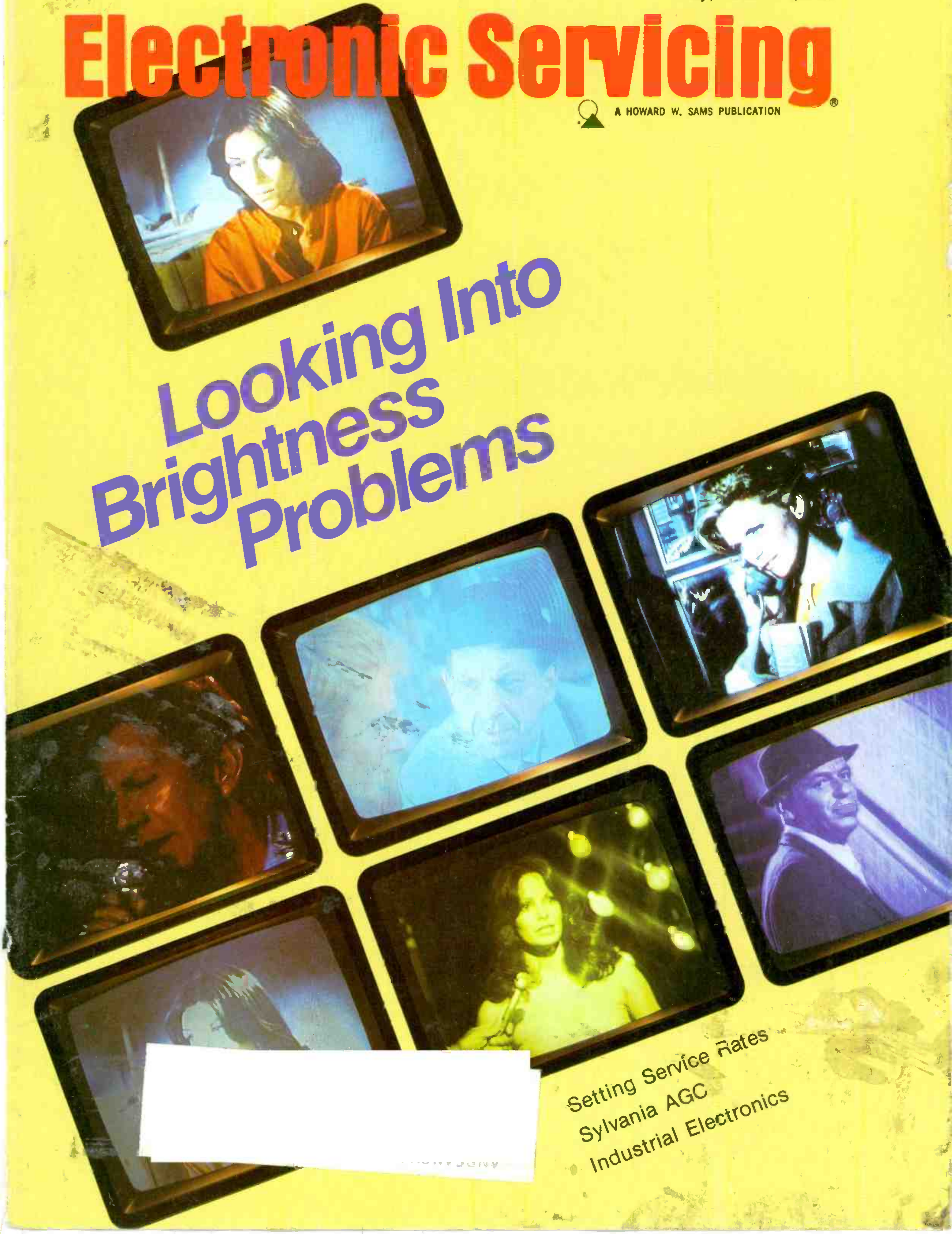
May, 1978 □ $2.25

Electronic Servicing

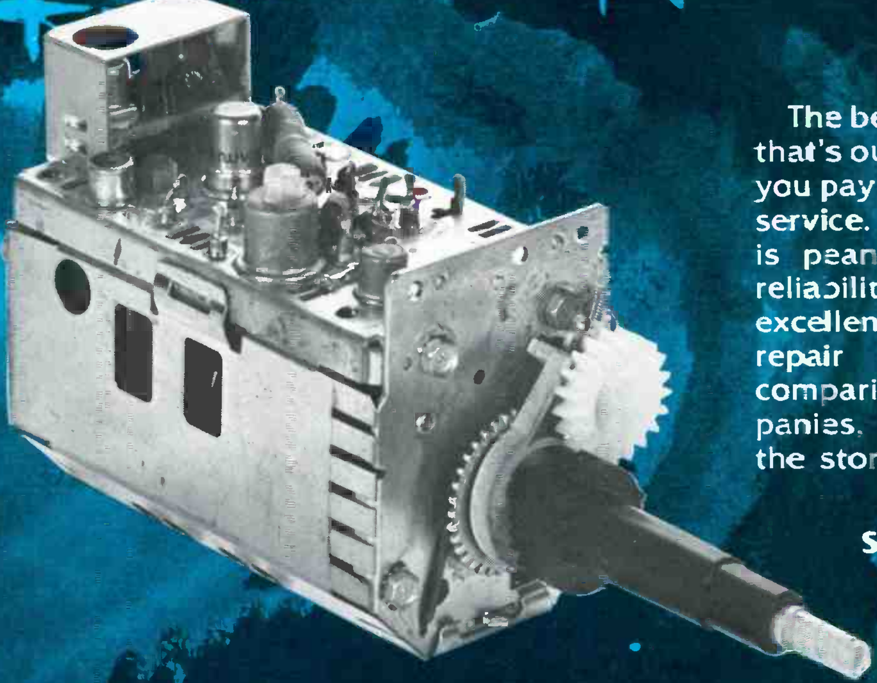
A HOWARD W. SAMS PUBLICATION



Looking Into Brightness Problems

Setting Service Rates
Sylvania AGC
Industrial Electronics

The Best of Everything Has It's Price... Even Tuner Service!



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Circle (1) on Reply Card

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Electronic Servicing®

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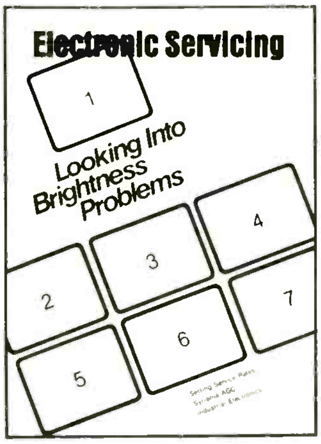

About The Cover—The cover pictures illustrate "Looking Into Brightness Problems." Picture #1 is a normal one; #2 is too dark; #3 is too bright; #4 has excessive contrast; #5 has white compression; #6 has no blue; and #7 has no green. Original slides by Carl Babcoke.

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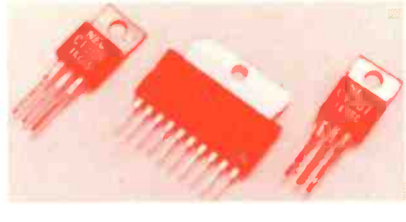

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2SK 34	1.10
2SK 40	70
2SK 41	1.10
2SK 49	1.30
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Circle (5) on Reply Card

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news of the industry

General Electric is developing a home video camera, reports *Retailing Home Furnishings.* The prototype unit is a miniaturized version of a color TV camera employing charged couplers for space savings, instead of the usual vidicon tube. To achieve the size and economic requirements necessary for mass marketing, GE and other companies are exploring the possible use of longitudinal scan machines.

Toshiba may establish a plant in Nashville to produce 200,000 color TV sets per year for the U.S. market. The planned move is the result of a reduced marketing quota for exports. Production will begin next July or August, according to the present schedule.

Retailing Home Furnishings reports that VTR sales continue to be strong, despite the belief that consumers are holding back purchases of 2-hour machines. This indicates to retailers that consumers are waiting for greater quantities of 4-hour systems to appear on the market. Product availability is a problem among competitors, making sales assessments difficult to predict.

The manufacture and sale of linear amplifiers used illegally to boost the power of CB radios has been banned by the FCC. Also, type acceptance of these amplifiers for amateur radio use will be required to prevent use of the units by CB operators in the 24-35 MHz range.

Zenith will continue to operate the audio and cabinet plant in Watsontown, Pennsylvania. According to *Electronic News,* Zenith plans to add the installation of electronic chassis and record changers in console and modular units to Watsontown's activities. About 700 employees will remain at the plant.

Toy manufacturers now are using microprocessors in more non-video games, a young, competitive market stimulated by the discovery of the MPU's memory capability, according to *Electronic News.*

Total U.S. market sales of radio and television receivers increased during March, according to the EIA. Color television sales were 966,326, an increase of 25.3% over the same month last year. Monochrome television receivers increased 20.6%, and radio sales reported a gain of 15.1%.

A self-contained modular work station providing more efficient servicing techniques is the subject of a 35-MM color slide presentation. The GTE Sylvania production explains features of the work station as a sales aid for distributors.

Hitachi of Japan has started a project to manufacture wall-type monochrome television screens using liquid-crystal displays. A prototype TV was announced last year. According to an item in *Retailing Home Furnishings,* the flat-screen TV and a book-sized portable should be on the market by 1980.

continued on page 6


Electronic
tube
Carl Meyer
President, A to Z TV Service
Clinton & Harlem Streets
Buffalo, New York 14224
"I buy from the source–GE.
They're the world's largest supplier
of receiving tubes."
Your reputation is our reputation
Tube Products Department · Owensboro, Kentucky 42301
GENERAL ELECTRIC

continued from page 4

Teleprompter Corporation has purchased a large-scale fiber optic CATV trunkline system that will replace an existing microwave link. This system is said to be the first of its kind in the nation, and is capable of carrying as many as 12 TV channels through a single glass fiber. The gallium-aluminum-arsenide lasers are controlled by frequency-division, multiplexed frequency modulation/intensity modulation.

A telephone with a built-in microprocessor and an eight-digit numerical display has been introduced by the Rolm Corporation. The numerical display indicates eight conditions, such as the number dialed, the time since the call began, and six others. No button need be pressed to answer an incoming call, and the phone can be used as an intercom. The phone system can be installed without requiring new multi-wire cables, for it operates from the conventional three-pair telephone wire.

An energy-saving high-efficiency sodium lamp has been developed by Westinghouse. The internal reflector allows most of the heat to escape through the rear of the bulb, while it directs the light from the front. Originally, the lamps were developed for use in mines, but other applications are predicted.

Sylvania lithium batteries, which function at -51°C, are accompanying Naomi Uemura en route to the North Pole. He is using the long-life, cold-resistant batteries in an effort to help pinpoint the location of Arctic samples he is gathering for the Smithsonian Institution. Celestial navigation techniques and other data will be evaluated by the Smithsonian via a transmitter that beams a 1-second signal every minute to an orbiting NASA satellite.

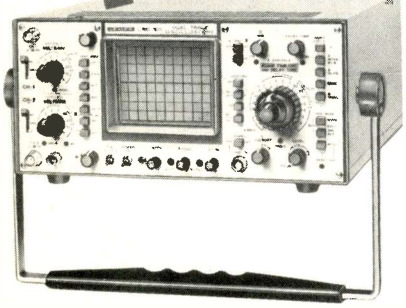
An experimental color TV broadcast satellite has been launched at Cape Canaveral for NASDA of Japan. Built by General Electric under a Toshiba contract, the satellite can broadcast to both remote and urban areas of the Japanese mainland and offshore islands. Almost a kilowatt of power will be beamed to earth for reception by antennas as small as 3.3 feet. This satellite was described in the July 1974 and August 1976 issues of **Electronic Servicing.**

A new, specialized series of VCR Photofacts to cover the growing videocassette recorder service market has been introduced by Howard W. Sams & Company. Specific VCR manufacturers are covered in separate volumes, with standard Photofact data included.

The FCC is taking action to halt the illegal sale of 23-channel CB radios. Field officials investigating the matter are concentrating on the dealers who continue to advertise the radios.

Frigidaire's first solid-state automatic ice-maker has been introduced. The microprocessor-controlled unit senses when the cubes are ready for use. Then, according to *Retailing Home Furnishings*, the cubes are dumped into a storage bin. The sensor has no moving parts.

APPROVED FOR VTR SERVICE



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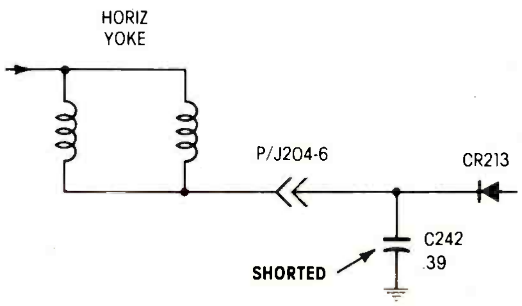
Circle (7) on Reply Card

symcure

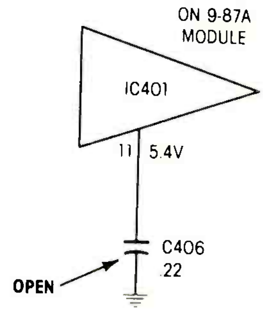
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Zenith 19GC45
PHOTOFACT—1546-2



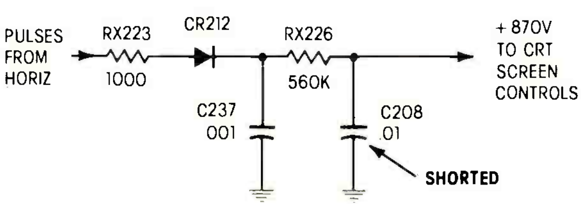
Symptom—Squeal, no HV, breaker trips
Cure—Check yoke capacitor C242, and replace it if shorted

Chassis—Zenith 19GC45
PHOTOFACT—1306-3



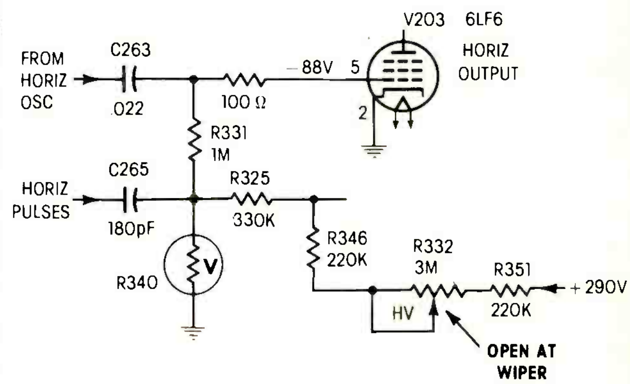
Symptom—Picture flashes; loses locking
Cure—One module 9-87A, check C406, and replace it if open

Chassis—Zenith 19GC45
PHOTOFACT—1546-2



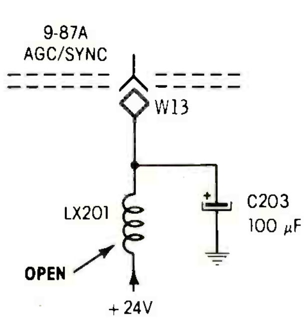
Symptom—No setup line; dark picture with green streaks
Cure—Check C208, and replace it if shorted

Chassis—Zenith 23DC14
PHOTOFACT—1305-3



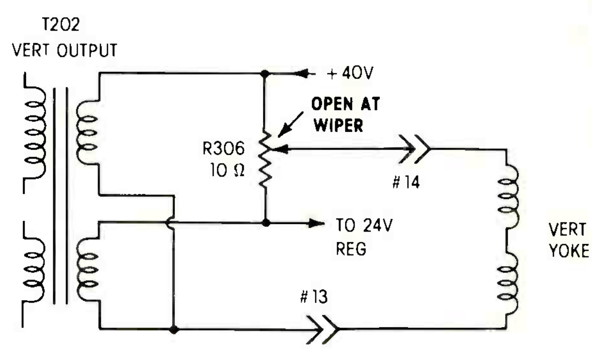
Symptom—Picture 2" narrow on each side
Cure—Check HV control R332, and replace it if open at wiper

Chassis—Zenith 19GC45
PHOTOFACT—1546-2



Symptom—No picture or sound; dim raster
Cure—Check peaking coil LX201, and replace it if open

Chassis—Zenith 23DC14
PHOTOFACT—1306-3



Symptom—No height
Cure—Check vertical-centering control R306, and replace it if open at wiper

Want more information? Circle the numbers of those items of interest to you

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61	62	63	64	65	66	67	68	69	70
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- G.☐ Other (Specify ....)

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61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

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C.☐ Independent or Self-Employed Service Technician
D.☐ Electronics, Radio, TV Manufacturer
E.☐ Industrial Electronic Service
F.☐ Wholesaler, Jobber, Distributor
G.☐ Other (Specify ....

Position
Check One:

H.☐ Owner, Manager
I.☐ Ser. Manager
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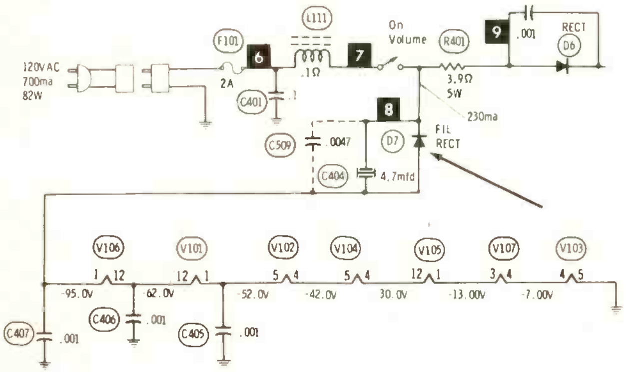
troubleshootingtips

Vertical stretch and vertical roll
Sanyo 21VG5 (Photofact 1416-2)

A customer brought in a portable Sanyo B&W television and reported a problem of vertical stretch and vertical roll after 15 minutes of operation.

I replaced the vertical oscillator-and-output tube (17JZ8), because it showed leakage on the tube checker. Next, I adjusted the height and linearity controls, and played the set for 20 minutes.



The problem seemed to be corrected, so the customer took the set home. Next day, however, the customer returned with the same complaint.

This time, I checked the voltages in the vertical circuit; they were okay. Then I replaced the vertical capacitor, but the trouble didn't go away. Also, coolant did not pinpoint the trouble.

The problem was beginning to get to me, but after just completing two tough-dog color sets, I was determined to find the solution. Turning off the shop's lights, I noticed that the tube heaters were too bright. The answer finally came to me: This set must have a heater diode.

Checking the D7 diode, I found it leaky. This put a higher heater voltage on all the tubes, causing the drift. I replaced both the diode and the output tube (17JZ8), which was weakened by this time. I adjusted the vertical linearity and height; then I replaced the horizontal output tube (33GY7), as the width decreased when I replaced the diode. The variable problems now were gone.

This trouble can occur in any set using a diode in the heater circuit.

Mac Kellman
Brooklyn, New York

Vertical flickering
Motorola STS-934
(Photofact 1316-2)

Adjustment of the vertical hold had no noticeable effect, so I pulled out the chassis drawer and removed the vertical board.

On previous occasions, I had found R53 and R32 to be the source of this particular problem. A quick glance at them this time showed a burned ring around R32, a 1.5-megohm resistor. I replaced the resistor and the 6BL8 vertical oscillator tube, and the flickering was gone.

Richard Serrano
Madero, California

reader's exchange

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*.

Needed: Tuning capacitor for Arvin AM/FM-stereo/phono model 86P58. *Wolfe Radio, RR1, Box 166, Hammond, Illinois 61929.*

Needed: An up-to-date manual for a Precision CRT tester/rejuvenator, model CR-60. Also, a complete set of socket adapters. *Robert G. Strebeck, Route 12, Box 64, Clarks Point Road, Baltimore, Maryland 21220.*

For Sale: Sencore model SG165 AM-FM stereo analyzer, like new, complete with probes and instruction manual, #395. *Al's TV Service, 1158 Burton S.W., Grand Rapids, Michigan 49509.*

Needed: 25-inch CRT face mask for Emerson TV model 26C42 chassis number 120920A. Please state price. *D. C. Nunn, 7268 Bruno, Richmond Heights, Missouri 63143.*

For Sale or Trade: Rider's television manuals volumes 1 to 12 (as a set) and 2, 3, 4, 6, 8, 9, 10, 14, 17 and 19. Make offer, or trade for one or all. *Ken Hanson, 3403 Broadway, Long Beach, California 90803.*

Needed: A sound-IF transformer (shown in Photofact 1428-1 as T301) for a B&W Broadmoor TV model 2012FG. *Valley TV, 62 Valley Way, West Orange, New Jersey 07052.*

Needed: Rider's radio manuals and test equipment in working order. Will trade or sell antique and hard-to-find radio tubes. State your needs. *Troch's, Television-Radio-Appliances, 290 Main Street, Spotswood, New Jersey 08884.*

Needed: Take-up reel for Sanyo tape recorder model MR-929. *M. H. Moses, 19 4th Artillery Road, Fort Leavenworth, Kansas 66027.*

Needed: Schematic for Talk-A-Phone model 2002. Will buy, or copy and return. *E. W. Chegwidden, 382 Shiloh Road, Kennesaw, Georgia 30144.*

Needed: Charts for Century model FC-2 and superior model TV-11 tube testers. *W. J. Wimes, 123 Lebanon Street, Springfield, Massachusetts 01109.*

Needed: RCA service notes volumes 1923-1928, 1929-1930, 1930-1931, and 1938. Also, Philco or Atwater-Kent cathederal radios. *J. A. Call, 1876 East 2990 South, Salt Lake City, Utah 84106.*

For Sale: B&K-Precision 1077B Analyst, $330; B&K 415 sweep/marker generator, $330; Sencore color-bar generator; Sencore sweep-circuit analyzer; and EICO flyback checker. For details, see ad in The Marketplace this issue. *Bob Begun, 1056 Fraser, Aurora, Colorado 80011.*

For Sale: EICO 628 tube tester, $50; B&K-Precision 1076 Analyst, $175; and other items, will trade. *Kenneth Miller, 10027 Calvin Street, Pittsburgh, Pennsylvania 15235, (412) 242-4701.*

Needed: Hickok tube testers, models 580-A and 6000, or comparable types, Hickok VTVMs, 209 series or 370 series. *Kenneth Miller, 10027 Calvin Street, Pittsburgh, Pennsylvania 15235, (412) 242-4701.*

For Sale: IRE proceedings, IRE transactions on broadcast and TV receivers and directories from 1958 to 1962 inclusive, best offer. Also, back issues of many other TV magazines, $2 each postpaid. *Isidore Forman, 9312 Avenue N, Brooklyn, New York 11236.*

Needed: Electrostatic-deflection picture tube 7JP4 or 8BP4. *Bowers Electronics Service, Box 321, Reading, Michigan 49274.*

For Sale: Conar Instruments communications receiver model 500, $60; and model 400, communications transmitter for 80, 40, and 15 meter bands, no crystals, $40. *William D. Shevtchuk, One Lois Avenue, Clifton, New Jersey 07014.*

Needed: Schematic and service manual for a Delco Wonder Bar AM/FM auto radio model 05CFWK1 (used in Cadillac). *Arnold E. Kading, Box 287, Hackensack, Minnesota 56452.*

For Sale: Heath IG-18 audio generator, new condition, $75; Heath IP-5220 variable AC supply, new condition, $100; and Hallicrafters S-76 receiver, original condition, with matching R46A speaker and manual, $125. *L. Kenison, 1705 11th Avenue, Yuma, Arizona 85364.*

Needed: An oscillator coil (part 738185) for a Dumont remote control number 471664. *Hal D. Swanson, Lowry AFB Trailer Park B-30, Denver, Colorado 80230.*

For Sale: RCA 10J106 test rig, one year old, with 40 adapters, $295 cash. Or, will trade for good B&K-Precision model 415. *Bill Howell TV, PO Box 169, Nicoma Park, Oklahoma 73066, (405) 733-3522.*

For Sale: Components to convert a test jig or TV for operation with solid-state chassis: Telematic TA-3000 transverter; 18 convergence loads; 24 yoke adapters; plus yoke, convergence coil, lateral magnet, and yoke extension. Total list was $325; will sell for $125. *Gerald L. McKouen, 534 Pacific, Lansing, Michigan 48910.*

Needed: Dialalarm Mark X "Compact" cassette tape recorder and automatic telephone dialer. Will buy, or copy and return. *Horace R. Cowles, 958 West 58th Street, Ashtabula, Ohio 44004.*

For Sale: 1800 or more new tubes (one or more of each number), some instruments, other components, etc. $9,000 cash—you pay the freight. *R. J. Tuttoilmondo, 6739 Pecanwood Drive, Hitchcock, Texas 77563, (713) 896-7840.*

continued on page 14

reader's exchange

continued from page 13

For Sale: About 170 TV tubes for $270; three flybacks for $10 (1 HVO-104, one Dumont 20009781, and one RCA); Halldorson Y-26 and Thordarson Y502 yokes for $10; and one 200-μF 300-volt and two 150-μF 250-volt electrolytics for $4.80. *Orlando J. Funk, Route 1, Box 5A, Corn, Oklahoma 73024.*

Needed: Wiring diagram for Millen power supply model 90202, to connect to Millen 1" scope model 90101. Name your price. *Homer B. Tilton, 3401 Camellia Drive, Apt. 401, Temple, Texas 76501.*

For Sale: Antique color TV in mint condition, 1965 Sears model 5170, $300 including shipping. *F. Jones, 604 Titi Circle, Eglin Air Force Base, Florida 32542.*

For Sale: WW II vintage transmitter tubes (large ones). Can be used as teaching aids or for personal display. KU-23s, 872As, and more. Write for list. *Larry Reid, 2350 North Medina, Simi Valley, California 93063.*

For Sale: B&K-Precision model 1075 television Analyst and model A107 Dyna-Sweep circuit analyzer, complete with instruction manuals and schematics, in good operating condition, $75 for both. *H. Mason, 13207 Park Lane, Oxon Hill, Maryland 20022.*

Needed: Rider's television volume 13 and a volume 1 (with 12" x 15" pages). Will trade 2 or 3 volumes for one that I need. *Ken Hanson, 3403 Broadway, Long Beach, California 90803.*

Needed: Meter movement for Knight model KG-640. *Horace R. Cowles, 958 West 58th Street, Ashtabula, Ohio 44044.*

Needed: Hammarlund model HQ-180 receiver. *W. S. Zukowski, 12 Lark Place, Old Bridge, New Jersey 08857.*

For Sale: Collins 75S-3 radio receiver, 3.4-30MHz frequency range, instruction book and 16 crystals included. Worth over $900. Sell for best offer over $550, or trade for Z80 or 8080 computer of equal value. *Simpler Electronics, RD2 Box 354, Second Street, Jackson, New Jersey 08527.*

Needed: Heathkit sweep/marker generator for about $75. Also, a triggered-sweep scope at a reasonable price. *George Campbell, 44445 13th Street East, Lancaster, California 93550.*

Needed: Seco tube tester model 107, in working condition, or repairable. State price and condition. *J. M. Smith, Ace TV and Appliance, 1010 West Nob Hill Blvd., Yakima, Washington 98902.*

Needed: Picture tube, for symphonic model TPS-30 portable B&W TV receiver (tube type C-6407, 3" rectangular). *Vernon Tiger, Team Electronics, West Acres Shopping Center, Fargo, North Dakota 58102.*

Needed: Schematic and/or service manual for a Monarch model SAT-460X AM/FM stereo receiver. Will buy, pay for copy, or copy and return. *A. D. Engle, 6161 Kellogg Drive, McLean, Virginia 22101.*

Needed: Instruction books or schematics for RCA-WR-59B and WR-39C. Will buy, pay for copy, or copy and return. *H. P. Nesbitt, RR 2, Box 63, Crystal River, Florida 32629.*

Needed: Complete schematic for model 30W95 Pilot stereo receiver. *Bill Greene, Master Radio & TV, 31A North Anderson, Boston, Massachusetts 02114.*

For Sale or Trade: Old receiving tubes. 6SC7, 6Z7, 6J7G, 6J5, 6N7, and others. Boxed, tested, some new. Trade for vintage tubes. *Larry Reid, 2350 North Medina, Simi Valley, California 96063.*

For Sale: Sencore CB42, CR31, and FE27. All like new, make offer. *Richard Gibson, Route 1, Box 606, Marion, South Carolina 29571.*

Needed: Two battery packs (number 12B012) for a Melcor model SC-535 calculator. *Nick Washinsky, 146 West End Avenue, Newark, New Jersey 07106.*

Needed: Used test equipment: picture tube tester and rejuvenator, yoke and flyback tester, isolation transformer, color-bar generator, resistor and capacitor substitution boxes, B&K-Precision TV analyst, or other TV test equipment. *Al Moschella, 1134 McKean Street, Philadelphia, Pennsylvania 19148, (215) HO7-3795.*

For Sale: B&K-Precision 1077B Analyst, $395; RCA WO-535A scope, $295; and EICO model 944 yoke and flyback tester, $40. All are new with instruction manuals and all leads and probes. You pay the freight. *Keith Kincaid, 1530 East Washington, Charleston, West Virginia 25311.*

For Sale: Tektronix 585A 85-MHz mainframe with type 82 dual-trace plug-in, $875; Lambda model LT-2095M power supply, 0-32VAC at 2 amps, $75; B&K-Precision CB Service Master model 1040, $250; Heathkit model IG-18 function generator, $50; Heathkit model IM-5238 AC voltmeter, $85; Jerrold model 601 sweep frequency generator, $35; Conar model 255 triggered scope w/probes, $180; B&K model 1430 scope $80. All in excellent condition, you pay shipping. *A-M Communications, 634 Delano Avenue, Prescott, Arizona 86301, (602) 445-4950.*

For Sale: B&K-Precision 415 sweep/marker generator, $325; B&K 1248 color generator, $100; B&K 2040 CB generator, $350; and B&K E200D RF signal generator, $100, shipping prepaid. *David A. Valencia, 7241 Tuolumne Drive, Goleta, California 93017.*

For Sale: B&K-Precision, model 415 sweep-marker generator, $400; model 467 CRT analyzer, $200; model 501A curve tracer, $150; and model 162 transistor tester, $100. Also, Leader, model LCG-388 color bar generator, $150; model LB-501 scope, $175; and model LV-77 FET-VOM, $45. All instruments are less than 2 years old, and priced less shipping costs. *Milton Obuch, 1308 North 4th Street, Sayre, Oklahoma 73662 (405) 928-3798.* □

Looking Into Brightness Problems

By Wayne Lemons, CET

Color-television receivers are susceptible to problems of wrong brightness. These symptoms include a dark picture, excessive brightness, poor focus with insufficient brightness, and no raster when the high voltage is okay. Also, wrong B&W screen colors are produced by a brightness problem that affects only one or two colors. These suggestions are intended for tube-equipped sets, although some apply to solid-state.

Brightness problems of color-TV receivers occur frequently, and technicians soon collect a useful storehouse of hints and tips gained from the successful repairs. Even so, the solutions are not always easy or without expensive detours. And, when the symptoms are erratic or intermittent, the problems are multiplied.

Some of the suggestions that follow probably are not new to you, but the best results are obtained when you do *all* of the tests in the sequence given here.

Back To Basics

Here are some fundamental truths that form the foundation of these suggestions. Whenever you get bogged down with brightness problems, and no solution can be found, read these over again, and look for a fresh viewpoint.

First, think of these three basics:

- When the intensities of all three picture-tube screen colors are varied by the same amount, the result is a change of brightness.
- When the normal B&W balance of the screen colors is changed (one color is made brighter, and the others are darkened, for example) the result is a change of screen color. This can be intentional (that's the way a color picture is formed), or it can be undesired, caused by a defect.
- The brightness of any one screen color is determined by the instantaneous voltages that are applied to the picture-tube gun. (Instantaneous voltages are made up of DC and AC voltages. However, in practical tests, the DC voltages make the most noticeable changes.)

When the three basic truths are expanded, they explain all cases of wrong brightness and incorrect colors as seen on the face of picture tubes.

Brightness rule

Restricting the previous basic truths *to brightness alone* allows us to form this rule: **Assuming the picture tube is okay, every true brightness problem is caused by incorrect DC voltages at one or more elements of the picture tube.** Of course, these DC voltages must be correct at the proper pin of the picture tube, and not merely at the CRT socket or somewhere in the chassis wiring. Open circuits can occur.

Probably you already know these facts. But, I have seen other good techs (who also knew the basics) turn controls, slide bias switches, change tubes, and replace parts that previously had been found to be bad in similar cases. Unfortunately, valuable clues often are obscured by these shortcuts. Quickie tests have definite values, but for best results, they should be used at the proper steps of a sequence.

Measurement of the DC picture-tube voltages should be one of the first brightness tests. The following sequence of tests should eliminate most wasted time during the diagnosis of a brightness problem.

Controls

Unless there is strong evidence that the customer or another tech has been tampering with the screen, drive, and bias controls, I suggest you don't adjust these controls. At least, not at first.

When the complaint is low brightness, allow time for the TV to warm up (a minute for tube sets), then rotate the front-mounted brightness control over the entire range, while you watch the screen of the picture tube. If the brightness increases in step with the control, but the maximum brightness (with the control fully clockwise) remains too dark, either the chassis or the picture tube has a defect.

If the picture becomes larger and darker with an increasing adjustment, and perhaps finally goes totally black, the problem is likely to be with the high voltage, and is not a genuine brightness problem.

Of course, excessive brightness (that does not respond to the normal adjustment of the front-panel controls) usually indicates a malfunction in the chassis.

Many other facts can be learned by this simple test. Focus that changes according to the brightness, white compression of the video, or drifting brightness that apparently changes as the picture tube heats, are some of the valuable clues. Many of these symptoms will point to a defect other than a brightness problem.

Picture-Tube Voltages

In cases where the symptoms indicate a chassis brightness problem, all of the picture tube voltages (including high voltage and focus voltage) should be measured at the socket. (Later, other symptoms might indicate a need for additional tests at the picture-tube *pins*, to eliminate the possibility of a bad socket connection or an open circuit. However, at this point, the socket measurements are sufficient.)

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Brightness

continued from page 16

If the problem is erratic or intermittent, these picture-tube voltages should be written down for reference later.

Note: Before measuring the picture-tube voltages, **turn down all color,** or else the grids will not have the correct voltages.

Often a quick analysis of the DC voltages will reveal a radical discrepancy, perhaps at the grids, cathodes, screens, focus, or high voltage. If you are that fortunate, then go directly to the suspected circuit for additional tests.

Schematic voltages

An excellent technique is to compare the measured voltages to those of the Photofact for that model. However, signal levels and setup adjustments change many of the voltages, so keep these ground rules in mind.

Before the DC voltages are measured during production of a Photofact, the TV receiver must be a production sample that is adjusted properly and is known to be working normally. Then, as I understand the procedure, the antenna leads are disconnected, the set's antenna terminals are connected together by a short wire, and the tuner is switched to a channel that has no signal. (Of course, *waveforms* are made with proper signals.)

You must expect some variations from these voltages because of parts tolerances in individual chassis, and because of different setup adjustments. For example, the screen-grid (G2) voltages vary more than any other measurements. Therefore, notice the three screen voltages shown on the Photofact schematic. Usually, the screen voltages of the set you're testing should fall between the lowest and highest Photofact voltages.

In like fashion, you usually can analyze two or three voltages in similar or duplicate circuits. For example, two demodulators (or three -Y amplifiers) should measure alike.

Any extreme difference from these typical voltages is reason enough to suspect a circuit defect.

If all of this talk about *expecting* the DC voltages to be different from the schematic values appears to cancel any value of the voltage tests, then read on. We'll see how to work efficiently within the limits of all these variables.

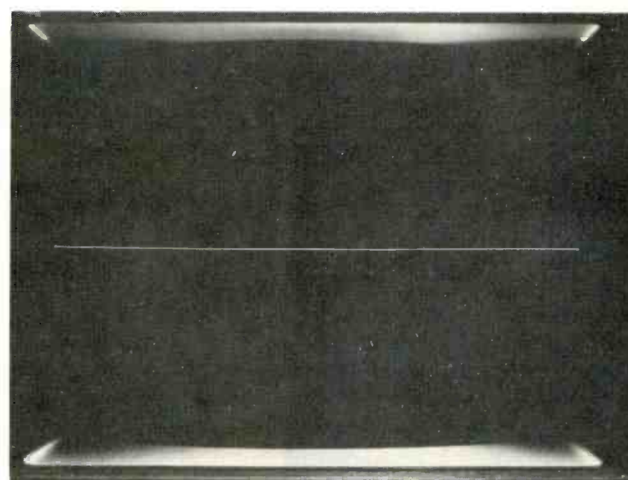
Testing With Service Switch

There is a quickie test, involving the service switch (S1), that can provide some of the same answers as obtained by voltage analysis. The results are not as accurate, but they are fast to obtain, and can strengthen the voltage-analysis diagnosis.

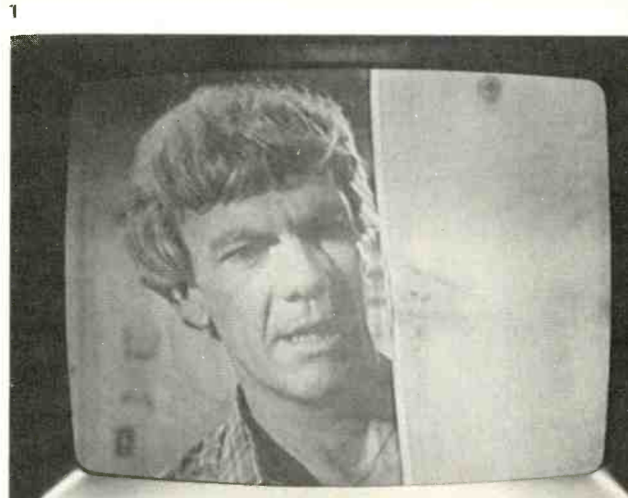
For our analysis, we'll be using the circuit of Figure 1. It is a composite of dozens of tube-equipped models.

continued on page 20

When no line is seen when the service/normal switch is in the service position, then the picture in the normal position probably is too dark, like this one. **Note:** for these pictures from a TV screen, the CRT mask has been illuminated to show that the picture symptoms are real, and not done by trick photography.

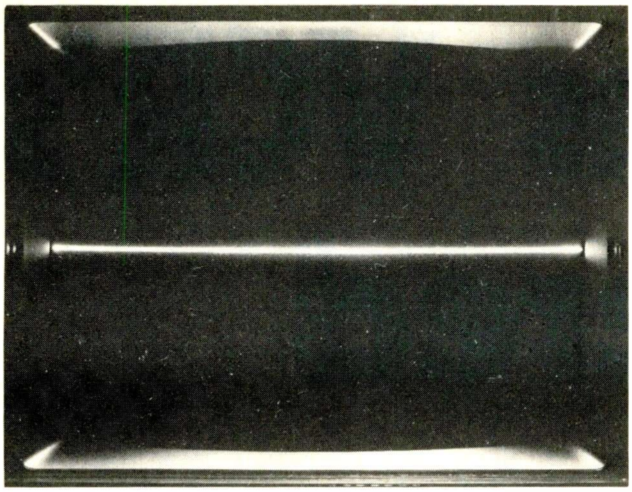


1



2

A dim horizontal line when the service/normal switch is at the service position (picture 1) should produce a picture that can be adjusted for normal brightness (picture 2).



1

2

A bright line when the switch is at the service position (picture 1) probably indicates a too-bright picture that can't be adjusted dark enough for normal brightness (picture 2).

Brightness

continued from page 18

Normal-service switches are included to increase the speed and accuracy of the gray-scale-tracking setup adjustments. They do two things: (1) the vertical sweep is eliminated to make the brightness of the resulting line more intense; and (2) the cathodes of the picture tube are held at a fixed DC voltage (thus preventing any false results from the brightness operation, and increasing the CRT bias).

When the color is turned down completely, and the switch moved to the "service" position, the *desired* result is a dim gray horizontal line. Any slight color tint or small amount of wrong brightness is to be corrected by adjustments of the three screen-grid controls.

In this case, we are using the color and brightness of the line as symptoms. Excessive brightness indicates too much positive voltage reaching the grids, wrong adjustments of the screen controls, or a defect which raises the screen voltage above normal.

If no horizontal line can be seen, the grid voltages might be too low, the screen controls might be turned down, or a defect might have decreased the voltage at all three screens.

As you can see, an abnormally bright or dim line in the service position indicates **the problem is not in the video** (it was disconnected during the test). Therefore, the wrong voltages are at the grid or screens.

On the other hand, a normal horizontal line in the service position (but wrong brightness with the normal setting) proves the brightness problem originates in the video stages or the cathodes of the picture tube.

Not all questions are answered by this handy test. Therefore, it should be preceded or followed by measurements of the DC voltages.

Circuit Operation

Typical DC voltages and signal sources of a color picture tube are shown in Figure 1. A knowledge of circuit operation is very valuable during troubleshooting; therefore, a short description follows.

Matrixing of the chroma and B&W signals is accomplished in the electron stream of the picture-tube guns. Chroma R-Y, B-Y, and G-Y signals are applied to the three grids. Video (or Y) signal is applied to all three picture-tube cathodes. In most cases, a different percentage of the Y signal is fed to each of the cathodes, but that's just a detail giving better tracking. (Most modern solid-state sets matrix the Y and -Y signals, amplify them, and apply them separately to the three cathodes. No signals reach the grids.)

Remember that DC-voltage changes at grids, cathodes, and screen grids *all* cause brightness changes. Therefore, variations of DC voltage in the chroma -Y stages will affect the grid voltages. And, variations of DC voltage in the video stages will affect the cathode voltages. Few screen-grid circuits have any tubes, transistors, or any active devices, so they are not prone to voltage changes.

A voltage change to any one grid, screen, or cathode of a gun, and no change at the other two guns, produces a change of B&W screen color. Brightness defects that *do not* change the screen color MUST change all three grids, cathodes, or screens by the same amount.

Therefore, the grid voltages (and the -Y amplifiers that drive them) are more likely to change the screen color than are the cathode voltages and the video amplifiers that drive them. Notice that this is not a rule, but is just playing the percentages. Many defects can change the video

Figure 1 (at right) This is a typical tube-type schematic of the circuits in a color TV that contribute to brightness problems. The video or Y signal is direct coupled to the cathodes of the picture tube. Therefore, higher positive cathode voltages reduce the brightness (an open video-output tube usually eliminates the raster and picture). Three separate -Y amplifiers are direct coupled to the CRT grids. Therefore, higher voltage at all three grids increases the picture brightness an open -Y amplifier brightens that associated color). All three screen-grid voltages are adjustable by separate controls, with the supply voltage coming from the boosted-boost circuit. This kind of blanker supplies pulses, and indirect bias to the -Y amplifiers, and provides a negative voltage needed by the brightness control. Most changes or defects in these circuits affect the brightness.

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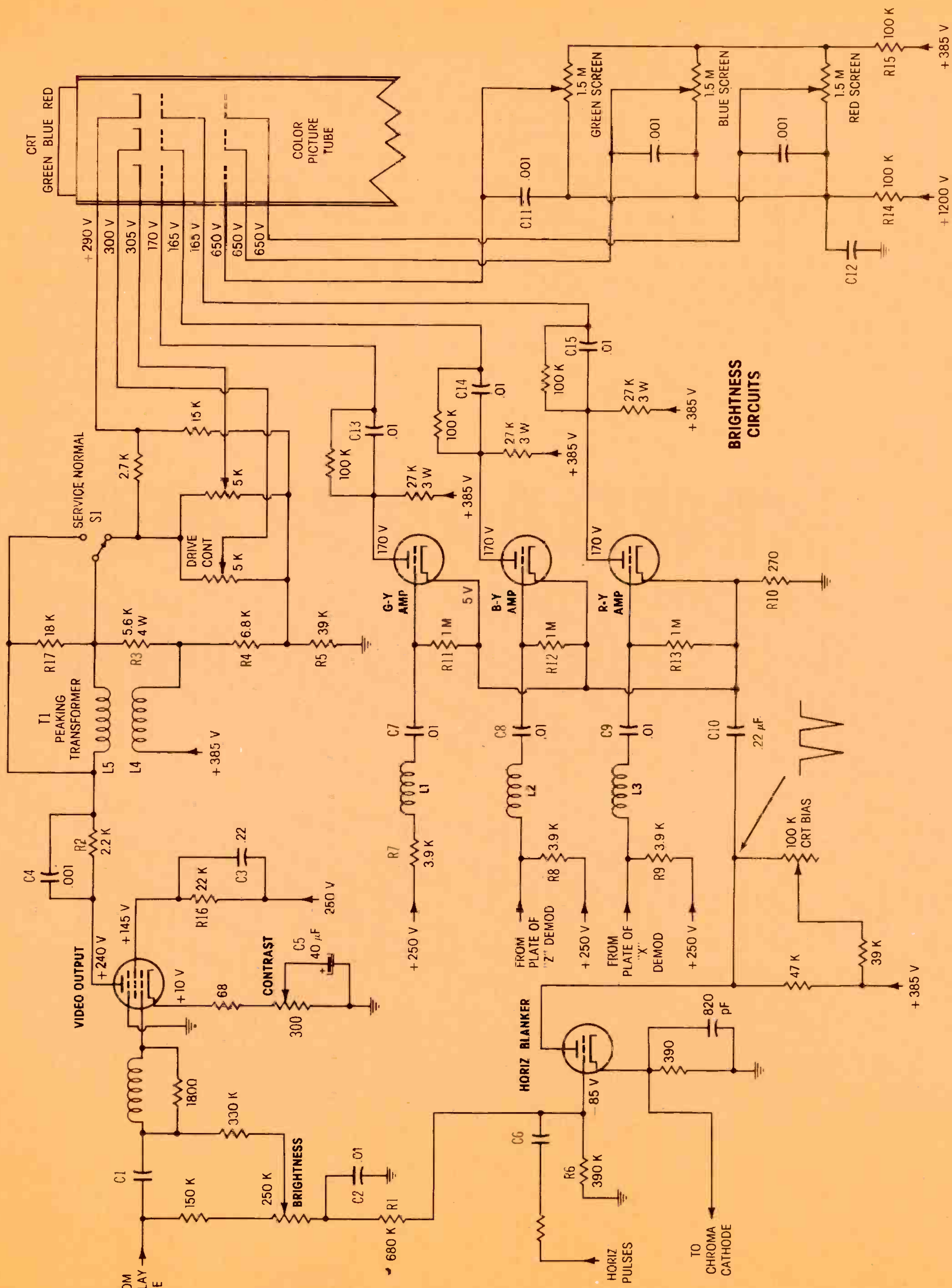
BRIGHTNESS CIRCUITS
CRT GREEN BLUE RED
COLOR PICTURE TUBE
VIDEO OUTPUT
CONTRAST
BRIGHTNESS
SERVICE NORMAL S1
DRIVE CONT
T1 PEAKING TRANSFORMER
G-Y AMP
B-Y AMP
R-Y AMP
HORIZ BLANKER
GREEN SCREEN
BLUE SCREEN
RED SCREEN
CRT BIAS
FROM DELAY LINE
HORIZ PULSES
TO CHROMA CATHODE
FROM PLATE OF "Z" DEMOD
FROM PLATE OF "X" DEMOD

Brightness

continued from page 21

DC voltages; few can change all -Y amplifier voltages simultaneously.

Screen voltages

Voltage supply for the screen grids comes from either the boost or the boosted-boost supplies of the horizontal-output circuit. Boost voltages are a byproduct of the damper action, and damper defects affect the width and high voltage as much as they do the brightness.

Voltages from the boosted-boost circuit usually have an intermediate-voltage rectifier that feeds only the vertical oscillator and the screens. A rectifier that's either shorted or open reduces the DC voltage to the boost level. Thus, the maximum brightness is reduced somewhat.

Other than that, most defects that change all three screen voltages are confined to out-of-tolerance resistors, or leaking capacitors connected to the ends of the screen controls. Spark gaps often reduce a screen voltage, but just one at a time.

Don't overlook a trouble of decreased screen voltages that has been concealed by someone else who previously has turned screen controls and bias pots or switches for maximum possible brightness. None of the receivers are designed to require maximum adjustments of these controls. Therefore, when you find these controls set at maximum, suspect a defect.

No Brightness Or Low Brightness

The most likely general cause of insufficient brightness is excessive bias at all three picture-tube guns. That's assuming the picture tube is okay, and the focus, screen, and high voltages are within tolerance.

Never forget that grid voltages and cathode voltages *both* contribute to the bias. Also, don't allow the positive voltage measured between grid and ground to deceive you. **True grid bias is measured between**

cathode and grid. For example, if the CRT cathodes measure +300 volts and the grids have +170 volts, the true bias is -130 volts.

When the screen grids have +650 to +700 volts, most CRTs will show a properly bright picture with biases ranging between -110 and -140 volts. The exact amount varies with the type of tube and its emission, but that's a good ballpark figure.

If the bias exceeds -150 volts, the brightness likely will be too dark. Perhaps no raster or picture can be seen. When that happens, are the grid voltages or cathode voltages at fault? Your best bet is to compare the schematic voltages with the ones you measure.

However, if the schematic is not available at that time, you can make another quickie test. This one is based on the range of DC voltages at the picture-tube cathodes when the brightness control is rotated through its entire range. **The voltage should vary a total of 40 volts to 80 volts for proper control of the brightness.**

A problem in the video stages can reduce the current in the video-output tube. This increases the plate voltage (less brightness), but the reduced current minimizes the amount of brightness variation. So, **a weak video-output tube produces a dark picture that does not change enough from the brightness-control adjustments.** Higher brightness requires a lower plate voltage (and lower CRT cathode voltages).

This test is quite effective for identifying *video* problems that affect brightness. A similar test for the chroma circuit and the CRT grids is not practical, because the circuits are not sufficiently alike.

Another test of the video is to measure the CRT cathode voltage for both positions of the service/normal switch. Some designs show almost no change of DC voltage. Others might increase 20 or 25 volts in the service position. However, any larger difference between the

continued on page 24

two voltages is an indication of a problem in the video amplifiers.

Blanking Versus Brightness

In circuits similar to the one in Figure 1, a strange interrelationship exists because of the horizontal-blanker circuit.

First, I must explain how and why the blanking operates. Negative-going pulses from the plate of the blanker tube are coupled through C10 to the common cathodes of all three -Y amplifiers. Several actions occur. These pulses are amplified without phase reversal, and the large negative-going plate pulses are coupled to the CRT grids (along with the chroma signals), where they blank out the brightness during horizontal retract. That's one function; but there's more.

Amplitude of the pulses fed to the cathodes is sufficient to cause grid current to flow. In effect, the grid and cathode function as a diode in a series DC-rectifier circuit. Negative AC (pulses) are applied to the cathode, while the .01 grid capacitor (C7, C8, or C9) functions as a peak-reading filter capacitor, and the 1M grid resistor acts as the load. Therefore, negative DC is produced at the grid. (This is relative to the cathode, so the grid does not necessarily measure negative from ground.) If you doubt this analysis, and think that rectification of the chroma signal is the source of the negative voltage, then you must account for these facts: The grid of the G-Y amplifier has the same voltage as the other two grids, but there is no chroma there; and varying the amplitude of the cathode pulses *does* change the negative voltage measured from grid to cathode.

The time constant of .01 and 1M is long compared to the horizontal frequency. Therefore, the negative voltage does not diminish much between pulses. Instead, it acts as a fixed bias for each -Y tube.

Now, anything that upsets the rectification also changes the tube bias, which in turn changes the brightness of that color. The normal and desired action is for stronger pulse amplitudes to produce more negative grid bias at all three grids, which raises the plate voltages (and the voltage of each CRT grid) to increase the brightness of the picture.

At the other extreme, a **total loss of cathode pulses** removes all rectified bias, forcing the -Y tubes to conduct more, and reducing the plate and CRT grid voltages to **cause a darker picture.**

One gun brightness changes

This bias-by-rectification produces some unexpected symptoms from common defects. Any defect that changes the amount of pulse rectification at just *one* -Y grid changes the B&W screen color.

The critical components are the 3.9K demodulator resistors (R7, R8, and R9), the RF chokes (L1, L2, and L3), the .01 capacitors (C7, C8, and C9) and the 1M grid resistors (R11, R12, and R13). The .01 capacitors are equivalent to the first filters of most power supplies, but in this circuit the .01 filter does not return

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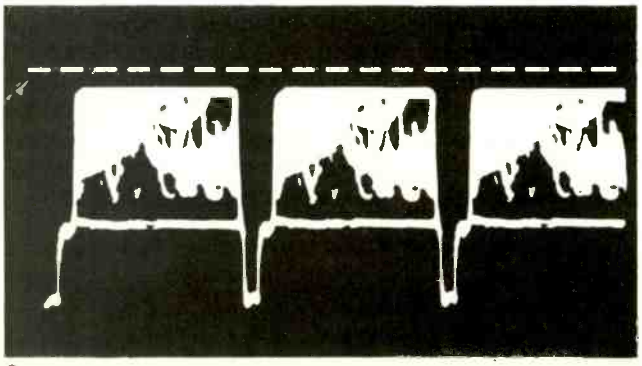
1


2


3

These pictures show the visual and waveform effects of white clipping. A normal picture (picture 1) has a full range of brightness from white to black. Video clipping of the white side of the waveform (picture 2) shows all shades of white and light gray as the same brightness. Notice that the CRT mask is brighter than the lightest part of the picture, while in Picture 1 they have the same brightness. Picture 3 shows the negative-going video waveform with white compression at the top. Without clipping, the waveform would extend up to the dotted line.

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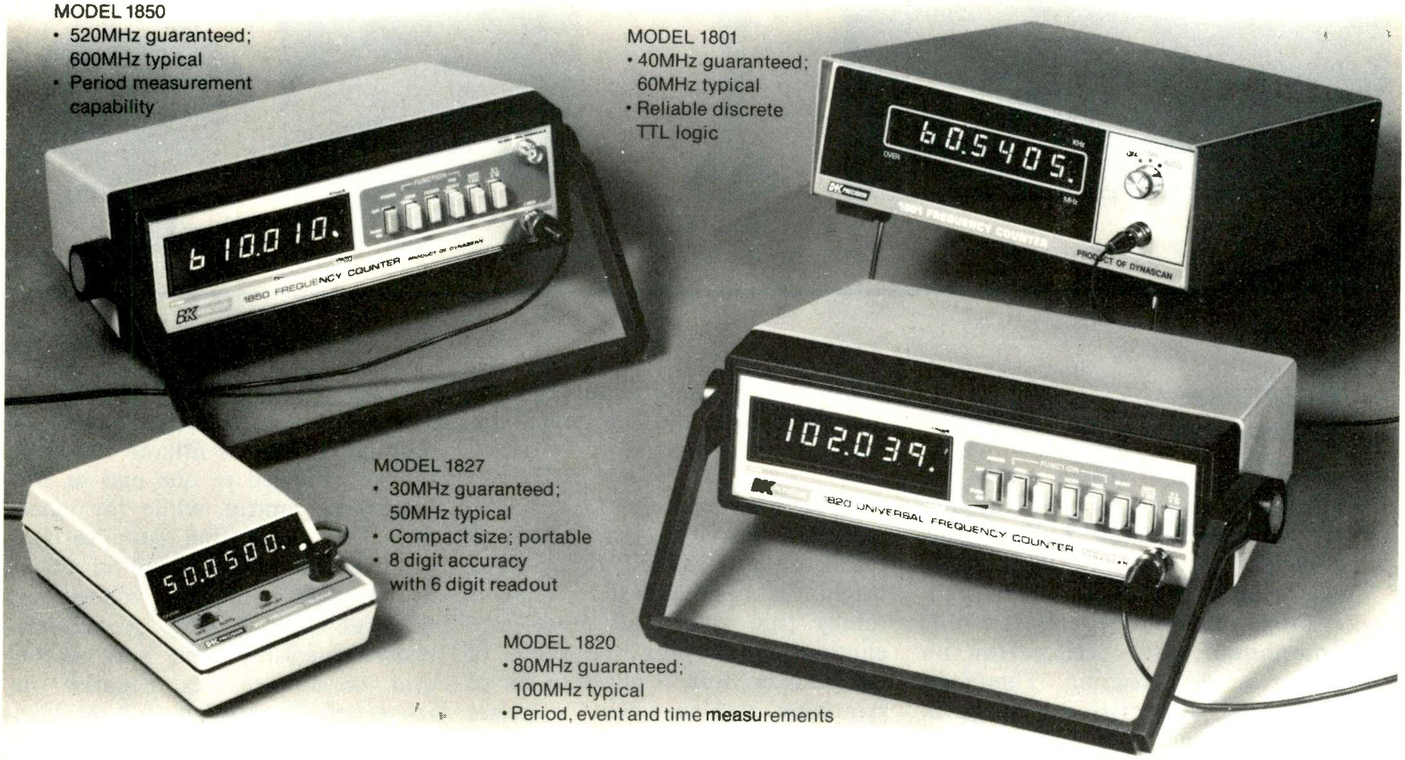

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Circle (15) on Reply Card

Brightness

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direct to ground. Instead each one returns to ground (or B+) through an RF choke and a 3.9K resistor (which is paralleled by the demodulator plate resistance). If this path is broken by an open connection or component, the rectification no longer is peak reading. Therefore, the negative rectified voltage is reduced, along with the tube bias and the brightness of the associated color.

For example, if either L2 or its .01 capacitor in the B-Y stage opened, the tube would lose bias, and the blue gun of the CRT would be biased to cutoff. The open would eliminate all of the "Z" demodulator signal, so a color picture would have only shades of red, green, orange, or yellow. Also, the B&W raster would have a greenish-yellow tint from the lack of blue.

These defects can be intermittent and thus hard to find. The most likely defect is an intermittently-open choke, or a bad solder joint in the path from the grid through the .01, the choke, and the demodulator load.

Symptoms that cancel

I have described how a loss of blanking pulses will reduce the brightness of the raster. That is totally true when the pulses are eliminated following the plate of the blanker. But, a puzzling set of symptoms develop when the pulses are lost at the *grid* circuit of the blanker.

Many of these typical models borrowed a negative voltage for the brightness control from the grid voltage of the blanker. There is no other reason for the connection between the two.

The blanker grid and C6 form a shunt-type peak-reading rectifier for the pulses. (We're ignoring for a moment the effect at the plate). The rectification produces a large negative voltage.

Direct coupling of the video stages creates a need for a negative voltage to cancel part of the positive voltage coming from a previous video stage. Therefore, a sample of the negative voltage at the blanker grid is filtered (R1 and C2) and applied to one end of the brightness control, while the video from the delay line supplies the positive voltage. A blend of these two voltages is the grid voltage for the video-output tube. A cathode resistor furnishes some bias, so the grid often measures negative in respect to the cathode, but positive relative to ground. As this bias is changed by the station signal and by the brightness control, the CRT brightness is changed.

Now, if this negative voltage at the brightness control is removed (perhaps C2 shorts), the grid of the video output receives excessive positive voltage. This reduces the plate voltage, along with the CRT cathodes voltages, and brightens the picture too much.

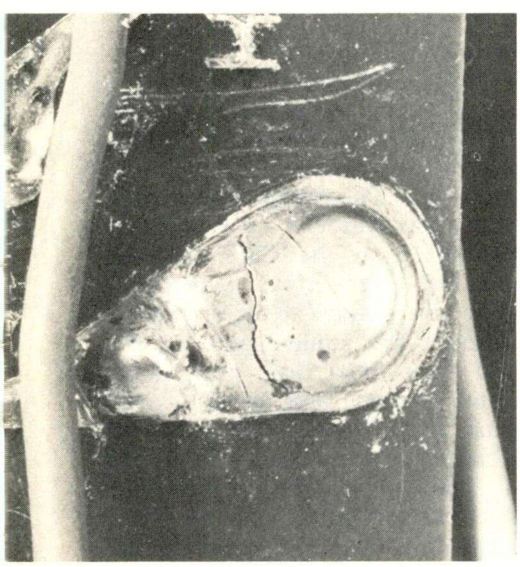
So, we have these two opposite conditions where a loss of pulses at the cathodes of the -Y amplifiers produces a darker picture, and a loss of negative voltage to the brightness control makes the pic-

ture brighter. But, notice that a defect at the blanker grid can accomplish both of these symptoms at the same time! (A gassy blanker tube or a leaky grid capacitor can cause the problem.)

One action tries to brighten the picture, while the other tries to darken it. The net effect is for the **picture to have moderate brightness, poor color, and very little change of brightness when the brightness control is adjusted.**

Follow these operations in Figure 1, and think about the many similar models that can have these peculiar symptoms.

Next, I'll tell you some of the components that have caused low or high brightness in the past.



Grounds of the heater circuit can develop tiny cracks around joints (such as this one) that are difficult to see, but open the circuit. When the board was twisted, the dark crack was visible completely around the rivet.

Actual Causes Of Low Brightness

These various defects have been know to cause low brightness:

- low emission of the picture tube. A good CRT tester is essential, and rejuvenation or a booster often can improve the emission.
- low emission in the video-output tube, which raises the CRT cathode voltages.
- increased value of the video-output cathode resistor or screen resistor. Also, reduced or missing heater voltage at the video-output tube.
- excessive bias at the video-output tube. This can be caused by a defective resistor or capacitor in the brightness circuit; a wrong setting of the brightness range control (if included); a defect in the vertical or horizontal blanking that's applied to a video stage; a wrong negative voltage supply (in this case, the DC grid voltage of the horizontal-blanker tube); or some types of blanker defects. **For example, if C6, the 390K resistor at the grid of the horizontal blanker, opens or increases, the negative voltage there exceeds -100 volts, thus applying too much negative bias to the video-output grid.**
- a weak horizontal-blanking tube, or a changed value of the plate resistor. Also, an open .22 microfarad capacitor (C10) between the blanker and the common cathodes of the -Y stages reduces the negative grid bias of the -Y amplifiers. Incidentally, **a slow-**

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Brightness

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warming blanker tube will give the symptoms of a weak CRT that warms up slowly, with gradually increasing brightness.

- a reduced value of the 270-ohm resistor (R10) at the common -Y cathodes.
- insufficient supply voltage to the screen controls, because of a bad boosted-boost rectifier or an increased value of the resistor between boosted-boost and the controls.
- a weak high-voltage rectifer tube can cause a large and dark picture.

Problems Of Excessive Brightness

The basic cause is easy to state: **Excessive brightness of the picture is the result of insufficient negative bias at the guns of the picture tube.** Of course, the amount of screen-grid voltage affects the brightness, but no practical increase of screen voltage *alone* can produce an uncontrollable brightness, unless the bias is wrong.

Too bright becomes no brightness

The symptoms of excessive brightness are many and varied, depending on the exact conditions and the circuit design. One common problem is that "high brightness" often changes to "no brightness."

Suppose a video defect forces the CRT to draw too much current, and the high voltage is reduced. If the condition stops at that point, the symptoms might be the focus is poor, the visual brightness might be darker than normal, picture size could be too large, and the measured HV might be about half of the usual value. (Some models lose width at the left, rather than showing a larger picture, and many have a vertical roll during times of HV variation.) Whatever the precise symptoms, they change with any brightness variation. Often, a slight increase of brightness triggers blooming, which eliminates the HV and the raster.

This loss of raster and HV can occur slowly, or so fast that it appears to happen instantaneously. Although the defect could be in the picture tube, it's more likely to be located in the Y or -Y amplifiers.

A fast test is to monitor the high voltage with a meter while you remove the base socket from the picture tube. If the HV returns, it's certain the problem is with CRT current (probably wrong bias or gas) and not from the high voltage.

A fine time to check the grid and cathode voltages at the socket is while the CRT is unplugged. This should indicate where to look for the defect.

Peaking coils

One of the most mystifying defects is an intermittent open in the L4 primary winding of peaking transformer T1. An open there removes all DC voltage (except that from CRT current—a negligible amount) from the CRT cathodes and the video-output plate. The grids have positive voltages, and the cathodes are almost zero, so the CRT guns draw their peak maximum current. This current overloads the HV rectifier and the horizontal sweep, thus eliminating all high voltage. The screen goes black without any blooming symptoms. (Sometimes the horizontal-output tube and the damper show dull red plates from the overload.) **DC-voltage measurements are your best bet for finding such opens.** Both ends of a winding should have

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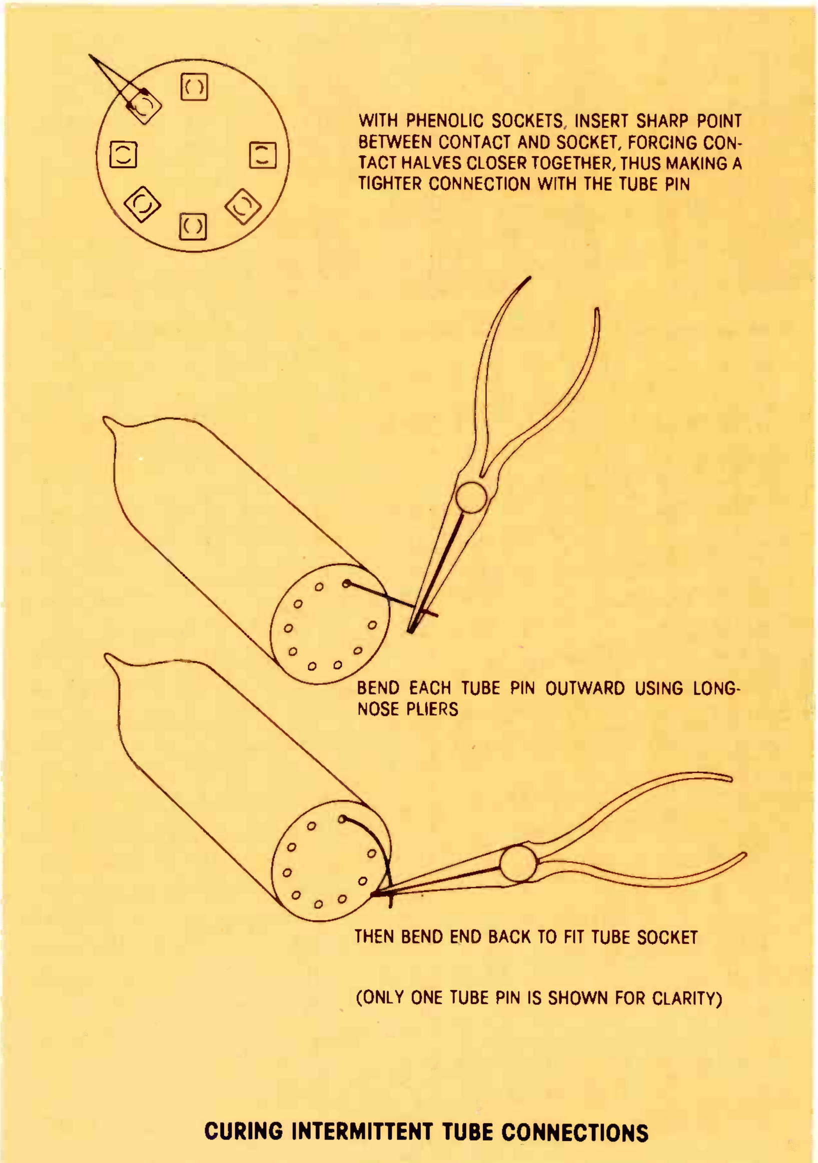
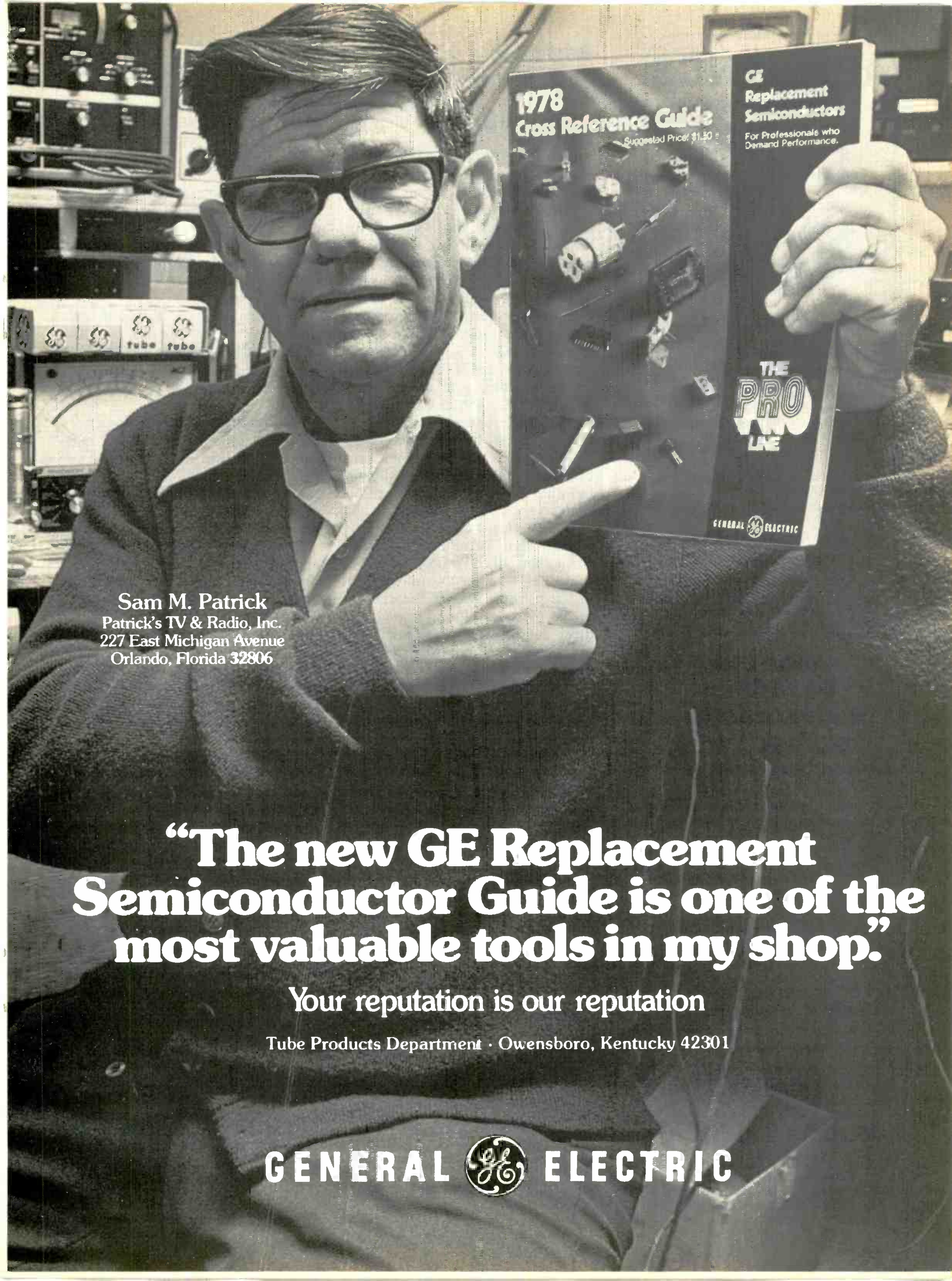


Figure 2 Temporary repairs of intermittent connections between tube pins and the sockets can be done in two ways: by bending either the socket contacts or the tube pins. (Bending of the tube pins has been exaggerated in the drawing, and only one pin is shown.)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Brightness

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the same voltage, unless the winding is open.

Other out-of-the-ordinary symptoms can orginate in this general area. For example, when the L5 secondary winding of peaking transformer T1 opens, the B&W picture has white compression (all brightness ranges from maximum to a medium gray appear as the same featureless gray). It's caused by the video-output plate load increasing from a normal total of about 4K up to about 22K.

Excessive brightness can be caused by leaky or shorted cathode capacitor C5, shorted C2, leaky C1 or C3, and reduced resistance of R16 or R5. If the resistance of R2 is decreased or C4 shorts, the brightness increases only slightly, but the brightness adjustment becomes very critical. (Minor brightness adjustments, or variations of station video, cause blooming.)

Another allied problem can be caused by a heater-to-cathode short in the picture tube. If the short is in the green or blue gun, and *that* drive control is at maximum, *the B&W video is removed from all guns.* Colors are not affected, but the picture is blurred and without contrast. The CRT heater is bypassed by a capacitor large enough to eliminate most of the video, but the brightness does not change much because the CRT heaters have positive DC applied to them. A heater-isolation transformer with sockets can be installed to remove the *symptoms* of such shorts.

-Y brightness problems

With these older receivers the most likely cause of excessive brightness or a blooming picture is a loss of heater voltage to one or both of the -Y amplifier tubes. Receivers of the CTC16 vintage were prone to loss of heater voltage when the heat of some resistors made the insulated heater wire brittle and likely to break. New wire should be installed.

Open grounds are troublemakers, too, both at the board groundpoints and the socket grounds to the boards. Some cracks are too narrow to be seen without magnification. Sometimes the bad joint can be found by flexing the suspected area. However, such bending often moves a joint far from the point where you're flexing the board. A visual inspection with a magnifying glass is highly recommended.

Open sockets produce many service headaches. When no socket is handy for replacement, but you need to verify the diagnosis, you can tighten the connections by bending either the socket contacts or the tube pins (Figure 2). Time test the receiver to see if the problem is cured.

Incidentally, some cases of frequent failure of the horizontal-output tube can be solved by repairing the causes of excessive CRT currents.

Solid-State Comparisons

If the solid-state chroma and video circuits are similar to those of Figure 1 (except for the tubes), you can expect many of these tips and defects will apply also to those receivers. But there are differences.

For example, the heater power of a tube HV rectifier is reduced when the DC load current is increased. For heavy loads, a point is reached where the heater voltage is too small to permit rectification, and the DC HV suddenly disappears. Solid-state triplers have no filaments or heaters; therefore, they keep on rectifying even when the heavy loads reduce the pulse amplitude and the DC-voltage output. There is no *sudden* loss of high voltage. Instead, the operation continues at reduced DC voltages, or until the breaker trips.

Also, many or most solid-state TV receivers have automatic brightness-limiter (ABL) circuits which operate to reduce the CRT current when it exceeds the design maximum. Therefore, it's rare to find a solid-state set with blooming from too much CRT current. Any excessive brightness is opposed by the ABL.

Comments

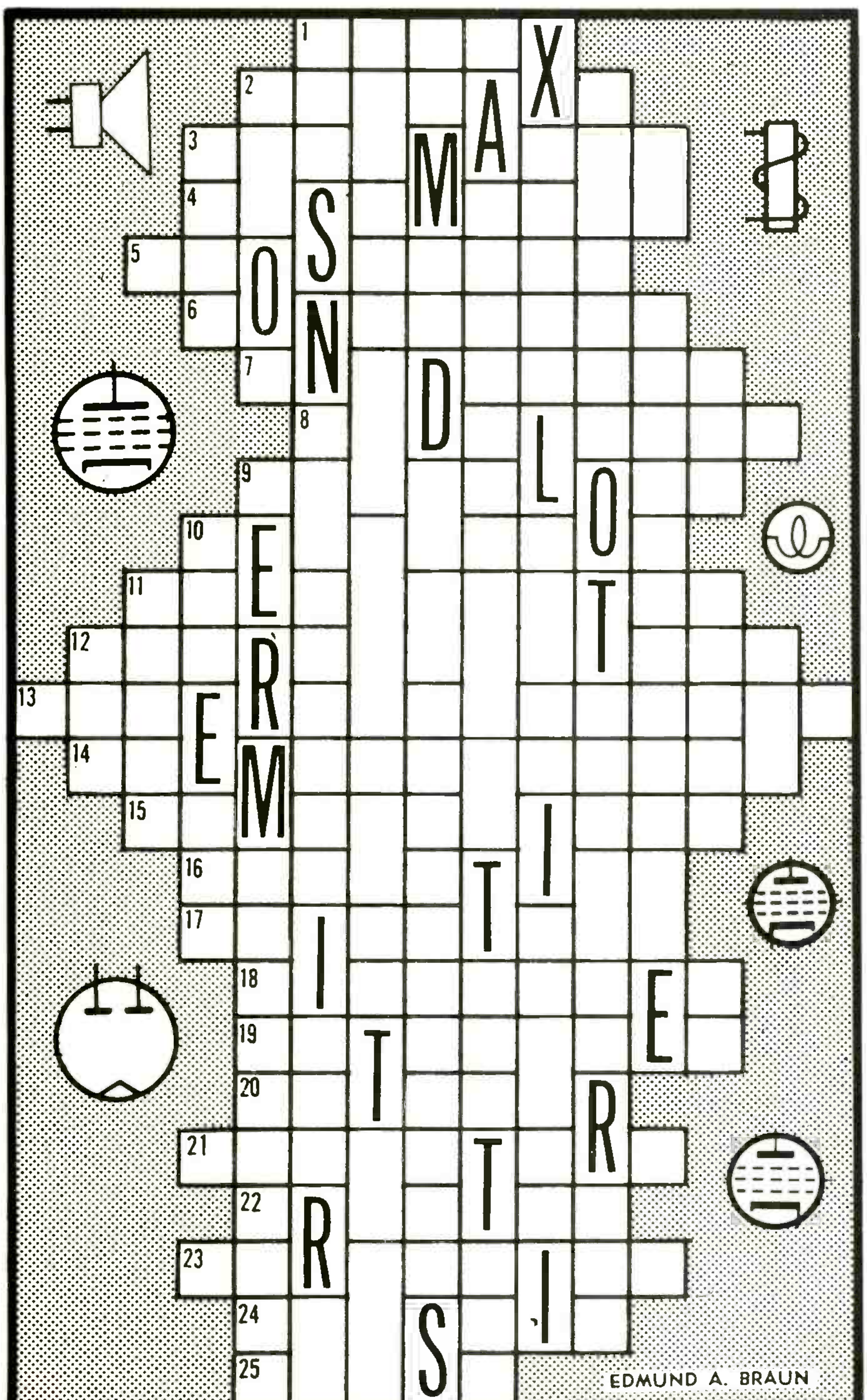
These tips and tests for brightness problems should help you know what type of defects to look for, and inspire you to make up your own test methods.

Write to the editor of **Electronic Servicing** if you have comments, questions, or suggestions for subjects to be discussed. ☐

WATTS COOKING?

by Edmund A. Braun

Here's watt's cooking—a Just-across-word Puzzle based on Electronics. Each word is connected to the word above and below by one or more letters but only one is shown as a clue. Each correct answer is worth 4 points; a perfect score is 100. It'll be fun except perhaps for someone who is sure that "currents" make good pies, or that "kilocycle" is a wheeled vehicle! Got a sharp pencil? Then relax and GO!



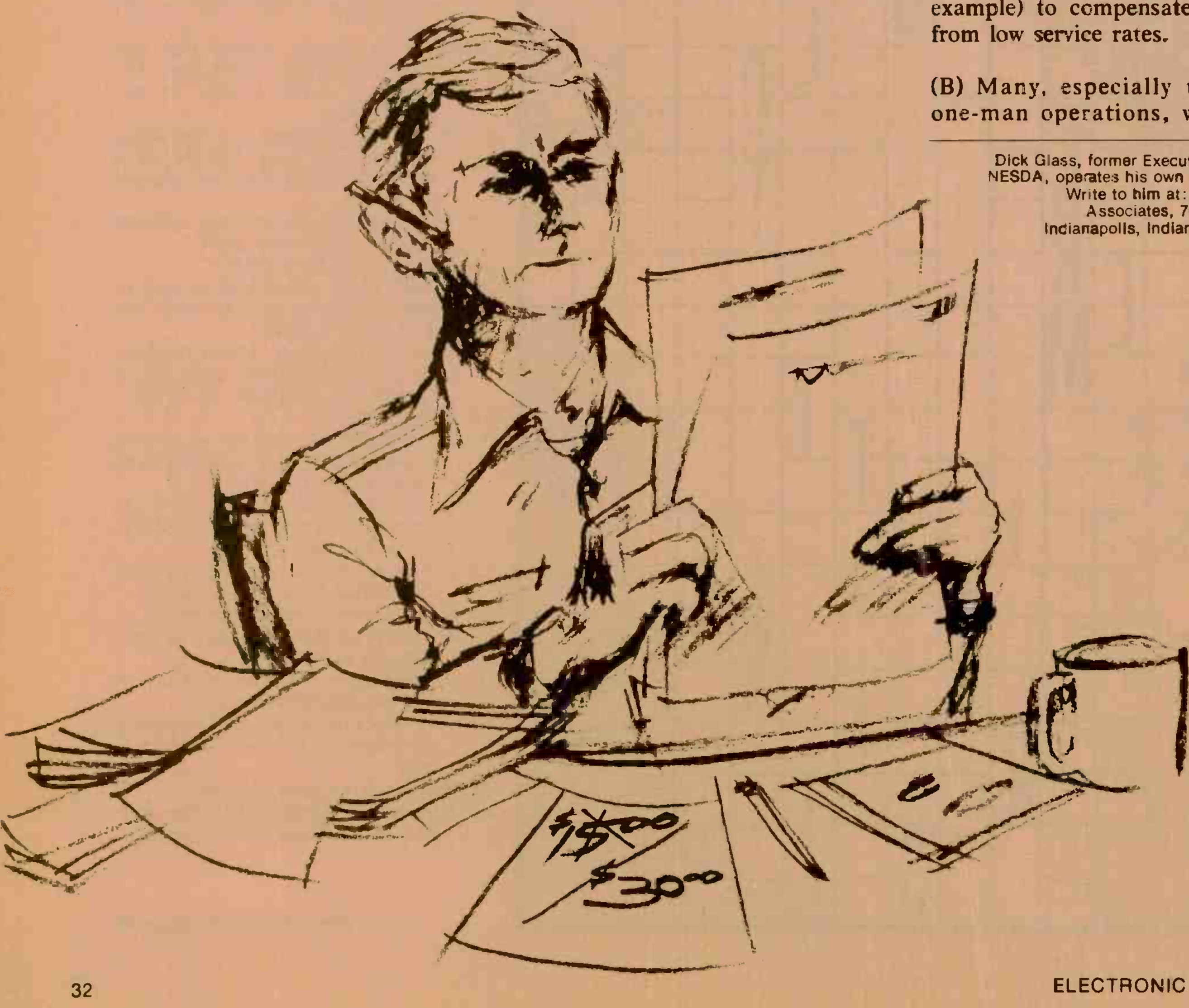
1 A spiral; a coil.
2 Oriented intergrowth between two crystals.
3 A determined computation of probable costs.
4 Already fitted together.
5 Being subjected to equal pressure from every side.
6 Substance able to transmit electricity.
7 Process to improve appearance or corrosion resistance of some metals.
8 Device that alters amplitude or frequency of wave in accordance with speech or signal.
9 Pertaining to propagation of a signal that is abnormal or unusual.
10 Type of rotating device that has two armature windings for changing a DC voltage to another value.
11 Device placed ahead of a frequency converter to pass signals of a desired frequency but reduce all others.
12 Pertaining to "shocking" power produced by water power.
13 A type of radio receiver.
14 Deposition of a thin layer of gas or vapor particles of gas onto the surface of a solid.
15 Balanced; having equal characteristics on each side of a central line, position, or value.
16 Demodulation.
17 An electronic switch in which breakdown of an auxiliary gap initiates conduction.
18 Tough fiber used in sheet form for insulating transformer windings from the core, etc.
19 Points of maximum displacement in a series of standing waves.
20 More efficient type of antenna.
21 Anything represented on a greatly reduced scale.
22 Pertaining to a circuit that is etched instead of wired.
23 The suppressing of undesired modes of oscillation in a magnetron.
24 The frame or base of a set.
25 Angular relationship between current and voltage in AC circuits.

See solution on page 66

Service Management Seminar, Part 5

(Establishing Service Rates)

Guessing about how much to charge for service can cause endless worry and problems. Methods are discussed for determining service rates that are profitable to you and fair to your customers.



Pricing Problems

Few service dealers know their actual costs of service calls, bench repairs, and other types of technical work. In fact, many shop owners, who calculated their costs, have discovered to their dismay that they are operating "below cost."

Of course, no business can continue very long when its prices are lower than the costs. So, one of the first thoughts which occurs to a shop owner, after the figures prove his business has been operating below cost, is that the figures or the method must be wrong. After all, the business continues to operate. Does this prove a mistake has been made? No, the answer is that the losses must be made up elsewhere.

Operating below cost

Here are several ways for a business to continue supply service work at prices below cost:

(A) Some shop owners rely on profits from product sales (TV receivers, tubes, and accessories, for example) to compensate for losses from low service rates.

(B) Many, especially those with one-man operations, work extra

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long hours for labor income that's comparable to others who work only 40 hours a week.

(C) Service shops limping along with below-cost prices often don't provide funds for retirement, vacations, sick pay, or insurance. Most businesses provide these for both owner and employees, and such fringe benefits can add 10% or more to the real income.

(D) The owner of a small shop might have his wife act as business manager and office girl, but not pay her enough (or anything) for her important help.

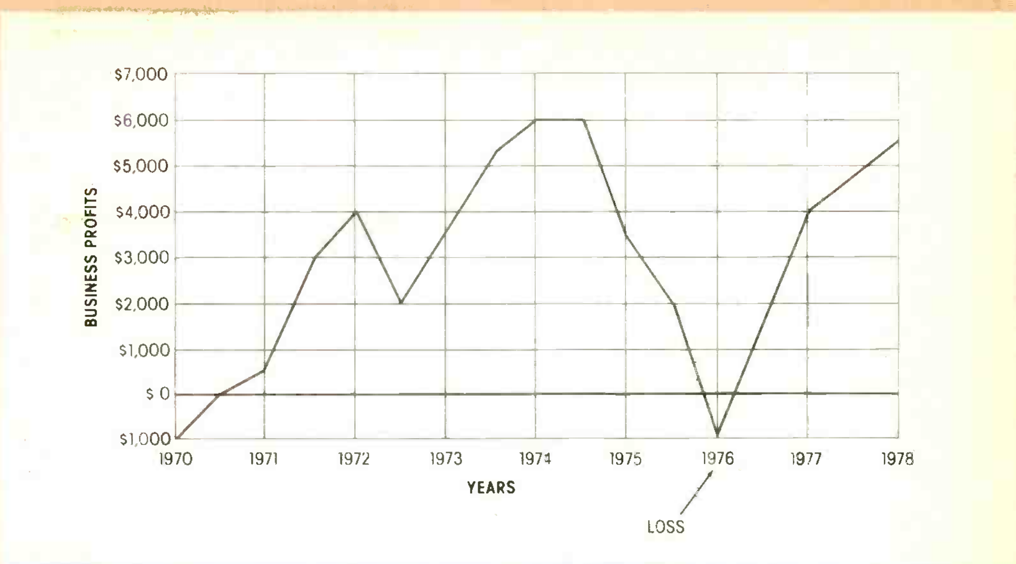

Figure 1 All businesses have variable profits (or losses—see 1976), and a "business profit" fund should be set aside to fill in during low-profit times.

False reasoning

Why do shop owners continued to price their services below cost? Here are some of the reasons:

- Their prices are comparable to other service shops in the area. They assume, therefore, that if the others can make a profit at those low rates, then they too should be able to have a profit. (Actually, *all* of the servicers in the area might be operating below cost.)
- They assume their bargain rates will induce the customers to like them, and perhaps buy some new products from them, thus making a profit.
- They privately believe their technical ability must be low; therefore, it's best to reduce the labor rate. Probably they downgrade themselves because of the many "tough dogs" that require many hours to solve. Perhaps they believe, "After all, I can't charge the customer the full rate for repairs that take many, many hours."
- They are afraid their customers won't pay any more than the present rate. In fact, some gripe now about "exorbitant" prices, even those that actually are below cost.

Everyone has heard these reasons (excuses), and they sound plausible. But are they valid?

One example

Recently I visited a service-only shop whose regular charge for a TV service call is $15.00. Yet, less than a two-hour drive away are other shops regularly charging twice that rate. These other shops are just as busy.

Here are some conclusions to be made about $15 service calls:

- An average service call takes one hour (including travel), so the shop never can receive more than $15 per hour of income.
- If the productivity is 50% (high for most one-man operations), his per-hour rate can average only $7.50.
- Even if the shop had no overhead costs (rent, heat, telephone, etc.), and didn't expect any business profit or return on the investment, this technician/owner could not make more than $7.50 per hour. Yet, many techs who work for someone else make that much, without investment or worry.
- With ordinary overhead costs, this shop would find great difficulty in paying its owner as much as $5.00 per hour. At that rate for 40 hours per week, he could make only about $10,400 per year. And, the financial problem is compounded, if his wife—or a hired assistant—takes care of the office while he's out on calls. This requires him to make several more dollars per hour to pay the helper.
- Profit from parts sales can help subsidize the below-cost labor rates, but one man rarely can sell more than $10,000 in parts in a year. If he were to clear 50% for parts sales, it would bring only $5,000 more in gross profit.

How much should a technician employee make?

The salary or "draw" of the technician who brings in the labor income is a large factor in determining service rates and profits. Therefore, the question of salary is very important in the present industry situation.

Today, technicians often are being hired at $8.00 per hour ($16,640 per year), with service managers receiving more. And it's still unusual for a shop-owner/technician to realize more than $25,000 per year. But even these insufficient rates are better than those of the past when techs were at the bottom of the economic order.

Compare those rates to a journeyman union electrician who makes more than $10 per hour plus benefits ($20,000 per year) almost anywhere. An IBM typewriter repairman does almost as well.

Electronic technicians must have far more training, knowledge, and experience than any repairman or electrician. In fact, their training never ceases. So, it seems that a technician should command a *higher* salary than those of lesser skills. The question is not, "**Should** techs make $25,000 per year?" Rather it is, "**How can** a tech make $25,000 each year?"

Many people end a discussion like this one by saying, "Customers just won't pay that much." If you believe that—as many impoverished service dealers and techs do—you are exactly where the customers want you to be. You're trapped! And, it's useless to dream that you later will make more money if competition eases, or you sell more

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Per-Hour Labor Charge Calculation
One-Man Shop

Technician wages (1)	$8.00	
Overhead Expenses ($10,000 ÷ 2080 hours) *	$4.81	* calculations based on 40-hour week, or 2080 hours per year
Return on Investment ($10% of $10,000 total investment)	$0.48	
Business-Profit (5% of $30,000 total sales)	$0.72	
Total income needed per hour	$14.01	
Total income needed per chargeable hour, if productivity is 50% ($14.01 ÷ .50)	$28.02	

Table 1 This is the method for calculating the labor income you need per hour in a one-man shop. All expenses (wages, overhead, ROI, and business profit) are reduced to the cost for one hour (out of 40 per week or 2080 per year) and added. This is the income per hour you need, **if** you could be 100% efficient. Since that is impossible, you must multiply by your productivity percentage (in decimal form), to obtain the income needed from **each hour of chargeable labor.**

Service Management

continued from page 33

products, or you become faster at making repairs.

A Better Solution

No, there is a better plan that will bring you more income now. The plan involves calculating your costs, setting some profit goals, and getting rid of your fears.

Perhaps, you now are thinking, "Sure it's easy for Glass or someone not in my position to say that. But, I can't take the risk of losing the business it's taken years to build up."

The good news is that servicers who established realistic service rates didn't take any risks at all. Invariably, they found their fears to be unfounded, and they wished they had taken the step before.

Also, there are no known cases of realistic pricing causing the failure of a service shop. There are hundreds of businesses which failed from too-low prices.

Get started

After you have set some profit goals according to our previous advice, now is the decisive time to review your service rates. Find out what your rates *should* be. Of course, no one will force you to raise your rates. But you owe it to yourself to determine what they SHOULD be.

If you examine your costs and then realize your charges are too low, you don't have to raise them in one large jump. Instead, you can change them a step at a time. For now, you need to understand HOW to set your rates. It's much easier to justify your higher rates—both to yourself and to your customers—after you know that the method and the pricing results are valid and correct.

The Ingredients Of Your Charges

These costs must be included in your prices:

1. technician's wages;
2. overhead expense;
3. return on investment;
4. business profit; and
5. the productivity factor.

Each of these will be discussed in detail.

Technician's wages

You must pay a technician to produce service income. It makes no difference whether the tech is you or an employee. One or both have to do the work, or no income is produced. Your shop's costs can't be calculated without including an "equivalent" technician wage for those hours you spend doing repair work. Some shop owners fool themselves by not including the cost of their own direct labor production. Of course, if you are an absentee owner, your compensation should not be included with the direct labor. But most shop owners are technicians, and they should receive at least $8 per hour for their repair time.

Overhead

Don't include technician wages or parts costs in "overhead" expense totals. Overhead is the operating expenses your business must pay, such as rent, utilities, truck expenses, insurance, advertising, and so forth. Service-only shops commonly have overhead totalling 40% of income. Some have overhead as high as 50%.

Many bookkeepers don't list the owner/manager salary properly, thus disguising either the true overhead cost, or the true direct-labor cost (or both). If you are not sure how this should be handled on your books, refer to Part 3 in the March issue of **Electronic Servicing.**

Return of Investment

Few shop owners ever think about or calculate the amount of money they have invested in the business. But, if you borrowed $10,000 to buy parts or test equipment, you surely would pay about 10% ($1,000) annual interest for the use of that money. In the same way, if you "loan" your business $10,000 of your personal money, you certainly deserve the same amount of interest. This is "return on investment." You're just cheating yourself if you invest your money and don't expect interest.

Inflation alone will decrease your investment by 6% to 10% per year, so a modest 6% or 8% return-on-investment merely keeps up with inflation, without permitting any interest.

You MUST calculate the "cost-of-money" and include it as a factor when you set realistic service rates.

Business profit

"Business profit" is not the same as money made by the business, and which goes into your pocket.

No business ever operates at constant levels (see Figure 1), but has ups and downs. Therefore, you must hold in reserve some business profits to pay the bills during low periods. Otherwise, you are forced to borrow, or take money from your personal bank account. Even if your plan calls for a business profit of only 5% of total sales, you must include this in your costs and in your prices.

Productivity

Productivity really isn't a direct factor in your costs. But after you settle on the per-hour income that you must have for each hour your doors are open, your per-hour income MUST be divided by your productivity percentage (as a decimal) to establish your actual service rate. It's not enough to calculate what you *need* per hour and "hoping" you will get it. Think of the many hours of "lost" time (answering the phone, talking to customers, etc.). Everyone from farmers to General Motors includes lost time in the price of the products, and so must you.

Table 1 first shows how to calculate the per-hour income needed when the productivity is 100%. Then, that figure is divided by the actual productivity as a decimal to show the rate for each *chargeable* hour.

Is your shop 75% productive, rather than 50%? That's good, and the increase poses no problem. In Table 1, divide $14.01 by .75 instead of by .50. This gives $18.68 as your per-hour service rate, instead of $28.02.

The calculation shows how productivity affects your rates. In the past, few servicers included it in the charges. Probably this error accounted for most cases of poor service income.

Including the productivity percentage becomes even more important when you learn that many shops average only 30% to 40% productivity. Change the productivity percentage in Table 2 to 30%, and you would have to charge $46.70 for each productive hour to average $14.01 for the 40 hours of each week.

Or, looking at the problem from another angle, a shop charging $15 per hour at 30% efficiency could bring in only $180 in 40 hours, or about $4.50 per hour! Sometimes this happens to new shops.

Two-Man Operation

Now that you know the basic ingredients of your per-hour charges, let's examine the differences between the one-man shop (Table 1) and a two-man shop (Table 2).

Notice that the overhead and the total investment both increased by 40% because of the additional technician. However, the increased volume of business allowed a per-man reduction of the return-on-investment (ROI), the overhead, and the business profit.

Also, the second technician receives only $7 per hour, compared to $8 for the owner. (In a partnership, both probably would receive $8 per hour, or whatever rate was agreed on.)

For practice, you should make the calculation of Table 2, but changing the wages to $5 and $4,

continued on page 36

continued from page 35

with a 40% productivity. The per-hour rate will be given at the end of this article.

After you have become proficient with the method, calculate the rates for your own shop, using the actual costs of wages and overhead. Include the return-on-investment you want, based on your actual investment. If you don't know your investment, figure it now. Add a business profit that you think is reasonable to cover the low periods. All of these items together make up the amount you *would* receive for each hour of labor, if your productivity were 100%. Because 100% productivity is impossible, you then divide that figure by your productivity percentage (expressed as a decimal) to arrive at the hourly rate you MUST charge, if you are to reach your goal.

Flat-Rate Pricing

Many shops use flat-rate pricing rather than hourly rates. That practice does not conflict with the principles given here. After all, these "flat rates" are based on some hourly figure determined by you. If you charge $20 for service calls and $40 for bench major repairs, you are working on a $20 per-hour rate.

So, if you prefer flat rates, determine your needed hourly rate and set the flat-rate prices for this rate versus the amount of time you estimate (or obtain from a time study) each particular job will require.

Sperry and Tech Spray pricing

Two different pricing systems are available to servicers who want to price repairs by the hours worked. The Tech Spray and Sperry Tech systems both work well for applying your hourly rates to the work functions.

Either system can be converted to flat rate. However, **I don't recommend flat rates.** Most servicers who solved both complaints and profit problems believe that an "increment" system based on a definite hourly rate is best.

Comments

Of course, you understand that the amounts used in Table 2 are only for an example, and your figures are expected to be different. You should expect more than 10% return-on-investment. If I were doing it, I would try for a larger business profit than the example of 5%. And of course, if both techs are experienced journeyman-level craftsmen, they should be receiving more than $7 to $8. Only you can determine these figures, and include them in your rates.

Some shop operators will feel the amounts in Table 2 are too low; others probably will believe they are too high. Two conditions can reduce the hourly rate: (1) The techs could work longer hours. In a partnership, the owners could agree to not accept overtime pay. (2) Parts profits could be included. (Many managers insist parts profits should not be a factor in labor rates.) In this example, profits from combined parts sales of $10,000 a year could be used to reduce the labor rate by $2.40 per hour. It's your decision whether or not to make these concessions.

Practice calculation

For the practice calculation of the two-man shop labor rate, you should have an answer of $22.06 per hour per man.

Per-Hour Labor Charge Calculation
Two-Man Shop

Technician wages (2)	$15.00	
Overhead expenses ($14,000 ÷ 2080 hours)	6.73	
Return on Investment ($15,000 total investment) *	.72	* 10% of $15,000 = $1500; $1500 ÷ 2080 hours = .72 per hour
Business-Profit (5% of $50,000 total sales)	1.20	
Total hourly income needed for 40 hours per week	$23.65	
Total hourly income needed for 40 hours per week, per tech (½)	$11.82	
Total chargeable hourly income needed, if productivity is 50%	$23.65	

Table 2 The method of calculating the per-hour labor income of a two-man shop is similar to that in Table 1, except the first figure is the income needed for **both** men, if they were 100% efficient. This figure should be divided by 2, giving the per-hour 100% labor income for each technician. Then, it is multiplied by the productivity percentage (in decimal form) to show the **per-hour chargeable labor of each man.**

Next Month

The "building-block" (or Nesvik) system described in this article is a good method that's sufficient for you to establish new rates or rework old ones. And I strongly urge you to make the calculations and evaluate the results.

However, there is another system (I will describe next month) that has some advantages.

Regardless of the method you use for determining your labor pricing, you should understand it thoroughly, know why every item is necessary, and believe in the rate. When you *know* the price rate is fair to both you and your customers, you will win every discussion about prices!

Remember, to reach that goal of $30,000 (or whatever amount you chose), you should not depend on good luck to solve your problems, but you must plan wisely and work with single-minded purpose. One vital step is calculating your proper service rates. □

Sam Wilson's Technical Notebook

4

By J. A. "Sam" Wilson, CET

Letters

I have received some interesting mail about the capacitor quiz and some of the statements I made in the February Technical Notebook. Many readers agree with me, and—as might be expected—a few disagree. So far, the letters have been professional, with clearly stated ideas. Therefore, I'm going to answer those letters that are of interest to many readers, and also to expand the theory of capacitors.

Ground rules about letters

Here are a few of my rules about letters. If I feel that my reply might embarrass a letter writer, I'll not give his name.

A time delay of two to three months is necessary before your letter can be answered in print. Each issue of the magazine is in production for two months, and mail deliveries require several days.

I'll only print excerpts from the letters, for space will permit no more.

If these rules don't present any severe problems, then I will enjoy exchanging information with you.

Impossible Capacitor Charge?

A Texas gentleman expressed several comments in his letter, including this statement, "You are wrong!" Now, I want to dispel that idea, immediately. The *only* time I was wrong was the time I thought I had made a mistake! (That should keep the mailman busy.)

Specifically, he was disagreeing about Question #2 about the metal pails that were nested one inside the other with a pail of dielectric between them, as shown in Figure 1. I had explained that after the capacitor is charged and the pails are disassembled, the metal pails (capacitor plates) could be touched together without discharging the capacitor. After the capacitor is assembled, the charge still remains.

This question bothered several letter writers. Perhaps I should point out that I have an advantage over the Texas reader, because I have performed this experiment probably 200 times as a demonstration to my classes. After seeing it work as described for 200 times, I believe it is true, despite the number of people who said it couldn't work that way.

However, the confusing thing about the Texas letter is that the writer and I are in violent agreement, but he seems to ***think*** we have a difference of opinion. I'll quote from the letter: "It is misleading to think that the 'energy in a capacitor is stored in the dielectric,' as you say in the article, and as I've read in many other books at this level. The energy stored in the capacitor resides in the electric field that's between the plates." I certainly have to agree, except to point out that the electric field is in the dielectric **between the plates,** and that's exactly what I said.

(Incidentally, I have written a short technical monograph entitled, "Why Johnny Can't Understand Capacitors." In it, I discuss with greater detail the relationship of the dielectric and the electric field to the capacitor.)

There was one statement in his letter that's not true, however. He

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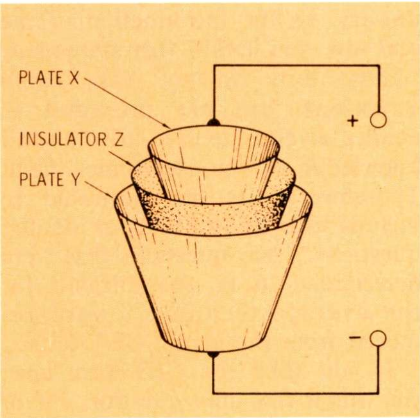

Figure 1 Construct a capacitor with three pails, two of metal and one of a high-voltage dielectric material. Charge the capacitor with a high DC voltage (to compensate for the low-capacitance value). Use insulating sticks to disassemble the pails. Short the two metal pails together (this should discharge the capacitor, **if** the charge is in the air between the disassembled pails). Reassemble the three pails, and check for a charge by using a shorting bar (with a well-insulated handle). A large arc when the shorting bar is connected between the two metal pails proves the charge is in the dielectric material. This drawing and the explanation were in the October and February magazines, also.

Sam Wilson's monthly "Technical Notebook" will present a variety of subjects and ideas. Sam has strong opinions, and possibly some will provoke conversation and controversy. The ideas and opinions of this column are not necessarily those of the editor or other employees of Electronic Servicing.

Your letters are welcome, so long as you give us permission to quote from them. Address all letters to:

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Technical Notebook

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says, "If you remove your insulating bucket and examine it, you would find it no different from any other piece of the same material." Having done this a number of times, I can tell you quite authoritatively that the insulator is very highly charged. And, when you handle it, the hair on your hand stands right on edge.

Excuses?

One reader living in North Carolina was very glad to see the quiz, because it gave him an excuse for having failed the CET examination. He wrote, "No wonder I have not been able to pass the ISCET test. You have done a lot of research and have ideas and knowledge the average technician never encounters."

I'm sorry, but he must look elsewhere for an excuse. First, the quiz questions in the article either were never used in the actual CET tests, or were used for a time and then withdrawn because I felt they presented unfair traps for the unwary. In the introduction of the real test, you'll find this statement: "These tests do not have catch questions, but are intended to evaluate the tech's all-around knowledge of the electronics field. Therefore, it is not desirable to include little-known facts or slanted questions." Any questions that were determined to be too difficult for the average technician were removed from the actual CET tests.

If you take the CET test now, you *might* find one question out of 75 that is related to the questions in the magazine quiz. If you miss only that one question, your grade still would be 98.6%. So, if you fail, there must be many other things that need to be learned or reviewed.

When I first started writing CET tests (about 1970), there were some complaints that the tests were too "academic." The protesters knew I was a college professor, so the complaints actually were aimed at me, rather than at the test.

After having heard this complaint over and over, we gave the test to a group of college professors. The failure rate among the professors was much higher than the technician's failure rate! That's not surprising, for the test is designed for *technicians*, and many questions can be answered from their practical experience without a knowledge of theory.

While I'm discussing the CET test, I'd like to say that the purpose of the whole CET program is to give technicians feelings of pride in their ability. When you pass the test, you're saying to the world, "I'm proud to be a technician, and proud of my electronic knowledge."

However, I'm opposed to technicians using the CET test or rating as a form of snobbery against fellow technicians. Many top-level techs in this country are not CETs. That does not reflect on their ability or knowledge. It means simply that they have not yet decided to take the test. Even so, I believe they *should* try the test, both to upgrade our industry in the eyes of outsiders, and to increase their pride of being a technician.

For Future Reference

Ddlitz Servis of Ellabell, Georgia, sent an interesting and informative letter about the relationship between the capacitance of a variable capacitor and the spacing between the rotor and stator plates.

Thanks, Mr. Servis, I'll use the information in a future article.

CET Options

In a letter from Mason, Michigan, J. Ramey asked for a list of options available in the CET program. At the present time, there are Consumer Electronics (radio and TV); Industrial Electronics; Communications; MATV; Audio; and Medical Electronics. I sent Mr. Ramey a list of the "CET Practice Tests" available in my monograph program.

Information also was sent to Frank Quackenbush of Canajoharie, New York.

No B + Voltage?

An interesting letter came from Barry C. Duncan of Rampoul, Illinois. It concerned Question #8, which is repeated here.

Question #8

In the tube circuit of Figure 2, the plate current of the amplifier tube has been cut off because of the open cathode-bias resistor. What approximate voltage should you expect to measure with a VTVM from cathode to ground?

Duncan and his boss tried an experiment by wiring a tube without a cathode resistor, and then measured the cathode-to-ground voltage. He measured a higher-than-normal voltage, but not so high as B+.

Mr. Duncan, I'm sorry you did not include the details of the experiment you conducted to

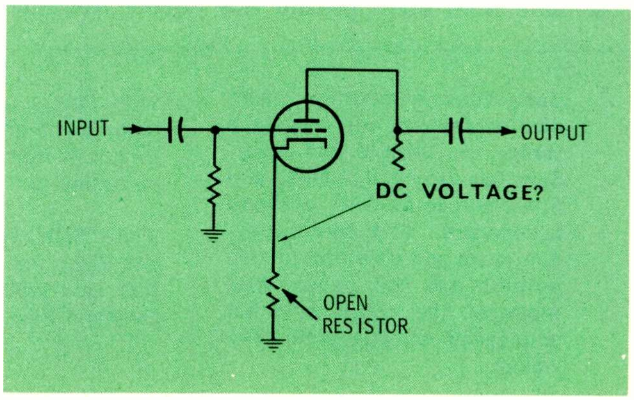

Figure 2 In the Technical Notebook for February, the question was asked: "What approximate voltage should you expect to measure (with a VTVM) from cathode to ground?" Study the next two figures, think about the theory, and simulate the problem. More information will be given, perhaps next month.

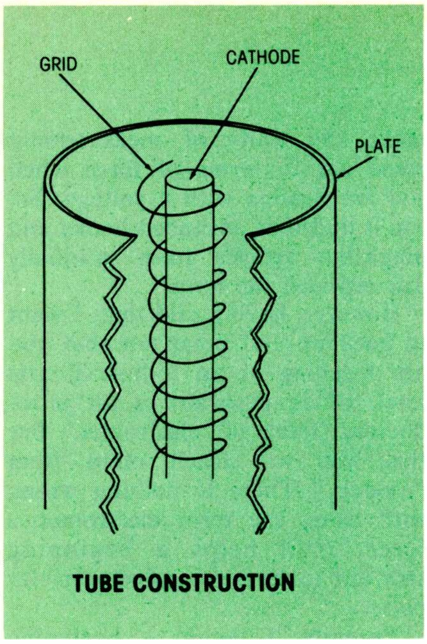

Figure 3 Internal capacitances exist between the elements of tubes. Can these capacitances function as uncharged capacitors, when the cathode circuit is open?

demonstrate (or refute) the high cathode voltage.

This won't work properly with just any type of tube. For example, a tetrode or pentode should not be used, because the screen acts as a Faraday shield between the plate and the cathode. Certain tubes with closely-spaced grid wires don't work well either, because of the shielding effect. Also, a high-impedance meter (11 megohms or higher) is absolutely necessary (otherwise the circuit isn't really open).

However, the question was not meant to imply that you *always* will measure B+ voltage at the cathode. The construction of a triode tube is somewhat like the drawing in Figure 3. If the capacitance is large enough (as it is with some triodes), the tube will behave in the same way as the uncharged capacitor in Figure 4, which passes voltage and current *until* it becomes charged.

Think about all these things. The results of some practical experiments will be given later, along with full schematics and readings. Is the cathode voltage caused by the unchanged-capacitance effect, or does it result from the tube conduction through the test meter? Or both?

In the meantime, thanks to Mr. Duncan for the letter.

"Sock Them Basics To Us"

In a nice letter signed as "Rapid Roy (WA9JA0)," R. B. Delange asked several questions. First, he wanted to know why an AC motor heats up excessively when the line voltage is low, even if the motor is not loaded to capacity.

Low line voltage decreases the field current, thus greatly reducing the counter EMF (voltage) that is generated by the rotating armature. This counter voltage limits the current through the armature. So, when it is abnormally low, the motor current becomes excessive.

The second question was, "What system do you use to index your own technical library?" I have more than 7,000 pounds of books (determined by weighing them the last time I moved). I use the "Hunt" system. When I want to find information, I just hunt and hunt and hunt. Sorry, wish I could have given you more help.

He also requested the name of a good one-source reference book about industrial electrical systems. Unfortunately, it's difficult to recommend just one book. Not all people are searching for the same information. I like my books laced with heavy portions of math, but this might not appeal to you. Some want theory, others want troubleshooting ideas. I doubt that it's possible for one single book to give you all you want.

I firmly believe in keeping a notebook for information that's interesting to me. In this way, I have accumulated a large amount of the data that I want. Also, I include notes listing the books which cover each subject. Perhaps you could begin a similar system.

Arturo Arauco of Chicago, Illinois, wanted me to recommend a book about integrated circuits. Howard Sams sells a series of "Cookbooks" about both linear and digital types, and I recommend this series. However, if you want engineering data or troubleshooting suggestions, you'll have to look elsewhere.

Incidentally, when I teach integrated circuit logic at a beginners level, I always recommend *How To Use Integrated Circuit Logic Elements* by Jack Streeter (Howard W. Sams book number 21081).

Kudos From Chicago

James W. Warner of Chicago, Illinois, sent a complimentary letter. He said, "Just received my issue of *ES* and have read and studied your 'Notebook.' I have but one word for it: 'excellent.' Thank you and keep up the fine work."

Warner went on to say he's 64 years old and works with audio equipment. In conclusion he said, "I don't ever expect to be a CET, because of the depth of knowledge required, but at my age I have enough to keep me busy." I think you are too modest, Mr. Warner. Many technicians told me after they took the test that they were surprised by how easy it was. I'm sending you a complimentary copy of my "Audio CET Practice Test." If you can answer more than 50% of the questions in the practice test, I would advise you to try the real test. Thanks for the letter.

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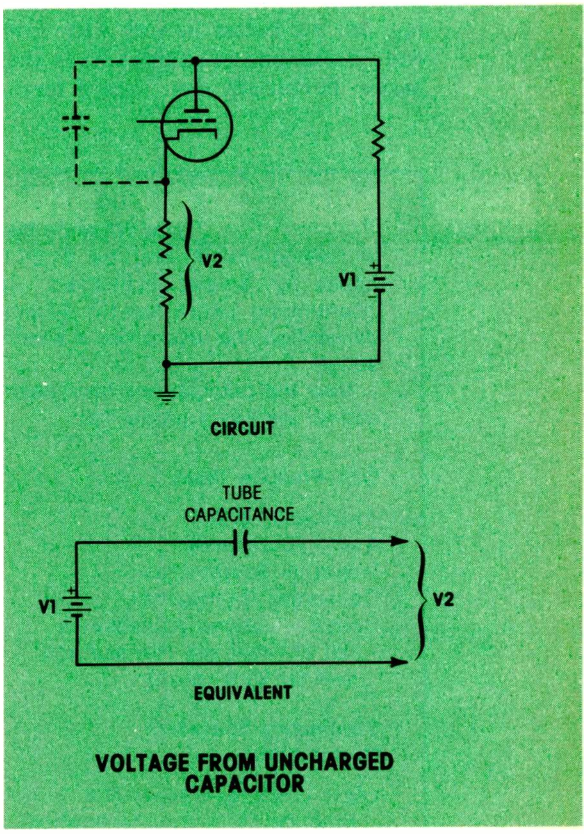

Figure 4 Can the grid-to-plate capacitances act as an uncharged capacitor, providing DC voltage from cathode to ground? If so, how long does the voltage remain at the cathode?

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Microprocessors

Terry A. VanKaughnett of Raleigh, North Carolina, asked for a series of articles about microprocessor systems. In my series about Basic Industrial Electronics, logic circuitry now is being discussed, and microprocessors will be analyzed in the near future. At the present time, I'm laying the groundwork for an understanding of microcomputers.

The Industrial Electronics series in this magazine explains digital circuits based on TTL logic, and eventually will cover the 8080 and Z80 microprocessors. On the other hand, my technical Monographs approach the subject using CMOS and the 6080 microprocessor series. Except for that basic difference, the articles and the monograph follow parallel paths. I believe that it's essential for technicians to know *both* systems. However, my experience has taught me that jumping back and forth between TTL and CMOS (and their respective microprocessor types) tends to be confusing. So, it's better to stay with just one system long enough to learn the basics. Eventually, you should learn the other system, and become proficient with both.

Whatever Happened To Electromotive Force?

In a letter, Adolph Krauz of New Hyde Park, New York, asked me about the term EMF. I had said in my article that the term EMF is deprecated, and that "voltage" should be used instead.

Krauz said, "I teach electronics at the Industrial Arts level in public high school. And yes, I still teach that EMF is what pushes the electrons. The very latest texts published by Goodhart Wilcox, *Electricity in Electronics* by Gerrish/Dugger and *Electricity And Basic Electronics* by Stephen R. Matt (copyright 1977), both concur with my belief. If, however, you are right and we are wrong, I want to know about it. As a teacher my information must be correct. Please supply me with references in your reply."

The term **electromotive force** now is in disfavor, especially in the higher levels of text material. Voltage is not a force, instead it is a unit of work. In the mathematics of electronics, it is not possible to make the units of measurement come out in terms of force when you are dealing with a voltage. So, you'll find that advanced books and magazine articles have gradually discontinued the term.

However, having said that, I want to back up and point out that you are teaching at an industrial arts level, which generally is an introductory level of electronics. For this, you will teach often from "models." There is nothing wrong with using the term electromotive force, *if* it helps a beginning student to understand electricity better.

Recently, I taught a beginning electricity course to a group of mechanical technicians from a local industry. I used the old, but effective, analogy of the water-and-pipe to explain how the electricity is moved by the pump called voltage.

Also, when I teach basic electric circuits, I continue to chase the electrons through the circuit. For this level, and the one you are teaching, the difficulty is motivating the students and capturing their interest. It is important to get them quickly to a point where they can perform some simple laboratory duties. At that time, there should be no detours into the more-advanced concepts of electronics.

I'm sure that Mr. Gerrish/Dugger (whom I know personally) and Stephen Matt were fully aware of all this when they wrote their books.

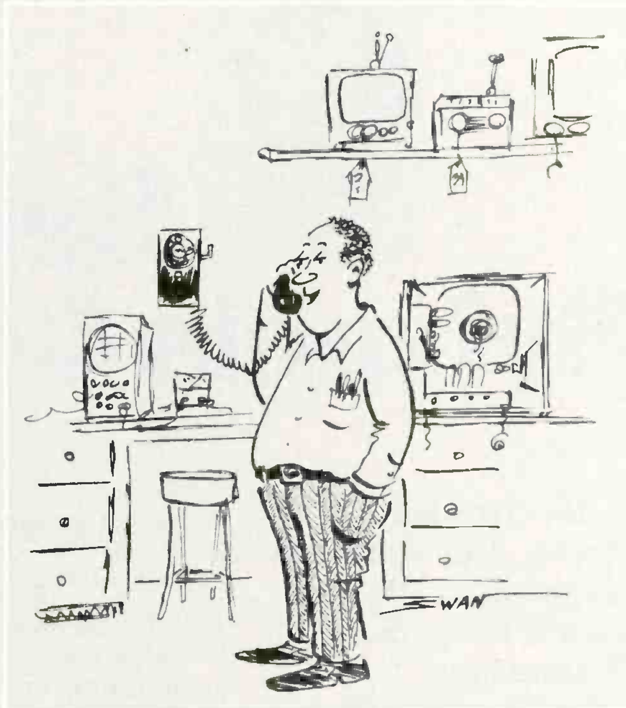
One more remark: teaching from models and analogies is an excellent technique to help beginners to understand. But all models have definite limitations. So, all you teachers and instructors, *please* hint to your students that later they must advance beyond models and learn more of the actual truth about electronics.

Next Month

In the next Technical Notebook, I'll go back to basic principles of magnetism, and give suggestions for measuring magnetism. I'm dwelling on magnetic theory just now because I want to discuss some unique and fascinating components, whose operations are based on simple magnetic theory. □

CARTOON CORNER

"It has AM, FM, SW, VHF, police broadcasts, shortwave, tape recorder and a clock sir, but to include color TV I'm afraid you'll have to go into a little larger set."



"Sorry, doctor, we don't make office calls, but if you'd care to bring it in I'll be happy to give it a series of tests."

"First it was only the picture that shrank."

"Golly—look at all those wires—
and those glass things—and all that other stuff."

Servicing Sylvania Color TV, Part 4

In the Sylvania E44 chassis, bias variations of less than 0.06 volts control the gain of the IF transistors. Therefore, for efficient servicing of the IF and AGC circuit, a technician needs to know how the circuit operates, and have a DC voltmeter capable of providing accurate readings of the small voltages found there. AFT operation and typical voltages also are discussed, along with troubleshooting suggestions.

By Gill Grieshaber, CET

IF Features

The IF module of the Sylvania E44 is easy to identify, because of the large shield around the IF circuits (see Figure 1). Holes are provided in the removable lid for alignment adjustments, and the coil numbers are indented in the metal cover. This module also contains part of the power supply components (explained in the February issue), and the entire sound section, including the two output transistors.

Under the shield (Figure 2) are all of the IF transistors, IF components, the AGC buffer transistor, and the AFT circuit. Previous articles have described the RF AGC circuit and the connection of the AFT voltage to the tuning voltage. These associated circuits are on the tuner-control module in the tuner cluster.

In addition, the module outside the shield has the 4.5-MHz trap and the video emitter follower (Q211).

The IF system has four stages with bipolar transistors. Three of the transistors are operated as conventional common-emitter amplifiers, but the second IF (Q204) is connected as a common-base type with the signal entering at the emitter. This is done so that the first-IF transistor can function as a DC amplifier, providing AGC control for the second-IF transistor.

Figure 3 shows a partial schematic of the IFs, AGC buffer, and the video emitter follower. Although the coils and other tuning components are not shown, the important DC paths for the AGC action are included.

One noteworthy feature of this IF/video circuitry is the small amount of variation in the DC voltages between weak-signal and strong-signal operation. Therefore, we will cover the operation in detail and give typical voltage variations to help you troubleshoot these circuits.

AGC Operation

No adjustments of any kind are provided in the E44 AGC circuit. This is unusual, and it makes a thorough understanding of the AGC operation necessary for any troubleshooting.

AGC keying is accomplished inside IC400 on the deflection module. A DC voltage (with unwanted pulses) from IC400 enters the IF module at terminal TA22. This voltage is your first testpoint for any AGC problem. In the sample chassis, the voltage measured +5.85 without a signal at the

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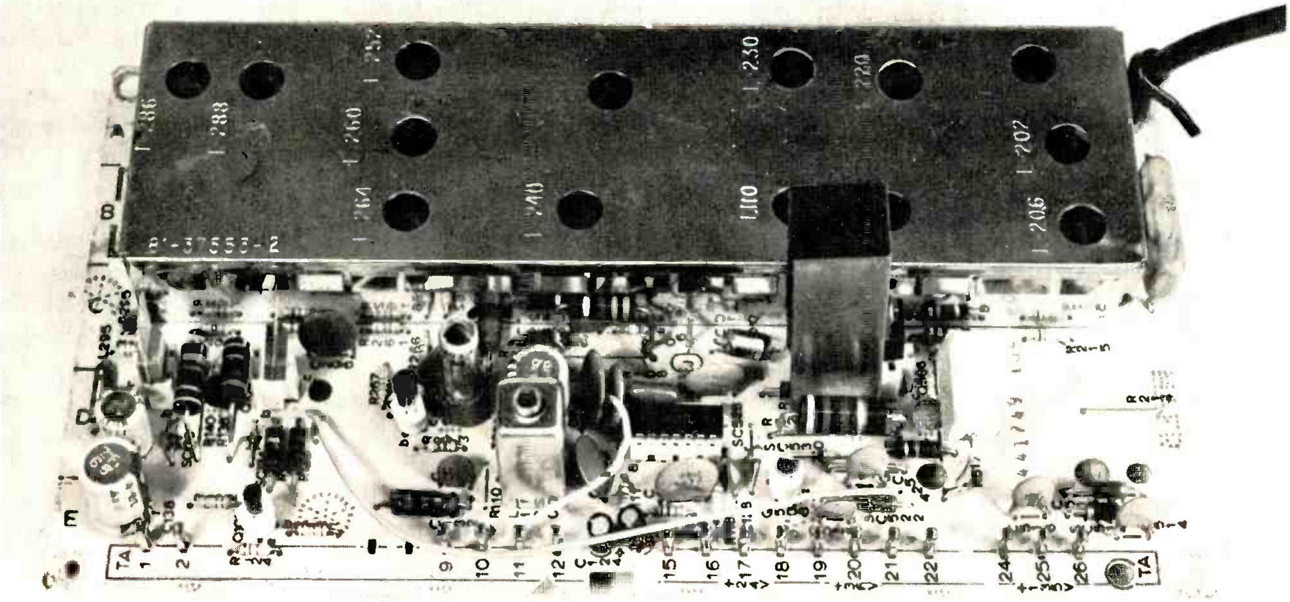

← FRONT OF TV

Figure 1 The IF transistors and other components are located inside the large shield on the IF/power-supply module of the Sylvania E44 chassis. Components of the sound circuit and some power-supply parts also are mounted on the module outside of the shield.

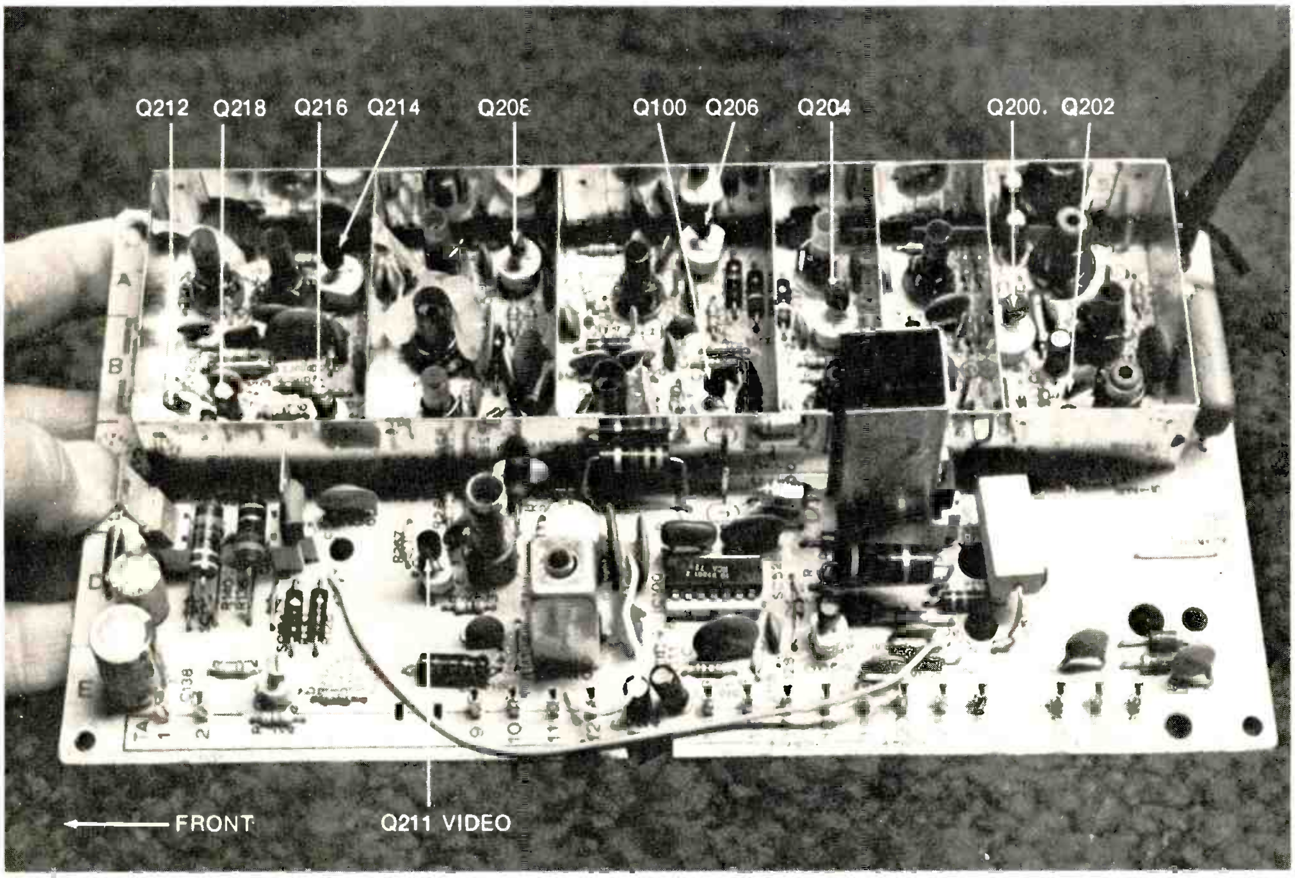

Figure 2 Arrows point out locations of the IF, AFT, and video transistors on the IF module. The top shield was removed before the picture was made.

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antenna terminals, or +12.42 volts at maximum output of the generator. The stations in your locality should provide readings between those extremes, with the exact reading depending on the signal strength.

At the base of Q202 (on the IF module), the incoming AGC voltage is reduced slightly and filtered by R213, R215, C217, and C215 to remove the pulses. (The factory schematic calls for R214—a 470-ohm resistor—between TA22 and the base of Q202, but this chassis had a jumper there. Evidently a minor circuit modification has been made.)

The gains of Q200 and Q204 are controlled by variations of the Q202 emitter voltage, the variable resistance and switching of diode SC210, and a slight change of the Q200 DC emitter voltage. Refer to Figure 4, as we explain how a diode can control the gain of a transistor.

Diode variable resistance

Most diodes are operated as voltage-controlled switches in circuits where it is desirable for the diodes to simulate either an open circuit or a short circuit (intermediate resistances are not wanted).

However, when a diode is supplied with forward-bias DC voltages between those causing open or short conditions (approximately 0.5 to 0.9 volt), the diode will act as a variable resistance whose value

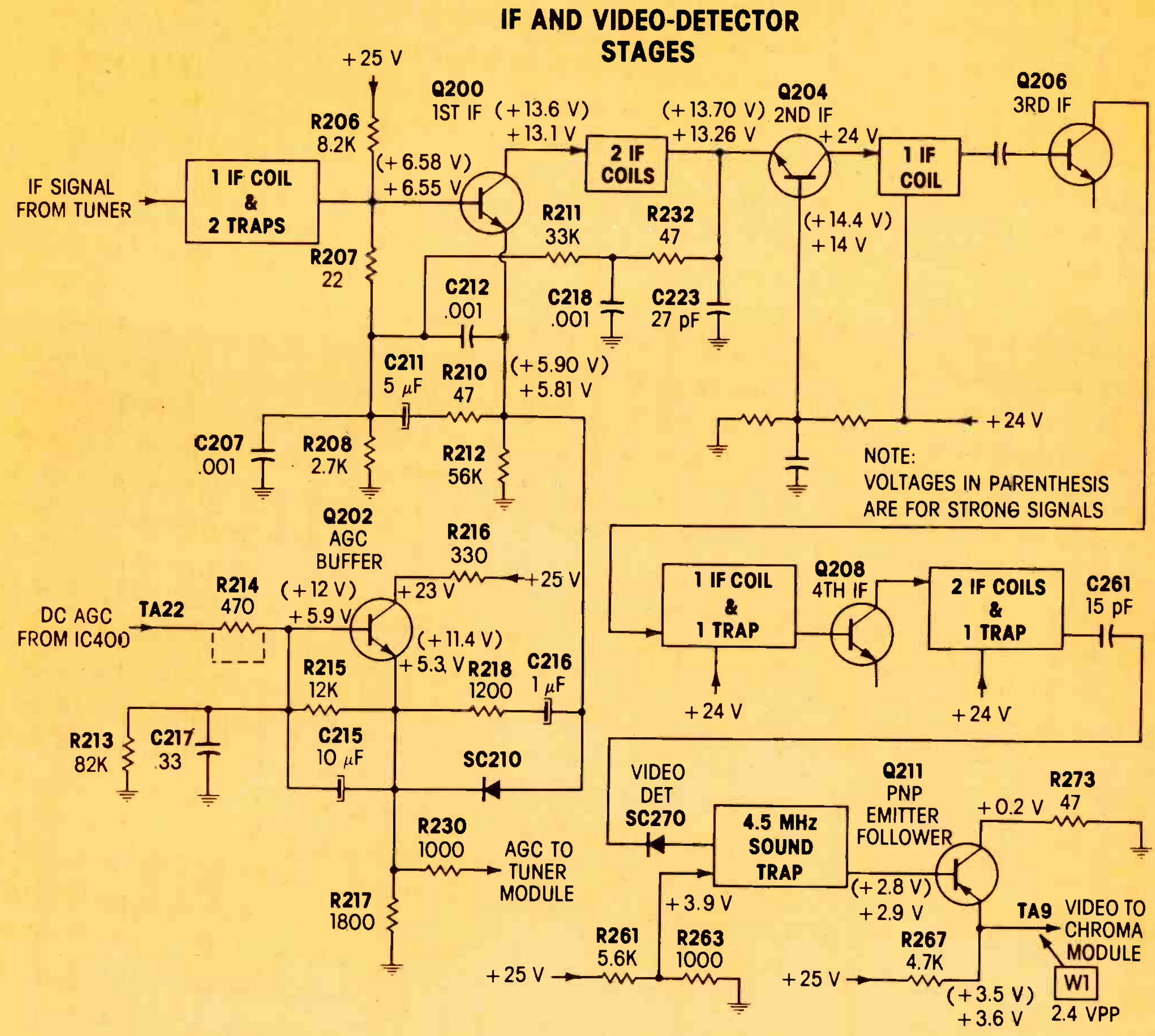

Figure 3 This schematic shows all of the IF wiring (in simplified form) plus the AGC buffer and the video emitter follower. Typical voltages are shown, with those produced by strong signals enclosed in parentheses. AGC for both Q200 and Q204 is accomplished by varying the Q200 emitter voltage.

depends on the applied voltage. This has been proved by tests where the diode resistances were calculated from applied voltage and resulting current. Values between almost zero ohms and several thousand ohms were obtained before problems of measuring small voltages and currents limited the accuracy of the readings.

In the Q200 IF stage of the E44 chassis, the emitter voltage is varied slightly by applying a range of DC voltages to diode SC210, so the diode resistance changes between a low value and an open circuit. This is done by applying the proper DC voltage (from the emiter of Q202) to the cathode of diode SC210.

A battery and variable control (shown in Figure 4) simulate the varying DC voltage from the Q202 emitter that drives the cathode of SC210. First, we'll analyze two extreme conditions.

Voltages for low gain

When the potentiometer of Figure 4 is adjusted to supply a higher positive voltage to the cathode of SC210 than is present at the anode, SC210 is reverse biased, and all conduction stops (the diode is open). The only other path from the emitter of Q200 to ground is through R212. Such a high value (56K) increases the emitter voltage, thus decreasing the Q200 forward bias, the C/E current, and the signal gain.

In the actual circuit, this action occurs when the TV signal is very strong. That's normal operation: but defects can cause this loss of gain when it's not wanted.

> **Troubleshooting Tip**
>
> If SC210 is open or reverse biased, the TV picture will have low contrast, probably will not lock, and will have no snow when the TV is tuned to an unused channel. See these symptoms in Figure 5.

Voltages for highest gain

At the other extreme of SC210 operation, assume that the control of Figure 4 is turned down until the cathode of SC210 has about +5 volts. The anode of SC210 previously was almost +6 volts; therefore, SC210 conducts and has a voltage drop of slightly more than 0.7 volt across it. This provides about +5.7 volts at the emitter of Q200, the first IF amplifier. The base of Q200 is supplied by a voltage divider with about +6.4 volts, providing a B/E bias of about +0.7 volt. Q200 has maximum gain, therefore, which is needed for the reception of weak signals.

Reducing the gain

As the pot is advanced to provide slightly more voltage to the cathode of SC210, the resistance of SC210 increases in step with the decreased forward bias, and less current from the emitter of Q200 (and R212) flows through SC210. This forces the Q200 emitter voltage higher, and since this is reduced forward

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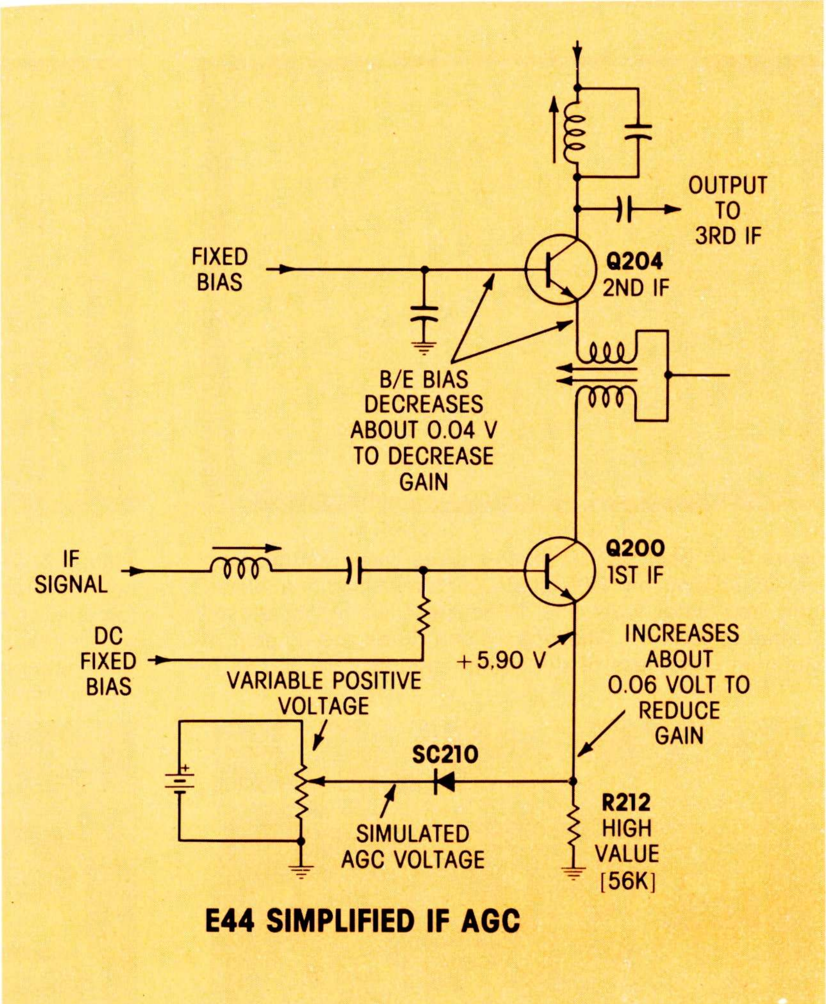

Figure 4 The principle of the IF AGC operation is shown by this simplified schematic. Check it against the one in Figure 3. Notice the small voltage variations at Q200 and Q204 during AGC operation.

Sylvania

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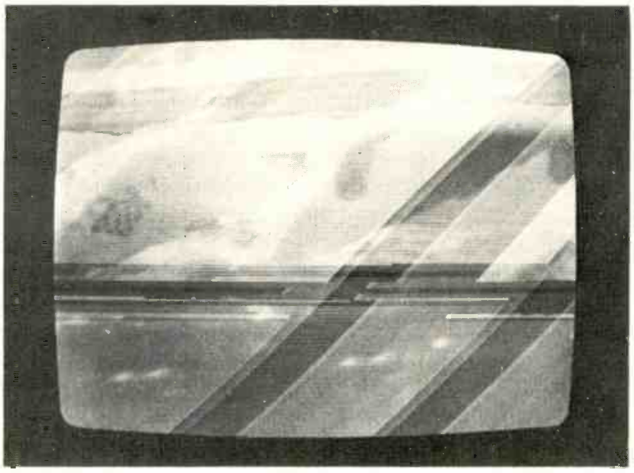
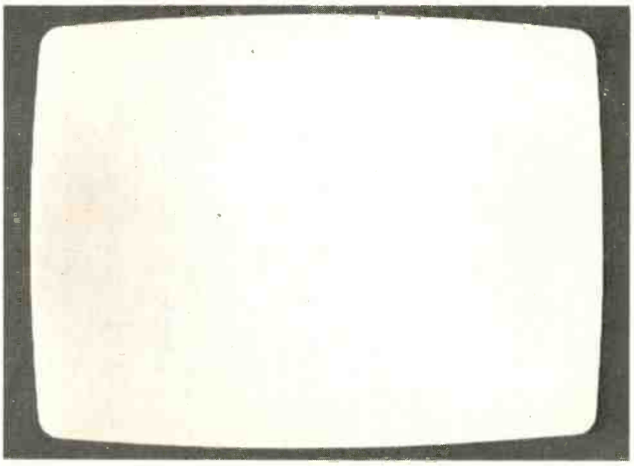
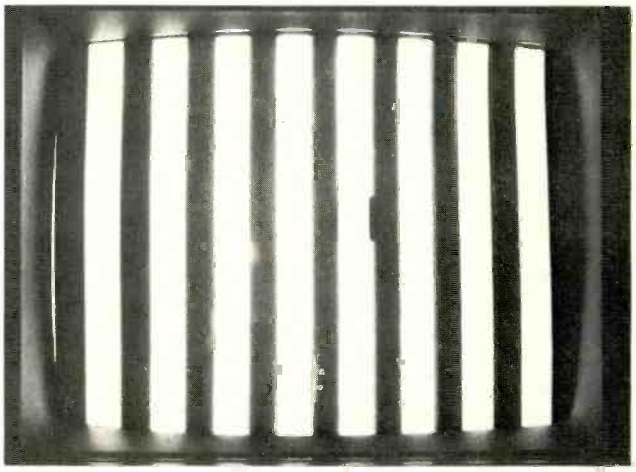


5A

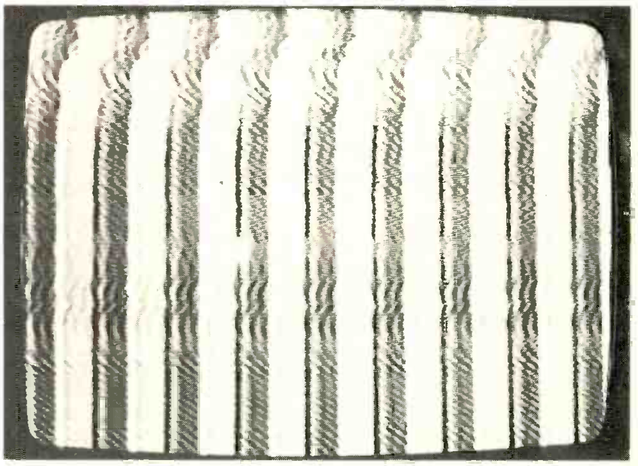


5B

Figure 5 An open SC310 diode causes weak contrast and loss of locking on TV signals (picture A), and a blank, snow-free raster when the TV is switched to an unused channel (picture B). The open diode holds the IF gain at minimum regardless of the signal strength.

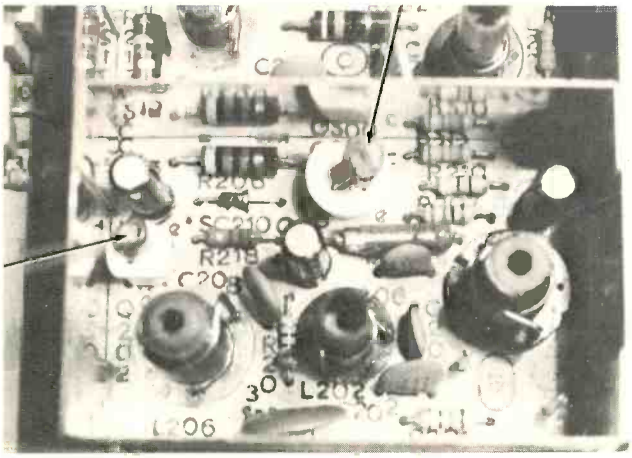


6A



6B

Figure 6 When SC210 is shorted, the AGC operates normally for all weak to moderately-strong input signals (picture A). However, a very-strong input signal produces an overload (probably of the tuner mixer), that's visible as beat patterns, reduced contrast, and horizontal instability (see picture B).



In this picture of the shielded-IF rear compartment, the Q202 AGC buffer is pointed out by the arrow at the left. Q200, the first IF transistor, is located just above the center, and SC210 is slightly to the left of Q200. As explained in the text, the small and large sockets are wired differently.

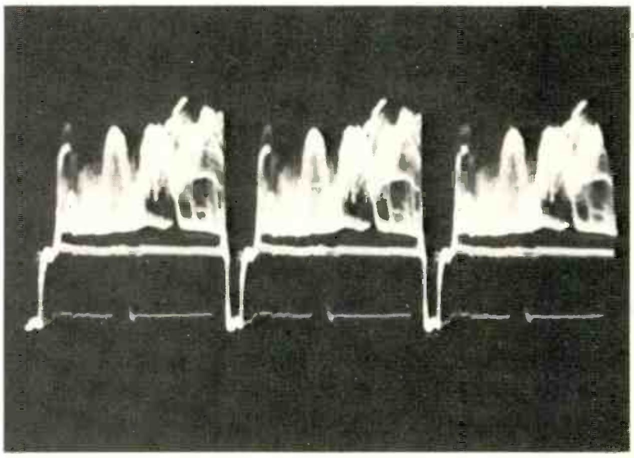


Figure 7 The video at the TA9 output terminal is negative-going, and the amplitude fluctuates around 2.2 to 2.4 volts PP. Notice the low amplitude of burst; it seems to be characteristic of this model.

bias, the current and gain of Q200 are reduced. (Notice that in Figure 3 the emitter voltage of Q202 increases with stronger signals from the TV station. So, the same gain reduction occurs in actual operation, also.)

Higher positive voltages from the pot continue to decrease the voltage drop across diode SC210 (along with higher internal resistance), thus further raising the Q200 emitter voltage (and decreasing the gain).

Notice that the rise of Q200 emitter voltage because of less current through SC210 is opposed by the reduced C/E current of Q200, since the Q200 base voltage is clamped by a divider. This slows down the increase of emitter voltage, but it does occur at a low rate.

Each increase of positive voltage at the cathode of SC210 reduces the gain of Q200 even more. (True of actual operation, too.)

Finally, the SC210 cathode voltage coming from the control again is increased until it is only about +0.5 volt below the anode voltage. This small forward bias stops all SC210 conduction. **Any higher cathode voltage does not change the Q200 emitter voltage or the gain.**

After SC210 is cut off, the Q200 emitter voltage is at its highest positive value, and the large 56K emitter resistor has eliminated most of the gain and the emitter current.

Now, before this SC210 cut-off voltage is reached, a resistor *could* have been substituted for SC210, and the Q200 gain reduction would have proceeded in the same way. (In fact, the RCA CTC38 chassis does that.)

RF AGC

However, after SC210 is cut off, any increase of positive voltage at Q202 emitter does not affect the Q200 gain, but is passed to the RF stage where it reduces the gain of the RF transistor. In other words, SC210 is required to stop the IF gain reduction and begin the RF gain reduction when the proper input signal level is reached. This prevents overload from strong signals and reduces the snow when the signals are weak.

Troubleshooting Tip

If SC210 is shorted or never becomes reverse biased, all strong TV signals will be overloaded (beat patterns and picture bending), while moderate and weak signals will be normal. See Figure 6 for pictures of the symptoms.

Q204 AGC

The previous explanation covered all of the AGC action, except for a hidden gain-reduction function in the Q204 circuit. The schematic of Figure 4 shows the essential components.

Notice that Q200 obtains its collector voltage and current from the emitter of Q204; the two transistors are in series to the DC power. The IF signal enters at the base of Q200, is amplified by Q200 and tuned by the IF transformers between there and the *emitter* of Q204. (Yes, the Q204 signal comes in at the emitter.) After amplification, the signal exits at the collector, where is it tuned before going to the third IF.

Q204 is connected as a grounded-base (or common-base) amplifier. This direct coupling between Q200 collector and the emitter of Q204 also allows the Q200 AGC to control Q204. Or, if you want to look at it that way, Q200 acts as a DC amplifier for the AGC voltage that is supplied to Q204.

The bases of both Q200 and Q204 are fed by fixed positive voltages that do not vary. (Actually, they vary slightly, but to simplify the explanation, we will pretend the voltages do not change.)

When a stronger signal is received and the emitter of Q200 becomes more positive, this is a reduction of the forward bias. Therefore, Q200 has less gain and decreased current. The reduced current increases the collector DC voltage, which is direct coupled to the emitter of Q204. Therefore, the Q204 emitter becomes more positive thus reducing the Q204 gain

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Sylvania

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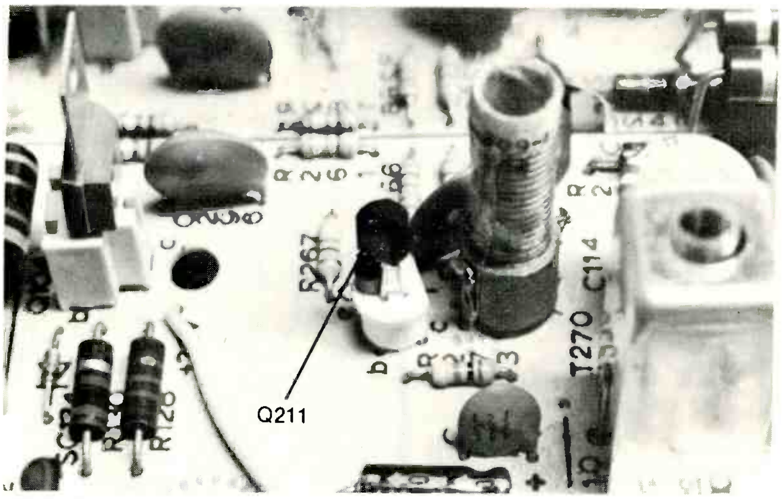

Q211, the video emitter follower, plugs into a socket, and has a ferrite bead threaded on the emitter lead. Just to the rear of Q211 (at the right, in the picture) is the 4.5-MHz sound trap.

Signal condition at TV	AGC DC voltage at TA22	Video DC voltage at TA9	Comments
no signal; leads shorted	+4.5 V	+4.25 V	absolutely no input; tuner snow only
generator connected but turned off	+5.8 V	+2.52 V	faint picture buried under snow
weak VHF TV station	+6.2 V	+3.42 V	good picture; slight snow
medium-strength VHF station	+8.8 V	+3.31 V	good picture
strong VHF TV signal	+9.5 V	+3.20 V	good picture; no snow
generator, full output	+12.4 V	+2.95 V	good pattern; no snow

NOTE: All voltages followed predictable results, except for the second condition. Although the AGC voltage was normal, the Q211 base and emitter voltages measured as if the input signal was higher than any station or the full generator output level. This was observed only when the snow and the video appeared to be about equal in the picture.

Table 1 The Q211 DC voltages vary according to the strength of the incoming TV signal.

and collector current.

In other words, **the gains of both Q200 and Q204 are reduced by the cutoff-bias method.**

One of the distinctive characteristics of this type of circuit is the small change of voltage that's necessary to accomplish AGC gain reduction. Figure 3 shows the DC voltages for no-signal and strong-signal operation, and the readings change so little that a digital meter is required for accurate measurements.

When a digital voltmeter was connected between base and emitter, the forward bias of Q200 tested +0.742 with a weak signal and +0.683 volt with a strong signal. That's a bias reduction of only 0.059 volt. In the same way, the bias of Q204 was +0.741 and +0.703 volt, for a variation of only 0.038 volt.

Other individual machines will have slightly different DC voltages, when they are measured to ground, but the B/E bias should be near these figures for normal operation. A VTVM can provide usable readings, if you watch the pointer while you disconnect the antenna. At least you can be sure that the reading either went up or it went down.

Detector And Emitter Follower

Video-detector diode SC270 is wired with its anode toward Q211, the video emitter-follower buffer. Therefore, two things should be true: (1) The video at the base and emitter of Q211 should be negative-going (that is, with the sync tips pointing downward); and (2), the DC voltages at the base and emitter of Q211 should become less positive when the incoming signal strength increases.

Well, a scope wavefore (Figure 7) proved the video at base and emitter was negative-going, alright. But some of the DC voltage readings were questionable. Over most of the variations of signal level, those voltages and the AGC voltage at TA22 behaved as they should. First, I should explain how the tests were made. A generator that had a good attenuator furnished channel 3 signal levels ranging between near-zero (with snow almost obscuring the pattern) up to levels stronger than those of local stations.

This seemed a perfect way to make repeatable and accurate readings at many signal levels. The first tests went well. No overload was noted at high levels, and the snow was normal at weak signals. Also, the AGC was very effective, keeping the video waveforms and the DC voltages at Q211 constant during changing signal levels.

However, when the generator was turned off to simulate a no-signal condition, the AGC voltage at TA22 was appropriately low, but the Q211 base and emitter voltages were less positive than when the signal was very strong! Several possibilities were tested (such as any voltage variation at the Q211 bias entering at R261 and R263—it didn't change), but no defects were found.

Just before giving up the search, I happened to test the voltages with the antenna leads removed, a short piece of wire connected across the antenna terminals, and the tuner rotated several channels away from any local station. These correct no-signal conditions produced Q211 DC voltages that were more positive than those with a strong signal. **Theory and practice finally were in agreement.**

During the previous test, the receiver evidently had some RF input, although nothing could be seen on the screen except snow, and this gave low-positive DC voltages at Q211 which erroneously indicated a strong signal.

Subsequent tests proved that the Q211 base and emitter voltages became less positive than anticipated when the snow nearly equalled the pattern. This evidently resulted from addition of the snow amplitude to the signal amplitude, and the effect surprised me.

If you make accurate tests of the AGC operation, keep in mind the conditions shown in Table 1. Also, if you want to duplicate the no-signal voltages shown on most schematics, you must do these three things: (1) remove the antenna leads; (2) place a *short* jumper across the antenna terminals on the TV; and (3) select a channel that's several numbers away from any active signal. **Only then can you trust the DC readings.**

AFT Operation

In Figure 8, Q214 amplifies the station picture carrier taken from the last IF stage and applies it to a phase detector consisting of SC282, SC284, T286, and associated components.

Q212 amplifies the DC voltage from the discriminator. Forward bias is provided by R283 and R287, but this voltage is changed by the discriminator according to the correction needed for proper tuning. Output of Q212 goes to the AFT circuit on the tuner-control module where it joins the tuning voltage before it's applied to the tuners.

Q216 and Q218 form an override circuit that eliminates almost all of the AFT voltage when no station is tuned in (this prevents the AFT from locking to the wrong channel). When negative-going video reaches the base of Q216, the transistor (which has no other forward bias) conducts only during the sync tips, passing only enough current to form about +7 volts at the collector (the DC voltage enters at the emitter). After this voltage is reduced by the voltage-divider R293/R296, it is not enough to forward-bias Q218 into conduction.

However, when only snow reaches Q216, it conducts heavily, producing about +23 volts at the collector. This is sufficient to bias Q218 into saturation, thus grounding R297 and reducing the Q212 collector voltage (which is the AFT voltage for the tuners) to almost zero.

Refer to Part 1 in the February issue for details of the additional AFT circuits that are on the tuner-control module, where the AFT and tuning voltages are combined.

Troubleshooting Tips

All of the IF-module transistors plug into sockets. This is very convenient for testing transistors

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out-of-circuit or replacing them. However, there are some very important facts to remember.

Watch those pins!

The six, white, larger-size transistor sockets that are under the IF shield are *not* wired in the conventional way. The original system placed the emitter at the left, base at the center above, and the collector to the right, when the leads faced you with the missing fourth pin at the center below.

Instead, the sockets of Q200, Q204, Q206, Q208, and AFT Q214 are wired with the base and emitter reversed from the original way. In addition, some of the transistors used in those sockets have the leads arranged in a conventional trio, while others have the leads in a straight line (and the base and emitter are reversed). Therefore, these transistors must have their leads bent in whatever way is required to match the sockets.

If you remove a transistor for testing and then re-install it with any leads interchanged, some components can be damaged, including the transistor. Even if no damage occurs, the TV performance will be poor. The same comments apply if you install a new transistor and fail to bend the leads

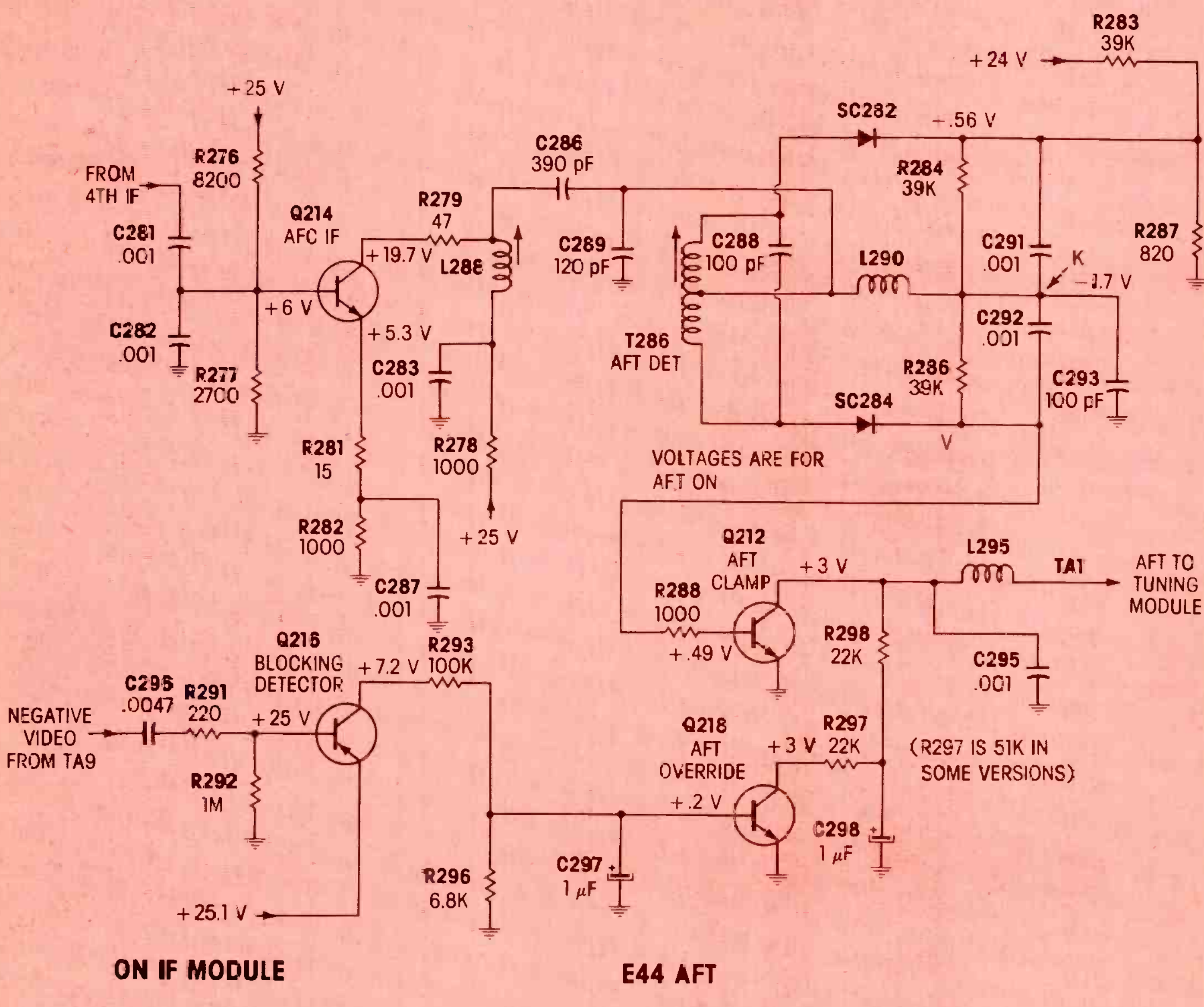
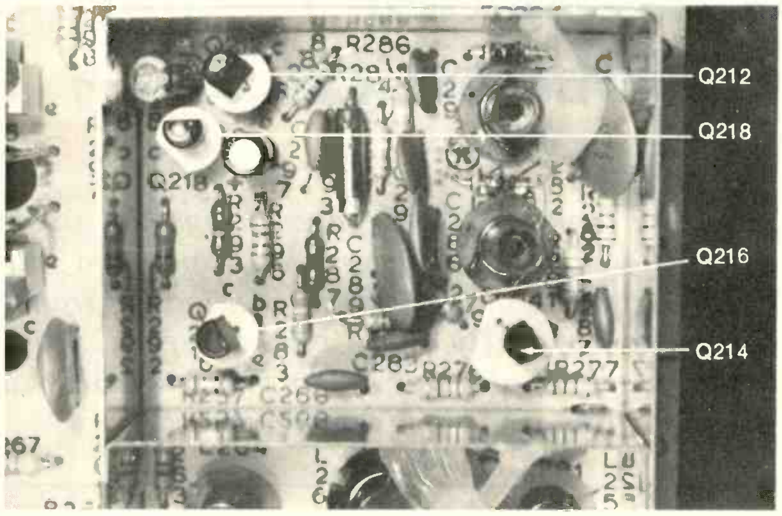


Figure 8 In the E44 AFT circuit: Q214 amplifies the 45.75-MHz picture carrier; SC282, SC284 and T286 operate as a phase detector; Q212 amplifies the correction voltage from the phase detector; and Q215 plus Q218 comprise the override circuit that disables the AFT during channel changes.

so they match the correct pins of the socket. (Don't ask me how I first learned that the sockets have different wiring!)

Each socket has a "b" for base, an "e" for emitter and a "c" for collector near the corresponding pin. But the board has many markings, and you should exercise extreme care. Remember that you are looking at the *top* of the socket, but locating the proper transistor pins by looking from the *bottom* of the transistor.

An ohmmeter test will identify the base of a transistor, but such simple tests are not very dependable for identifying the emitter and collector. Therefore, when installing new transistors, you should use a tester that provides positive identification of the leads. Or, you should look up the specs of that particular transistor. Check the schematic or Photofact to determine the correct leads.



Arrows point out the AFT transistors that are located inside the front compartment of the IF shield.

Symptoms of open transistors

Although it is impossible to describe every symptom produced by *all* kinds of transistor defects, we will list the picture and sound symptoms that occur when each transistor is removed **to simulate an open transistor.**

These are the major symptoms:

- An open Q202 (AGC amp) allows good sound when a station is received, but no raster or picture can be seen. When tuned to an unused channel, the TV has normal noise in the sound and snow on the screen.
- An open Q200 (first IF) causes good sound and a moderately-bright raster with traces of out-of-lock video. However, no snow is seen and little noise is heard when no station is received.
- If Q200 is installed with the **emitter and collector reversed,** the sound will be normal, but the picture will have some snow (but no locking) on stations of moderate signal strength. Between active channels, the snow is very light.
- An open Q204 (second IF) gives about the same symptoms as Q200 (dim raster with a trace of rolling video, and noisy sound).
- An open Q206 (third IF) allows a moderately-bright raster without snow or picture, and with some noise (without station audio) from the speaker.
- An open Q208 (fourth IF) permits normal sound on an active channel, but no video or snow on the moderately-bright raster.

These symptoms correspond approximately to those of tube-equipped TV receivers.

Preliminary IF tests

Three steps should allow you to prove the IF has a defect, or that the performance is normal.

First, notice the symptoms of picture and sound, both on channel and without a signal, and compare them with the previous list.

Second, check the AGC voltage at terminal TA22 of the IF module as you tune in stations of various signal strengths. A weak station should produce about +5 to +6 volts. This rises to about +12 volts for a very strong carrier. Compare your readings with these standard ones.

Third, use your scope to look at the video waveform at the output (pin TA9 of the IF module), and measure the DC voltage. Remember that the output signal is negative-going; therefore, an excessive signal produced by insufficient AGC will have more amplitude along with a less-positive DC voltage. At the other extreme, excessive AGC or reduced IF gain will cause less amplitude and a more-positive DC reading.

Any extreme deviation from normal waveform and DC readings indicates tuner, IF, or AGC defects.

Scope and DC-voltage tests

Scopes seldom are used for signal tracing in the IF stages, because the gain of most scopes is nearly zero at the 42-to-47-MHz frequencies. However, it's likely that a 35-MHz model would show the proper modulated-RF waveform at a reduced (and non-calibrated) level. Detector probes can be used, but the loading is severe, giving false results. Also, touching many IF points with any kind of probe detunes the alignment.

Therefore, in the tuned IF stages, most troubleshooting is confined to DC-voltage measurements, resistance tests, and transistor checks or replacements.

The Sylvania E44 IF module is replaceable, and you can install a new one under warranty or as an option instead of repairing it.

Next Month

Chroma, video, and matrixing circuits are discussed next month.□

The Basics of Industrial Electronics, Part 11

By J. A. "Sam" Wilson, CET

A second look at NAND gates brings the surprise of **two** *different NAND formulas, and* **two** *different NOR formulas, along with a method of transposing formulas correctly. The characteristics of NOR latches are explained, also five troubleshooting questions are asked and answered.*

NAND Gate Revisited

A Nebraska reader/technician called me last March asking for an explanation of this NAND-gate statement that appeared on page 54 of the February **Electronic Servicing:** "The math symbol should be read **NOT A AND B equals L.** It is important that the overbar reach across both letters without a break," The inquiry is welcome because it gives me the opportunity of making some important points about digital circuits.

Probably the best way of explaining the statement is to carry both conditions ($\overline{A \times B}$ = L, and $\bar{A} \times \bar{B}$ =L) through to the end. The first formula actually means that the *overall* AND function is negated at the output, while the second one calls for each individual *input* to be negated (inverted) before it reaches the AND gate.

We'll try both formulas, and show the results.

Inverted AND output

An AND gate with the output inverted is shown in Figure 1, along with the truth table. Notice that the output state in the "L" column is obtained by inverting the A x B column of the AND.

All conditions are satisfied, so **inverting the output of an AND gate DOES form a NAND gate,** which has the same formula as in the February article.

Inverted AND inputs?

In Figure 2, both the A and B inputs are inverted separately, giving $\bar{A}$ and $\bar{B}$ inputs to the AND gate. A glance at the inputs and the final output column reveals that the combination logic does NOT form a NAND gate.

Therefore, **inverting the inputs of an AND gate does NOT produce a NAND!**

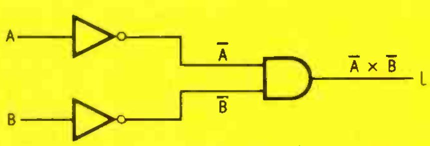
These two sets of facts prove that $\overline{A \times B}$ = L is not the same as $\bar{A} \times \bar{B}$ = L. Remember, with combinational logic, only the A and B inputs and the L output states are important to the type of gate.

If you memorized the truth tables of the various gates as we discussed them during the past months, you are in for a surprise. **The logic circuit and truth table in Figure 2 actually forms a NOR gate!** However, the $\bar{A} \times \bar{B}$ = L NOR formula is different from the $\overline{A + B}$ = L NOR formula given in February. This will be explained later.

Avoid NOR Errors

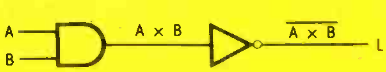
A similar situation exists with NOR logic made from OR and NOT gates. The NOR math expression $\overline{A + B}$ = L is not the same as $\bar{A} + \bar{B}$ = L.

Figure 3 shows a NOR gate constructed by feeding the *output*



A	B	$\bar{A}$	$\bar{B}$	$\bar{A} \times \bar{B}$
0	0	1	1	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	0

Figure 1 An AND gate followed by a NOT gate becomes a NAND. The math formula for AND gates is read, "A AND B = L." The NOT gate at the output negates that so it reads, "NOT A AND B = L." As shown in the drawing, the overbar should cover both letters and the expression which is in between. (It might be more clear written "NOT (A AND B) = L.")



A	B	A x B	$\overline{A \times B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Figure 2 Inverting both inputs of an AND gate does **not** produce a NAND gate (notice the differences in the truth tables). Instead, it is another way to construct a NOR gate. The formula is read, "NOT A AND NOT B = L. **Remember:** NOT A AND B = L isn't the same as NOT A AND NOT B = L.

of an OR gate through an inverter. The truth table verifies that the combinational logic circuit is a NOR, with a formula of $\overline{A + B}$ = L.

In the same way, Figure 4 shows a digital circuit formed by inverting both the A and B *inputs* to an OR gate. The output has the formula $\bar{A} + \bar{B}$ = L, which compared to the output formula for the NOR gate in Figure 3, proves that inverting the inputs of an OR gate does NOT give the same results as inverting the output of an OR.

The truth table in Figure 4 proves the digital circuit is not a NOR, but is a NAND! However, the $\bar{A} + \bar{B}$ = L formula is different from the NAND formula given last February ($\overline{A \times B}$ = L).

These facts bring up two interesting points: (1) changing the overbar from a continuous line over the entire input to two individual overbars, produces a *different* gate; and (2) there must be more than one formula for each gate.

How else can we account for *two* NAND formulas and *two* formulas for NOR?

Conversion By DeMorgan's Laws

Because the $\overline{A \times B}$ = L NAND formula of Figure 1 equals the $\bar{A} + \bar{B}$ = L NAND formula of Figure 4, it follows that $\overline{A \times B} = \bar{A} + \bar{B}$. Also, the NOR formulas of Figure 2 and Figure 3 give us the combined formula $\bar{A} \times \bar{B} = \overline{A + B}$. These assumptions can be proven by an application of DeMorgan's Laws.

DeMorgan's Laws are very important for working problems in Boolean Algebra, and for showing that basic gates can be combined to obtain a desired output.

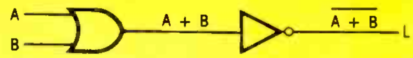
Troubleshooting question #1

Using the integrated-circuit packages of Figure 5, how can you connect the pins to construct a NAND gate?

Hint: the output of a NOR gate is $\overline{A + B}$. If this output is inverted, as shown in Figure 6, the gate is an OR.

(Answers to the troubleshooting questions are given at the end of this article.)

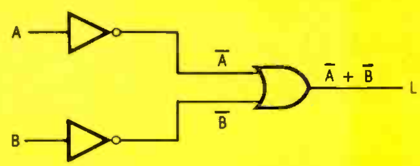
continued on page 54



CIRCUIT AND TRUTH TABLES FOR $\overline{A + B}$

B	A + B	A + B	$\overline{A + B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

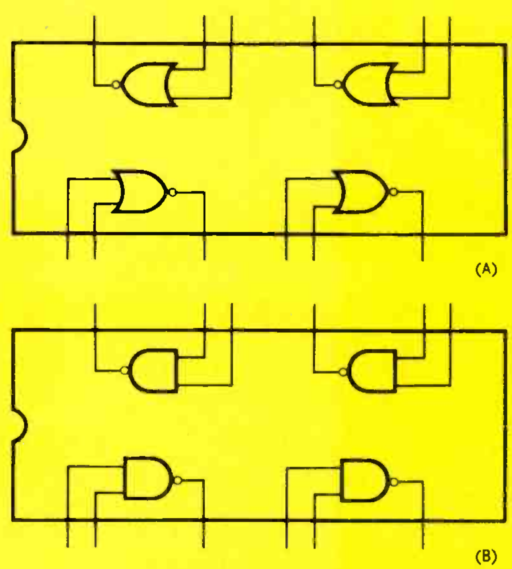
Figure 3 A NOR gate can be constructed by an OR gate whose output is inverted with a NOT. The formula is read, "NOT A OR B = L." (Try thinking of it as "NOT (A OR B) = L.")



A	B	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$
0	0	1	1	1
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0

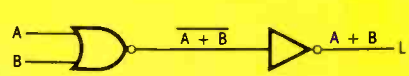
ANOTHER NAND CIRCUIT

Figure 4 Inverting both inputs or an OR gate does **not** produce a NOR gate. (Compare the truth tables of Figure 3 and Figure 4.) The formula is read, "NOT A OR NOT B = L." Compare only the two inputs and the output columns of the truth tables in Figures 1, 2, 3 and 4. This combinational logic produces a NAND gate. However, the formula is not the same as the one previously given for NANDs. DeMorgan's Law will clarify the situation.



COMPONENTS FOR TROUBLESHOOTING QUESTION #1

Figure 5 Using either the NOR gates of (A), or the NAND gates of (B), how can you connect several gates to construct one NAND gate?



A	B	$\overline{A + B}$	L
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1

INVERTING THE OUTPUT OF A NOR PRODUCES AN OR GATE

Figure 6 This is a hint for answering Troubleshooting question #1.

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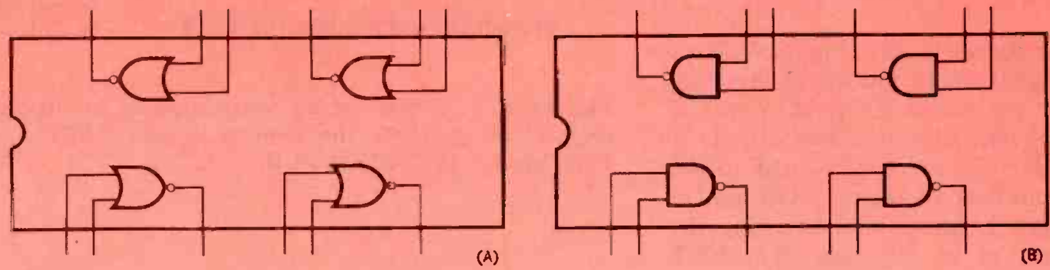

COMPONENTS FOR TROUBLESHOOTING QUESTION #2

Figure 7 Using either the NOR gates of (A), or the NAND gates of (B), how can you connect several gates to construct a NOR gate?

NOTES

In digit logic, the x and + signs NEVER mean "times" and "plus".

The x sign is read AND, and the + sign is read OR.

An overbar negates (inverts state) whatever is under it. For example, $\overline{A \times B}$ means NOT A AND B.

"AND" LOGIC

AND		
0	0	0
0	1	0
1	0	0
1	1	1

formulas: $A \times B = L$; $A\,B = L$; $A \cdot B = L$

read as: A AND B = L

means: A high and B high gives high output (anything else gives a low output)

"OR" LOGIC

OR		
0	0	0
0	1	1
1	0	1
1	1	1

formula: $A + B = L$

read as: A OR B = L

means: A high or B high (or both) gives high output (both inputs low gives a low output)

"NOT" LOGIC

NOT	
0	1
1	0

formula: $\overline{A} = L$

read as: NOT A = L

means: Output state is reverse of input (inverter)

"NAND" LOGIC

NAND		
0	0	1
0	1	1
1	0	1
1	1	0

formula: $\overline{A \times B} = L$

read as: NOT A AND B = L

means: A high and B high = low output (either or both inputs low gives a high output) (it is a negated-output AND gate)

"NOR" LOGIC

NOR		
0	0	1
0	1	0
1	0	0
1	1	0

formula: $\overline{A + B} = L$

read as: NOT A OR B = L

means: (either of both inputs high gives a low output) (both inputs low gives a high output) (it is an inverted-output OR gate)

"EXCLUSIVE OR" LOGIC

EXC OR		
0	0	0
0	1	1
1	0	1
1	1	0

formulas: $\overline{A}\,B + A\,\overline{B} = L$; $A \oplus B = L$

read as: NOT A and B, or A and NOT B = L

means: (either input high gives a high output, but both inputs high or both low gives a low output)

DeMorgan's Laws
In a digital-logic math expression, the overbar always can be broken it you **also** change the **sign** of the expression. Also, a broken overbar can be made continuous if you change the sign of the expression.

EXAMPLES: $\overline{A + B} = \overline{A} \times \overline{B}$; $\overline{A} + \overline{B} = \overline{A \times B}$

Chart 1 Here is a chart with many helpful digital facts compiled for easy reference. Refer to it as you answer the questions and work the experiments.

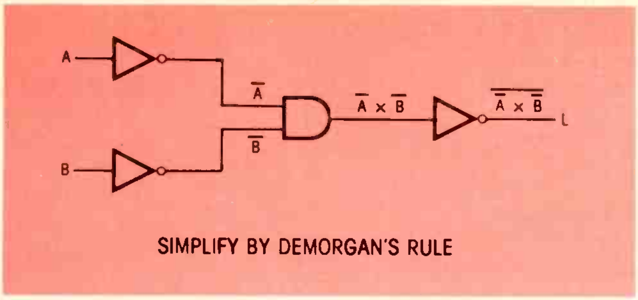

Figure 8 DeMorgan's Law states that a continuous bar over the entire A and/or B input expression can be changed to two separate bars over the individual A and B input letters, by simultaneously changing the sign of the expression. Also, individual overbars of the A and B inputs can be changed to one continuous bar over both, by changing the sign of the expression.

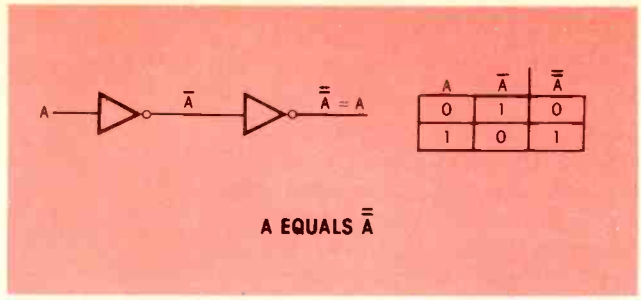

Figure 9 A double overbar equals no bars.

Troubleshooting question #2

Using the integrated-circuit packages of Figure 7, how can you connect the pins to construct a NOR circuit?

DeMorgan's Laws simplified

John Merriner, CET, a California friend, gave me this simple rule for remembering DeMorgan's Laws: In digital-logic math expressions, **the overbar always can be broken, if you also change the sign of the expression.**

Using this easy-to-remember rule, it's possible to simplify some types of circuits, such as the one in Figure 8. The output is:

$$\overline{\overline{A} \times \overline{B}} = L$$

For the first step, break the overbar and change the sign of the operator:

$$\overline{\overline{A}} + \overline{\overline{B}} = L$$

Now, a double overbar is similar to a double negative in the English language. If we say, "You can't not go," it means, "You can go." In digital language, a "NOT NOT A" is the same as an "A." This is illustrated by the circuitry in Figure 9.

Chart

Chart 1 summarizes many gate formulas and other important material.

A New Symbol?

Several inquiries have been received about the industrial symbol in Figure 12, page 53, of the February article. The normally-closed contact was not correctly drawn. (A capacitor symbol was used by mistake.) The correct illustration is shown in Figure 10.

NOR Electronic Model

A request has been received for an electronic discrete model for a NOR gate (models were shown for AND, OR, NOT, and NAND). Figure 11 is a NOR gate using two transistors.

When both switches are open, both transistors are cut off, there is no current through the collector resistor, and the output voltage at L is high.

Closing *either* or *both* switches provides forward bias to one or both transistors, thus producing saturation. This is a low-resistance short at the L output, so the output has logic 0.

All such electronic models are

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INDUSTRIAL

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given only to help your understanding of the principles. Actual IC versions are not constructed that way. Integrated-circuit technology produces greatly improved bipolar gates. And CMOS gates are made using MOSFETs.

NOR Latches

Previously, the NAND latch was discussed. It also is called an RS flip-flop or a bounceless switch. During the quiescent period of a NAND flip-flop, the R and S inputs both have highs. The flip-flop condition is changed from high to low by momentarily switching the R input to low (zero volts). And, it is changed from low to high by

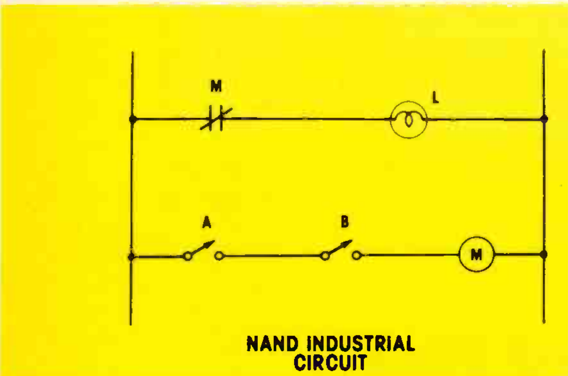


Figure 10 The normally-closed contact in Figure 12 page 53 of the February ELECTRONIC SERVICING was incorrectly drawn. This contact is correct for an industrial schematic.

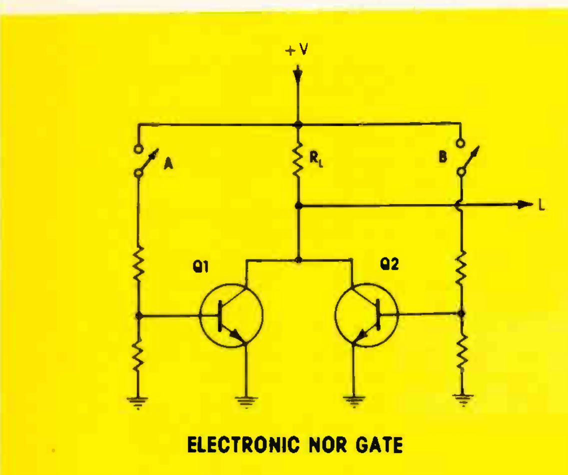


Figure 11 This is an electronic model of a NOR gate, constructed with discrete components. Either or both switches in high state produces a low output.

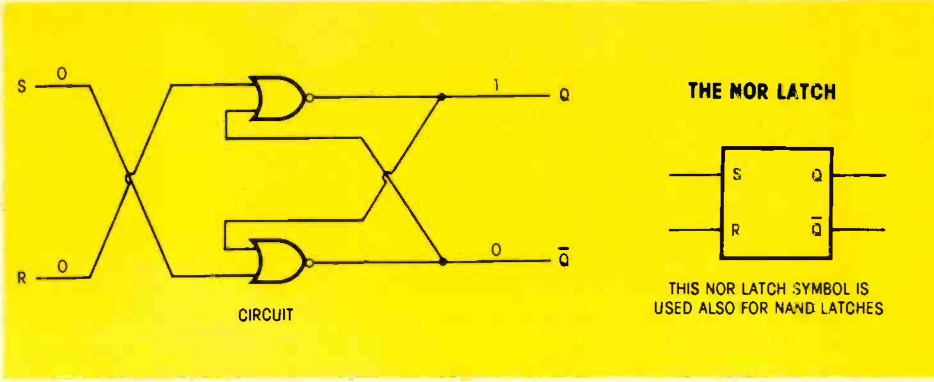


Figure 12 The schematic at the top is a latch circuit, constructed with two NOR gates. The inputs are criss-crossed so the package symbol is the same for both NAND and NOR latches.

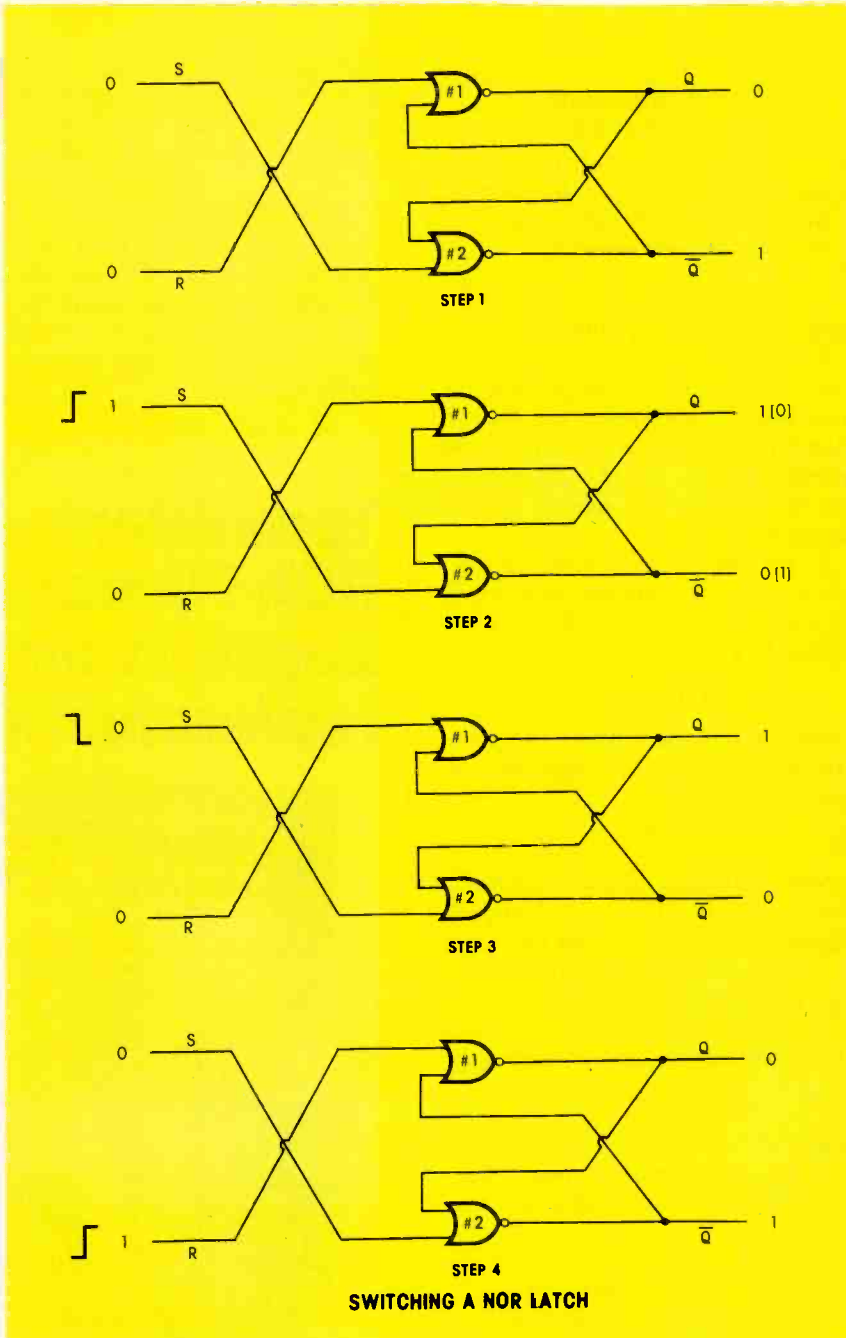


Figure 13 These are the four steps for switching a NOR latch from low output to high, and then back to low again.

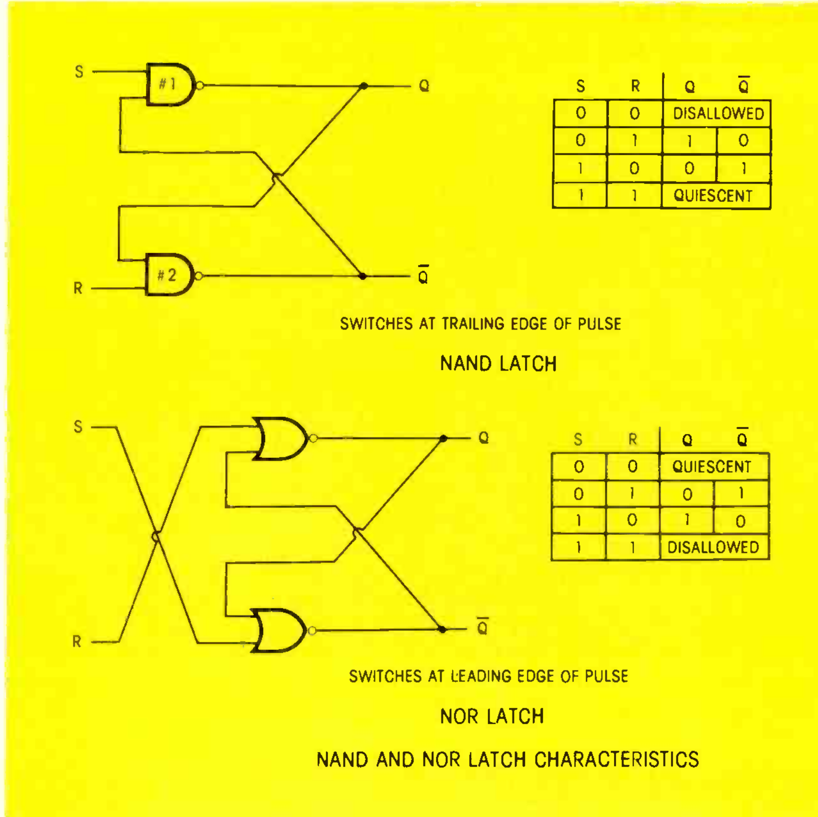
momentarily switching the S terminal to low (zero volts).

A latch can be made also with NOR gates. It, too, is called an RS flip-flop and a bounceless switch. As shown in Figure 12, the input leads are crossed to place the set and reset terminals in the standard location for flip-flops.

For a NOR latch, the S and R input terminals both are held at logic-level **zero** during the quiescent period. To switch the flip-flop, the proper input terminal is switched momentarily to logic 1 (high). Note: the two inputs should *never* be switched to logic 1 at the same time.

Troubleshooting question #3

Is the latch of Figure 12 in the high condition, or in the low condition?



S	R	Q	$\overline{Q}$
0	0	DISALLOWED	
0	1	1	0
1	0	0	1
1	1	QUIESCENT	

S	R	Q	$\overline{Q}$
0	0	QUIESCENT	
0	1	0	1
1	0	1	0
1	1	DISALLOWED	

Figure 14

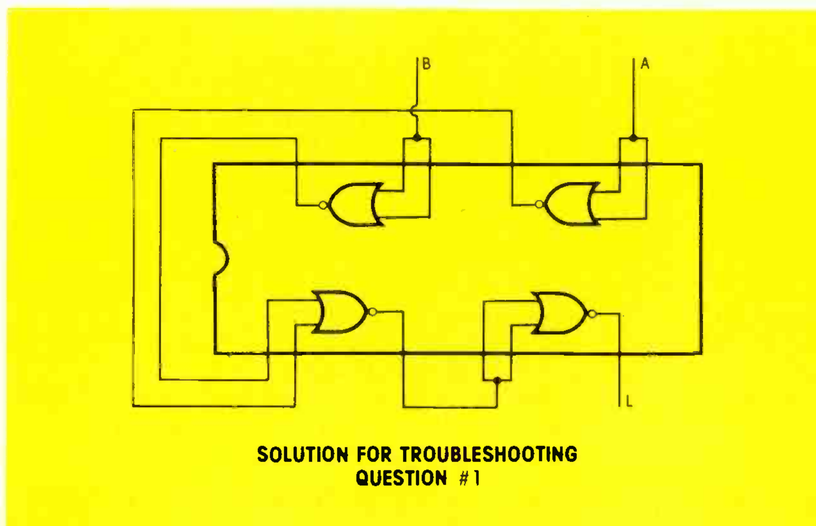


Figure 15 This is one way of making a NAND from four NOR gates.

Switching NOR latches

Figure 13 gives some switching information for NOR latches. During step 1, the latch is in the low condition, and the two inputs have lows, which is the quiescent condition for NORs.

For step 2, the S input is switched to logic 1. (A NOR latch is switched by changing the proper input terminal from logic 0 to logic 1.) The stepping voltage for switching is equivalent to the leading (rising) edge of a square wave. Therefore, **NOR flip-flops normally are switched by the leading edge of an input pulse.** By contrast, **NAND flip-flops normally are switched at the trailing (falling) edge of an input pulse.** These are important points that you should memorize.

Flip-flops of the TTL logic family usually are made with NANDs, while flip-flops of the CMOS logic family usually are made with NORs. Therefore, TTL flip-flops switch during the leading edge of input pulses, while CMOS flip-flops switch on the trailing edge of input pulses.

When the S terminal in step 2 of Figure 13 is switched to logic 1, the inputs to NOR #2 becomes 1 and 0. (The previous levels are shown in parentheses.)

The 0 output of NOR #2 is delivered to the input of NOR #1, making two logic 0 inputs for NOR #1, and this causes the output to switch to logic level 1. **Note that the flip-flop has been switched from low to high by the leading edge of the input signal at the S terminal.**

During step #3 the logic level at input terminal S has been returned to 0. Again, the NOR flip-flop is in the quiescent condition, but with a high-output condition.

For step #4 of Figure 13, the NOR flip-flop has been switched to a low condition by the leading edge of a positive pulse at terminal R. When the pulse returns to logic 0, the flip-flop will remain in the low (quiescent) condition. The flip-flop has been taken through four steps, and now is in the original condition.

Troubleshooting question #4

In a NOR latch circuit, the R input terminal is stuck in a logic 1 condition. Will the latch be stuck in a low (logic 0) condition?

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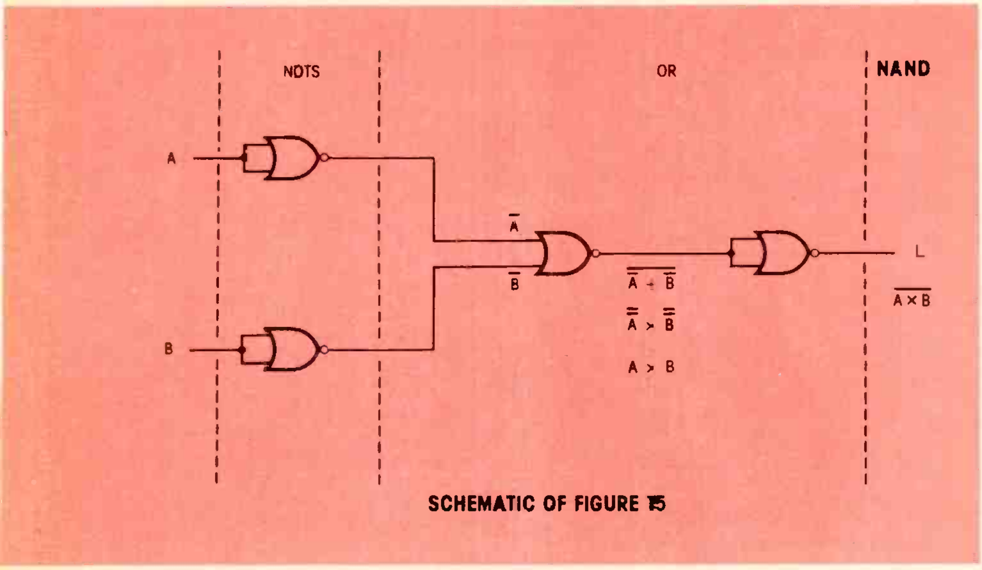

Figure 16 The circuit of Figure 15 can be drawn this way. Two NOTs feed a NOR, thus forming an AND, then the final NOT changes it to a NAND.

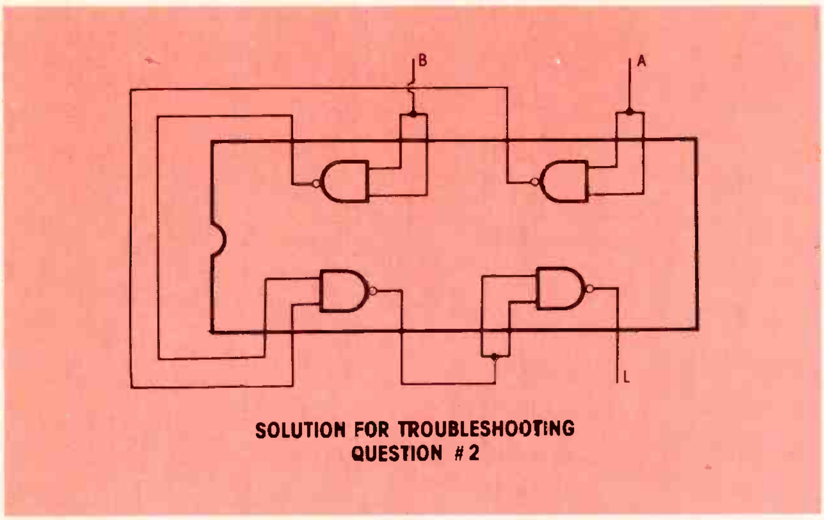

Figure 17 Here is one way of wiring four NANDs to produce a NOR.

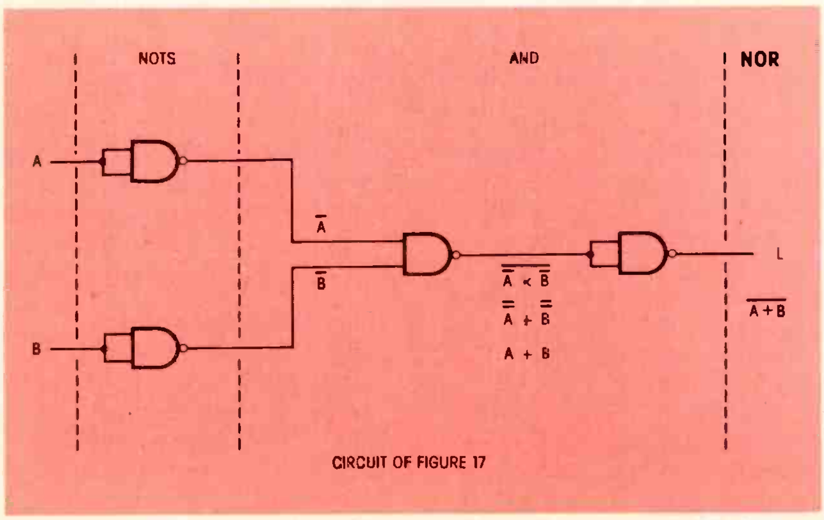

Figure 18 This is the circuit of Figure 17. Two NOTs and a NAND become an OR, and the final NOT changes it to a NOR.

NAND And NOR Latch Truth Tables

Figure 14 shows the conditions for quiescence and switching in NAND and NOR truth tables.

> **Troubleshooting Question #5**
>
> A CMOS NOR latch will operate with a power-supply voltage of only 5 volts. Is it okay to substitute a CMOS NOR latch for a defective TTL NAND latch?

Experiments with latches will be illustrated next month.

Answers To Troubleshooting Questions

Answer #1. The NOR gates can be wired to make a NAND, as shown in Figure 15. Perhaps you used different NANDS for inverters, but the important thing is for inversion to occur at the inputs, and again at the NOR output (to produce an OR). Refer to Figure 16 for a simplified schematic.

Answer #2. Connect the NAND gates as shown in Figure 17 to construct a NOR. You can select different gates to be used as NOTs, but the final circuit should be similar to the one in Figure 18.

Answer #3. The NOR latch in Figure 12 is in the high condition (Q is 1, and $\overline{Q}$ is 0). The output logic levels are the same for both high and low conditions of NAND and NOR latches.

Answer #4. A NOR latch with the R input terminal stuck at logic 1 will be stuck in the low condition only as long as the S terminal remains at logic level 0. If S is switched to high, the condition can't be determined, for operation with both inputs high is disallowed.

Answer #5. No, a CMOS NOR latch should not be substituted for a TTL NAND latch, because CMOS latches switch at the leading edge, while TTL latches switch at the trailing edge. (There are a few rare exceptions.) Also, CMOS latches, when operated at the TTL voltage of 5 volts, switch slower than TTL latches do. □

PART 2

Servicing Betamax Videotape Recorders

By Harry Kybett

Videotape recording requires the B&W and chroma signals to be separated. This article describes how the B&W signal is recorded, and discusses some problems of "time-base errors," along with suggestions for troubleshooting common troubles.

The Betamax Format

The Sony Betamax is a two-head, helical-type Home Video Cassette Recorder (HVCR) which wraps the tape around the head drum by slightly more than 180 degrees. Table 1 lists the important dimensions, and Figure 1 shows the layout of tracks on the tape. Vertical sync and blanking are recorded near one end of each slant track, and each track has the composite video of one vertical field (262.5 horizontal lines).

Dual-speed specs

Dual-speed models (such as SL8200) have an "X" type head that gives a track width of 30 microinches. In the one-hour mode, the tape speed is maximum. Therefore, guard bands are formed.

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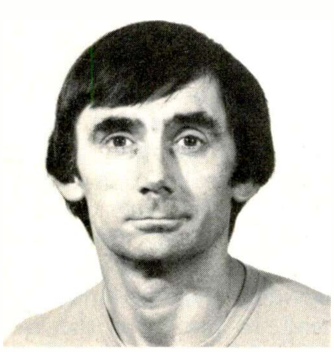
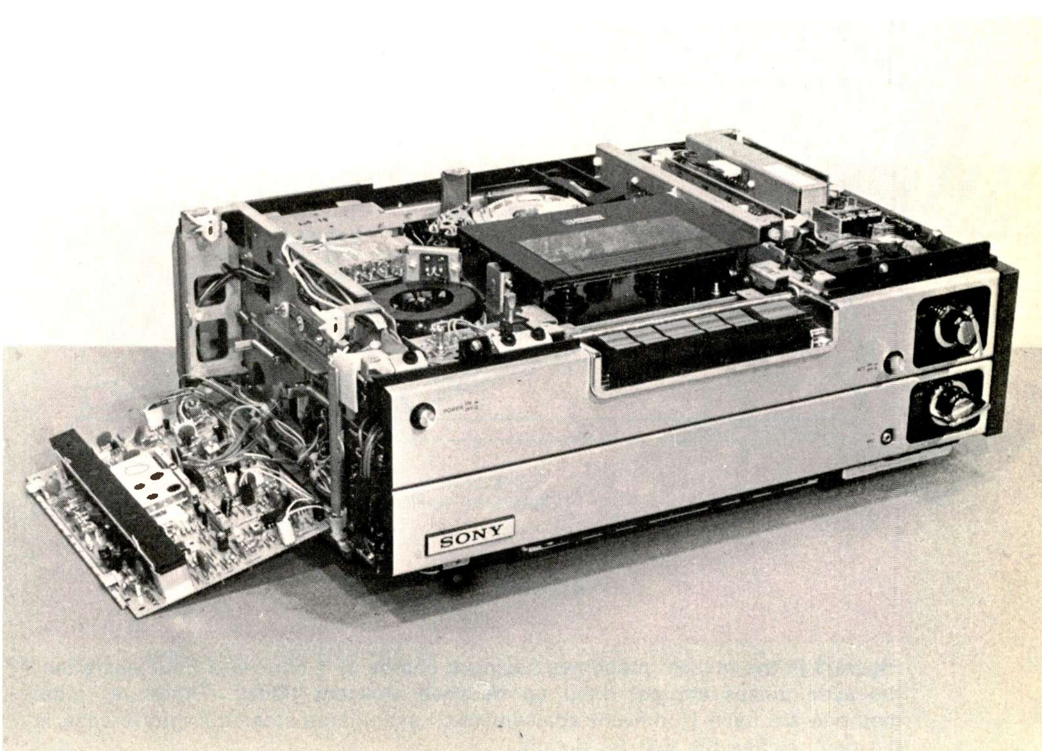
Table 1
Betamax Format Specs

Tape Width	0.5 inches
Video Track Width	30 microns
Head Gap	6 microns
Control Track Width	0.6 MM
Audio Track Width	1.05 MM
Tape Speed	4 CMS & 2 CMS
Head Speed	272 IPS
FM Frequencies	3.5 MHz to 4.8 MHz
Chroma Frequency	688 KHz

Table 1 Betamax format specifications





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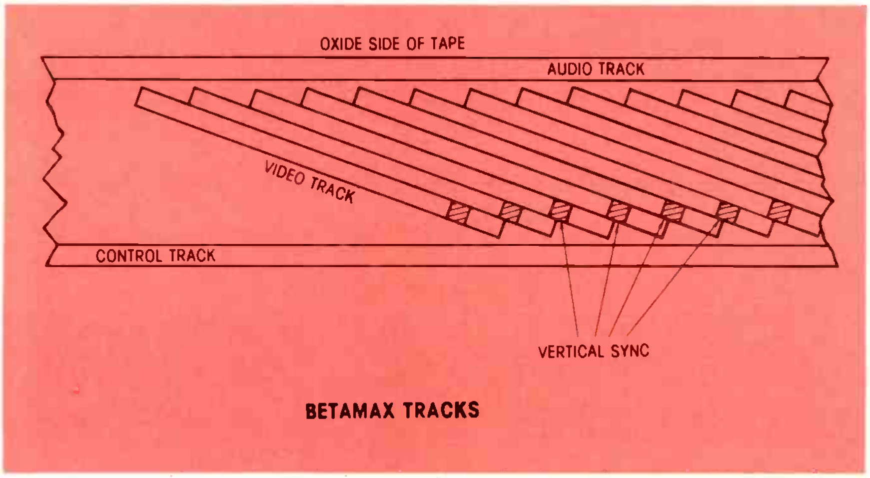

Figure 1 In the Betamax format, the audio and control tracks are at opposite edges of the 0.5-inch tape, and the video tracks are located at an angle to the tape. Each track has the composite video of one vertical field, with the vertical interval recorded near one end.

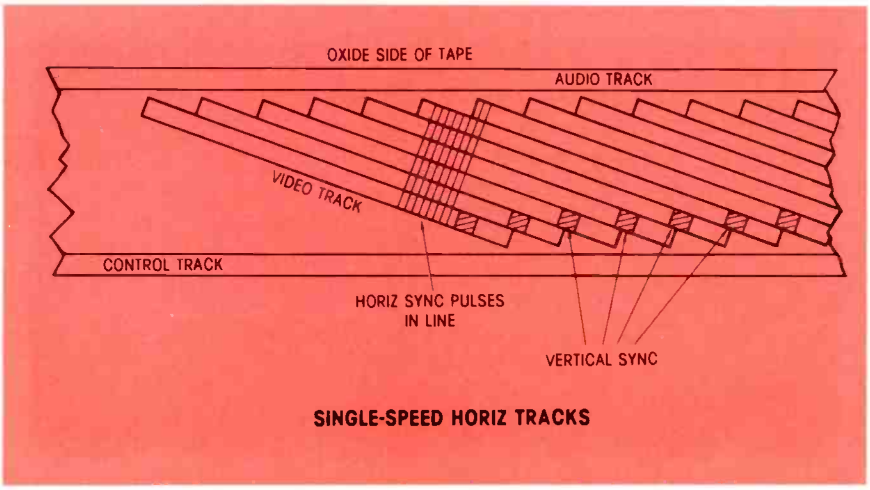

Figure 2 In the older single-speed models, the horizontal sync pulses were in-line across the tracks, to minimize interference patterns from crosstalk.

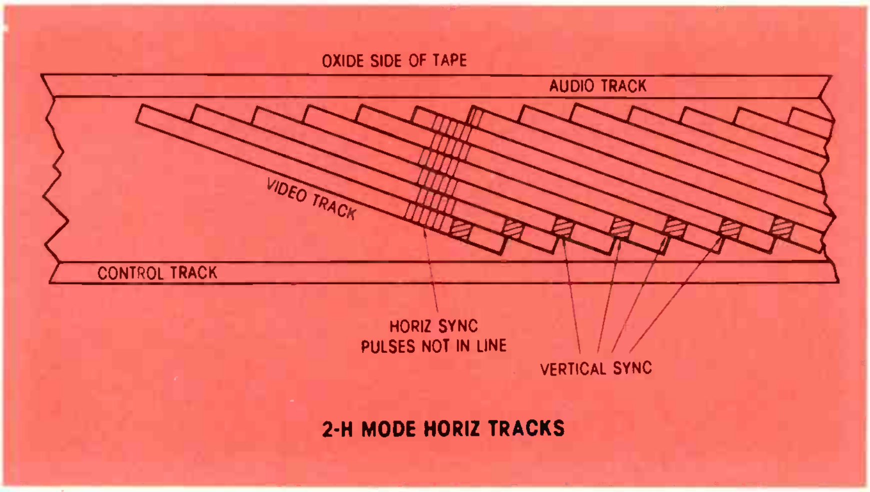

Figure 3 In the present machines having a choice of 1-hour or 2-hour operation, the sync pulses are not lined up between adjacent tracks. Therefore, other methods are used to prevent adjacent-track sync-pulse crosstalk interference in the picture. See the text for details.

During 2-hour operation, the tape speed is halved, and the tracks are so close together that no guard bands are produced. Of course, the 2-hour mode allows a significant saving of tape, because of the slower tape speed through the machine.

Single-speed models (SL7200, etc) have the wider 58-microinch head, so no guard bands are formed.

This lack of guard bands produces the possibility of problems not found in some other VTRs. The most serious of these problems is crosstalk interference patterns in the picture, caused by even the slightest mistracking. Such mistracking occurs during playback if the heads do not follow precisely the same track laid down during recording. Each head covers most of the desired track and part of the wrong one. With guard bands, any mistracking reduces the signal level somewhat, because the head scans part of the track in addition to some of the unrecorded guard band, but there is no crosstalk.

In the Betamax, this crosstalk interference has been avoided by an azimuth offset of the gap in the video heads. One head is canted 7 degrees in one direction, and the other head is titled 7 degrees in the opposite direction. At the high FM frequency, the 14-degree tilt between heads allows each head to ignore the track intended for the other. (In audio recording, a slight tilt between recording and playback heads reduces the high-frequency response drastically. Of course, with video, the recording and playing of each individual track is done by the *same* head, so the tilt is the same for both recording and playing, and the response and signal level is not degraded by the tilt.) The servo operation insures that the proper head scans the matching track.

In the original single-speed models, the format was designed to make the horizontal-sync pulses in the video tracks lined up as shown in Figure 2. This in-line sync is necessary to prevent beat patterns caused by crosstalk between the sync pulses, and to allow still-frame pictures.

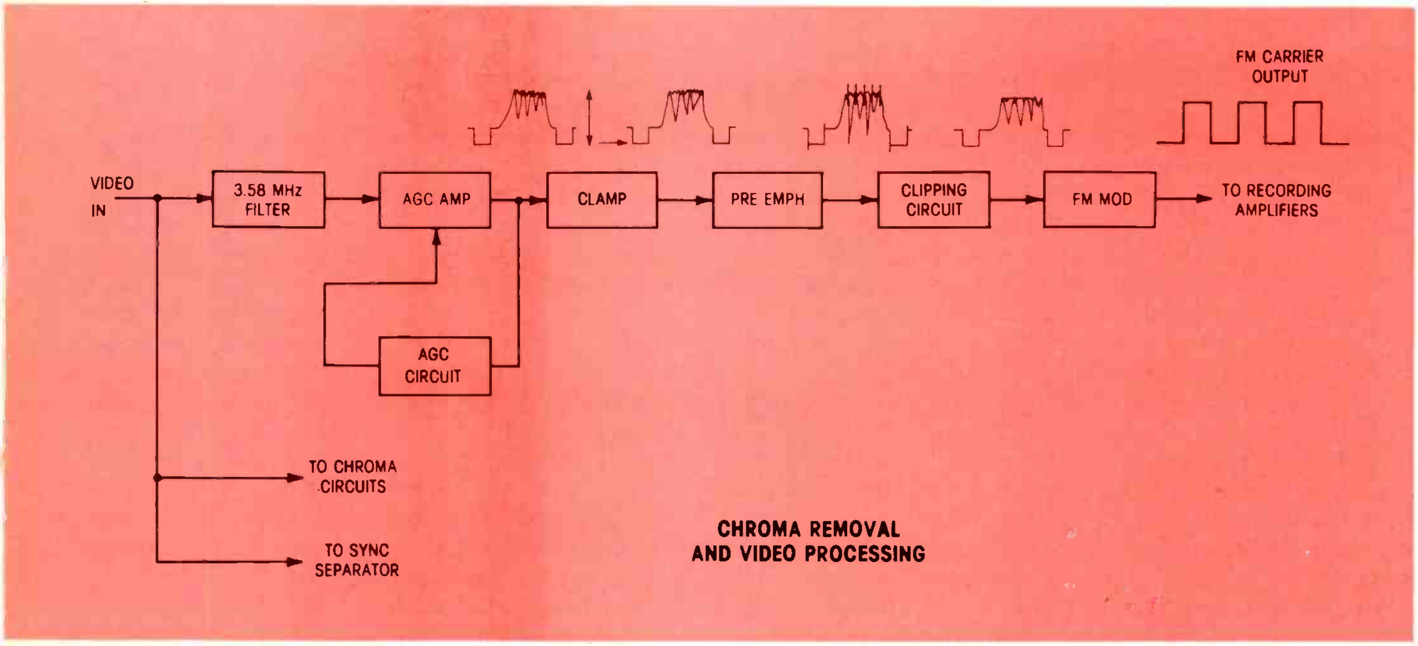

Figure 4 This block diagram shows the general functions necessary during color recordings. Both heads in parallel receive the FM carrier.

However, in the 2-hour mode, the sync pulses are not lined up (Figure 3), and if not otherwise prevented, the sync crosstalk would cause a wavy vertical line near the right edge of the picture. During the recording process, the interference line is eliminated by an alteration of the FM frequency, when the "B" head is recording. We will not discuss the method, at this time.

Because of the horizontal sync-pulse alignment, a video signal with broadcast-type 2:1 interlace should be used. If a small video camera with random sync is used, the sync pulses will drift (because of the camera's unstable sync), and cause shifting interference patterns in the picture.

FM Recording

In video equipment, the standard is a 1 volt peak-to-peak (PP) video signal, and this is the correct input for a VTR. Inside the Betamax, the signal is divided into three paths: the luminance (B&W); the chroma; and the sync separator. We will discuss only the luminance, at this time.

The luminance video first passes through a 3.58 MHz filter (see Figure 4) that removes the chroma signal and the burst. The remaining monochrome video signal enters an AGC amplifier, which will accept a signal between 0.5 volt and 2 volts PP and then adjust it to the correct design level for the circuitry that follows.

DC restoration (sync-tip clamping) is essential for VTRs with FM recording, so the next circuit of the block diagram is the sync clamp. The sync clamp has little more than a diode and a potentiometer to clamp the sync tips, and it operates

continued on page 64

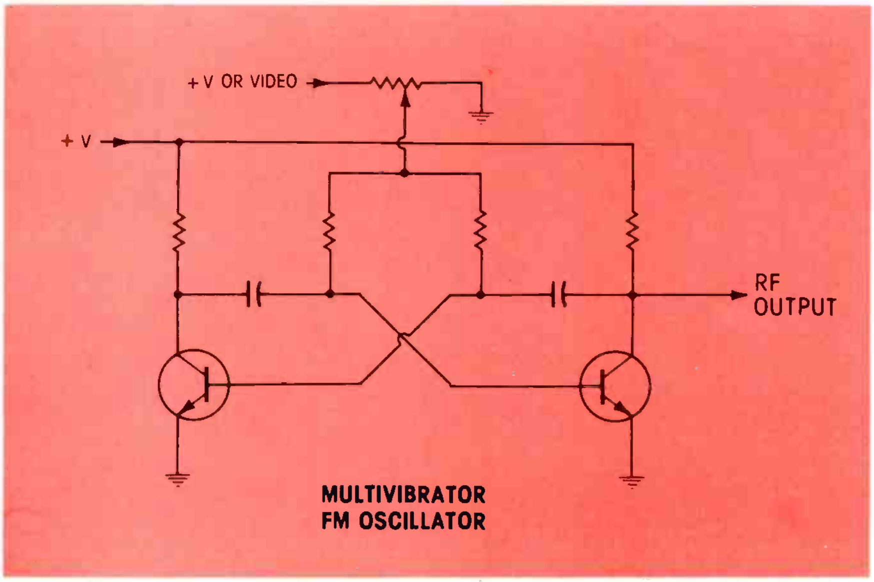

Figure 5 The recording carrier originates in a multivibrator, whose frequency is varied by video that has been changed to DC by clamping. For illustration, the variable frequency is shown being controlled by an adjustable DC voltage.

continued from page 63

to make the signal into varying DC. From this point on, DC coupling is used to preserve the DC component.

Next, to prevent any reduction of the signal-to-noise ratio, the video signal is pre-emphasized by boosting the high frequencies, much like the pre-emphasis used in FM radio. The pre-emphasis sometimes produces overshoots which can exceed peak white or the sync tips, and a clipping circuits removes them.

The signal now is fed to the FM modulator (to be discussed a bit later), and the output of the modulator goes to the record amplifiers. These record amplifiers drive the tape heads hard enough to saturate the tape. The heads are driven by rotating transformers, which consist of about 3 turns of wire mounted on a static part of the head assembly and another 3 turns on a rotating part. Physically, these primary and secondary windings of the "transformer" are very close, to obtain maximum transfer of energy. This system provides frictionless, contactless, and noiseless transfer of the signal.

A simple multivibrator (see Figure 5) produces the FM signal. As with any multivibrator, the values of the base capacitors and resistors determine the approximate operating frequency. The potentiometer of Figure 5 varies a positive voltage that's fed to the base resistors to change the frequency. Increased positive voltage raises the frequency.

Now, if the voltage supply and potentiometer are replaced by a signal, the frequency will depend on the DC level of the signal. Any video signal used to control the oscillator must have a definite DC voltage level for sync, blanking, and peak white, and a variable DC for the video part of the signal. That's why the sync tips are clamped to a certain DC level, and why a definite PP level is required at the output of the AGC amplifier.

FM Demodulation And Playback

Figure 6 shows a block diagram of the playback demodulation system. The same heads that recorded the tracks are used to scan those tracks during playback, and to pick up the tiny magnetic variations from the tape. These small video signals are transferred via the rotating transformers to individual head preamplifiers, one for each head. At the output of the preamplifiers, the frequency response and level of the two signals must be identical.

Also, at the output of the preamplifiers are electronic switches (synched to the head rotation) that pass one channel at a time and block the other. Therefore, from the switching amplifier is a series of FM signals. Alternate "bursts" of signal are those from the same head. In other words, the output signal comes first from head A, then head B, head A again, etc. The scope waveform of Figure 7 shows an abnormally reduced level of the signals from one head. This is a defect that must be repaired before the performance can be satisfactory.

The reconstructed continuous FM signal at the output of the switchers is applied to a series of limiters and amplifiers. Three

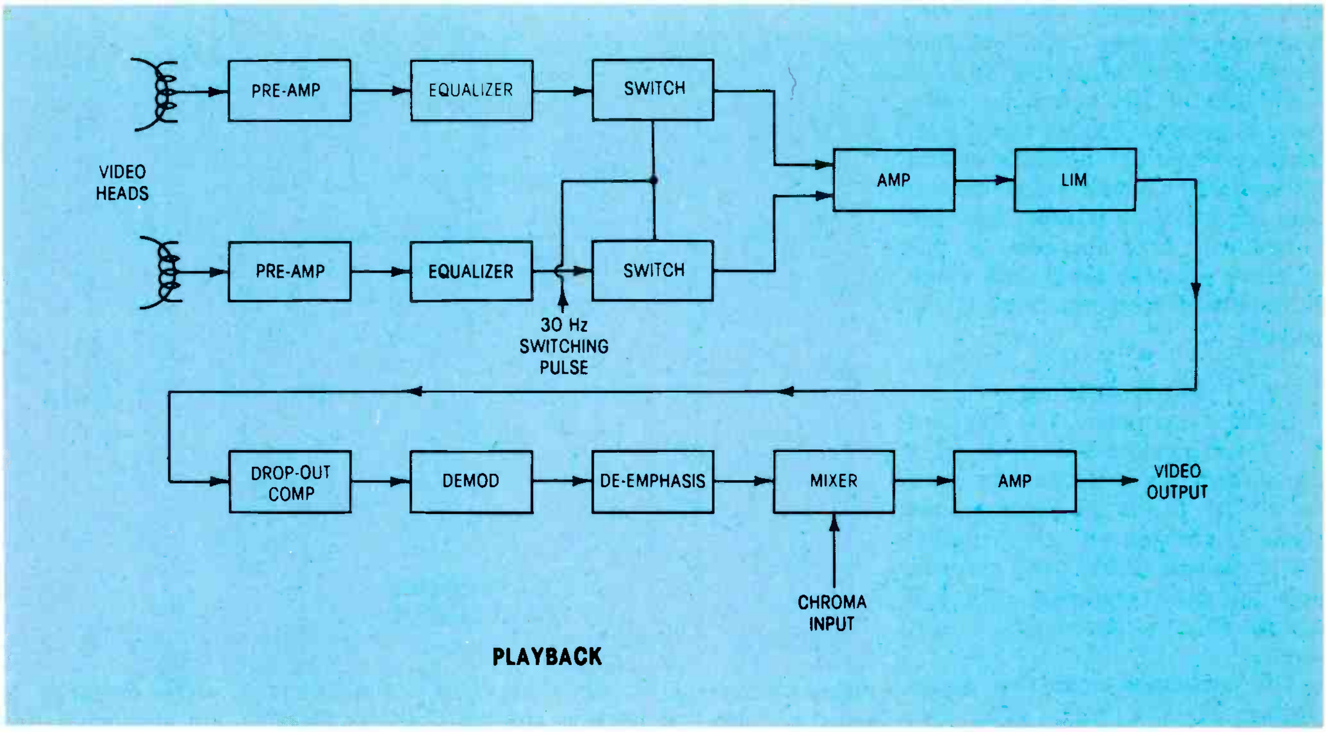

Figure 6 The general functions of a VTR during playback are shown by the block diagram.

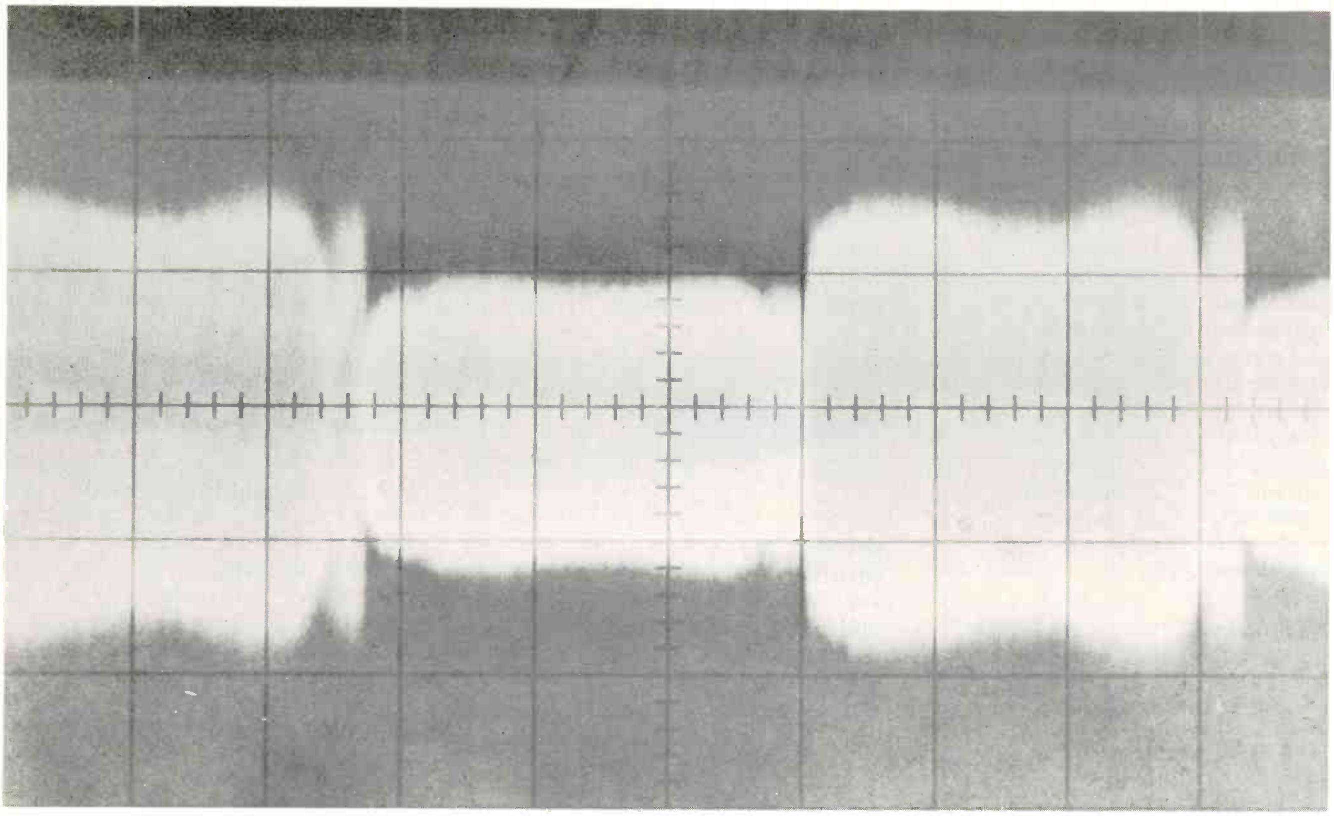

Figure 7 This scope waveform shows unbalanced RF output signals coming from the two heads/preamps channels, after they have been combined by switching.

stages are used to produce an FM square wave with all of the AM variations removed. This is necessary, because the AM variations are noise.

Now, the FM signal is ready for demodulation, which will restore the pre-emphasized video signal. In turn, this signal is de-emphasized by a RC low-pass filter, and is fed to the output amplifiers of the VTR.

During playback, "drop-out compensation" often is used (Figure 8). Small holes or gaps in the oxide coating of the tape cause horizontal flashes on the screen with the picture. Drop-outs can be masked by removing the horizontal line of video where they occur, and replacing that line with a delayed previous line. The Drop-Out Compensator (DOC) senses the loss of FM from the head signal, and operates an electronic switch. This switch substitutes the output from a one-horizontal-line delay circuit, so the previous line of video is repeated.

The DOC sensor circuit has a sensitivity control. When a tape is being viewed, the control is adjusted for a minimum number of flashes.

The E-E Signal

In most VTRs, a sample of the FM signal that's applied to the video heads also is fed to the input of the playback chain. There it is demodulated, and passed along to supply the signal for the monitor picture.

This special monitor output is called an "electronics-to-electronics" signal, or an E-E signal, for short. Therefore, it is an excellent check of the picture quality through both the record and playback circuits. However, it does not reveal what signal quality is actually recorded on the tape. Conventional playback is needed to check that.

General Information

The preceding was general information about VTR functions. Next month, the Betamax circuits are described in more detail. □

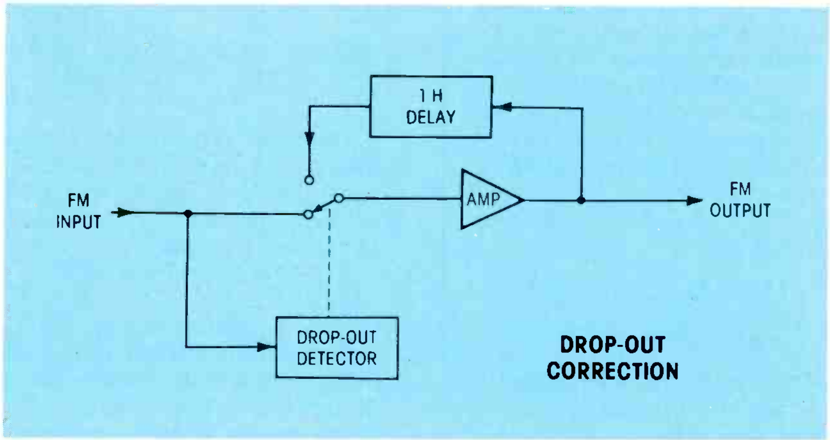

Figure 8 Drop-out compensation is accomplished by substituting a previous horizontal line of video (that's been delayed by the time of one line) for one that has drop-outs. Of course, the switching is done electronically.

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

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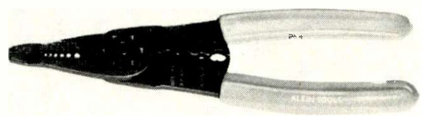
68-72	Pretty good.
76-84	Smart!
88-96	Brilliant!
100	PERFECT! You're a genius!

productreport

Cutting Tool

The model 1010 all-purpose tool by **Klein Tools** is used for cutting wire, stripping wire, cutting screws, and crimping insulated and non-insulated connectors from 10



through 22 gauge. The narrow serrated jaws allow the worker to use the tool as a pliers to pull, loop and bend wire. Cutters for 4-40, 5-40, 6-32, 8-32, 10-32 and 10-24 screws are included.

Circle (28) on Reply Card

Noise Filter

Cornell-Dubilier Electronics has added a new noise filter, the CBFT315D, to its line. The filter corrects transceiver noise interference by reducing both radiated and conducted noise originating from the ignition coil/point assembly.

The unit mounts directly onto the ignition coil with no additional parts, nuts or bolts. The thread arrangement on the filter is metric on one end and standard on the other, allowing it to be used on domestic or imported vehicles.

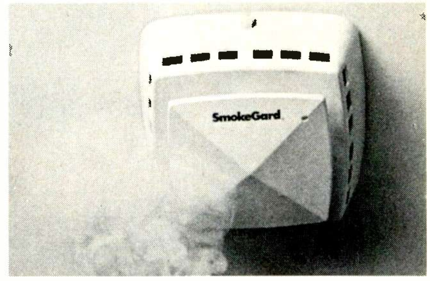
The filter is rated at .1 Mfd, 20 amps and incorporates 600 volt construction to guard against high voltage inductive "spikes" present at the coil terminal.

Circle (29) on Reply Card

Smoke Alarm

An ionization home smoke alarm (S29) by **Mountain West** is designed to detect earliest stages of fire. There are no wires to connect; the unit has a self-contained sounder.

It also can operate remote equipment such as a bell, a siren, a light,



a monitor panel or a telephone dialer using built-in relay with .125 amp, 115 VAC rated contacts, SPDT. The horn "clicks" when batteries are weak. The pilot light pulses every five to ten seconds to assure that the batteries are good.

Circle (30) on Reply Card

Five-Core and Single-Core Solder

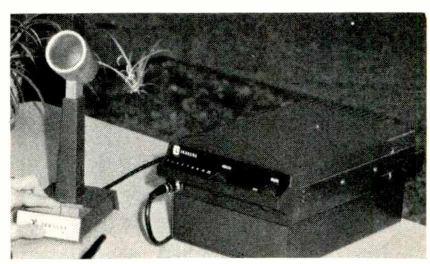
American-made five-core and single-core solder is now part of **Tech Spray's** line of chemicals and service forms. This solder meets federal specifications, and is available on 1-pound spools and 1-ounce pocket dispensers.

Circle (31) on Reply Card

UHF Base Station

The land mobile radio division of the **E. F. Johnson Company** has developed a new UHF base-station two-way radio with 15-watts output.

The Fleetcom II 1558 FM two-way radio base station employs a temperature compensating crystal oscillator (TCXO) for the ±.00025% frequency stability required of base station operation.



Included is a desk microphone, a desk-top pedestal with built-in speaker, and a 117-VAC power supply.

Circle (32) on Reply Card

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test equipment report

Low Distortion Generator

Heath has redesigned their standard audio generator to include pushbutton switching and total solid-state circuitry. The model IG-1272 generator provides a low-distortion sinewave output over a range of 5 Hz to 100 KHz.

Pushbuttons select the first three significant digits and also control the frequency multiplier and output attenuator. The unit can be operated in a continuously-variable frequency mode, also.

A level meter allows monitoring for repeatable setups.

A buffered sync signal, for use with a scope or frequency counter, is available at a rear panel BNC connector. The generator includes cable and leads.

Circle (33) on Reply Card

New SINADDER

Helper Instrument's SINADDER-3 combines the SINADDER with an audio voltmeter, and includes an internal speaker for listening to the

signal in both the SINAD and the audio-volts functions. An internal source of 1-KHz tone is provided. A 115/230-volt transformer and a 12-volt plug are standard.

The SINADDER-3 sells for $249.

Circle (34) on Reply Card

Multimeter

De Forest Electronics has introduced a multimeter that provides accurate measurement of complex waveforms, such as transformer magnetizing current; thyristor-controlled voltage and current; and pulse drive for motors and servos.

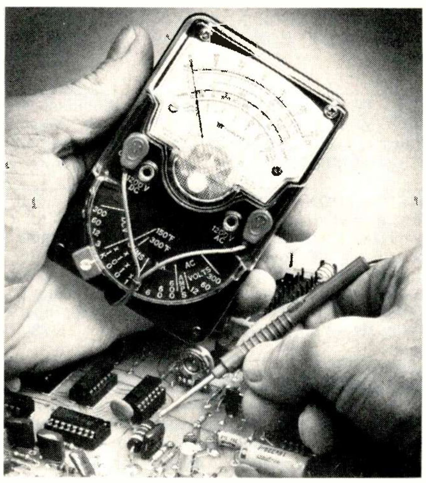
Resistances can be measured in-circuit with minimal loading effects from semiconductor junctions. The maximum open circuit ohmmeter voltage is limited to 2 volts to protect the gate insulation of MOSFETS and other delicate devices. The MM300 also is capable of portable operation for up to seven hours from a sealed-electrolyte internal battery.

Circle (35) on Reply Card

Volt-Ohm-Ammeter

Model 100-T system from **Triplett** includes a small VOM with two direct-reading temperature scales from -50°F to +150°F, and from +50°F to +300°F. In addition to the temperature probe, the 100-T includes VOM leads, a clamp-on AC ammeter, and a plug-in line separator for current readings on standard line cords.

The basic model 390 "shirt pocket" VOM has five AC/DC voltage ranges from 0-1200 volts, four DC milliampere ranges from .6-600 MA, and four resistance ranges from 10K to 10 megohms.



Model 10 clamp-on AC ammeter permits current readings in six ranges (up to 300 amps) to be performed without opening the circuit. And, the plug-in line separator "divides" a standard line cord, to permit clamp-on AC current measurements at sensitive 0.3 and 0.6 ampere full-scale readings.

Circle (36) on Reply Card

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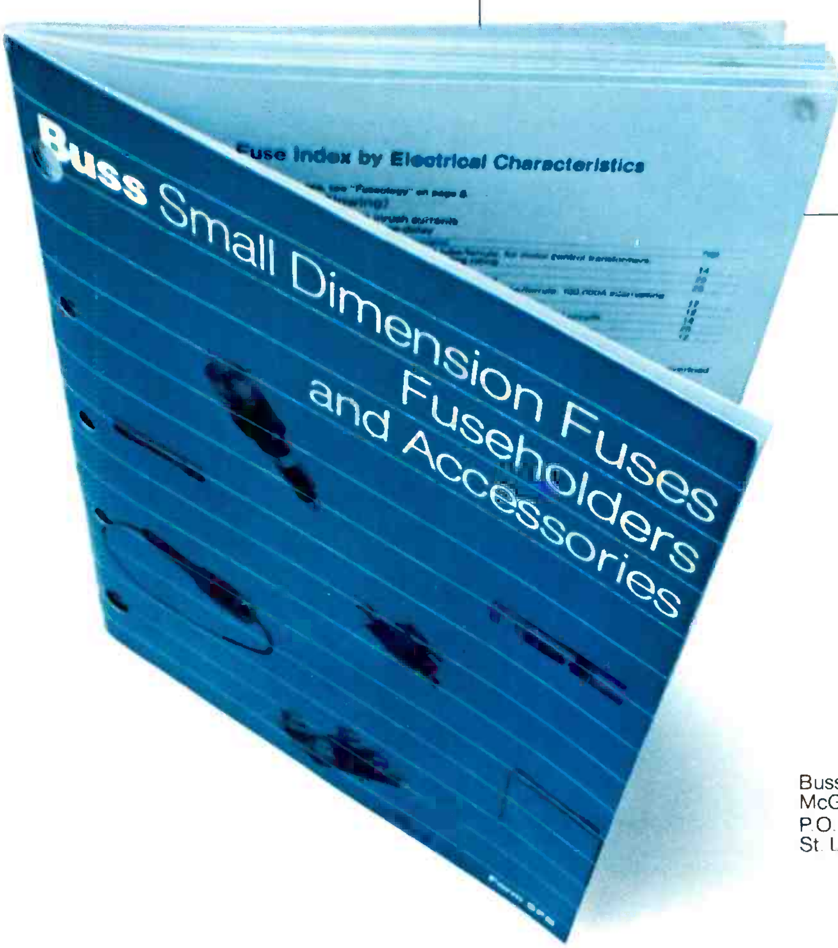

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