tester or the transistor. Also, *four* ranges of current are read on the meter. This gives the effect of a log scale for reading a wide variation of current.

The "GAIN" switch has a spring to return it to the center (off) position. To the left is the "TRANSISTOR BETA" position, with "FET GM" on the right. Just below the gain switch is one that selects either "LO PWR" or "HI PWR." That refers to the power rating of the device, and a transistor often gives a different beta on each power. This is normal, for beta *does* change with base drive.

continued on page 70

Solution to

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10 wattmeter	23 grasshopper
11 magnetism	24 insulator
12 capacitor	25 delay
13 sparkover	

Start with 100 points and deduct 4 points for any part you may not have answered correctly.

Your rating:

60 - 64	You struck out. Sorry.
68 - 72	You're on first.
76 - 84	You're on second.
88 - 96	You're on third.
100	OHM RUN! Congratulations!

Test Lab

continued from page 69

Frequency Cutoff

The subject of transistor frequency response is not a simple one, so I'll not attempt to explain it in detail just now. But remember this: The B&K-Precision model 530 does an excellent and needed job of measuring unity-gain frequency; but that figure does *NOT* directly tell the normal efficient frequency of operation. In other words, a transistor giving a reading of 34 MHz is not to be used at 34 MHz, but probably below 10.7 MHz. **The meter reading indicates the frequency where the transistor gain is 1, or unity.** A transistor can't even oscillate when the gain is only 1.

After you have tested many transistors for unity-gain frequency, you will be able to make sound judgments about the general uses for transistors having certain ranges of frequency. Some examples will be given later.

Testing transistors for the frequency of unity gain is very simple. Separate sockets are marked for PNP or NPN types, and a 3-pin plug with short wires and clips is provided for transistors that don't fit the socket.

Insert the transistor into the proper socket, observing the correct C/B/E markings. Start with the "RANGE MHZ" switch in the 0-1500 MHz range. If no reading is obtained, change to next lower (0-500 MHz), or go on to the 0-100 MHz range. Use the highest range that gives a reading above the minimum listed in the instruction book. Often, a transistor will give a reading with two (or even all three) ranges. Believe the one that provides the highest reading.

The picture in Figure 4 shows an RCA SK3018 giving a reading of 400 MHz on the 0-500 MHz range. A transistor designed for audio use will not give a reading on any range.

Figure 4 Controls, meter, and circuitry for measuring the frequency where a bipolar transistor gives a gain of one are at the left. They are completely separate from the controls for the other tests. A test frequency of 1 MHz is used for the 100-MHz range; 10 MHz for the 500-MHz range; and 30 MHz for the 1500-MHz range.

Comments

The B&K-Precision model 530 semiconductor tester was easy and simple to use, presenting no problems of operation or interpretation.

Several dozen transistors are kept in the lab for evaluating all brands of transistor testers, and all of the past readings are recorded. If you ever have compared beta readings made on two different models, undoubtedly you found the readings differed by 10% to 200%. This is normal, because the transistor beta *does* change with each slight variation of forward bias.

Therefore, it is not a criticism for me to say the model 530 gave figures that were approximately the same as those from curve tracers, conventional static-beta meters, and other varied types of equipment.

Many of these transistors could not be identified by their markings. However, an old 2N408 tested okay, but gave no reading on the frequency test; a 2N410 (probably used in the IFs of ancient transistor radios) gave a 1-MHz reading; a 2N2613 read 12-MHz on the 100 MHz range; and a SK3018 read 70 on the 100-MHz range and 400 on the 500-MHz range. A defective SK3018 measured low gain and a 10-MHz unity gain, thus proving the tests are valid.

The B&K-Precision model 530 should be a welcome addition to any service bench, especially for the frequency tests. Not only can unknown transistors be evaluated for suitability in RF circuits, but the condition of transistors with standdard numbers can be verified. □

test equipment report

Field Strength Analyst

PTS Electronics' new Field Strength Analyst (model 5001) combines the features of an all-channel field-strength meter and TV tuner analyst in one piece of equipment.

When used as a field strength meter, model 5001 is tunable to all UHF and VHF channels and has a three-position attenuator switch which allows signal measurement from 0 to 100,000 microvolts. The meter scale is calibrated in microvolts and dBs. The analyst portion can be used to substitute the VHF or UHF and/or any combination of the two for any 41 MHz television receiver. It also can be used to check the IF and AGC stages of a television receiver.

The model 5001 is powered by either AC or DC, and has a detachable AC line cord.

For More Details Circle (35) on Reply Card

DVM With Frequency Counter

A 5½-digit DVM from **Dana** features a built-in frequency counter in addition to measuring ACV, DCV, and ohms. Model 5100 has .43 yellow LEDs for reduced eye fatigue, and a switchable filter which provides inherent noise rejection at multiples of 10 Hz. In some cases, the built-in counter (measuring frequencies from 10 Hz to 20 MHz) eliminates the need for a separate frequency counter.

Optional accessories include current shunts, high voltage probe 5 to 50 KV, RF probe, and a true-RMS AC converter.

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