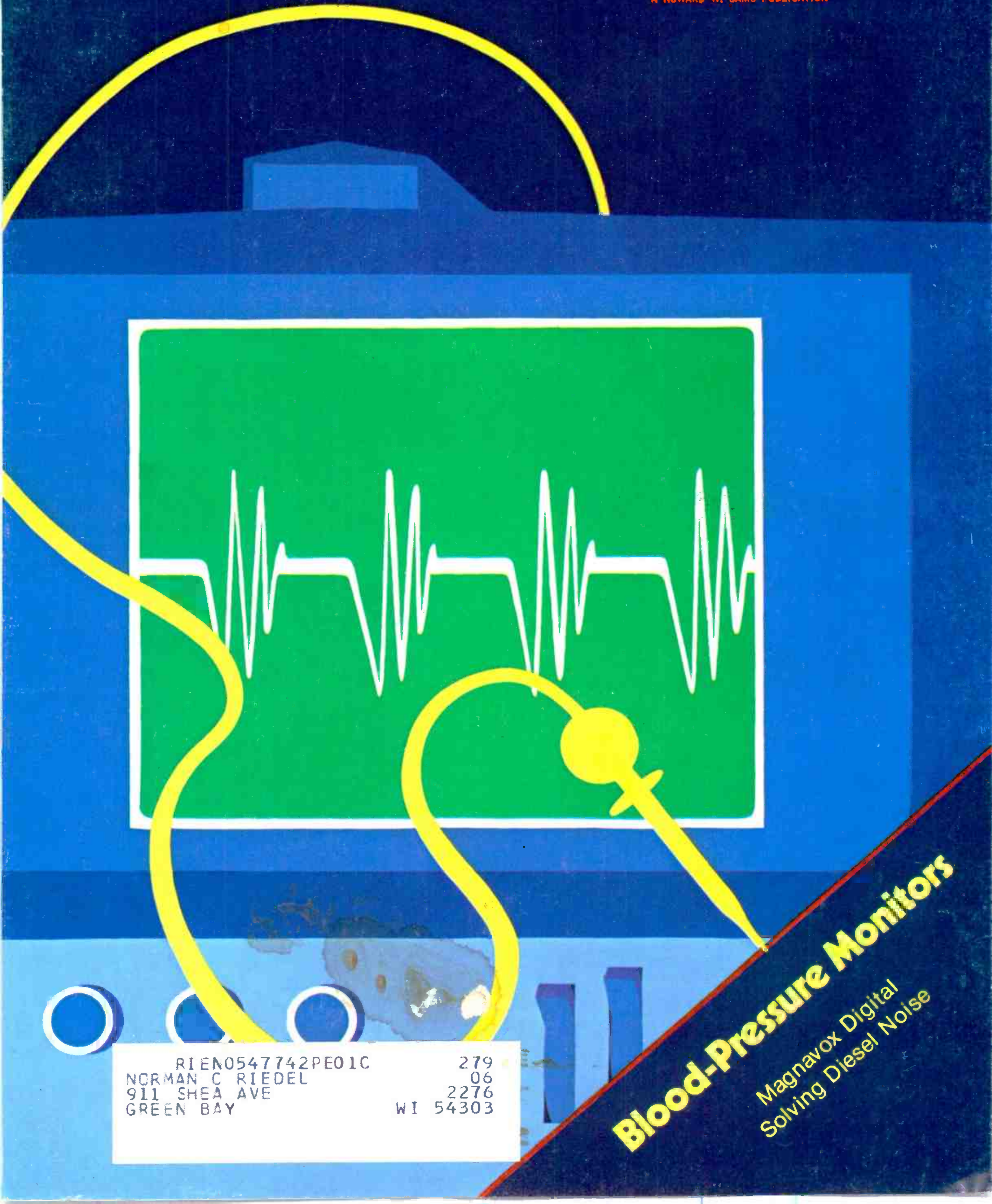
December, 1977 • 75 cents

Electronic Servicing

A HOWARD W. SAMS PUBLICATION



Blood-Pressure Monitors

Magnavox Digital

Solving Diesel Noise

December, 1977 □ Volume 27, No. 12

Electronic Servicing®

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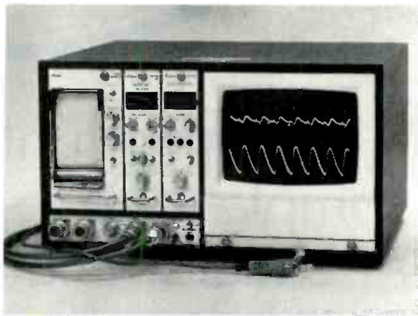

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About the cover—The cover picture symbolizes medical instruments, such as blood-pressure monitors. Design by Mary Christoph.

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electronicscanner

news of the industry

Sony and Zenith have dropped prices on their videocassette recorders. Sony's two-hour Betamax now lists for $1,095, while Zenith's VCR (made by Sony), sells for $995. Both units previously sold for $1,300.

Panasonic and Matsushita Electric are developing a home computer, according to *Retailing Home Furnishings*. The computer is expected to be marketed in the U.S. before the end of 1978.

Color-television sales in October were 15.7% above the total sold during the same period last year. Color TV sales to dealers in the first 10 months of 1977 were up 19.8% over 1976, totaling more than seven million sets. October sales for B&W sets were 601,599; up 13.1% from October 1976. B&W sales for the first 10 months were 4.3 million; up 8% from last year.

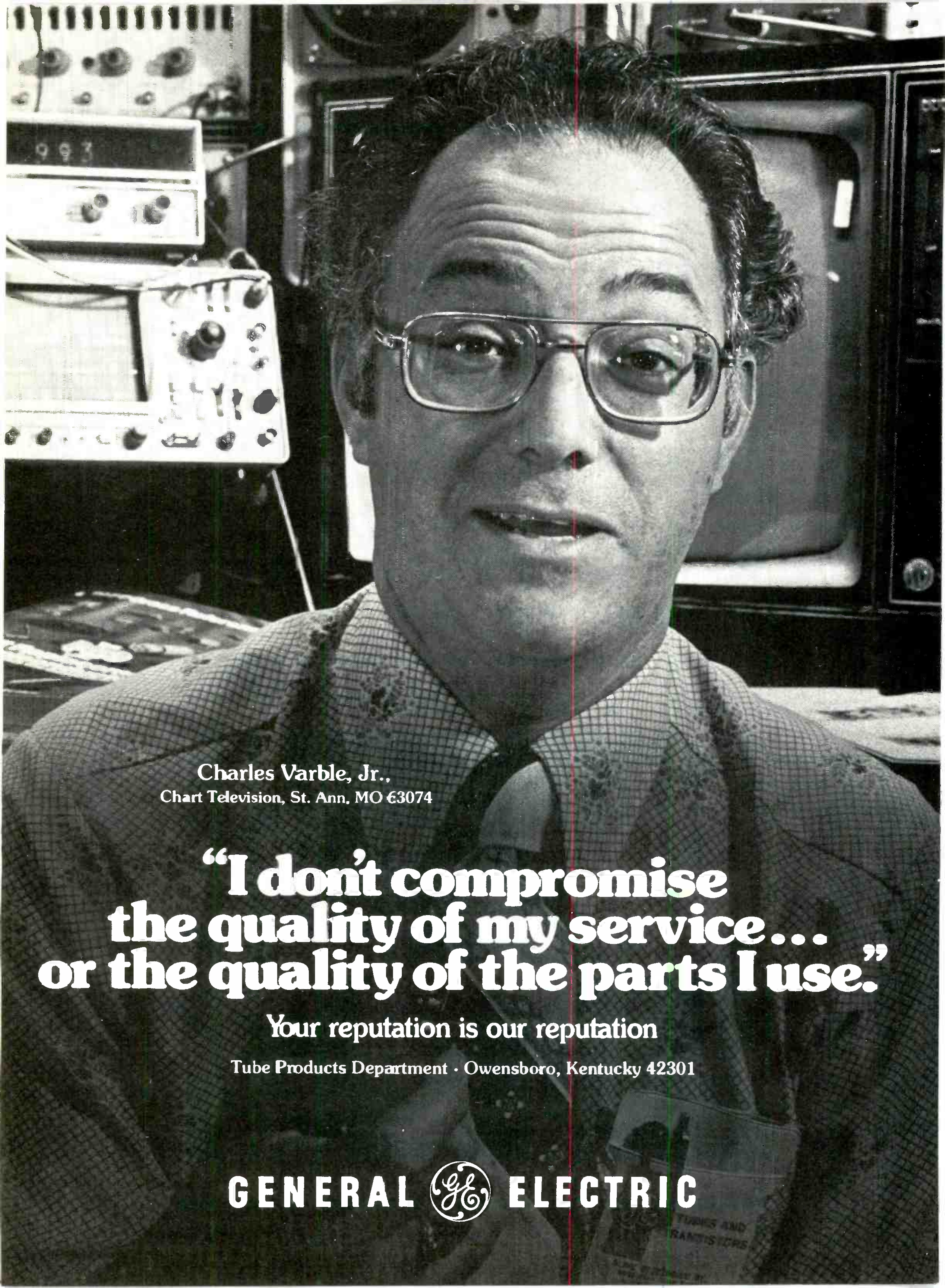
A new system of AM stereo has been developed by the broadcast products division of the Harris Corporation. Previously, one difficulty was in squeezing two-channel signals into the narrow bandwidth allocated to AM broadcast stations. Called "compatible phase multiplex" (CPM), the Harris system will be evaluated by the FCC. Minimum changes would be necessary to the AM stations, and the price of conversion is estimated to cost each station between $3,000 and $5,000. Of course, AM stereo receivers must be designed for the system that's finally adopted. Present AM receivers would receive the stereo programs in monaural.

GTE Sylvania has developed an exclusive system for protecting television-circuitry from damage caused by interelectrode arcing in the electron guns of color picture tubes. The system, called the Integral Surge Limiter (ISL), lowers the peak value of the arc current, thus reducing the possibility of damaging the semiconductors, when a high-voltage arc occurs. To do this, the ISL adds a resistive internal coating—independent of the normal internal conductive coating—between the tube's large coated funnel area and the electron gun.

New CB products utilizing microprocessors, large-scale integrated circuits, and microcomputers will heighten consumer interest in personal communications this winter, according to EIA spokesman John Sodolski. Many manufacturers will be offering selective calling, priority channel scanning, channel memory storage, and digital keyboard entry.

The National Appliance Radio-Electronics Dealers Association [NARDA] has scheduled several one-day sessions for improving sales volume, including: January 19, Rockford, Illinois; February 14 and 16, Baylor University in Waco, Texas; and May 2 and 4, Bloomington, Minnesota.

VTR sales should total one million units by 1979, according to Jack Sauter, RCA vice president of marketing for the consumer-electronics division. Other statistics; 78% of VTR purchasers say no technician was needed to install the unit: 97% say videocassettes are easy to operate; and 67% have hooked up their units to console models, rather than portable TV sets.



Charles Varble, Jr.,
Chart Television, St. Ann, MO 63074
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Your reputation is our reputation
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GENERAL ELECTRIC

continued from page 6

Car-stereo sales were up 14% to 15% last summer, and many retailers expect them to stay high the year-round. According to *Retailing Home Furnishings*, the reasons cited for the increase were improved product availability, better-quality products, and the development of additional accessories.

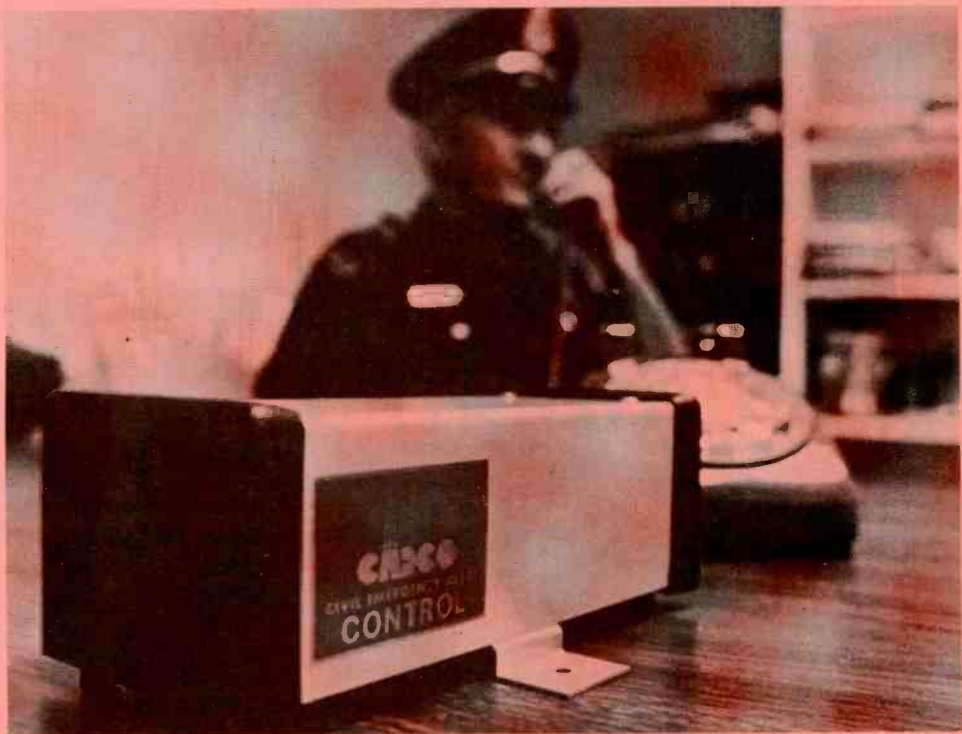
U.S. color TV imports declined 26.1% in the third quarter of 1977, compared to the same period a year ago. VTR imports increased 222.9% in the third quarter of this year. B&W TV imports increased slightly, audio tape player imports declined 5.2%, and home and auto radio imports increased 4%.

Hitachi has developed a device that will allow color images to be stored on low-cost, long-life B&W microfilm. A stripe filter is added to an ordinary color microfilm camera, which converts the three primary colors to B&W microfilm film. The reproduction device then produces ordinary color TV images from the microfilm.

Taiwan and South Korea are challenging Japan's dominance as the top home-electronics exporter to the United States. The voluntary restraint program limiting Japanese color TV exports caused a 17% drop in a 9-month period. Meanwhile, South Korea and Taiwan have increased exports about 100%.

EICO Electronic Instrument has moved to 108 New South Road, Hicksville, New York 11801. The phone number is (516) 681-9300.

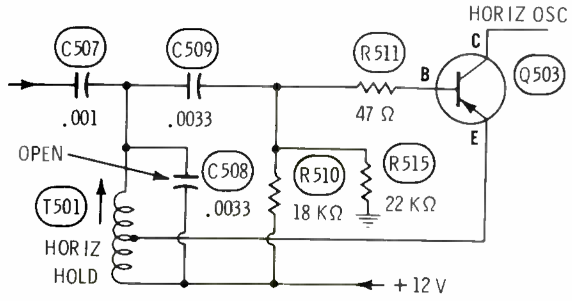
Cadco has developed a civil emergency alert system for communities with CATV, but no locally-originated television. The equipment, installed in a municipal building, such as a fire or police station, permits immediate interruption of all CATV channels for emergency or other public-service announcements.



symcure

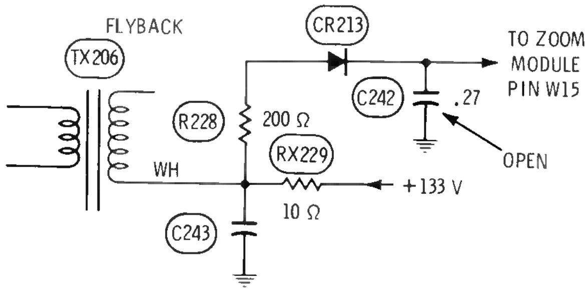
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Zenith 12FB12X B&W
PHOTOFACT—1535-3



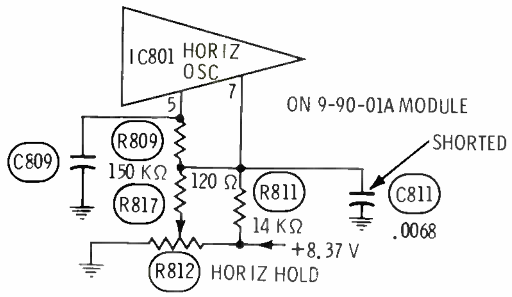
Symptom—Incorrect horizontal frequency, width is narrow
Cure—Check tuning capacitor C508, and replace it if open

Chassis—Zenith 25HC50
PHOTOFACT—1650-2



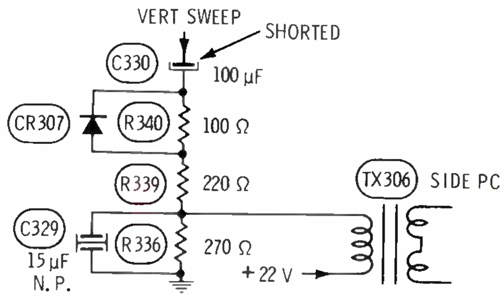
Symptom—Zoom light stays on
Cure—Check C242 (near zoom module), and replace it if open

Chassis—Zenith 23HC45
PHOTOFACT—1637-2



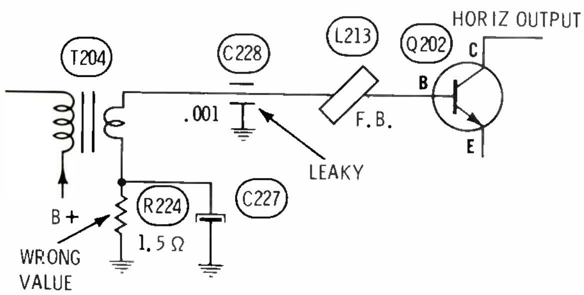
Symptom—No high voltage
Cure—Check C811 on 9-90 module, and replace it if shorted

Chassis—Zenith 13GC10
PHOTOFACT—1540-2



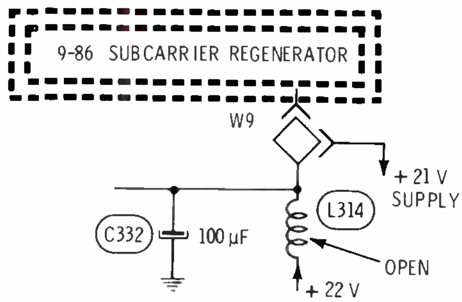
Symptom—Excessive pincushioning along the sides
Cure—Check C330, and replace it if shorted

Chassis—Zenith 23HC45
PHOTOFACT—1637-2



Symptom—Slight foldover near center of raster
Cure—Check C228, and replace it if leaky (also, check R224)

Chassis—Zenith 13GC10
PHOTOFACT—1540-2



Symptom—Retrace lines, little control of brightness, and the video is negative
Cure—Check peaking coil L314, and replace it if open

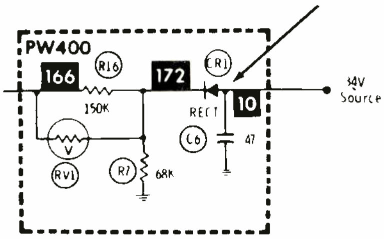
troubleshootingtips

Hum bar and a slow height change
RCA CTC53XP
(Photofact 1201-1)

Initially, I assumed that a faulty filter capacitor was causing hum, but after I subbed all filters, nothing was improved. I then decided to use the scope, and found the problem in less than 10 minutes.

A check at circuitrace 43, ahead of the delay line, showed no hum. But at point 70, the scope did show hum modulation, compressed video, and large sync. I continued by checking the brightness-limit circuit, and on through to the -34V source.

Finally, a simple scope diode check of CR1 on the PW400 board found high leakage. I replaced it, and the problem was corrected.



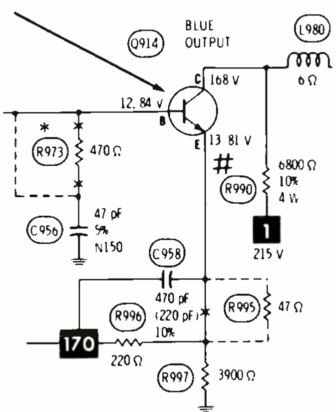
For a moment after the diode was replaced, I thought I had goofed, since the brightness was lower and the vertical size was smaller than with the old part. However, after a routine adjustment of the proper controls, these symptoms were eliminated.

Probably the most confusing thing was that the apparent defect (according to the original symptoms) was on PW700, while the bad component was on the PW400 board.

Ed Tanrath
Rockford, Illinois

Intermittent blue lines
Sylvania E11-3
(Photofact 1503-2)

After the set had been on for several hours, intermittent horizontal blue lines flashed across the screen. These lines had no regular width or spacing, varying from one thin line to several lines 4-inches high.



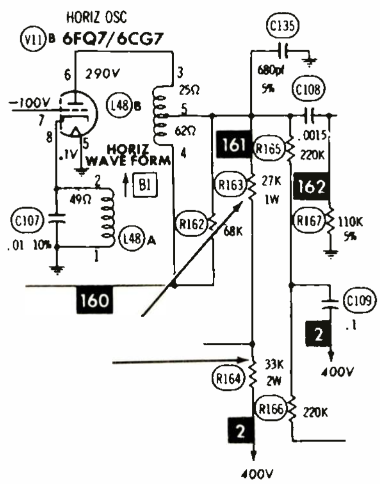
Normal troubleshooting procedures showed all voltage, resistance, and scope waveforms to be normal. Then I discovered I could touch my finger to the heat sink of transistor Q914 (blue output) and the blue lines would appear. Although Q914 checked out okay with a transistor tester, replacing it restored a normal picture.

Vernon Allen
Columbus, Georgia

Narrow raster
RCA CTC35
(Photofact 925-2)

The raster was narrow by about an inch on the right side. Horizontal hold was not very broad, but adequate; and everything else on the chassis was normal. After substituting the sweep driver, damper, and oscillator tubes, I assumed it was a circuit defect.

The first check was the waveform at the horizontal-output grid, and the pulse was more than adequate; output-tube voltages were in the ball park; high voltage was about right; and the high-voltage transformer ran cool. The grid sawtooth was too healthy, however, causing a DC grid voltage of -80 volts instead of the usual -60 to -63 volts. This helped explain the narrow raster as a result of reduced output-tube current, but I still didn't know why the horizontal oscillator was running so strong.



I measured the B+ and boost; both were down to +240 and +550 (instead of +280 and +750). This indicated excessive loading on the supplies. A fast test of the two resistors (R163 and R164) supplying the oscillator plate voltage showed them both to be about one-tenth their original values. Ironically, the orange multiplier bands appeared reddish, and at first I thought I had read the schematic wrong. The resistors were supposed to be 27K and 33K, not 2.7K and 3.3K. I replaced them and got a full-width raster plus a normal wide locking range.

I seldom use the DC input of my scope because it often requires annoying repositioning of the centering pot. In addition, this was a tube set with large voltage and signal levels, and therefore, approximate voltage and waveform readings were good enough (I thought). I was wrong!

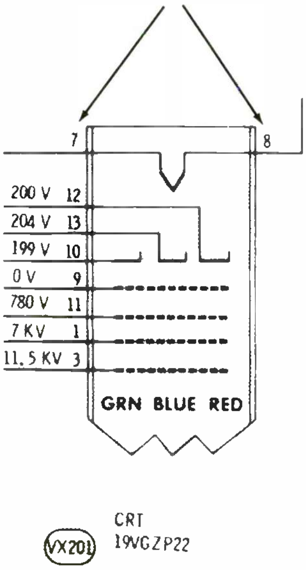
If I had used the scope on the DC input for my first test, I would have gone back to the oscillator and found those two resistors without a lot of lost time. Even if I'd used the AC input, and paid closer attention to the exact amplitude (rather than a hasty "the waveform is there" attitude), I would have been ahead.

Ball-park readings are not to be trusted, even in a tube set (obviously not in the solid-state). One last thing to remember: all symptoms, no matter how subtle, should be noted. I don't intend to get caught again, as I did on this one.

J. E. Strenk
Rhinebeck, New York

Intermittent raster
Zenith 19HC50
(Photofact 1681-2)

When receiving a complaint of intermittent raster (and the problem just won't act up on the bench), question your customer to see if the screen went black very slowly or suddenly.



If the problem occurs slowly, a possible cause could be cold solder joints at the heater circuit of the CRT in the 9-121 video output module that's mounted on the base socket itself.

I have encountered two similar problems during the past several months. And, in addition to the filament leads, I found several other solder joints also loose on this Zenith module. I would advise careful inspection of all solder joints on this module to prevent future difficulty.

Gary Steenwyk
Holland, Michigan

reader's exchange

For Sale: Complete shop equipment. Model 1077B Analyst. $375; model 415 sweep/marker generator. $375; and model 1472 dual-trace scope. $495. All are B&K-Precision with cables and manuals and are two years old. *Acadian TV. 16256 Eleventh Ave. NE. Seattle. Washington 98155.*

Needed: Schematic and operating manual for Hewlett-Packard model 120A scope. Will buy. pay for copy. or will copy and return. *K. J. Malley. 319 North Avenue. Aurora. Illinois 60505.*

For Sale: Old type radio tubes. 01A. 112. 199. 230. 120. etc. Complete list sent on request. *G. J. Fitzgerald. 112 Kingswood Place. Girard. Pennsylvania 16417.*

Needed: Schematic and parts list for Truetone (Western Auto) model DC-4850 auto radio. *Charles D. Prater. Edna. Kentucky 41419.*

For Sale: Precision tube tester model 654 with instruction manual. Also. 200 tubes. most b&w TV and radios. *Woodrow Clemson. 6775 Foxshire Drive. Florissant. Missouri 63033.*

Needed: B&K-Precision 1077 Analyst. *Paul Grim. 6632 E. Oak Street. Scottsdale. Arizona 85257.*

For Sale: RCA WR69A generator. Need RCA WR99A generator. *C. W. Hume. 108 Hillcrest Circle. Greenville. South Carolina 29609.*

For Sale: New LM-3.5A digital multimeter by Non-Linear Systems. in original packing with warranty. $135. *Clyde A. McDaniel. 532 Tom Van Arden Drive. Shelbyville. Indiana 46176.*

Needed: Schematic and parts list for Concord model SC-302 AM-FM stereo/phonograph. Will buy. pay for copy. or copy and return. *Harold E. Kautz. Jr.. 1115 E. Caracas Avenue. Hershey. Pennsylvania 17033.*

For Sale: General Atronics K115RM rack-mounted scope with DC-15 MHz dual-trace plug-in; B&K-Precision 1076 TV Analyst; Eico 955 capacitor tester. Heathkit 10-1128 vector monitor; ITT M-0178 magnetic phone dialer. 19-inch wide brushed-aluminum panel is machined to accept four ganged cassette mechanisms in a cassette duplicator. These are "as-is," or for parts: model 155 RCA 3-inch scope; model 248 5-inch Dumont scope; Eico 221 VTVM; Heathkit V7A VTVM; 25 small electronic flash units. I will supply more information on any item. Please specify. and send a self-addressed. stamped envelope. *Thomas Walls. 6360 Montgomery Avenue. Philadelphia. Pennsylvania 19151.*

For Sale: 440 tubes for 20% of list (80% discount). Write for details. *M. L. Chapin. 53811 Franklin. Utica. Michigan 48087.*

For Sale: Precision 5-inch scope model ES-150 DC to 5 MHz plus set of test probes. used about one hour. Both for $85. *M. M. Lippeth. Sr.. 4838 N. Claremont Avenue. Chicago. Illinois 60625.*

Needed: CB test equipment. such as an RF generator for 40 channels. and a CB scope. *Michael Harlinski. 180 Cherokee Drive. Springfield. Massachusetts 01109.*

Needed: Used electronic service test equipment to start radio. TV. stereo and CB servicing business. Need not be in working order. but should be repairable. Can afford little more than shipping charges. *Tom Garz. R.R. 1. Box 218A. Hortonville. Wisconsin 54944.*

Needed: Socket modification kit (648SMK) or information and schematic plus calibration data for a Jackson tube tester model 648. Will buy. or copy and return. *Tucker Joyce. 133-E Baskerville Court. Danville. Virginia 24541.*

For Sale: New RCA senior voltohmyst WV-98C. $70; new EMC tube/transistor tester model 215. $30. *Ralph Rosenfeld. 180 Tottenham Road. Lynbrook. New York 11563.*

Needed: Transistor. FET. diode tester. (in- and out-of-circuit). Degaussing coil for color TV. and SWR. watt and % of modulation meter for CB radios. Also. "Cleveland Institute of Electronics" books for correspondence course to give free to anyone who can use them. *Donald R. Young. 1148 E. Par Drive. Brookfield. Ohio 44403.*

Needed: Front end. tuning capacitor. and printed board (part P1242). for Fisher model 220T receiver and amplifier. Please contact. *Louis J. Hauber. 269 Rock Road. Ridgewood. New Jersey 07450.*

For Sale: HW-101 5-band radio. power supply HP-23B. dummy load HN-31. wattmeter/SWR HM-102. and IO-4530 scope. All Heath and never used. *Dennie Barker. 21881 Christopher. Elkhart. Indiana 46514.*

Needed: Schematic and T278 transformer for model CH-18. series Y-66 Challenger public-address amplifier. Pay reasonable cost. *J. L. Bachelor. Box 561. FBPO. Norfolk. Virginia 23593.*

For Sale or Trade: CMC pulse generator 6108C; CMC totalizing counter. 302A; Eico 368 sweep/marker generator; Triplett 3490 transistor analyzer; Hewlett-Packard frequency meter 500B; B&K-Precision 440 CRT tester. Need 3-inch scope. and dual power supply; ±20 V or so. variable and regulated. *Ed Tanrath. Electronic Services. 3035 LaSalle Avenue. Rockford. Illinois 61111.*

Needed: Power transformer for Bogen power amplifier HO-125. Part number T357-2; primary 117 VAC. secondary 1 1800 VCT. secondary 2 630 VCT. *Allan Gawlik. 54 Goodrich Road. Lackawanna. New York 14218.*

Needed: 110390 VHF plug-in assembly. 110389 UHF plug-in assembly. and 110388 accessory antenna and balun-matching transformer for model 840 Amphenol field-strength meter with TV plug-in tuner. *Ralph H. Nichols. Phils Antenna Service 4911 Fair Oaks Blvd.. Carmichael. California 95608.*

Needed: Instruction books and schematics for Precision models E420 and E440. Will purchase, or copy and return. *W. S. Nevitt, 3065 Lynette St., Castro Valley, California 95446.*

For Trade: B&K-Precision model 1460 scope (triggered solid-state); Sencore model SM-158 Speed Aligner; and Sencore model BE-156 Align-O-Pack. All in new condition. *Michael Harlinski, 180 Cherokee Drive, Springfield, Massachusetts 01109.*

Needed: Schematics and logic diagrams for Olympia desktop calculator model ICR-412 (MTI). Will buy, or copy and return. *Ed Robinson, Electronic Ventures, Inc., 104 Greenwood Avenue, Wakefield, Massachusetts 01880.*

For Sale: B&K model 415 TV sweep/marker generator, never used, complete with all cables and instruction manuals. Half the current list price, plus shipping. Send money order to *Clarence Gillow, CG Television Service, P.O. Box 2245, Prescott, Arizona 86302.*

For Sale: Riders Manual volumes 2-27 with index. *Ed Zaharatos, Box 817, Medford, Long Island, New York 11763.*

Needed: Manual schematic, parts list, power cable and interface cable between TV monitor and tape unit for a Concord VTR. No model number available. Will buy, or copy and return. *Israel Lawrence, P.O. Box 487, Haleiwa, Hawaii 96712.*

Needed: Service and operating manual for B&K-Precision sweep/marker generator, model 415. Will buy, or copy and return. *Phil Niewdomski, 122 Meserole Avenue, Brooklyn, New York 11222.*

For Sale: A 1976 B&K model 467 CRT tester and a B&K AK670 adapter, never used, $313 value for $200. *Mrs. George Bembenck, Route 2, Hayward, Wisconsin 54843.*

Needed: Used RCA WV98A and Sencore "Big Henry" meters, in good condition and reasonably priced. *Paulmer Williams, 106 S. Jefferson Street, Lewisburg, West Virginia 24901.*

Needed: Schematic and alignment instructions for AM/FM radio with 8-track tape imported by I.D. Electronics, model A4408. Will buy or copy and return. *Ed Robinson, Electronic Ventures, Inc., 104 Greenwood Avenue, Wakefield, Massachusetts 01880.*

Needed: A color-coded connecting cable between the power pack and the main chassis of a Majestic radio console, model 70 or 70B (circa 1926). Power Pack is 7-P-697P3, using a UX280 or CX380 rectifier tube. *H. D. Hughes, 3712 28th Avenue E., Tacoma, Washington 98404.*

Needed: A schematic for an Altec 342B Amplifier. The only numbers are 391338 and serial 9117. *James Mitchell, Box 688, Homosassa, Florida 32646.*

continued on page 14

For More Details Circle (7) on Reply Card

For More Details Circle (8) on Reply Card

reader's exchange

continued from page 13

Needed: Flyback transformer for an Olympic chassis CTC20 color TV. Part number is TR34650 (no longer available from Olympic). Will pay C.O.D. charges and price of transformer. Prefer new one. Write to me before shipping. *C. N. Pedigo, 3038 Richard Avenue NE, Roanoke, Virginia 24012.*

For Sale: Eico 950A resistance/capacitance comparator; Eico 400 scope, and Radio City Products signal generator 706A (150 kHz to 220 MHz). Best offer. *Robert McAndrew, 1541 Williamsbridge Road, Bronx, New York 10461.*

Needed: A 400CVB22 or a 16CYP22 picture tube. *Edmond N. Khoury, 4017 Berkshire, Detroit, Michigan 48224.*

For Sale: Heathkit model IG-57A TV post-marker sweep generator, assembled and checked, with attenuator, all leads and manual. Never used. $125. *Edward H. West, 57 Eastlake, Tuscaloosa, Alabama 35401.*

Needed: Two sound IF transformers for GE television, model TR-805 AEB, chassis TA; also need a schematic for an Atwater Kent radio, model 708. Will buy, copy and return, or pay for copy. *Tommy Patterson, 623 S. Broadway Street, Forest City, North Carolina 28043.*

Needed: Schematic and operating manual for an Accurate Instrument VTVM model 152. Will pay for manual plus postage. *Clarence England, England Radio-TV Service, Route 1, Box 135A, Rose Hill, Virginia 24281.*

Needed: Deflection yoke, part 140438, for RCA KCS 174D b&w portable TV. *Ted Lommerse, 928 Wolverine, Monroe, Michigan 48161.*

Needed: Two each ECH81/6AJ8 and EBF89/6DC8 tubes, new or good used, for a Grundig radio model 8095. (A 6AD8 or 6N8 substitutes for a EBF891/6DC8.) *Richard Napper, 811 Osage, Manhattan, Kansas 66502.*

Needed: Manual and/or schematic for a Triplett FM-AM signal generator, model 3433. Will buy, or copy and return. *Harrison Radio & TV, 205 Claremont, Petersburg, Virginia 23803.*

For Sale: Telematic solid-state test jig parts. Yoke, blue lateral magnet, convergence coils, all (18) convergence loads, yoke adapters (24), and TA-3500 Transverter. Over $300 invested; will sell for $150, or best offer. Write for yoke adapter list. *Jerry McKouen, 534 Pacific Avenue, Lansing, Michigan 48910.*

For Sale: Heath model IM-1210 digital multimeter used only 6 months, excellent condition, $50. *Ed Young, 1107 Cypress Point Drive, Placentia, California 92670.*

For Sale: B&K-Precision television analyst model 1077B, $300. *Edan TV Service, 100 Compton Avenue, W. Keansburg, New Jersey 07734.*

For Sale: Old radios. One pilot model T71, AC-battery, with schematic, good condition; one model G503 Zenith radio, AC-battery, good condition, with schematic. *Frank Randolph, 6123 Main Street, Lanham, Maryland 20801.*

Needed: Schematic and alignment instructions for portable multiband (AM, FM, LW, SW) radio. The only information on it says: "Transworld Junior," "Pygmy of Paris," "Country of origin France." Will buy, or copy and return. *Ed Robinsin, 104 Greenwood Avenue, Wakefield, Massachusetts 01880.*

Needed: Flyback transformer part 334PO3801 for a Coronado model TV 23-1021A portable B&W TV set. *J. Burlingame, 516 East 65th, Tacoma, Washington 98404.*

Needed: Used convergence-board assembly for Magnavox color TV model TV-109 (25"), U-322-R1. Quote price. *Lake Central Service Company, 19 Bayview Boulevard, Fort Meyers Beach, Florida 33931.*

Needed: New or used sweep transformer for J.C. Penny color TV model 2881-87 (1968), #TLF-5201 (made by Panasonic), *Lake Central Service Company, 19 Bayview Boulevard, Fort Meyers Beach, Florida 33931.*

For Sale: RCA 10J103 color-TV test jig with connectors; and Hickok model 215 semiconductor analyzer and checker. *Jack Wilson, Wilson Electronics, Route 1, Pomona, Kansas 66076.*

Needed: Schematic for Wilcox-Gay Recordio model 6B10. Will copy and return. *Donald Gross, P.O. Box 30, Cameron Mills, New York 14820.*

Needed: Drive-screen board Magnavox #703180-4 for T933-18 chassis. Send price and information to: *Robert Strebeck, RFD 12, Box 64, Clarks Point Road, Baltimore, Maryland 21220.*

Needed: Power transformer (part no. 20800-295) for Hickok model 677. *John Marczuk, 656 Quarry Road, Harleysville, Pennsylvania 19438.*

For Sale: Eico scope model 460, $125; Eico sweep-marker generator model 369, $125; B&K-Precision TV analyst model 1076, $200; RCA color-bar generator model WR64B, $100; Eico flyback/yoke tester model 944, $35; 30-KV Pomona test probe, model 2900A, $20. All equipment is in excellent condition. *Peter Cameron, Box 12, Alliston, Ontario, Canada L0M 1A0.*

For Sale: Used color TV picture tubes: 23VANP22, 23EGP22, and 90JB22, $20 each. Also, used TV yokes with convergence boards and magnets: YT 103-4 and DY-76AT. $15 each. *Willie R. Collins Jr., 3303 Garland, Hopewell, Virginia 23860.*

For Sale: A General Radio 740B capacitor-test bridge, $45. Can ship UPS. *Ann Brokloff, 132 W. Lytle, State College, Pennsylvania 16801.*

For Sale or Trade: RCA 9"x11" bound volumes of service notes, 1929-1930, 1931-1932, 1933, and 1940, for radio receivers, Victrolas, and test equipment. Also, RCA original paperback TV service data for 630TS-648. *Troch's, 290 Main, Spotswood, New Jersey 08884.*

For Sale: ICS Electronics course. Forty-seven books which also include: math, chemistry, and physics, $26. *John J. Augustine, 530 North 9th, Reading, Pennsylvania 19604.*

Needed: Schematic and parts list for B&K-Precision 1077B Television Analyst. Will buy, or copy and return. Would consider purchase of a non-working analyst at sacrifice price. State age and condition. *Robert MacLachlan, 1022 Fourth, Jackson, Michigan 49203.*

Needed: Rider's radio volume 23; price no object. Also, need old servicing magazines. Will pay cash, or swap miscellaneous Rider's radio volumes, brand new, and Rider's TV, 1 through 20, fair condition. Call or write. *Donald E. Erickson, 6059 Essex, Riverside, California 92504.*

Needed: Schematic and service manual for Benrus Technical Products scope model 1100 M16, serial 16-225; also plug-in model 300 M16. Will copy and return. *Bill King, King's Electronics, 1330 N.E. Old Salem Road, Albany, Oregon 97321.*

Needed: Schematic for an Atwater Kent model 110. Will pay for schematic (or a copy) plus mailing costs. *M. W. Smith, 400 Brandon Road, Richmond, Virginia 23224.*

Needed: Schematic for a Johnson "Viking Valiant" transmitter, 240-104-1 or 240-104-2. (This is an old ham unit with 21 tubes.) *Michael Ray Roseman, 11900 Lawnview, Cincinnati, Ohio 45246.*

For Sale: Heathkit general-purpose RF generator, $35, with manual. *Moss Comm., 1210 E. 1st Street, Sioux Center, Iowa 51250.*

Needed: Schematic for Nova-Tech "Air-O-Ear" model 711-WN/4B multi-band receiver. Will buy, or copy and return. *R. S. Couey, 1112 Zircon, Corona, California 91720.*

For Sale: Hickok model 512 dual-trace 10-MHz solid-state triggered scope, with probes, CRT overlays, and manual. Scope still in warranty and in excellent condition, $460. *Gregory Richardson, Route 2, Box 75, Hurricane, West Virgina 25526.*

Needed: Service-and-instruction manual for an RCA WO-88A scope. Will buy, or copy and return. *Lyle N. Cleary, 3235 N. 12th, Lincoln, Nebraska 68521.*

Needed: Schematic, manual, or other information for a military scope OS57/USM38. Will buy, or copy and return. *C. L. Rickard, 3228 Santiago, San Francisco, California 94116.* □

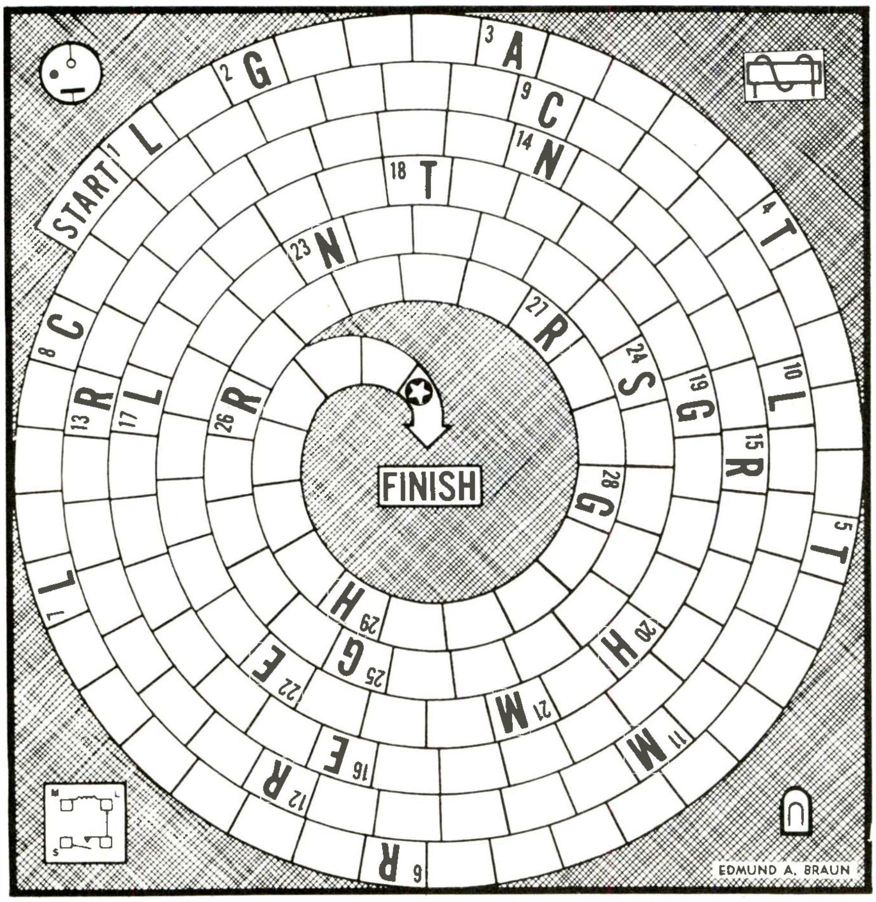
"He discovered fire, invented the wheel, and now he's working on something else."

Electronic Roundup!

by Edmund A. Braun

Hi there! It's Roundup Time! 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 116. It should be quite simple to get a high rating except perhaps for a bull-thrower who thinks "antenna" is a female relative, or that "catalyst" refers to a feline with shorter legs on one side! So sharpen your pencil; put on your thinking cap, and GO!

1 Section or branch of a component or system.
2 Numerical indication of the degree of contrast in a televised image.
3 Centimeter-gram-second electromagnetic unit of potential difference.
4 In radar, a specific object of radar search or surveillance.
5 Solid-state semiconducting device with resistance varying with temperature.
6 Pertaining to charge remaining on capacitor plates after initial discharge.
7 The science of correct reasoning.
8 Having a common center, such as a circle within a circle.
9 Piece of natural quartz.
10 Alkaline metal used in construction of photoelectric cells.
11 Device used in checking signals.
12 This impedes the flow of electricity.
13 A resonant cavity consisting of lumped inductance and capacitance.
14 Device for cutting holes of various sizes and shapes in sheet metal.
15 Outlet or socket into which a plug can be inserted to make electrical connection.
16 Outside of a thing's extent or surface.
17 Unit of luminance.
18 Trying to discover, confirm, or disprove.
19 Pictorial presentation of relation between two or more variables.
20 Slang for a licensed radio operator who operates as a hobby.
21 A code of dash-dot signals.
22 An addition or prolongation; a type of cord.
23 Clusters of oxide particles protruding above surface of a magnetic tape.
24 Type of iron made of copper.
25 Material introduced into a vacuum tube during manufacture for greater evacuation.
26 Device to turn antenna for sharpest reception.
27 Circular-shaped contracting part of a plug usually placed back of but insulated from the tip.
28 Low frequency video interference.
29 A droning or buzzing sound.



Check your rounded-up answers with solution on page 66.

Electronic Blood-Pressure Measurements

By Joseph J. Carr, CET

Spot-tests of patients blood pressures usually are done by the "cuff" method. Long-term monitoring of blood pressure requires sophisticated electronic equipment, including pressure transducers and amplifier/readout modules. The information supplements our continuing coverage of industrial electronics, and gives us a glimpse into the fascinating world of medical electronics.

A History Of Blood-Pressure Measurements

One of the most frequent measurements made by doctors is "taking" the patients blood pressure. This uncomplicated test is made possible by one important fact: human hearts do not pump in a smooth stream, but the heartbeat creates a pulsatile blood flow through the arteries. The changing pressure can be felt at the wrist, neck, and other areas of the body.

Stephen Hales, an Englishman, is credited with taking the first direct measurements of arterial pressure. About 1773, he inserted a thin manometer tube directly into one of the neck arteries of an unanesthetized horse. Of course, most people would object to such a method for them. The modern indirect method (without incision), using the familiar blood-pressure cuff, was invented in 1905 by N. S. Korotkoff. The sounds heard during the test have been named in his honor.

But, the technique was not verified for general clinical use until the early 1930s.

Blood-Pressure Waveform

Figure 1A shows a typical human arterial blood-pressure waveform for a person whose pressure is "120 over 80," or "120/80." After the heart contracts, the arterial pressure rises to the maximum value (systolic), and then falls to the resting value (diastolic) between heartbeats.

For the indirect "cuff" method of measuring blood pressure, a cuff (bladder) is wrapped around the patient's arm. It is equipped with a rubber squeeze ball, used for inflating the cuff with air pressure. A mercury column (or a gauge) reads the air pressure inside the cuff. This equipment is known as a "sphygmomanometer."

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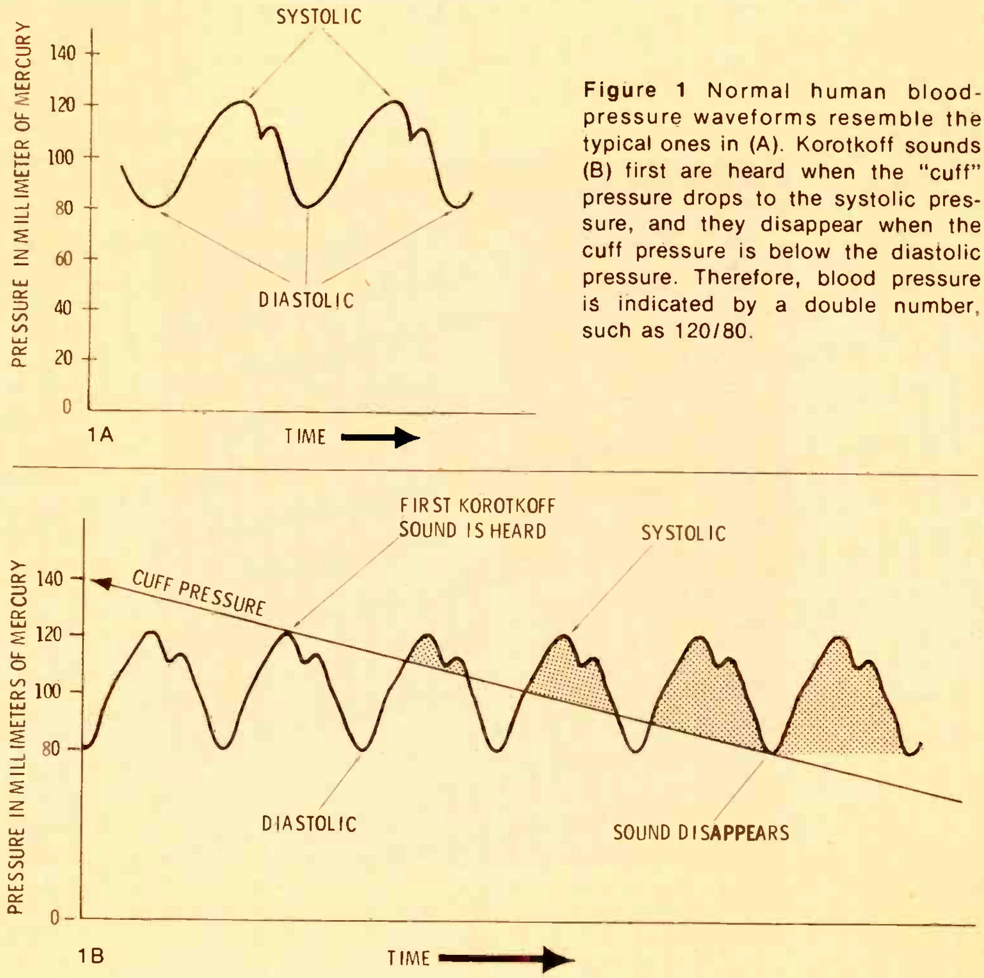

Figure 1 Normal human blood-pressure waveforms resemble the typical ones in (A). Korotkoff sounds (B) first are heard when the "cuff" pressure drops to the systolic pressure, and they disappear when the cuff pressure is below the diastolic pressure. Therefore, blood pressure is indicated by a double number, such as 120/80.

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Measuring Blood Pressure With The Cuff

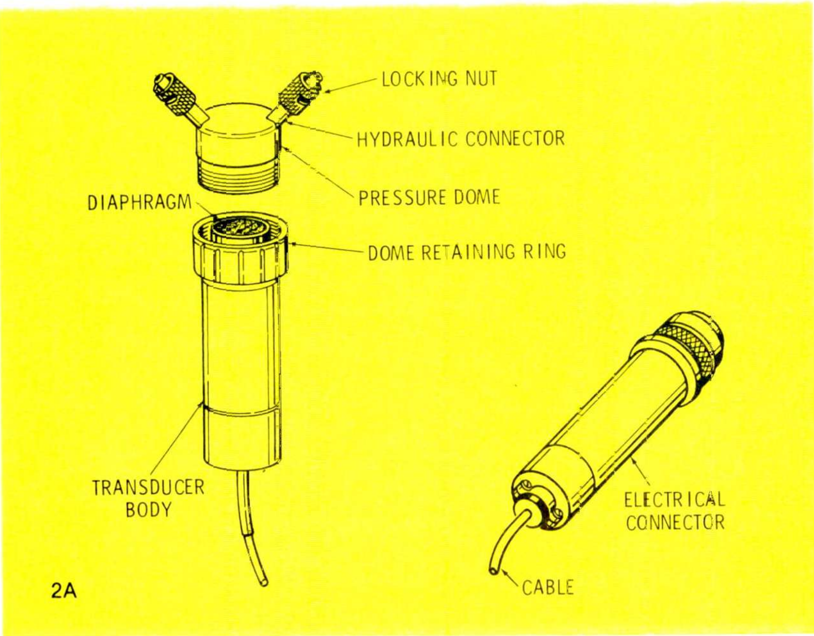
In typical operation, the cuff is wrapped around the patient's arm, and the doctor or nurse places a stethoscope downstream (usually at the inside of the elbow). While listening with the stethoscope, the operator pumps up the cuff pressure until it is high enough to stop the flow of all blood in the artery that's being monitored. Now, the cuff pressure is allowed to leak *slowly* (about 3 millimeters of mercury per second is considered best), while the operator watches the mercury column or spring-loaded gauge that shows the cuff pressure.

When the systolic pressure is just sufficient to overcome the cuff pressure, the operator will hear in the stethoscope the characteristic "Korotkoff sounds" (crashing, turbulent sounds). These sounds continue until the cuff pressure drops to the level of the patient's diastolic pressure, as shown by the drawing of Figure 1B.

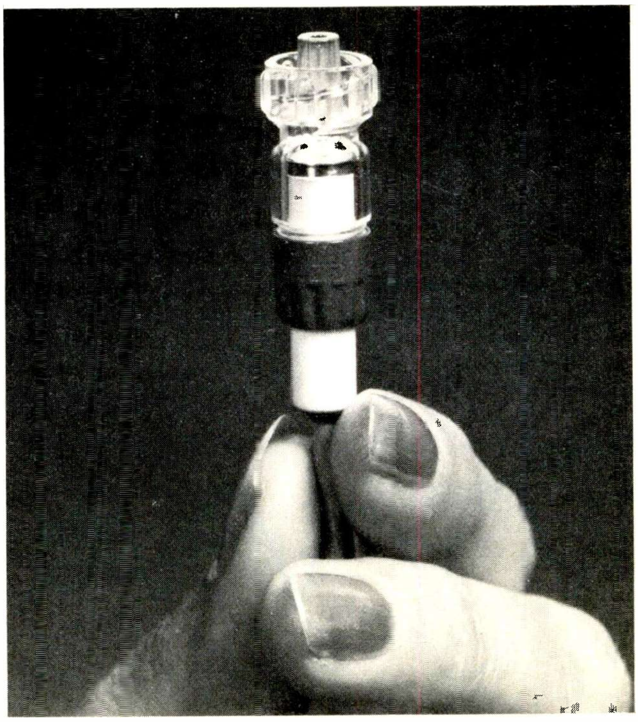
It's fascinating to analyze the Korotkoff sounds by comparing them to a similar electronic condition. Assume an amplifier stage using a NPN transistor, plus a circuit to vary the DC forward bias from zero up to the normal positive voltage. Also, we must specify an input sine wave signal, having a peak amplitude that's less than the required DC bias. (The peak amplitude corresponds to the blood pressure between the systolic and diastolic points, and the DC bias is representative of the cuff pressure.)

Starting with the DC bias at zero voltage, the transistor will have no gain and no output (the cuff pressure is greater than the systolic pressure). When the cutoff is reduced (by increasing the forward bias) the input tips of the sine waves act as bias, strengthening the DC bias, and the output has weak pulses. Further reduction of cutoff allows amplification of about half of each sine wave; therefore, stronger pulses are produced at the collector. Both of these conditions result in a distorted signal, which has many extra harmonics, and the output sound is a loud buzz. (These correspond to the loud Korotkoff sounds; they also are heard mostly because the jagged waveform has high harmonics that fall within the pass band of the stethoscope.)

Additional reduction of the transistor cutoff reduces the distortion, allowing the sine waves to show only a slight clipping of the negative peaks. Finally, with normal bias, the output at the collector has perfect sine waves, which *sound* weaker because the harmonics are gone, and the result is a smooth hum. (When the cuff pressure drops below the diastolic pressure, the stethoscope is trying to reproduce a 1-Hz to 1½-Hz near-sine wave. But this is below the cutoff frequency of the stethoscope, so the operator hears little sound.)



2A



2B

Figure 2 (A) A Hewlett-Packard 1280-series blood-pressure transducer is shown by the drawing. (B) The picture shows the appearance of a Statham transducer. (*Courtesy of Statham Instruments*)

Continuous BP Monitoring

The cuff method of checking blood pressure requires a minimum of equipment, and it is very useful for short spot measurements. However, it is cumbersome and subject to many errors when used for long-term monitoring in a hospital or clinic. For example, the whole attention of an operator is required, and the noises of a hospital can mask the faint Korotkoff sounds, making the readings uncertain.

Usually, long-term monitoring is done by a direct method, adapted from the Hales method of two centuries ago. A special pressure transducer is connected to an arm or wrist artery by a saline-filled catheter (tube).

Figures 2A and 2B show medical blood-pressure transducers manufactured by Hewlett-Packard and Statham, while a typical bedside setup is shown in Figure 3A. The syringe can be used for delivering medications to the patient via the catheter, or for withdrawing blood samples needed for lab measurement of arterial blood gases.

Incidentally, these syringes are the source of many service problems; they are capable of ruining a normal transducer in short order!

For best accuracy, it's best to calibrate the transducer and the amplifier for it at bedside, just before the measurement. The pro-

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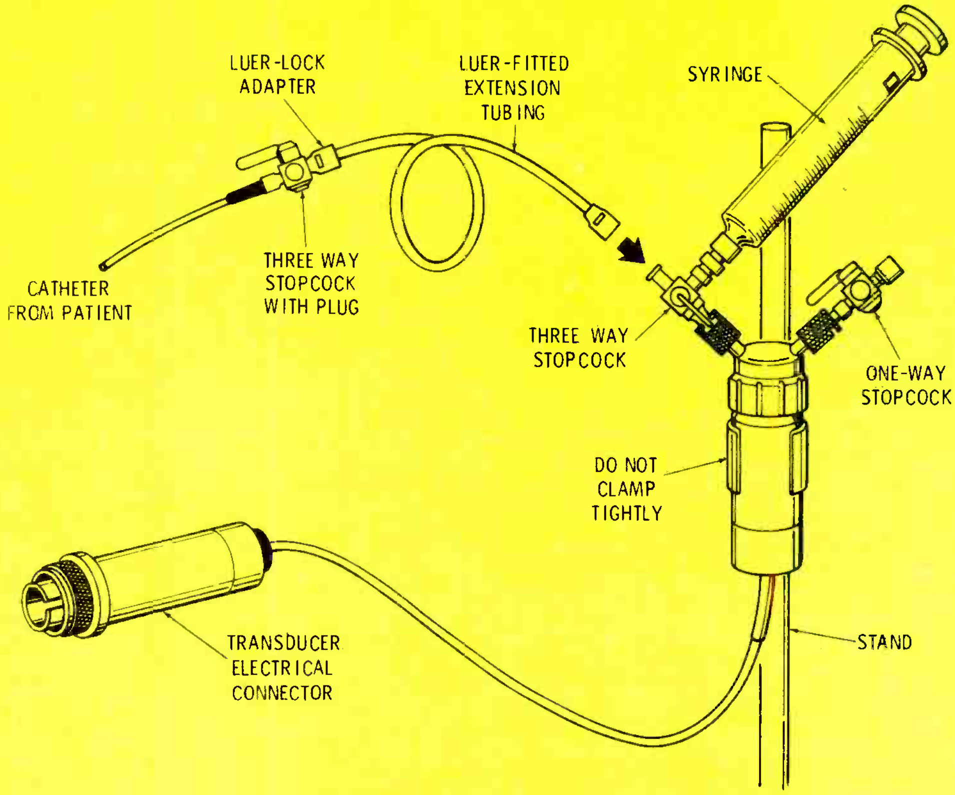
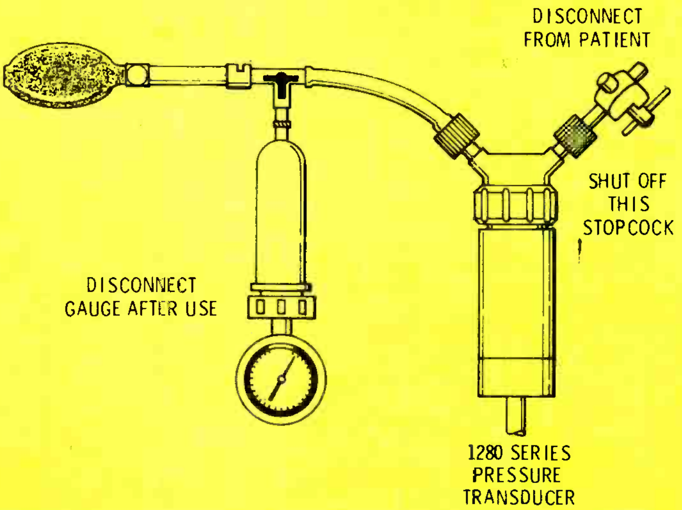


3A



3B

Figure 3 A typical bedside setup for measuring blood pressure is shown at (A). A calibration method (B) for Hewlett-Packard transducers uses a squeeze bulb and a gauge.

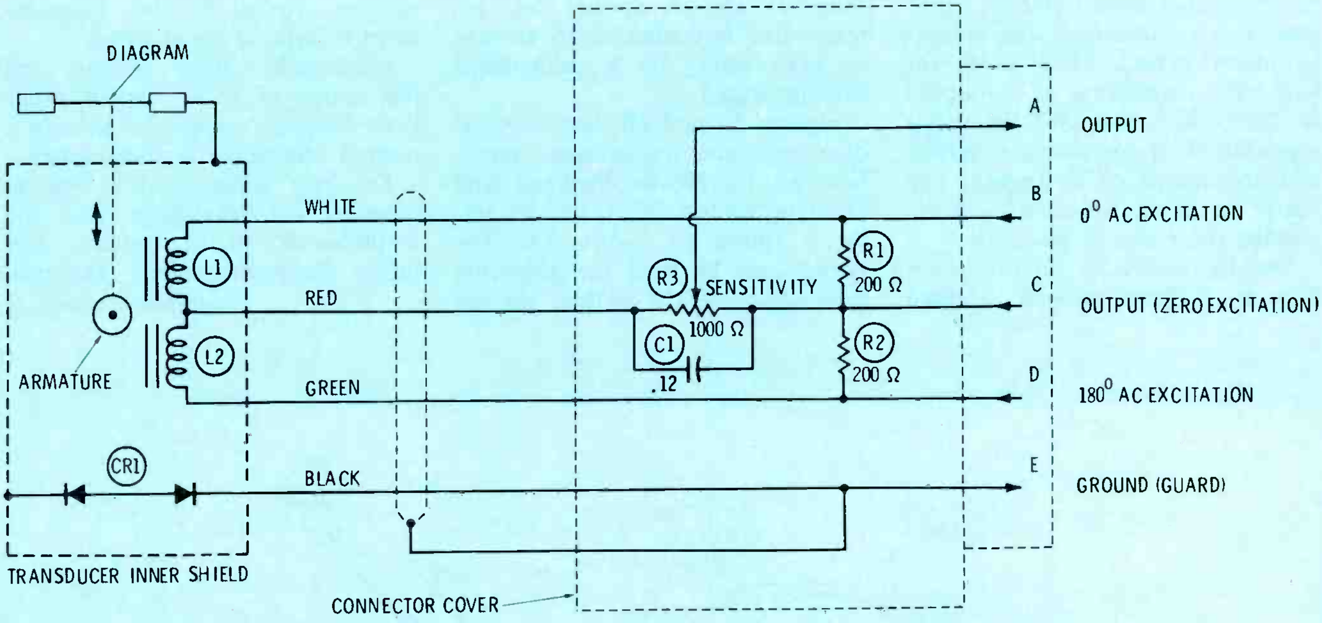


Figure 4 This is the internal circuit of Hewlett-Packard 1280-series blood-pressure transducers. The three resistors are mounted inside the large connector. Included is a graph of pressure versus output voltage.

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cedure (Figure 3B) should be done only after the nurse or physician has disconnected the transducer from the patient's arterial line (called the A-line).

The individual manufacturers use different techniques for simplifying the calibration procedure, while preventing excessive loss of accuracy. For example, some provide hand-selected transducers that meet a rigid specification. This works fine for a time, but the rugged environment of the hospital soon ruins the calibration, and the manometer must be used.

Other manufacturers provide a "scale factor" or "calibration factor" for each transducer. The factor is dialed into the pressure amplifier (usually it's just a gain adjustment that allows the amplifier to produce a standard output for a given pressure. These calibration factors are valid only for a short time after they are calculated, and afterwards the manometer must be used to redetermine the correct setting.

Another approach is to include a sensitivity control inside either the transducer or its connector (see Figure 4). This control should be adjusted so a specified output signal amplitude is obtained for a standard applied pressure.

Balanced Bridges

Most late-model blood-pressure transducers are variations of the Wheatstone bridge. For example, the Statham transducers consist of a four-element resistive strain gauge that's bonded to a thin metal diaphragm where the pressure is applied. When pressure moves the diaphragm, the resistances are varied in opposite values. Either AC or DC excitation is applied across two opposite ends of the bridge, and the output signal is taken from the other pair of opposing connections.

Circuit of the Hewlett-Packard model 1280 blood-pressure transducer is shown in Figure 4. The resistors R1 and R2, and the inductors L1 and L2 are the four arms of a bridge. AC excitation is applied between pins B and D, while the output is taken from pins A and C. Most Hewlett-Packard pressure amplifiers supply an excitation of 5-volts RMS at 2400 Hz.

When the pressure is zero (that is, the transducer is at atmospheric pressure), the diaphragm is at rest, with the core armature positioned equally in L1 and L2. This makes the inductive reactances equal in value, the bridge is balanced, and no output AC signal appears between pins A and C.

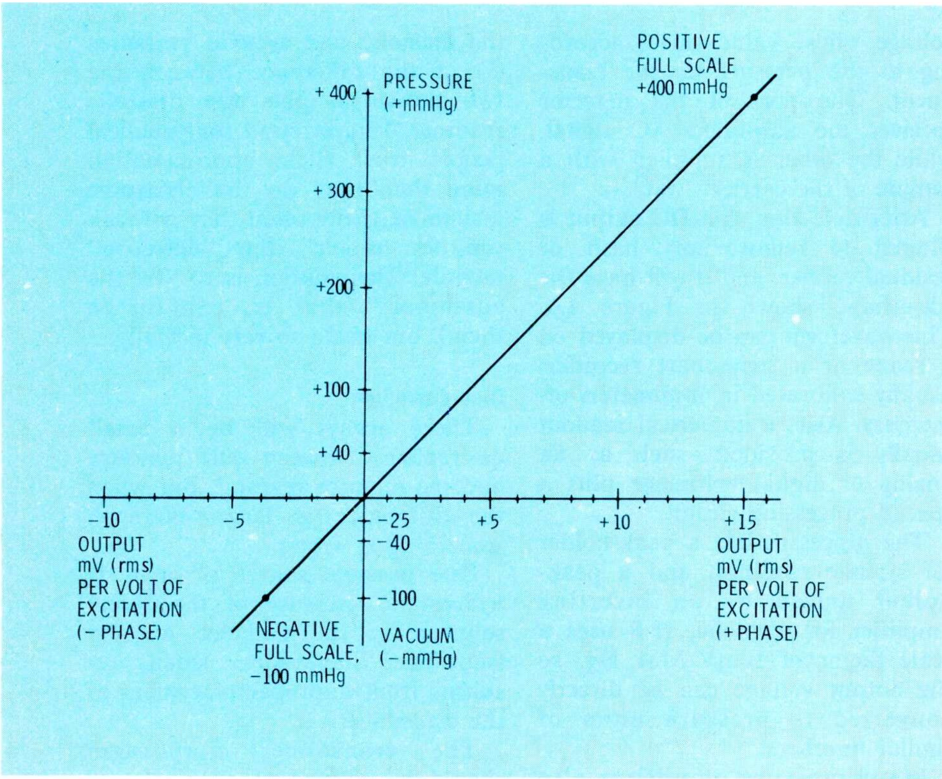
However, as pressure is applied, the armature moves, and the inductors no longer are matched. An output voltage is produced, because the bridge now is unbalanced.

The Hewlett-Packard transducer comes equipped with a large electrical connector (see Figure 2A) that houses R1, R2, and R3. Potentiometer R3 is the sensitivity-calibration adjustment, mentioned before.

Transducer sensitivity

If we know the excitation voltage and the applied pressure, the sensitivity specification of a transducer allows a calculation of the output level. Sensitivity is given in units of μV/V/MM Hg. Thus, a typical transducer might have a sensitivity of 10 μV/V/MM Hg. Then, if the excitation is 10 volts, and the applied pressure is 120 MM of Hg, the output will be 10 x 10 x 120 μV = 12,000 μV (or 12 millivolts).

Such a small output voltage requires amplification, and sometimes other processing, before it is displayed on a meter or on a graphical device such as an oscillo-



scope or a strip-chart recorder.

Commercial Monitoring Systems

The Statham patient-monitoring system (Figure 5A) contains a strip-chart recorder, an electrocardiograph (ECG) amplifier, a blood-pressure amplifier, and a two-channel non-fade scope. Incidentally, this kind of scope is very popular because it allows the waveform to remain on the screen long enough to permit a detailed visual analysis. In fact, the trace can be frozen indefinitely. These scopes have a digital data-storage system to hold the trace. An analog-to-digital converter digitizes the analog waveform, and stores it in a computer-like memory. Then, a digital-to-analog converter re-converts the digital signal to the original analog signal for the vertical amplifiers of the scope.

Figure 5B shows the Hewlett-Packard mainframe that contains (in this particular case) an ECG preamplifier/heart-rate module, and a pressure-amplifier module. In the H-P system, a series of half-rack module cabinets are used. Some instruments, such as a scope, take up an entire half rack. Others, such as a strip-chart recorder, require a full rack. But, most are the quarter-rack type, as shown in the picture.

A different type of pressure-monitoring system is shown in Figure 5C. It is a complete physiological monitoring system manufactured by "Electronics for Medicine" (E-for-M). Model VR-6 is used extensively in medical and life-sciences research, or clinically in cardiac catheterization laboratories. The right side of the upper deck contains the scope and its controls, while the left side is a preamplifier rack. This particular system has two pressure amplifiers (3 and 4), and several other types.

A scope-trace recording device is on the lower section. A light-sensitive roll of paper is passed in front of a CRT that shows the same trace as that on the upper scope. This type of recording is required when high-frequency (over a few hundred Hertz) features of the waveform must be recorded. Pens simply can't follow the fast motion of such signals.

Transducer Amplifiers

Two basic types of transducer amplifiers are used in the measurements of pressures. They are: DC; and AC carrier. Each DC amplifier has a differential input to accom-

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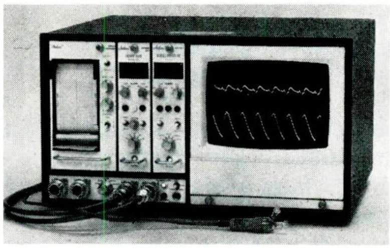

Figure 5A This Statham bedside monitor has (from left to right) a strip-chart recorder, heart-rate module, blood-pressure module, and a scope, with a P23 ID transducer in front. *(Courtesy of Statham)*

Figure 5B A Hewlett-Packard mainframe for bedside monitoring can have any of several modules. In this case, the top unit is an ECG preamplifier and heart-rate module, and at the bottom is a blood-pressure module. *(Courtesy of Hewlett-Packard)*

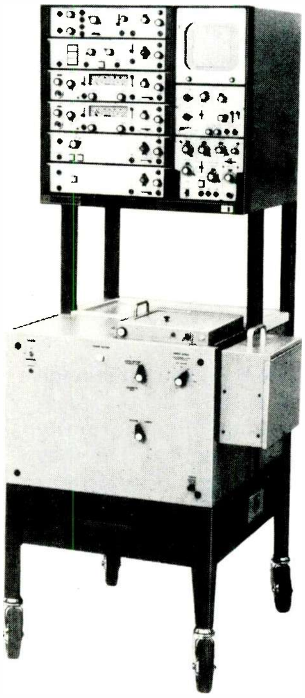

Figure 5C A complete model VR-6 physiological monitoring system by "Electronics For Medicine" includes two blood-pressure amplifiers with meters, plus a scope for viewing most of the waveforms from the various instruments. At the bottom is a strip-chart recorder, for permanent waveforms. *(Courtesy of Electronics For Medicine)*

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modate the output terminals of the transducer, and balance out most of the hum pickup. But, the other stages are single-ended. Operational amplifiers (op-amps) often are used in such circuits.

The other type of transducer amplifier employs an AC carrier, as found in Hewlett-Packard models. Carrier amplifiers can operate either from resistive or inductive transducers, although they usually are designed for inductive transducers. Amplitude of the signal is proportional to the pressure in the system, while the phase of the signal indicates whether a pressure or a vacuum is being measured.

Either the carrier amplifier will accept excitation from the mainframe, or it will generate its own AC carrier, depending on the model. As mentioned, H-P uses 2.4-KHz carriers, but others use a 1-KHz or a 5-KHz carrier, of a power sufficient to drive a 100-ohm load at the rated output (usually 5-volts RMS).

Following amplification of the carrier, a synchronous detector (demodulator) is used to convert the transducer carrier signal to a DC voltage whose value varies according to the pressure at the transducer. One port of the detector receives the amplified AC signal, while the other is supplied with a sample of the carrier.

After detection, the DC output is filtered to remove any hash or residual carrier, and it will have the waveshape shown in Figure 1A. This waveform can be displayed on a scope or a strip-chart recorder, usually calibrated in millimeters-of-mercury. Also, a numerical readout usually is provided, such as an analog or digital voltmeter plus a special processing circuit.

The processor has a peak-holder for systolic readings, and a peak-holder driven by an inverting amplifier for diastolic. H-P uses a scale factor of 10mV/MM Hg, so the output voltage can be directly converted to pressure units of similar numbers.

Many pressure amplifiers also provide an optional mean-pressure readout. Mean-pressure is a measure of the time average (area under the curve) of the pressure wave. In electronic terms, it is the *average* pressure reading that's taken from the waveform.

However, medical people rely on an approximation calculated from the diastolic and systolic pressures (⅓ of the difference between the two pressures, plus the diastolic reading). I have found that medical people trust their approximation more than they do the electronic machines. Quite often they will ask you to "repair" the "defective" module. The solution is to "fix the customer" (that is, explain to them), but to do so *very* tactfully.

Discrepancies

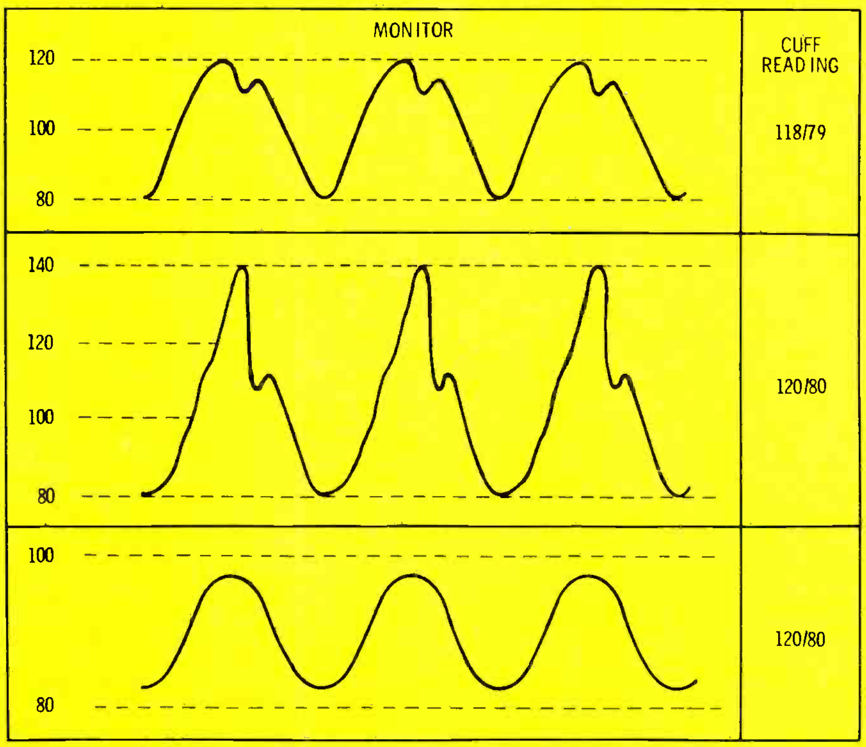
There always will be a small discrepancy between cuff pressure and the monitor reading. But when the difference is large, however, something is wrong.

One possible source of error is hydrostatic pressure of the saline solution in the catheter on the transducer diaphragm; usually resulting from improper placement of the transducer.

The transducer diaphragm should be aligned mechanically so it is located about 10 CM above the patient (assuming that the patient is lying on his back). If the system has been balanced (zeroed and calibrated) with the transducer in another position, large errors are likely to result.

In Figure 6, two erroneous waveforms are shown, along with the

Figure 6 Pressure readings from cuffs and from pressure amplifiers normally are not identical, but they are close. Equipment troubles can cause some of the wrong waveforms shown here. (A) This is a normal waveform giving a 118/79 cuff reading. (B) Stretching of the peaks can be caused by tubing resonances (ringing), giving a false 140/80 reading. (C) Air or blood in the catheter line produces a damped waveform. In all three cases, the cuff reading is the most correct.



correct typical one for comparison. The effect of resonance (acoustic ringing) is shown in Figure 6B. If the catheter tubing finds resonances, then the rising edge of the waveform will tend to overshoot and ring. This is similar to the ringing of a tuned circuit in electronics. The cure for such ringing is to change the diameter of the tubing, the length, or the type of tubing. Another possibility is to reposition the catheter.

Some nurses have been known to "cure" ringing by introducing a small air bubble inside the transducer done. This wrong practice should be discouraged vigorously. Air is a gas, so it is compressible. Liquids are non-compressible. Therefore, the introduction of air into a liquid pressure-measuring system will produce *large* errors.

A damped pressure signal (Figure 6C) is formed when blood or air bubbles get into the catheter line. A preventative method used by most hospitals is to have a constant flush of a solution through the system.

Hypotensive patients (those with low blood pressure) also might produce a smoother waveform, such as the one of Figure 6C, but the nurses usually know about low pressure from previous cuff measurements, and thus make allowances.

Strained transducers

Occasionally, you might see "strained" transducers that indicate a pressure or a vacuum, even when open to the atmosphere. Often, it is caused by the syringe mentioned before. Most transducers can't tolerate much of a vacuum, or too much overpressure. Typically, they operate up to a pressure of +400 MM Hg, but down only to -50 or -100 MM Hg without some damage or change of calibration. If the stopcocks are in the wrong positions when a nurse attempts to withdraw a blood sample for gases analysis, a vacuum will be applied to the diaphragm. The small 3-CC syringes are the worst offenders, for they can generate either high pressures or a high vacuum.

Test simulator

A simulator (that replaces the transducer during tests of a blood-pressure system) either can be purchased (Med-Search Systems, Inc., Chevy Chase, Maryland), or you can build a less-accurate version (Figure 7). Construct the circuit inside a shielded box, and use a connector that's compatible with the system you are troubleshooting.

The four resistors form a bridge. Although the precise resistances are not critical, they must be matched closely, perhaps by using or selecting 1% (or better) tolerance resistors.

When switch S1 is open to simulate zero pressure, the bridge is balanced. The other two switch positions unbalance the bridge by different amounts, to simulate various unbalances. One of the resistors should select a value duplicating a 0-to-30 MM Hg venous pressure range, and the other should simulate the arterial range of 0-to-300 MM Hg. □

Note: this information about electronic blood-pressure monitors (plus factory manuals of each machine) **can** *help you get started repairing similar equipment. However, we urge you to obtain further training before you actually begin such repairs. With medical equipment, human lives can be endangered by substandard work; therefore, your responsibility as a technician is enormous. Prepare wisely.*

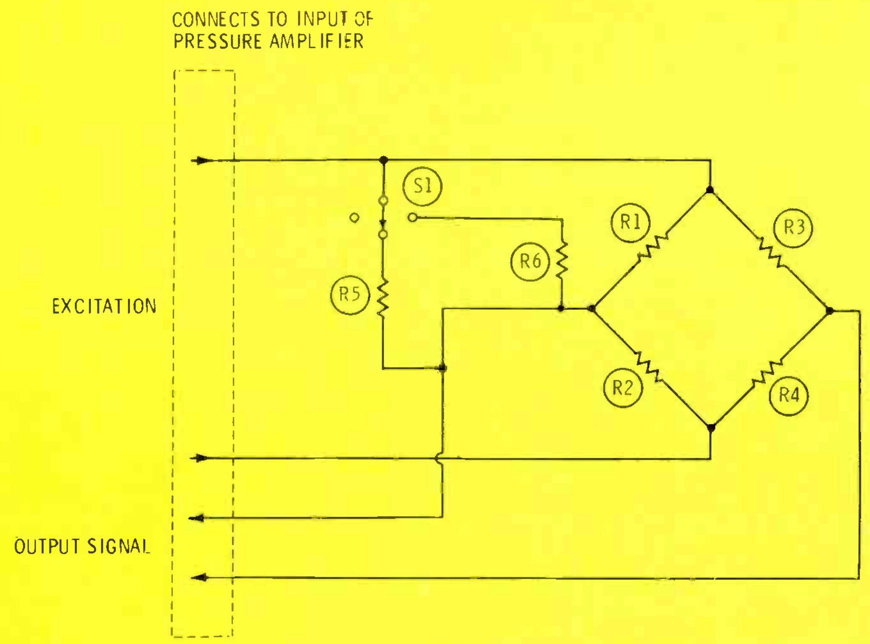
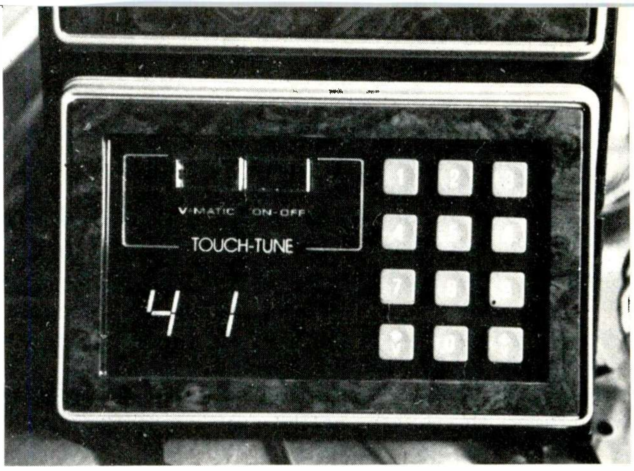
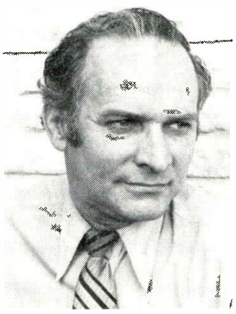


Figure 7 A simulator (for testing pressure transducers and amplifiers) can be purchased or constructed. The resistance bridge (made of 1%—or better—matched resistors for R1, R2, R3, and R4) simulates a zero reading in the atmosphere. Switching in R5 or R6 should produce a reading that's typical for venous or arterial pressures.



No variable controls are used on the Touch-Tune front panel of the Magnavox T995.

Servicing Magnavox Modular Color TV, Part 7



By Gill Grieshaber, CET

Thorough explanations, along with DC voltages and waveforms, are given for the digital channel number and digital control of the varactor-tuning-voltage sections of the Magnavox Touch-Tune system in T995 chassis.

Three ICs are under a tight radiation shield, and three more are visible in Figure 1. In addition, the control circuits of the Magnavox Touch-Tune system in T995 chassis require 20 transistors, plus five more in the two tuners. (Remote operation adds four transistors in the remote receiver.)

Neither tuner has any moving parts, but DC voltages control the ranges and tuning. Bandswitching is done by diodes, which act as shorts when forward biased, and as opens when reverse biased. Voltage-Variable Capacitance (VVC) varactor diodes tune the channels by supplying a capacitance that changes with the reverse bias (see Figure 2). Table 1 shows the measured DC switching voltages, and Table 2 gives the DC voltages obtained for tuning the various channels.

The sophisticated digital circuitry of the Touch-Tune system that controls both the UHF and VHF tuners is unique, although varactor tuners are not new. Therefore, most of the explanations will be about the controlling circuits.

General Operation

Figure 3 is a block diagram of the Touch-Tune system; refer to it often, as the individual circuits are analyzed in detail.

The **yellow, green, red,** and **blue** levers on the panel (pictured in color on the November cover) are used *only* for the initial programming, for making changes of channels, or to correct for fine-tuning drift. After programming, the stations are selected by the non-locking pushbuttons of the keyboard, and the channel numbers light automatically. The tuning meter and the range LEDs operate at all times, and you can check them at any time, although the main purpose is to aid in the programming. It is rather fascinating to see the LEDs light and the meter swing, after you push the buttons for a new channel.

Pushbutton selection of programmed channels is done without hunting or scanning. During remote-control operation, the chan-

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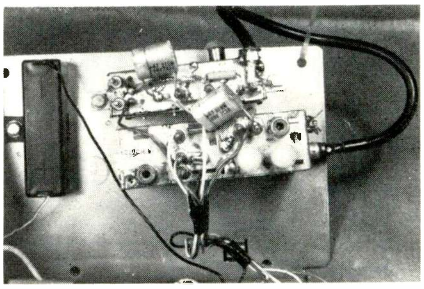

Both the UHF tuner (top) and the VHF tuner (bottom) are small, and they are mounted on the side of the control chassis. To the left is the alkaline cell that helps maintain the memories during times of no power.

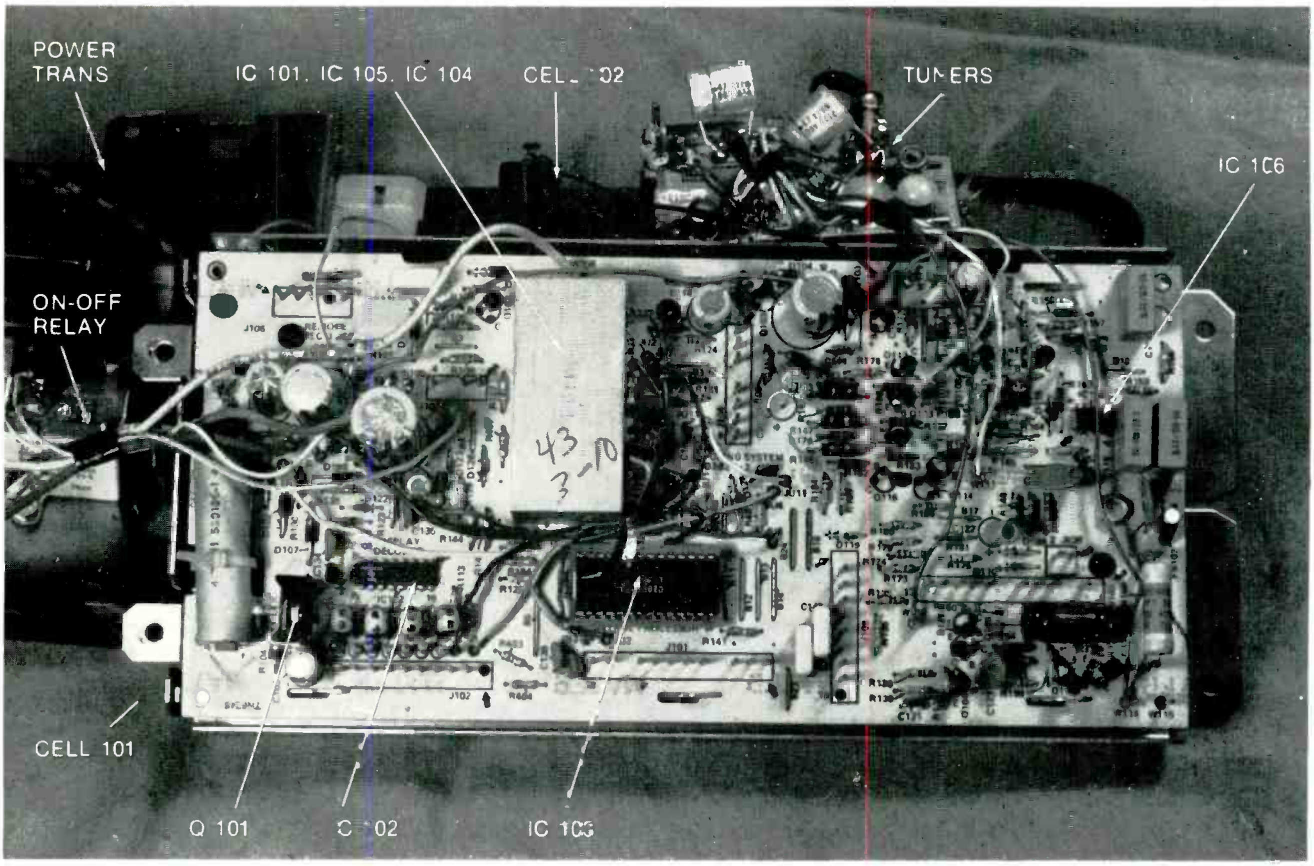

Figure 1 Major components of the Touch-Tune control chassis are indicated by the arrows.

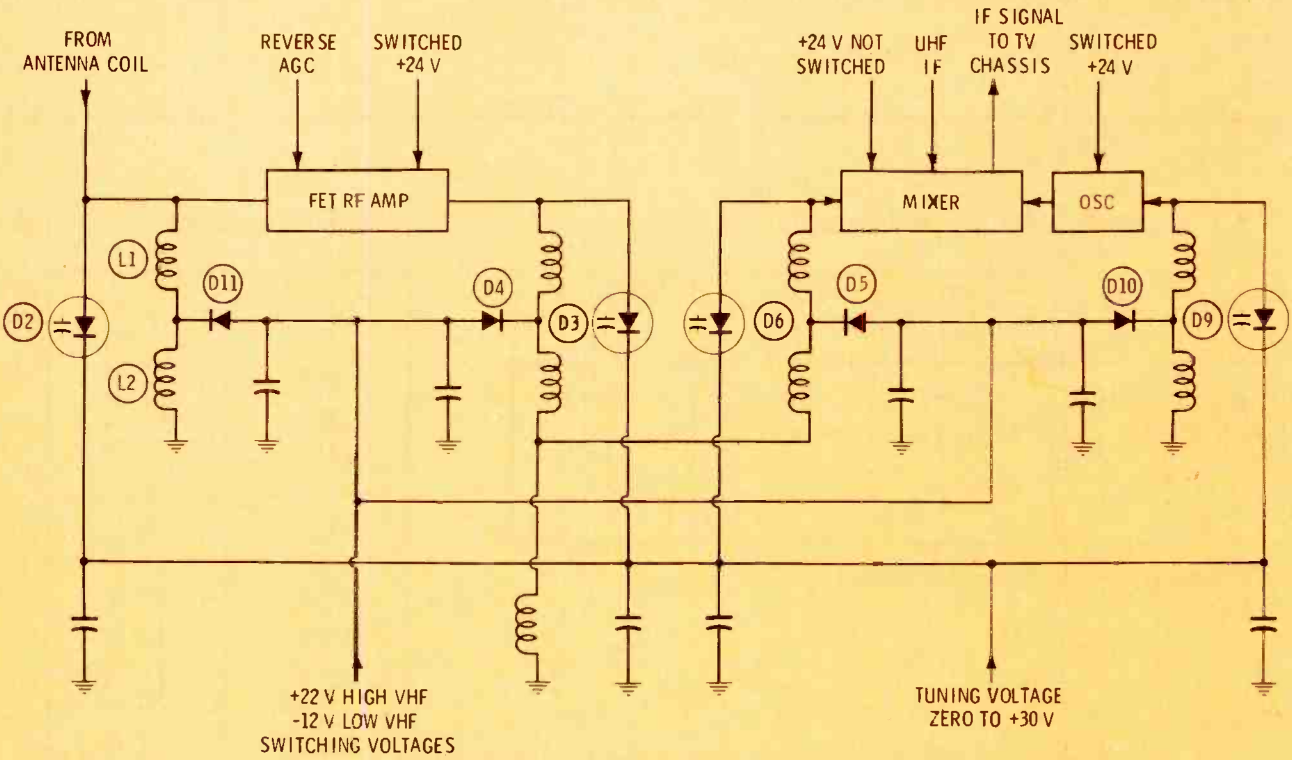

Figure 2 A block diagram of the Voltage-Variable Capacitance (VVC) VHF tuner shows the tuning varactors (D2, D3, D6, and D9), and the switching diodes (D11, D4, D5, and D10). L1 is the high-VHF RF coil, and L2 plus L1 is used to tune the low-VHF band. Therefore, for low-VHF operation, about -12 volts is applied to the anode of D11, forcing it to be an open circuit. But for the high-VHF band, +22 volts is applied through a resistor to the anode of D11, forward biasing it into full conduction. L2 is shorted out effectively, since the anode of D11 is bypassed to ground. Other tuned stages operate similarly.

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nels are scanned sequentially. Each press of the remote button advances the tuners to the next programmed channel. Therefore, for remote convenience, the unused channels should be programmed to "zero" by the red channel-number switch. (It is not necessary to change the tuning voltage via the blue switch.)

Station selection with models having a remote can be done *either* by the remote or by the keyboard buttons. However, if you use the keyboard buttons to select an unused channel that had been programmed to "zero" for the remote operation, the correct channel digits will appear, but flashing on and off to indicate non-programming.

Memories

IC103 and IC104 each contain a 20-location Random-Access Memory (RAM), and these memories store the data required to tune in 20 different TV channels. As mentioned last month, the two battery cells are required to furnish a "keep alive" power for these memories, during times the AC power is turned off.

Clocks

In digital language, a "clock" is the source of a signal (usually pulses or square waves) that's used to time something, or to "enable" a function. Loosely translated, enable means to trigger it on, or to make it possible.

Two clock signals are necessary in the Touch-Tune system. One is the 60-Hz clock, and the waveform is produced by clipping power-transformer sine waves. The other clock signal starts at the 3.64-MHz oscillator, then a divide-by-four circuit changes it to 910-KHz square waves. It is used in the remote decoder, and in the formation of the tuning DC voltage. A counter and flip-flop circuit in IC104 produces DC pulses at a 220-Kz repetition rate. The width (duty cycle) of the pulses is varied according to the channel, and the train of pulses is filtered to produce the DC voltage for the varactor diodes in the tuners.

These circuits, and other important ones, will be analyzed in detail.

60-Hz clock and keyboard signals

Schematics last month showed how the keyboard and 60-Hz clock signals were made. To form the positive-going keyboard signals, diodes clipped the bottom half of out-of-phase sine waves that came from the power transformer.

Also, sine waves from one 60-Hz source were clipped and amplified by a transistor (Q120), producing near-perfect square waves for the 60-HZ clock signal.

The keyboard and 60-Hz clock waveforms are shown with correct phase in Figure 4.

IC103 Circuits

IC103 is a large 28-pin device having many functions (see Figure 5). The internal stages of the IC are shown in block form to clarify the operation.

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BANDSWITCHING VOLTAGES

	BAND 1 (2-6)	BAND 2 (7-13)	BAND 3 (UHF)
VHF BANDSWITCH	-12.3 V	+21.4 V	-12.3 V
VHF RF & OSC	+21.4 V	+21.4 V	0 V
VHF MIXER	+24.1 V	+24.1 V	+24.1 V
UHF B+	0 V	0 V	+24.1 V

Table 1 These are the bandswitching voltages actually measured at the tuners.

MEASURED TUNING VOLTS

CH2	+ 4.42 V
CH3	+ 6.51 V
CH4	+ 8.41 V
CH5	+13.53 V
CH6	+21.20 V
CH7	+10.15 V
CH8	+11.18 V
CH9	+12.32 V
CH9	+12.32 V
CH10	+13.36 V
CH11	+15.49 V
CH12	+17.76 V
CH13	+21.10 V
CH19	+ 5.56 V
CH27	+ 7.88 V
CH41	+ 9.36 V

Table 2 The Magnavox literature lists a range of voltages for the tuning DC supply voltage for the tuners. The sample-TV tuning voltages measured as shown.

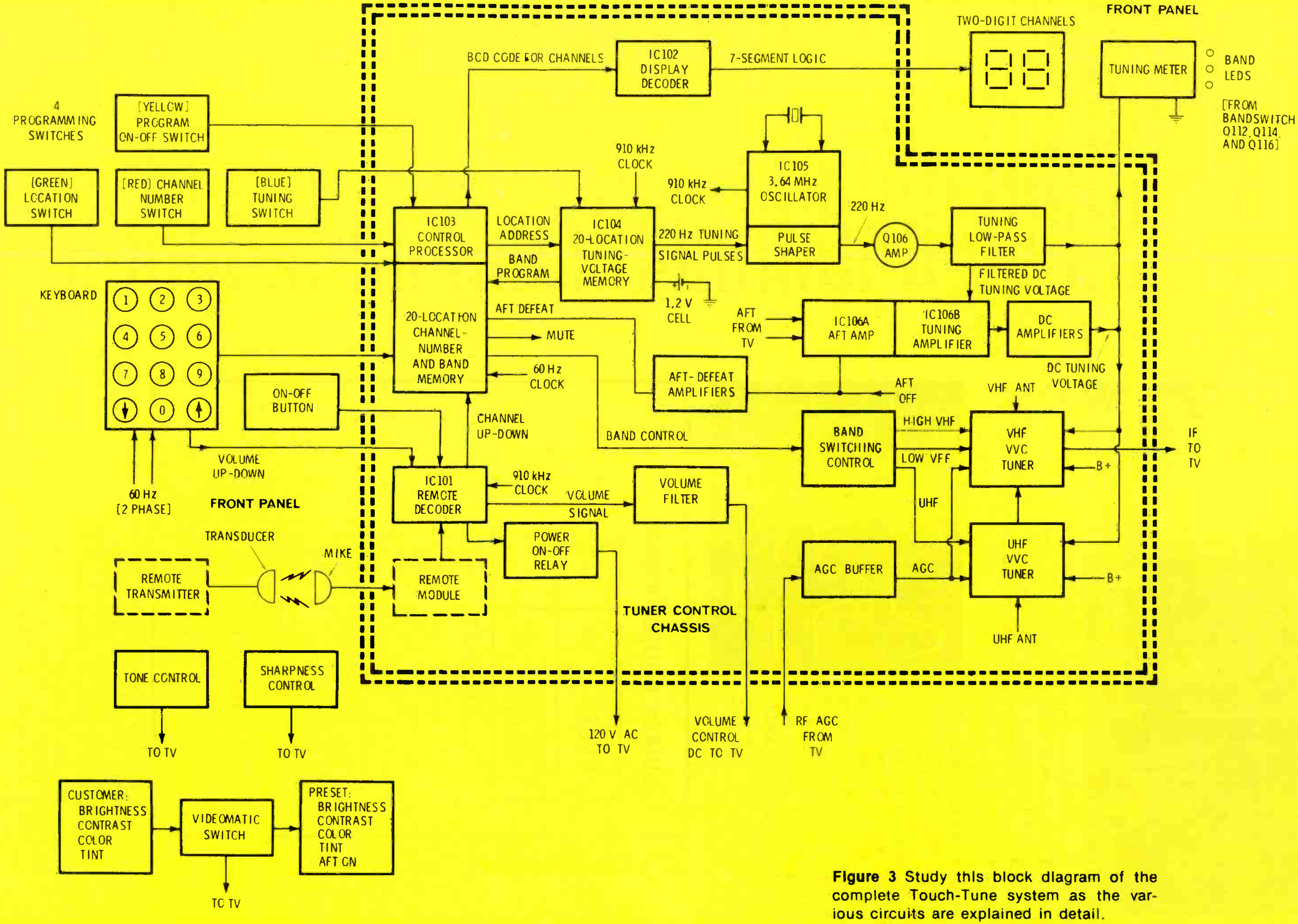
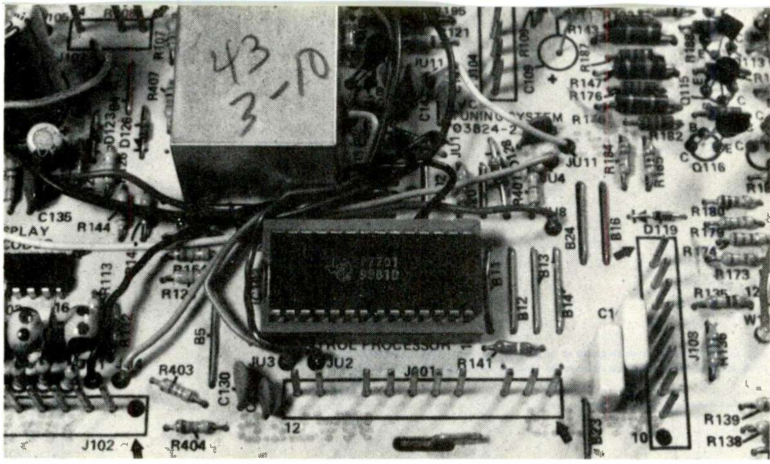


Figure 3 Study this block diagram of the complete Touch-Tune system as the various circuits are explained in detail.



IC103, the control processor, is the largest one on the control chassis. It has 28 pins. Three of the ICs incorporate the new Integrated Injection Logic (called I squared L) that permits low-current drives; therefore, the "highs" are supplied at lower DC voltage levels than for other digital circuits.

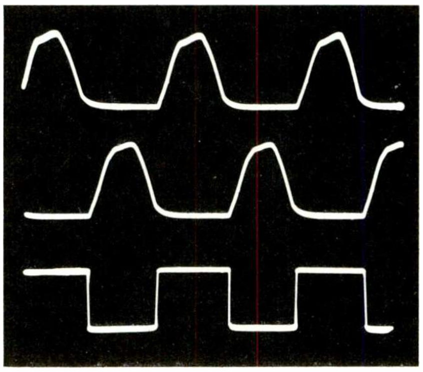


Figure 4 The top trace is the "even" keyboard waveform; at the center is the "odd" keyboard waveform, while the bottom trace is the 60-Hz clock output. These are shown in correct relative phase, with the "even" and clock waveforms in-phase. The keyboard signals also supply the digital readout; and they are made by clipping sine waves from the power transformer.

BINARY CODED DECIMAL (BCD)

BINARY	D	C	B	A
DECIMAL VALUE	8	4	2	1

EXAMPLES
0001 = 1
0010 = 2
0011 = 3
0100 = 4
0101 = 5
0110 = 6
0111 = 7
1000 = 8
1001 = 9

OR 0001 - - 0011 = 13
0010 - - 0111 = 27
0100 - - 0001 = 41

Table 3 Change Binary-Coded Decimal highs (1) and lows (0) to ordinary decimal values by adding the decimal equivalents together. A is the least significant BCD number, having a value of 1, B has 3, C has 4, and D (the most-significant number) has a value of 8. The lows count for nothing. Therefore, decimal 9 is made up of 8 for D, nothing for C and B, and one for A; making a total of 9 for the BCD code of 1001.

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Keyboard operation

Notice that *two* keyboard swiches connect to *each* IC103 keyboard input, such as pin 6, 7, 8, 9, or 10. Without additional data, *both* switches would produce the *same* results. A type of multiplexing allows definite identification of each pushbutton. Pushbuttons 1 through 9 are supplied with positive halves of sine waves. This is called the "odd" keyboard signal, since it's applied only to the odd-numbered buttons.

In the same way, pushbuttons 0 through 8 receive waveforms from the "even" keyboard signal.

Keying (enabling) pulses are needed now to identify the phase of the keyboard signal that is sent to the IC, and this phase will identify which of each pair of buttons has been operated. That's the purpose of the 60-HZ clock signal. (Figure 4 shows that the clock and the even-keyboard signals are in phase, while the clock and the odd-keyboard waveforms are out of phase.)

For example, the outputs of both the 0 and 1 pushbuttons connect to pin 6 of IC103, and the clock signal enters at pin 12. Both signals reach the BCD-encoder section of IC103. When the clock signal is *high* (positive), the IC checks for a *high* keyboard signal. The high keyboard signal proves that the 0 (even-keyboard) button is the one supplying the waveform.

During the other half-cycles, when the clock signal is *low*, a *high* keyboard signal proves the waveform is odd, and the IC identifies the source as button 1.

IC103 ignores all other conditions, such as finding a low when a high is expected, or when the keyboard signal is missing.

When a change to another TV channel is desired, two pushbuttons must be pressed in sequence. Channels below 10 must have a zero pushed before the signal channel number. For example, push zero and four for channel 4.

Immediately after the first digit is selected, the channel LED display blanks out. The second digit is selected, and the new channel appears almost instantly, along with

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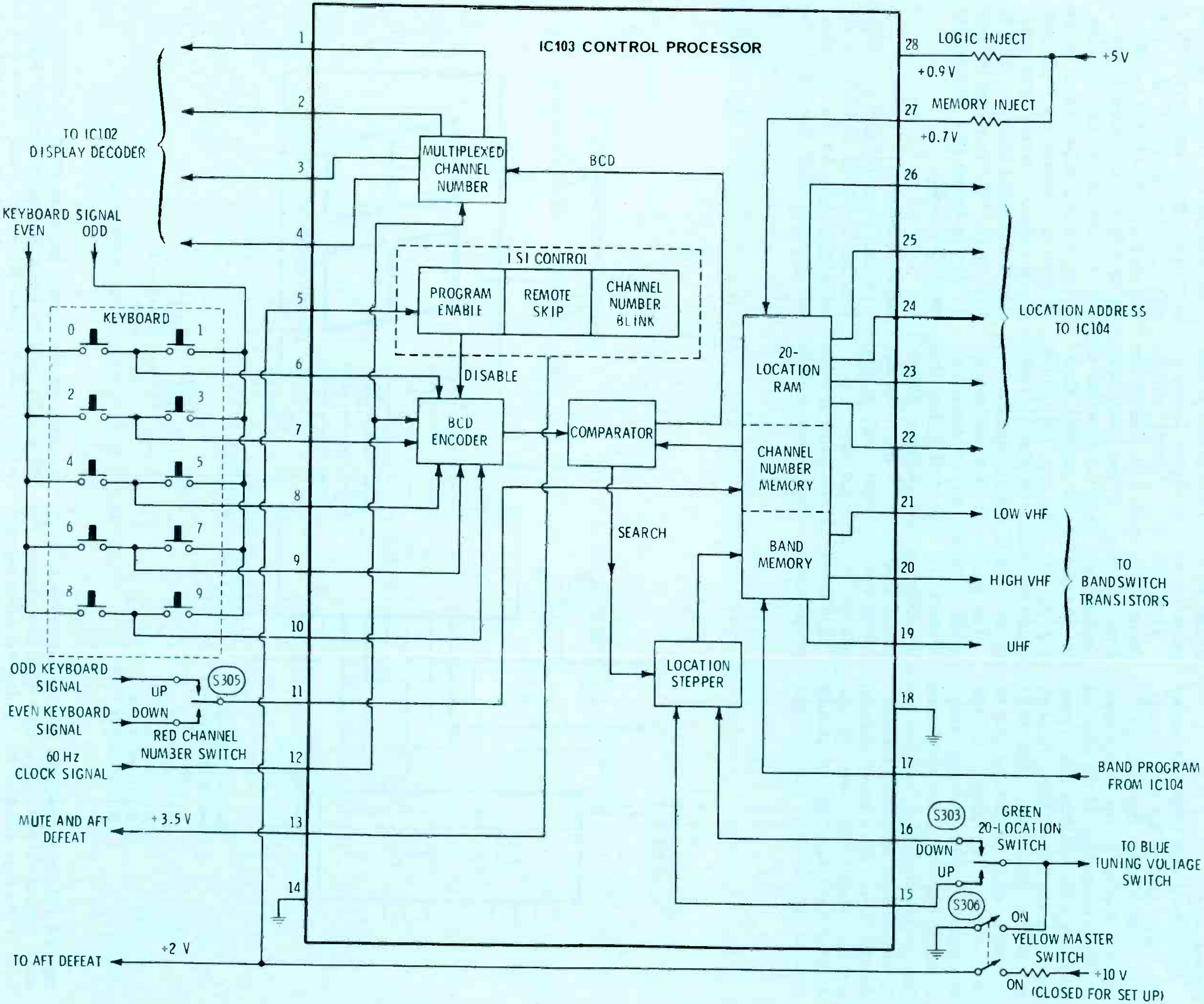

Figure 5 Internal functions of IC103 are shown by blocks, and the external signals are listed with the pin numbers (which are shown as they are on the actual IC). The red, green, and yellow programming switches connect to IC103, while the blue tuning switch operates with IC104.

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the new channel number on the readout display.

The channel-number selection and the tuning of the desired channel are two *separate* general actions that occur simultaneously.

Channel display

After the second channel number has been selected by the buttons, the Binary-Coded Decimal (BCD) encoder applies to the comparator the BCD equivalents of the channel numbers, while the location stepper rapidly scans the memory through all 20 locations. Also, the BCD channel number of each location in the memory is applied to the comparator. The stepper stops scanning when these two conditions become identical (that is, when the desired channel number is reached). At this time, the correct channel number should be seen on the display (and the station should appear on the TV screen—but that's explained later). However, if the selected channel has not been programmed previously, the digital display—with the correct channel number—will blink on and off, and the screen will show snow only.

Programming switches

Three of the four programming switches connect to IC103, and they should be mentioned briefly before we go on with the digital display.

S305, the red channel switch, operates from either the odd or the even keyboard clipped waveform, applying one phase or the other to the channel-number memory. Pushing up or down on the switch causes the digital display to count up or down in channel numbers.

The green 20-location switch (S303) searches up or down one channel at a time, and it does this by activating the location stepper inside IC103. (The blue tuning-voltage switch works with IC104, and will be explained later.)

S306, the yellow-knob master programming switch, either enables or prevents operation of the other three programming switches. There are two separate actions. The center (or common) wire from the green and blue switches are grounded by the yellow switch when it is pushed to the "on" position. When the yellow switch is open, neither the green nor the blue switch can have any effect.

Whether or not the red program switch operates is determined by a high or a low at pin 5 of IC103. When the yellow switch is on, about +1.94 volts DC is applied to pin 5, and the red switch can be used. Pulling out the yellow knob to the off position removes the high, and prevents the red switch from scanning the channel numbers. This is done by the "program-enable" and the disable circuit that connects to the BCD decoder.

Address location

Outputs from the RAM in IC103 (pins 26, 25, 24, 23, and 22) contain the address code for the location of the channels that have had the

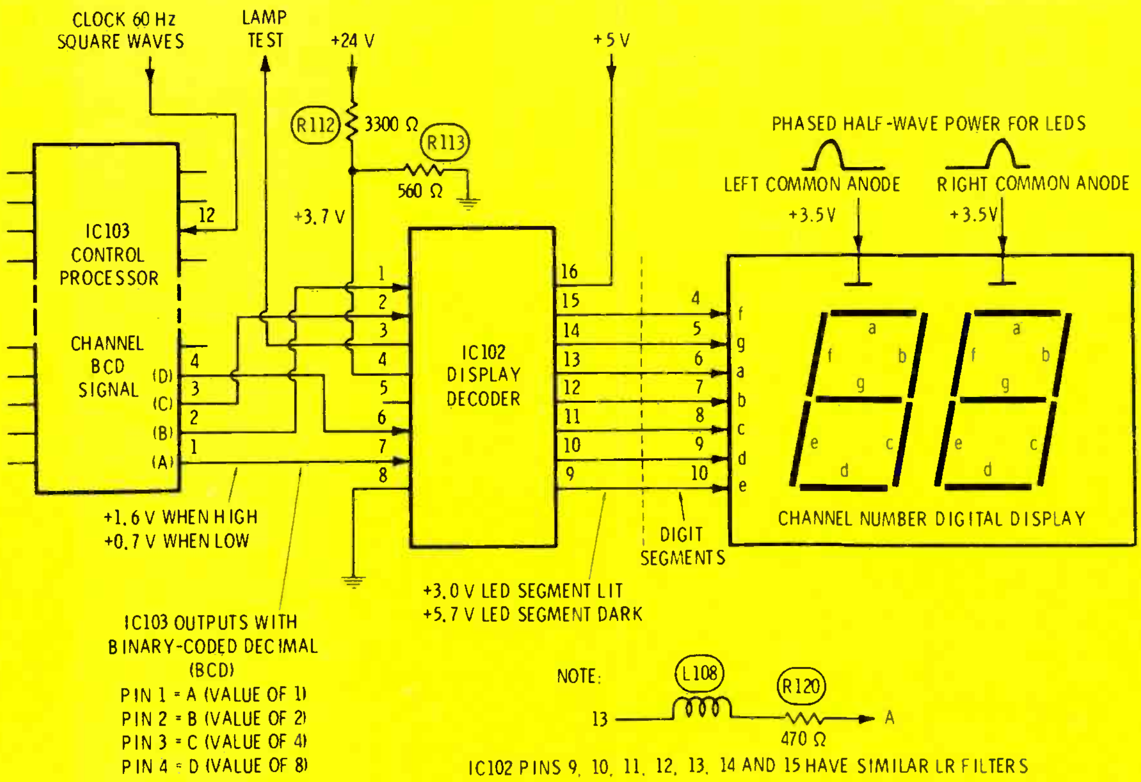

Figure 6 The display decoder, IC102, receives the A, B, C, and D lines of the BCD output from IC103 and changes the BCD to the logic required for lighting the seven-segment LED display. Multiplexing of the two channel digits is done by using the 60-Hz clock signal in IC103 to alternate the BCD codes, and by using the opposite-phased keyboard supply to furnish power to the LED digits. Notice that the BCD highs have a DC value of only about +1.6 volt.

channel number programmed. These signals (highs and lows) go to the location-address decoder in IC104, which will be explained later.

Another mulitplex

Continuing with the channel display circuitry, another multiplexing arrangement permits both of the seven-segment LED digits to use the same BCD and display-decoder wiring. Only one digit is lighted at a time; they alternate. However, the 60-HZ flashing rate permits both to *appear* lighted continuously.

Output of the comparator activates the multiplexed channel-number BCD converter, while the 60-Hz clock signal keys the output into alternate segments. This part of IC103 has four output lines for the four values of the 8/4/2/1-value BCD system (which is explained in Table 3).

Each of these four lines either is high (about +1.6 volt DC) or low (about +0.7 volt DC), and the BCD signals are sent to pins 1, 2, 6, and 7 of IC102 (see the block diagram in Figure 6), the display decoder that changes BCD logic into seven-segment-display logic.

To avoid complications, the inductances and resistors in the seven lines between the output of IC102 and the front-panel LED display are omitted from the main schematic of Figure 6. However, the values are shown below, and all seven lines are alike.

Power for the LED segments in the digital display is brought to the common anodes of the two digits. Then the segments light, when the display decoder shorts the proper cathodes to ground.

In the BCD encoder and multiplexer parts of IC103, the 60-Hz clock permits just one of the two signals (for the digits) to be developed at a time. They alternate at the 60-Hz rate. Also, the voltages for the anodes of the LEDs come from the same source as the two keyboard signals (alternate-phase clipped sine waves of DC voltage), which differ in phase by 180°.

The seven corresponding cathode segments of the two LED digits are connected in parallel. Although the *same* display-decoder signal goes to *both* of the LED digits, only one lights. It displays the number

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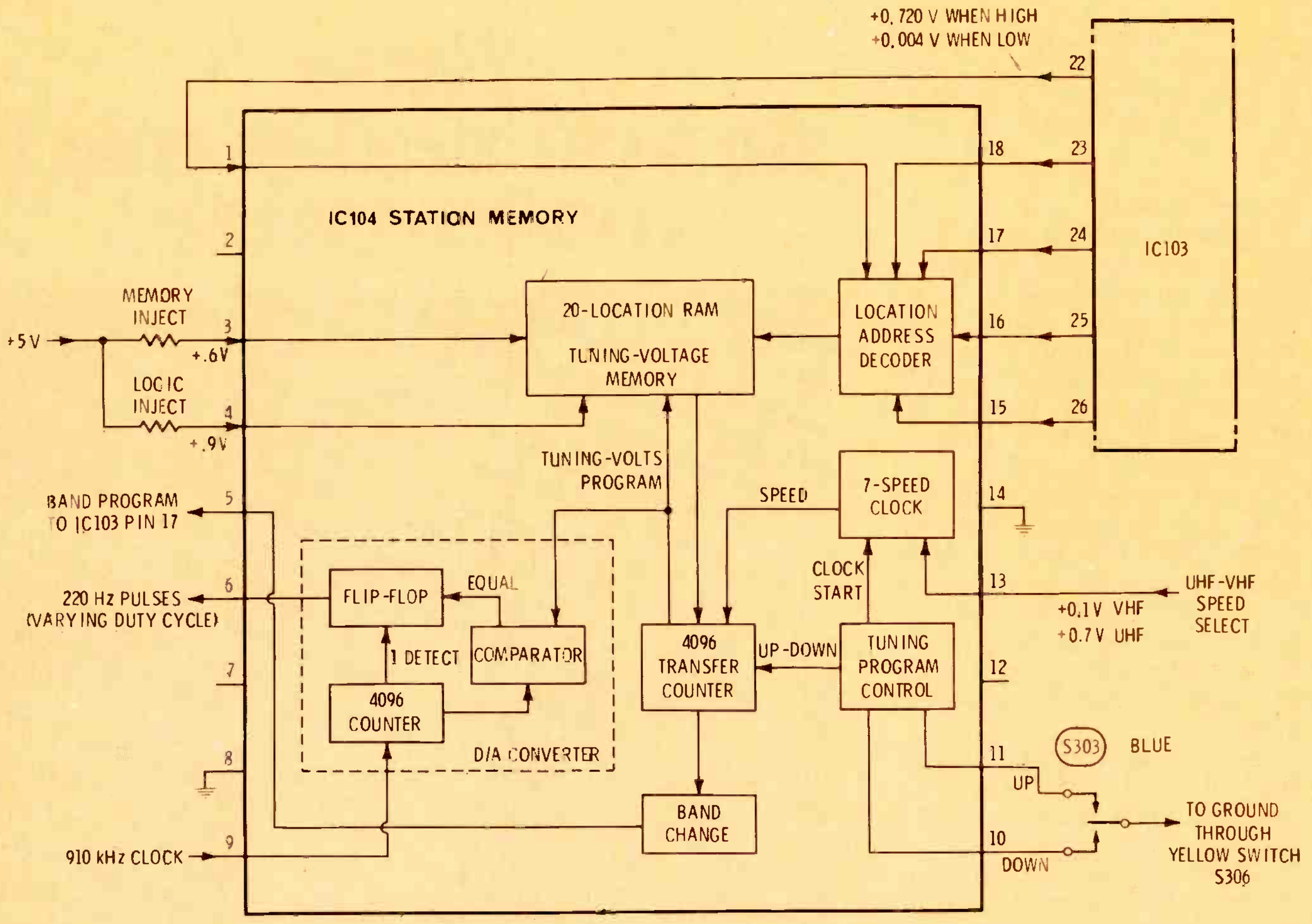

Figure 7 Internal functions of IC104 are shown by the blocks, with pin numbers in the proper sequence. The varying-width pulses of DC voltage from pin 6 are filtered to form the tuning voltage. Grounding pin 10 or 11 (through the yellow switch) starts incrementing or decrementing the 7-speed clock and the 4096 transfer counter.

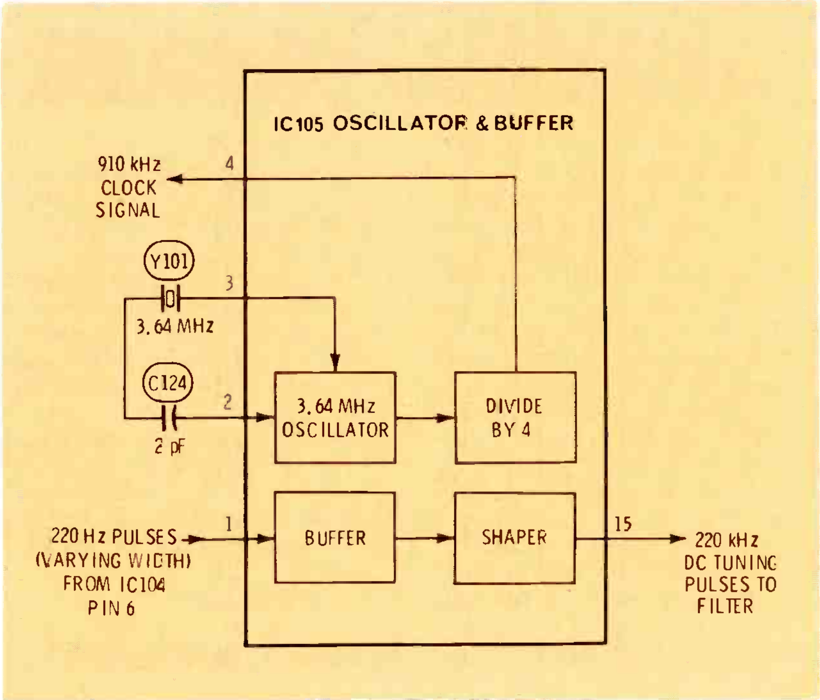

Figure 8 IC105 has two separate functions. It is the 3.64-MHz oscillator and X4 divider; also, a section acts as a buffer and waveform shaper of the 220-Hz pulses that will become the tuning voltage.

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selected by the multiplexing operation.

Then, during the next half-cycle of the 60-Hz frequency, the other digit has the correct anode supply to make it light. However, by this time the decoder signal to both LEDs has changed to the other number. Therefore, both LED digits appear to glow continuously, and each has a different channel number.

IC104 Tuning Data

A block diagram of the wiring inside and around IC104 is shown in Figure 7. This IC can be operated in two different modes (the programming mode, and the normal-operation mode). We'll discuss the normal mode first.

IC103 (previously described) initiates the location binary address from its 20-location RAM when a programmed channel number is selected. These address codes are highs and lows that enter IC104 at pins 15, 16, 17, 18, and 1 (see Figure 7).

The address decoder selects the proper location in the IC104 20-location RAM (that's for the tuning-voltage memory data), according to the address code.

Each memory location has 12 flip-flop circuits that produce a certain binary number between 0 and 4096. This binary number goes through the 4096-transfer/counter to the comparator. The other signal for the comparator is from the 4096 counter, which is driven by the 910-KHz clock signal. The counter runs constantly, so it counts from 0 to 4096 and repeats over and over.

A digital-to-analog convertor is formed by the 4096 counter, the comparator, and the flip-flop (shown at the lower-right corner of the schematic). **The pulses from the flip-flop are the start of the tuning for each channel.**

Output of the flip-flop goes *high* each time the 4096 counter begins the count of 1, and the output remains *high* until the counter reaches the number that has already been transferred to the comparator from the selected RAM location. When the two numbers at the inputs of the comparator are equal, the output of the flip-flop goes *low* until the 4096 counter reaches the count of 1 again. At that point, the output of the flip-flop goes *high*. This is the end of the first cycle of operation.

Therefore, the pulse output from the flip-flop at IC104 pin 6 has a duty cycle (pulse width—not repetition rate) that is different for each channel (the time period between the 4096 transfer and the 4096 counter is different for each channel.)

These variable-duty pulses are amplified and filtered to form the tuning DC voltage for both tuners. But, before that process is described, we must cover the programming of the IC104.

Programming channel-tuning

To program the RAM with the memory for a certain channel, it's necessary only to store the correct binary number in the RAM. This is done by the S303 blue switch, which grounds (through the yellow switch) either pin 11 or 10 of IC104.

Grounding one pin sends an up or down signal to the transfer/counter and a starting pulse to the 7-speed clock. Then the 7-speed clock determines how fast the transfer/counter operates. Output of the transfer/counter is a binary number that changes between 0 and 4096, and it is applied both to the RAM memory, and to the comparator.

Normally, the blue lever is held in position for several seconds, while the varying duty cycle of the flip-flop signal changes the tuning voltage. **When the blue switch is turned off, the output of the transfer/counter stops, and the binary number at the output is stored in the RAM.**

Because considerable time would be required to cover an entire half of the VHF band, for example, the designers have included a helpful feature. When the blue switch first is operated, the 7-speed clock starts at the slowest speed. If the switch is held on constantly, the clock advances through each higher speed in turn, thus allowing fast changes between widely-separated channels. However, short operations of the blue switch allow slow and accurate channel tunings.

UHF tuning normally would proceed at a faster rate than VHF does, because only one range is used. Application of a DC voltage (of about +0.68 to the 7-speed clock by way of pin 13) reduces the tuning speed to about half.

Of course, the transfer/counter can increment or decrement, according to the position of the blue lever and switch.

Bandswitching

When the blue switch is in the up position and the transfer-counter is decrementing (counting down), the DC tuning voltage is increasing. When the transfer/counter reaches 0 (where the tuning voltage is maximum) and recycles back to the starting point of 4096 (zero tuning voltage), a single positive-going pulse is developed. This pulse emerges from IC104 at pin 5, and it goes to pin 17 of IC103 where it controls the band memory. Therefore, the bandswitching circuitry

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changes the tuner-switching voltages to those necessary for the next tuning band. The sequence with the blue lever in the up position is: from band 1 to band 2; from band 2 to band 3; from band 3 to band 1; etc. The cycle keeps repeating so long as the blue switch is in the up position.

When the blue lever is held down (incrementing or counting up), the DC tuning voltage is decreasing, and an opposite sequence takes place. As the transfer/counter counts up to zero tuning voltage at 4096 and jumps to 0 (maximum voltage;, *two* positive-going pulses come from the band-change circuit at pin 5, and the band is changed to the next *lower*. This sequence continues, if the blue lever is held down, from band 3, to 2, to 1, to 3, etc.

Of course, when channels are selected by the pushbuttons on the front panel, the 4096 transfer/counter is triggered by the location RAM, and the location and band are selected automatically.

Amplifying And Filtering The Tuning Voltage

We have established that the output of the flip-flop at IC104 pin 6 is a series of 220-Hz (repetition-rate) pulses that vary in width (duty cycle) according to the channel selected.

From there, the pulses are sent to pin 1 of IC105, which has two functions. Part of IC105 is the 3.64-MHz oscillator and the divider to supply the 910-KHz clock signal.

Also inside IC105 are a buffer and pulse shaper (see Figure 8) for the pulses that exit at pin 15. Then the pulses are fed to the base of Q106, an amplifier and phase inverter. The pulses at the output of Q106 (from the collector) are filtered by a three-section RC low-pass filter (R157/C116, R158/C117, and R159/C118). Figure 9 shows the schematic and the waveforms.

One IC and three transistors (amplifiers and emitter followers) modify the DC voltage before it is ready for the two tuners. In addition, the AFT is added to the other input of the op-amp IC, to change slightly the tuning of *all* stages in the tuners, and not merely the oscillators (as is the case with non-varactor tuners). Those details must wait until next month.

Next Month

Several discrete transistors are used in the remainder of the circuits to accomplish AFT defeat during programming, amplify and modify the tuning voltage, operate the switching of the three bands, and supply AGC to both tuners. All of these circuits will be discussed in the next issue, along with the volume-control circuits. □

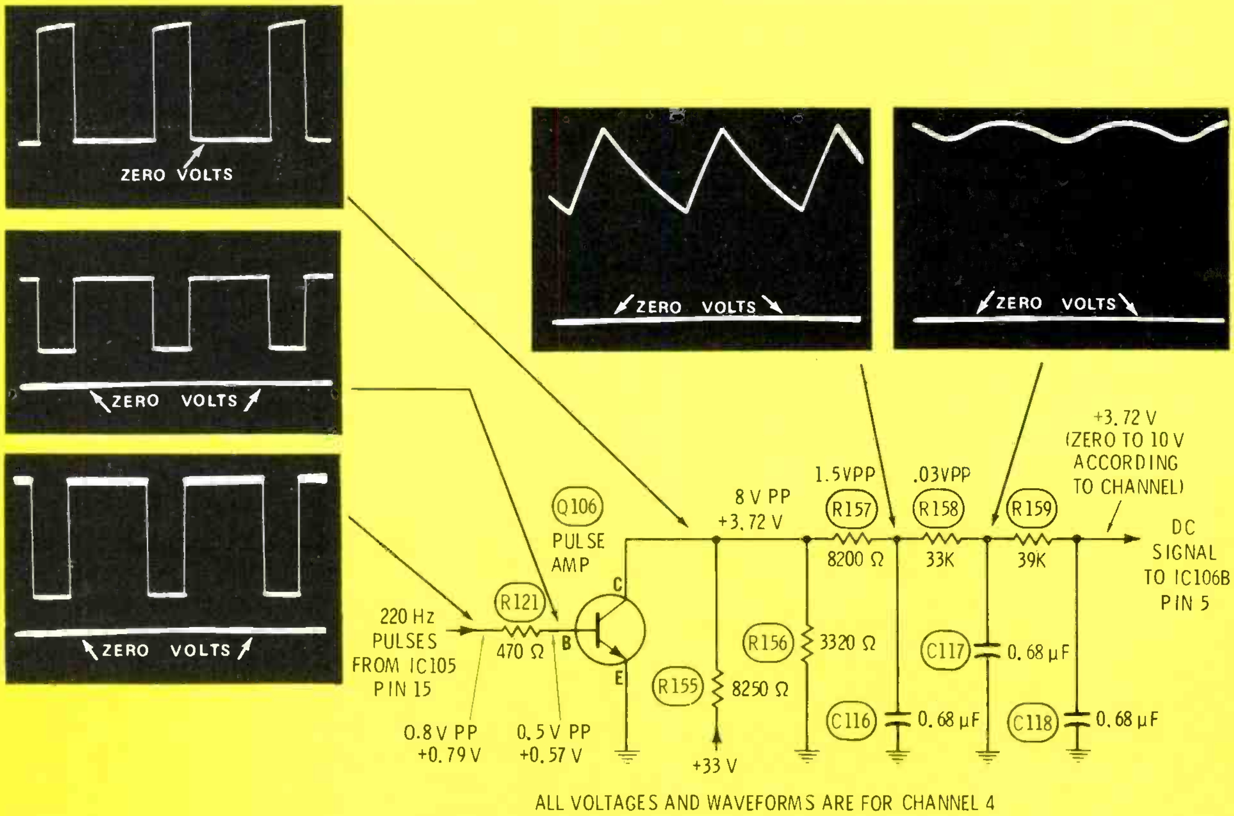


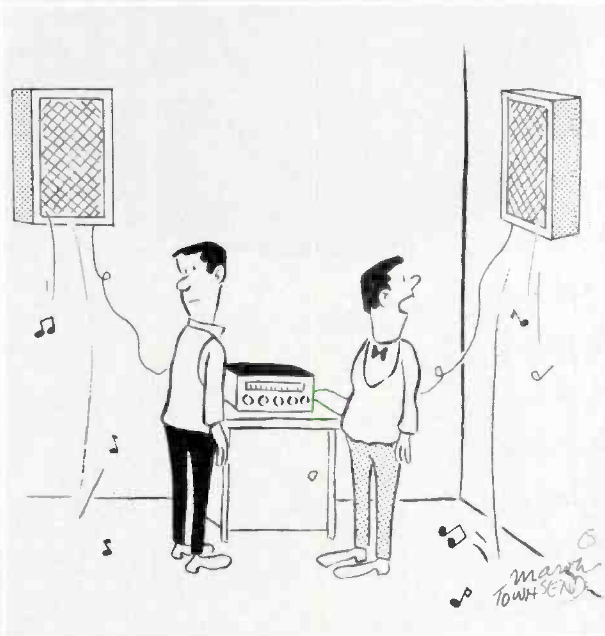
Figure 9 Q106 amplifies and inverts the varying-width pulses. The waveforms, DC readings, and AC peak-to-peak readings were recorded for channel 4, and they will be different for other channels. Output from R159/C118 contained so little ripple that it could not be seen on a sensitive scope. After mixing with the AFT voltage, and being amplified and impedance-changed in other stages, the output DC voltage (which is different for each channel—see Table 2) is applied to the varactor diodes in both tuners.

CARTOON CORNER

"Have the replacement batteries for my watch come in yet?"

"I'm making progress. I have it working on one channel in one position!"

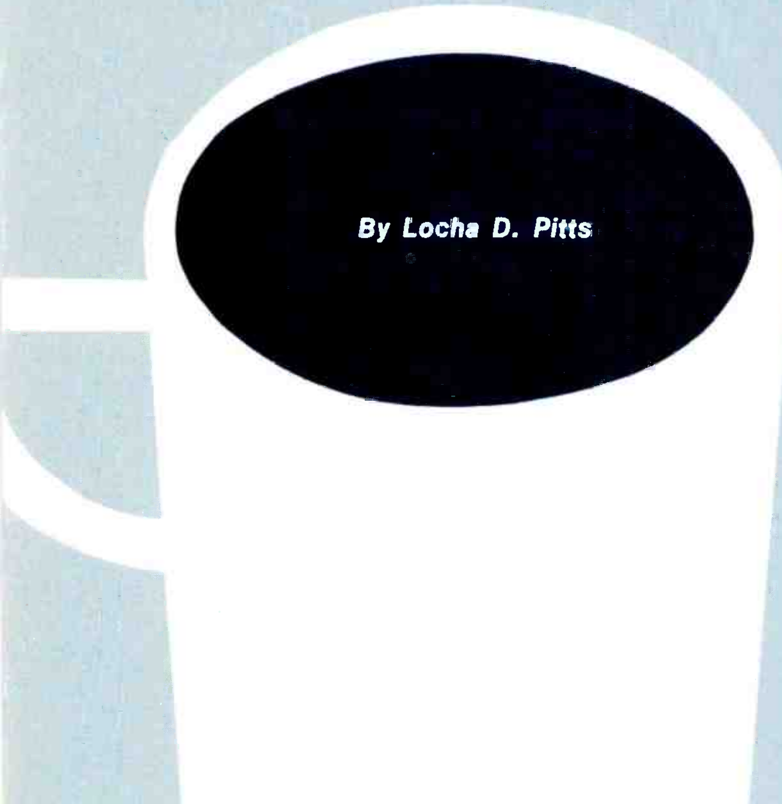
"Well let me put it to you this way...This model is known as the Edsel of the TV repair circuit."



"I'd say your audio output is a little weak."

Over the Coffee Cups

A practical philosophy of troubleshooting



You've followed standard troubleshooting procedures and the "dog" still doesn't work. So, what are you going to do now, friend?

Troubleshooting is a difficult art to learn, especially when everyone is too important or too busy to provide apprenticeship training, and employers prefer 25-year-old technicians with 10-years experience in CB-chroma circuits and ECL-logic crystal sets.

The electronic technician's world is assembled from intermittent fuses, mismarked diodes, broken pins, leaky capacitors, wires with only one end, corroded switch contacts, sticking meter pointers, missing transformer cores, misrouted wires, hair-line cracks, touchy circuit breakers, and infinite ways for components to go bad. Believe me, every tech needs all of the help he can get.

So, let's sit down with cups of coffee, and talk about a few ideas that might help solve some of these electronic problems, which seem to defy all logic.

Use Your Test Equipment

You shouldn't attempt difficult troubleshooting unless your test equipment is in good shape—and *your most important test equipment is your mind and body.*

The technician who hasn't discovered that he's human (and not a robot) will waste kilohours on a difficult problem when he is tired, sleepy, hungry, angry, hungover, or worried. How are you going to fix a "dog" if you are a Cathode Head (charged with negativity)? A lot of exasperating unfixables have become "a piece of cake" after a good night's sleep, a coffee break, or some time spent on a routine task.

Ask For Help

Once you've decided you don't have to be perfect, you can *ask another technician* for help. Most employers and customers are concerned only that you fix the hunk of copper, silicon, and carbon. They don't care where the troubleshooting ideas come from, so long as you fix the gear.

Ideally, you should talk to a technician who has good judgment, and is experienced with the type of equipment you are troubleshooting.

He might tell you to check the plate voltage in the color-killer circuit, or remind you that this particular set obtains a B+ voltage from the cathode of the audio output tube. Or, perhaps while describing the symptoms, you'll remember that you forgot to check the color oscillator, or to replace the modulator transistor. Maybe you'll remember to *peak* the grid and *dip* the plate.

Sometimes talking to a parts supplier can be helpful. The first color picture tube I ever replaced died after a month. After a counterman at the local distributor told me about the many cold solder joints at the heater pins of the picture tubes, I was able to restore it to new life by applying a few drops of solder.

Be Persistent

Some troubles require *persistence* more than intelligence. I recall the case of a kilowatt mobile transmitter which remained inoperative for more than a year because no one had the presistence to remove the power supply from the equipment cabinet, in order to get at the terminals below the chassis.

It took three hours to remove the cumbersome beast, but only five minutes to confirm that a power transformer secondary winding had burned up.

Read Technical Publications

Too many techs fail to read technical magazines and manuals, and thus are unaware of many changes in the field. In the days when a certain resistor in the tuner was *supposed* to open under any overload, such techs could have prevented much head scratching by reading in the magazines about the problem. Also, if you don't know about scan-rectified power supplies, you probably will waste precious hours testing the power sources, instead of looking for the defect in the horizontal sweep.

If you have a technical manual for the bucket-of-bolts you're working on, sit down and read about the circuits that—from the symptoms—seem suspect. Or, obtain a book or magazine article dealing with similar problems or circuits.

Some technicians pride themselves on trouble-shooting *without* a schematic. This attitude was understandable in the days of the five-tube AC/DC radio, but when you get in over your head, you *must* have a schematic, and you need to study it. It always seems to turn out that pin 7 is *supposed* to be tied to pin 8. Or, what looks like a multivibrator is really a differential-input stage.

Question Your Assumptions

Every good technician makes a lot of assumptions when he first opens up a piece of equipment for inspection. These assumptions usually simplify and speed up the work. However, when your frustration has you calling for the men in white coats, you'd better begin questioning all assumptions.

Normally, all of us would expect a simple tube layout chart to be correct. But, I once fixed a TV set (after a tinkerer had been playing with it) by deciding intuitively that the tube chart was wrong. I began to swap the two tuner tubes. And, as I brought the RF-amplifier tube near the socket it was *not* supposed to be in, loud sounds came from the speaker, and the picture appeared.

Speaking of assumptions, did you know that the "A" modification of a popular op-amp IC has different pin connections for offset adjustment than the original version did? If you assume the pin connections are the same (who wouldn't) and replace the original with an "A" version, the circuit won't work.

Today, the most dangerous assumption is that the equipment is properly wired with the correct components in the right places. Be especially wary of one-of-a-kind industrial equipment, kits, and low-priced consumer gear.

I remember the fun of debugging a kit-type amplifier, built by a color-blind technician. He had interchanged only four resistors. But, what output tube works well with 2200-ohm grid resistors, instead of the specified 2.2-megohm value?

Then, the VOR Omnirange system had performed very poorly for six months, before I discovered that the complex antenna had been wrongly color-coded at the factory.

If you have troubles in one part of the set, make certain the rest of the set is working properly before proceeding. *Consider the sync problems you can get from power-supply hum or low B+.*

Even if the secondary problems aren't causing your primary symptoms, it's a lot easier to work on gear after you're confident everything else is working the way it should. (Sync problems are easier to troubleshoot after you've replaced that worn-out picture tube.)

Years ago, I knew a fellow who fixed TV sets by replacing *all* tubes. If that didn't repair it, he replaced *all* the capacitors; if that didn't fix it, he replaced *all* resistors. If you think that's funny, you should have been there when he cut out about 20 capacitors, without marking where they came from!

Of course, if you have localized a problem to a specific circuit (such as the focus section of a color TV), it could be cheaper and quicker to substitute three or four dollars worth of parts, rather than spending an hour or two trying to discover *which* part is defective.

What now? The nitty gritty of troubleshooting comes when *you seem to have done everything possible, and you've run out of ideas.* Inertia at this point can be deadly.

Try Something Different

Do something! Anything! Make more measurements. Do a few substitutions; try your intuition. Use different test equipment. Make a list of all possible causes of the trouble that you can think of, *including those you've already checked out.* Compare voltages, resistances, or waveforms with those of a similar and known-good unit. Or, compare with the other channel, if you're wroking on a stereo amplifier.

I suppose you expect me to sum up all this advice, but I'm not going to. Get us some more coffee and I'll tell you about the transceiver power transformer we had to melt out with a blow torch. □

Eliminating Radio Noise in Diesel Trucks

By Forest Belt, CET

Although Diesel engines have no ignition systems to make spark noises, many other devices in a truck can drown out weak radio signals.

When radio communication signals are strong, the electrical noises generated by diesel trucks don't cause any problems. However, over-the-road trucks never stay long at any one place, and the signal quality varies greatly. Around a terminal city, dispatchers try to keep in touch through business or transportation radio. On the highway it is imperative for the drivers to maintain clear Citizen's Band (CB) communications. Many of these temporary locations only permit the reception of very weak vehicle noise to be eliminated. So, you have a compelling reason for reducing the truck-created electrical noises.

Gasoline versus diesel

Gasoline engines radiate more noise than do the diesels. Their ignition systems are powerful spark-gap transmitters. Even with interference filters and suppression devices installed on the ignition system impulse noise persists to a

large degree. That's why two-way radios have noise-limiting circuits.

Most highway tractors—those mammoth semi-trailer rigs—are powered by diesel engines. Ignition of the fuel occurs because of supercompression, rather than because of a spark in the cylinders. So, no high-energy spark-gap noise pulses are there to cause popping noises in the communications radio. This absence of spark wipes out about half of the noise problems, and simplifies your interference suppression.

Other Sources of Noise

Don't let the lack of arcing ignition noises lull you into ignoring other sources of radio noise. Any big truck still has many of them. For the best communications, you must take effective steps to combat those problems.

Generators And Regulators

Highest on the list of noise troublemakers in diesel rigs is the generator, or the alternator. Although both do essentially the same job, they are quite different.

Older vehicles came equipped with DC generators and regulators; and the segmented commutators of the generators are a prime source of quick brush wear and the resulting sparking.

Periodic dressing (smoothing) of the commutator, and replacement of the brushes, are essential for keeping generators electrically quiet. Capacitors added across the DC-voltage output often help by reducing the sparking, and by preventing the noise from radiating through the wiring.

Alternators

Alternators also generate DC power, but do so in two separate steps. AC power is produced, and then is rectified by diodes mounted inside the alternator.

The alternator rotor has slip-rings, with brushes contacting the rings, to transfer the alternating voltage to the diodes. Slip-rings are smooth—not segmented, as in generators—but sparking (and noise) can develop when the brushes are severely worn, or after the rings are

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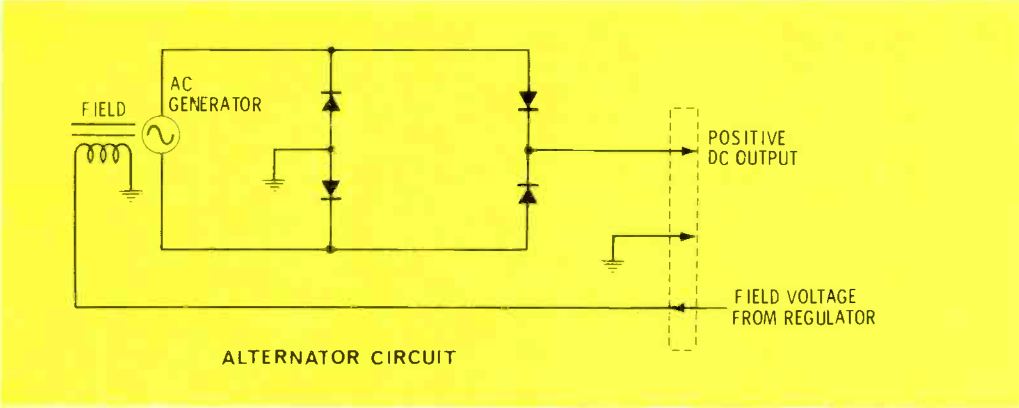

Figure 1 Alternators produce AC voltage, which is rectified by diodes. Noise sources include the slip-rings and brushes that feed power to the diodes, and the diodes themselves. Not all have the negative side grounded.

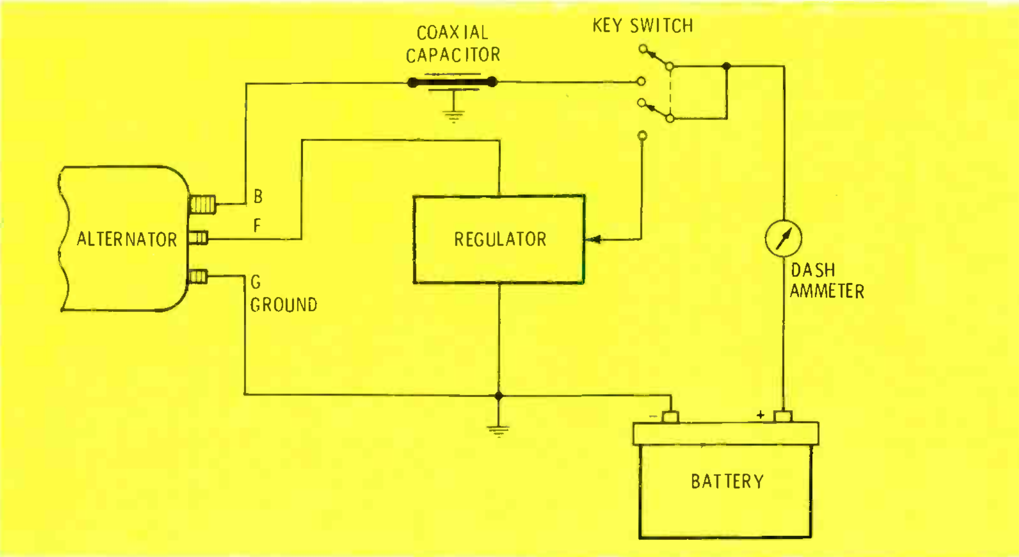

Figure 2 This block diagram of alternator wiring shows where the coaxial capacitor should be inserted, for best noise reduction. It should be mounted very near the DC-output post.

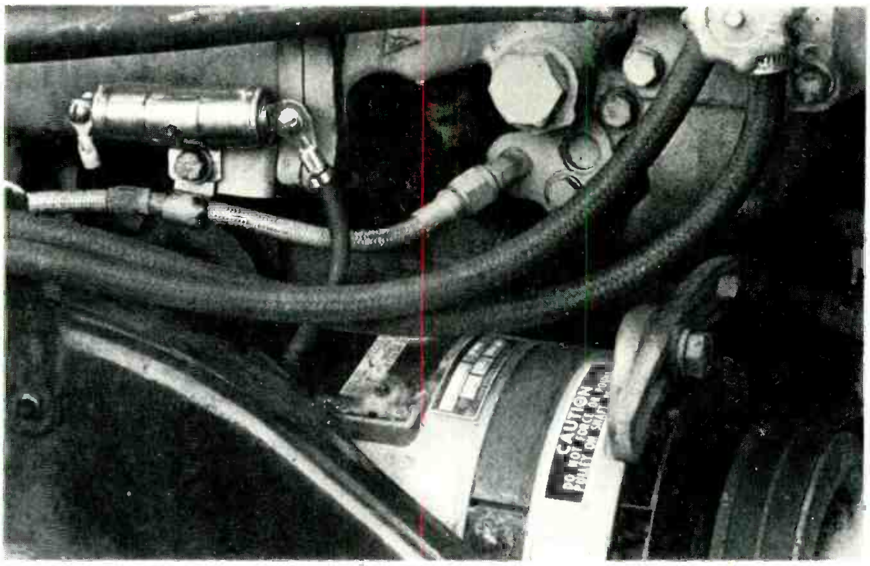

Figure 3 Mounting the coaxial capacitor on the engine block is not best, because of the extra heat there. On the other hand, you should mount the capacitor as close to the alternator as possible. Ideally, the capacitor should be mounted on the alternator or its bracket.

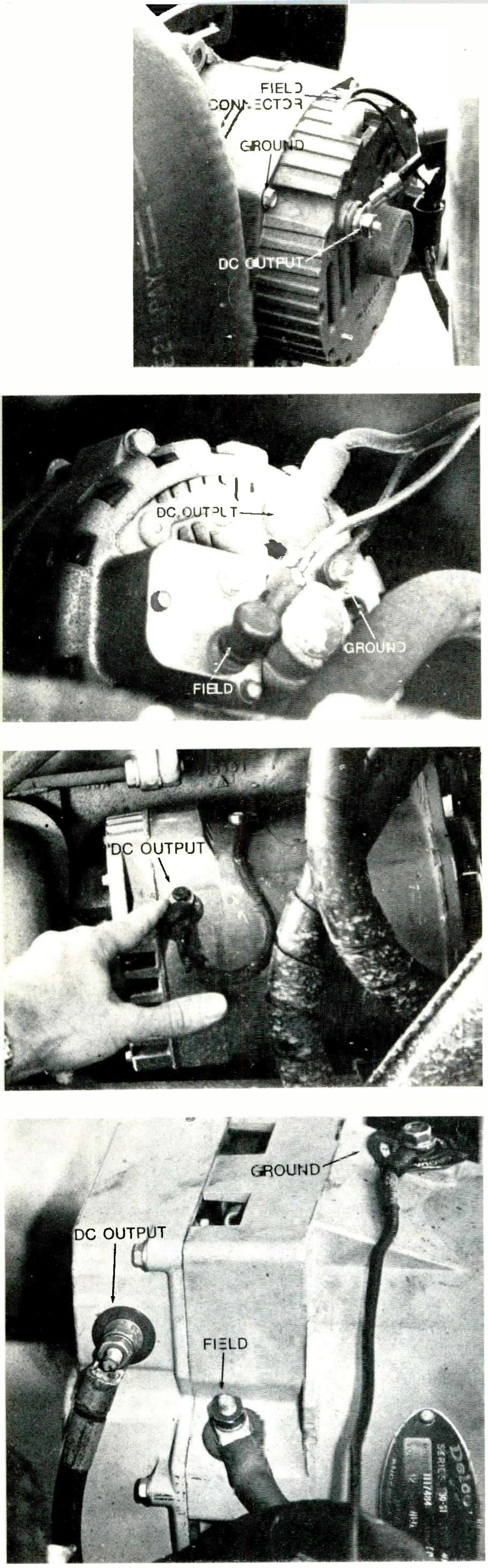

Figure 4 Here are examples of different alternators, showing the terminal posts and the ground. NEVER connect a capacitor to a field wire or post. Connect it only to the DC-output post.

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pitted or worn. The condition is regenerative, with more sparking causing more pitting, and worse pitting causing increased sparking. Therefore, prompt repair could save the truck owner money, and reduce the radio noise at the same time. The cure is a polishing and smoothing of the slip-rings, and a replacement of the brushes. Of course, that's a job for a truck mechanic, but you should suggest that it be done anytime the alternator noise is worse than average.

Truth is, however, that few cases of noise interference from alternators originate at the slip-rings. It's good to have an alternator checked whenever noise is severe, but that's not the best place to begin.

Rectifier diodes account for most RF noise that comes from an alternator charging system. How? Take a look at the alternator diagram of Figure 1.

Alternating current generated by the armature rotating in the magnetic field is rectified by the diodes. But diodes normally are not analog devices. As the voltage applied to a diode rises to the conduction voltage, the diode current begins abruptly. This rapid switching creates an RF pulse that is radiated. Although these pulses are weak, they can be picked up by a sensitive communications receiver.

Frequency of the AC inside the alternator varies with the engine speed. So, the switching of the diodes also varies in step with the changes of engine speed. That's why you hear alternator noise as a "whine" that changes pitch as you race the engine. The RF radiation appears to be modulated by the alternator diode switching frequency.

Curing Alternator Whine

Radiation noise from the alternator does not come directly from the diodes; they are inside the alternator housing, thus are shielded. Instead, the RF travels on the DC output wire. Even worse, the wire can act as a transmitting antenna. That tells you where the cure must begin. But first, you must learn how to reach the alternator.

Raising the cab

The engine components are not easily accessible, as they are in the family car. First, you either must raise the huge hood, or lift the entire cab. Unless you're familiar with the various hydraulic systems that raise cabs, let the driver or mechanic do it for you.

Gain access to the truck batteries. Usually, there are two or four. Take off the battery cables from all of them. There must be NO voltage at the alternator, when you start unfastening cables, and adding a capacitor.

Next, locate the alternator. It always is mounted at the front or rear of the engine, where it can be rotated by a pulley and belt. A few alternators are buried so deep that you can't reach them easily. For those, you must find and trace the DC output cable.

Best whine suppression is accomplished by installing a capacitor at the DC output terminal of the alternator. But don't settle for the ordinary kind of capacitor that truck dealers often install in parallel with hot wires. **Use only a coaxial type** (often called a "feed-through" capacitor). For truck systems, choose the 100-ampere size. The center wire of the capacitor must carry the full charging current. Figure 2 shows the wiring diagram.

A coaxial capacitor installed near the alternator in a Cummins truck engine is pictured in Figure 3. Install the capacitor right at the DC output terminal, or as near as possible, where it can be grounded properly.

Which is the output?

Learn to identify the DC output post of an alternator; it always is the *larger* terminal post. The smaller post feeds the alternator field, **and it absolutely *MUST NOT* have a capacitor wired to it** (the voltage here often is not pure DC, and a capacitor might ruin the regulation operation).

Figure 4 shows several kinds of truck alternators, with the DC posts pointed out by arrows. We must repeat: do NOT make a mistake by connecting a capacitor to the field post; else you will cause expensive damage.

Check with a voltmeter for

voltage at the alternator DC post. There should be none. If there is, you have not removed all of the battery connections. The alternator can be ruined, if a hot wire touches the wrong places. Also, you might ruin a regulator or battery. Pull off the cables from BOTH posts of *all* batteries.

Grounding

One important factor for reducing the alternator whine is installing the coaxial capacitor at a good ground. The engine block is okay, but that's not the best place. Engine heat can damage a capacitor within a few months. Ordinarily, the handiest mounting is a frame bolt on the alternator housing. Also, consider the bolt that holds the alternator to its hanger bracket.

Mounting the capacitor

Figure 5 illustrates the procedure for mounting the capacitor. A jumper cable comes packaged with the capacitor. For the demonstration, I have selected a Sprague 0.1 or 0.5 microfarad coaxial capacitor, having a 100-ampere current feedthrough rating.

Remove the DC output cable from the alternator post, and install one end of the jumper cable in its place. If the alternator DC post is too large for the lug, use a round file or a tapered reamer to enlarge the hole in the lug of the jumper wire. (You might also have to enlarge the capacitor mounting-flange hole, to make it fit under the grounding bolt.)

The lug at the other end of the jumper cable fastens to either end of the capacitor. Then, you fasten the DC-output wire—which came from the alternator post—to the other end of the capacitor.

The feed-through wire inside the capacitor carries the current through from the alternator to the output cable, while the bypassing capacitance is between the feed-through and ground. This filtering arrangement is far more effective for eliminating RF and whine from the DC cable than is an ordinary bypass capacitor connected between the DC post and ground.

Sometimes your work is easier if you mount the capacitor first, and than connect the wires. Other trucks allow you to save time by doing the wiring before you locate the capacitor under its mounting bolt. In either case, don't tighten the bolts until all connections and the mounting are completed. This helps to prevent undue strain on the capacitor and the alternator post.

Notice the field connection in Figure 5; it's a plug-in connector. Some alternator designs use this method of preventing wrong connections (such as capacitors) to the alternator field winding. Never connect *anything* to the field wire or post.

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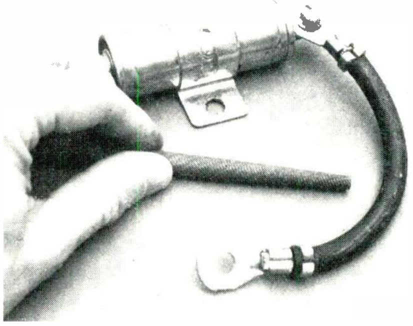

Figure 5 A round file or tapered reamer should be used to enlarge the mounting hole or terminal hole, as needed.

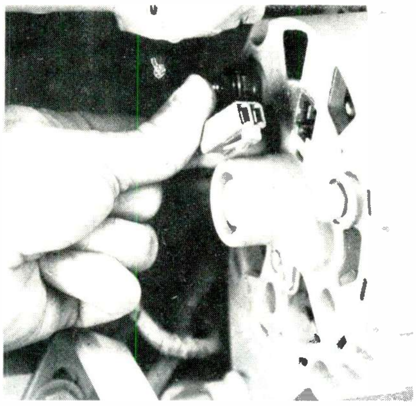

Figure 5B This field wire has a plug-in connector, which prevents you from accidentally connecting any components (such as a capacitor) that could cause damage.

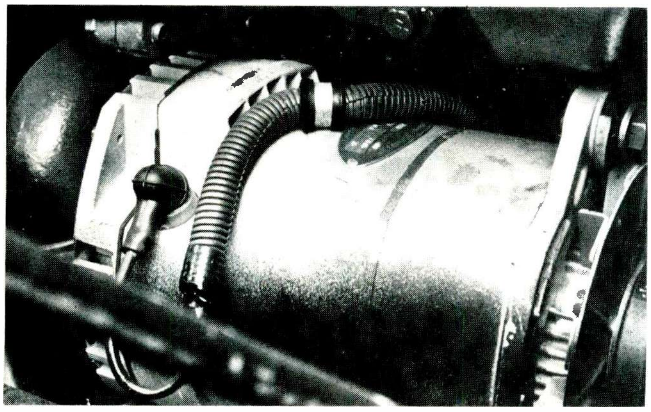

Figure 6 Newer alternators have built-in electronic regulation circuits, so no field wire or post is needed.

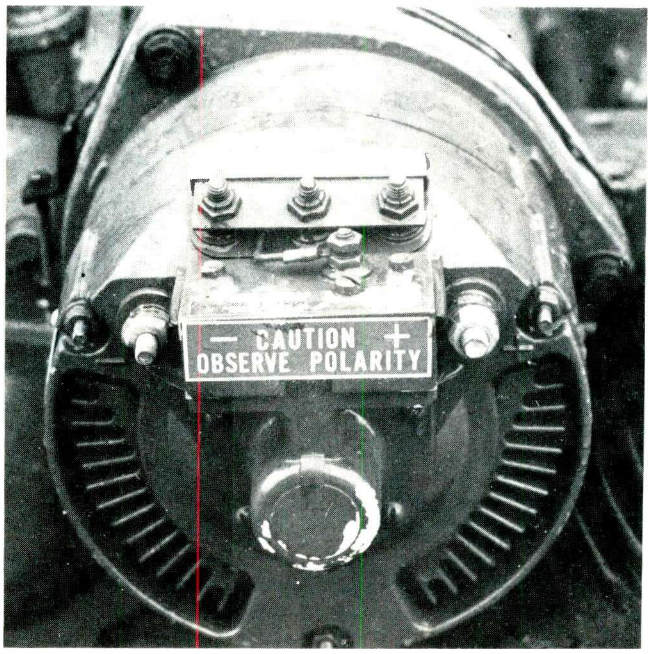

Figure 6B (at right) Some alternators can be strapped for either negative or positive ground. Usually, you should add a coaxial capacitor only to the ungrounded or hot wire.

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Watch For Variations

You'll find any number of wiring arrangements in modern diesel trucks. Some recent alternators have the electronic voltage regulator installed inside the alternator case, with the diodes. With those models, you will not find an external field connection (Figure 6). All that's seen on this unit is a single heavy DC output cable at one terminal post.

The other alternator of Figure 6B can be connected for either negative or positive ground. Negative ground is used in most trucks, but some have positive ground. The electronic regulator is on top of the alternator. You can reach the field post, but don't connect anything to it. If both cables connecting to the positive/negative alternator are long, insert a coaxial capacitor in series with *both* cables. But, when the ground cable is short, don't bother with bypassing it.

These steps solve most cases of alternator whine for any kind of radio. However,some older trucks—where the regulator is located at some distance from the alternator—can develop some noise that is radiated by the field wire. Remember, you absolutely *should not* bypass the field wire, even if it does radiate RF noise. In such cases, you can replace the field wire with a coaxial cable.

Installing the coax

When you replace a field wire with coax, disconnect the field wire at both ends. The center conductor of the coax will take its place. Strip back the coaxial shield at both ends sufficiently to allow it to reach a grounding point. Install crimped lugs (Figure 7) on both the center wire and the shield. Connect the coaxial center wire in place of the original field wire from regulator to alternator. Finally, ground the shielding at both ends. If it's not possible to ground the shield at both ends, then ground the alternator end.

This technique can eliminate most noise interference originating in the regulator, without damaging the alternator or the regulator. If you have done all of these steps, but the whine still is audible, call in a mechanic for repairs to the alternator.

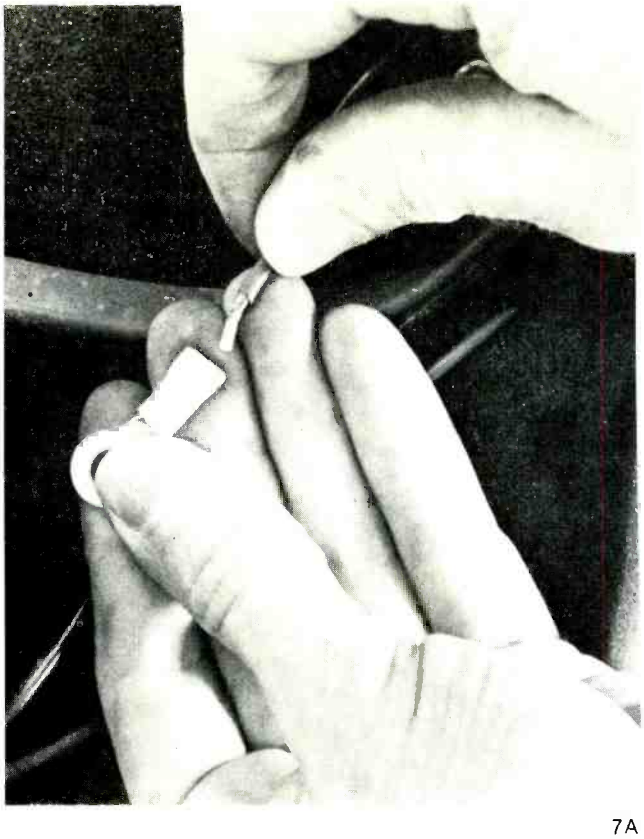
Air Conditioners And Blowers

Other appliances can generate noise that's just as bothersome during radio reception as alternator whine. Air conditioner and heater blowers probably rate second in order of aggravation.

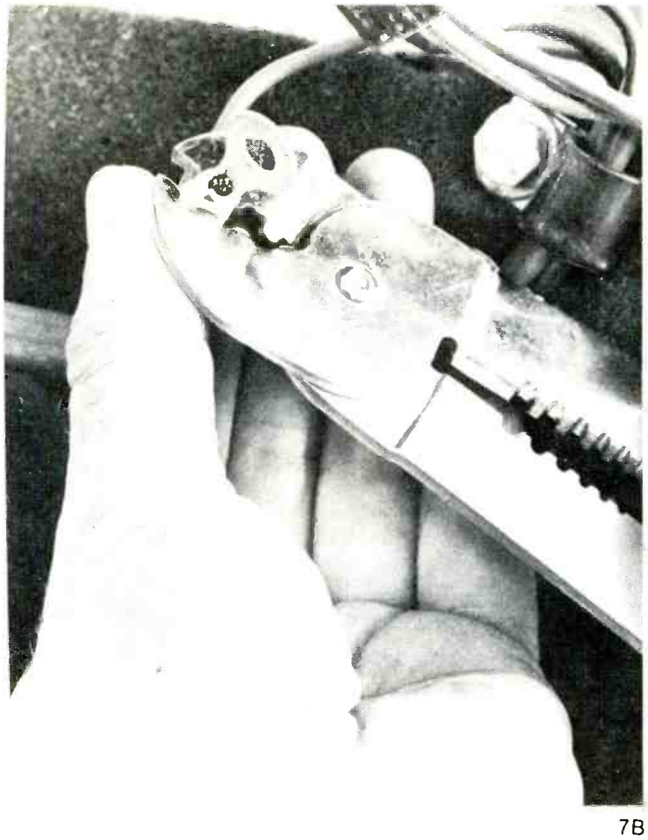
Some blowers create noise during high-speed operation, but not at slower speeds. Therefore, try all speeds, while you listen to a channel that has a weak signal or no signal.

Curing blower noises requires coaxial capacitors, too, although the current rating can be much lower. A 20-ampere size is adequate. If only one speed makes RF noise, the blower motor might have several windings. For the best cure, bypass both hot wires that feed voltage to the motor.

For best results, you should mount the capacitors as near the motor as possible. This could be a



7A



7B

Figure 7 (A) Crimp lugs onto the ends of all wires (don't merely tin the lead and wrap it around a terminal). Strip ¼-inch of insulation, tin the strands, and insert into the lug barrel, before crimping. (B) Avoid loose connections by using a crimping tool (which also can strip the wires).

big job, requiring you to drop the whole air conditioner down to where the blower motor is accessible. Also, some conditioners have two motors; if so, noise-proof both.

Mount the coaxial capacitor first, at a good grounding point (but near the motor). You'll probably have to cut the hot wire in order to insert the capacitor. Do this after the capacitor is mounted.

Make the installation in workmanlike fashion, using lugs on the free ends of the cut wire (see Figure 7). Use the special cutting/crimping tool to prevent problems later.

Here's another little installation hint. If the hole in the capacitor mounting flange is too small to accept the bolt you want to ground it under, use diagonal cutters to snip out a V-shaped notch (Figure 8) that will fit under the bolt.

Make sure the mounting bolt is *very* tight. If you can push the capacitor back and forth by hand—and it loosens the bolt, or the bracket slides out from under the bolt—it's too loose. A week of truck vibration will loosen it, also. *Solid* and *tight* are the watchwords. The same applies to the capacitor lug connections. Tighten them enough that you can't pull them loose by hand.

One last pointer about air conditioners. An electric solenoid operates a clutch that drives the compressor from the fan-belt pulley. Sometimes noise originates in the solenoid. It can be suppressed by identifying the wire coming from the front of the compressor, and installing a coaxial bypass capacitor near the clutch solenoid.

Defogger fans

Noisy defogger fans require bypassing, when the noise can be heard in the radio. The method is similar to that for blower motors. Of course, few are noisy, so don't bother to bypass any that are quiet.

Other Noise Sources

In theory, any electrically-operated device in or on a truck can cause noise interference to the reception of weak radio signals. Almost always, **the solution is to bypass the power wire near the device that generates the noise. Where long wires are involved, coaxial capacitors are more effective** than are the bypass types.

Not all noises are easy to identify, and those require tests and some diagnosis. For example, a certain noise begins as soon as you turn on the main switch, in preparation for starting the engine. That's sure to be caused by the electrical fuel pump. Figure 9A shows a fuel pump with a 0.005 microfarad disc capacitor paralleled across the drive motor.

Fuel gauges can create clicking or rasping sounds (but of course, only when they have power). If the gauges can be switched between fuel tanks, try both to identify which one needs bypassing.

Other electric devices operate only when the engine is running. Some examples are: oil-pressure sender; water or manifold temperature sensors; or overheat shutdown devices. Some of these have more than one hot wire. Use your voltmeter to find out which wires have voltage. Disc capacitors are effective for these devices. Use 0.005

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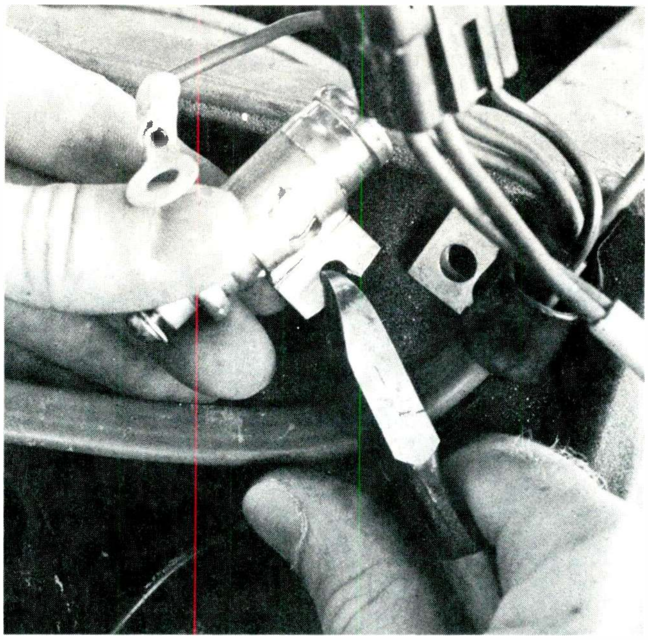
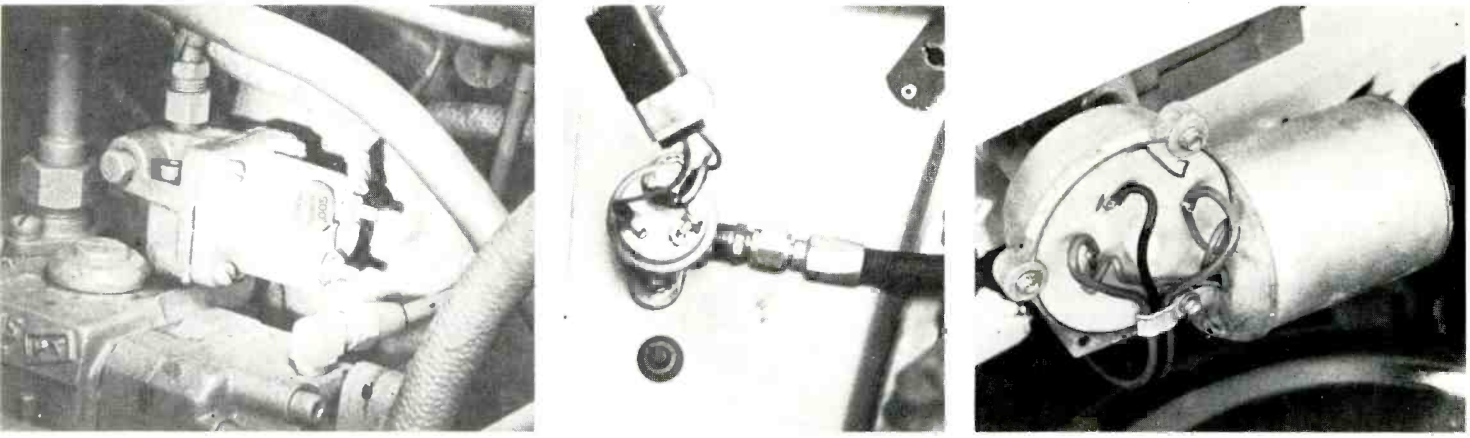
8A



8B

Figure 8 (A) A typical coaxial capacitor (20-ampere rating) is shown before it's mounted and wired. (B) If the mounting bolt is larger than the hole in the capacitor, use diagonal cutting pliers to make a V-shaped hole for mounting. Tighten the mounting bolt with the correct-sized wrench (not pliers).



9A 9B 9C

Figure 9 Disc capacitors are effective for reducing the noise from: (A) electric fuel pumps; (B) oil-pressure warning switches; and (C) windshield-wiper motors.

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microfarad or larger sizes. Buy types that are not affected by temperature extremes (such as Sprague CBK-7 types).

Windshield wipers are easy to spot as noise sources. Just turn them on, and with a weak radio signal, listen for a back-and-forth grinding noise from the motor. Check both speeds. As you can see in Figure 9, there are three wires (one for fast, one for slow speed, and one for a ground). Use your voltmeter to identify them.

Usually disc capacitors from hot wire to ground (on either or both hot wires) will stop the noise. For worse cases, you'll have to install a 0.1 microfarad coaxial capacitor in whichever lead (or both) carries the RF radiation.

Comments

These suggestions should lead you to the proper means of identifying and suppressing almost any electrical noise developed in a diesel truck.

Careful questioning of the driver often can bring you valuable clues. After you've figured out the source of the noise, one of the bypassing techniques described here will minimize the noise. You might not be able to filter out every tiny pop or scrape, but you *can* extend the range of communications. And your trucker customer definitely will approve. □

book review

Electric Guitar Amplifier Handbook (Fourth Edition)
Author: Jack Darr
Publisher: Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Indiana 46268.
Size: 384 pages, 11" x 8 5/8"
Price: $9.95 paperback

Procedures for servicing and troubleshooting both tube and transistor electric guitar amplifiers are discussed. The *Handbook*, divided into three sections, gives the basic "typical circuits" used in all amplifiers. Section One, "How Guitar Amplifiers Work," covers signal amplification, special signal circuits, and the power supply. Section Two, "Service Procedures and Techniques," deals with amplifier signal circuits, power-supply circuits, transformers and speakers, cables and pickups, and customer complaints. The final section, "Commercial Instrument Amplifiers," shows schematics for both small amplifiers and the "big boomers." The book also includes safety precautions, special servicing techniques, and data on how to choose replacement transistors. All test and servicing methods are said to be "bench-tested" on commercial amplifiers, and the power-output tests are taken from factory service data.

Workshop in Solid State (Second Edition)
Author: Harold Ennes
Publisher: Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Indiana 46268
Size: 382 pages, 8 1/2" x 5 1/2"
Price: $7.95 paperback

The technician's transistion from electron tubes to solid-state devices is treated in this book. Both approach and content reflect the author's background in broadcast electronics—with many broadcast-oriented circuits—but the basic principles apply to other areas of electronics. The text assumes previous training in electronics, and has some advanced information, falling between the simplified serviceman approach and the sophisticated mathematical and equivalent-circuit approach. When covering the principles of solid-state devices, the author discusses circuits for both linear and pulse applications, introduces logic-circuit fundamentals, and gives practical information on testing and servicing. Practice questions follow most of the chapters, and the answers are given in an appendix.

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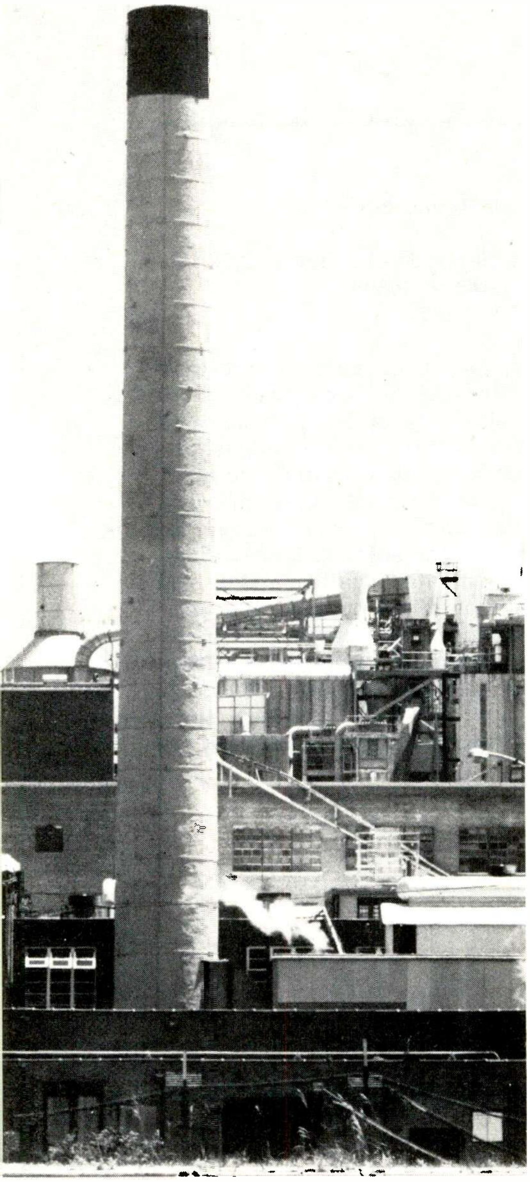

The Basics of Industrial Electronics, Part 6

By J. A. "Sam" Wilson, CET

This article completes our analysis of basic transducers. Also included is information about varactor diodes and ferrite beads [that are used often in TV receivers]. The coverage of digital-logic circuits begins next month.

Inductive Heating

As shown in Figure 1, a metal ring is placed in the field of an inductance, which has an appropriate amount of AC power applied to it. The ring acts somewhat similar to a one-turn short in the inductance winding, and a small voltage at very large current is formed in the ring. Heat in the metal ring is produced by the electron current flowing through the metal.

Inductive heating is used for welding pipes and other metallic components during fabrication.

Varactor Diodes—Simulated Capacitors

A diode can act as a variable capacitor when the reverse bias across it is varied. A junction diode made with N-type and P-type semiconductor materials is believed to have a **depletion region** near the junction, where there are few charge carriers. In other words, the depletion region acts as an insulator.

The P-type and N-type materials that are outside of the depletion region have normal concentrations of holes and electrons, so they can conduct when a voltage is present.

Therefore, the junction diode might be considered two conductors separated by an insulator. Of course, that is the definition of a **capacitor**, and these diodes exhibit some capacitance characteristics.

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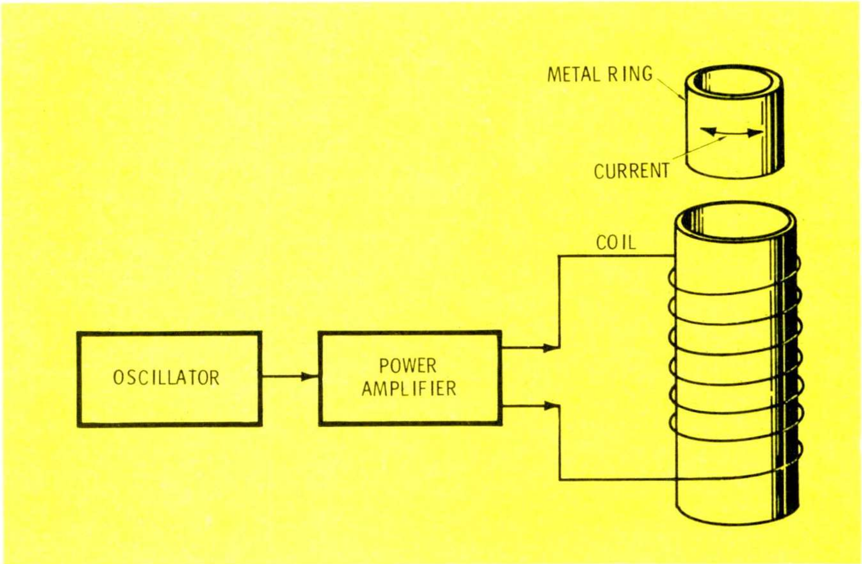

Figure 1 AC current in a metal ring placed in the field of an inductor produces heat. The RF frequency and the amount of power applied to the coil determines how hot the ring becomes. •

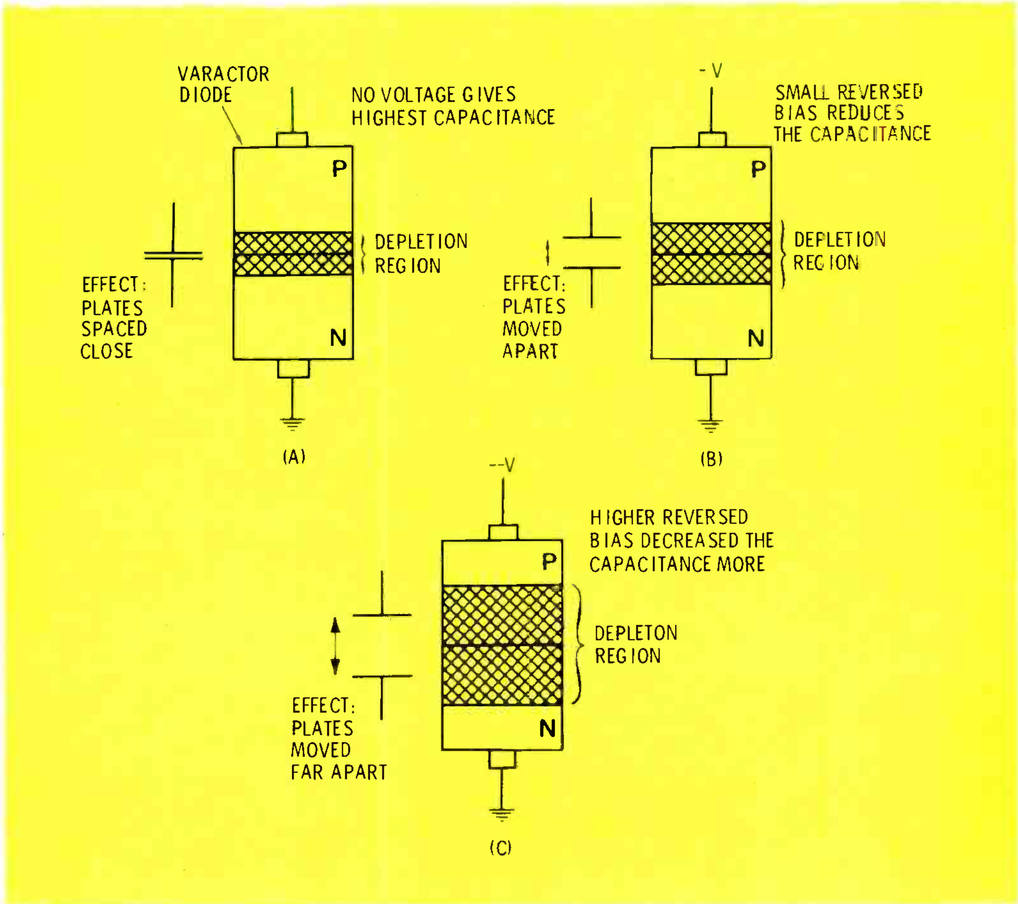

Figure 2 Reverse bias applied to a junction diode changes the size of the depletion region, giving the effect of moving the plates of a capacitor to produce a varying capacitance.

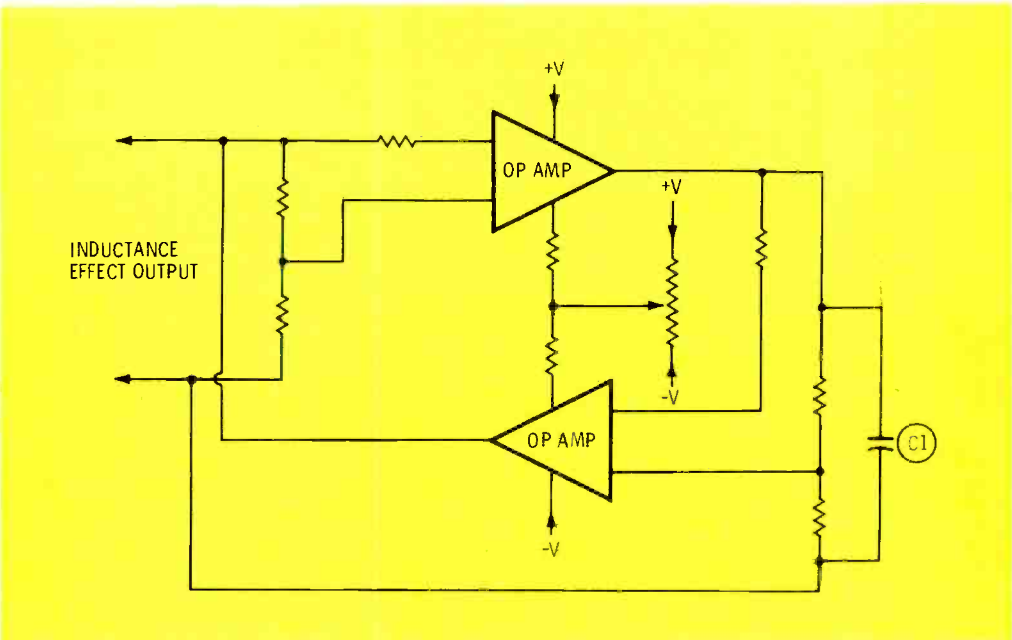

Figure 3 An inductance effect can be obtained by this circuit that uses op-amps. The advantage over discrete coils is that such **gyrator** circuits can be made small enough to be included inside ICs.

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Without any voltage applied to the diode, the depletion zone is thinnest, and the capacitance is largest, because the "capacitor" plates are near each other. (Figure 2A).

A moderate amount of reversed bias (Figure 2B) widens the depletion region, gives the effect of a wider separation of the plates, and lowers the capacitance. A higher reversed bias increases the action, and the measured capacitance is reduced even more (Figure 2C).

Gyrators—Simulated Inductors

Inductors often are large and bulky when compared to capacitors and other components in semiconductor circuits. They are not suited for use inside Integrated Circuits (ICs). If they must be used with an IC, the inductor is mounted externally.

This problem of physical size can be solved by a **gyrator,** because gyrators can be included inside of ICs. The one in Figure 3 is made with RCA CA3060 op-amps, and the RCA manual about linear ICs states that inductance values in excess of 3,000 henries have been achieved. One drawback preventing its use above the audio range is the amount of phase shift introduced by the op-amps.

Ferrite Beads—Simulated Inductors?

Ferrite beads are small rings made of powdered iron that are usually placed over a wire (see Figure 4). The bead and wire combination acts as a small inductance. Little effect is noted from the beads except above about 50 MHz. Therefore, they are most useful when added to SCR or switching-transistor circuits, where they minimize the radiation of narrow transients (otherwise, the radiation might cause vertical lines on a TV picture, for example).

Why are the beads used instead of discrete RF chokes? It's because **beads add inductance without self-resonance.** In other words, an RF choke would function correctly to suppress the transient, but it might resonate with the stray capacitance of the circuit, producing a peak or valley in the response curve, which might cause ringing.

Active Transducers

Active transducers produce an output voltage that is proportional to the condition of the material being sensed.

There are six basic methods of generating a voltage. They are:

- **Frictional.** Voltage is generated by rubbing insulating materials together. Electrostatic generators produce high-voltage low-current power;
- **Chemical.** Voltage is produced when two dissimilar metals are

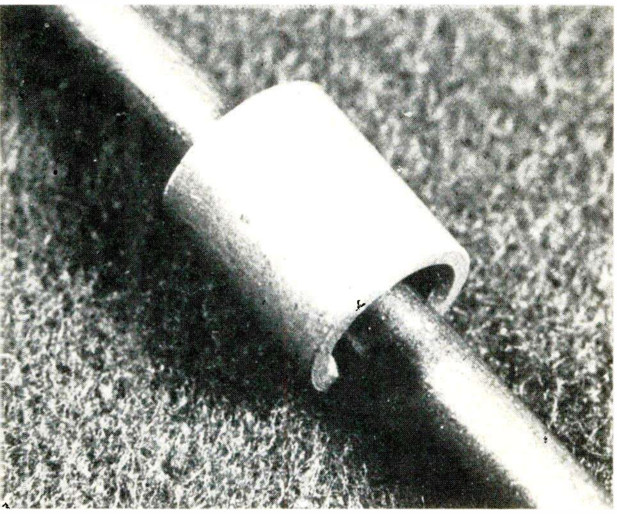

Figure 4 When placed around wire conductor, ferrite beads act as a small inductance. The advantage over coils is that the wire and bead do not have any self-resonance.

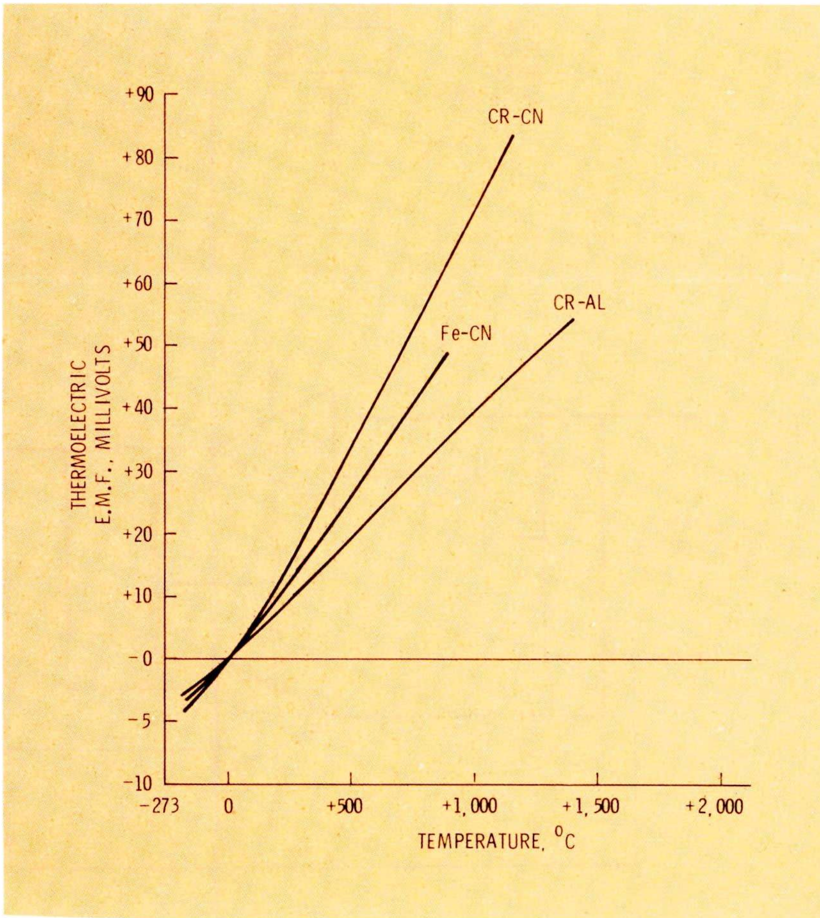

Figure 5 These curves show the amount of millivolts produced by each junction of CR-CN, FE-CN, or CR-AL metals in a thermocouple.

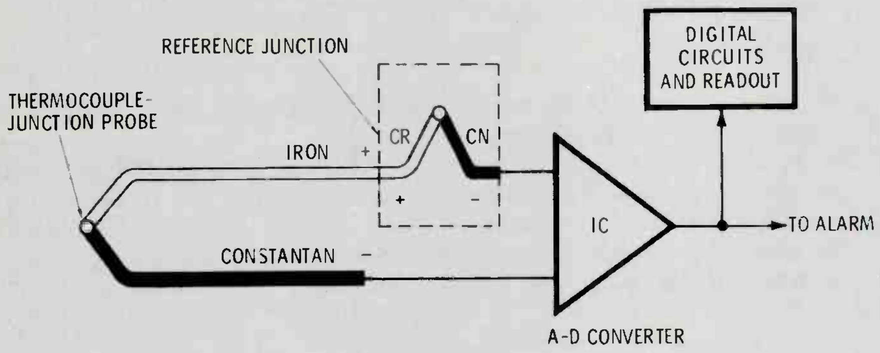

Figure 6 Accurate temperature measurements by a thermocouple device requires a reference junction, operated at the ambient temperature, that opposes the voltage from the measuring junction. The output can be increased by using multiple junctions. An analog meter can be used to read the output voltage, or (as shown) a digital circuit can activate an alarm and show the temperature on a decimal readout.

immersed in an acid or alkali solution;

- **Thermal.** When the junction of two dissimilar metals is heated, voltage is generated. Such junctions are called **thermocouples**;
- **Optical.** Voltage is generated when photocells are exposed to light;
- **Pressure.** When pressure is exerted against certain crystalline materials, voltage is produced. This is known as the **piezoelectric** effect; and
- **Electromechanical.** Voltage can be generated by moving a conductor through a magnetic field (or vice versa).

Chemical transducers

Except for a few applications (such as monitoring the pH factor of a liquid), chemical transducers are not often used.

Thermocouples

The types of metals used and the temperature at the junction determines the amount of voltage generated by a thermocouple. Figure 5 shows curves for different combinations of metals.

In choosing the materials for a thermocouple, the cost and the range of voltages desired are two important factors.

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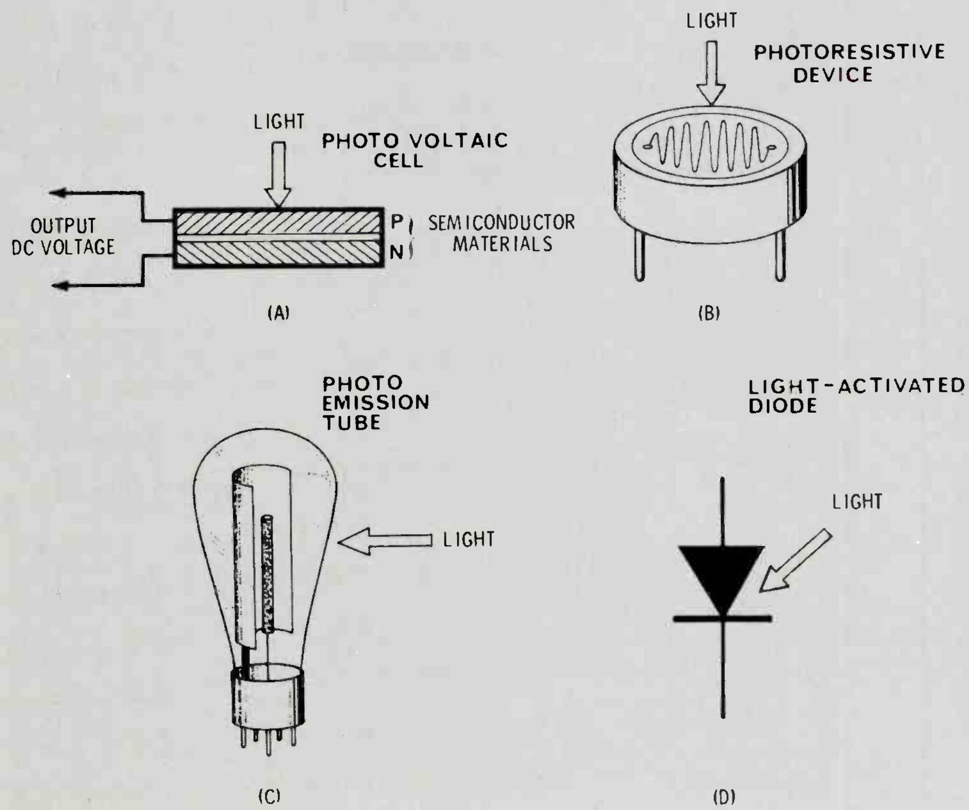

Figure 7 Here are four types of photosensitive devices. Only (A) is an active kind. (A) Semiconductor photovoltaic cells (photocells) emit a DC voltage when illuminated by light. (B) Photoresistive devices change resistance according to the intensity of light on them. Cadmium-sulfide cells are one common type. (C) In a photoemission tube the electron emission from the curved surface depends on the amount of light. (D) With light-activated diodes, the forward conduction varies according to the amount of light.

Industrial

continued from page 53

A thermocouple can be used to measure temperatures (Figure 6). For accurate readings, it is necessary for the thermocouple leads to be held at a constant temperature. The output voltage is dependent on the difference between the sensed temperature and the reference temperature.

The A/D (analog-to-digital) converter changes the thermocouple's DC output voltage to a digital signal that can be displayed on a 7-segment readout as a decimal

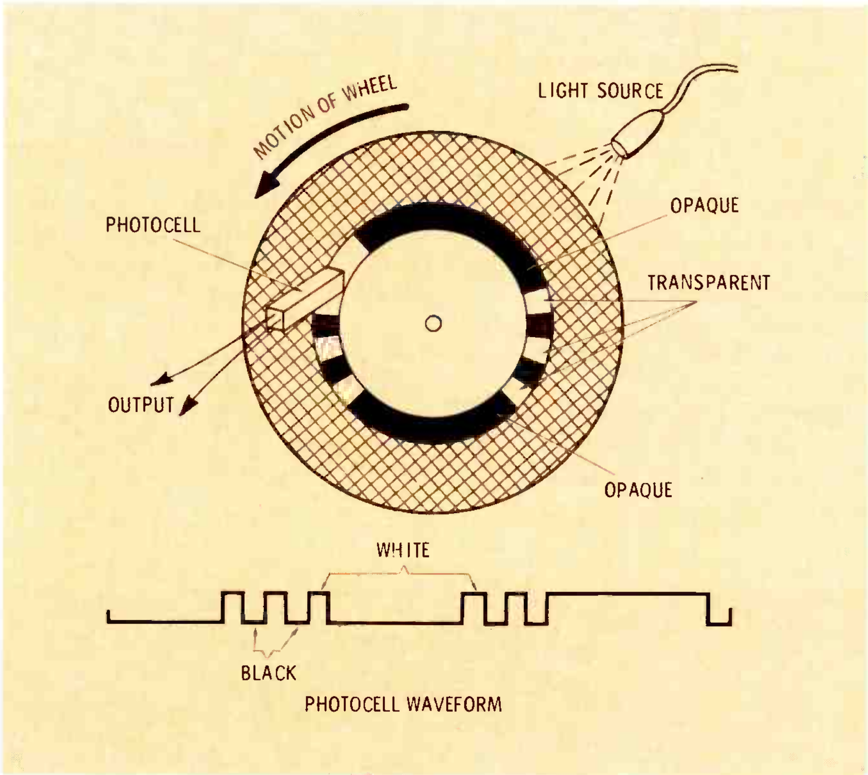

Figure 8 A rotating disc with transparent sections between a light source and the photocell can act as a digital encoder.

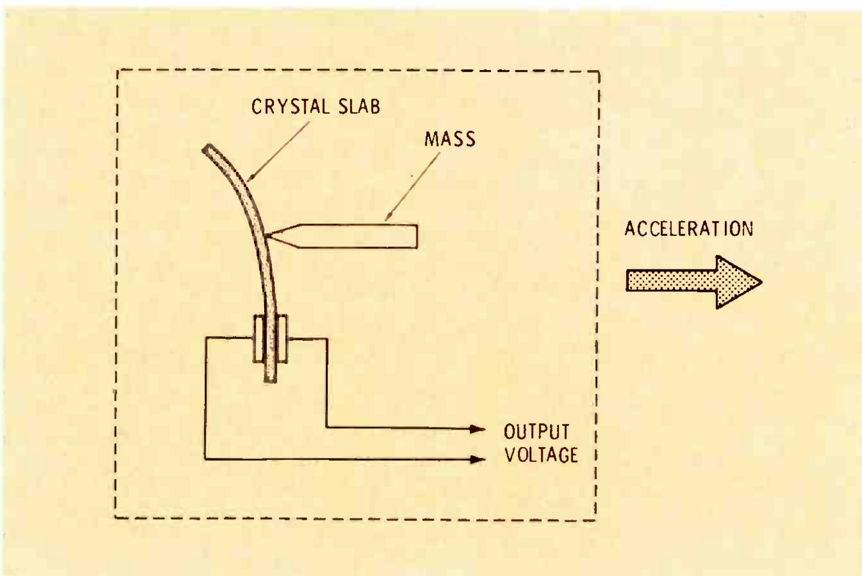

Figure 9 In an accelerometer, the signal from a crystal slab is in proportion to the amount of acceleration applied to the standard mass.

number. If the temperature becomes excessive, and exceeds a predetermined value, the voltage comparator section of the IC activates an alarm.

A/D converters and voltage comparators will be covered in a few months when we discuss digital circuits.

Phototransducers

Figure 7 illustrates some basic kinds of phototransducers, but *only* the photovoltaic cell (photocell) is an active transducer. The others are passive, and should *NOT* be referred to as photocells.

The simple **encoder** of Figure 8 uses a photocell. As the disc rotates, the photocell is alternately exposed to light and darkness. Waveform of the output voltage is determined by the pattern on the disc.

Piezoelectric transducers

A number of crystalline materials can generate a voltage when pressure is exerted against them. However, only a few are useful in transducers.

One problem with many of the materials is a low **Curie Point** (that is, the temperature where the piezoelectric effect ceases). Other materials have a melting point that's too low for practical use.

Insensitivity is another problem with some piezoelectric materials. This means that a large force is needed to obtain only a low voltage output.

Also, many piezoelectric materials are soluble in water, so even a small amount of moisture (such as high humidity) eventually can destroy them as a generator.

After eliminating the piezoelectric materials that are not suitable for transducers, the only types remaining are quartz, ceramic crystals, and some form of barium titanate.

Quartz is a rock-like crystal found in nature. Ceramic types are made from powdered materials that are pressed into the desired shape, and then fired at high temperatures. Barium titanate was the first man-made material to be used commercially as a transducer. The precise composition of piezoelectric materials usually is a secret that's closely guarded by the manufacturer.

Piezoelectric transducers often are used for measuring a change of force or pressure, rather than for measuring a steady load. One example is the **accelerometer** of Figure 9. When the device is accelerated, the movable mass presses against the slab of crystalline material. The voltage output comes from terminals attached to the crystal, and the voltage is proportional to the amount of acceleration.

Incidentally, don't use the terms *stress* and *strain* interchangeably if you use them to describe equipment such as an accelerometer. Stress is the amount of force exerted, and strain is the change of shape that results from the stress.

Electromechanical transducers

When there is a relative motion between a conductor and a magnetic field, a voltage is induced in the conductor. This is a statement of **Faraday's Law,** and it's the principle behind electromagnetic transducers.

Think of these transducers as generators of either AC or DC power. The frequency or DC output voltage is a direct function of the rate of the shaft rotation of the amount they are turned.

A **tachometer** is one good example of a electromechanical transducer. It's used to sense the speed of a motor. One method incorporating a closed loop is shown in Figure 10.

One important characteristic of a synchronous motor is that the speed varies precisely in step with the frequency of the supply voltage. That's why synch motors are used in electric clocks.

The output of the tachometer has a frequency determined by the speed of the motor. This signal is one input of a frequency comparator, while a reference frequency is the other input signal.

If the two input signals have exactly the same frequency, no correction voltage is developed.

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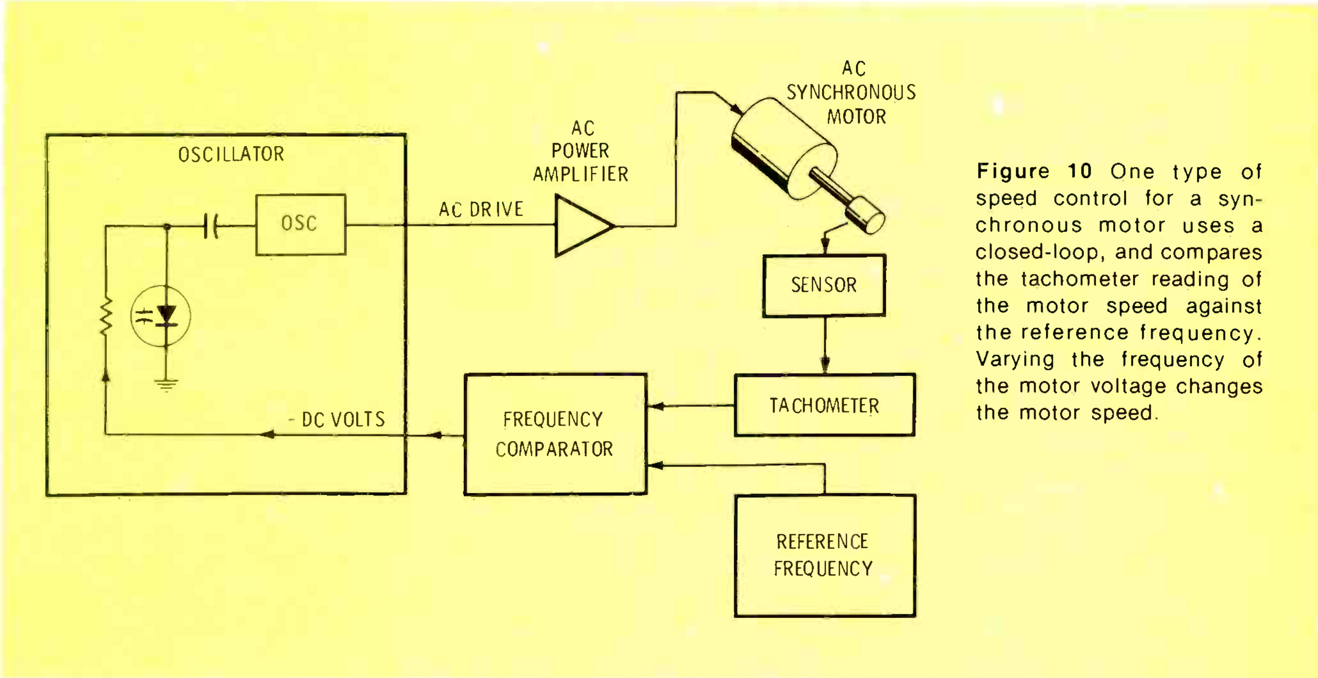

Figure 10 One type of speed control for a synchronous motor uses a closed-loop, and compares the tachometer reading of the motor speed against the reference frequency. Varying the frequency of the motor voltage changes the motor speed.

Industrial

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When the motor speed (and the tachometer frequency) is too fast or too slow, the frequency comparator produces a DC correction voltage that controls the amount of reverse bias at the varactor diode. This diode is part of the LC circuit that determines the oscillator frequency; therefore, the correction voltage changes the frequency, making the synchronous motor run faster or slower, as required, until the tachometer and the reference frequency are identical.

A similar closed-loop arrangement also can be used to control the speed of a DC motor (Figure 11). In this case, the output of the tachometer is a DC voltage that varies directly with the motor speed. The tachometer DC voltage and the reference DC voltage are examined by the comparator circuit. When the motor speed is incorrect, the comparator control voltage changes the DC voltage coming from the power supply. This voltage usually is applied to both the armature and the field of the motor; however, some types of DC motors are designed to be controlled by the armature voltage, while the field voltage remains constant.

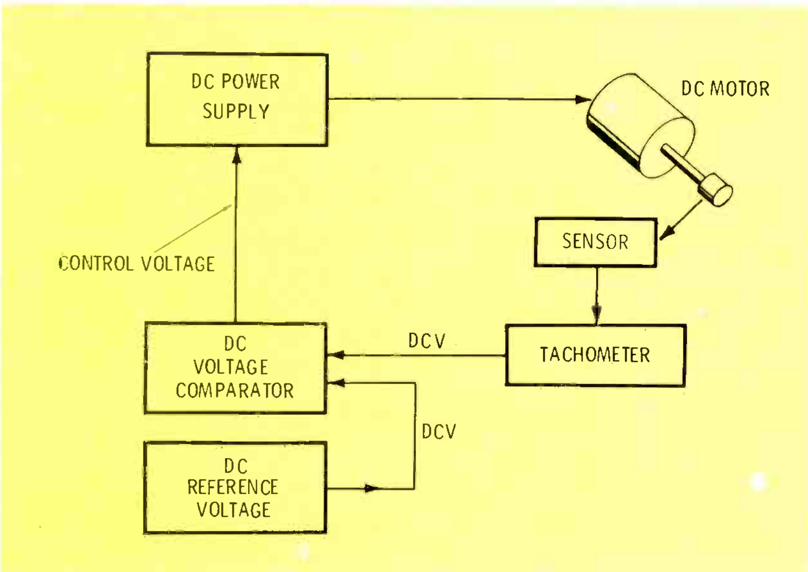

Figure 11 A speed control for a DC motor is similar to the one in Figure 10, except the reference and sensor signals are DC, the comparator works from those DC voltages, and the motor speed is changed by varying the applied DC voltage.

Next Month

Many industrial functions and processes must be monitored and controlled to keep them within the range of specifications. Corrections can't be made properly without a knowledge of the conditions at all times. That's the function of transducers, because they can sense speed, pressure, position, intensity of light, heat, color, and a variety of other characteristics.

If we compare a control system to a human, the transducers are the equivalent of eyes, ears,and fingers. A logic system is like the brain. Of course, this analogy is not perfect, because no logic system can reason. Instead, it reacts to simple programs that already are stored in the system.

Therefore, in the next issue, we will begin an in-depth study of logic circuitry. □

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, CET

Sencore Family Of Cricket Testers

One feature of all Sencore-series transistor testers is the audio tone that sounds during successful in-circuit and lead-identification tests. The audio sound probably suggested the name of Cricket; but, don't expect a Cricket to chirp one short sound and then stop. The audio tone is continuous until switched off.

Model TF26, the first Cricket, tested only the ability of a transistor to amplify a test signal, and it required AC power. It was followed by the Super Cricket TF30, also an AC model, which in addition to the basic good/bad Cricket test, checked gain and leakage out-of-circuit.

Now there are two new versions, both portable, with batteries or an AC adapter. Model TF40 Pocket Cricket gives a good/bad in-circuit test, along with identifications of polarity and leads. The latest one is

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Model TF46 Portable Super Cricket Transistor And FET Tester from Sencore operates from internal battery cells. A door slides over the meter face, to protect it during transportation. The test lead compartment, at the bottom, is closed for the picture.

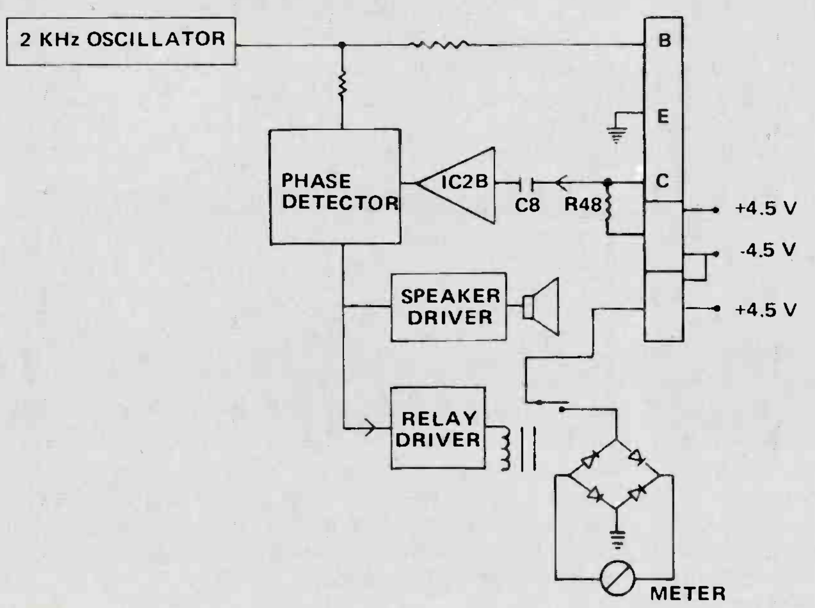


Figure 1 After the permutator switch has been set correctly, a 2-KHz square-wave signal is fed to the base of the transistor (that's being tested), and bias of the proper polarity is applied to the emitter. A sample of the base signal, and a sample of the inverted square waves from the collector, go to a logic phase detector. When both signals are present, the meter and the speaker tone are activated. (*Courtesy of Sencore*)

continued from page 57

model TF46, the Super Cricket, that's described here.

All Crickets operate on the premise that no other circuit component can produce a phase-inverted output signal. Therefore, square waves are applied to the base, and the collector signal is examined for out-of-phase square waves. If they are present in sufficient amplitude, the transistor *must* be amplifying; and the meter reading and Cricket tone from an internal speaker indicates a good transistor. (See Figure 1.)

Also, Crickets have switches for connecting all possible combinations of the three leads, in both polarities. These six combinations for each polarity allow the transistor to be connected to the Cricket test leads in any random order. Then, after the Cricket tone is obtained—by operation of the switches—the knob pointer and the color sequence of the panel marking opposite it identify which transistor elements are connected to the red, green, and yellow test leads. Thus, the leads are identified during the test.

Model TF46 Cricket

The full name of the TF46 (Portable Super Cricket Transistor & FET Tester) tells us that both bipolar and FET transistors can be tested. In smaller letters, it also says: "In-Circuit Cricket Tester & Out-Of-Circuit Parameter Tester." Therefore, you should perform first the Cricket in-circuit lead-identification and good/bad tests. Then, if the result is "bad," the transistor should be removed for accurate tests out-of-circuit.

This sequence is necessary and logical, because in-circuit tests *must* fail when the impedances are less than 50 ohms. In other cases, the collector-versus-emitter lead identification might be indecisive.

In-circuit tests offer convenience, while out-of-circuit tests provide accuracy.

One new feature is the **automatic power-shutoff** circuit that turns off the battery power after ten minutes of operation. This prevents ruining the batteries when you forget to turn off the machine. Of course, power can be restored for another 10 minutes by a couple of pushes on the on-off button.

Testing with the TF46

Here is the proper sequence of tests for bipolar transistors:

• Connect the EZ-Hook insulated clips of the TF46 cable to the transistor; it's not necessary to match colors and transistor leads;

• Depress *only* the PUSH ON-OFF switch (it should latch);

• Rotate the large "permutator" test knob (Figure 2) either CW or CCW;

• Stop rotating the knob when you find **two adjacent positions** that give a meter reading near the center of the green "good" meter area, plus a continuous tone from the internal speaker. (Normal bipolar transistors provide low gain

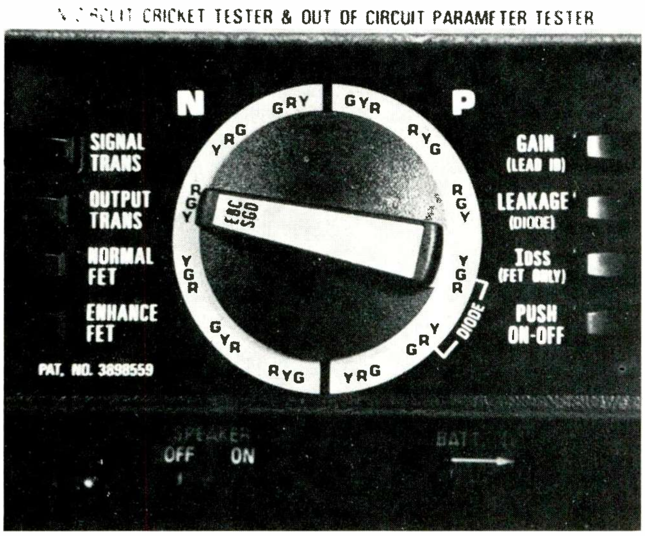


Figure 2 In the center is the permutator-switch pointer, which selects all combinations of leads and polarity. The eight pushbuttons at the sides select the conditions and functions. The gain, IDSS, and leakage buttons are the only ones that do not latch. The SPEAKER OFF/ON switch can be seen dimly at the left bottom; it is at the back of the storage compartment. The BATT TEST switch is shown at the right bottom corner.

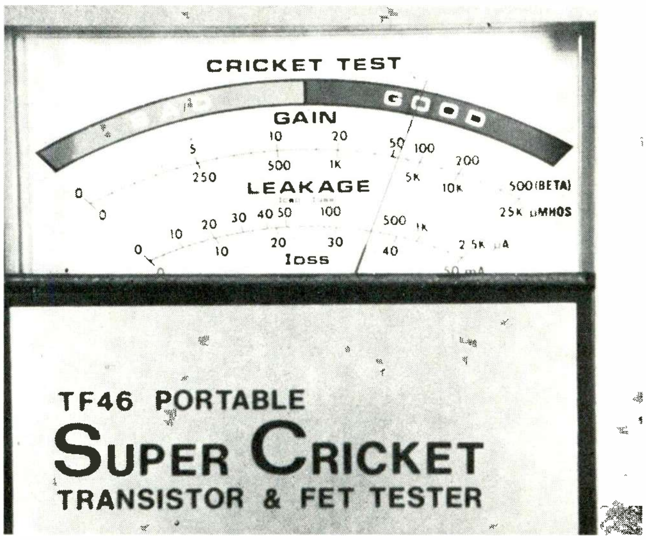


Figure 3 The five scales of the TF46 meter are, from top to bottom: good/bad Cricket and battery test; 0 to 500 beta for bipolar transistors; 0 to 25K microhms for FETs; 0 to 2,500 microamperes for transistor leakage; and 0 to 50 milliamperes for FET leakage.

when the collector and emitter are reversed, and the Cricket test is so sensitive that a gain of less than 2 will activate the "good" test;)

- The six switch positions at the left are for N (NPN) polarity transistors, and the six at the right are for P (PNP) polarity transistors. **Therefore, the polarity of the transistor has been determined;**
- Read the color code (of the transistor wires and hooks) at the end of the pointer, which has E, B, and C (for emitter, base, and collector). As shown in Figure 2, Y is next to E; so the yellow wire is connected to the emitter. G is next to B (the green wire is connected to the base), and R is by the C (the red wire is connected to the collector). Of course, the S, G, and D (for source, gate, and drain) for FETs are there, too. Therefore, **the position of the permutator switch indicates the elements of the transistor.** But, the collector and emitter might be interchanged, so another step is required to determine which is collector and which is emitter;
- Select SIGNAL TRANS, if the transistor is small; or push the OUTPUT TRANS button, if the transistor is a power type. (These buttons latch, and stay in position;)
- Press the GAIN button (and keep pressing it during the next test, for it does not latch); and
- Turn the permutator switch alternately to the two positions that gave the Cricket tone, noticing the gain reading on the meter. The position that shows the higher gain reading provides the correct transistor-connection color code.

Some circuit impedances are so low that both gain readings in-circuit are nearly unreadable. If there is no significant difference of the readings, the device might be an FET (see page 20 of the Sencore instruction booklet). **Or, it is a bipolar type which reads virtually no gain in-circuit.** In such cases, you must guess at the identity of collector and emitter; or you should remove the transistor for a more-accurate out-of-circuit gain test.

Leakage of a transistor *and* its circuit can be read by continuous pressing of the LEAKAGE button (none of the buttons on the right latch), while you rotate the permutator switch. The various tests are explained in the instruction booklet. **Leakage tests made when the transistor is out-of-circuit measure the leakage of the transistor only.** Similar tests are provided for FETs, and a separate scale is included on the meter face (Figure 3).

Meter Power

The TF46 operates from six size "AA" cells. Zinc-carbon or alkaline cells can be used alone. When an optional external PA202 AC adapter is added, it supplies the power, and the cells act as filters (don't use the adapter without any cells). If Ni-Cad cells are used, the adapter charges them. A switch at the bottom of the test-lead storage compartment allows the battery condition to be read on the good/bad meter scale.

Comments

Many transistors were checked with the Sencore TF46 Cricket, and not one false answer was obtained. The tester does not indicate whether a transistor is made of germanium or silicon; but that lack is typical of many testers. An ohmmeter test of one junction will show you which material is used in the transistor.

No Cricket response was obtained with a horizontal-output transistor, nor with a series-pass power supply regulator. Those transistors should be removed for out-of-circuit checks. I don't know of *any* tester that can check those transistors in-circuit.

A Cricket tone and meter reading were obtained for all of the small (signal) transistors in a modular color TV (see Figure 4). The high in-circuit leakages proved why most of them did not give usable gain readings. However, the gain of several emitter followers checked about right.

In summary, the Sencore model TF46 Super Cricket transistor tester was easy to operate, and no wrong diagnosis of good or bad transistors was made during our extensive tests. □

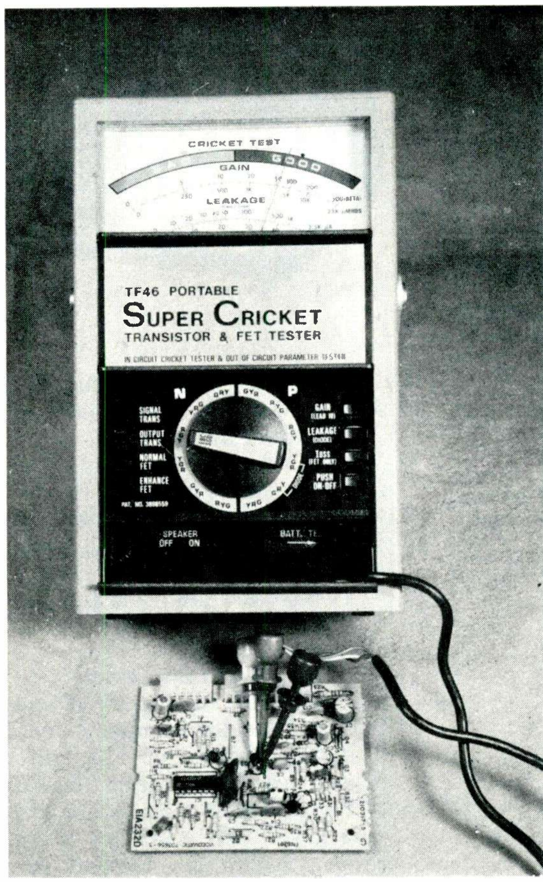


Figure 4 The Sencore TF46 Super Cricket is shown giving a "good" Cricket in-circuit reading of a transistor on a Magnavox module.

test equipment report

Frequency Counters

Two new frequency counters (YC-500S and YC-500E) are available from **Yaesu Electronics.**

Model "S" has an accuracy of 2 Part-Per-Million (PPM), and model "E" is rated at 0.02 PPM.

Both counters have a six-digit display, count from 10 Hz to 500 MHz in two ranges, and have a built-in power supply with provision for 12 VDC operation.

For More Details Circle (25) on Reply Card

Hi-Fi Generators

The RE101 RF signal generator, from the **London Company,** features a digital display of FM and AM carrier frequencies from 150 KHz to 30 MHz, and 86 MHz to 130 MHz in six ranges, plus a special 10.7 MHz range. Sweep is provided for all frequencies, with two sweep widths and a center-frequency marker.

FM and AM modulation can be supplied either from internal or external sources. Inherent distortion is said to be less than 0.5% FM and 0.3% AM. When used with its companion SMG40 stereo generator, L/R separation will be greater than 60 dB, between 80 Hz and 5 KHz. The "state-of-the-art" attenuator is continuously variable over a 140 dB range, providing from 0.1 microvolt to 1 volt RMS. Low RF leakage allows sensitivity measurements down to 0.5 microvolts.

The companion SMG40 stereo signal generator is a time-multiplexed modulator intended for use with the RE101 or other RF signal source. It provides pushbutton control of all composite signal functions, including: L&R, L=R, L=-R, L, and R.

For More Details Circle (26) on Reply Card

Automatic Analog Voltmeter

Helper Instruments has introduced the "Voltadder," an autoranging analog AC/DC voltmeter intended to speed troubleshooting operation. Separate panel meters are provided for the AC and DC components, and both meters operate simultaneously from a single probe.

Both AC and DC meters are independently autoranging, with LED indicators showing which scale is in use. The DC meter also has automatic-polarity switching.

For More Details Circle (27) on Reply Card

Frequency Counter

A full-feature frequency counter for CB and amateur radio applications is available from **Communications Power.**

The FC-70 frequency counter has a seven-digit LED readout with anti-glare louvers, and resolves to 10 Hz. The unit operates either from 12-volts DC or 115-volts AC, with quick-disconnect cables supplied for both. A 40-MHz limit is guaranteed, and 55-MHz is typical.

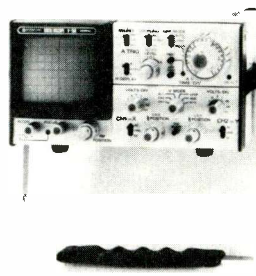
Rated at 0.0003% accuracy, the FC-70 will accept 400 watts of through-put power. With its high-impedance input, it can measure RF oscillators, grid-dip meters, and test IF frequencies.

For More Details Circle (28) on Reply Card

Scopes

Two new "mini-portable" oscilloscopes are offered by **Hitachi.**

Model V-059B is a 7-MHz scope designed for use in the field, as



either a troubleshooting tool or a TV waveform monitor. The TV-sync separator provides improved locking at video horizontal and vertical rates. The scope can be powered from AC line, 12 VDC, or a self-contained rechargeable battery with built-in charger.

It features keyed DC restoration, external trigger input, external horizontal inputs, direct or 10X probe input, maximum vertical deflection sensitivity of 10 MV/div, and sweep rates from 20 milliseconds/division to 10 microsecond/division, plus a 10X magnifier.

Model V-158 has many of the same features, but it is dual-trace, with 15-MHz bandwidth, has delayed sweep, a 3½-inch internal-graticule CRT, and 8 KV of anode voltage for a brighter, sharper trace.

For More Details Circle (29) on Reply Card

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For More Details Circle (14) on Reply Card

product report

Tool Cases

Vaco Products has introduced two tool cases: Super Case II and Super Zip.

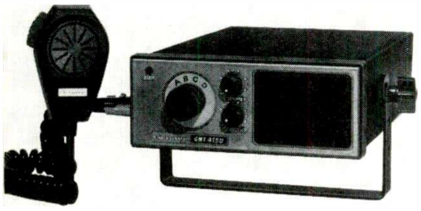
Super Case II contains 45 professional tools and a terminal kit in a vinyl-covered wood attache case. It includes interchangeable blades and handles to form screwdriver or nutdriver, plus pliers, electrical tools and screwdrivers.

Super Zip holds 36 tools in a zippered vinyl-covered case. Included are: a handle and interchangeable blades to form screwdrivers, hex drivers, and nutdrivers; pliers; crimping tool.

For More Details Circle (30) on Reply Card

UHF Transceiver

General Aviation Electronics has introduced a new 450-to-512 MHz 15-watt UHF transceiver that is compatible with existing UHF systems. The unit comes in three models: GMT-115-U, GMT-215-U and GMT-415-U.



GMT-115-U is a one-channel transceiver and includes an 8-pole monolithic crystal filter. The unit has a high-sensitivity RF head end, and capability for the addition of subaudible tone-squelch module.

GMT-215-U is a two-channel transceiver, and the GMT-415-U has three channels.

Included with all three models are a microphone, microphone clip, DC power cord, and a mounting bracket.

For More Details Circle (31) on Reply Card

Mounting Systems

"Ultra Grip" systems by **American Radio** permit installation of radios, speakers, mikes, tools, etc., without drilling holes.

Ultra Grip fasteners use the Velcro® hooks-and-loop system, combined with an acrylic foam, and will stay attached to surfaces without falling off. The holding power is said to be three pounds per square inch.

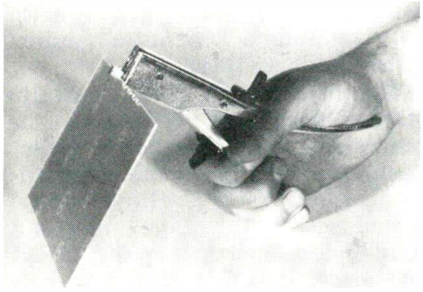
The Ultra Grip line includes: "Strips" that will hold heavy and large objects (radios, speakers, etc.); "Spots" that will hold mikes, tools, log books, etc.; and "Arrows" that will hold most objects to carpeted surfaces.

Suggested prices range from $1.99 to $4.99.

For More Details Circle (32) on Reply Card

Nibbling Tool

GC Electronics' new nibbling tool (number 805) cuts clean holes of



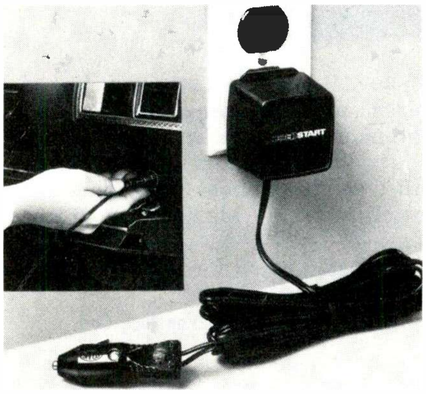
any shape and size in metal or plastic. The tool is capable of cutting 18-gauge steel, or 1/16"-thick copper, aluminum or plastic.

The hand-operated tool can be used for templates, shims, and model parts.

For More Details Circle (33) on Reply Card

Car-Battery Warmer

Coldstart by **Dynamic Instrument** keeps automobile batteries warm and at peak power for cold weather starts, or for infrequently used vehicles.



It plugs into the vehicle's cigarette-lighter receptacle, and into a 120-volt AC outlet.

For More Details Circle (34) on Reply Card

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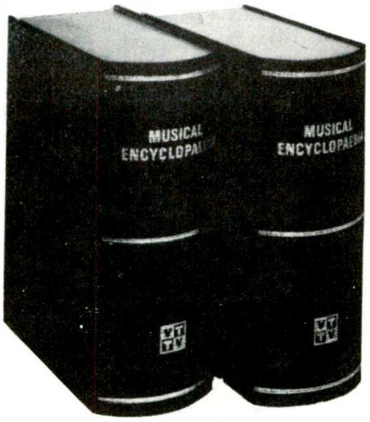
"Book" Speakers

Videoton of Budapest, Hungary is offering a new stereo speaker system resembling a bound encyclopedia volume. The speakers, 11½



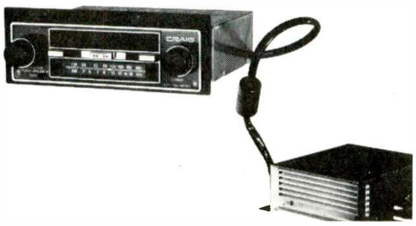
inches high, offer 15-watt continuous power-handling capacity; 8-ohm impedance; 60-22,000 Hz frequency response; one 2-5/8" tweeter, and two 3½" woofers. Suggested retail price is $49.95.

For More Details Circle (35) on Reply Card

Car Stereos

Craig has expanded its line of car stereos with the introduction of eight new models, including one 8-track and seven cassette tape players.

The T680 features stereo-matrix, AM/FM/MPX radio, manual and automatic eject, and a separate circuit that dims the radio dial with the car dash lights. It has a suggested price of $179.95.



Model T631 features a digital readout display for station selection, stereo-matrix, AM/FM/MPX radio, automatic repeat, and five AM or FM station preset for simplified tuning. It is retail priced at $269.95.

For More Details Circle (36) on Reply Card

Stereo Crossover

The Pyramid 1000 Stereo Crossover from **Showco** has an electronic cross-over frequency of 800 Hz with less than .5% total harmonic and intermodulation distortion.

The S-2501 electronic frequency-dividing network was designed to complement Showco's Pyramid 1000 speaker system, but may be used in any system where bi-amplification is desirable.

For More Details Circle (37) on Reply Card

Cassette Storage Boxes

Components for cassette storage, transportation, and protection now are available in one package from **3M Company's** Magnetic Audio/Video Products Division.

The new Scotch C-Box cassette storage boxes can be stacked or rearranged in any number or order Each C-Box unit holds one standard-size tape cassette, allows push-button access to the tape, and has a front index label to identify album and artist. A drawer insert card is included with each unit to index more detailed information.

The 10-pack of storage boxes comes with carrying handle and wall-mounting bracket. The boxes also come in three-to-a-package units, or as optional packaging for Scotch Classic, Master, or Dynarange 60- and 90-minute cassettes.

Suggested retail for the 10-pack is $9.99.

For More Details Circle (38) on Reply Card

Loudspeakers

Two new compact loudspeaker systems combining high efficiency, high power handling, and wide frequency response have been announced by **Shure Brothers**.

The SR112 is for permanent installation indoors, and features extra weather protection to allow outdoor use for limited periods of time. The SR116 is a portable unit with a carrying handle. Each system has two 8" bass speakers and a horn tweeter in a ported bass-reflex cabinet. The impedance is 8 ohms, and the maximum power rating is 100 watts.

Suggested net price is $340 for the SR112, and $384 for the SR116.

For More Details Circle (39) on Reply Card

In-Dash Car Stereo

Sparkomatic is offering four new in-dash car-stereo models designed with special CB controls and circuitry so that a Sparkomatic 40-channel CB module can be added at any time.

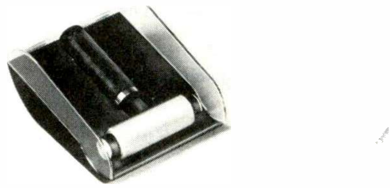
Each unit features CB standby, enabling the driver to monitor any CB channel while listening to the radio; stereo indicator light; AM/FM and local/distance switch; volume and tone control; tuning and balance knobs; and, adjustable shafts and short chassis to fit all cars.

The new models come with either manual or push-button control, and either 8-track or stereo cassette.

For More Details Circle (40) on Reply Card

Record Cleaner

A record cleaner with roller-like action that removes dirt, dust, foreign matter, and fingerprints from phonograph records, and whose surface tackiness can be renewed by washing, is available from **Rotel of America**.



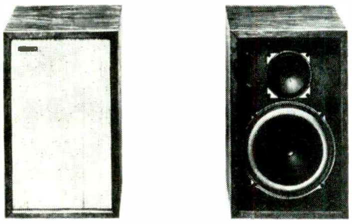
The "Rolling Cleaner" uses a specially formulated rubber-elastomer material which retains its original surface tackiness. Stains, dust, and dirt that accumulate on the surface may be removed by hand washing the roller in a neutral detergent/warm water solution.

The cleaner retails for about $20 and is complete with a protective plastic collar which slips over the roller and helps prevent nicks, mars, and cuts.

For More Details Circle (41) on Reply Card

Stereo Speaker

Videoton of Budapest, Hungary, is entering the U.S. market with the introduction of a new suspension speaker system which may be used



on a shelf or on the floor.

The Saphir I (model DP 202 A) features a proprietory suspension system.

For More Details Circle (42) on Reply Card

Cleaning Kits

Bib Hi-Fi has a new tape-head

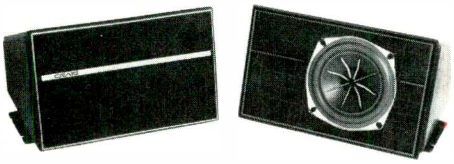
maintenance kit which includes cleaning tool, anti-static cleaning liquid, inspection mirror, brush, cloth and pads. The specially designed cleaning tool comes with an interchangeable head for easy access to tape heads.

Also available from Bib Hi-Fi is a cassette editing and splicing kit which incorporates a newly patented tape splicer for diagonal or butt splices. Two rocker clamps hold the tape firmly on a non-slip base to ensure accuracy in editing.

For More Details Circle (43) on Reply Card

Car Stereo Speaker

A "Trans-Rib" automotive speaker line has been introduced by **Craig.** First model in the line is the R780, a surface-mount speaker system.



The speakers feature a light-mass cone, long-thrust acoustic driver, plus special support and sound transmission "ribs". Ribs are supported at the speaker's cone center by the voice coil and extend outward, distributing all frequencies over the entire cone surface with phase coherence. The effect is similar to a cone tweeter, without the phase distortion inherent with most coaxial or three-way speaker systems.

Suggested minimum retail for the R780 mobile surface mount speaker kit is $99.95.

For More Details Circle (44) on Reply Card

MATV Amplifier

Jerrold Electronics has developed a series of MATV amplifiers capable of providing up to 4-volts of output on single UHF-TV channels 14 through 70.

The amplifiers are designated UHPM-*, with the asterisk standing for the desired channel number. A separate unit is available for each UHF channel, 14 through 70.

Typical output capability at 0.5 dB sync compression is 72 dBmV (4.0 volts). Gain is 60 dB, and the output range is 63 to 72 dBmV, with full AGC. AGC holds constant within 1 dB, for input variations over a 30 dB range.

Designed for rack or wall mounting, UHPM amplifiers can be combined via loop-thru mixing. Test points are provided for both input and output. The units are priced at $350 each.

For More Details Circle (45) on Reply Card

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antenna systems report

CB antennas

A new line of CB antennas for mobile and base-station applications has been introduced by **Antenna Incorporated.**

The new antennas feature a larger loading coil to reduce power loss. The mobile antennas feature 17-7PH stainless steel whips, stainless steel shock springs, and 17 feet of RG-58/U coaxial cable with Antenna's in-line connector (said to be exclusive).

The base-loaded mobile antennas are available with cowl mounts (model 11150), ¾-inch hole mounts (model 12750), and pre-assembled trunk-lip mounts (model 17650). The line also includes a 5/8 wavelength base-station antenna (model 22650)

For More Details Circle (46) on Reply Card

CB Antenna Parts

GC Electronics has made available exact replacement parts for CB antennas, including: a chrome-plated shock spring and adaptor (19-100) with a hex wrench; a replacement antenna base (19-106); a replacement collet (19-108); a replacement contact pin (19-109); a replacement loading coil (19-110); and PH 17-7 stainless steel replacement whips in 36-inch and 40-inch lengths (19-112, 19-114).

Replacement tips also are available for top- and center-loaded antennas (19-120, 19-125).

Constructed of corrosion-free material, the replacement parts fit GC Electronics' CB antennas, as well as most other brands.

For More Details Circle (47) on Reply Card

CB Antenna Disconnector

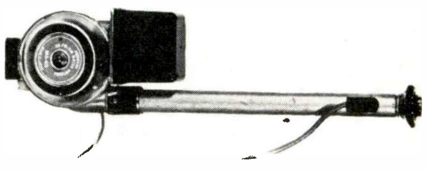
Gold Line's model 1116 antenna disconnector features a spring-load design for "press and twist" removal and attachment. The adaptor accommodates any length mobile antenna and is equipped with 3/8-24 threads to fit bumper, mirror, and other mounts.

For More Details Circle (48) on Reply Card

Electric Antenna

Audiovox's new CB/AM/FM-stereo radio antenna (model MA-40) extends and retracts automatically when the driver turns his ignition on and off. A safety relay, built into the unit, prevents damage to the output transistors by allowing the CB to operate only when the antenna is fully extended.

The MA-40 has a manual height-adjusting switch designed to obtain optimum AM/FM reception, plus a signal-splitting coupler with a fine-tuning feature. For the CB function, an SWR adjustment also has been furnished at the antenna's top load.



The new antenna can be used on both 23- and 40-channel CBs. It comes complete with front and rear mount assembly, wiring harness, hardware, manual toggle switch, tunable coupler, and spanner wrench.

For More Details Circle (49) on Reply Card

CB Antenna

A 40-channel trunk-lid or rooftop-mount CB antenna is available from **Panasonic Parts Division.** The RD-9100 antenna, measuring 40½" overall, is base-loaded with a fiberglass whip. Twelve RD-9100 antennas are packed in a master carton.

For More Details Circle (50) on Reply Card

Low-Loss Coaxial Cable

Berk-Tek has introduced its new "RG-8X" coaxial cable to the CB/ham market.

This miniaturized, low-loss RG-8X coaxial cable replaces RG-8/U types. More flexible and 40% smaller than RG 8/U, the new cable features 95% braid shielding and 19-strand center conductor.

Because attenuation is only 1.35 dB (nominal) at CB frequencies, users are said to obtain as much as 2 dB gain over typical 58/U-type antenna cables.

For More Details Circle (51) on Reply Card

TV antenna

The Target BS-110, **S & A Electronics'** omni-directional TV antenna with end feed, is designed for minimal space applications, including portable base station, apartments and marine use.

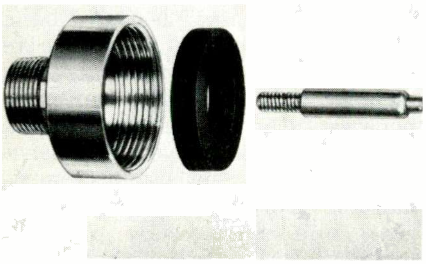
The antenna will withstand winds of more than 100 MPH and has no radial elements to bend or coils to burn out or detune, according to a company spokesman. The half-wave dipole antenna is constructed of fiberglass with nickel chrome-plated ferrules.

It has a frequency of 27 MHz, and the VSWR is said to be 1.5:1 or better across 40 channels. Gain is 3.75 dB. The unit comes with mounting bolts and matching harness that mates with the standard PL-259 UHF connector.

For More Details Circle (52) on Reply Card

Antenna Mount Adapter

Antenna Incorporated has developed a land-mobile mounting device which will adapt the company's antennas to fit the standard Motorola mount.



The model 41901, available as an accessory device, allows total interchangeability between Antenna Incorporated and Motorola antennas, or any other antennas using the Motorola-style mount. Designed to accommodate any standard base-loaded antenna, the mount fits over the Motorola mount with a special threading device, which then is attached to the female connection of the antenna.

Suggested retail price of the model 41901 mount is $4.77.

For More Details Circle (53) on Reply Card

CB Antenna

Channel Master has designed a new version of its "Power Wing" CB antenna for installation on trucks, vans, and recreational vehicles.

The unit combines a capacitively top-loaded design with a grooved-core, high-Q coil housed in a weatherproof base.

The 16-inch antenna has a short telescoping fine-tuning stub on top. It is made of aircraft-strength aluminum, and is protected with a marine acrylic coating and a neoprene gasket for weatherproofing. Retail price is $29.95.

For More Details Circle (54) on Reply Card

CB Antenna System

A new, high-performance 40-channel mobile CB antenna system is available from **Avanti.**

Featuring a magnetic mount for roof or trunk location, the model AV-727 permits instant removal for hideaway or car wash. Other features include a hermetically-sealed coil, a ribbed base to provide a long leakage path, and a 48-inch whip.

The system, complete with 18-foot coaxial cable, is priced at $32.95.

For More Details Circle (55) on Reply Card

CB Mobile Antenna

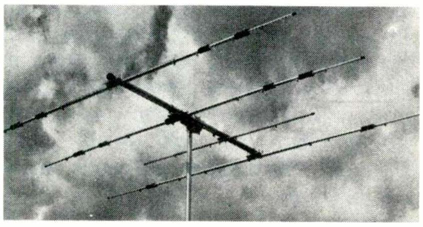
Commander has manufactured a 13-inch twin-loaded CB mobile antenna. The antenna, "Magnum Ears," has a VSWR that's said to be adjustable to 1.2:1 or better over all 40 channels.

The antenna includes a 6-pole magnetic mount (4-inch diameter), and twin-loaded radiating elements, forming a centerfed dipole. Suggested retail price is $21.95.

For More Details Circle (56) on Reply Card

Amateur Radio Antenna

Cushcraft's ATB-34 beam antenna has four active elements covering the 10-15 meter and 20-meter amateur bands. The ATB-34 features Hy-Q power-rated traps and a 30-dB front-to-back ratio. It is designed for daily operation, dx-ing, contests, and emergency service.



Constructed of heavy-wall seamless aluminum tubing, the element and mast mounts are ¼-inch aluminum with zinc-plated steel U-bolts. All feed point fasteners are stainless steel. Elements are fully adjustable through circular telescope clamps. All components are factory-machined and the element sections are marked for proper dimensions. The package includes a 1-1 balun.

For More Details Circle (57) on Reply Card

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6 Residual	21 Morse
7 Logic	22 Extension
8 Concentric	23 Nodules
9 Crystal	24 Soldering
10 Lithium	25 Getter
11 Monitor	26 Rotator
12 Resistor	27 Ring
13 Rhumbatron	28 Glitch
14 Nibbler	29 Humming
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92-100 Terrific.
104-112 Topnotch.
116 PERFECT! You're an Electronic Cowboy!

(*Morse, Samuel Finley Breese. American artist and inventor. 1791-1872)

catalogs literature

Circle appropriate number on Reader Service Card.

60. B&K-Precision—A new 44-page test-instrument catalog features a broad range of test equipment. Scopes, frequency counters, digital and analog multimeters, audio and RF signal generators, semiconductor testers, power supplies, and CB and TV test instruments are included in the "BK-78" catalog. A complete line of scope and instrument probes also is described.

61. Antenna Incorporated—A reference chart describes the company's land-mobile antennas for commercial two-way communications systems. Included are antennas for 25-30 MHz, 30-36 MHz, 36-42 MHz, 42-50 MHz and 130-174 MHz frequency ranges, as well as the various mounting configurations. It also has quarter wavelength antennas for the 136-512 MHz frequency range, base station antennas covering the 25-54 MHz and 130-174 MHz frequency ranges, and monitor antennas. In addition, there is a section describing the company's antenna accessories.

62. Nortronics—Now available is a new 20-page catalog designed to aid dealers in merchandising Recorder Care Maintenance Products. The catalog is illustrated with color and black-and-white photos showing available self-standing displays, counter racks, supporting literature, and products grouped by application on individual pages. Merchandising and selling information is carried across the top of each page; product description appears along the bottom.

63. GC Electronics—"Problem-solver" Electronic Chemical Handbook contains detailed descriptions, uses, and applications of 160 GC Electronics' chemicals. The 53-page handbook is supplemented with numerous "in-use" photographs as well as detailed product and container specifications. There is information on adhesives, cleaners, coatings, PC chemicals, solvents, thinners and lubricants.

64. Cornell-Dubilier—CB reception problems in both mobile and base installations are the subjects of the Filter System Selector Chart. The Mobile Installation Chart recommends filters for typical noise problems in four catagories. The problems of TV and radio interference are discussed under base stations. The overall chart covers one side of a standard-size page, and is multicolored for fast reference. Catalog numbers for recommended filters are listed.

65. General Electric—Descriptions of the complete GE line of light- and heavy-duty industrial soldering irons, parts and accessories highlight this revised, illustrated 14-page Soldering Irons Catalog, GEP-1545A. The new catalog contains illustrations of each soldering iron, interchangeable threaded tips, and many accessories.

69. Heath—A new 96-page catalog describing nearly 400 electronic kits is being offered. Product categories include: amateur radio; hi-fi components; color TV; test instruments; digital clocks and weather instruments; radio control equipment; marine, aircraft, and auto accessories; and more. New products include a three-way bookshelf speaker system, 40-channel CB radios, and a mount-anywhere touch-control light switch.

82. Sperry Instruments—SP-76 (Issue B) is a new product bulletin featuring the company's complete line of AC snap-arounds, Electric Paks and Master Electric Kits. In addition, the bulletin covers new introductions to the present line: the SR-25 swivel case voltammeter; the EXP-300 "Easy Volt" VOM; and the SPR-311 VOA. Also included are detailed specifications, product descriptions, a list of features, packaging information and prices for all Sperry snap-arounds.

83. Teledyne Ansonia—Solderless connectors, terminals and wiring accessories are featured in an 80-page catalog. Individual products (shown in actual size) are color-coded for easy reference and ordering procedure.

themarketplace

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TEST EQUIPMENT like new, some in original cartons, complete with manuals and probes: B & K Television Analyst 1077B $250, Heath: IO-14 8MHz Scope $150, ID-22 Electronic Switch $20, IT-11 Capacitor Checker $30, IG-42 Lab RF Generator $70, IG-57 Sweep-Post Marker Generator $80, IO-101 Vectorscope and color bar Generator $80, IM-25 Solid State VTVM $35, Eico: 902 Intermodulation and Harmonic Distortion Analyzer $200, 261 AC VTVM $65. Sold separately or everything for $800, freight collect. Ray Electronics, 7310 Sabal Drive, Miami Lakes, Florida, 33014. Phone 305-557-2317. 12-77-1t

For Sale (Cont.)

FOR SALE OR TRADE—193 SAMS PHOTOFACTS complete and in excellent condition—from #1 thru 600—all for $175.00 or trade for television test equipment. Kenneth Miller, 10027 Calvin St., Pittsburg, Pa. 15235. 12-77-1t

PHOTOFACTS #200 thru #1577 have all sets from #800 to #1577 total 1,112 sets for $1,100.00. B&K test equipment, #1470 dual trace scope $450.00, #415 sweep/marker generator $350.00. #1801 frequency counter $200.00, plus other equipment. R. Wright, 517 Quarry #5, Susanville, Cal. 96130. 12-77-1t

TV & RADIO TUBES 36c EA!! Free color catalog. Cornell, 4221 University, San Diego, California 92105. 8-76-tf

Services

ELECTRONIC MANUFACTURERS; electronic and printed circuits requiring hand finish assembly or modification work wanted. Via drop ship method. Gilbert Whitley, R.R.2, Metamora, Ill. 61548. 11-77-3t

Education-Instruction

REPAIR TV TUNERS—High Earnings; Complete Course Details, 12 Repair Tricks, Many Plans, Two Lessons, all for $2 Refundable. Frank Bocek, Box 3236 Enterprise, Redding, Calif. 96001 8-76-tf

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TOP TV TECHNICAN wants job/business in San Fernado Valley, California area. Shelly Rattner, 3223 Lawrence Ave., Oceanside, N.Y. 11572, (516) 536-5019. 12-77-1t

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Digital-logic circuitry will be emphasized, as J. A. "Sam" Wilson begins a study of digital logic in industrial electronics systems, and Gill Grieshaber looks at digital circuitry in his Servicing Magnavox series.

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