February, 1978 ☐ $2.25

Electronic Servicing

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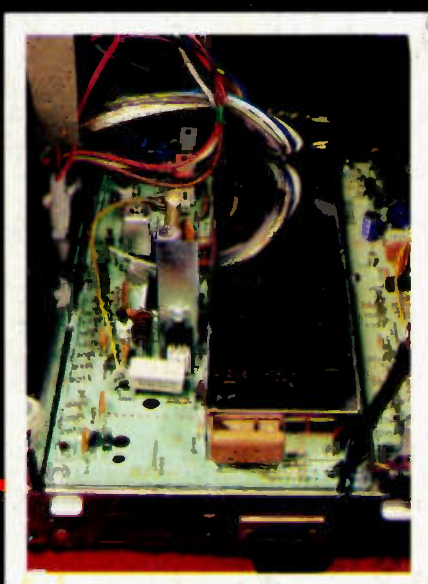
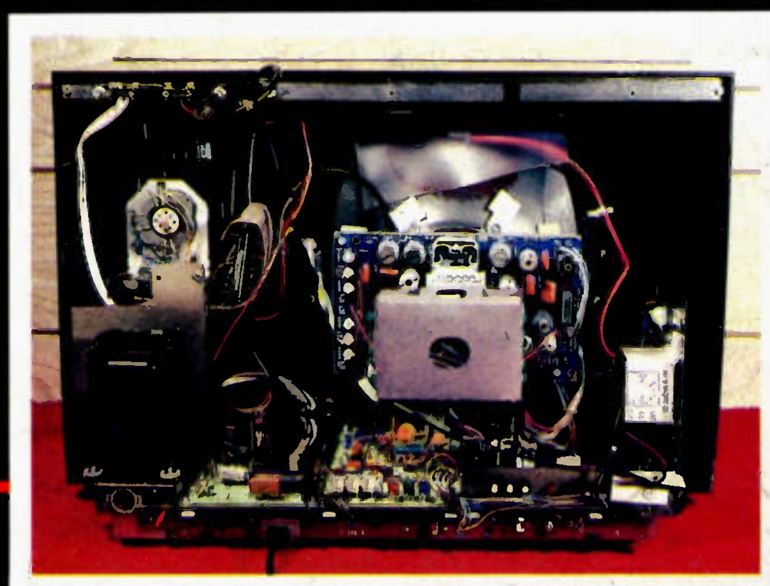
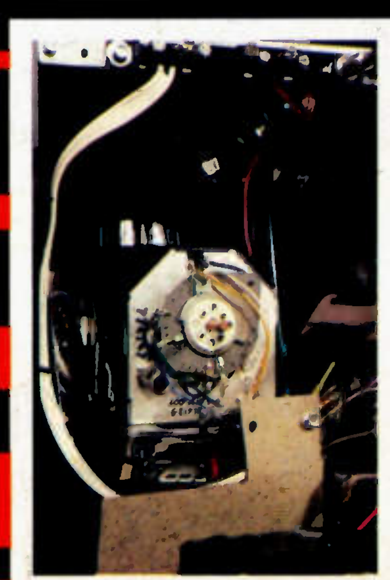
NEW........................

E44 Sylvania Circuits







Sam Wilson's Technical Notebook

Signal-Seeking Radios

February, 1978 □ Volume 28, No. 2

Electronic Servicing®

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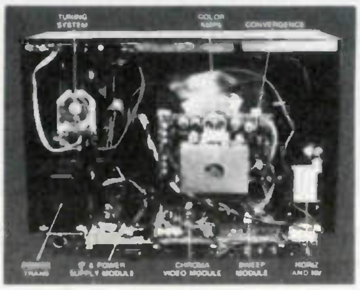

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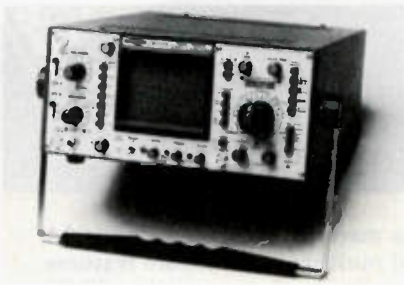

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About the cover—Various views of the Sylvania E44 chassis are shown. The pictures are by Carl Babcoke.

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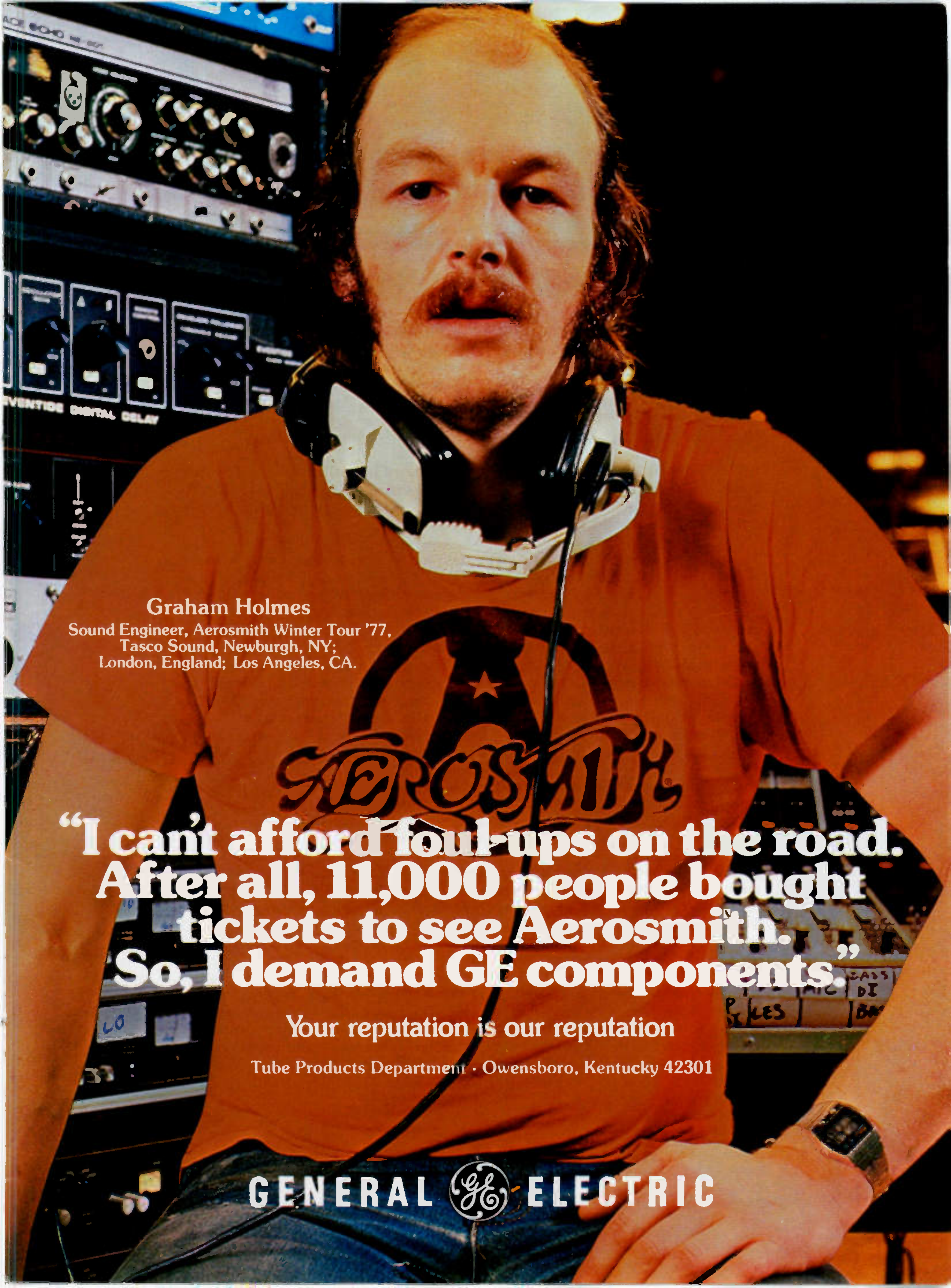
Graham Holmes
Sound Engineer, Aerosmith Winter Tour '77,
Tasco Sound, Newburgh, NY;
London, England; Los Angeles, CA.
"I can't afford foul-ups on the road.
After all, 11,000 people bought
tickets to see Aerosmith.
So, I demand GE components."
Your reputation is our reputation
Tube Products Department · Owensboro, Kentucky 42301
GENERAL ELECTRIC
EVENTIDE DIGITAL DELAY
AEROSMITH

electronicscanner

news of the industry

A report on the competing systems of stereophonic broadcasting in the AM broadcast band was filed with the FCC by the National AM Stereophonic Radio Committee. According to the report, the three systems studied and tested by the committee are capable of transmitting and receiving stereophonic sound with fidelity nearly comparable to FM stereo, as well as being compatible with existing radio receivers and radio transmitters. The systems tested were by Belar Electronics Laboratory, Magnavox, and Motorola.

EICO Electronic Instrument Company recently moved its headquarters to 108 New South Road, Hicksville, New York. The new location will permit the effective integration of the company's engineering, production, and shipping departments in a large, modern building.

Two color television pictures have been transmitted simultaneously over a single channel by CBS. The system, called STRAP (Simultaneous Transmission and Reception of Alternating Pictures) delivered two football games to the CBS technology center in New York via Western Union satellite. The two synchronized signals were fed into the STRAP encoder, which removed the odd fields from one and the even fields from the other. The remaining fields then were combined and transmitted like any normal video signal. The signal was received at the CBS center, and separated into two half pictures. To form the complete pictures, an "interpolation" process created the missing lines by averaging the difference between the remaining lines. This was done by taking one element from the top line, the next element from the bottom line, one from the top line again, etc. After separation, the two pictures were used as halftime football highlights.

The FCC is urging persons applying for CB licenses to stop sending in the $4.00 fee. As of January 1, 1978 the commission suspended collection of all fees, including those for CB licenses. The FCC is currently returning money already sent in, which is slowing down the issuance of new licenses.

A California-based CB manufacturer has been granted a six-month extension to market 23-channel receiver/converters, according to *Electronic News*. The deadline for selling 23-channel CB transceivers was January 1, and it remains in effect. Tanner Electronic Systems Technology received the extension after telling the FCC that 12,344 unsold receivers remained in its inventories, and an additional 15,000 units would have to be repurchased from dealers.

An all-industry Consumer Electronic Service Council has been formed to work with manufacturers to correct inadequacies of supplier warranty-service policies. Although the immediate purpose will be to work out these warranty-service policies, the council eventually will serve as a liaison between consumer electronic-service associations and manufacturers in a number of trade-related problems. The council was formed at a meeting of NARDA, NATESA, and NESDA representatives in Chicago.

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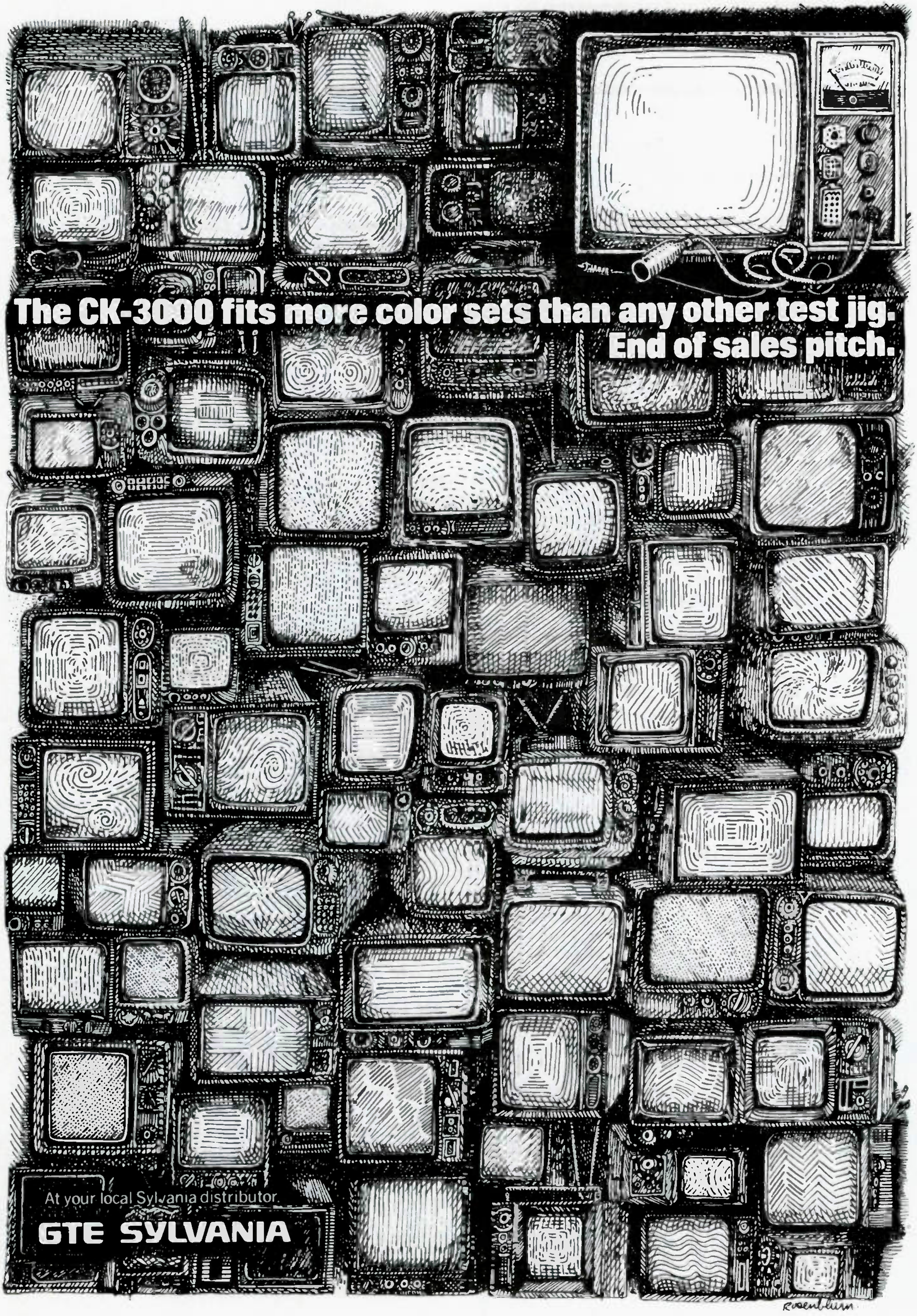

The CK-3000 fits more color sets than any other test jig.
End of sales pitch.
At your local Sylvania distributor.
GTE SYLVANIA
Rosenblum

continued from page 4

RCA and GE have reduced their orders for Japanese-made CB radios, *Electronic News* reports. GE still is actively involved in the CB market, although it has decreased the size of its orders. RCA, on the other hand, it reevaluating its position in the CB market, and may drop out altogether if CB sales do not improve.

Toshiba of Japan is planning to build a color television plant in Nashville, Tennessee. The plant, to be located on a 100-acre tract, will produce 200,000 sets per year, primarily 18-inch models. This line eventually would be expanded to include 12-inch and 24-inch models. Construction is scheduled to begin early this year, with production starting about July. Toshiba is raising $8 million for the new facility.

Counterfeit 4-channel audio receivers are being sold to audio dealers under the Harman Kardon trademark, it has been announced by the company. The receivers (model 900) now being offered were not manufactured, authorized, modified, or inspected by Harman Kardon, Inc., and the company warns that many of these sets will prove to be defective. Neither Harman Kardon nor its warranty stations will accept any responsibility for these receivers. The firm is taking legal steps to protect its trademark, reputation, and dealers.

A series of color television test transmissions over a 12-mile optical fiber loop has been successfully completed by the British Broadcasting Corporation in collaboration with Standard Telephones and Cables. The optical link, with a capacity of almost 2,000 simultaneous telephone conversations, connects two towns located near London. During the tests, no basic problems were identified in the use of fiber optics as a medium for transmitting digital TV. However, indications are that the great potential of fiber optics will be realized in the long-line transmission of television, since microwave channels will not meet all future growth requirements.

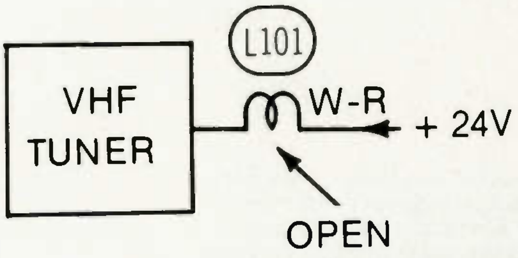
Total U.S. sales of color television receivers to dealers were the second highest in history in 1977, rising to 9.1 million units, according to the Electronic Industries Association (EIA). The record year for color television sales was 1973, when 9.3 million receivers were sold to dealers. The 1977 color TV sales mark of 9,106,826 represents an increase of 18.3% over the 7.7 million units sold in 1976. Total television sales to dealers in 1977 were 14.8 million, an increase of 14.5% over the 12.9 million units sold during 1976. Monochrome television sales in 1977 were 5.7 million, a gain of 9% over the 5.2 million units sold the previous year.

Normal use of electronic video games should not result in damage to TV screens, but prolonged use, particularly on B&W sets, could leave a permanent imprint on the screen. That was the result of tests conducted by the Federal Trade Commission (FTC). The FTC study revealed that electronic games with high levels of modulation could leave permanent patterns on B&W television screens after 100 to 200 hours of use. Nearly 400 hours of prolonged use would be required before any imprint appeared on color TV sets. The FTC said that complaints about imprints have come primarily from dealers, who display the games continuously.

symcure

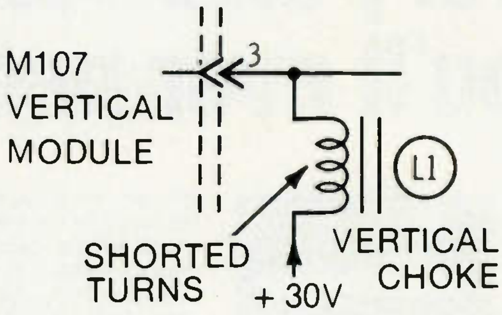
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Magnavox T995
PHOTOFACT—1469-1



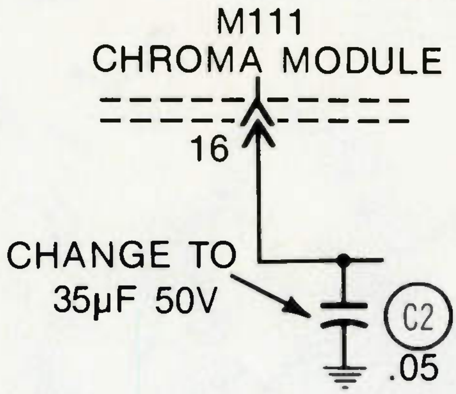
Symptom—Total loss of tuner signal, might be intermittent
Cure—Check L101 (on tuner assembly), and replace it if open

Chassis—Magnavox T995
PHOTOFACT—1469-1



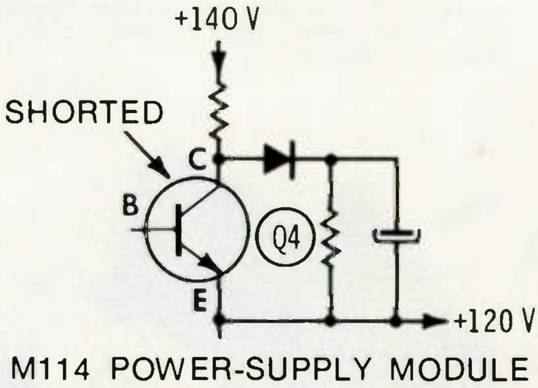
Symptom—Retrace lines and poor height and linearity
Cure—Check L1 vertical choke, and replace it if any turns are shorted

Chassis—Magnavox T995
PHOTOFACT—1469-1



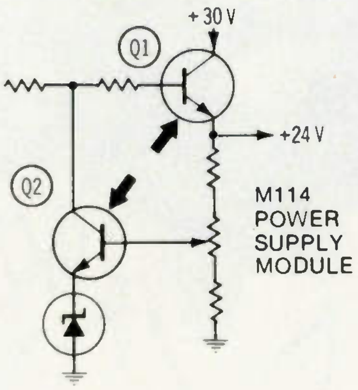
Symptom—CRT arcs have damaged chroma IC
Cure—If early production, replace C2 with 33 microfarad at 50 volts

Chassis—Magnavox T995
PHOTOFACT—1469-1



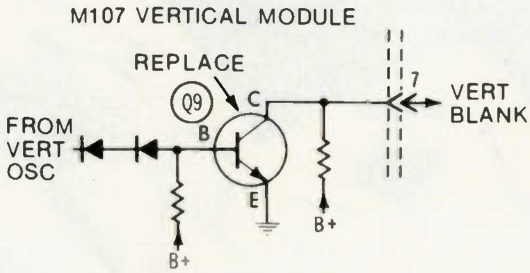
Symptom—Excessive HV, and HV adjust has no effect
Cure—Replace Q4, or the M114 power-supply module

Chassis—Magnavox T995
PHOTOFACT—1469-1



Symptom—Defective M114 PS module
Cure—Examine Q1 and Q2, if either is a 610217-1, replace it with a 171417-1 kit

Chassis—Magnavox T995
PHOTOFACT—1469-1



Symptom—No channel readout with STAR system
Cure—Replace Q9 vertical-blanking transistor, or the M107 vertical module

reader's exchange

Needed: RCA WR-64A color/bar generator, or equivalent. *Fred Jensen, Mill Street, Greenville, New Hampshire 03048.*

Needed: Schematic for an Amphenol number 21266 color-bar generator. Will buy, or copy and return. *E. F. Logsdon, 208 W. De La Guerra, Santa Barbara, California 93101.*

Needed: A back for 21-inch round-tube Zenith color TV; metal or hardboard; state price. *Universal TV, 3223 Lawrence, Oceanside, New York 11572.*

Needed: Power transformer #7034 for York clock radio, model DCR92. *Stan's TV Service, R.D. 2, Box 136, Phillipsburg, New Jersey 08865.*

For Sale: Tektronix model 551 dual-beam scope, with power supply and stand, in excellent condition, $650. *Bob Thomas, Virgo Optics, 33 Poplar Drive, Stirling, New Jersey 07980.*

For Sale: Lectrotech model SMG-12 sweep/marker-generator for VHF channels 2-13 plus UHF, complete with probes, leads, and instruction manual. Like new, $150. *Al's TV Service, 1158 Burton, S.W., Grand Rapids, Michigan 49509.*

For Sale: B&K-Precision 747 tube tester, $125; B&K 1077B analyst, $400; Heath IG57A post-marker/sweep generator, $75. All new and in perfect working order. *Fred Bigelow, 1371 Collier Avenue, Fort Myers, Florida 33901.*

Needed: Riders radio volumes 1 and 23, and the index for volumes 1 to 15, or 16 to 23; old radio tubes with 4 pins; old radio manuals, 1920 to 1950. *Ben Westfall 323½ Newport Ave., Long Beach, California 90814.*

For Sale: Heathkit IG-57A post-marker/sweep-generator, good shape, used very little; Hewlett-Packard 350D attenuator; Thordarson Y48 100° yoke, never used; and RCA 104482 (972958-3). *Wayne Vlieger, 6610 South High, Littleton, Colorado 80121.*

For Sale: Heathkit IM-18 utility voltmeter, $18; and EMC model 212 transistor tester, $9. Both in good condition. *Tom Vander Tuuk, 340 Oakwood Drive, Griffith, Indiana 46319.*

Needed: Source of a 12 VDC turntable for 33-1/3 RPM records. *Greg Sprehn, P.O. Box 740, Laytonville, California 95454.*

For Sale: Panasonic SE-4340 4-track record/8-track modular stereo. Used, $200 (shipping free). *Greg Sprehn, P.O. Box 740, Laytonville, California 95454.*

Needed: Digital-clock assembly part number 1-548-064-00 for Sony model TFM-C660W FM/AM digital-clock radio. *Bernard H. Serota, 2502 S. Philly Street, Philadelphia, Pennsylvania 19748.*

Needed: Service manual for model 1700F Wurlitzer jukebox. *Cliff Nadiger, 8073 Wonderland Boulevard, Redding, California 96001.*

For Sale: CB test equipment, used less than one year, all in excellent condition, manuals included with all equipment. B&K-Precision model 1040 CB Servicemaster, $200 plus shipping; B&K-Precision model 2040 signal generator, $375 plus shipping; B&K-Precision model 1801 auto-ranging frequency counter, $150 plus shipping; and B&K-Precision model 1640 power supply 11-15 VDC regulated, $75 plus shipping. *Gil McCallister, Route 2, Box F120, Frederick Road, Stephens City, Virginia 22655.*

Needed: Schematic and HV transformer (or part number) for Sears TV model 528.60624; also, service manual for GE color TV model WM270 CBW-2. Will buy. *Herminio Torres, 1563 Ponce de Leon Avenue, Rio Piedras, Puerto Rico 00926.*

Needed: Schematic or service manual for a Friden (Singer) model EC1114 14-digit desk calculator. Will buy, or copy and return. *Robert Miller, Route 1, Box 234, Anadarko, Oklahoma 73005.*

Needed: A Lafayette Micro P-450. Want a serviceable unit or a UHF front-end; also alignment procedure. *Conner TV Service, 709 W. Craighead Road, Charlotte, North Carolina 28206.*

For Sale: Heathkit video game (GD-1380) and Target gun (GDA-1380-1) with manuals, assembled, and in excellent condition, $55. *Richard E. Brown, POB 75, Nashua, New Hampshire 03061.*

For Sale: Heath GR270 TV power supply, $20; 5 years of Radio-Electronics Magazine, $4 per year. *D. J. Mace, RD 4, Box 84, Bellefonte, Pennsylvania 16823.*

Needed: B&K-Precision 415 sweep/marker generator; B&K-Precision 1077B TV analyst; and a late-model CRT tester (must be able to check in-line tubes). *George C. Pullen, 6722 Botetourt Drive, Oxon Hill, Maryland 20022.*

For Sale: Heathkit scope model 10-102, factory wired and calibrated, with probes, good condition, $85; and a Telematic VHF-UHF tuner sub, AC or battery, slightly used, $50. *Willis B. Ormes, 1420 Melrose, Fort Wayne, Indiana 46808.*

Needed: Schematic and service manual for Edcor 2-channel wireless amplifier, model SS-22. Will buy, or copy and return. *William Nolting, 1120 Tremont, Cedar Falls, Iowa 50613.*

For Sale or Trade: 100 used TV tuners in lots of 25, for Riders radio manuals, test equipment, or cash. *Troch's Television, Radio, Appliances; 290 Main, Spotswood, New Jersey 08884.*

For Sale: Model 1M-16 Heath solid-state voltmeter; model 1G57A sweep generator; model 1G72 audio generator; model KG635 5-inch Knight scope; model KG686 Knight RF generator, model 1077B B&K-Precision Analyst. All in good condition. Reasonable offer. *F. E. Christian, 43 Redbud Drive, Route 2, Harrisman, Tennessee 37748.*

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reader's exchange

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For Sale: Approximately 450 TV tubes, all in original boxes, 55 transistors and ICs, plus miscellaneous parts. *A. R. Tuttle, 8266 Robindale, Dearborn Heights, Michigan 48127.*

Needed: A meter for an Accurate Instrument Company model 257 tube tester. Or, the name and address of someone who can repair the meter. *Ponce L. Smith, 2978 Holcomb, Detroit, Michigan 48214.*

Needed: Horizontal driver transformer, number 21-0073 (G-12323) for Truetone TV model 2DC3609. *H. Sievers, 6819 Willamette Drive, Austin, Texas 78723.*

For Sale: Sylvania color test jig, model CK1500X, in good condition, with set-up index, all universal cables, 30 yoke cables, and 19 color cables; $350, plus shipping. *W. W. Pegues, P.O. Box 25592, Charlotte, North Carolina 28212.*

Needed: Schematic and service information for an Allied AM/FM-stereo receiver, model 390; and also for APF AM/FM-stereo plus 8-track receiver, model 303. Will buy, or copy and return. *Thomas Lutz, Consumer Electronics, 614 Edwards, Aurora, Illinois 60505.*

For Sale or Trade: WD11 and WD11A tubes, $10 each; Radiola battery-radio service manual for 1922-1927, 35 pages, $5, covers all Radiola battery radios and 10 not covered in Riders. *Antique Radio Shop, 3403 Broadway, Long Beach, California 90803.*

Needed: Schematic and operating instruction for Precision E-200 signal generator; also, need to buy tube checker and capacitor tester. *Ralph Dorough Radio & TV, 117 Pecan, Terrell, Texas 75160.*

For Sale: B&K-Precision 1077B TV Analyzer, like new, asking $450; Heathkit capacitor and resistor sub boxes; and EMC tube tester, model 213. *Pete Varsalona, 44 Mason, Newton, New Jersey 07860.*

Needed: Operation manual and schematic for a Hickok model 610A universal television and FM alignment signal generator. Will buy, or copy and return, paying postage both ways. *Thomas E. Phillips, 404 E. Main, West Newton, Pennsylvania 15089.*

Needed: Picture tube for Symphonic miniature 1½-inch screen B&W TV model TPS-30, new or used in good condition. State price. *William E. Branch, Branch's TV Service, 3722 Emerson, Jacksonville, Florida 32207.*

Needed: Hickok 209 (A or B), a good mutual-conductance tube tester, and a late-model transistor tester that identifies and tests FETs, etc. *Kenneth Miller, 10027 Calvin Street, Pittsburgh, Pennsylvania 15235.*

Needed: Schematic and alignment data for a Heathkit AR-3, and for a Bendix MRT-6FB FM transceiver (converted for 2-meter operation). Will copy and return. *Robert D. Houlihan, 497 East Fremont, Galesburg, Illinois 61401.*

Needed: Service data for a Mayfair AM-FM phono/stereo and 8-track model 3502D. (It appears to be made by Sanyo.) Numbers on the printed circuit board are CMK-33/P-1071. *Lawrence D. Brown, BBC Box 153, Springfield, Missouri 65802.*

For Sale: Sencore PS148A scope; B&K-Precision 1075 analyzer. Both like new, make offer. *Edward Morawski, 8640 Warren Boulevard, Centerline, Michigan 48015.*

Needed: Schematic for Dynavox stereo phonograph, model 624. *A. J. Snell, 49 Abbott Road, Somerset, New Jersey 08873.*

Needed: Power transformer (part #T23B91) for Triplett model 3441-A scope. Also, need manuals for the following: Ballantine peak voltmeter model 305-A, and Tektronix time mark generator, model 180-S1. *Clyde N. Smith, 11 Brown, Reynoldsville, Pennsylvania 15851.*

Needed: Service manual for a Pioneer Stereomaster receiver model SMB200 #GG4277, made in Tokyo about 25 years ago. Will buy, or copy and return. *Edward C. Brown, Box 134, Cromberg, California 96103.*

For Sale: Kenwood general-coverage short-wave receiver, $175 plus shipping; and Yaesu FT-101EE amateur SSB transceiver, $600 plus shipping. Also, send SASE for a listing of personal belongings from my DX shack. *Bill Coleman, Jr., Coleman Electronics, P.O. Box 1601, Rocky Mount, North Carolina 27801.*

For Sale: Bell & Howell radio and television training course: includes 16 textbooks, all experiments, all tests with answers, and design console (AC/DC power supply and sine-square wave generator) $250. *David Tully, 586 Buttonwoods, Warwick, Rhode Island 02886.*

For Sale or Trade: A 1077-B B&K-Precision analyst and a 415 sweep/marker generator, both in warranty, with cards. Best offer. I need an RCA WR514A sweep/marker generator and a Simpson 383-A. *Thomas F. Burns, 9 Allegheny Terrace, Pittsburgh, Pennsylvania 15207.*

For Sale: B&K-Precision TV analyst model 1077B, 6 months old, never used, $340; B&K-Precision model 501A semiconductor curve tracer, $95, hardly used; and EICO signal tracer model 147A, $30. *Ashly's Electronics, 644 Central, East Orange, New Jersey 07018*

Needed: Rider, Supreme, and factory manuals; also early radio textbooks from the 1930s and before. Write giving the asking price. *M. Beitman, P.O. Box 46, Highland Park, Illinois 60035.*

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reader's exchange

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Needed: 1077B B&K-Precision, and Sencore FC45, TF46, CB42, VA48, CB41, SG165 and YF33. *Edward Morawski, 8640 Warren Boulevard, Centerline, Michigan 48015.*

Needed: Schematic for Hewlett-Packard model 200C audio oscillator. Will copy and return. *G. Grass, 1122 Madison, Rahway, New Jersey 07065.*

For Sale or Trade: Heath TV post-marker sweep generator model IG-57A, in good condition, complete with instructions, 75-ohm cables, attenuator and probes, $75; and Eico flyback and yoke tester model 944, new, with instructions, $25. Need Heath sine/square audio generator model IG-18 (or equivalent). *W. W. Pegues, P.O. Box 25592, Charlotte, North Carolina 28212.*

For Sale: Old radio tubes, types 47, 5Z3, 56, 6B7, 6B5, 39/44, UX171A and UY227. *Bob Gelnett's Radio & TV, R.D. 1, Box 498, Liverpool, Pennsylvania 17045.*

Needed: Fourth video-IF transformer part #VIF-2508 for a small Singer TV, model #TV6U. *Brothers' Electronics, 15485 Grayfield, Detroit, Michigan 48223.*

For Sale: Heathkit vectorscope model IO-101, $120; B&K-Precision semiconductor curve tracer, $90; and EICO signal tracer model 147A, $25. *Ashly's Electronics, 644 Central, East Orange, New Jersey 07018.*

Needed: Flyback transformer for Broadmoor model 9611C, part number VZ12017; new or good used. *J.C. Sellers, 26771 Bruce, Highland, California 92346.*

For Sale: RCA Mark II color test jig complete with adapters, like new in original cartons, $100; and GC tube-tester/CRT-reactivator, $30. *Douglas Haustein, 94 Winaws, Crawford, New Jersey 07016.*

For Sale: About 1800 new tubes (one or more of each number), some instruments, other components, etc. All for $9000 cash, and you pay the freight. *R. J. Tuttoilmondo, 6739 Pecanwood Road, Hitchcock, Texas 77563.*

Needed: Schematic and parts list for a Jackson picture tube tester/restorer model 825. Will buy, or copy and return. *Lalla Servicenter, 3825 South Broadway, St. Louis, Missouri 63118.*

Needed: CB radios (working or not). Send price, and I will advise. *Willman Cullen, 3701 West First, Suite 201, Los Angeles, California 90004.*

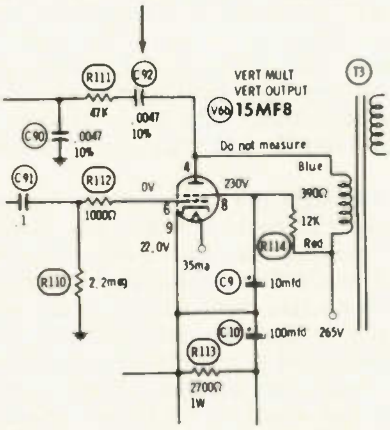
Needed: A 3-inch dual-trace triggered-sweep solid-state scope for 4 MHz or better. Include all original manuals. Will consider purchase of a non-working repairable unit. *P.J. Hanson, 207 Long, North Aurora, Illinois 60542.*

Needed: Instruction manual for B&K-Precision TV analyst model 1075. Will buy, or copy and return. *Stanley W. Griffin, 700 Steele, Winnsboro, Louisiana 71295.* □

troubleshooting tips

Rapid vertical roll
Zenith 14CC16Z chassis
(Photofact 1233-3)

The hold control could not stop the roll. I began to check the DC voltages and noticed an erratic negative voltage at the grid (pin 6) of the 15MF8 vertical-output tube. This point normally should have zero volts.



After more testing, I found a shorted capacitor (C92) in the positive-feedback loop. Replacing it allowed locking of the vertical, and restored the zero voltage in pin 6.

Charles Jackson
Buchner, Illinois

Hum, distortion, and intermittent volume
Windsor AM/FM radio, model 2136
(No Photofact)

The AM/FM radio, a transistorized replica of a circa-1932 "cathedral"-type, had 60-Hz hum, distorted FM, and an intermittent volume control.

A shot of tuner wash cleaned up the volume problem, but the hum remained.

I first tested the two power-supply filters (470 microfarad at 16 volts) in circuit with a capacitance meter, as the copper leads were exposed above the circuit board. The filters were okay. After scratching my head a few times, I looked carefully at the other side of the PC board and found that the negative lead of one filter had never been soldered at the factory.

Re-soldering eliminated the hum on both bands. Apparently, mechanical contact of the filter lead to the circuit board kept the problem from showing up before. However, the FM sound still was garbled.

A magnifying glass and some "eyeballing" spotted a broken lead of a disc cap in the FM IFs. Nicks on the lead (probably made by an assembler) weakened it to the point where vibration finally broke it. Soldering restored the FM tone quality and added greater accuracy to the FM dial calibration. The repair was complete.

Rudy Dehn
Brooklyn, New York

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troubleshooting tips

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Pinball machine resetting Bally "Fireball"
(No photofact)

While I was operating the flippers or bumpers on the "Fireball" machine, it occasionally would reset itself for no apparent reason. The score would go back to zero, and all lights for bonus, extra ball, number of players, and balls in play would light up.

The local distributor told us to replace the main logic circuit board, but this did not correct the problem.

At first, I thought the machine was overloading the power supply, but could not find any evidence of it. So, while playing the machine and looking for symptoms, I realized what the problem could be: an open spike-protection diode on one of the relay coils.

The reason is that the voltage pulse from a de-energizing relay coil can make logic circuits go crazy. Although I didn't find an open diode, I did find one flipper relay coil which didn't have a spike-protection diode. I installed one, and the problem hasn't reoccurred since.

William Britt
Wilmington, North Carolina

No reception, receiver noise present Realistic TRC-57 CB radio
(Photofact CB-102)

The customer complained that the set would go dead, but preliminary bench tests showed no problems. When taking a closer look, however, I found a defective voltage regulator in the AM transmit circuitry. I replaced TR-31 and TR-30 (both transistors were open), and returned the set to the customer.

One week later the customer brought the set back, with the same complaint. This time, after 24 hours of "on" time, I happened to be listening in the SSB mode, when I heard 'birdies" that seemed to move across the channel I was listening to, and then nothing but clear channel noise could be heard.

On a hunch, I connected the frequency counter to TP-5 (19-MHz VCO-buffer output). The frequency should have been 19.357 MHz (channel 16), but read 19.8 MHz.

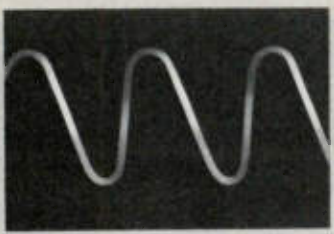
I checked the VCO output control voltage at TP-3, and found a normal 6 VDC. But, when I shorted TP-3 to ground (which should have changed the frequency drastically), there was no effect.

When I removed the VCO module from the PC board and de-soldered the lid of the can, I discovered that all the components inside the can were potted in epoxy resin. That stopped any repairs to the module.

After waiting six weeks for a replacement module, I installed it, and the new module worked perfectly, with no adjustments needed.

Alfred Soboleski
Hamburg, New York

Two Emmys for VIR. One to the signal. One to General Electric for using it first.



The National Academy of Television Arts and Sciences made two awards last year for outstanding achievement in engineering development.

An Emmy to the Electronic Industries Association committee that developed the VIR signal. And an Emmy to General Electric "for the first application of the Vertical Interval Reference (VIR) signal system to television receivers."

When the VIR signal is added to the picture signal, stations can automatically correct the color balance even though distortions may have occurred on the way. The development of VIR was a big step for color broadcasting.

With the VIR signal system established, the next challenge was to design a TV set that could use it. So General Electric developed the VIR Broadcast Controlled Color System. And won an Emmy of our own.

With computer-like circuitry, GE VIR color sets automatically adjust color and tint – sixty times a second – in accordance with the VIR signal broadcast with many color programs.

We know you'll be passing on the news of our Emmy to your customers. So will we. In national TV and magazine advertising. And with a full dealer promotional kit. All highlighting General Electric's Emmy award-winning VIR Broadcast Controlled Color System.

THIS IS GE PERFORMANCE TELEVISION.

GENERAL ELECTRIC

Servicing Sylvania Color TV, Part 1

By Gill Grieshaber, CET

This first article describing circuit operations and features of the Sylvania E44 chassis, also analyzes the varactor tuners and the power-supply functions. This is a 19-inch table model having relatively uncomplicated circuits, which should contribute to the dependability and permit convenient servicing.

General Description

The 19" table-model E44-chassis Sylvania will be analyzed thoroughly for the next few months. The chassis has three large modules, with pin connectors that allow each module to be removed without unsoldering (after four screws are taken out). In addition, a small module is on the tuning assembly, and a circuit board (with the color-output transistors and other components) is fastened to the base socket of the delta-gun picture tube. This contrasts with other TVs, which have a dozen or more smaller modules.

Features

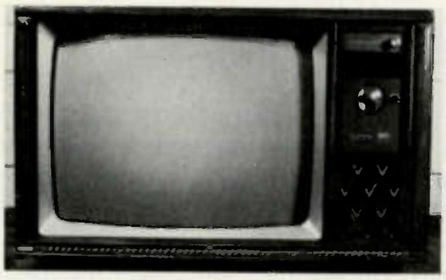
These are some interesting features of the Sylvania E44 chassis color TV:

- A voltage-regulating power transformer supplies AC power. This is the kind that has the 3.5 microfarad capacitor across the saturated secondary windings;
- Both of the VHF and UHF tuners are varactor-tuned types;
- One tuning knob selects 13 VHF and 9 UHF channels, with the illuminated numbers shown on the single rotating drum dial. The UHF channels require a simple adjustment for each active channel, and a front-panel meter helps locate the desired channels;
- A digital count-down circuit eliminates both the horizontal-hold and the vertical-hold controls;
- Four transistors are used in the video IF circuit;
- A front-mounted light sensor varies the contrast, brightness, and color according to the intensity of the room lighting;
- Only 155 watts are required for a non-remote model; and
- All of the ICs and most of the transistors plug into sockets, for easy removal during servicing.

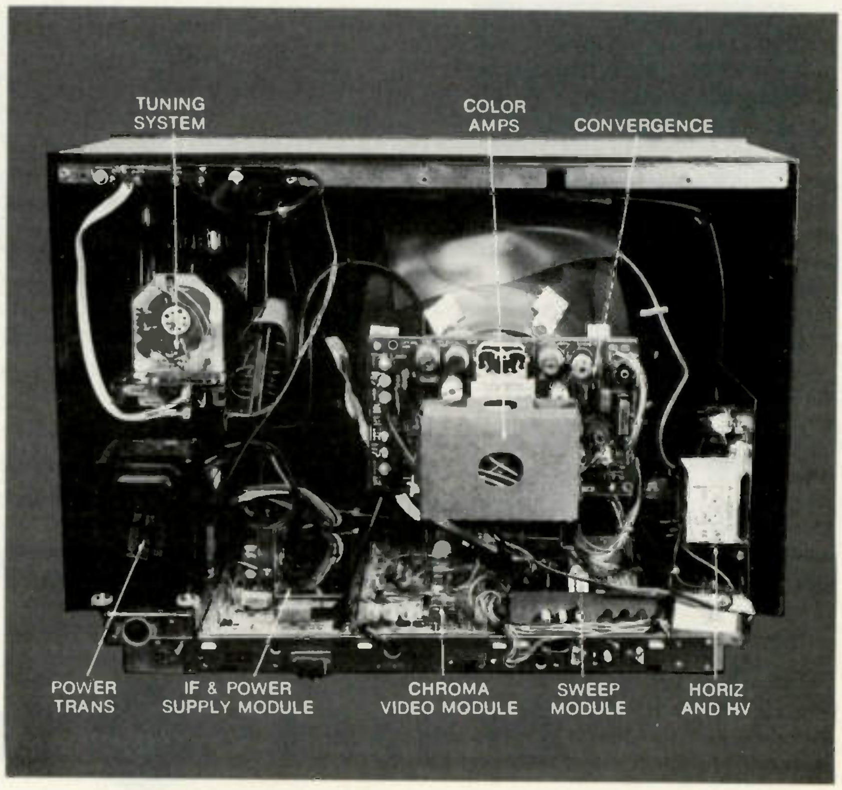
Details of these features and other important circuit operations will be discussed in depth.

Varactor Tuning System

When I first glanced at the tuner area (Figure 1), I thought the large shielded enclosure contained a conventional turret tuner. After all, the appearance is nearly identical to such tuners, complete with a drum dial operated by gears from the "tuner" shaft, and with a wafer switch mounted on the shaft outside at the rear. But actually, the housing contains the "tuning mechanism," consisting of 21 strips on a drum. And each strip has a multi-turn variable resistor (poten-



Sylvania model CX7176P (chassis E44-03) has a simulated-wood cabinet, a single tuning knob and channel-number drum for 13 VHF and 8 UHF channels, and a 19" delta-gun picture tube.



Layout of the solid-state modules (at right) and other components is uncluttered. Some modules and other major components are indicated. A small module is attached to the tuner assembly, one circuit board is combined with the picture-tube base, and the convergence board is attached to the convergence components on the neck of the picture tube. A regulating transformer is included, for "cold-chassis" operation.

tiometer) that determines the tuning voltage for one TV channel. The switch at the back supplies the bandswitching DC voltages for both varactor tuners, which are mounted below the assembly, almost out of sight. A bottom view of the tuners is shown in Figure 2. Other Sylvania models have combined VHF and UHF varactor tuners.

The tuner assembly

A side view of the tuner-mounting assembly is shown by a picture and a drawing with callouts in Figure 3. When a remote control is included, the receiver mounts above the tuning mechanism, and the motor fastens to the back end of the shaft.

Figure 4A shows several of the variable-resistor strips of the tuning mechanism. At the left are the gears that turn the threaded rods which move the center contact of the resistor. This corresponds to the fine tuning in conventional tuners. At the lower left is the white roller of the detent. These strips can be removed by merely pressing them toward the front of the mechanism and lifting out the rear end.

One of the tuning-resistor strips is pictured in Figure 4B after its

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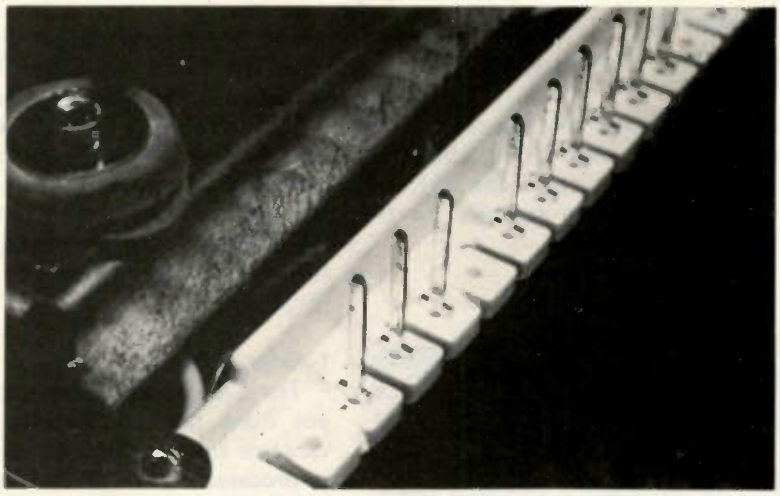
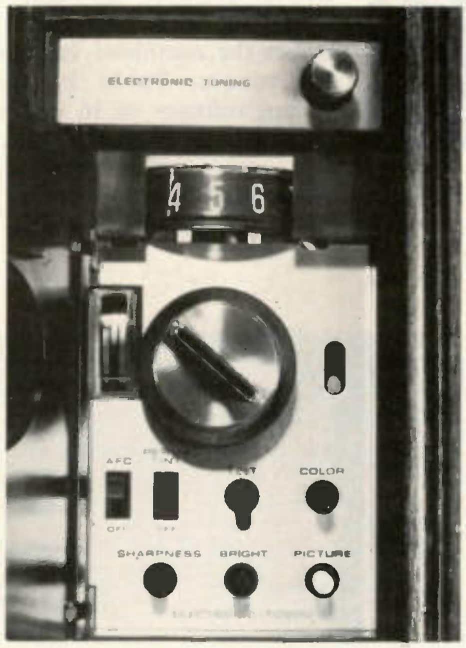


The three large modules (above) are connected by strips of pins at the chassis (as shown here) and by spring sockets on the modules. In addition, each module is held securely by four screws.



When the door of the controls is opened, the tuning meter (at the left), the AFC and PermaTint switches, and the variable controls are accessible.

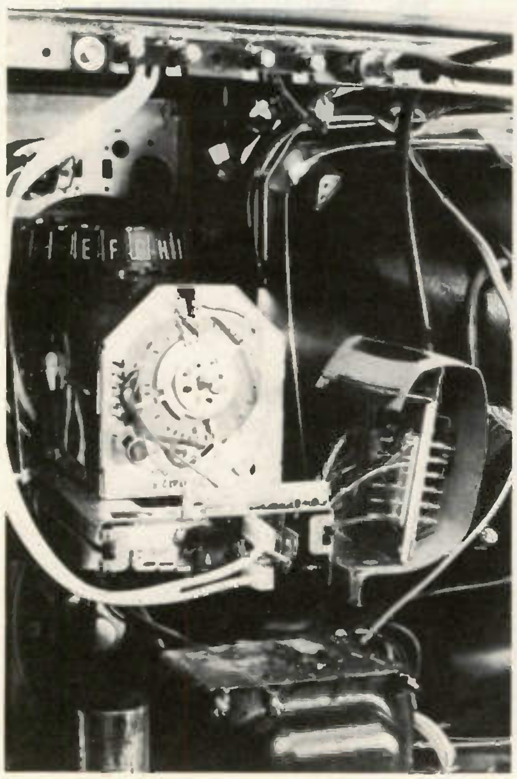
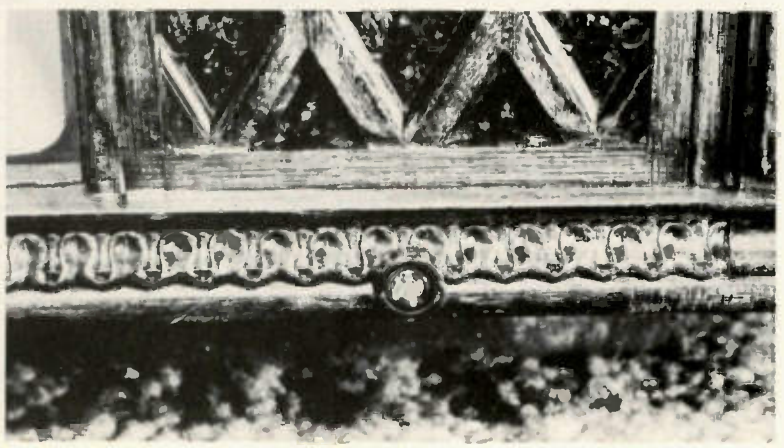


Figure 1 (at left) The tuner assembly appears to have a conventional turret tuner and a rotating channel-number dial. However, the tuner-like enclosure really has 21 variable-resistor strips that originate the tuning voltage for each channel. The VHF and UHF varactor tuners are mounted underneath the shelf, and a small module with tuning-voltage and AGC transistors is attached to the side.

The sensor of room light is located just below the speaker grill.



Sylvania

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removal from the turret. One contact is at each end of the strip, and the ground is made through the spring that is fastened to the "bottom."

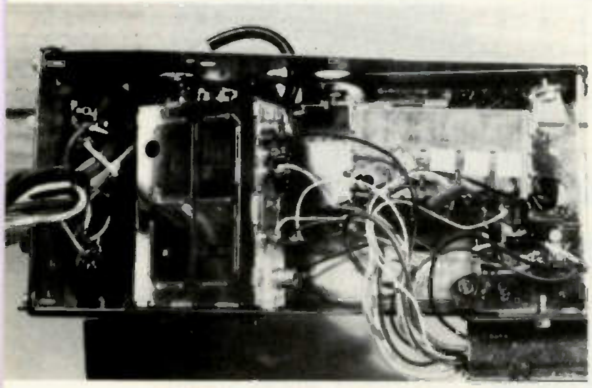

Figure 2 The VHF tuner is at the left, and the UHF tuner is at the right, in this picture of the bottom of the tuning assembly. Neither tuner has any moving parts, because they are varactor-tuned.

The block diagram of Figure 5 gives the interconnections between elements of the tuning system.

Included on the 02-43057-1 module that's attached to the tuner assembly are two transistors for the RF AGC, and two emitter-follower transistors for the processing of the tuning voltage from the strips (Figure 6).

Tuning voltage

The DC voltage from each strip pot does not go directly to the varactor tuners. Instead, the voltage is processed through two cascaded emitter followers (see Figure 7), and then the AFT voltage is added before the combined voltages reach the tuners. Table 1 shows the tuning voltages of 16 channels, as measured in the sample TV.

Tuner AGC

An RF stage is supplied in the UHF tuner; therefore, additional processing of the tuner-AGC voltage from the main TV chassis is required, as shown in Figure 7B.

Q1202 is wired as a common emitter, so it does give some gain. The output goes to the RF stage of the VHF tuner, and also to the next AGC transistor, Q1204, which is a darlington-type emitter follower. The darlington transistor has very-high input impedance. From the emitter, the UHF AGC voltage passes through the voltage-delay diode (SC1222), and on to the UHF tuner.

Power Wiring And Supplies

The schematic of Figure 8 shows the power-transformer wiring, the +201-volt supply, the regulator circuit for the +25.6-volt supply, the +37.1-volt supply, and the +138.8-volt supply for the horizontal-output transistor. These voltages

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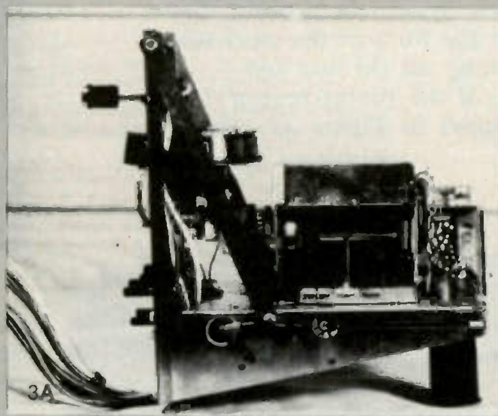
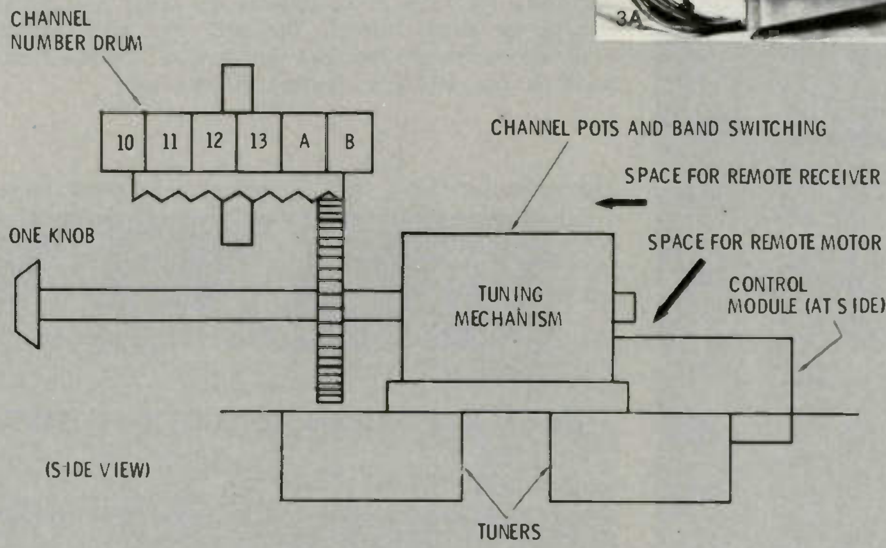
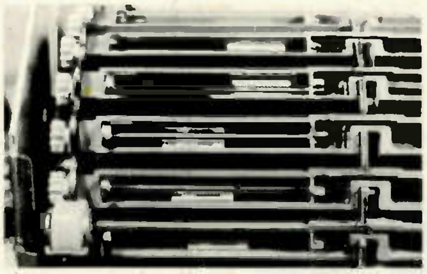
Figure 3 When the tuner assembly was removed from the TV and propped up on the bench, it looked like this. The drawing identifies the various components.



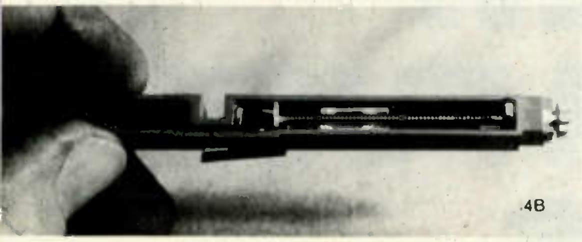


3B

TUNER ASSEMBLY



4A



4B

Sylvania

continued from page 20

were measured with a 3½-digit digital meter, and other individual sets probably will be slightly different. The accurate readings do not imply that the TV requires those precise voltages.

In addition, horizontal pulses are rectified to produce the picture-tube screen-grid voltages. That is the only scan rectified supply, and it will be described under the horizontal sweep.

Regulated transformer

The power transformer (T500) is

continued on page 24

Figure 4 (at left) These are the variable-resistor channel-tuning strips, that were revealed when the shield was removed from the tuning mechanism (picture A). The detent roller can be seen at the lower-left corner, and the small gears function as fine-tuning adjustments for the channels. Picture B shows one strip. Connecting lugs are at each end, and the spring (below) contacts ground, when the strip is in the drum. When the gear is turned, the threaded rod moves the center contact strip (on the white block) along a flat resistance element.

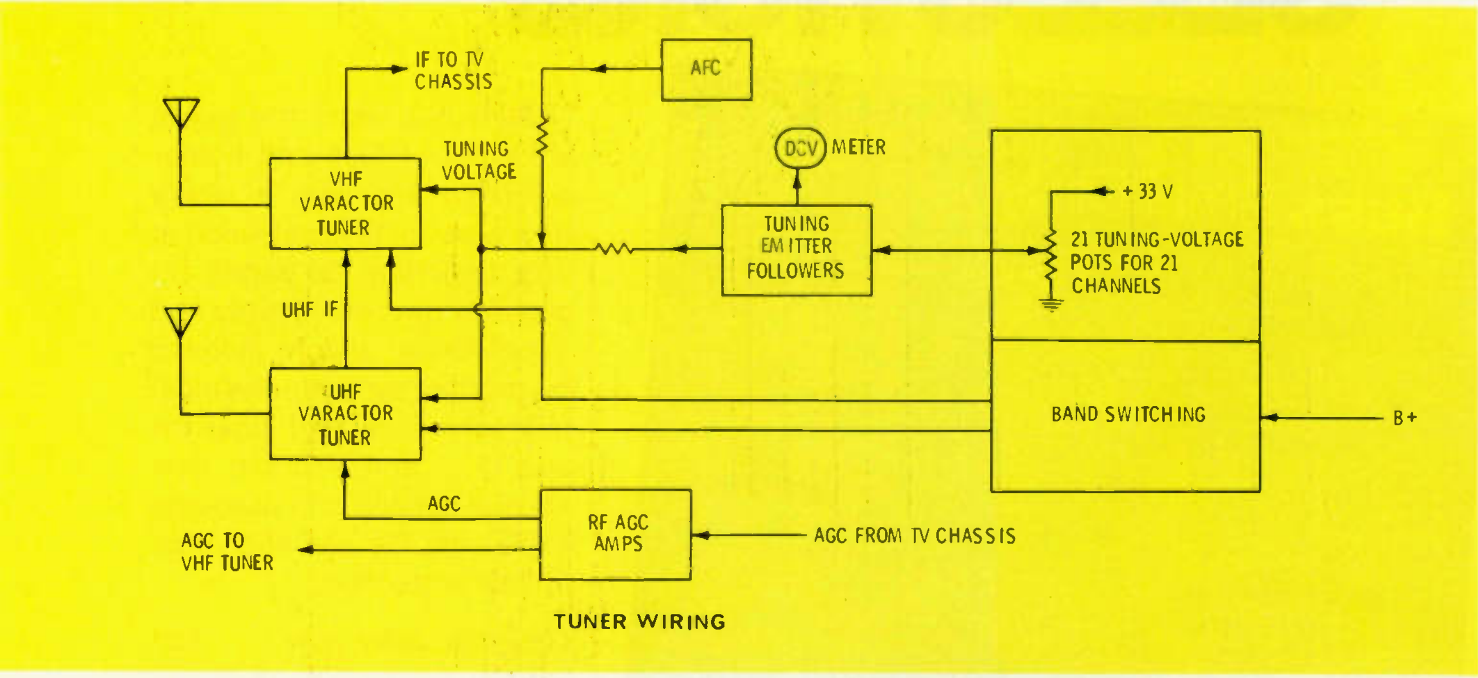


Figure 5 The block diagram shows the interconnection of tuner components.

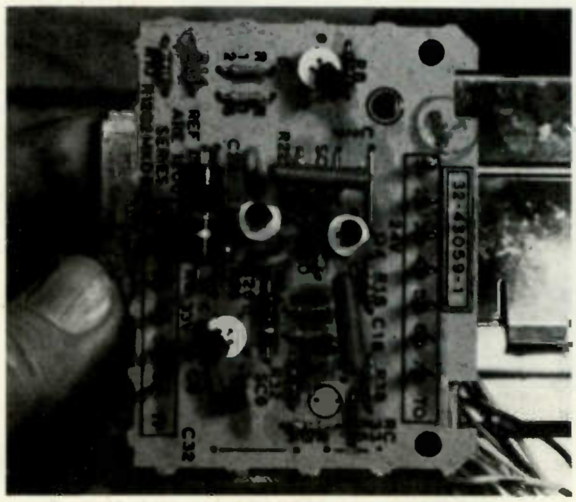
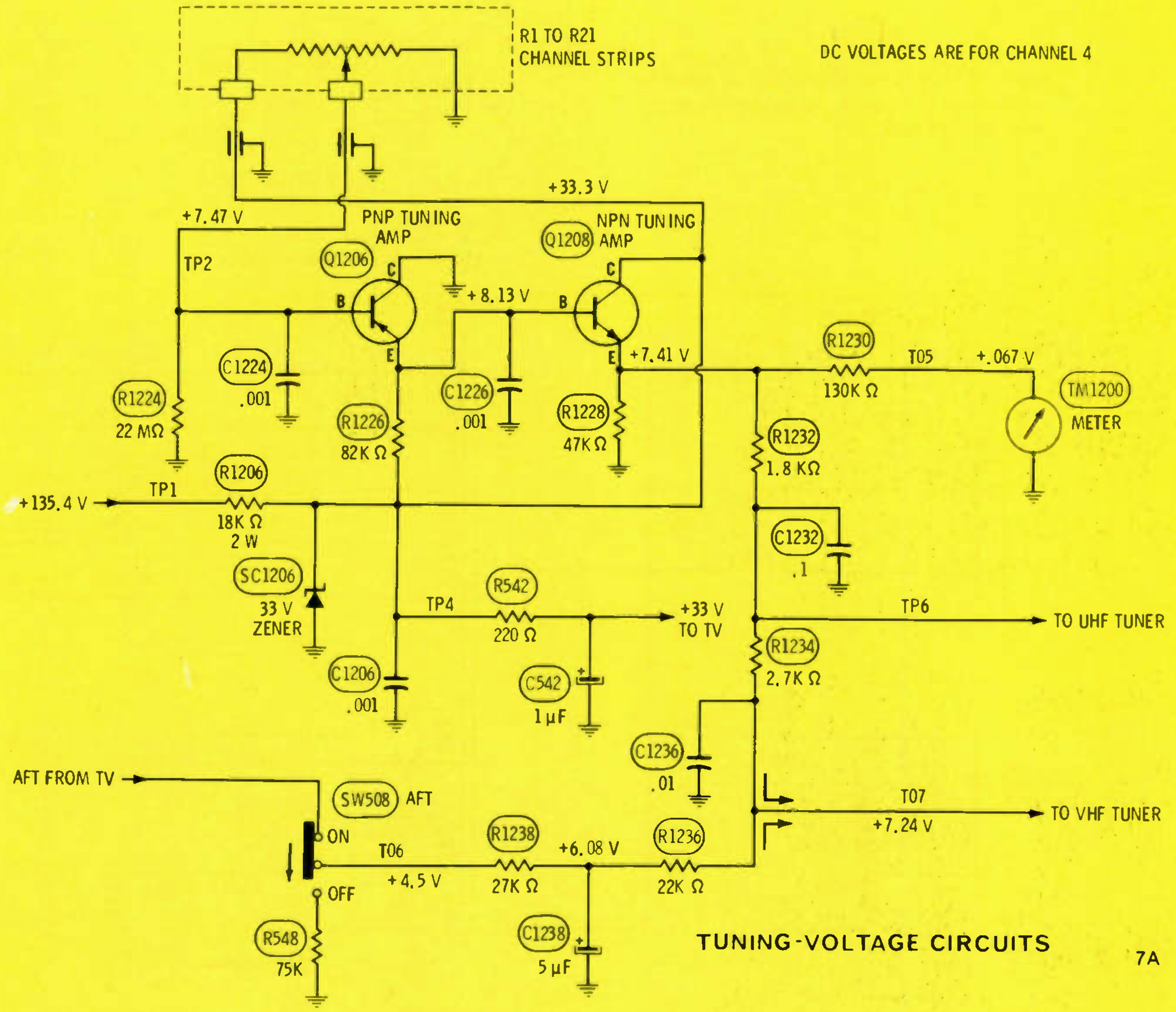


Figure 6 Two AGC transistors, two tuning-voltage transistors, and other associated components are located on the small 02-43057-1 module that's mounted at the side of the tuner assembly.

Table 1
Tuning Voltages

Channel	Tuning Voltage
	VHF at T07
2	+3.51
3	+5.16
4	+7.23
5	+11.30
6	+15.24
7	+10.50
8	+11.49
9	+13.26
10	+14.25
11	+16.04
12	+17.73
13	+21.91
	UHF at TP6
19	+3.21
27	+5.12
41	+8.52



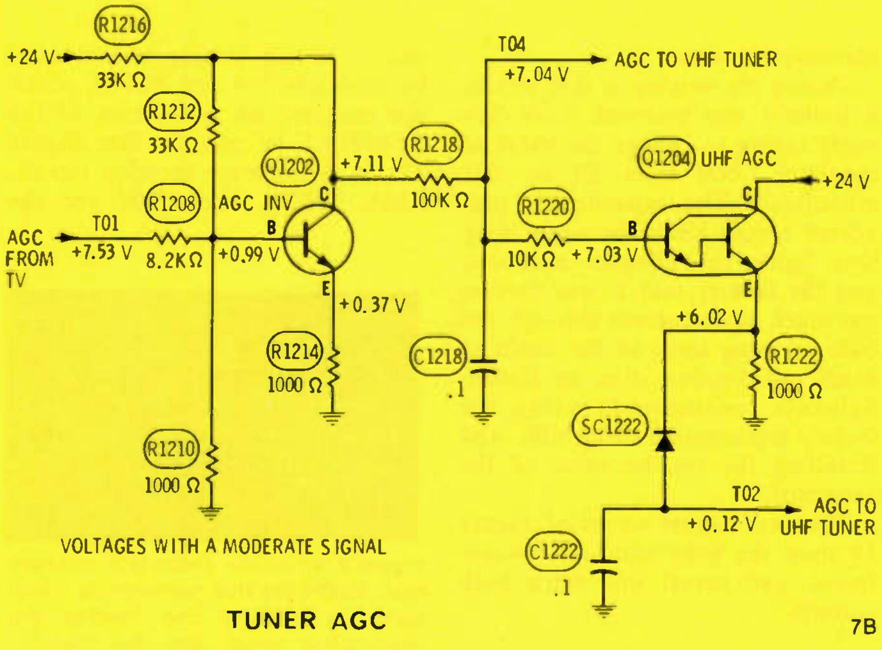


Figure 7 The schematic at A is the wiring of the production and processing of the tuning voltages. The DC voltages are for channel 4. Notice that the AFT voltage is combined with the tuning voltage, before the resulting voltage is sent to the tuners. In the B schematic is shown the processing of the AGC voltages for the two tuners.

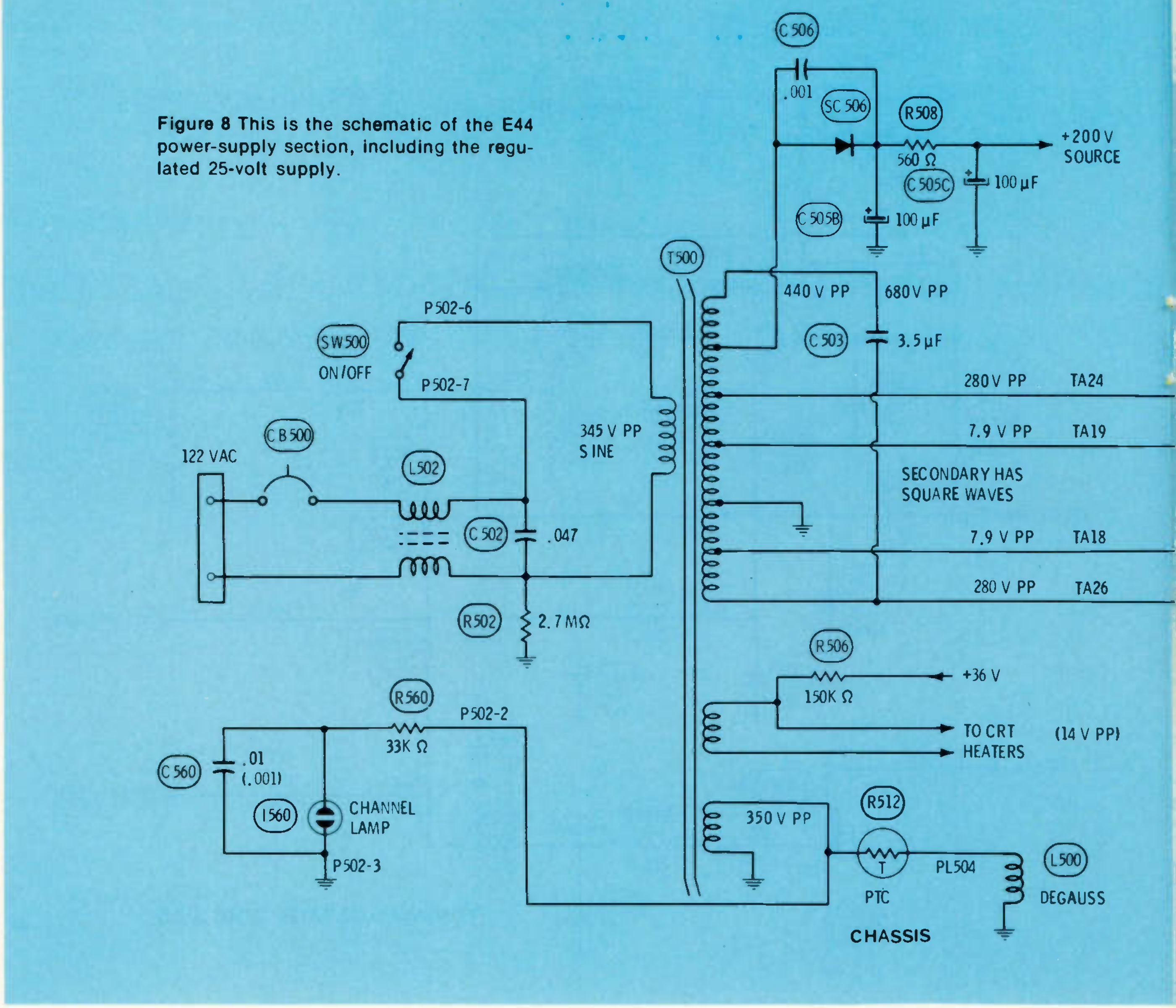


Figure 8 This is the schematic of the E44 power-supply section, including the regulated 25-volt supply.

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the type that regulates the secondary voltages by using internal shunts to saturate the secondary windings. A 3.5 microfarad nonpolarized capacitor is paralleled across the secondary to further increase the regulation. This capacitor is mounted on the front of the chassis near the power transformer. If it ever opens, the picture will be very small on all sides.

The waveform of all secondary voltages is a slow-rise square wave (Figure 9), except for the winding that supplies the degaussing PTC resistor and coil. That winding also powers the neon bulb that lights the channel numbers of the drum, and it has a **sine** waveform, as shown in Figure 10.

Dial lamp capacitor

During the writing of this article, a bulletin was received from Sylvania saying to change the value of capacitor C560 from .01 to .001 microfarad. The capacitor is paralleled across I560, the neon lamp that lights the channel numbers, and the factory said it was forcing too much peak current through the bulb, causing some of the bulbs to black out, become dim, or flicker. Sylvania recommends using the factory replacement neon bulb, and installing the smaller value of the capacitor.

The near-square waves of Figure 11 show the before-and-after waveforms, and reveal this extra bulb current.

DC voltage supplies

Returning to Figure 8, we find the +138-volt supply is produced by diodes SC514 and SC516, which are mounted on the corner of the 02-41749-1 IF module (see Figure 12), in a full-wave rectifier circuit. L505, C505A, and C507 are the

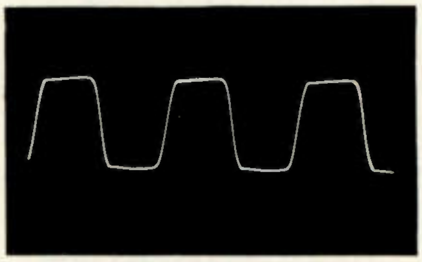
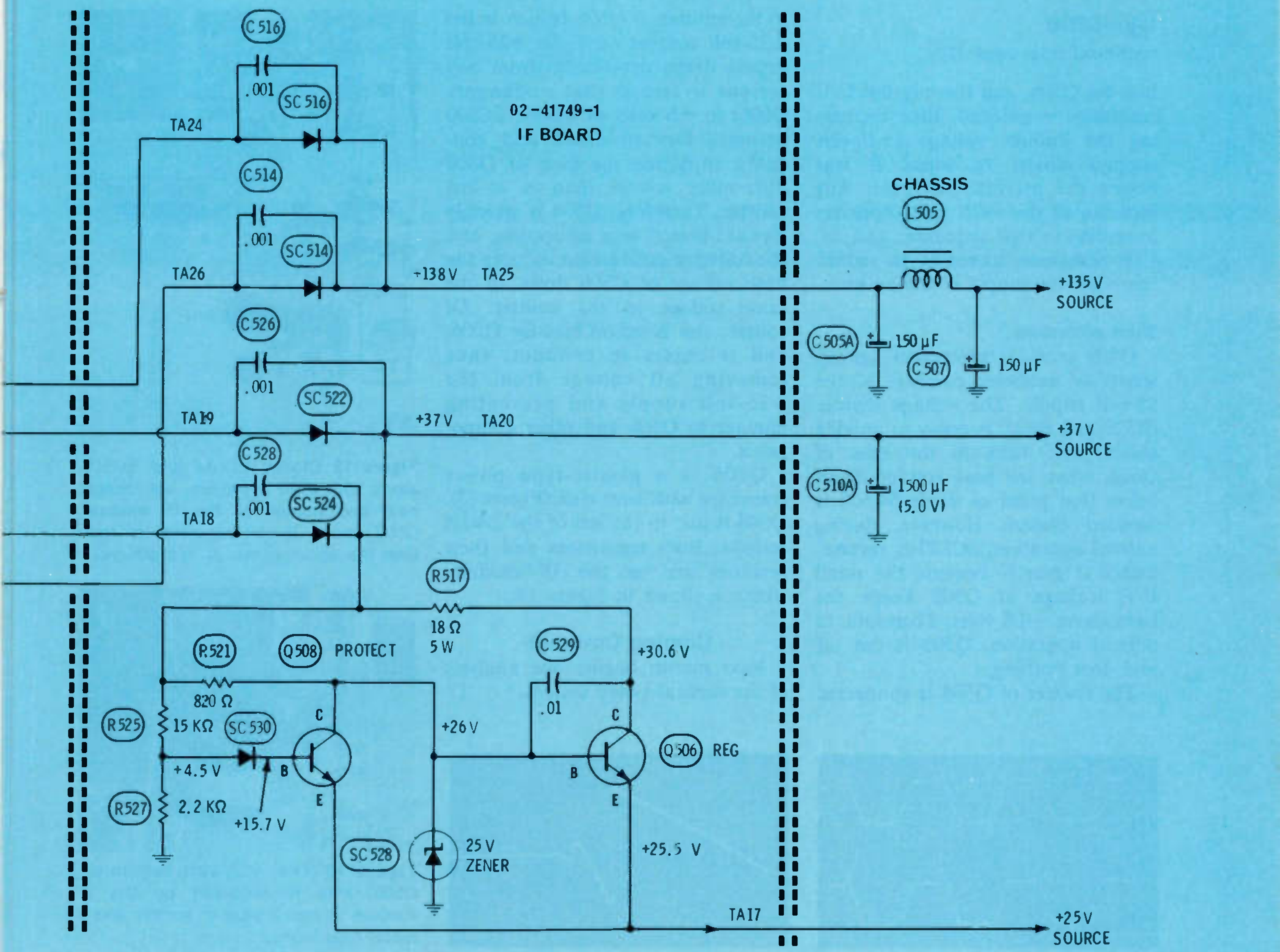


Figure 9 All of the secondary voltages from T500 have this near-square waveform, except the one feeding the degaussing circuit and the channel-illuminating neon bulb. That waveform is a sinewave.



filtering components. No regulation is provided, except by the power transformer.

Similarly, diodes SC522 and SC524 (also on the IF module) supply the +37-volt supply, that's filtered by C510A, which is on the main chassis.

From the +37-volt supply is taken the voltage to operate the regulated +25-volt supply (those transistors and components are on the IF module, also).

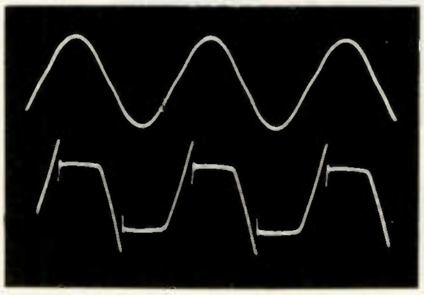
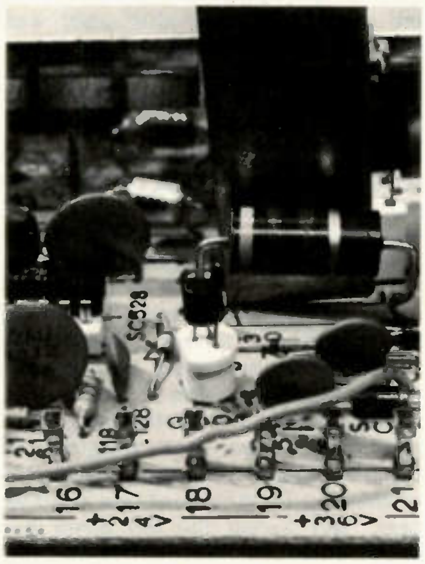


Figure 10 At the top is the sinewave applied to R560 of the channel-lamp supply. The distorted square waves found at the neon bulb are shown by the lower trace.

Regulated +25 volts

Q506 is wired as a series-type variable resistor that maintains a regulated +25 volts by changing the C/E resistance as needed. The base voltage is supplied by R521, and is stabilized by zener diode SC528. Of course, the bias of Q506 depends both on the base voltage (clamped by the zener) and on the emitter voltage (which is the +25-volt supply). Therefore, when the +25 volts is decreased for any reason, this is increased forward

continued on page 26



All of the ICs and most of the transistors (such as Q508 shown here) are plugged into sockets. This greatly simplifies servicing.

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bias for Q506, and the internal C/E resistance is reduced, thus increasing the emitter voltage (+25-volt supply) almost to where it was before the previous decrease. Any increase of the +25 volts operates in reverse to that sequence, and the C/E resistance increases to reduce the +25-volt supply at the emitter.

Short protection

Q508 provides protection against shorts or excessive currents of the 25-volt supply. The voltage divider (R525 and R527) is ready to provide about +4.5 volts to the base of Q508, when the base voltage drops below that point so diode SC530 is forward biased. However, during normal operation, SC530 is reverse-biased (Figure 8) because the small B/E leakage of Q508 keeps the base above +4.5 volts. Therefore, in normal operation, Q508 is cut off and does nothing.

The emitter of Q508 is connected to the emitter of Q506 (which is the +25-volt source), so if the +25-volt supply drops drastically (from any serious overload that endangers Q506) to +5 volts or below, SC530 becomes forward-biased and conducts, supplying the base of Q508 with more voltage than is at the emitter. Therefore, Q508 is strongly forward-biased into saturation, and the collector conduction reduces the base voltage of Q506 down to the same voltage as the emitter. Of course, this is cutoff bias for Q506, and it ceases to conduct, thus removing all voltage from the +25-volt supply and preventing damage to Q506 and other components.

Q506 is a plastic-type power transistor with heat sink (Figure 13). Q508 is just to the left of the 2-watt resistor. Both transistors and their resistors are on the IF module, which is shown in Figure 14.

Coming Coverage

Next month begins our analysis of the vertical-sweep system. □

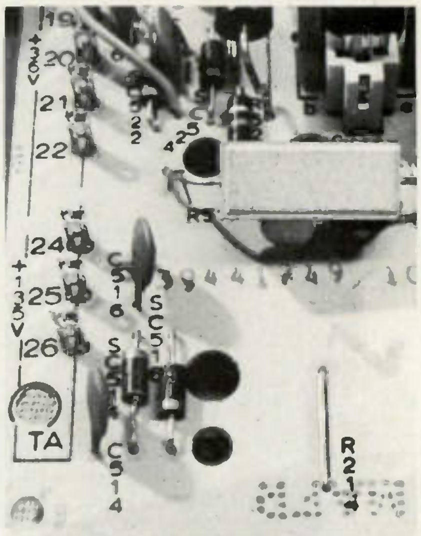


Figure 12 Diodes SC514 and SC516, along with their bypasses, are located near one corner of the IF module. Q506, the +35-volt regulator is seen near the upper corner of the picture.

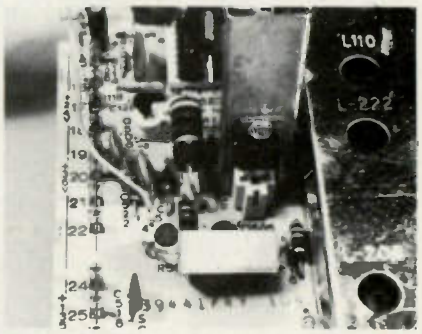


Figure 13 The +35-volt regulator, Q506, also is mounted on the IF module. It has a plug-in socket and a metal heat sink.

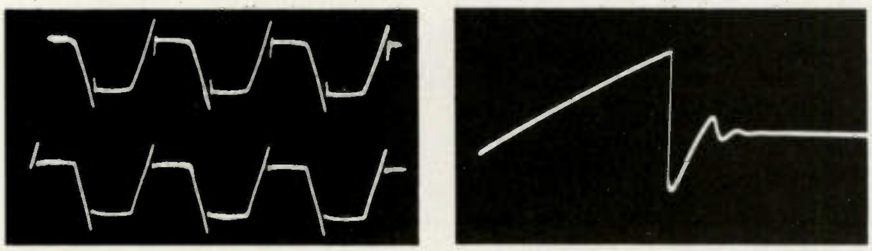


Figure 11 The top waveform of A (at left) is the original one with a .01 value of C560 (which parallels the neon bulb). Compare that trace with the lower one made after C560 was changed to a .001 (value recommended by Sylvania). The only difference is the overshoot of the fast drop from the sinewave to the flat area created by the neon regulation. The bottom trace is typical of neon bulbs fed by AC voltage through a current-limiting resistance. The waveform follows the sine wave up the positive peak until the voltage is sufficient to ionize the neon gas. Up to this point, the neon has drawn no current. The strong current (after ionization) reduces the neon voltage to the "regulation" voltage (shown by the flat area). The regulation of the neon maintains a constant voltage during the remainder of the rise to the tip of the positive peak, and during the fall down the other side until the extinguishing voltage is reached. At this point, ionization ceases, and the neon voltage follows the sinewave until a similar ionization point is reached on the negative slope (neons ionize on either positive or negative voltages). Then, the same action occurs during the negative peak. Now, when a neon is supplied power through a resistor without any capacitor, the first current causes a drop with a tiny overshoot before the regulation becomes fully effective. After that, the delicate balance between voltage and current at the neon bulb is maintained by a rapid series of very-small corrections, that are not usually visible on a scope. But the addition of the .01 capacitor delays the beginning of stable regulation. R560 and C560 form a time-constant filter, which requires a definite time to charge and discharge. The expanded waveform of picture B (at right) shows how the neon voltage overshoots in a classic ringing (decaying wavetrain) form. The extra current, represented by the deep negative overshoot, is an **overload** of the neon bulb that sometimes causes early failure of the bulb. That's why Sylvania recommends changing the capacitor to a .001 value.

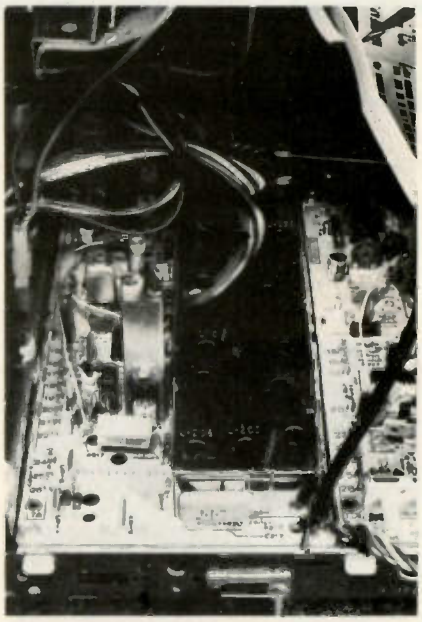
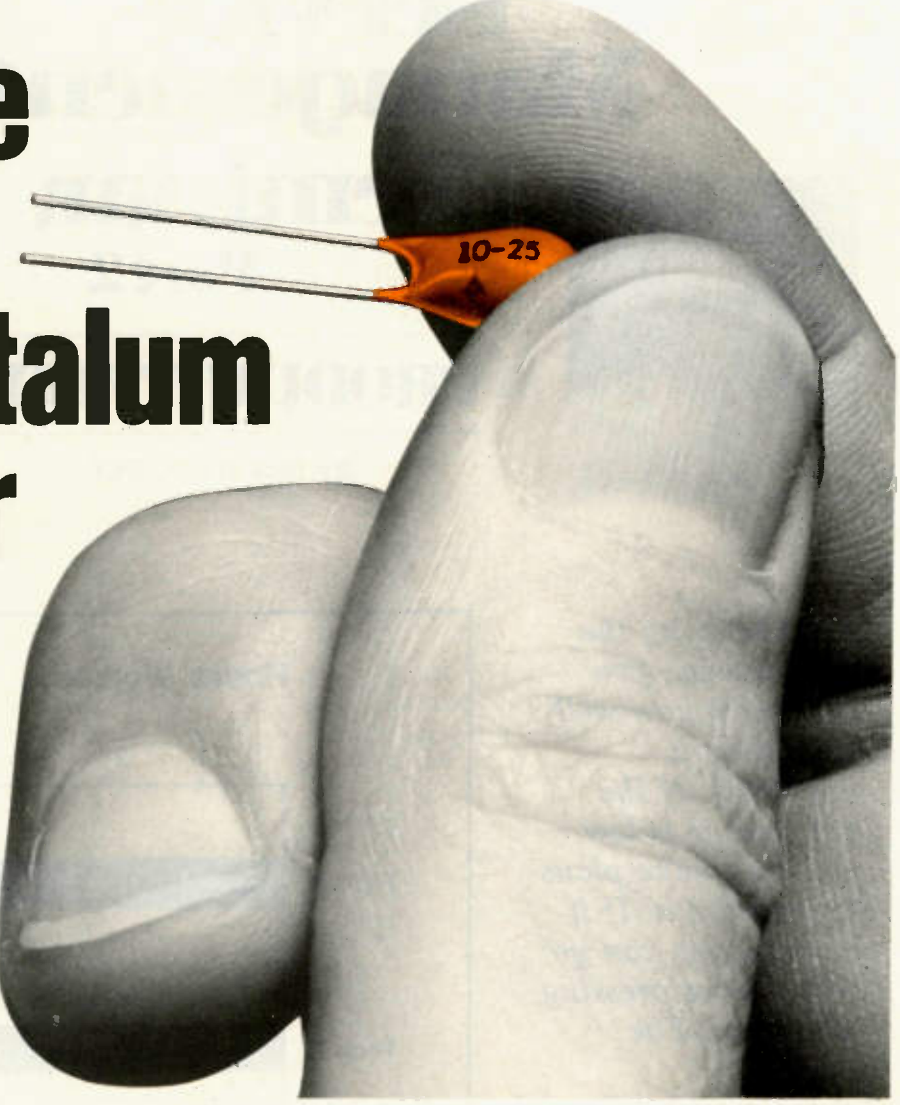


Figure 14 This is a picture of the 02-41749-1 IF module as it looks in the chassis between the power transformer on the left and the chroma module on the right.

Best way to replace a dipped solid-tantalum capacitor



Use a Sprague Type SD Tantalex® Replacement Capacitor. You can count on its matching or exceeding the original quality of the capacitor it replaces. Quality features include: ❶ High stability with very little capacitance change even at outer limits of operating temperature range of −55°C to +85°C (−67°F to +185°F). ❷ Low dissipation factor permits higher ripple currents. ❸ Capacitance tolerances of ±10%. ❹ Hard epoxy coating that's highly resistant to moisture and mechanical damage.

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2	SD35-R339	.33	8	SD35-6R89	6.8
5	SD35-R479	.47	10	SD35-109	10
2	SD35-R689	.68	2	SD35-159	15
8	SD35-19	1.0	8	SD35-229	22
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Service Management Seminar, Part 2

PRODUCTIVITY

By Dick Glass, CET

By measuring the productivity, you can know how well your shop is operating. If the percentage is low, you can make plans to improve it. If it is okay, you can go on to more pressing problems. The methods recommended here can be used to measure the productivity in just a few minutes.

Why Measure Your Productivity?

Suppose your productivity is 70%. Or 80%. Or 90%. Probably you don't care what it is. After all, you're working at top speed, repairing radios, TVs, stereos, etc. There's no way you can improve, is there?

Also, you've gotten along okay so far without knowing anything about productivity. So, why not spend all of your extra time studying new developments (such as VIR circuits

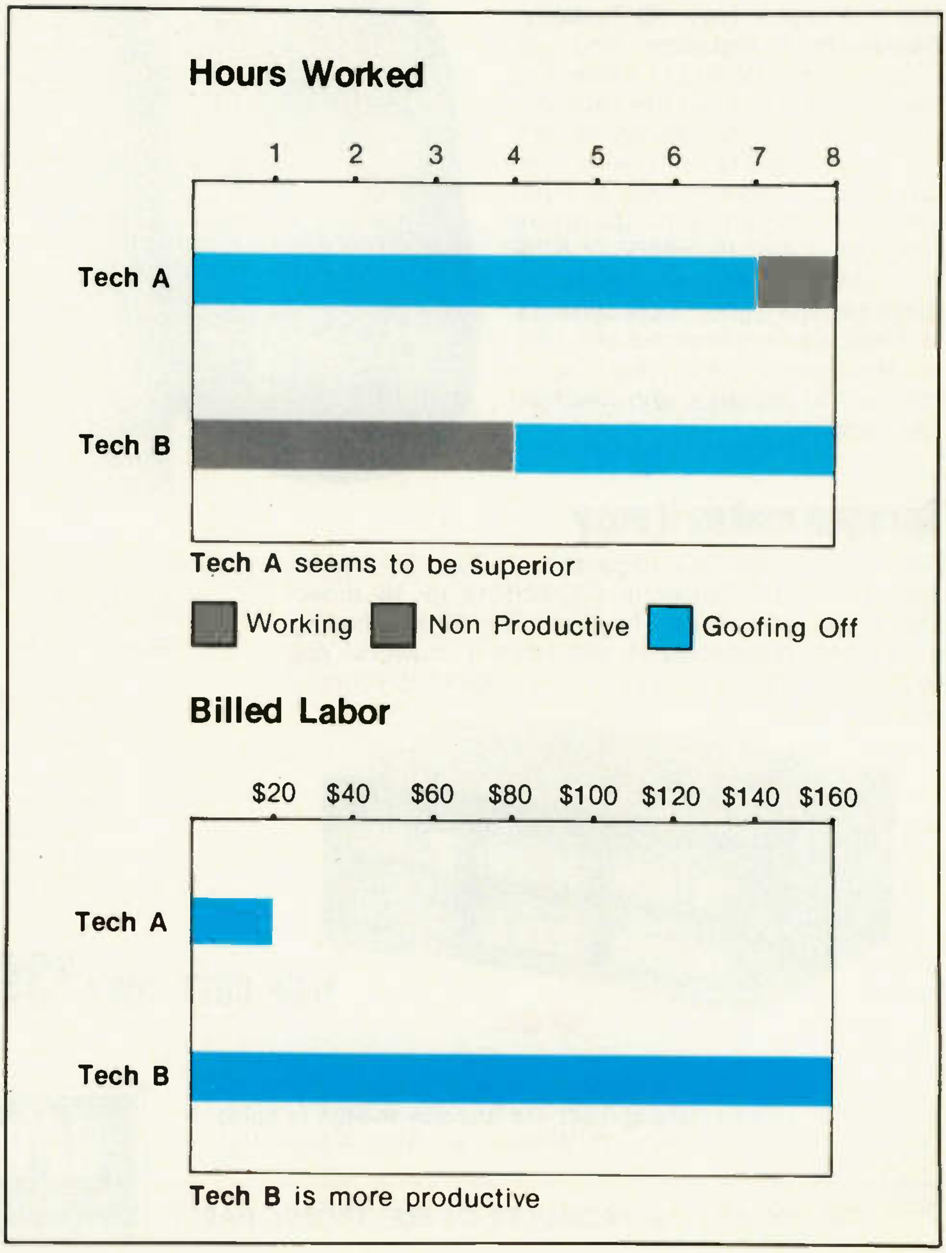

Figure 1

or using spectrum analyzers) to improve your *technical* knowledge? It's logical that your increased knowledge will make your job easier and shorten the time of each repair. Therefore, you will obtain more benefits by studying technical subjects rather than by calculating some "useless" percentage of productivity. That philosophy sounds logical, but it is basically wrong.

Excuses

All of those reasons really are only excuses; although they contain some truth. You should continue to study the new technology, or your abilities will diminish when the new products need servicing. If you are an employee, your boss will spur you on to perform at a high peak level. Or, if you own the shop, the fear of starvation and bankruptcy keeps you working fast and long.

Nevertheless, if you have intentions or dreams of becoming wealthy, you have an imperative need to know how to calculate your own productivity, and also that of all your employees.

You're No Good With Figures?

Don't worry if you have little skill with mathematics. If you can add up a service invoice, then you can figure productivity. Only very simple calculations are involved. These are even easier, if you have a hand calculator.

Remember, productivity calculations are not "ratio analysis," P&L research, or any other forms of complicated drudgery. In fact, you'll find that it is easy and fun to do.

Benefits

There are several important benefits from knowing the exact productivity percentage of your shop:

1. You will think better of yourself. When you don't know your productivity rating, you probably assume that it is *low*. After all, you do have "tough dogs" frequently, and they slow you down. Also, the paperwork and phone calls waste much of your time. Maybe you're embarrassed to admit that your average is four completed repairs per day. But, if you know your average productivity is 60%, and that 60% is darned good, you might start thinking more highly of yourself.

2. You will improve. When you know what your average has been, you have a point of comparison. If your percentage is 35%, you will want to find ways to save time and increase that 35%. Later, when you measure it again, and find you have been successful in increasing the percentage to 40%, you know you're doing something right! That's progress.

3. You won't fight the wrong problem. What if you have a TV problem, and have no way of determining whether the defect is at the AC wall socket, in the TV chassis, or in the antenna system? You can waste time checking all three possible areas before finding the source of the problem. Of course, you are not that helpless. A "rabbit-ears" antenna can be substituted for the antenna system, and you can measure the voltage at the AC socket. After you know those are not to blame, you can go right to the TV chassis as the source of the defect. In the same way, suppose you don't know whether your financial problem is caused by: low labor charges; low productivity; or too-low pricing of parts. Because you don't know for certain which is responsible, you are likely to waste precious time and energy trying to solve the WRONG problem. Many owners and managers assume that low productivity *always* is the culprit, and they try to corner more service jobs, which forces them to work longer hours. If your productivity is NOT bad, this approach is a vicious circle, making the situation worse. Find the real problem, and then work toward solving it.

4. Pride will return. No self-respecting technician will watch his

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TABLE 1
Expected Productive Averages

1 Man shop	30%
2 to 3 techs	40%
3 to 6 techs	50%
6 & over techs	60%

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TABLE 2—Four-Man Shop Productivity

#1. Owner/tech	$300	÷	20	÷	$25	=	60.0%
#2. Bench tech	$600	÷	40	÷	$25	=	60.0%
#3. Apprentice	$200	÷	30	÷	$25	=	26.6%
#4. Outside tech	$600	÷	44	÷	$25	=	54.5%
Combined	$1700	÷	134	÷	$25	=	50.7%

This box shows productivity for one week for the total shop as well as the individual technicians. The 50.7% percentage might be expected to be lower (perhaps 45%) for the entire year.

fellow workers outproduce him, without at least trying to catch up and surpass them. One facet of human nature is that good-natured competition gives zest to work. But without a rating system, this incentive is lost. Take advantage of this trait by posting the productivity percentages on the bulletin board for all to see. Or, if you want fantastic results, base each technicians wages partially on the average productivity!

5. More accurate pricing. Most service managers have serious questions about their prices. On one hand, they know their profits and wages both are too low. However, they frequently are confronted by customers who strongly suggest that the charges are too high. Of course, productivity is not the only factor determining your charges, but it is helpful to know if your productivity is average or above. If so, then your prices are not "high" because of poor efficiency.

These are five good reasons for wanting to know the productivity rating of your shop. You're convinced, I hope, so it's time to do some figuring.

Figuring Productivity

Calculation of productivity is easier for technicians than it is for most other job categories. For example, how would you figure the productivity of a hospital nurse? Should you count the number of patients and the number of "shots" compared with an industry norm? No! In this, and many other professions, the quality of the service, the clean personal appearance, and a helpful attitude can be more important than any statistical average. In similar ways, the productivity of electronic technicians can be evaluated either by meaningless or important standards.

One way to measure the productivity of an electronic technician might be to spy on him from a hidden position as he worked at the bench. If he wastes one hour out of eight on breaks, personal phone calls, or "shooting-the-bull," then he might be considered as 87.5% productive. (Seven hours working divided by the eight hours he was paid for equals .875 or 87.5%).

The method can show the percentage of time spent actually working. That allows you to identify a lazy tech; but does it help your profits? No, that's worthless information. **Instead, you need to determine how productive he is, and not how many hours he works.** Isn't a tech more valuable to his firm if he produces a dozen highly-profitable jobs in four hours (and goofs-off the other four), than if he works hard for the whole eight hours just completing one unprofitable repair? Study Figure 1 before you answer.

Base the productivity on dollars

Don't base the productivity rating on the hours spent, the hours worked, or the wages paid. Use only dollars paid the technician versus the dollars he brought in. That's the first rule of measuring productivity.

Use the hourly shop rate

The second rule for figuring productivity is: use the shop hourly rate of billed labor. Now, all shops attempt to charge a certain amount per hour. Even those that use some kind of "flat-rate" pricing (where a specific price is charged for certain repair functions) base it on the knowledge that some jobs take more (or less) time to complete than the average of all repairs. For instance, we expect that less is needed to repair a child's record player than to repair a color TV or a videotape recorder. Therefore, the phono repair might be priced at $15 on the flat-rate chart, while the VTR might have a flat-rate price of $90. Probably, the phono is estimated to take a half hour, compared to three hours for the VTR.

In these two examples, your "hourly rate" is about $30.

It's okay to be uncertain

This is the third rule for figuring productivity: **don't worry if you don't know your exact hourly rate.** When you don't know the hourly rate for this first calculation, merely *estimate* the number of hours actually worked by you or your employees. Later, you will have more accurate figures for the subsequent calculations.

If you repair TV sets and make home calls, your service-call rate usually is about the same as your hourly rate, so use that figure at first. Also, estimate your own productive time, or subtract the hours not devoted to repairs. The hours you spend buying, managing, accounting, selling, etc., really must be considered part of the overhead, and should not count toward the productive time.

> Here is the productivity formula:
> **Labor produced divided by hours worked divided by the shop hourly rate equals productivity.**

Let's assume the total labor produced last week by one technician was $500, the number of hours worked was 40, and the shop's hourly rate was $25. When we plug them into the productivity formula, it reads this way: $500 divided by 40 (equals 12.5) divided by $25 equals 0.5 (or 50%).

Note: An alternate way of handling the math is to multiply the hourly rate by the number of hours worked per week. That represents 100% productivity. So, $25 times 40 hours equals $1,000, which is the minimum possible to produce. Then divide that figure by $500, the actual income, to give the productivity ($500 divided by $1,000 equals 0.5, or 50%).

Your productivity is figured the same way, except you take only those hours actually used for repairs (those hours when you wore the manager's hat don't count here).

Questions

What do you do about the time spent sweeping floors or cleaning the "john"; or the tech's time when he sells products at the counter?

You should subtract the time a technician spends selling. That's a sales expense, not a service expense,

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TABLE 3—Total Shop Productivity

Formula: Annual total labor sales ÷ Annual tech hours ÷ Shop rate per hour = ANNUAL PRODUCTIVITY

Problem: $75,000 ÷ 6500 hrs. ÷ $25 = ANNUAL PRODUCTIVITY

Step #1: $75,000 ÷ 6500 = $11.54 per hour

Step #2: $11.54 ÷ $25 = 46% Annual Productivity

and must be accounted for in the sales figures. The other chores that technicians often do (talking to customers, repairing trade-in merchandise, or delivering new sets) are necessary, and have value, which must be allowed for in the productivity.

In the larger shops, a bench tech should spend *all* of his time working as a technician, and an outside tech should devote 100% of the work day making service calls. The manager usually does the non-productive (but necessary) extra functions. This specialization is the main reason larger shops consistently show higher productivity percentages than those of the one-man to three-man shops. A larger percentage of the tech's time is used for direct production.

But, regardless of the shop size, 100% productivity is very rare.

What Is Good Productivity?

In many actual examples, the productivity varies according to the number of technicians (see Table 1). Productivity runs from 30% to 60%, with the larger shops showing the higher figures.

Those figures imply that a one-man service department *never* can be as productive as one tech in a multi-tech shop can. On the surface, *this conclusion seems to be illogical.* If you calculate *only* the actual servicing time, the technician should be *equally* productive, regardless of the shop size.

Here are some of the factors that modify the results. The one-man operator usually works on all brands. Therefore, he can't become well acquainted with them all, and thus he works more slowly. The same problem occurs in finding parts. Perhaps he can't afford service data for all brands and models, and so it requires more hours to identify defective parts and obtain correct replacements. He is interrupted more often, and finds it difficult to get "back on the track" after each interruption. Lastly, he has no fellow technicians to give hints or advice. All of these impediments reduce the productivity of the small shop.

Efficiency equals more profit?

Unquestionably, larger shops have a higher percentage of production. However, higher productivity does not necessarily bring an equally large profit.

Larger shops usually have additional "backup" personnel, such as parts men, counter attendants, bookkeepers, receptionists, service managers, etc. These extra people remove the time-wasting chores from the technicians, thus allowing them to be more productive. On the other hand, the increased money from the higher production is needed to pay the salaries of these non-productive employees.

Of course, the costs of these "overhead" people are not part of the "direct labor" on the Profit-And-Loss (P&L) sheet, because they are rated as clerical, management, or miscellaneous employees.

This is a gray area that is handled in many different ways by bookkeepers, so we'll give one more example to clarify the situation.

Apprentice

An apprentice certainly is not "overhead." His working hours and the income produced do affect the productivity—both his own, and that of the shop as a whole. If he has low productivity, his percentage will reduce the average productivity of the entire shop. On the other hand, he might be assisting the journeymen techs, thus improving their percentages. In that case, the apprentice would not be lowering the shop's productivity. His wages never should be considered as overhead.

Table 2 shows the productivity of a typical (but efficient) shop.

Annual Productivity

Many technicians show very high productivity for a week or so. However, such things as vacations, training courses, sick days, etc. pull down the percentage over a full year. Therefore, it is advisable to calculate the shop's total annual production. The method is the same, except that changes of personnel (two techs for part of the year, and four for the winter season) make it a bit dated.

One big advantage is that the averaging over a longer time produces a more dependable figure to use when setting prices, or when judging the improvement of the business.

Calculate the annual productivity by taking the total labor sales (without parts sales) from your P&L sheet. From the payroll records, obtain the number of technician hours worked (including your estimate of the number of service hours you contributed). Divide the total labor income by the tech-hours worked. This is the annual income-per-hour. Divide the annual income-per-hour by the hourly rate of your shop, and the answer, expressed as a percentage, is the total annual productivity.

One example is shown in Table 3.

Comments

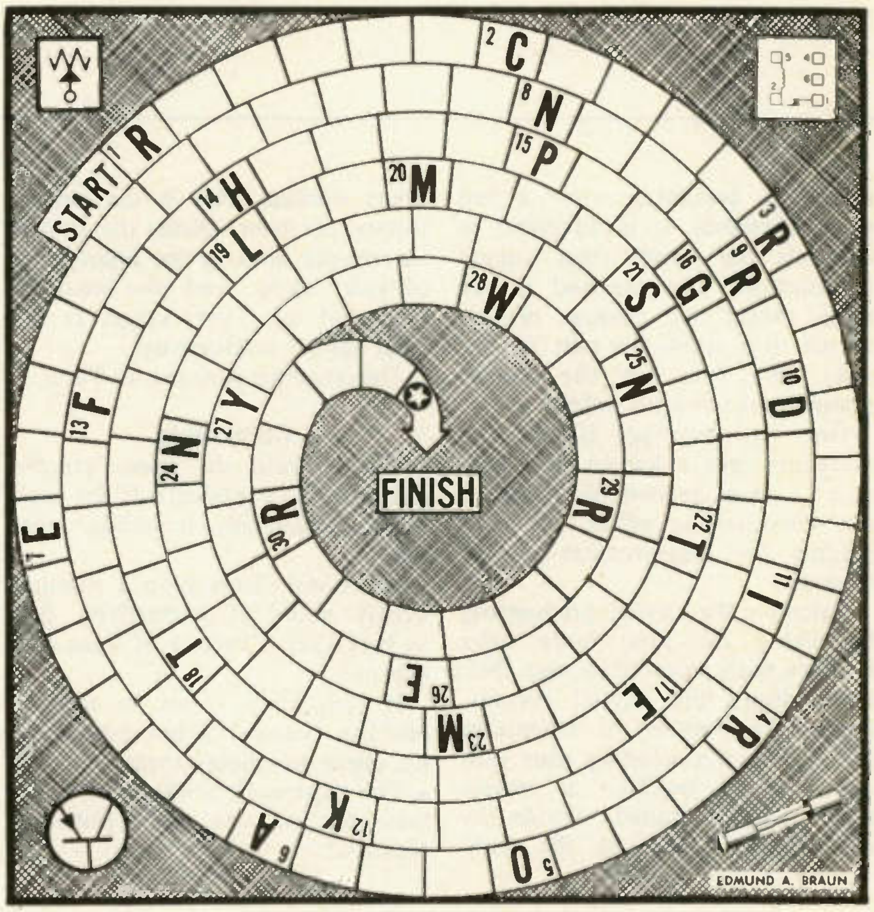
You should do these simple calculations of productivity for each of the technicians, including yourself.

Successful shops keep a running weekly record of productivity, just as they keep a record of sales and expenses.

If your shop seems to have a problem because of low productivity, check for these causes:

- The paperwork is excessive; eliminate all you can, even just one function;
- Parts and supplies are not convenient for the techs to obtain, thus wasting their time;
- You accept repair jobs for the older products, which often have multiple and time-consuming troubles to slow down the techs;
- Your test equipment is old or inefficient;
- Tools are so scarce that several techs must share the same ones;
- Warranty repair jobs are not paying expenses; and
- Your service data and replacement-parts stock are not adequate.

Another advantage of *measuring* productivity is that you automatically will begin thinking more about it; and the thinking will lead to remedial actions. These and similar improvements will become key factors in your $30,000-per-year Success Plan. □



If you can go through a revolving door a few times without getting dizzy, you'll have fun solving this Pinwheel Puzzle based on electronics. The last letter of each word is the first letter of the next word. Each correct answer is worth 4 points; a perfect score is 120. If you're a novice in electronics and miss a couple, don't worry; you'll have added to your vocabulary in this field. It should be fairly easy to get a high rating except perhaps for someone who thinks "specific" is an ocean, or that "bistable" means near a horse house! Thinking cap on? Then, GO!

In the Ohm Stretch!

by Edmund A. Braun.

1 Pertaining to an antenna with long-wire radiators comprising an equilateral parallelogram with oblique angles.
2 Reddish-brown ductile metallic element.
3 Device that maintains a designated characteristic at a predetermined value or varies it according to a predetermined plan.
4 Ancestor of television.
5 Long-range hyperbolic navigation system.
6 Chemical compound for coating recording discs, etc.
7 Protective cured plastic coating placed around delicate electronic components.
8 Beam-powered tube that has a nine-pin base.
9 One of the primary colors.
10 Prefix meaning one-tenth.
11 Electrical safety device.
12 Pertaining to the law that current flowing to a given point in a circuit is equal to the current flowing away from the points; and other laws.
13 The light from an electric discharge through the air.
14 Circuit connections for electronic equipment.
15 Device at the end of a cord that can be inserted into a jack or other receptacle.
16 Finely divided carbon used in constuction of some carbon resistance elements.
17 Articles in a kit or outfit such as apparatus, furnishings, meters, etc.
18 Fitting for making a convenient electrical connection.
19 Flexible nonmetallic tubing placed around insulated wire for protection.
20 Poles on which antennas are mounted.
21 Any part connected in parallel with another part.
22 Arrangement of two or more similar circuits or amplifying stages in which the output of one circuit provides the input of the next.
23 Tube having a high power output at high frequencies but very low inter-electrode capacitance.
24 Television system employing invisible rays for scanning purposes at the transmitter.
25 The opposite of positive.
26 A measure of unavailable energy in a thermodynamic system.
27 Color of band on a resistor to denote 4.
28 Thin, semiconductor slice of silicon or germanium.
29 An electrode which functions primarily to reverse the direction of an electron stream.
30 Electromechanical device operated by variation in conditions of a circuit, which in turn, operates devices on other circuits.

Dizzy? No?
Then, turn to the solution on page 66.

Sam Wilson's Technical Notebook

J. A. "Sam" Wilson
CET

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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Misleading Questions

One of my volunteer jobs has been to prepare questions for the International Society of Certified Electronic Technicians (ISCET) for testing those who want to become Certified Electronic Technicians (CETs).

You'd think that it would be a simple matter to make up 75 questions designed to test broad areas of electronic knowledge. But, let me assure you, it's not easy. You can't take a course in school about test making, and you can't find a book that teaches the rules. So, at first I made some mistakes.

Very quickly, I learned that certain types of questions become traps for unwary technicians, causing them to mark a wrong answer to a question they understood fairly well.

For example, questions asked in a positive way (such as, "Which of the following determines the

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amount of current in the circuit?") produced many more correct answers. While negative questions ("Which of the following does NOT determine the amount of current in the circuit?") caused more wrong answers.

The subject matter also plays an important part in the final score. Questions about capacitances and capacitors were more often missed than questions involving resistors. When you know this before you make up a test, how do you decide on a reasonable number of questions about capacitors? These tests do not have "catch" questions, but are intended to evaluate the tech's all-round knowledge of the electronics field. Therefore, it's not desirable to include little-known facts or slanted questions.

I have a list of questions that have been answered incorrectly most often in the CET tests. Not all were made difficult by the exact wording of the questions. Some referred to new components, while others were about basic subjects that often are not understood completely. These 10 questions were not used in the tests, but are similar. The answers follow the last question. What was your score?

Question 1

The simple capacitor of Figure 1 is charged with DC from a battery. After the capacitor is charged completely, the battery is disconnected and the plates are moved farther apart. **Does this affect the capacitor voltage?** If so, is the voltage larger or smaller?

Question 2

If you have been following the "Basics of Industrial Electronics" in **Electronic Servicing,** this next question will be easy to answer.

When three pails (or buckets) are stacked tightly together (an insulating pail between the two metal ones), they form a low-value capacitor (Figure 2). This capacitor is charged by about one million volts DC. The capacitor is disassembled (very carefully!), and the two metal pails touched together for a time. When the three pails are reassembled in the original way, **what is the voltage between plates X and Y?**

Question 3

The next question brought me more "hate" mail than any other part of the CET test. An uncharged capacitor is connected to a battery, as shown in Figure 3. **What is the voltage between terminals A and B?** To make it easy, I gave only two possible answers. The voltage either is 100 volts, or it is zero volts.

Question 4

When technicians connect two capacitors in series, they should understand thoroughly the division of the voltages across them. The two capacitors of Figure 4 are connected in series across a battery. **Which capacitor has the larger voltage drop across it?**

Question 5

Varactor tuners are old stuff now, so you should have no problem with the circuit of Figure 5. However, when the question first appeared in a CET test, varactor diodes were new to consumer products, and the question was difficult for the techs. **To increase the capacitance of the varactor**

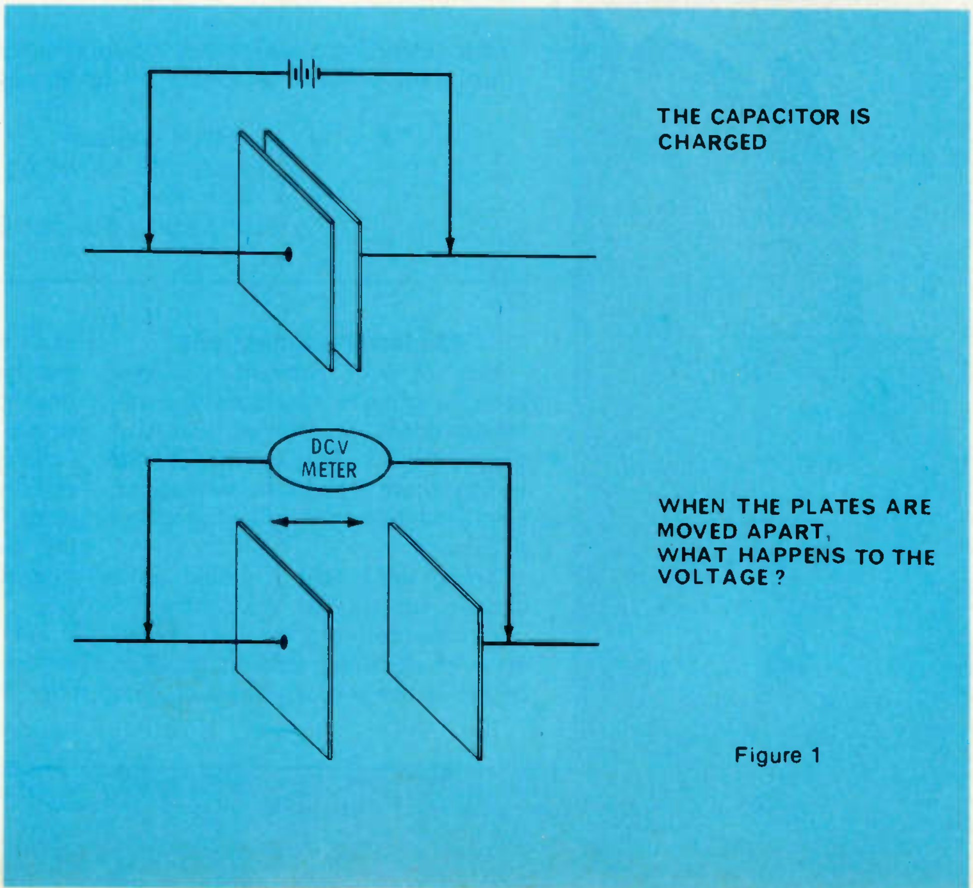


Figure 1

diode, should you move the arm of the variable resistor toward the positive point A, or toward the zero point B?

Question 6

This next question aroused the second-highest level of righteous indignation. In the tube circuit of Figure 6 (remember tubes?), an RF transformer has primary winding L1 and secondary winding L2. **Are C1 and L2 the components of a series-tuned or a parallel-tuned circuit?**

Question 7

Figure 7 shows a parallel-tuned RF circuit, with the capacitor made to be varied for proper tuning. In the dim days of old, two or three such variable capacitors often were operated from a common shaft. Sometimes, to achieve better "tracking" with the other tuned circuits, the tech changed the spacing between the plates of one capacitor

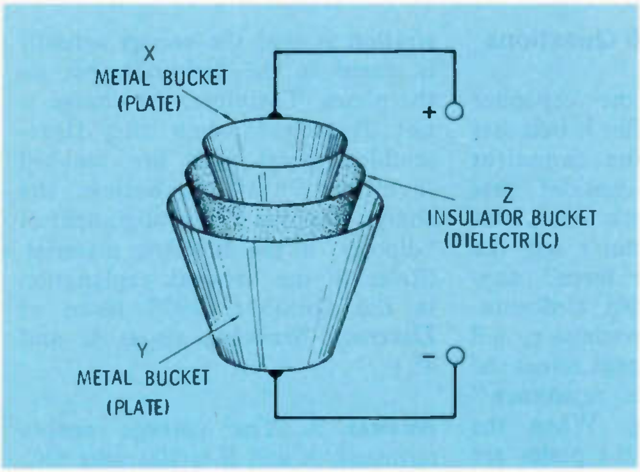


Figure 2

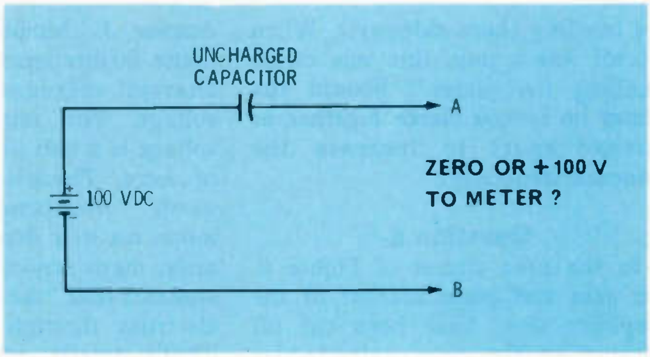


Figure 3

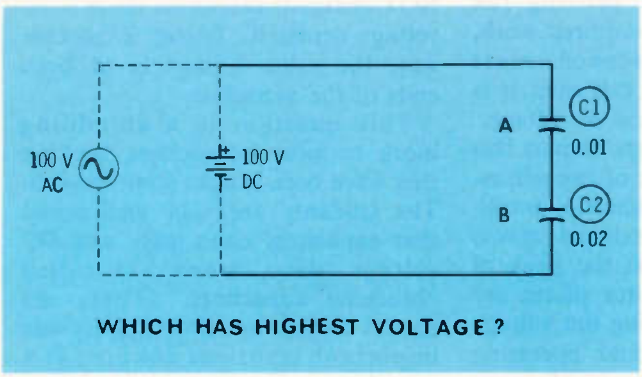


Figure 4

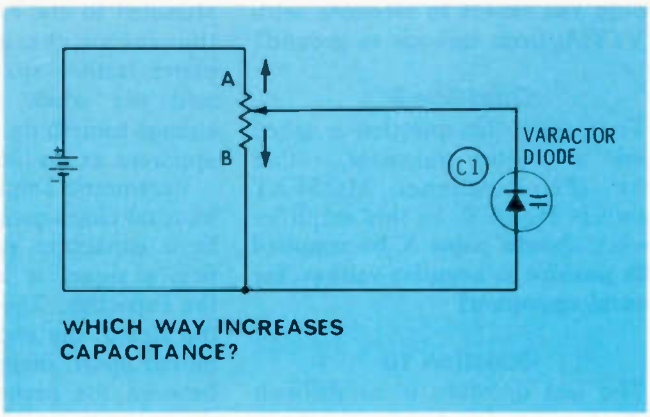


Figure 5

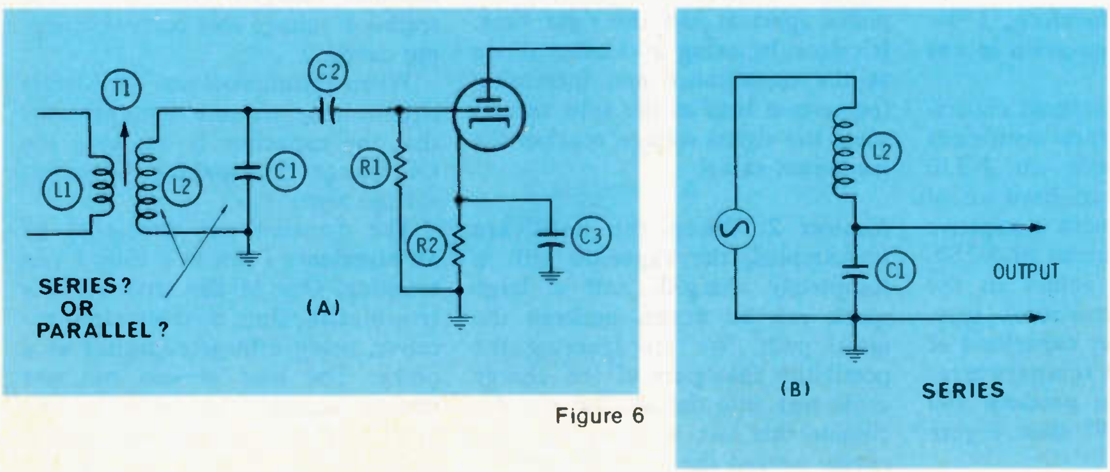


Figure 6

Figure 7

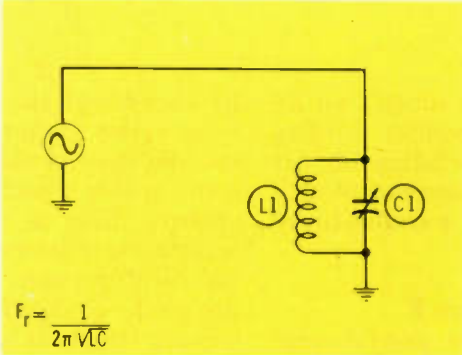
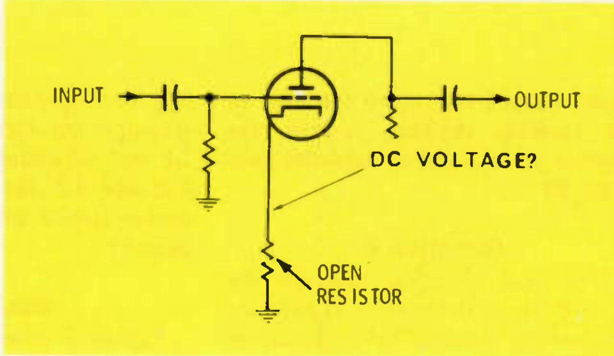


Figure 8



Technical Notebook

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(by bending them sideways). When Hector was a pup, this was called "knifing the plates." **Should the plates be moved closer together or farther apart to increase the resonant frequency?**

Question 8

In the tube circuit of Figure 8, the gain and plate current of the amplifier stage have 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?**

Question 9

Frequently, this question is asked about a bipolar transistor, rather than the P-channel MOSFET shown in Figure 9. In this amplifier circuit, **should point X be supplied with positive or negative voltage, for normal operation?**

Question 10

The last question is so difficult that no one in a group of 20 technicians at a service seminar could answer it. Therefore, I decided not to use the question in any CET test.

You need a 100-picofarad capacitor with a temperature coefficient of N330. You have no N330 capacitors, but you do have all of the standard values with a negative temperature coefficient of N750. Also, you have all values in the NPO (negative-positive-zero) type. **How can you connect capacitors of these two different temperature-coefficient ratings to produce 100 picofarad with N330?** (See Figure 10.)

Answers To The 10 Questions

Answer 1. Moving the capacitor plates farther apart after it becomes charged *increases* the capacitor voltage. You must consider that voltage is a unit of work, *not* a unit of force. Physicists don't use the words "electromotive force" anymore, for it is deceptive. Unfortunately, many schools continue to tell students that "the voltage forces the electrons through the resistance." That's totally wrong. When the capacitor is charged, the plates are attracted to one another because of the unlike charges. Moving the plates farther apart requires work, and the work expended *must* change something. In this case, it is apparent as an increase of voltage.

Parametric amplifiers employ this unusual characteristic of capacitors. In a capacitive parametric amplifier, a signal is introduced across the capacitor. Then at the peak of the signal, the capacitor plates are moved apart, increasing the voltage between the plates, and operating the same as an increase of input signal. The trick is in moving the plates apart at just the right time. It's done by using a varactor diode as the capacitance and increasing the reverse bias at the split second when the signal voltage reaches the maximum value.

Answer 2. When the pails are reassembled, the capacitor still is completely charged, and a large spark can be drawn between the metal pails. We are ignoring the possibility that part of the charge could leak into the air, for in a dry climate this loss is negligible. The reason behind this startling demonstration is that the energy actually is stored in the dielectric, not on the plates. Therefore, the charge is not disturbed when the disassembled metal pails are touched together. Physicists believe the charge is stored by the alignment of "dipoles" in the dielectric material. (Refer to the detailed explanation in the October, 1977 issue of **Electronic Servicing,** pages 42 and 45.)

Answer 3. The voltage across terminals A and B is 100 volts DC. Remember that the capacitor is NOT charged; therefore, there is no voltage across it. To say it another way, the same voltage is at both ends of the capacitor.

This question is a stumbling block to most technicians, because they have been taught from *models*. The students are told and retold that capacitors can't pass any DC voltage. Also, many are called "blocking capacitors." These are partial truths, but they neglect one important transient condition: **a capacitor passes current UNTIL it becomes charged.** (Remember the textbook voltage and current charging curves?)

When technicians see the simple circuit, they assume automatically that the capacitor is blocking the DC voltage, thus making the output voltage zero.

The question was prompted by an experience I saw in a class I was teaching. One of the students was troubleshooting a television receiver, using a large capacitor as a probe. The lead at one end was resting against the palm of his hand, and he was probing around with the other lead. I warned him

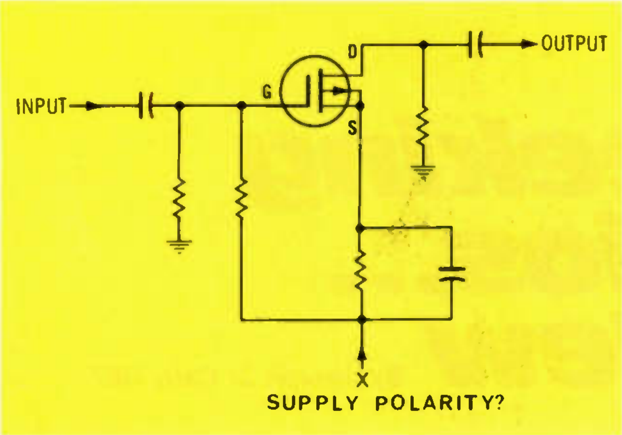
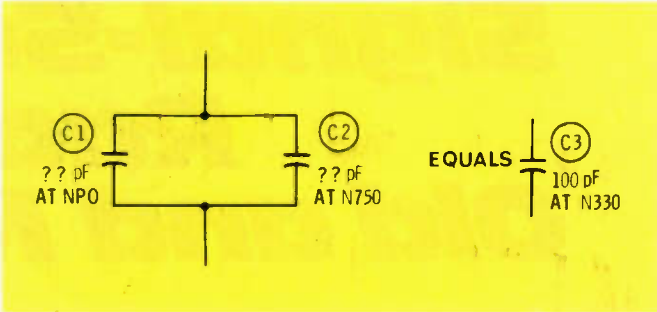


Figure 9

Figure 10



to be careful, but he explained that he couldn't get shocked because he was working in a DC circuit. At that second, he reached a hot point of the circuit, and jumped three feet from the floor when the shock proved to him that **a capacitor could** (and did under those conditions) **pass a DC voltage for a time.**

Answer 4. The larger voltage always is across the smaller capacitor. This is true regardless of whether the applied voltage is DC or AC. With the values given in Figure 4, C1 will have twice as much voltage as will C2. In other words, one-third of the power-supply voltage is across C2, and two-thirds of the voltage is across C1. (Two 600-volt capacitors don't add to 1200 volts, unless the capacitances are equal.)

Answer 5. The arm of the control must be moved toward the B (zero voltage) terminal to increase the capacitance of the varactor diode. Moving the plates of a capacitor farther apart decreases the capacitance, and moving them closer increases the capacitance. In varactor diodes, increasing the reverse bias has the effect of moving the edges of the depletion region farther apart, thus decreasing the capacitance. To increase the capacitance, the reverse bias must be decreased, thus narrowing the depletion region of the varactor diode, and increasing the capacitance.

Answer 6. In this configuration, L2 and C1 are in series. Whether the same current flows through both components or not is the one condition that determines if a tuned circuit is parallel or series tuned. The signal voltage for L2 and C1 is not introduced at their common ungrounded ends (if it were, the circuit would be parallel tuned). Instead, the signal comes from L1 to L2 by induction. Any signal induced inside a coil is considered to be in series with the cold end of the winding. Therefore, you can imagine the signal as coming from a small generator that's connected between the cold end of L2 and ground. Looking at it that way, L2 and C1 definitely are series tuned, as shown in the drawing of Figure 6B.

Answer 7. To increase the resonant frequency, the capacitance must be decreased. To decrease the capacitance, the plates of a capacitor must be moved farther apart. Refer to Figure 7 for the tuned-frequency formula. Notice that the capacitance is in the denominator of the fraction. To increase the frequency, it is necessary to decrease the value of the denominator.

Answer 8. The positive voltage at the cathode of the tube will be very high, possibly as high as the supply voltage. There are two effects here. The plate and cathode of the tube act as a capacitor that's not charged, so both plates have the same DC voltage. On the other hand, the tube cathode is hot and the tube is *ready* to pass current, except the open cathode prevents it. The cathode-to-ground DC voltage is cutoff bias; therefore, the tube draws no current. With tube-equipped radios, technicians occasionally were surprised to find the radio would play weakly if a one-thousand-ohms-per-volt VOM was used to bridge an open cathode resistor. The meter resistance became the cathode-bias resistor.

Answer 9. The polarity of the supply voltage at point X must be positive, for proper operation of the P-channel MOSFET. The drain must be negative relative to the source. In other words, the source must be positive compared to the drain.

Answer 10. Parallel a 44 picofarad N750 capacitor with a 56 picofarad NPO capacitor to produce the effect of a 100 picofarad N330 capacitor. Of course, that short answer demands a full explanation.

I first learned a method of calculating the values by reading a Mallory ad on page 26 of the February, 1963 *PF Reporter.*

Follow this calculation: Multiply the capacitance you need (in picofarads) by the desired temperature coefficient. Then divide the answer by 750 (the temperature coefficient you have). That answer is the capacitance of the N750 capacitor. Find the value of the NPO capacitor by subtracting the N750 capacitance (that you've just calculated) from the *total* capacitance you need.

In this case, multiply 100 (needed capacitance) by 330 (the desired temperature coefficient). The answer of 33,000 is divided by 750 (the available temperature coefficient) to produce 44 (44 picofarads at N750). Then subtract 44 (picofarads) from 100 (picofarads, the needed capacitance, to give 56 (the picofarad value of the NPO capacitor). □

Signal-Seeking Radios... Old and New

By Joseph J. Carr, CET

The mechanical "seeking" of the older car radios is compared with the new all-electronic versions that use digital techniques and components.

Early Models Of Signal Seekers

Signal-seeking car radios have been on the market since the early 1950s. Until recently, there were only two basic types: motor driven and power-spring driven. That refers to the method of moving the tuning from one end of the band to the other.

Motor types

In the motor-driven types of seekers, which were used mostly in older Ford radios and some recent Japanese imports, a small DC

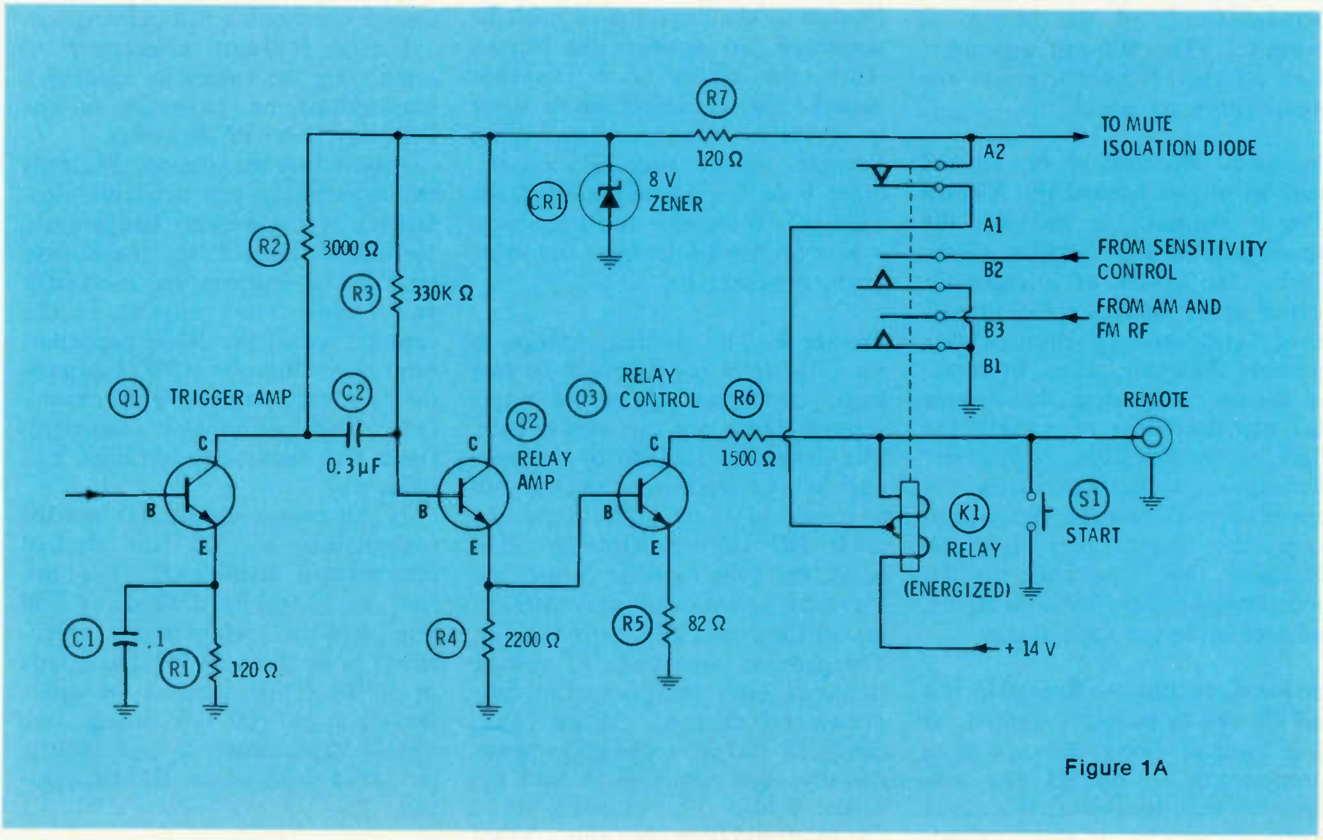


Figure 1A

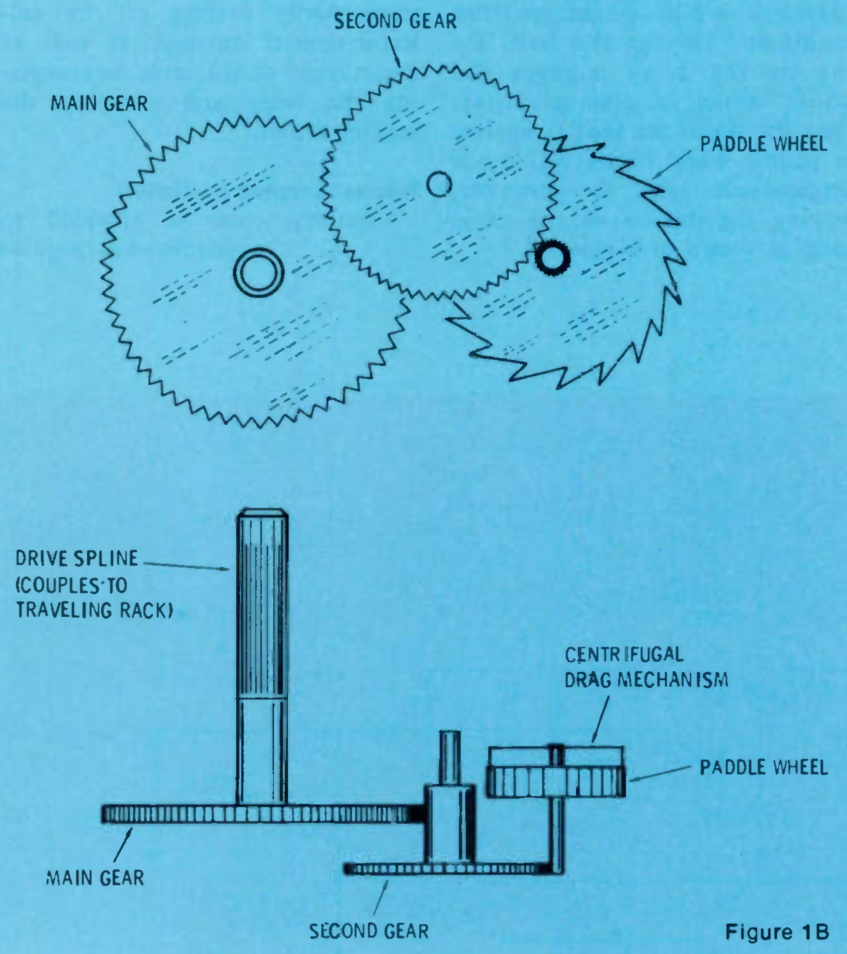


Figure 1B

motor drove the manual tuner. Some models didn't declutch the manual tuning shaft, and the turning knob rotated as the radio would seek across the band.

Power-spring types

Delco Wonder Bar radios are the prime example of the power-spring types, although a few Becker Mexico models also used the technique.

A power spring drives a traveling-rack/worm-gear assembly that is ganged to the manual tuning system. A solenoid (that's activated by trip switches) is connected to both the tuner and the power spring. When the tuner slowly seeks up the frequencies and reaches the high-end stop, a switch closes and energizes the solenoid. Power from the solenoid recocks the power spring as it rapidly returns the tuner to the low end of the dial.

These actions of the Wonder Bar are controlled by: an amplifier circuit (see Figure 1A); a gear-train governor (Figure 1B); and a relay (Figure 1C). When the radio user presses the Wonder Bar, the starting switch (SW1 in Figure 1A) is closed momentarily. That energizes the coil of relay K1, causing

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Figure 1C

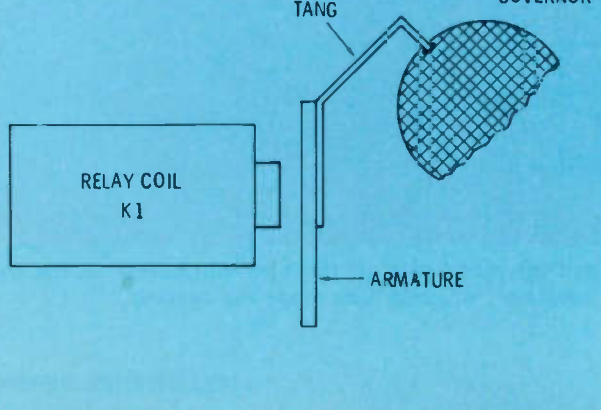

Figure 1 (A) After the relay K1 has been energized manually, voltage is supplied to Q2 and Q3, latching the relay. A pulse from the trigger amplifier causes a peak-reading rectification by C2 and the B/E junction of Q2. After the pulse has passed, the Q2 base has some rectified negative voltage that cancels part of the bias, thus stopping the conduction, and opening the relay. The relay then stays open until energized again. (B) A gear-train governor regulates the speed during the mechanical seeking. (C) A tang of the relay armature moves through a hole in the side of the governor assembly (when the relay is de-energized), jamming the paddle wheel and halting the seeking.

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contacts A1 and A2 to close, which applies B+ power to the amplifier circuit. Relay amplifier Q2 becomes forward biased and conducts. The Q2 emitter current is applied to R4 and the base/emitter junction of Q3. The DC voltage at the base of Q3 (the relay-control transistor) saturates Q3, and the Q3 collector current maintains a strong current though the starting switch is no longer closed. The relay curcuit now is electrically latched, and will remain energized until the Q3 current is forced to decrease below the critical amount required to keep the relay closed.

Governor

The governor gear train (Figure 1B) is a speed regulator containing a set of gears and a centrifugal-drag mechanism. The spline of the governor's drive is ganged to the traveling rack to limit the forward speed of the rack.

When the rack is traveling in the reverse direction, during the solenoid/spring recock cycle, the governor is free-wheeling, and does not retard the speed. Therefore, the governor operates only during the slower seek part of the cycle.

There is a hole in the governor housing and through this hole, the tang on the relay engages the paddle wheel of the governor. When the tip of the tang is against the paddle wheel (when K1 is not energized), it jams the governor, stopping the motion of the radio tuner, as shown in Figure 1C.

On the other hand, relay K1 is energized during the seek cycle; therefore, the tang is pulled away from the governor paddle wheel, allowing it to rotate. Now the rack is free to move from the low end of the broadcast band toward the high end. When a station is received, a trigger signal reaches the base of Q1 in Figure 1A. This trigger signal is amplified by Q1 and is applied to the base of Q2, momentarily cutting off its collector/emitter current, as well as the current of Q3, thus de-energizing the relay and stopping the seeking travel.

Precise stopping on station

Circuitry must be provided to

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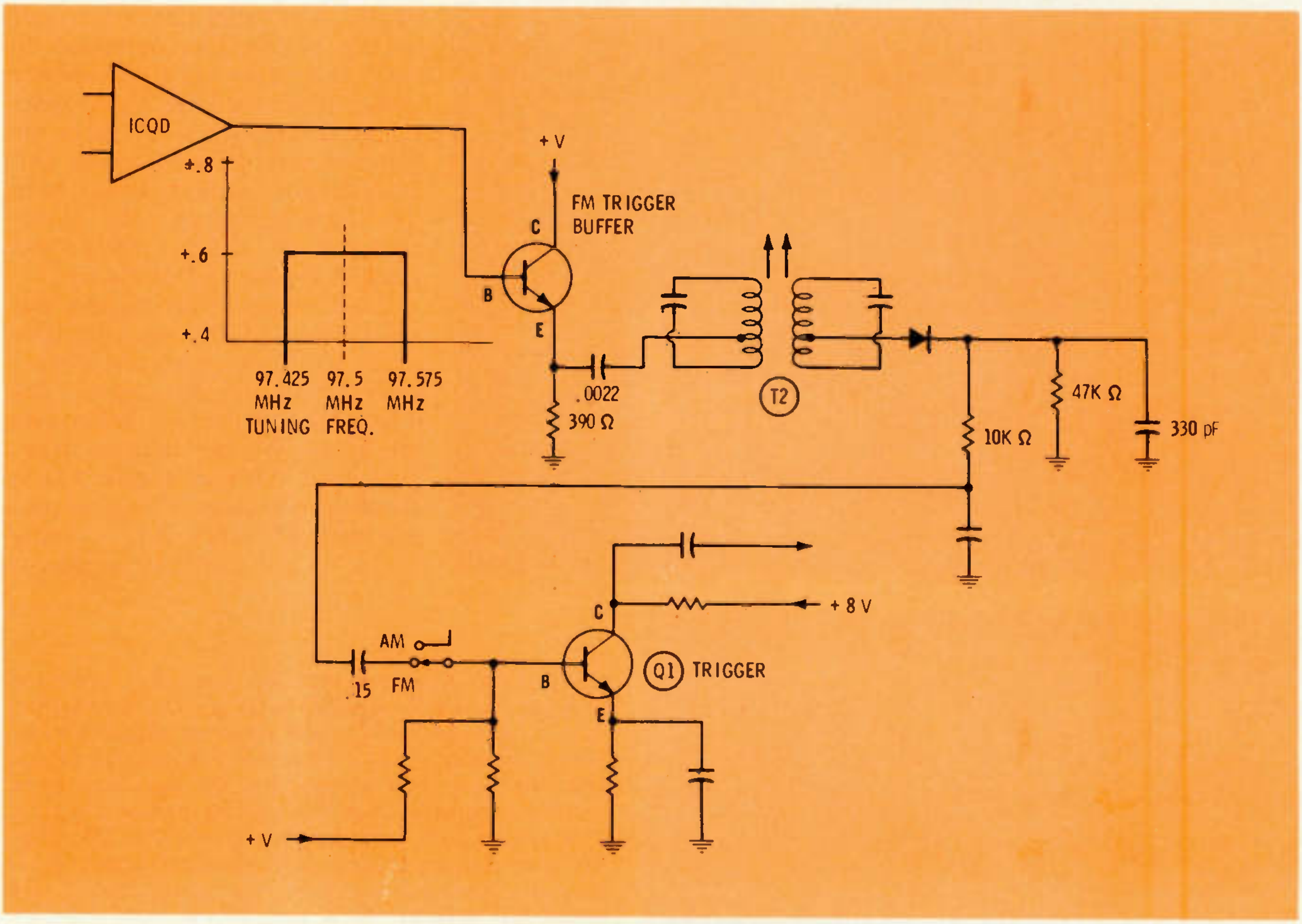

Figure 2 The base of the FM trigger buffer has forward bias only near the center of the FM-station signal. The signal appears suddenly during seeking, is rectified by the diode, and the pulse cuts off the bias temporarily of the trigger transistor, which in turn stops the seeking.

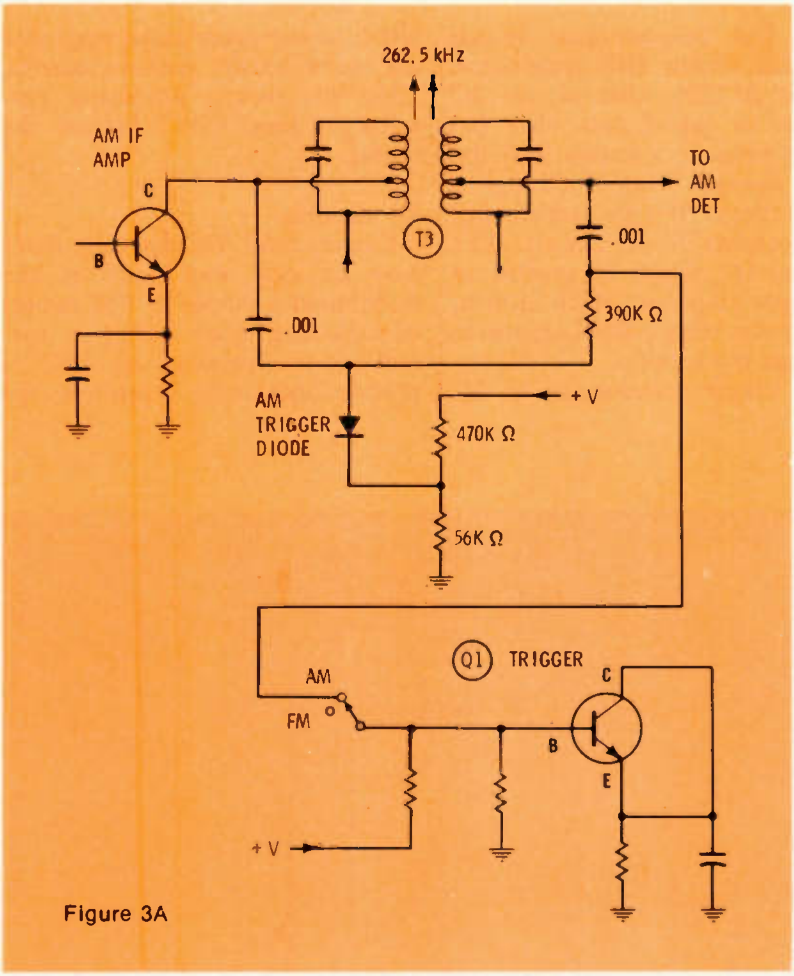

Figure 3A

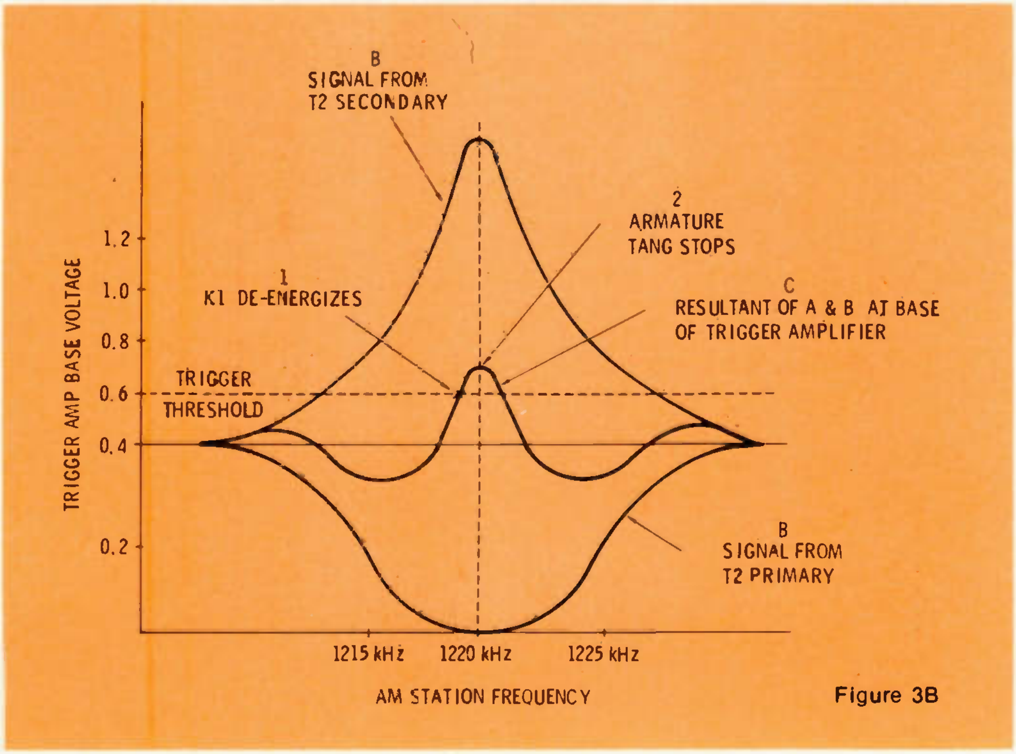

Figure 3B

Figure 3 (A) Signals from both the primary and secondary of the AM-detector IF transformer are combined, so the base voltage of Q1 becomes properly forward biased only at the center of the carrier. (B) These are the response waveforms of the IF primary and secondary, which are combined to make a positive signal only at the center of the station's carrier.

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stop the signal seeker exactly at the center of the station carrier. Without such circuitry, the stopping would be erratic, and it might not be near enough to the carrier for proper radio operation.

Figure 2 shows the FM-type stopping circuit used in recent Delco car radios. Some variations of this circuit have been in use for several years, and still are used in current non-electronically-tuned Delco Wonder Bar receivers.

The FM demodulator is an integrated circuit (IC) quadrature detector (ICQD). One of the IC pins has an output only when the radio is tuned to a station; and the output signal is coupled through a special trigger IF-type transformer to a rectifier/filter circuit. The resulting DC signal is applied to the trigger amplifier, which in turn, cuts off the relay-control transistor and stops the seeking.

The trigger transformer is adjusted so the tuner stops very near the center of the station's carrier. Then, the radio's Automatic Frequency Control (AFC) finishes the tuning.

AM stopping

Conventional AM detectors don't have an easy way (such as the discriminator output in FM radios) of indicating when tuning is correct, or of operating an AFC to provide fine tuning. Therefore, the

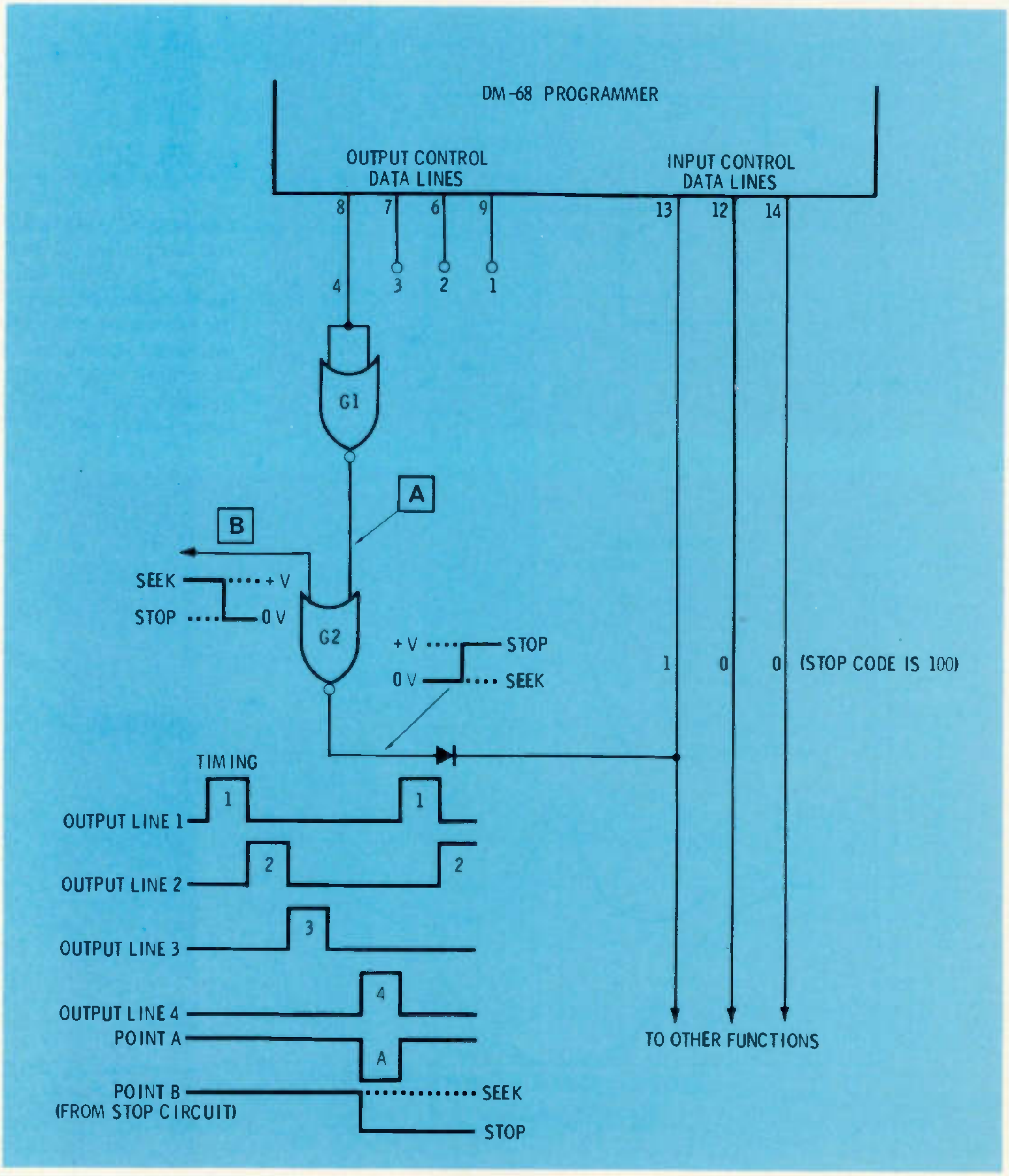

Figure 4 The DM-68 programmer IC in the 1978 all-electronic Delco radios uses a digital code at the three input lines, which during the proper clock period, halts the seeker action.

AM stopping circuit is more complex.

Instead of a discriminator, the addition of signals from both the primary and the secondary of the second IF AM transformer provides the stop signal.

During AM reception, trigger transistor Q1 has a fixed DC forward bias of +0.4-volt (see Figure 3A). Since it is a silicon transistor that requires about +0.6-volt for proper conduction, it's cut off.

When the primary and secondary waveforms of Figure 3B are added together, the resulting signal plus the fixed DC forward bias at the base of Q1 biases Q1 into full conduction near the center of the radio's passband. Actually, the threshold of conduction is exceeded just *before* the tuning reaches the center of the station, to allow sufficient time for the relay tang to fall into and stop the paddle wheel. If exceeding the threshold saturated Q1 *only* at the center of the station, the mechanical inertia of the tuner would carry it past the station.

Thus far, the circuits have been used in Delco radios of the Wonder Bar type for many years. Also, the power-spring mechanism is essentially the same as it was when first introduced. Of course, transistors and ICs have replaced the tubes, and the mechanical assembly has been refined to make it more precise and smaller.

Electronically-Tuned With Digital Readout

During 1977, Delco introduced a digital-readout AM-FM car radio, and in 1978 brought out an electronically-tuned digital radio that has a computor-like "programmer" IC that controls all of the tuning functions, including signal seeking. Even the mechanical components are limited to a few switches, such as the manual-tuning switch!

Phase-locked loops are used for the frequency selection of both AM and FM bands. The PLL, and all other tuning functions, are controlled by the DM-68 programmer, which also contains memory registers to hold the PLL "N" codes for the station selected by the pushbuttons.

The DM-68 programmer (Figure 4) has three control-data input lines, and four control-data output lines, plus several special-purpose output lines.

The four control-data output lines are multiplexed at an 80-Hertz rate. Each line sequentially has a "high," with only one high at any time. This provides four separate clock periods for the control functions.

All of the input lines are common for all tuning functions, but the DM-68 can recognize only certain commands that occur during each clock period. For example: during clock period #1, DM-68 examines the "N" code to determine if the station corresponds to it; during period #2, any changes of the manual tuner-input lines are recognized; the pushbutton commands are selected during period 3; and period #4 is for all seeker or scanner functions.

Actually, the radio has two different types of seeking operation. In the ordinary seek mode, the radio advances upband to the next higher-frequency station, and then stops there until another seek command is received from the user. However, in the scan mode, the radio advances to the next higher station, and remains there for 5 to 7 seconds. During this time, the user can cancel the command, and the radio remains tuned to that station. If no cancellation is received during the waiting time, the radio automatically advances to the next higher station and repeats the sequence.

The seeker action generated by the programmer depends on the code that appears at the three input lines during the fourth clock period. One code is interpreted as a seek command, another as a scan command, and still another as a stop command. The AM and FM stop circuits are included to produce a stop command when it's appropriate.

Figure 4 also shows the timing for the circuit operation. The stop code of the input control-data lines (pins 13, 12, and 14) is 1-0-0. This means pin 13 is high, and the other two are low.

When the fourth clock period occurs, pin 8 goes high. This pulse is applied to an inverter made by tying together both inputs of a two-input NOR gate, G1. Therefore, point A (at the output of G1) goes low only during clock period four, and the output connects to one input of another NOR gate, G2.

The other input of the NOR gate comes from a transistor (Q4 in Figure 5 and 6) that handles the stop-circuit signals. When this G2 input is high (during the seek mode), the output of G2 will be low. The output of G2 goes low **only** when **both** inputs are low during the fourth clock period.

AM stop circuit

Transistor Q4 in Figure 5 serves as the stop gate for both AM and FM, and its collector is wired to point B in Figure 4. The collector voltage will be high for seek, and low for stop.

Q4 is controlled by a comparator (one-fourth of a Delco DM-87 comparator IC).

Incidentally, comparators have been described as an "amplifier with too much gain," and that is a good capsule summary. Most comparators are similar to operational amplifiers (op-amps) without negative feedback. The open-loop gain of comparators ranges between 20,000 to more than 1,000,000, depending on the exact device. Comparators have the usual inverting and non-inverting inputs. And the high gain causes the output to saturate when the input voltages are not equal. In other words, the output of a comparator swings high or low in response to the state of voltages applied to the + and - inputs.

In the circuit of Figure 5, the comparator output remains low if E1 and D2 are equal, or if E1 is greater that E2. The output will go

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high only if E1 has a voltage that's lower than the one at E2.

The voltage at point E1 is determined by Q2 and Q3 in an AND gate circuit. The transistors normally are cut off, and E1 will be about +8-volts DC. Voltage at point E2 is supplied by the DC voltage divider consisting of R6 and R7. Notice that R7 produces a hysteresis by the positive feedback from the output to pin 5.

A single integrated circuit (DM-88) takes care of all the AM functions. The DC voltage at DM-88 pin 9 (point A) is zero when no station is being received; however, the positive voltage increases linearly in step with the incoming signal strength. This voltage is applied through a voltage divider (R1 and R2) to the base of Q2. It is sufficient at the base to saturate Q2, but no emitter current flows because Q3 is between the emitter and ground, and Q3 is cut off.

Transistor Q3 receives bias from two sources. One source is the resistors R4 and R5, and the other is the rectified output of Q1 and D2. As the radio tunes into a station carrier, the lower sideband (LSB) comes through first. Diode D2 detects the signal and feeds a negative DC voltage to the base of Q3, where it partially cancels the positive bias there. Q3 remains cut off. At the *center* of the carrier, the IF signal amplitude at D2 is reduced, along with the negative voltage applied to the Q3 base. Therefore, Q3 now has bias, and it conducts.

Both Q2 and Q3 now are forward biased and conducting; therefore the E1 voltage (at the collector of Q2) is just a fraction of a volt (a low). This is a lower voltage than the one at pin 5 of IC2, so the output of IC2 goes high, forward biasing Q4, and thereby stopping the seeker action.

FM stopping circuit

The FM stopping circuitry of Figure 6 uses the remaining three comparators of DM-87 to compare the FM AGC and AFC voltages to appropriate reference voltages. The same Q4 functions as the stop-gate transistor. When point D is low, the radio seeks; when point D is high, the seek action is stopped.

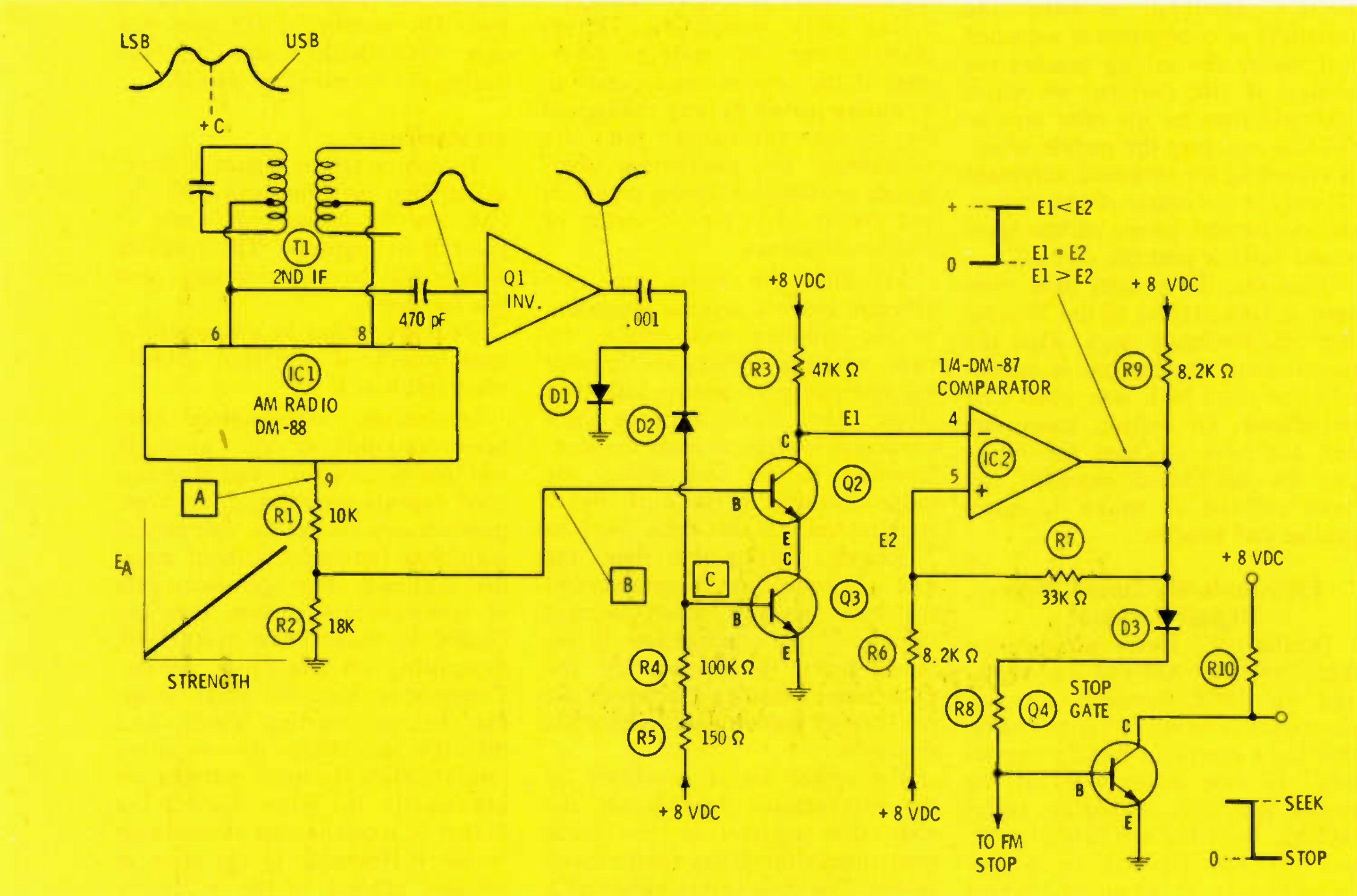


Figure 5 This is the Delco all-electronic AM-stopping circuit.

All three comparators (IC1A, IC1B, and IC1C) must have high outputs before point D can have a high. When any or all of the three comparator outputs is low, point D is low, and the seek action continues.

Comparators IC1A and IC1B form a dual-limit (or "window") comparator that monitors the AFC voltage. AFC voltages vary around some center-frequency value, and the comparator voltages are arranged so the AFC voltage is below the limit of one comparator and above the limit of the other. The difference between these limits is a "window" where the AFC voltage must fit, before both comparator outputs can go high. When the outputs at point C are high, diode D3 is reverse biased, allowing point D to go high, when IC1C permits it.

However, the output of IC1C can go high only when the AGC voltage indicates the station carrier has sufficient strength to provide a noise-free audio signal. Otherwise, the weak stations are skipped. When the AGC voltage at E4 is higher than the reference voltage, the IC1C comparator output snaps high, allowing point D to go high.

Switch S1 is the local/distant control. When S1 is in the open (local) position, R8 is part of the voltage divider, supplying point E5 with a higher reference voltage, which forces the system to skip all but the very strong carriers. For reception of distant or weak stations, S1 is closed, leaving only the voltage drop across the two diodes. Therefore, stations producing fairly-low AGC voltages will satisfy the comparator, and allow the seeking system to stop.

When both AGC and AFC conditions are met, point D voltage goes high and forward biases Q4, through D4. The collector of Q4 drops to a low, and within 1/80th of a second, the low is interpreted by the seeker as a stop command.

Comments

A knowledge of digital troubleshooting principles and of the correct operation of the Delco circuits is necessary for the successful repairs of these electronic-tuning radios. □

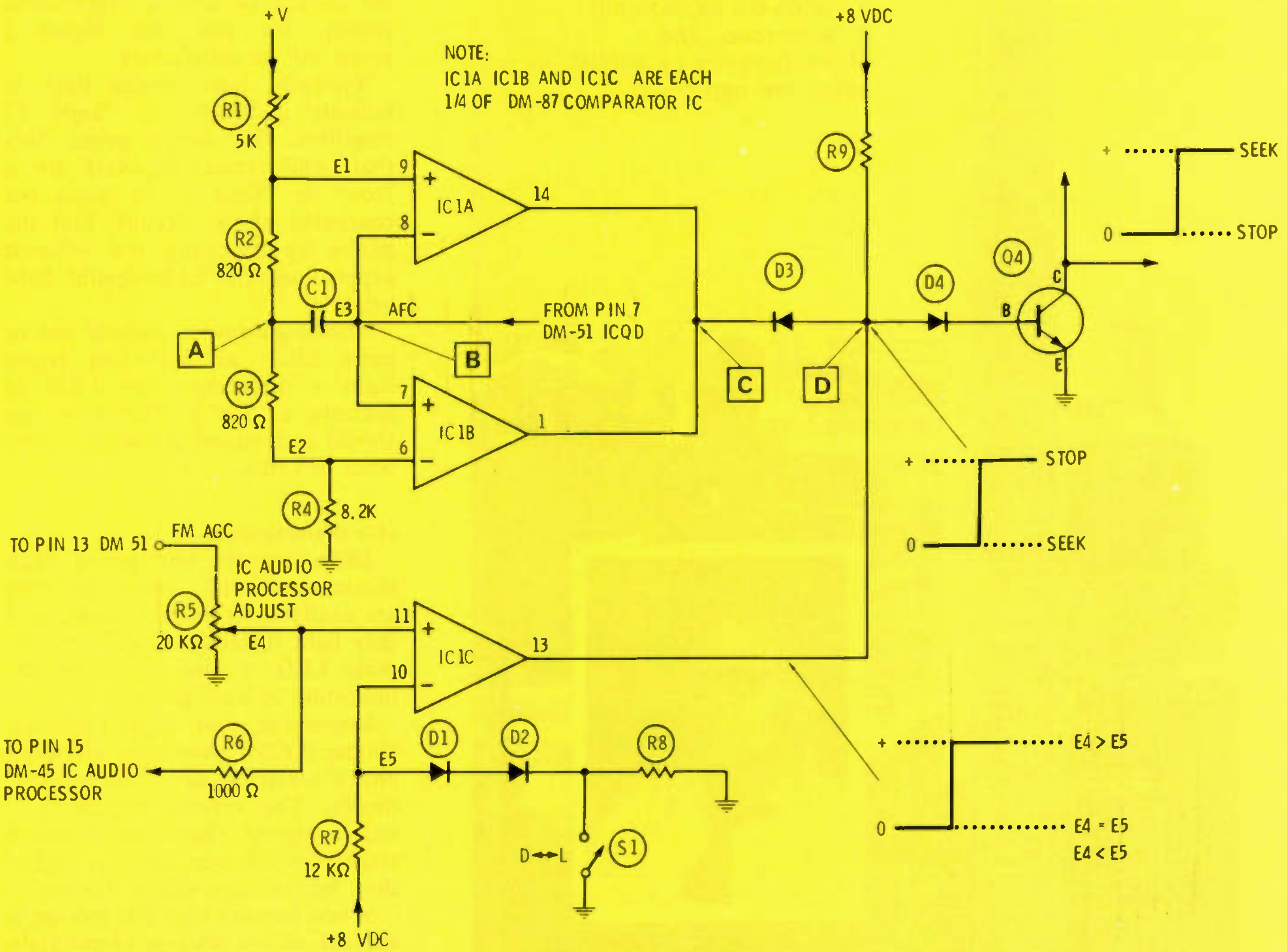
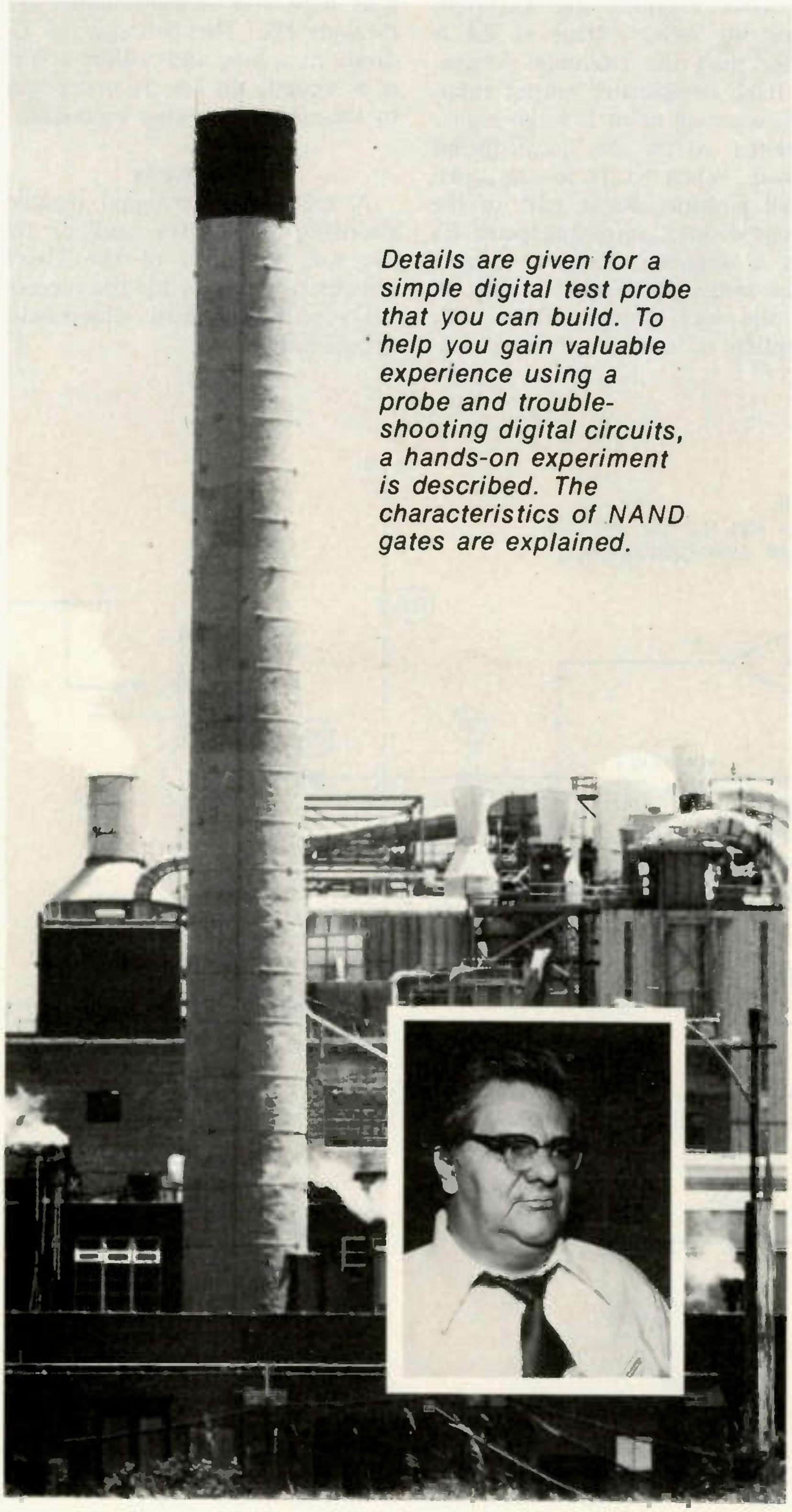


Figure 6 Comparators have output highs when a station is tuned in, thus stopping the FM seeking of the Delco all-electronic radio.

The Basics of Industrial Electronics, Part 8

By J. A. "Sam" Wilson, CET



Details are given for a simple digital test probe that you can build. To help you gain valuable experience using a probe and trouble-shooting digital circuits, a hands-on experiment is described. The characteristics of NAND gates are explained.

Building A Probe (Experiment #1)

When you become experienced at troubleshooting digital problems, undoubtedly you will want a sophisticated logic probe. However, the probe of Figure 1 is adequate for studying the basic gates and other individual building blocks.

Power to light the LED comes from the digital gate that's being tested, and some logic circuits should not be loaded so heavily. Later, we will describe another build-it-yourself probe which has lighter loading, and also we'll give the details of several commercial probes. For now, the Figure 1 probe will be satisfactory.

Typically, logic probes light to indicate a "high" or "logic 1" condition. Our simple probe does that, while remaining dark for a "low" or "logic 0" (or when not connected to the circuit). Test the probe by touching the +5-volt supply bus; the LED should light brightly.

Most logic probes include one or more LEDs as indicators (some light a different-color LED to indicate a "low"). Therefore, you should understand a few characteristics of LEDs.

LED characteristics

LEDs require less power than incandescent dial lamps do, they are available in several colors, and they light instantly. These features make LEDs a good choice for the indicators of logic probes.

Remember that Light-Emitting-Diodes (LEDs) have some electrical characteristics of power-supply diodes. The reverse resistance is much higher than the forward resistance (however, both are higher than for common silicon diodes).

When forward-bias DC voltage is applied, diodes attempt to maintain a constant voltage drop between anode and cathode. Above the

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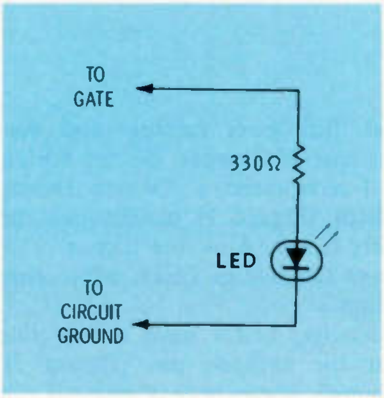
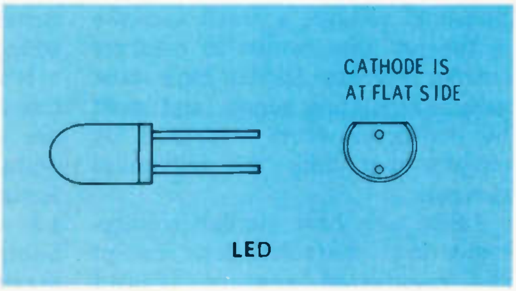


Figure 1 (at left) This simple circuit will indicate the logic state of the gates discussed here.

Figure 2 (at right) Most of the larger LEDs have a flat spot on the plastic case that identifies the cathode lead. Some LEDs have a dot beside the cathode wire, and the tiny ones intended to be mounted on a circuit board might have the cathode bar symbol as part of the flat cathode lead.



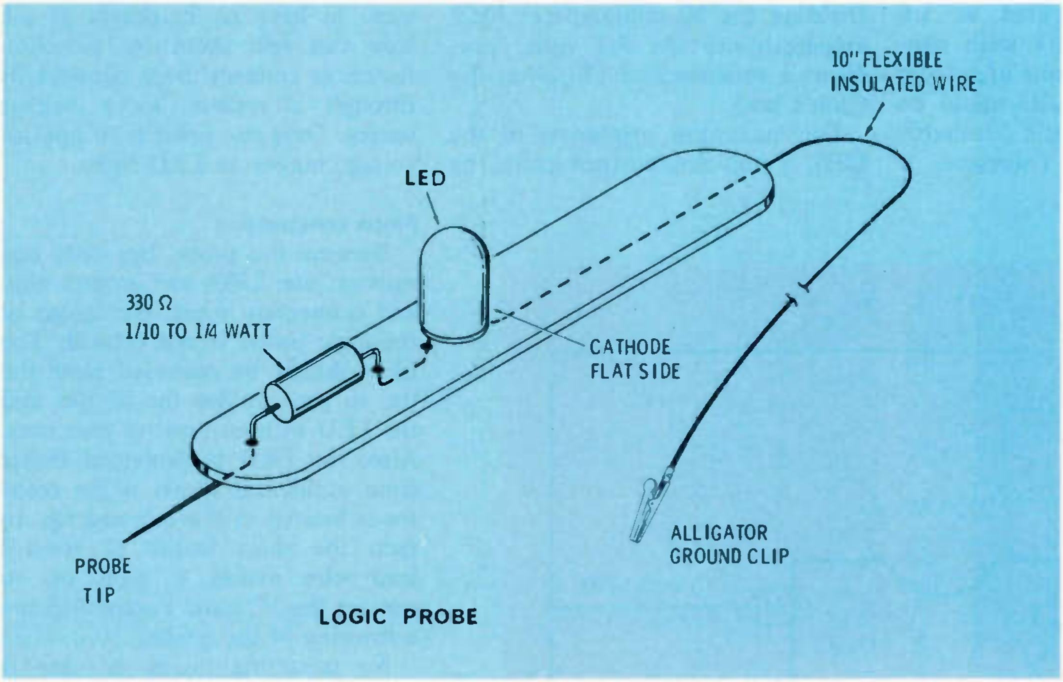
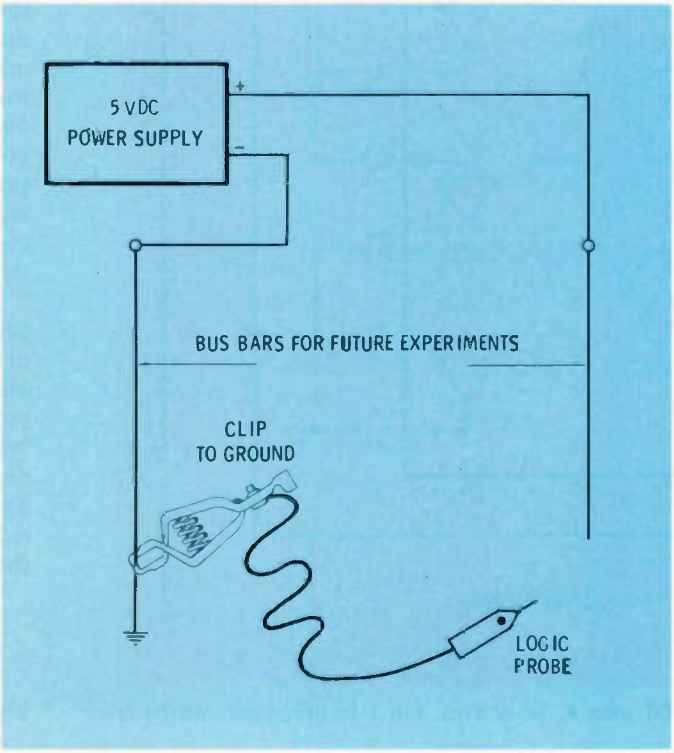


Figure 3 (above) A probe can be wired on a tongue-depressor or a piece of plastic. The LED should be near the tip, and the wiring should be insulated to prevent accidental shorts.

Figure 4 (at right) If you don't have a logic "breadboard," you can prepare for the experiment of testing the NOT gates by connecting a power supply to stiff bus wires.



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threshold voltage, a small increase of forward bias results in a larger current increase. Diodes have some voltage-regulating action, and must be protected from overload by circuits that limit the maximum current.

LEDs also have similar voltage-regulating characteristics, except the regulation centers around higher voltages.

Many LEDs are rated at 1.6 volts. If such an LED were connected from the +5 volts of a logic gate to ground, the LED would be grossly overloaded, and probably would fail rapidly. Therefore, a current-limiting resistor must be added in series with each LED.

It's easy to calçulate the value of this current-limiting resistor. LEDs are available in many different voltages and currents, but let's assume we have an LED rated at 1.6 volts and 20 milliamperes. Subtract the 1.6 volts from the maximum voltage (5 volts). This leaves 3.4 volts for the resistor. Dividing the 20 milliamperes (0.02 amperes) into the 3.4 volts, produces a resistance of 170 ohms (by Ohm's law).

For maximum brightness of the LED, a 180-ohm resistor could be used. But lower voltages and currents provide longer life for LEDs. So, I recommend a 330-ohm limiting resistor (Figure 1) to improve the safety factor. Also, the higher value allows the use of LEDs with other ratings.

Usually, LEDs have a flat side near the cathode pin (Figure 2); although, some have a colored dot beside the cathode lead, and a few seem to have no markings at all. You can test them on an ohmmeter, or connect them temporarily through a resistor to a voltage source. Only one polarity of applied voltage makes an LED light.

Probe construction

Because the probe has only one resistor, one LED, one ground clip, and connecting wires, the layout of the logic probe is not critical. The LED should be mounted near the tip, so you can see the IC pin and the LED without moving your eyes. Also, the LED is protected better from accidental shorts if the resistor is located at the extreme tip. In fact, the short length of resistor lead wire makes a good tip to contact the IC pins. Figure 3 shows a drawing of the probe.

No mounting board or case is necessary, except to protect against shorts, and to make the assembly more rigid (thus minimizing intermittent connections at the IC, and making the probe easier to handle). Some constructors attach the components to a wooden tongue-depressor. Others build the circuit inside a discarded pen case. Of course, some insulation (even plastic tape) should be provided.

A steady "high" applied to the probe causes maximum brightness of the LED, while a "low" does not allow any light. If the gate has pulses, the LED will have partial brightness or flash on and off, depending on the repetition rate. Test the probe by connecting to the +5-volt supply. (See Figure 4 for the experiment setup).

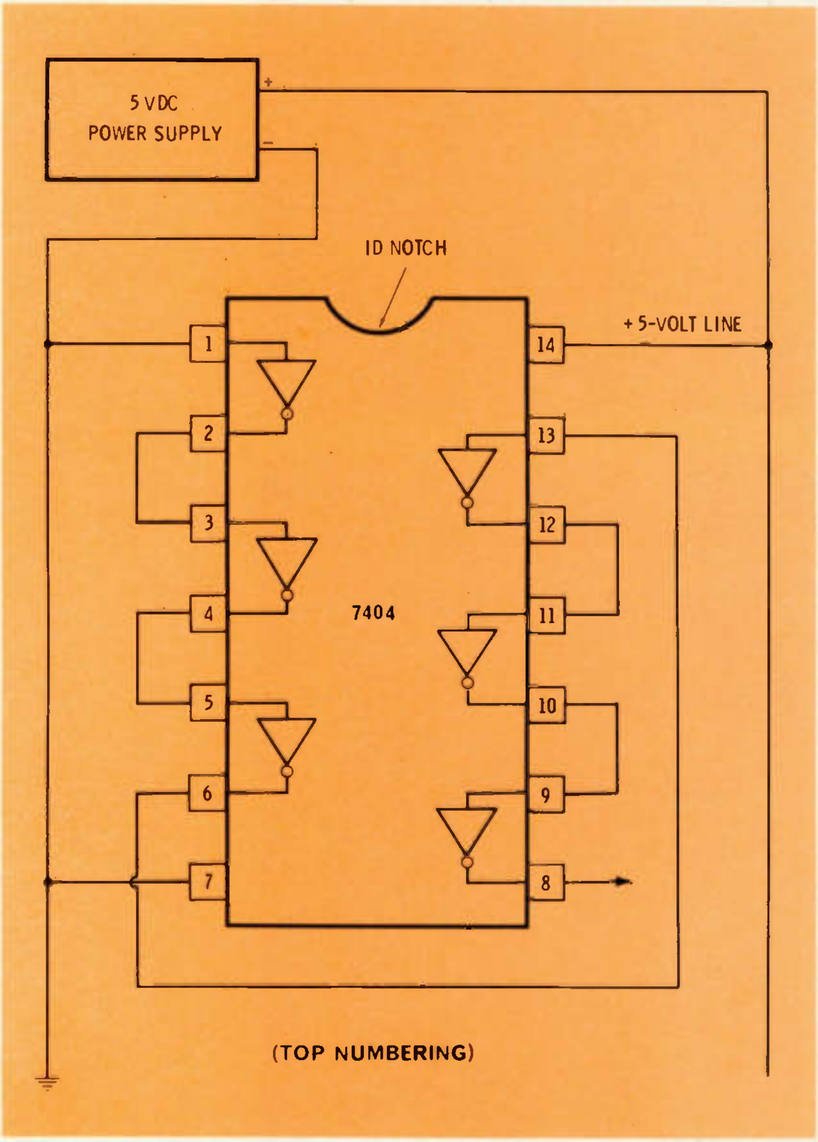

Figure 5 Wire the hex NOT gate IC as shown. Pin 1 is grounded, which is equivalent to logic 0.

Testing Hex NOT Gates (Experiment #2)

This experiment is intended to test all six NOT gates of a 7404 IC

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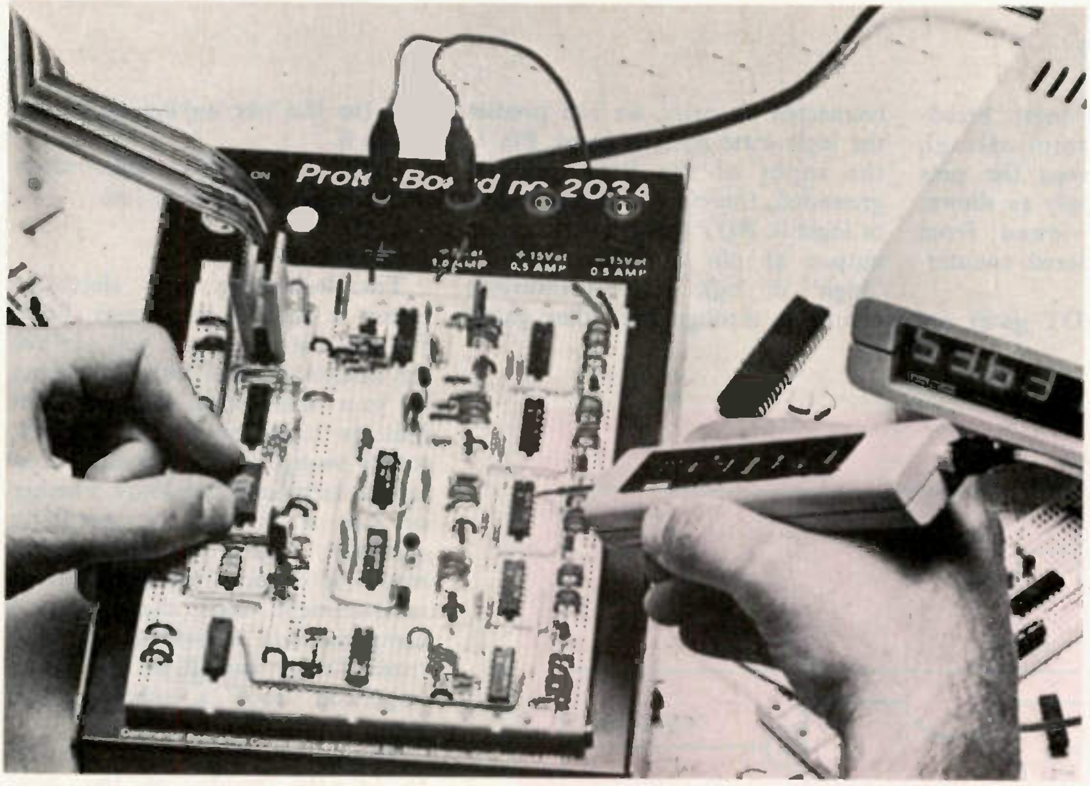

Commercial prototype boards, complete with power supplies, can be obtained from several manufacturers. (Courtesy of Continental Specialties Corporation)

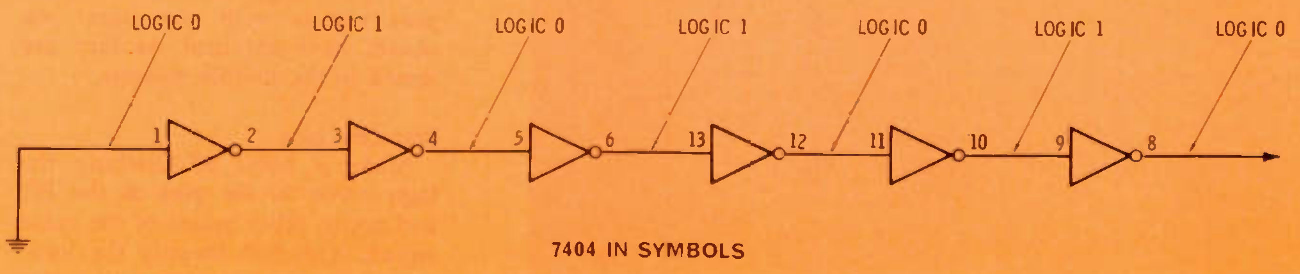

Figure 6 These are the logic levels of Figure 5, when drawn with the gates arrange in a line.

PIN NUMBER	CORRECT LOGIC LEVEL	MEASURED LOGIC LEVEL
7	0	______
14	1	______
1	0	______
2	1	______
3	1	______
4	0	______
5	0	______
6	1	______
13	1	______
12	0	______
11	0	______
10	1	______
9	1	______
8	0	______

Figure 7 Record the results of your tests of the IC in Figure 5 at the blanks of the right column. Then compare them with the expected results in the center column.

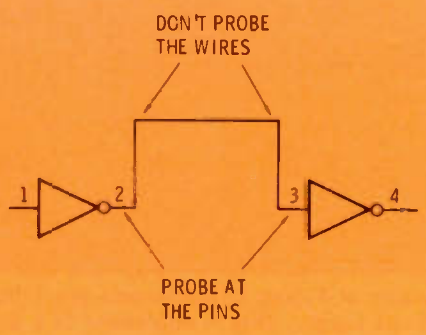

Figure 8 For the highest accuracy of digital tests, connect the logic probe to the IC pins, and not to the circuit wiring.

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(Figure 5). Using a logic bread-board (or point-to-point wiring), connect the IC between the pins and to the power supply as shown. Remember, when viewed from above, ICs are numbered counter-clockwise.

Since all of the NOT gates are connected in series, we can predict the logic state at each point. Pin 1, the input of the first gate, is grounded, therefore it has a "low" or logic 0. NOT gates invert, so the output at pin 2 should have a "high" or logic 1. This inversion continues through the other gates, with the last one having an output at pin 8.

Figure 6 shows the logic states with the gates drawn in line.

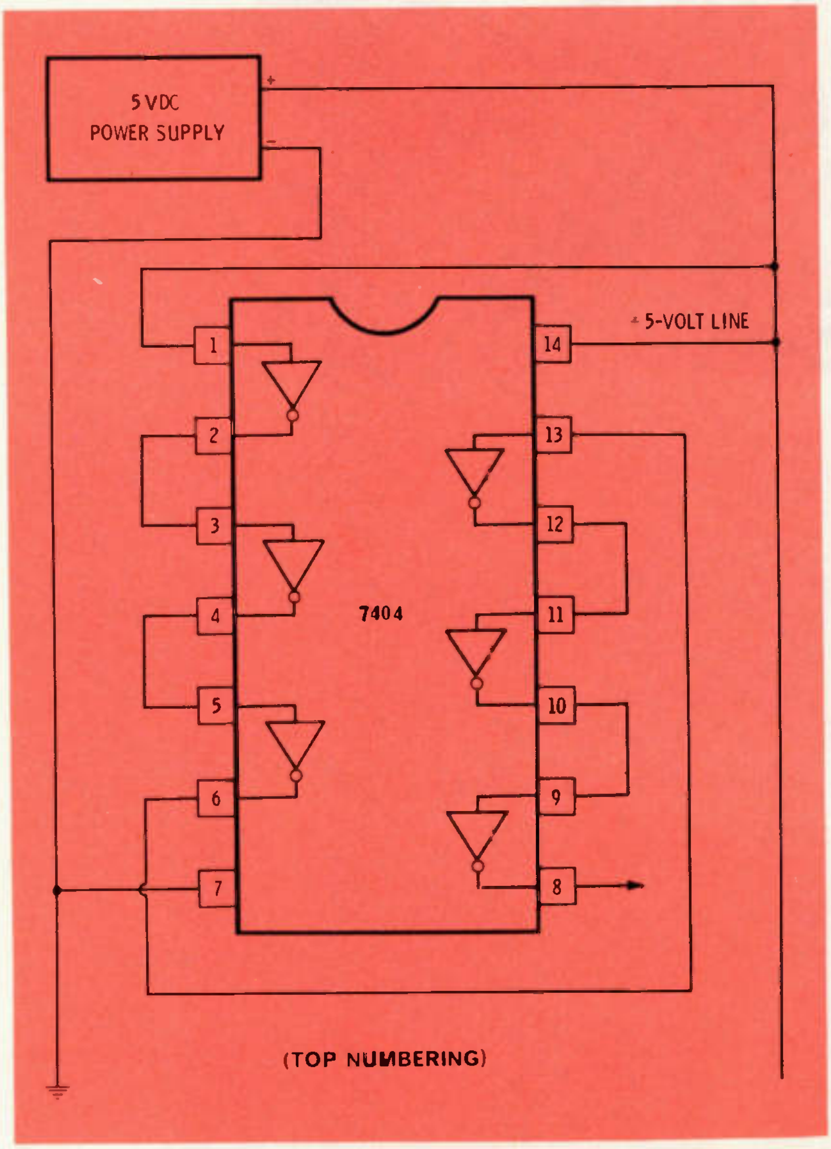


Figure 9 In the schematic of Figure 5, disconnect pin 1 from ground, and connect it to the +5-volt supply. This is equivalent to a logic 1.

Troubleshooting gates

Troubleshooting any electronic circuit is done in two stages. First, you make a test; then, you analyze the results of that test. According to your knowledge, did the test indicate operation that is correct, totally wrong, or questionable? You see, no technician can know whether or not a circuit is operating correctly, unless he knows what results to expect from each test or measurement. And that's why a comprehensive knowledge of electronic theory should be the most-important "tool" a technician can have.

The table in Figure 7 is for you to list the results of the logic measurements you made of the six NOT gates (right column). Compare your results with the ones you *should* have obtained, as they are shown in the middle column.

Probe the pins

Make a habit of touching the logic probe **to the pins of the IC,** and not to other points of the same circuit. This will identify the location of any open circuits with better accuracy in less time.

For example, in Figure 8, you should find a logic level 1 at pin 2. Also, the same logic level 1 should be found at pin 3. Therefore, if you measure a level 1 at pin 2, but none at pin 3, an open circuit must be between those two pins. But, if you measured a logic 0 somewhere along the *wiring* between pins 2 and 3, you would not know whether the first logic NOT gate was defective, or an open circuit was located between the test point and pin 2.

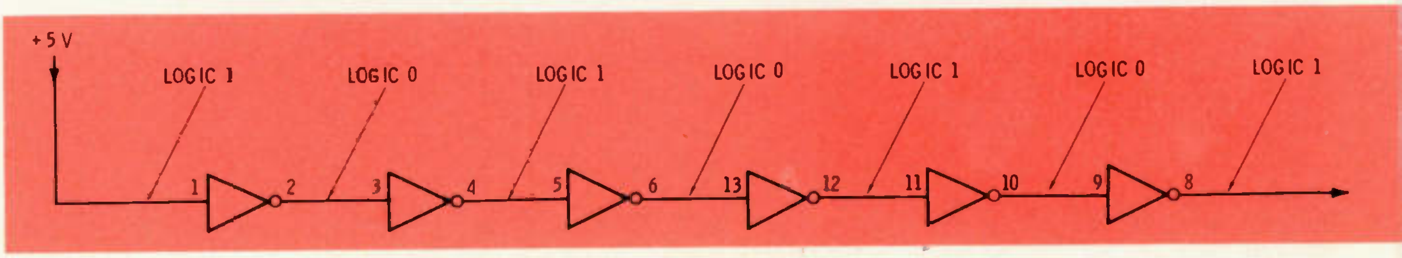


Figure 10 These are the logic levels in the circuit of Figure 9.

Troubleshooting question #1
Assuming that all of the measurements recorded in Figure 7 were correct, with the second and third columns the same, have you *completely* checked the six NOT gates? (Answers for the questions are at the end of the article.)

Testing NOT Gates, second part

As shown in Figure 9, change the test circuit of the NOT gates (see Figure 5) by removing pin 1 from ground and connecting it to the +5-volt line. This places a logic 1

continued on page 54

PIN NUMBER	CORRECT LOGIC LEVEL	MEASURED LOGIC LEVEL
7	0	______
14	1	______
1	1	______
2	0	______
3	0	______
4	1	______
5	1	______
6	0	______
13	0	______
12	1	______
11	1	______
10	0	______
9	0	______
8	1	______

Figure 11 Record the logic levels of the second test of the NOT gates (Figures 9 and 10) in the blanks of the right column. The correct results are listed in the center column.

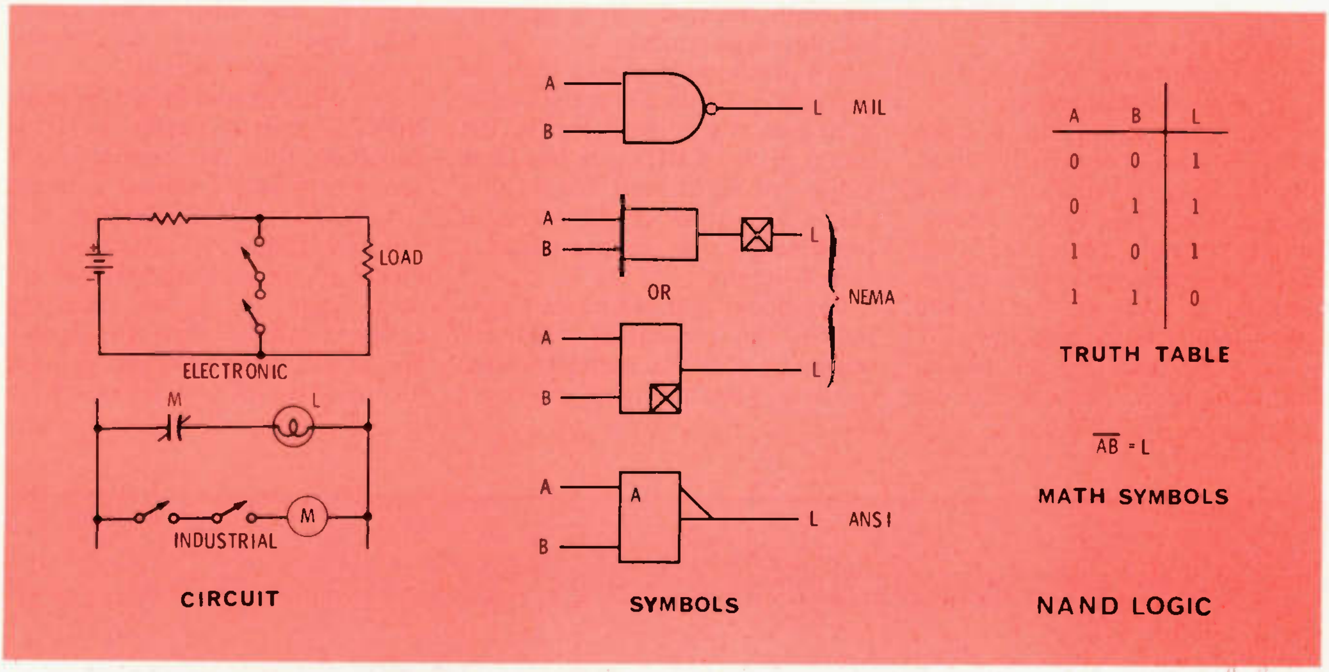
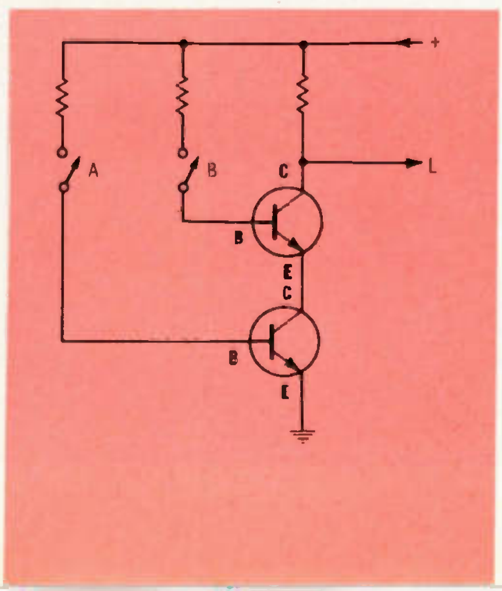


Figure 12 (above) These are the characteristics of NAND gates. You should memorize the truth table and the math symbol.

Figure 13 (at right) A NAND gate can be constructed from two bipolar transistors wired in series between load resistor and ground. The transistors can conduct only when both have forward bias (switches closed). Therefore, when both inputs have logic 1, the output has logic 0.



continued from page 53

at pin 1; therefore, the output at pins 2 and 3 should be logic 0, from 4 should be logic 1, etc, until a logic 1 ("high") should be found at the last pin, number 8.

In other words, reversing the input logic level should reverse the logic levels of *all* the gates, as summarized in Figure 10.

The table of Figure 11 again provides a column for you to write in the results of your probe measurements of each NOT gate.

Troubleshooting question #2

After having completed the tables in Figures 7 and 11 and finding your results are correct, are you convinced now that each of the six logic gates is working properly?

Comments About The Experiments

These experiments have been written so you can merely "read through" them, if you don't want to perform them. You have a choice. But, I strongly feel that such hands-on experience is very important to the overall "feel" and understanding of logic circuitry.

So far, you have learned how to construct a simple probe and to use it for making measurements of a typical IC package. You know now that a NOT gate should be checked with *both* "high" and "low" inputs to be certain one of the gates is not "hung up" at some level. You know that the probe will prove whether or not the DC supply voltage actually reaches the IC.

These are not profound experiments, but they are important for the foundation of future work with logic circuitry.

NAND Logic

NAND is the next basic gate to be analyzed. The word comes from a combination of NOT and AND, and that's a clue about the functions.

Figure 12 gives the four things about NAND gates that you should memorize: the schematic symbols; the truth table; the basic circuits; and the math symbol.

The truth table shows that the *only* way to obtain a 0 at the output is to have 1's at both inputs. (Of course, if the NAND gate has *three* inputs, all three must have 1's to obtain an output of 0.) All other combinations of inputs cause a logic 1 output.

Remember that the contact symbol in the industrial "ladder" schematic calls for normally-closed contacts, when the relay coil is not energized. When both switches are closed (logic 1), the contacts open (logic 0), and the load has no power (logic 0). Any other switch conditions (one or more low inputs) produce a logic 1 output.

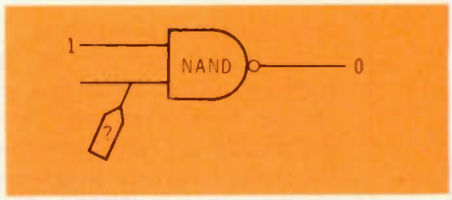


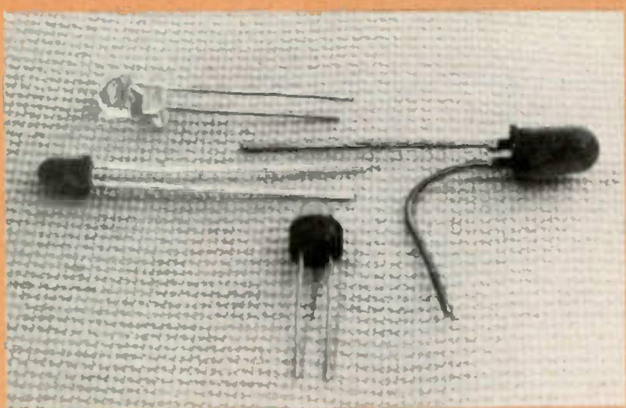
Figure 14 If one input of a NAND gate is a logic 1 and the output is logic 0, what is the logic state of the other input?

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.

A NAND gate made with two bipolar transistors is shown in Figure 13. When both switches are open (logic 0), neither transistor conducts (output logic 1). If only one switch is closed (logic 1, logic 0), one transistor is ready to

Practical LED Tests

By Carl Babcoke, Editor



Our electronics industry has its share of technical myths and half truths, and several have been circulated about LEDs. Most of the wrong impressions can be eliminated by correct answers to these questions. Do all LEDs have the same voltage rating? (The impression sometimes has been given that *all* LEDs should be operated at 1.6 volts DC.) Is the forward resistance of LEDs different from the reverse resistance? How does the front-to-

continued on page 56

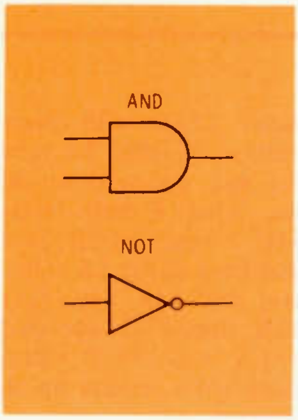
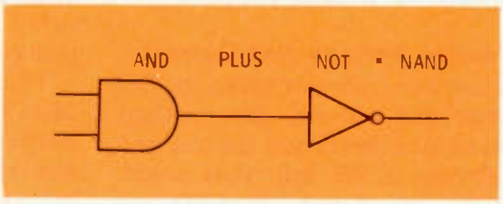


Figure 15 (at left) How can a NOT gate and an AND gate be connected to form a NAND gate?

Figure 16 (below) A NAND gate can be obtained by adding a NOT gate to the output of an AND gate.



conduct, but the other is open, so there is no current through them, and the output remains logic 1. **Only when BOTH switches are closed** (logic 1, logic 1) can both transistors conduct, producing a logic 0 output.

> **Troubleshooting question #3**
> In the NAND gate of Figure 14 one of the inputs is at logic 1, and the output has logic 0. If the NAND gate is working properly, what must the probe indicate?

> **Troubleshooting question #4**
> Figure 15 shows the MIL symbols for a NOT gate and an AND gate. How should these gates be connected to produce a NAND logic circuit?

Answers To Troubleshooting Questions

Answer #1 No, you have not checked the logic gates completely. For example, suppose one of the gates is hung up so its output always is at logic 1. In that case, inputs of **either** logic 1 or logic 0 would not change the output logic 1. If the input has logic 0, you would believe incorrectly that the logic 1 output proves normal inversion operation; whereas, an input of logic 1 also would appear to produce a logic 1 output. For a total test, you must reverse the input logic state and verify that the output also reverses its state.

Answer #2 Yes, by making two tests, you now have verified correct operation of all logic gates. Not only must a certain input state produce the expected output state, but reversing the input state also must produce a reversed output state.

Answer #3 The logic probe should indicate logic 1 ("high"). The only way of obtaining an output of logic 0 from a NAND gate is to have logic 1 at both (or all) inputs.

Answer #4 Figure 16 shows how to connect an AND gate with a following NOT gate to obtain the performance of a NAND gate. This is an important concept, for it implies that you can connect together several basic gates to form other types of gates. For example, by using a sufficient number of NAND gates, you can construct any of the basic logic gates. In the same way, if you have enough NOR gates, any of the basic gates can be produced. In later articles, we will demonstrate this truth more thoroughly.

Next Month

In the next article, I will show how NAND gates can be connected to produce the performance of other gates. Also, the basics of other logic gates will be discussed. □

continued from page 54

back ratio compare to ordinary silicon power-supply diodes? Can LEDs be operated also from AC? Does an LED light at all from reverse current? Can LEDs be damaged easily by reverse voltage? What is the best way of testing LEDs? These questions are not often answered; therefore, I decided to test some typical LEDs under controlled conditions, and thus learn the answers.

Connecting LEDs For Tests

The assortment of 15 LEDs I obtained had four different types. Also, I bought a single higher-priced LED for comparison purposes. Several of the LEDs are shown in the picture.

Each LED in turn was connected to the adjustable supply voltage through a current-limiting resistor. The color coding of the resistor indicated 330 ohms, but it measured 350 ohms. One digital voltmeter was connected to monitor the LED current, and another DMM was used to measure the supply voltage and the LED voltage, as shown in the schematic.

To make the tests compatible with the needs of digital-logic probes, I kept the supply at about +5 volts, for most of the tests.

Testing Voltage And Current

First, one LED was tested for DC voltage and current, the readings were written down, and the hue and brightness of the light were noted. For the second test, the LED was reversed in polarity, and the reverse current was measured and written on the data table. At -6 volts (the supply voltage without any load), most LEDs showed no measurable leakage (0.00 mills on the 20 milliampere range). All 16 LEDs were checked, and the readings recorded.

Range Of Measured LED Voltages

These LEDs showed a surprising range of voltages. One type had about 3.5 volts at about 4 milliamperes, another kind measured about 3.1 volts at 9.5 mills, and others of larger sizes checked about 1.70 volts at 9.5 mills. In addition, the catalog of one prominent manufacturer shows LEDs with these specs: 2.2 volts at 10 mills; 2.4 volts at 20 mills; and 1.6 volts at 20 milliamperes. Also, I have measured several 7-segment displays that operated from about 1.6 volts.

Therefore, we can say that *MOST* LEDs should be operated between +1.6 and +1.7 volts; however, some types require up to twice that voltage.

Resistance Tests

The forward and reverse resistances of the 16 LEDs were checked easily with an ohmmeter, and the tests identified the anodes and cathodes.

On the 1K range of a VTVM, the majority of the LEDs showed a forward resistance between 90K and 150K (although one type required a change to the 1M range, where the reading was 80M). Most of the reverse-bias resistances were infinitely high (open), however one LED tested only 15M.

When tested on the same 1K range of the VTVM, power-supply silicon diodes measured around 5K. So, LEDs have much higher resis-

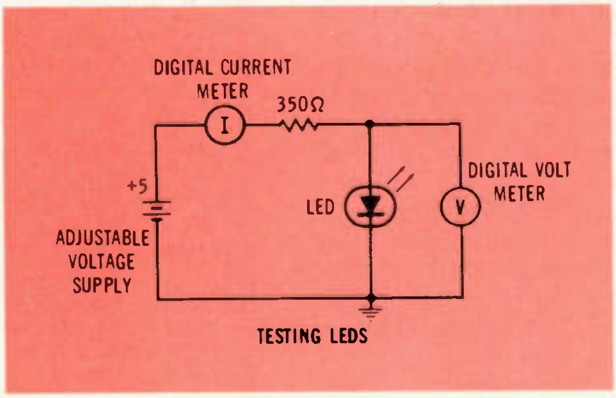


TABLE A
LED Reverse Current

(The same circuit, but with the LED polarity reversed)

LED Voltage	LED Current in Milliamperes
-16	0.00
-17	1.02
-17.3	4.03
-18	12.14
-18.85	20.08
-21	40.60

tances than do ordinary power-supply diodes, and have higher voltage drops.

Reverse Breakdown Voltage

Next, I attempted to destroy one of the +3.11-voltage LEDs by applying excessive reverse-bias voltage.

In the catalogs, many LEDs are listed as having reverse breakdown voltages between 3 volts and 10 volts. These figures imply that LEDs can't withstand much reverse voltage without damage or excessive current.

The reversed-polarity LED was connected to the variable-voltage supply through the same 350-ohm resistor, and the meter readout was watched carefully as the reverse voltage was increased slowly. Up to -16 volts, no current was measured. At 17 volts, the current was slightly above 1 milliampere, and higher voltages increased the current at an exponential rate. Table A gives the results at six values of reversed voltage.

The readings are similar to those obtained by the reverse-biasing of zener diodes. Therefore, it seems appropriate to say that LEDs *can* exhibit a zener effect, when heavily reverse-biased.

Incidentally, the LED did not short out, and it glowed normally when forward voltage was applied later.

AC Operation?

From the results of the resistance and reverse-voltage tests, it seems clear that most modern LEDs can be used safely with low AC voltages, and will have normal diode action (although with higher voltage drop).

For additional dependability, a fast-switching silicon diode could be connected in parallel with the LED, but with the polarity reversed.

Regulation Effect

When a current-limiting resistor is connected in series with an LED, the diode effect tends to regulate or stabilize the DC voltage across the LED. To illustrate this action, the most-expensive of the 16 LEDs was tested in the circuit with seven different supply voltages, as shown in Table B. Which voltage is correct for that LED?

Power-supply diodes have the same kind of regulation when operated in similar circuits with DC power. However, the center of the regulation is around 0.9 to 1.0 volt.

TABLE B
LED Voltage Versus Current

Supply Volts	LED Volts	Mills	Calculated Resistance
1.90	1.52	1.09	1394 ohms
2.99	1.60	3.92	410 ohms
3.99	1.64	6.59	248 ohms
5.02	1.69	9.41	185 ohms
6.00	1.73	12.10	157 ohms
7.00	1.77	14.80	119 ohms
8.85	1.83	19.90	91 ohms

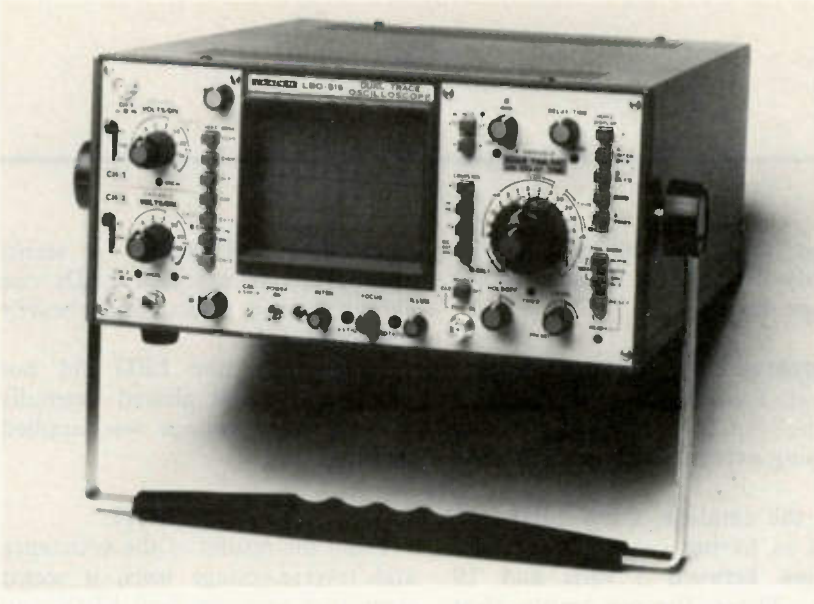
A 20.4% increase of voltage produced a 1725% increase of current.

Answers And Comments

Here are answers to some questions asked at the beginning:

- LEDs are available in many different voltage and current ratings. Probably, the most popular is the 1.6-volt rating. However, I have not yet found one that drew even a fraction of the 20 milliamperes that seems to be a standard for many types. I would advise you to test LEDs as shown here before you include one in a circuit, especially if the ratings are not shown;
- LEDs can be checked by measuring the forward and reverse resistances. However, the readings are much higher than those for conventional diodes, and such tests are not very informative, except for identifying the anode and cathode.
- Yes, LEDs can be operated from AC power, provided the reverse voltage is below the reverse-voltage rating of the LED. Otherwise, an additional conventional diode must be added for protection;
- LEDs produce no light from reverse current. Neither will they light when tested for forward conduction by an ohmmeter; and
- LEDs appear to have a zener action that protects them from damage when the reverse voltage and current is not too excessive. However, they can't tolerate the high reverse voltages that are normal for power-supply operation.

Although LEDs with current-limiting resistors attempt to stabilize the **voltage drop** across themselves, the current does vary greatly with small changes of voltage. Also, the brightness increases in step (approximately) with the increase of current. □



Model LBO-515 dual-trace 25-MHz scope by Leader has a second horizontal-sweep time base for expanding small areas of a waveform. The trace is very bright and sharp because of a high accelerating voltage at the CRT, and an internal illuminated graticule eliminates parallax.

Reports from the test lab

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

By Carl Babcoke

Leader Model LBO-515 Scope

Scopes with additional functions and improved performances are becoming necessary for testing digital circuits, microprocessers, and other sophisticated devices. The Leader LBO-515 has those extra capabilities.

General Features

Leader model LBO-515 has all usual functions of a modern dual-trace triggered-sweep scope. The waveform of either channel 1 or channel 2 can be displayed. Also, pushbuttons provide a manual choice of either "chop" or "alternate" display of both waveforms.

However, **the unique features are in the horizontal-sweep section,** where the conventional (or "A") sweep has a "hold-off" control, and a second "B" sweep is provided to enlarge specific areas of the waveform. This is called "delayed sweep", and the enlargement is additional to the X10 magnification. Such wide horizontal expansions are required for analyzing narrow pulses.

Vertical Amplifiers

There are two identical vertical amplifiers. The bandwidth is rated at -3 dB from 2 Hz to 25 MHz for AC coupling, and from DC to 25 MHz for DC coupling. The rise time is 14 nanoseconds. No ringing or overshoot was noticed in any of the complex waveforms tested.

Lever switches select channel inputs of DC coupling, AC coupling, or ground. The grounded-input mode is very helpful for moving the zero-voltage line to any desired point. The lever switches were faster and easier to operate than are some other types.

Maximum sensitivity of both channels is 5 millivolts (0.005 volts) per calibration division on the CRT screen. Ten ranges are provided, in a 1-2-5 sequence, up to 5 volts per division. A variable control allows adjustments of waveform heights between the ranges.

When the variable control is being used, the calibration is not known, and an "uncal" LED lights to remind you. For ±3% calibration accuracy, turn the variable control clockwise until a switch clicks and the "uncal" LED goes dark. Maximum input voltage is 600 volts peak.

Each channel has a delay line, which permits the horizontal to be triggered by the undelayed signal, and thus display the leading edge of the waveform (usually eliminated by the time required for the sweep to begin).

Centering controls are provided for both vertical channels.

Pushbutton switches select: channel 1 waveform; channel 2 waveform; a composite of both waveforms; alternate waveforms; or chopped waveforms (where the two waveforms are switched at 250 KHz). The polarity of the channel 2 waveform can be inverted by another pushbutton, while the trigger button allows either channel 1 or channel 2 waveform to sync the horizontal sweep.

CRT And Controls

Size of the rectangular CRT was not listed, but the screen has 8 vertical and 10 horizontal divisions. Each division is 0.8 centimeter. Parallax error is eliminated by the internal graticule lines. Variable graticule illumination can change the lines from black to white.

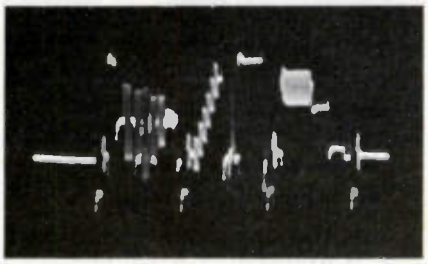
Waveform sharpness and brilliance are very good because of the 6-KV accelerating voltage and the screwdriver-adjustable astigmatism control. A similar control eliminates any waveform tilting.

The LED on-indicator, the on/off switch, and a terminal with a 0.5 VPP squarewave (for probe adjustments) are located to the left of the CRT controls.

Horizontal Sweep

Two time-base horizontal-sweep circuits are included. Time base "A" has 20 steps from 0.5 second-per-division to 0.2 microsecond-per-division, plus a variable control (with an LED to show uncalibrated operation). The other time base will be explained later.

Sync for triggering the horizontal sweep can come from either vertical channel or from an external source (through the "source" pushbutton). Four other pushbuttons modify the sync signal. The "AC" button does not allow locking below 20 Hz, and the "HF Rej" (high-frequency rejection) button limits the high-frequency locking to 10 KHz. The "TV" button supplies vertical or horizontal sync from any composite video, and a "DC—ext only" button extends the external-sync locking down to DC. In addition, a "slope" button allows locking either to positive-going or negative-going signals.



Stable VITS and VIR waveforms were displayed on the LBO-515.

The "level" control adjusts the amplitude level that starts the sweep, and also selects a positive or negative point. This action is conventional. For simple waveforms, the control can be turned fully CCW to the "preset" position where locking occurs automatically. When sync is triggering the horizontal sweep correctly, the "trig'd" LED lights (a help in making locking adjustments).

Associated with this operation is the "A holdoff" control that removes an adjustable amount of sweep near the end of the trace; an action that's helpful with some digital waveforms.

Delayed "B" sweep

Eight pushbuttons are arranged vertically down the right edge of the front panel. Most of these are used for the *delayed sweep* that has the effect of widening selected areas of the regular waveform.

Eighteen positions from 0.1 second-per-division to 0.2 microsecond-per-division are provided for time base "B," which is completely separate from the conventional "A" time base.

First, the normal "A" time base controls are adjusted to obtain a stable waveform that includes the area where the trace expansion is needed. For this step, the "A" button under "horiz display" is depressed.

Next, the "A inten by B" (A display intensified by the B display) button is pressed, and the area (which will become the expanded trace) has more brightness. The "delay time" control moves the brighter area horizontally, and the setting of the "B time/div" switch determines the width of this area; therefore, these two controls are adjusted so only the portion of the waveform that's to be examined is in the brighter area.

When the "B dly'd" (B time base) button is pressed, *only* the area formerly brightened will cover the screen (same height, and full width). If needed, the "delay time" knob can be used to move the waveform across the screen for pinpointing any specific area.

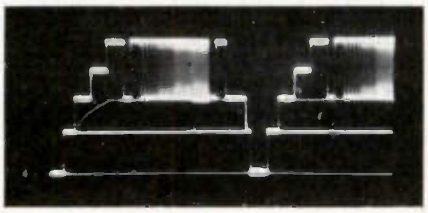
Some types of waveforms will have less jitter if the "B trg'd" (B time base triggered) button is used. Evidently, the sweep is started by the first edge of the expanded area. Refer to the instruction book for more details.

Other buttons allow single traces of infrequent signals. Also, the "X-Y" button uses channel 1 for the X input and channel 2 for the Y input of a vectorscope. The advantage is that both channels have identical phase and frequency response.

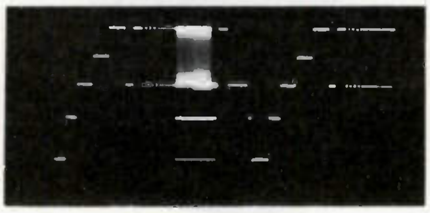
Comments

Two X1/X10 probes with insulated hook tips are included, and they functioned very well. Accuracy of the various calibrations seemed to be excellent, and the internal CRT graticule allowed the same accuracy of peak-to-peak readings regardless of the angle of view. No drift of the two traces was observed (very rare with dual-trace scopes).

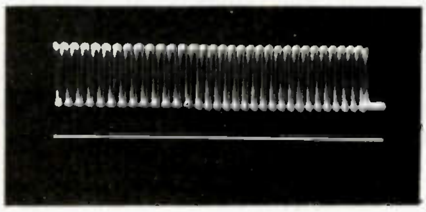
Operation of the delayed "B" sweep enabled me to obtain several waveforms not possible with conventional triggered-sweep scopes. This function is essential for proper display of certain digital waveforms. □



A



B



C

Multi-frequency waveform from a video generator was used to show the operation of time-base B. (A) Five bursts of different frequencies are part of this video waveform. The normal "horizontal display" button A was used. (B) When the "A inten by B" button was pressed, only part of the waveform was brightened (the scope intensity was reduced slightly to avoid overexposing the brighter area). The area brightened included the 3-MHz and 3.58-MHz bursts. (C) Pressing the "B dely'd" button expanded the two bursts to fill the entire screen. More or less expansion is possible with other adjustments. This feature is highly recommended for digital waveforms.

product report

Detection System

The P14 vehicle-detection system by **Mountain West** has a magnetic sensor that is buried in the dirt at the side of a road or driveway. The connecting cable can be installed just a few inches underground, and routed to the control unit, which can be located up to 2500 feet from the probe.

When a slow-moving vehicle comes within the detection range of 6 to 8 feet, the change of the earth's magnetic field is detected by the sensor, causing a relay in the control unit to close. The relay can turn on lights, bells, or horns having ratings under 2 amperes.

The system is said to be weatherproof, tamperproof, and not subject to false alarms.

Each unit costs $159.

For More Details Circle (38) on Reply Card

Calculator

Hewlett-Packard has developed the first pocket-sized programmable calculator with a built-in printer.

The HP-19C is designed for sophisticated problem solving by engineers, scientists, technicians, and students who need a permanent record of their calculations.

The calculator, priced at $345, features 98 program steps, continuous memory, editing and programming functions, 30 data-storage registers, and a quiet thermal printer.

A 203-page owner's manual and a 164-page applications book are included.

For More Details Circle (39) on Reply Card

Light

Tweezer Lite, by the **Tweezer Lite Company**, combines tweezers and a battery-operated light. The light is turned on by a clockwise rotation of the body. A penlight-type bulb and battery are supplied. The tweezer portion is made of surgical-grade stainless steel, with precision-ground tips.

For More Details Circle (54) on Reply Card

Desoldering Braid

The original desoldering braid now is available in a tell-tale color from **Wik-it Electronics**.

The built-in color indicates where to snip off the used braid for minimal waste. The non-spattering metallic braid wicks up solder, without leaving a corrosive or conductive residue.

The new "Chroma Wik-it" is tinned copper-wire braid with non-conductive rosin.

For More Details Circle (40) on Reply Card

Features of these products were supplied by the manufacturers, and are listed at no charge to them. If you want factory bulletins, circle the corresponding number on the Reply Card, affix a stamp, list the required information, and mail the card.

test equipment report

Digital Multimeter

A 4½-digit, 5-function autoranging digital multimeter from **Hewlett-Packard** measures DC from 1 microvolt to 1.2 kilovolts full scale with a mid-range accuracy of ±.03% of reading +1 count.

True-RMS AC measurement range is 200 millivolts to 1200 volts with 10 microvolt sensitivity and a mid-range accuracy of ±(0.3% of reading + 20 counts) over a 20 Hz to 100 kHz bandwidth.

Wideband, true-RMS AC voltage and current measurements may be made using either AC or DC coupling. AC coupling eliminates any DC component. DC coupling can be selected in the case of a badly-distorted waveform where it becomes necessary to measure true-RMS AC plus DC.

One unusual feature is the 2K-ohm range, which provides 1-milliampere of current. The forward voltage drop across a diode junction is displayed on the digital readout. Thus, the test measures germanium, silicon, light-emitting, and Schottky diodes in volts, even though the instrument is in the resistance function.

Model 3466A sells for $650.

For More Details Circle (41) on Reply Card

Triggered Scope

The LBO-507, a 20-MHz triggered-sweep scope by **Leader**, offers automatic triggering for maximum display stability with minimal adjustments. Ten-millivolt/CM to 20-V/CM vertical sensitivity is calibrated in 11 steps; a 1-2-5 sequence up to 50-V/CM with the variable control; and a 17.5 nanosecond rise time.

Accuracy is +3%, with input impedance of 1 megohm shunted by 35 picofarads. DC bandwidth is 20 MHz (-3 dB), and for AC it is 2 Hz-20 MHz (-3 dB). Sweep speed is 0.5-microsecond/CM to .2 sec/CM with 18 steps in a 1-2-5 sequence. The unit has a bright, 5-inch CRT, with an 8x10-CM effective area, and has a contoured carrying handle which also serves as a locking bale.

The LBO-507 is priced at less than $500, and comes with a low-capacitance probe and a terminal adapter.

For More Details Circle (42) on Reply Card

Frequency Counter

Sencore's new FC45 frequency counter, with continuous frequency-checking capability from audio through VHF and UHF bands, uses a high-accuracy, temperature-controlled oven to achieve a one part in one million (1 PPM) accuracy.

The FC45 audio-through-VHF counter has a 25 mV average sensitivity throughout the band, for servicing with a pick-up loop that does not upset the circuit frequency.

An all-direct-reading, eight-digit display with all-pushbutton action makes the FC45 easy to use.

Suggested price is $395. An optional PR47 Prescaler, which is connected into the input cable, is available for $125.

For More Details Circle (43) on Reply Card

Hi-Fi Generator

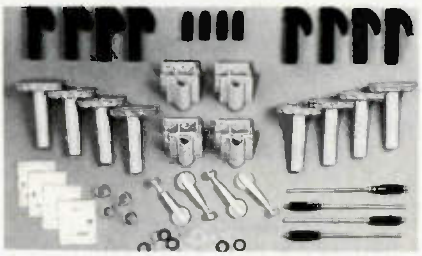
The RE101 RF signal generator from the **London Company** has inherent distortion of less than 0.05% FM, not 0.5% as reported in the January issue.

Features of these products were supplied by the manufacturers, and are listed at no charge to them. If you want factory bulletins, circle the corresponding number on the Reply Card, affix a stamp, list the required information, and mail the card.

antenna systems report

Antenna Parts Kit

A recreational-vehicle antenna parts kit, **Winegard** model RV-100, is designed for repairs of Winegard RVH model crank-up antennas. Included are multiples of common parts required for field repair work: shafts, gears, springs, fasteners, handles, and washers. The kit includes a few old-style parts. List price is $74.50.



For More Details Circle (44) on Reply Card

Indoor CB Antenna

Antenna Incorporated's new model 13510 magnetic-mount antenna is a do-it-yourself apartment house CB antenna. When placed on top of a range, refrigerator, dishwasher, or other metal-clad appliance, the "Zapper" uses the metal in the appliance to form the ground plane.

The antenna system also works on furnaces or stationary tubs with metal rims in single family homes. If no appliances are conveniently located, a 4-sq. ft. piece of metal window screen will form an adequate ground plane.

For More Details Circle (45) on Reply Card

Antenna Rotator

The "Beam Master" antenna rotor by **Channel Master** was designed for CB beam antennas with up to 5 square feet of wind-loading area, or large TV antenna arrays. It features a heavy-duty tool-steel gear system; weatherprotected housing with snap-lock cover; and a low-profile rotor-control unit.

The rotator can withstand 8,400 inch-pounds of vertical force and has a built-in thrust bearing that can handle 250-pound loads. The mast support can accommodate masting having 1- to 2-inch outside diameters.

The unit comes with a strip guide, terminal barriers, a strain-relief, and furniture-protecting base pads. Beam Master is available in 115 VAC (model 9515) or 220 VAC (model 9508). Suggested retail is $89.95 for model 9515.

For More Details Circle (46) on Reply Card

AM Radio Amplifier

The AMA-51 by **Extronix** amplifies signals received by a roof-top antenna and re-transmits them inside sales areas to overcome the poor reception in steel-framed buildings, and to minimize the electrical interference generated by fluorescent lights, elevators, and appliances.

The amplifier boosts the AM radio band to a satisfactory reception level without tuning. The composite output of the amplifier, used in conjunction with master distribution systems, is rated at 3.0 volts for 75 ohms, with all distortion down at least 40 dB.

For More Details Circle (47) on Reply Card

CB Base-station Antenna

"Herman," a ½-wavelength dipole base-station antenna, is the latest addition to **Antenna Incorporated's** line of CB radio antennas.

The 16-foot antenna is made of welded and drawn aircraft-quality aluminum tubing. All mounting hardware is either cadmium-plated steel or gold dichromated aluminum. The unit weighs 3½ pounds.

Herman maintains an SWR of 1.35:1 or better across 40 channels. The antenna also features quick assembly and installation, with fold-down radials and a telescoping vertical radiator.

Suggested resale price is $39.95.

For More Details Circle (48) on Reply Card

Features of these products were supplied by the manufacturers, and are listed at no charge to them. If you want factory bulletins, circle the corresponding number on the Reply Card, affix a stamp, list the required information, and mail the card.

audio systems report

Auto Audio Products

RCA has added four AutoSound line products, including two tape players, an FM converter, and a set of speakers with padded grilles.

The 12R206 cassette player and the 12R305 8-track tape player were designed for under-dash installation by the "do-it-yourselfer."

Model 12R206 mini-cassette, which can fit into most glove compartments, has 4.5 RMS watts of power per channel, and is compatible with 3- or 8-ohm speakers. The optional price is $59.95.

The 12R305 8-track player features automatic repeat and fast-forward pushbuttons. Audio power is 4.5 RMS watts per channel, and the optional price is $59.95.

Model 12R905 FM converter adapts any existing AM car radio to receive FM broadcasts. The integrated-circuit converter has a tuning knob and an on/off switch. Optional price is $29.95.

The 12R408 set of car speakers, with 10-ounce ceramic magnets, is designed for flush-mount installation. The snap-on grilles are foam-padded, and have a textured black finish. The optional price is $20.95.

For More Details Circle (49) on Reply Card

Speaker Filter

A newly designed stereo-speaker interference filter from **Electronics Specialists** minimizes audio interference and distortion caused by CB transmissions. This simple-to-install, compact filter is available at $9.95 per pair.

For More Details Circle (50) on Reply Card

Stereo Preamplifier

Uher has modified its BR-211 bracket/stereo-preamplifier, for use with the company's CR-210 and CR-134 car stereo cassette recorders.

The unit can be used with any AM/FM/MPX radio, and any outboard amplifier and speaker combination.

The preamplifier automatically switches from cassette recorder to radio when the CR-210 is turned off. The BR-211 also allows tape recording from the radio without interrupting the program.

For More Details Circle (51) on Reply Card

Microphone

Astatic's omnidirectional dynamic model 877L public-address and paging microphone has a smooth wide-band frequency response with a slight rise above 2000 Hz for "presence." The frequency response is 50 to 12,000 Hz, and the nominal impedance is 400 ohms.

For More Details Circle (52) on Reply Card

Record Cleaning System

The model 1100 Vac-O-Rec record cleaning system from **VOR** features a more powerful motor than VOR's model 100 record cleaner, an improved on/off switching system, and a washable dust filter cartridge.

Model 1100 uses natural mohair fibers to loosen dust particles from record grooves, while at the same time an impeller fan vacuums the dust and dirt out and away from the record.

Suggested retail price is $44.95.

For More Details Circle (53) on Reply Card

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Solution to

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1 Rhombic
2 Copper
3 Regulator
4 Radio
5 Omega
6 Acetate
7 Encapsulation
8 Novar
9 Red
10 Deci
11 Interlock
12 Kirchhoff
13 Flash
14 Hookup
15 Plug
16 Graphite
17 Equipment
18 Terminal
19 Loom
20 Masts
21 Shunt
22 Tandem
23 Megatron
24 Noctovision
25 Negative
26 Entropy
27 Yellow
28 Wafer
29 Repeller
30 Relay

Start with 120 points and deduct 4 points for any part you may not have answered correctly.

Your rating:

0-68	Scratch.
72-84	Also ran.
88-96	Show.
100-116	Place.
120	Win!

catalogs literature

59. **MTI**—A brochure describes the contents of two new home-study courses. A 4-lesson course covering semiconductors is designed for all technicians. Those planning to service land-mobile equipment will be interested in the 34-lesson professional FM two-way-radio course.

61. **Electronic Tool**—The catalog features tool kits ranging from complex kits for sophisticated electronic servicing, to simple kits for production lines. A test-equipment section offers inexpensive analog meters, ultra-compact digital multimeters, and portable scopes.

62. **Bird Electronic**—A 4-page brochure lists 19 "Tenuline" RF-attenuator models ranging from 25 watts to 4000 watts continuous duty, and from 3 dB to 30 dB of fixed attenuation. The Bulletin No. Tenu/7 lists all pertinent data in standard and metric units.

63. **Mallory**—Illustrations, descriptions and ordering information are given for more than 8,000 electronic components and related products in a general catalog. Included are capacitors, controls, switches, semiconductors, audible signal devices, security products, cassette recording tape, and product merchandisers.

64. **Motorola**—The Two-Way Radio Test Equipment Catalogue (RO-9-19) describes 31 additions to the line. Included are the R-1200A service monitor, the R-1010A signal generator and the S-1228A FM station monitor.

70. **Channel Master**—A pocket catalog covers the firm's "Phase 40" and the "Super Phase 40" models of mobile CB transceiver, the "Command Base 40" base station transceiver, mobile and base station power microphones, and the "Interceptor," a 10-channel, 4-band scanner monitor.

71. **Workman Electronic Products**—WD496, a suggested distributor stock package, lists 19 often-required components for TV-game servicing. Included are crystals, chips, switches, controls, antenna junction boxes, and AC adaptors.

72. **Bell Industries**—A 12-page CB coil-replacement and cross-reference guide classifies coils for equipment under 67 CB trade names. Some 3,300 manufacturer part numbers are cross-referenced to J. M. Miller Division part numbers.

73. **Micro Switch**—The proper photoelectric control for distances ranging from 6 feet to 700 feet can be found in the "Comparison Guide for Modulated LED Photoelectric Controls." The guide reviews eight modulated products with long-life LEDs, increased vibration resistance, quick alignment, IC chips and monolithic integrated circuit technology.

74. **Sencore**—Five product line brochures include all 25 instruments grouped in five product lines. The brochures cover digital multimeters, communications and CB instruments, scopes, transistor and tube testers, and TV and radio equipment. Photos, benefits, applications, and specifications are included for each product.

75. **Ora Electronics**—Featured in an 8-page catalog are Japanese replacement parts for CB radio, TV, and hi-fi equipment. The parts include integrated circuits, transistors (2S Series), ceramic filters, and tape and cassette heads.

76. **Sprague Products**—A 48-page component replacement guide, K-1200A, contains CB component information for capacitors, semiconductors, resistors, plus a section devoted to radio-interference filters, and CB radio-installation aids.

77. **Turner**—An illustrated accessory catalog features the "Whip-Flip" anti-theft CB antenna mounts, and the "Insta-Mount" mirror. Also described are a variety of mounts for stainless steel and fiberglass antennas.

81. **Leader**—More than 40 test instruments and accessories are featured in the 1977/78 catalog. The products include scopes, vectorscopes, multi-meter and millivolt meters, audio analyzers, digital frequency counters, signal and sweep-marker generators, color-bar pattern generators, and a broad range of communications performance-test products. It is indexed. □

the marketplace

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2SA 70	1.10	2SA 847	.59	2SC 460	.59	2SC 929	.59	2SC 1584	8.50	2SD 427	2.80
2SA 101	.59	2SA 850	.70	2SC 461	.59	2SC 930	.59	2SC 1586	6.60	2SD 525	1.60
2SA 102	.59	2SA 872A	.59	2SC 481	1.60	2SC 943	1.20	2SC 1624	1.30	2SD 526	1.10
2SA 234	.59	2SA 908	11.00	2SC 482	1.50	2SC 945	.59	2SC 1626	1.10	2SD 555A	6.60
2SA 342	.90	2SB 54	.59	2SC 485	1.60	2SC 959	1.50	2SC 1628	1.30	2SD 610	1.90
2SA 353	.70	2SB 55	1.10	2SC 486	1.60	2SC 971	1.00	2SC 1647	.59		
2SA 377	2.00	2SB 75	.59	2SC 493	3.90	2SC 983	1.00	2SC 1669	1.60	FET	
2SA 440	.90	2SB 77	.59	2SC 495	1.00	2SC 984	.90	2SC 1674	.59	2SK 19	1.60
2SA 483	3.00	2SB 186	.59	2SC 497	1.60	2SC 1000BL	.59	2SC 1675	.59	2SK 30	.90
2SA 484	2.50	2SB 187	.59	2SC 509	.90	2SC 1014	1.20	2SC 1678	2.25	2SK 33	1.10
2SA 485	2.00	2SB 202	1.60	2SC 517	3.95	2SC 1017	1.40	2SC 1682	.45	2SK 34	1.10
2SA 489	1.60	2SB 220	.70	2SC 535	.70	2SC 1018	1.20	2SC 1684	.59	2SK 40	.70
2SA 495	.70	2SB 303	.59	2SC 536	.59	2SC 1030C	2.80	2SC 1708	.59	2SK 49	1.30
2SA 496	1.10	2SB 324	.70	2SC 537	.59	2SC 1047	.70	2SC 1728	2.00	2SK 55	1.30
2SA 497	1.60	2SB 337	1.60	2SC 538A	.70	2SC 1060	2.25	2SC 1760	2.00	2SK 68	1.30
2SA 509	.70	2SB 367	1.50	2SC 562	2.15	2SC 1061	1.40	2SC 1775	.45	3SK 22	2.55
2SA 525	2.50	2SB 368B	2.15	2SC 563	1.10	2SC 1080	4.40	2SC 1816	4.25	3SK 35	2.25
2SA 537	2.25	2SB 379	1.10	2SC 620	.59	2SC 1096	1.00	2SC 1885	.70	3SK 39	2.25
2SA 539	.70	2SB 400	.59	2SC 627	1.60	2SC 1111	3.40	2SC 1908	.59	3SK 40	2.25
2SA 561	.59	2SB 405	.70	2SC 632A	.70	2SC 1115	3.40	2SC 1909	4.40	3SK 41	2.50
2SA 562	.59	2SB 407	1.40	2SC 644	.59	2SC 1116	4.40	2SC 1951	1.10	3SK 45	2.50
2SA 564A	.59	2SB 415	.70	2SC 645	.70	2SC 1116A	4.90	2SC 1957	1.20	MK 10	2.00
2SA 565	1.10	2SB 434	1.20	2SC 650	1.30	2SC 1124	1.30	2SC 1969	4.90		
2SA 566	3.40	2SB 463	1.50	2SC 668	.59	2SC 1162	1.10	2SC 1973	1.10	IC	
2SA 606	1.90	2SB 471	1.60	2SC 680	2.80	2SC 1166	.59	2SC 1975	4.40	AN 2140	3.40
2SA 624	1.10	2SB 472	2.80	2SC 684	1.40	2SC 1173	.90	2SC 2028	.90	AN 315	3.70
2SA 627	3.60	2SB 474	1.20	2SC 693B	.59	2SC 1175	.90	2SC 2029	3.90	BA 511	3.40
2SA 628	.59	2SB 492	1.00	2SC 696	1.95	2SC 1177	14.00	2SC 2091	3.60	BA 521	3.70
2SA 634	.90	2SB 507	1.60	2SC 708A	1.90	2SC 1189	1.40	2SC 2092	3.90	HA 1151	3.70
2SA 640	.59	2SB 509	1.90	2SC 710	.59	2SC 1211D	.70	2SC 2098	3.90	LA 4400	3.70
2SA 643	.70	2SB 514	1.90	2SC 711	.59	2SC 1213	.70	2SD 28	2.80	TA 7045M	3.00
2SA 659	.59	2SB 526C	1.30	2SC 712	.59	2SC 1222	.45	2SD 75	1.10	SN 7400	.19
2SA 663	4.90	2SB 527	1.90	2SC 717	.59	2SC 1226	1.00	2SD 90	1.60	SN 7490	.60
2SA 666	.70	2SB 528D	1.60	2SC 730	4.40	2SC 1237	4.25	2SD 91	1.60	TA 7055P	3.00
2SA 672	.70	2SB 531	3.40	2SC 732	.59	2SC 1239	3.50	2SD 92	1.50	TA 7060P	1.60
2SA 673	.70	2SB 536	1.60	2SC 733	.59	2SC 1279	.70	2SD 118	3.00	TA 7061AP	1.90
2SA 678	.70	2SB 537	1.60	2SC 734	.59	2SC 1306	4.40	2SD 130	1.20	TA 7062	1.90
2SA 683	.70	2SB 539	4.90	2SC 735	.59	2SC 1307	4.90	2SD 142	2.00	TA 7205P	3.90
2SA 684	.70	2SB 541	4.40	2SC 738	.59	2SC 1312	.59	2SD 143	2.80	TA 7310P	3.95
2SA 695	.70	2SB 554	10.00	2SC 756	2.80	2SC 1313G	.59	2SD 178	1.40	uPC 592H2	1.60
2SA 697	.70	2SB 557	3.40	2SC 763	.59	2SC 1317	.59	2SD 180	2.50	PLL 02A	8.80
2SA 706	1.60	2SB 561B	.70	2SC 773	.70	2SC 1318	.59	2SD 187	.59		
2SA 715	1.40	2SB 564	.90	2SC 774	1.60	2SC 1327	.59	2SD 188	3.00	DIODES	
2SA 719	.70	2SB 595	1.90	2SC 775	1.95	2SC 1330	1.50	2SD 205	1.40	1S 84	1.00
2SA 720	.70	2SB 600A	7.00	2SC 776	2.65	2SC 1342	.59	2SD 217	4.40	1S 188	.45
2SA 721	.70	2SC 183	.59	2SC 777	3.50	2SC 1344	.59	2SD 218	3.70	1S 332	.45
2SA 725	.59	2SC 184	.59	2SC 778	3.60	2SC 1345D	.59	2SD 223	1.90	1S 953	.45
2SA 726	.59	2SC 281	.59	2SC 781	2.65	2SC 1359	1.40	2SD 224	1.90	1S 1007	.45
2SA 733	.59	2SC 284	1.40	2SC 783R	3.60	2SC 1360	1.00	2SD 226	1.60	1S 1209	.45
2SA 740	2.65	2SC 367	.90	2SC 784	.59	2SC 1362	.59	2SD 227	.59	1S 1211	.45
2SA 744	3.70	2SC 369	.70	2SC 785	.70	2SC 1364	1.40	2SD 234	1.00	1S 1555	.32
2SA 745R	4.40	2SC 371	.59	2SC 789	1.00	2SC 1377	4.90	2SD 235	1.00	1S 1588	.32
2SA 747	5.80	2SC 372	.59	2SC 793	2.80	2SC 1383	.59	2SD 287	3.70	1S 1885	.45
2SA 750	.59	2SC 373	.59	2SC 799	3.60	2SC 1400	.59	2SD 313	1.10	1S 2076	.45
2SA 756	3.40	2SC 374	.59	2SC 815	.59	2SC 1402	3.70	2SD 315	1.20	1S 2093	.45
2SA 758	5.80	2SC 380	.59	2SC 828	.59	2SC 1403	3.70	2SD 325	1.10	1S 2473	.45
2SA 774	.59	2SC 381	.59	2SC 829	.59	2SC 1419	1.10	2SD 356D	1.10	1N 34	.25
2SA 777	1.10	2SC 382	.59	2SC 838	.59	2SC 1444	2.80	2SD 357D	1.00	1N 60	.25
2SA 798	.70	2SC 387	.59	2SC 839	.59	2SC 1448	1.10	2SD 358	1.30		
2SA 814	1.90	2SC 394	.59	2SC 870	.59	2SC 1449	1.00	2SD 360	1.20		
2SA 816	.70	2SC 403	.59	2SC 871	.59	2SC 1451	1.60	2SD 371S	2.80		
2SA 818	1.40	2SC 430	1.10	2SC 897	2.65	2SC 1475	1.40	2SD 382	1.40		

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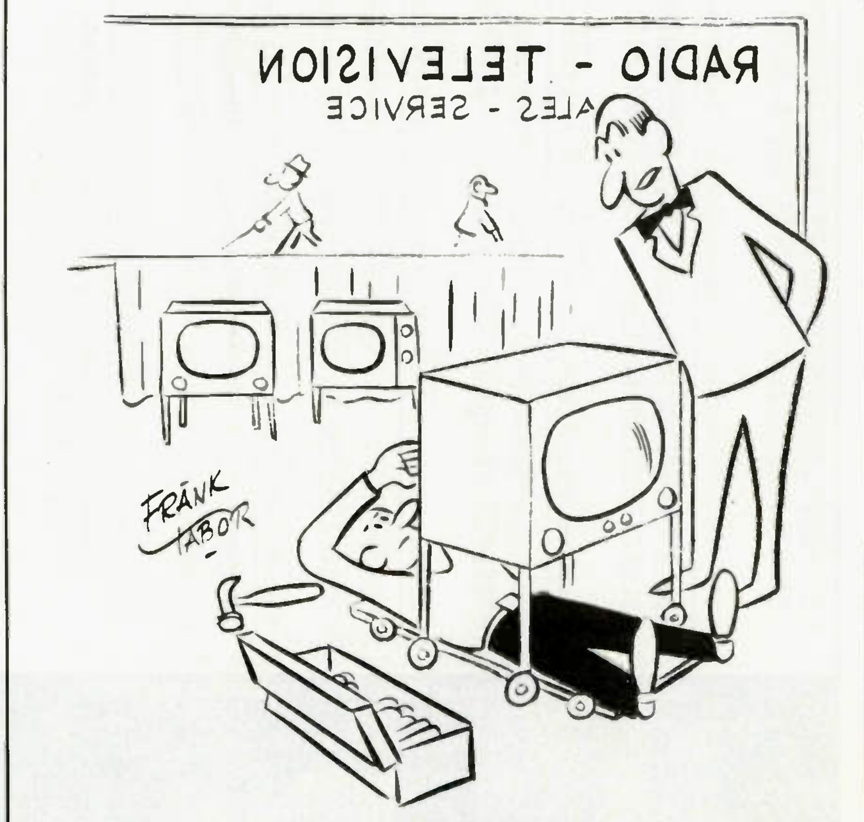

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