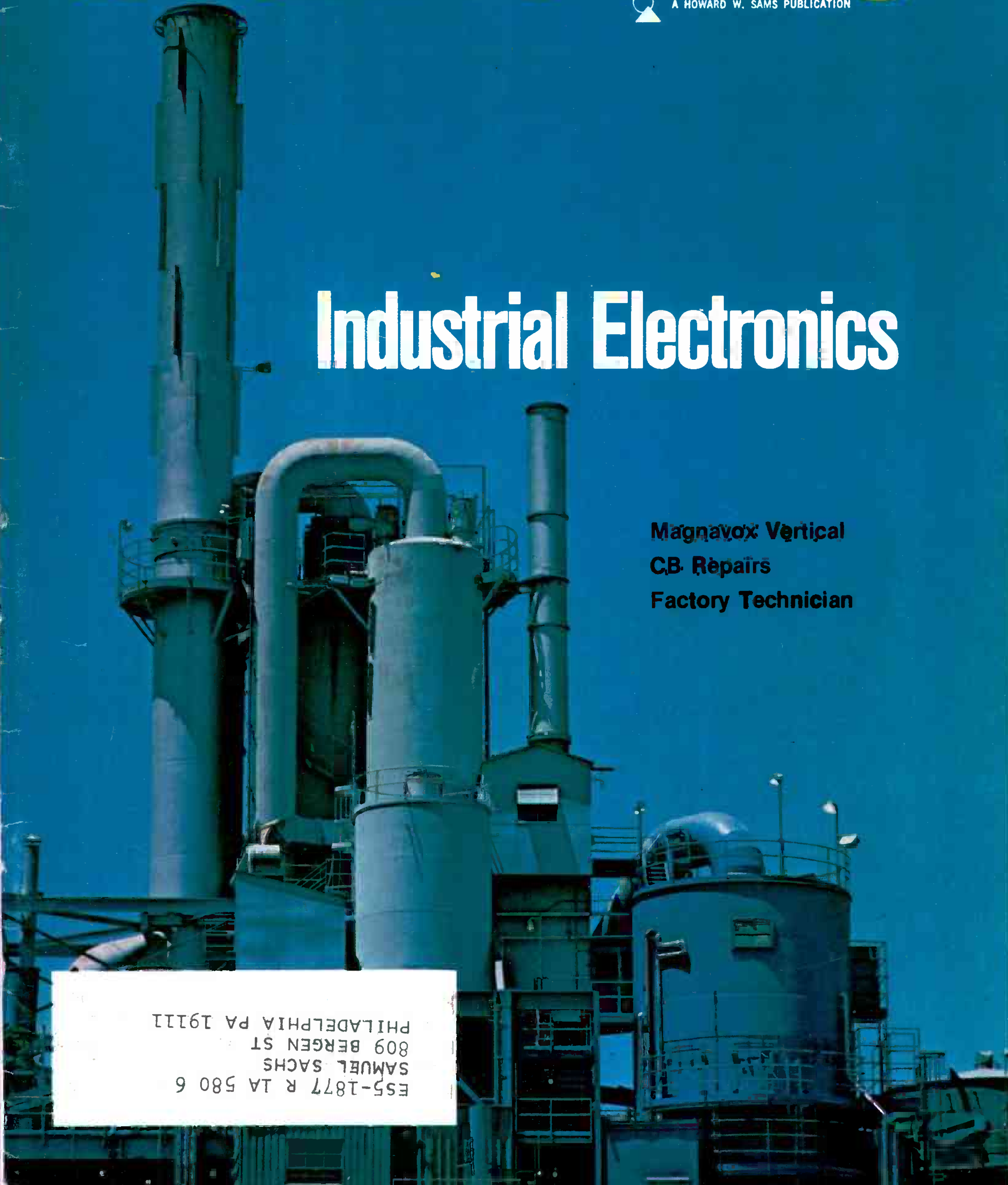
July, 1977 □ 75 cents

Electronic Servicing

A HOWARD W. SAMS PUBLICATION

Industrial Electronics

Magnavox Vertical
CB Repairs
Factory Technician



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PTS ELECTRONICS, INC.

PRECISION TUNER SERVICE

THE COMPLETE LIST OF ALL PTS SERVICENTERS APPEARS ON THE NEXT PAGE

For More Details Circle (1) on Reply Card

July, 1977 ☐ Volume 27, No. 7

Electronic Servicing®

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About The Cover

This photograph by Carl Babcoke of the Proctor And Gamble soap factory in Kansas City, Kansas illustrates the field of industrial electronics.

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ELECTRONIC SERVICING is edited for technicians who repair home-entertainment electronic equipment (such as TV, radio, tape, stereo, and record player), and for industrial technicians who repair defective production-line merchandise, test equipment, or industrial controls in factories.

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For More Details Circle (4) on Reply Card

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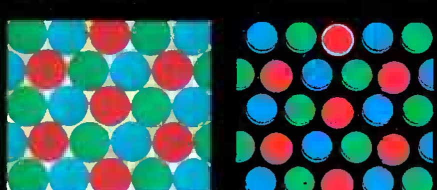
Before Chromacolor, every large screen color TV picture was made up of thousands of tiny red, green and blue dots on a gray background.

But Zenith found a way to make the dots smaller, surround them with jet black and, for the first time, fully illuminate every dot not only for greater brilliance, but also for dramatic contrast.



The result was the famous Chromacolor picture tube – widely recognized at its introduction as one of the most important breakthroughs in color picture tube technology since the coming of color television.

Today, Chromacolor still represents a significant forward step in the state of picture tube technology...in brightness, contrast, and true-to-life color.

And for reliability, there's no comparison between a Chromacolor picture tube from your Zenith distributor and that you may attempt to re-build yourself. When you get down to it, you simply can't invest man hours in a re-built that will seldom, if ever, measure up to the reliability, the consistency, the integrity of a factory-supplied Chromacolor.

As a result of this reliability, Chromacolor can do a lot for older color TV's...and many not-so-old sets as well. Even those of other makes.

That's why you should check with your Zenith distributor now and stock up with Zenith's 17", 19", 23", and 25" diagonal sizes.

Besides brightening your customers' picture viewing, Chromacolor will brighten your profit picture too! Reliably!

Call your Zenith distributor now.

electronic scanner

news of the industry

The FCC has begun a study of AM stereo broadcasting, a development that could produce a new generation of radios. This action resulted from pressure by AM radio station owners, represented by the National AM Stereophonic Radio Committee (NAMSRC), who want stereo in order to compete with FM stations. The first step will be to review the results of tests being conducted by NAMSRC on several versions of AM stereo.

Piano music now can be recorded and played back through a new system developed by Superscope. The "Pianocorder" uses a complex electronic linkage to the piano's hammer assembly to record and play cassettes on a tape deck attached beneath the keyboard. The unit has a suggested retail price of $1,250 for uprights and $1,400 for grand pianos.

A "mini-service" manual for television technicians is being included in General Electric's 1978 line of color televisions. The mini-manuals are located in a specially-designed enclosure on the back of each set, accessible only to the technician. The manuals cover adjustment procedures, safety information, symptom/cause troubleshooting charts, parts lists, parts ordering information, and a full-sized schematic diagram of the particular chassis.

Alaska has begun its first live prime-time public television programming on a one-year experimental basis. The direct transmission is made possible through a NASA communications satellite, ATS-6, and the cooperation of groups in the continental United States. PBS is transmitting its evening schedule to KAKM in Anchorage and KUAC-TV in Fairbanks. The Corporation for Public Broadcasting is funding the transmission through contracts with the Rocky Mountain Corporation for Public Broadcasting and the Public Service Satellite Consortium.

The State of Connecticut has enacted a law prohibiting franchised cable companies from repairing, leasing or selling television set and home entertainment units covered by the state's licensing law. The act, signed into law by Governor Ella Grasso, has the full support of the Television Service Association (TELSA) of Connecticut. According to Kaz Glista, TELSA legislative committeeman, Connecticut "is believed to be the first state to protect the independent servicers from unfair competition from the TV cable companies."

Sony has introduced a two-hour videocassette recorder, a videocassette changer and a $2,000 portable multiband radio/cassette-recorder combination. The new Betamax home videocassette recorder has a suggested list price of $1300, and will accept one- or two-hour cassettes. The changer, available later this year, will double the recording and playing time of Betamax videocassette recorders.

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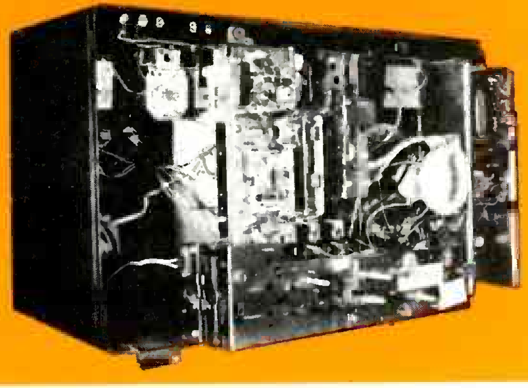
Tuner Service Corporation



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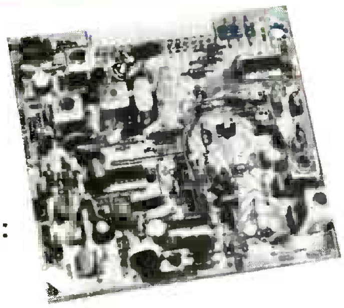

TSC has been repairing private brand TV modules for over 3 years.

Expanded facilities now include modules for:
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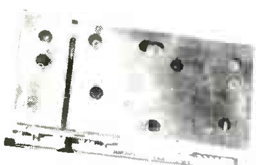

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ALABAMA	BIRMINGHAM, ALABAMA 35212	5623 1st Avenue North	Tel. 205-592-9150
ARKANSAS	LITTLE ROCK, ARKANSAS 72204	4200-C Asher Ave.	Tel. 501-661-0393
CALIFORNIA	NORTH HOLLYWOOD, CALIF. 91601	10654 Magnolia Boulevard	Tel. 213-769-2720
	SAN MATEO, CALIF. 94402	600 S. Amphlett Blvd.	Tel. 415-348-3292
	MODESTO, CALIF. 95351	123 Phoenix Avenue	Tel. 209-521-8051
FLORIDA	TAMPA, FLORIDA 33606	1505 Cypress Street	Tel. 813-253-0324
	FT. LAUDERDALE, FLORIDA 33309	3516 N.W. 10th Ave.	Tel. 305-566-4882
GEORGIA	ATLANTA, GA. 30310	646 Evans St. S.W.	Tel. 404-758-2232
ILLINOIS	URBANA, ILLINOIS 61801	908 E. Main Street	Tel. 217-384-2052
	SKOKIE, ILLINOIS 60076	5110 West Brown Street	Tel. 312-675-0230
INDIANA	INDIANAPOLIS, INDIANA 46204	112 West St. Clair Street	Tel. 317-632-3493
KENTUCKY	LOUISVILLE, KENTUCKY 40205	2244 Taylorsville Road	Tel. 502-452-1191
LOUISIANA	SHREVEPORT, LOUISIANA 71104	2423 Southern Avenue	Tel. 318-221-3027
MASSACHUSETTS	SPRINGFIELD, MASS. 01108	405 Dickinson St.	Tel. 413-788-8206
MISSOURI	ST. LOUIS, MISSOURI 63132	9577 Page Avenue	Tel. 314-429-0633
NEVADA	LAS VEGAS, NEVADA 89102	1114 South Casino Center Blvd.	Tel. 702-384-4235
NEW JERSEY	TRENTON, NEW JERSEY 08638	1139 Pennsylvania Ave.	Tel. 609-393-0999
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N. CAROLINA	GREENSBORO, N.C. 27405	2914 E. Market Street	Tel. 919-273-6276
OHIO	CLEVELAND, OHIO 44109	4525 Pearl Road	Tel. 216-741-2314
OREGON	PORTLAND, OREGON 97210	1732 N.W. 25th Ave., P.O. Box 10141	Tel. 503-222-9059
PENNSYLVANIA	PITTSBURGH, PA. 15209	515 Grant Avenue	Tel. 412-821-4004
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TSC

WATCH US GROW

If you want to branch out into the TV Tuner Repair Business write to the Bloomington Headquarters about a franchise.

For More Details Circle (6) on Reply Card

continued from page 6

A seven-transistor portable AM radio only ½-inch thick has been introduced in Japan by the Matsushita Company. Tip-type electronic components, which have no lead wires or housing, were specifically designed to miniaturize the circuitry. A flexible PC board also was employed to achieve optimum space usage. Other features include a voltage stabilizer, film-cone speaker, and ultra-thin tuning capacitor. Panasonic, a division of Matsushita, is expected to market the radio in the U.S.

GTE Sylvania has delivered to the Institute for Applied Geodesy in West Germany a laser ranging system that provides precise distance measurements between satellites and an earth station. The Institute will use the system to measure accurately the shape and field of the earth's gravity and to ascertain such changes as continental shifts, pole movements, and earth rotation variations.

A complete home videocassette system, featuring a recording tape deck and video color camera for "home movies," has been introduced by JVC Corporation. The new "Vidstar" VHS Video Home System uses ½-inch tape, and connects to television sets through the antenna terminals. Videotape cassettes are available in 2-hour, 1-hour and ½-hour lengths. The Vidstar Color Camera, for making home cassettes, comes with a camera control unit which allows the user to transfer home movies or 35mm slides to videocassettes. The VHS system has instant playback, and features a digital timer for taping shows automatically. JVC officials project that almost 300,000 U.S. homes will have a video deck by 1978, with more than a million decks in use by 1980.

News from the

SERVICE ASSOCIATIONS

NESDA Elections

LeRoy Ragsdale, former president of NESDA, has announced that he will be a candidate for NESDA president in the upcoming elections to be held during the August NESDA convention in Orlando, Florida.

Ragsdale served as NESDA president in 1975-1976, and had served as national vice president in 1974-1975. He also was president of NATESA in 1970-1971.

Other candidates for president are John McPherson and Everett Pershing, the current NESDA president.

The 1977 National Electronic-Service Convention will be held at the Sheraton Towers Hotel in Orlando, Florida August 16-21. This year's theme is "The Wonderful World of Service." Planned for the convention are a golf tourney, technical-training seminars, and a trade show.

For more information on the convention, write to: NESDA, 1715 Expo Lane, Indianapolis, Indiana 46224.

NATESA Convention

The 28th annual NATESA Convention will be held August 25-28, 1977 at Carson's Nordic Hills Resort in Itasca, Illinois (located between O'Hare International Airport and Chicago).

The convention will open with a golf tourney on the 25th, and continue through the 28th with service business management and official association business sessions, as well as a "New Technology" seminar.

For additional information, write to NATESA, 5908 South Troy Street, Chicago, Illinois 60629.

CSEA Supports "War Fund"

Members of the California State Electronics Association (CSEA) have voted unanimously to raise $100,000 as a volunteer "war fund" to defray costs of legal actions against TV manufacturers' in-warranty service fees.

The original suit was filed in California state court two years ago by Miles Sterling, president of Electro TV in Garden Grove. Recently, James Ballard, president of Serviset, Sunnyvale, filed another lawsuit in federal court.

Both legal actions are designed to prevent TV manufacturers and their agents from soliciting shops for in-warranty service for less than the cost of performing the service.

CSEA Annual Elections

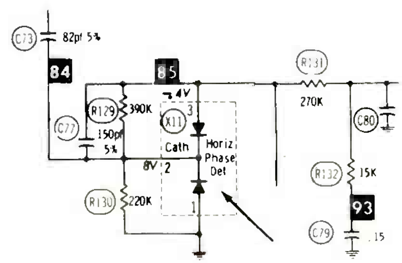
Donald M. Surette of TV Radio Den, Carmichael, was re-elected president of the California State Electronics Association during CSEA's annual meeting, held recently in San Jose, California. ☐

troubleshooting tips

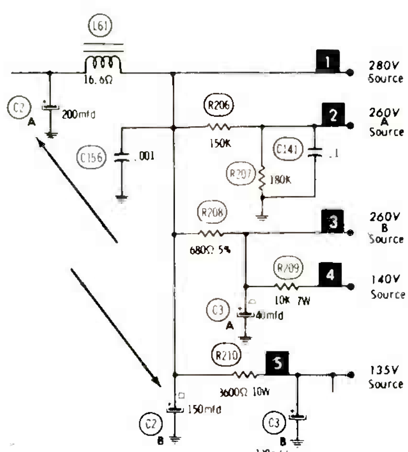
Send in your helpful tips—we pay!

Poor locking
RCA CTC36M
(Photofact 1077-2)

Horizontal locking was loose and erratic. I checked the tubes and replaced a shorted 4KE8 tuner oscillator/converter tube and the sync and AGC tubes. Only a slight improvement was noted.



Most DC voltages in the sync amplifier, sync separator, and AGC/noise-invertor stages were okay, except for pin 2 of the horizontal AFC tube and one other point. Replacement of X11, the phase-detector diodes, gave a little tighter locking, but still not normal.



Pin 2 of the AGC tube showed a slightly-low DC voltage, so I decided to check the power-supply voltages, and found the +260 supply was about 10 volts low. I looked at C2, and it appeared normal, without any white powder to indicate leakage of the dielectric. But when I disconnected the leads of C2 and measured each section, the 200 microfarad was about 60, and the 150 microfarad was about 50.

I replaced C2, and the locking returned to normal. However, the tubes and diodes had to be retained for best results. Evidently, all were contributing to the problem.

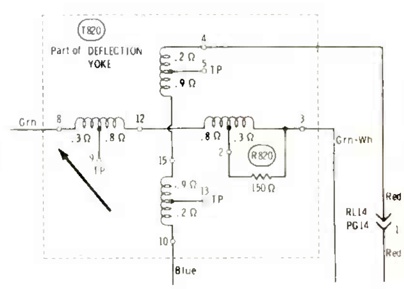
Vaughn A. Deem
North Ogden, Utah

Blown fuses
General Electric YA and YM
(Photofact 1617-1)

The first TV with this recurring problem took about three hours of my hard work to locate a short between the vertical and horizontal yoke windings of a GE YA chassis. Afterwards, I thought of a way of proving the defect in only a few minutes.

Suspect such a yoke short when the 1-ampere fuse on the YA is blown, or the YM has tripped the breaker. Try this sequence of tests:

- Unplug the vertical yoke and pincushion connectors;
- Replace the fuse (or reset the breaker), turn on the power, and check for high voltage. Normal HV proves the overload was coming from the vertical. Turn off power;
- Remove both mounting screws from the horizontal-output transistor and turn on the power;
- Measure for any positive voltage at the green wire on the yoke side of the vertical plug. Any voltage indicates leakage, and full B+ proves a dead short between yoke windings.



You know now whether to replace the vertical module or the yoke. Don't forget to replace the screws in the output transistor.

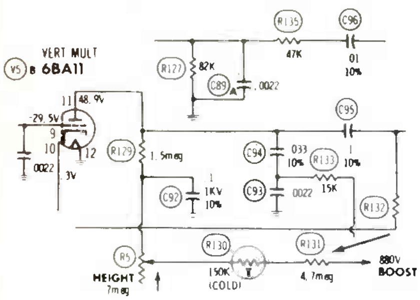
I have located bad yokes in several of these models, without wasting extra time.

Curtis A. Routley
Columbus, Mississippi

Insufficient height
Zenith 16Z8C50
(Photofact 1074-3)

The screen showed black at the bottom of the picture and poor linearity at the top. New 6HE5 and 6BA11 tubes did not help at all. After measuring a few DC voltages around the vertical-output tube, I decided to parallel some of the electrolytic capacitors, since the set was about seven years old and it was likely the filters were drying out.

According to a previous tip in Electronic Servicing, I paralleled C6 (the one to the convergence circuit), but there was no improvement. Other B+ electrolytics also proved to be okay.



Because most cases of poor height and linearity originate in the vertical-output stage, I had concentrated my attention there. But when I measured the DC voltage at the plate of V5 (the oscillator, or half of the multivibrator), I discovered only +12 volts instead of the expected +50 volts. Voltage on the height-control side of the thermistor (R130) also was low. My VOM could not read R131 (4.7 megohms), so I changed to a VTVM, and found that R131 was very high in resistance.

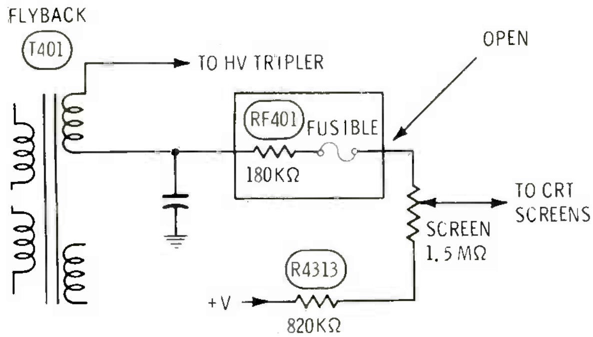
Replacement of the resistor and readjustment of height and linearity solved the height problem.

Incidentally, I made this repair without pulling the chassis, by turning the cabinet on its side and removing the metal bottom cover.

Al Potter
Parlin, New Jersey

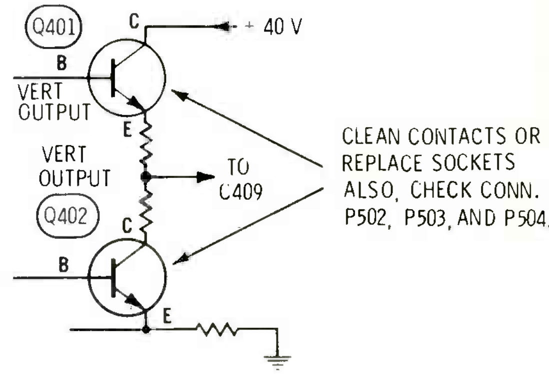
What would you like to read in ES? Send in your ideas.

Chassis—RCA CTC74
PHOTOFACT—1588-1



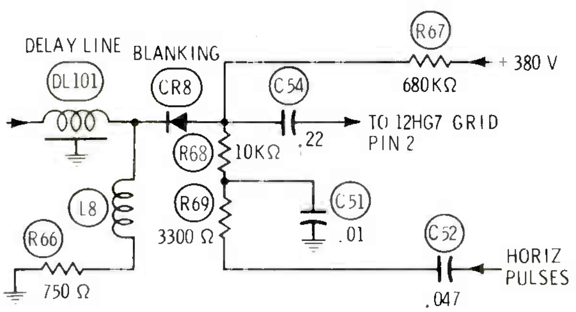
Symptom—Low brightness and smeared video
Cure—Check for open RF401 screen fuse device; might be caused by open L503 or C401 in gate circuit of ITR401

Chassis—RCA CTC74
PHOTOFACT—1588-1



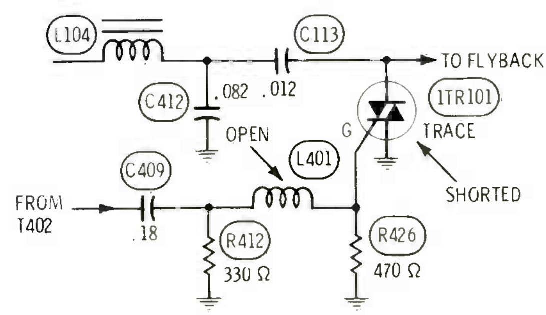
Symptom—Intermittent height or roll
Cure—Check sockets of vertical-output transistors; clean contacts or replace with new sockets

Chassis—RCA CTC39
PHOTOFACT—1246-2



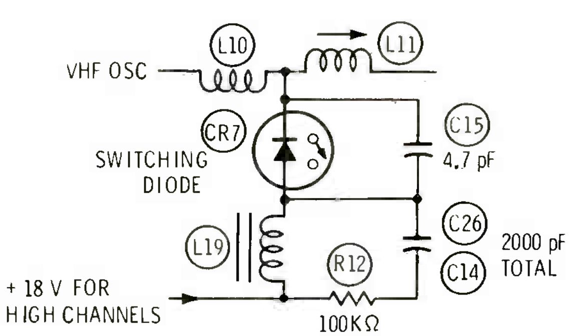
Symptom—Smeared video and horizontal pulling
Cure—Check for leaky or shorted blanking diode; also value of R66

Chassis—RCA CTC62
PHOTOFACT—1345-2



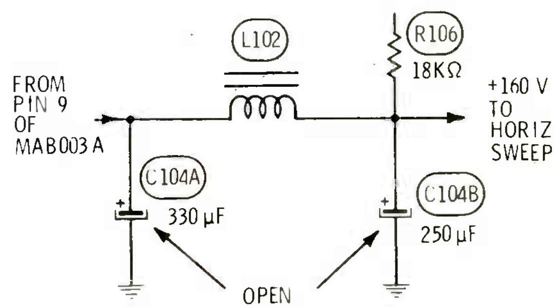
Symptom—No high voltage
Cure—Check for open L401 and shorted ITR101 (ruined from excessive voltage caused by the open choke)

Chassis—RCA CTC81 (varactor tuning)
PHOTOFACT—1615-2



Symptom—No low-band VHF; high VHF and UHF okay
Cure—Check for a defective low-band switching diode, such as CR7

Chassis—RCA CTC68
PHOTOFACT—1437-2



Symptom—Narrow picture with center foldover (perhaps squeal)
Cure—Check filter capacitor C104, and replace it if open

reader's exchange

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

Needed: Information about where I can obtain sewing machine needles (Eldredge brand) for the "Expert B" sewing machine, manufactured by National Sewing Machine Company of Belvidere, Illinois (now out of business). These needles need to be about 3/16-inches longer than the standard type. *Jethro F. Perry, Box 488, Lewisporte, Canada A0G 3A0.*

Needed: B&K-Precision Model 1076 (or later) TV Analyst, triggered scope, and other test equipment for general service work. Advise condition and price. *Thomas Walls, 6360 Montgomery Avenue, Philadelphia, Pennsylvania 19151.*

For Sale: Heath TS-4A sweeper/marker with marker added 4-250 MC), $40; Knight sweeper with marker added (0-250 MC), $30; RCA WG-304B modulator for color alignment, $50; Eico 944 flyback & yoke tester, $20; and Supi scope tube (brand new), $12. All mint condition, complete with cables and manuals. *Donald Stevens, 1005 N. Brookfield Street, South Bend, Indiana 46628.*

Needed: Back issues of *Electronic Servicing*; Riders radio 23; any Riders TV; other manuals & magazines. Will buy or swap. *Donald Erickson, 6059 Essex Street, Riverside, California 92504.*

Needed: One 12K8 tube. Also, schematic for Echophone commercial radio receiver (model unknown) with 12K8, 12SK7, 12SQ7, 12J5, 50L6, and 35Z5 tubes. *Arthur Hall, 603 Glenpark Court, Nashville, Tennessee 37217.*

Needed: Schematic and instruction manual for Accurate Instrument dwell-and-tachometer meter, Model BT-162. Also, up-to-date supplement chart and schematic for Model 257 tube tester from same company. *James L. Pate, Rt. 2, Box 97B, Hillsboro, Missouri 63050.*

For Sale: B&K Model 801 capacitor analyst; B&K Model 1076 TV analyst; RCA Model WO-910 scope; RCA WR-64A color generator; RCA WA-44C sine/square audio generator; Precision Model E-440 color-bar generator; Precision Model E-200-C signal generator; Precision Model E-400 sweep generator; Eico Model 950-B resistance capacitance comparator; Triple H Model 630-NA VOM; Electronic Instrument Model A-460 field-strength meter. Manual and schematics included with each instrument. *Steve Topley, 145 Qarry Street, Mt. Pleasant, Pennsylvania 15666.*

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Needed: Schematic for Stewart-Warner AM/SW radio receiver Model 62TC26. Will buy, pay for copy, or copy and return. *David N. Ludwig, 4642-4 Chicago Drive, Andrews AFB, Maryland 20335.*

Needed: Up-to-date roll chart or way of updating Precision tube tester, Model 10-12. *Gilbert Goodwater, Route 1, Sprague, Washington 99032.*

For Sale: Many manuals including Rider's and thousands of other diagrams on all types of electronic equipment such as x-rays, Dyathermy, all kinds of old battery sets; and a complete original file of Atwater-Kent radios. *G. G. Farnsworth, 201-205 East Mullan Ave., Waterloo, Iowa 50704.*

For Sale: LM21 Frequency Meter with AC power supply and all calibration charts and manuals. Excellent condition. Make offer, or will trade for what you have. *William Borstel, 412 Belle Alliance Drive, LaPlace, Louisiana 70068.*

Needed: A method of modifying a Hickok Model 534 tube tester to check 10-pin and 12-pin tubes. *Leo Quinn, 7836 Clearview Drive, Citrus Heights, California 95610.*

Needed: A series TM500 or 7000 Tektronix scope, with pulse generator, dual-trace, digital multimeter, spectrum analyzer, frequency counter, and other plug-in units for experimental work. Please state description, age, and price in first letter. *Leo Quinn, 7836 Clearview Drive, Citrus Heights, California 95610.*

For Sale: One Motorola comparator test set Model MU 290, $15 postpaid. *John Stiles, Sherwood, North Dakota 58782.*

Needed: Technical data about a 35-unit motel Sonolent alarm system for one of my motel accounts. The company was formerly at Phoenix, Arizona and I understand the company is out of business. *David Karr, 4967 Teddy Drive, Columbus, Ohio 43227.*

Needed: Technical information for a Minshall-Estey organ, model number could be 397, serial number H 1893. *Electronic Organ Service, Marion, Michigan 49665*

Needed: Schematic or service manual for EMC (Electronic Measurements Corporation) RF/AF crystal-marker/TV-bar-generator, Model 700. Will copy and return. *John Brouzakis, TV & Radio Repair, Route 2, Box 602B, Charleroi, Pennsylvania 15022.*

Needed: Deflection yoke for a Coronado 13-inch color portable TV, Model 22-1671A, part VZ 13067. *T. H. Davenport, 109 West Center Street, Bellevue, Ohio 44811.*

Needed: Instruction and service books for tube-type test instruments. *Don Wainwright, P.O. Box 374, Arroyo Hondo, New Mexico 87513.*

For Sale: B&K Model 415 TV sweep/marker generator, never used, complete, $290 plus shipping costs. *Byron-LeClaire TV, 4218 N. Ottawa, Norridge, Illinois 60634.*

Needed: B&K 1077B TV analyzer, not too old and in good working condition, reasonable price. *C. B. Vaghani, 9006 Centerville Road, Manassas, Virginia 22110.*

For Sale: Many old table-model and console radios and 10-inch TVs. Used 4, 5, 6, 7-pin, octal- and loctal-based tubes. Best offer, or trade for scanner or CB gear. *John H. Lang, RD 3, Box 87B, Hudson, New York 12534.*

For Sale or Trade: Eico Model 610 tube-tester adapter for Novar, Compactron, and Nuvistor tubes, with sheet of tester settings. Millivac DC milli-micro-voltmeter, with manual & calibration, $55; McMurdo Silver VOMAX 900A manual, $1.50. *Howard Adams, 209 West Shadywood Drive, Midwest City, Oklahoma 73110.*

Needed: Power transformer (Number TR 13-2) for AM H. H. Scott amplifier Model 299C. New or used; state price. *H. E. Pagarigan, 308 Parkway, Pt. Pleasant Beach, New Jersey 08742.*

Trade: New in original carton, Leader LSW-330 post-injection sweep/marker generator, $449.95 original price; would like to trade for Leader LSW-250 TV-FM sweep/marker generator, original price $349.95, or equal. *Electronic Service Co., 7328 Crystal Valley Road, Little Rock, Arkansas 72210.*

For Sale: RCA WO-91A scope with manual, $85; or trade for RCA WR-50B signal generator. *Aurie Antilla, 4066 Mt. Everest Blvd., San Diego, California 92111.*

For Sale: Sencore SM 152 sweep/marker generator, with all cables and books, $275; Heath AC voltmeter IM-5238, wired and calibrated, $75. Send money order. I pay for shipping and insurance. *Mario Rosigvolo, 368 South Hill Blvd., Daly City, California 94014.*

For Sale: or exchange for photo enlarger or? Heathkit post-marker, sweep generator Model IG-57A, assembled but needs checkout. *Walter Fleischer, 1025 Arizona Street, Melbourne, Florida 32901.*

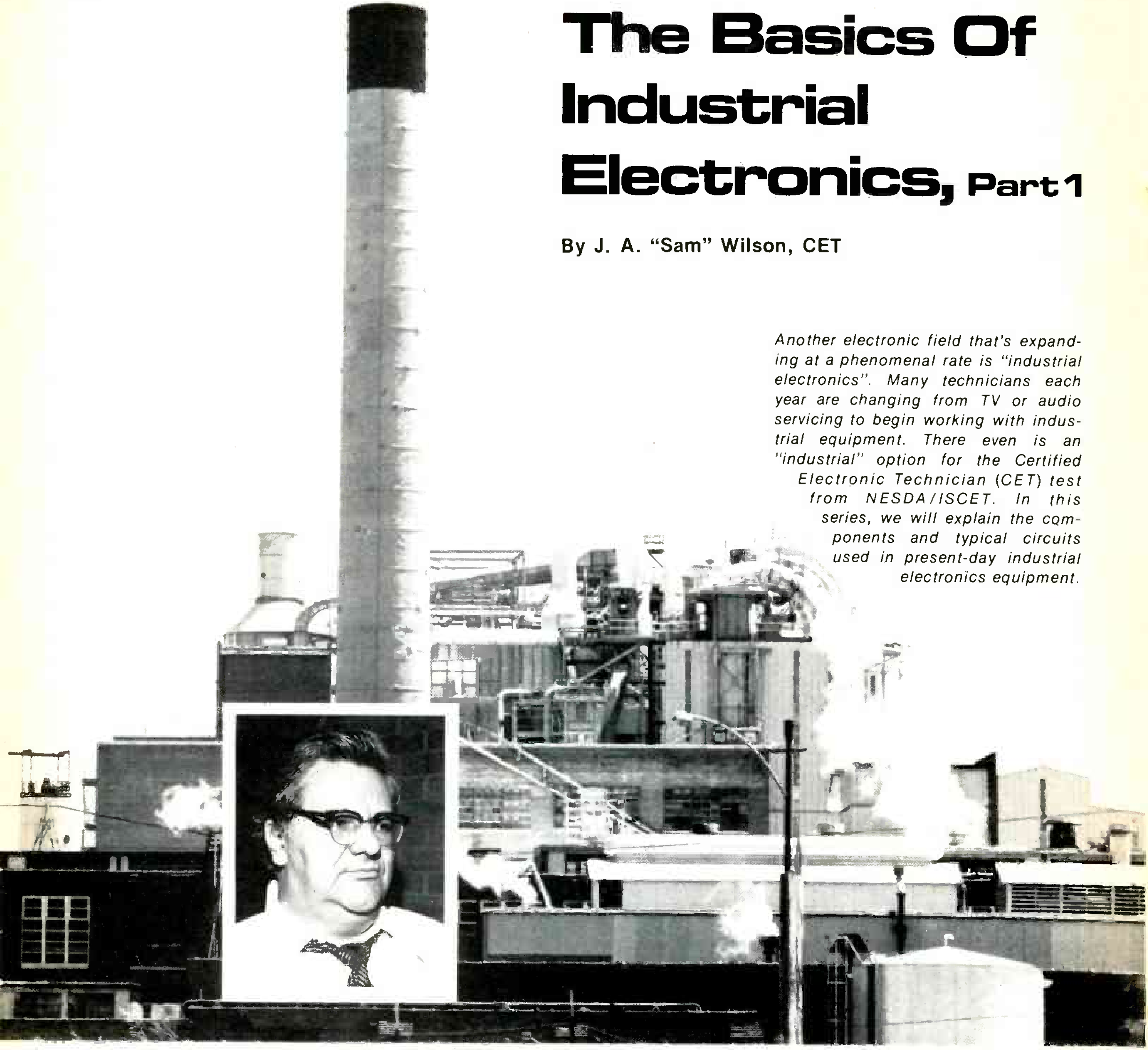
Needed: Knight KG-2000 oscilloscope for parts. Must have good power supply. *Thomas Walls, 6360 Montgomery Avenue, Philadelphia, Pennsylvania 19151.*

Needed: Schematic and power transformer for Heathkit Model V5 VTVM, will buy. *William Mayer, 5722 SW 1st Court, Cape Coral, Florida 33904.* □

The Basics Of Industrial Electronics, Part 1

By J. A. "Sam" Wilson, CET

Another electronic field that's expanding at a phenomenal rate is "industrial electronics". Many technicians each year are changing from TV or audio servicing to begin working with industrial equipment. There even is an "industrial" option for the Certified Electronic Technician (CET) test from NESDA/ISCET. In this series, we will explain the components and typical circuits used in present-day industrial electronics equipment.



It would be helpful if we could give a clear and accurate definition of "industrial electronics", including what it is and also what it is not. Unfortunately, we can't precisely set the limits of any electronic area, because the various fields are interwoven tightly.

Suppose, for example, we defined industrial electronics as "the applications of electronic principles in industry". That definition would include intercoms, telephone systems, television, tape/disc recording and playback, computers, and a host of other devices which are so important that they rate a category of their own.

On the other hand, if you try to narrow the definition by calling it a "study of the use of electronic principles in control systems", you automatically include garage-door openers and remote-control television tuners.

My point is this: any complete study of industrial electronics should cover some subjects that sometimes are included in the more conventional electronic subjects. For example, we will emphasize control systems, logic- and computer-circuitry measurements, and processing. As a bonus, the series also will include the type of information that is needed for you to pass the Industrial Electronics CET test.

Control-Systems Hardware

Solid-state components have changed completely the kind of "hardware" that is used in control systems. Earlier circuits for controlling industrial machinery had "thyratron" and "neon" tubes.

Thyratrons are gas-filled triode tubes which are capable of switching large currents. SCRs are the solid-state equivalents of thyratrons. Neons are gas-filled cold-cathode diodes that have a "breakover" characteristic. In other words, no current flows until the voltage exceeds a minimum critical value. Three-layer diodes, called "diacs", and the modern solid-state equivalent.

Integrated circuits (ICs) have made possible giant changes in the design and capabilities of industrial electronic systems. However, not all of these systems employ ICs. For example, the control circuits manufactured by Versaframe (see Figure 1) have discrete (separate and distinct) components, including transistors, diodes, and resistors. In ICs, all of these components would be in a single small package.

However, we won't omit vacuum tubes, for many rugged items of equipment still use them.

Basic Controls

Although industrial electronics includes many other important subjects besides control systems, such systems are used extensively in many applications. Usually they are the "open-loop" type, or the "closed-loop" controls. To compare the two systems, we will use block

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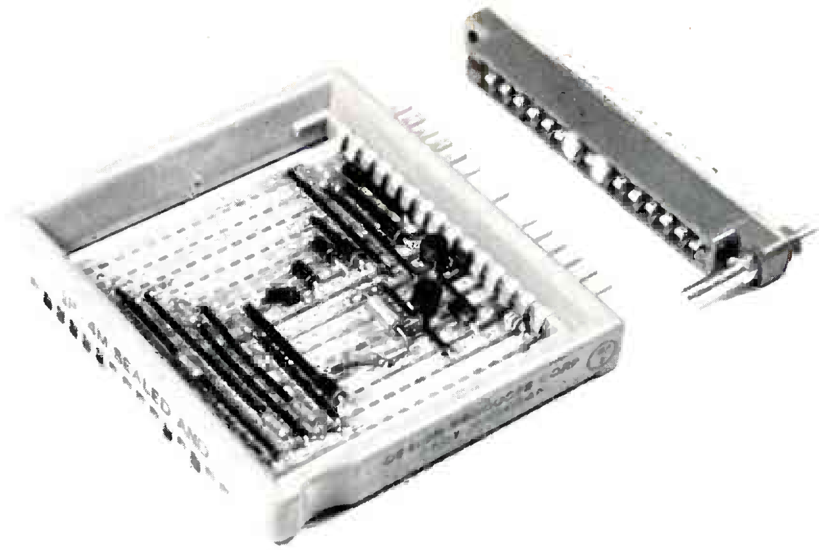

Fig. 1 Some wired logic modules have discrete components. (*Courtesy of Versaframe Division of Design Products*)

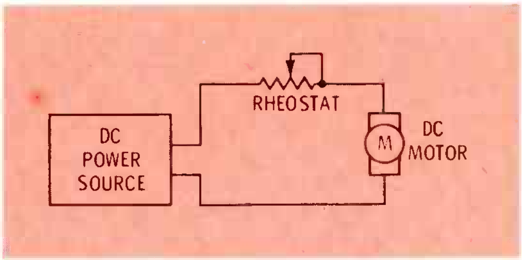

Fig. 2 A power rheostat is the most simple controller of DC-motor speed. Motor speed and power depends primarily on the current.

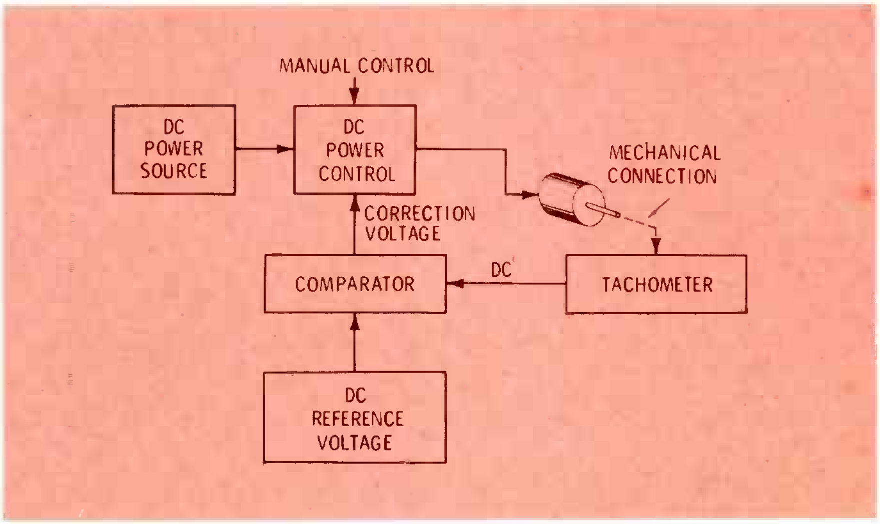

Fig. 3 A closed-loop analog system can control the speed of a DC motor. Faster shaft rotation produces a higher positive voltage from the tachometer, and this variable voltage is compared with a fixed DC reference voltage. Wrong motor speeds cause a positive or negative correction voltage from the comparator, and it adjusts the power-control circuit in the direction needed to restore the correct motor speed.

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diagrams for the speed control of DC motors.

Open-loop controls

As shown in Figure 2, the speed of the DC motor is dependent upon the armature current. A variable resistor (wired as a rheostat) controls the amount of current.

This is an example of open-loop control, because following the setting of the rheostat, there is no direct control of the speed. If the load on the motor changes, so will the shaft speed.

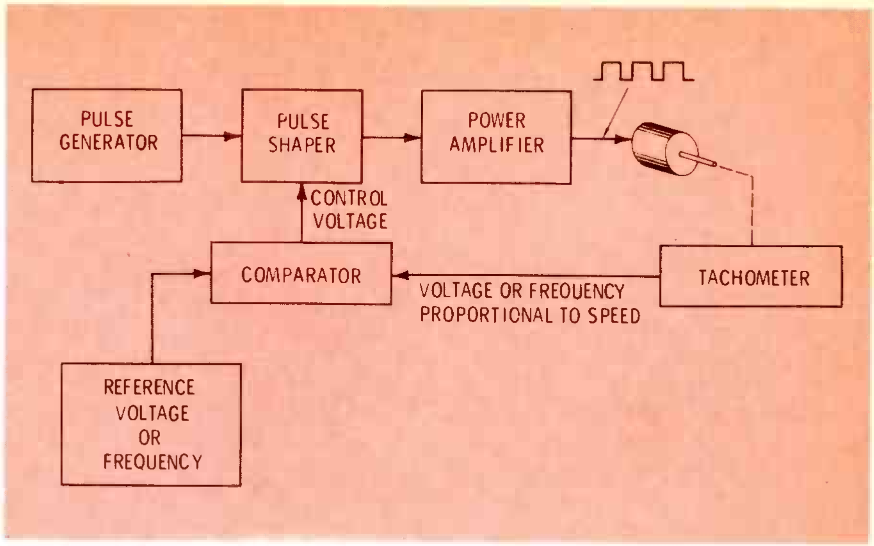

Fig. 4 Digital control of DC motor speed changes the width of the pulses of DC voltage.

Closed-loop controls

One example of a closed-loop speed-control system is given in Figure 3. This system is not necessarily the best one for regulating motor speed, but it does illustrate the principles that are involved.

First, a manual adjustment sets the armature current to the desired value, which should provide the approximate speed. Motor speed is sensed by a tachometer which, in this example, has a DC output voltage that is proportional to the motor speed. Faster motor speed develops a higher DC voltage.

The variable tachometer voltage is compared to a non-varying (reference) DC voltage. When the two voltages are equal, it is assumed that the motor speed is normal, and no correction is needed.

If the motor speed changes, a correction voltage (that is proportional to the error) is fed to the control circuit. The correction voltage restores the motor speed.

Closed-loop speed-control systems continually monitor the motor speed, and correct it when it is slow or fast. Sometimes these systems are called "continuous", to indicate control at all times.

Closed-loop systems of this type require a sensor for measuring the speed, comparators for determining the relationship of the DC voltages, amplifiers, power supplies, and other refinements. Although such analog systems can be designed to hold the speed fairly well, digital closed-loop systems usually have better control and are more efficient.

Digital closed-loop systems

The block diagram of a closed-loop digital system for controlling the speed of a DC motor is given in

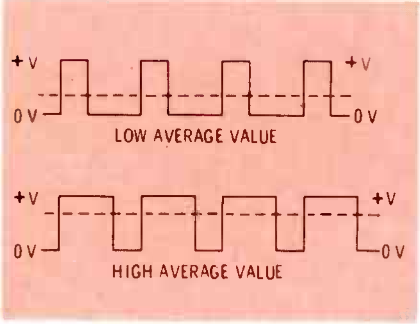

Fig. 5 Narrow duty-cycle pulses (above) have a low average voltage, while below are shown wide duty-cycle pulses that have a high average.

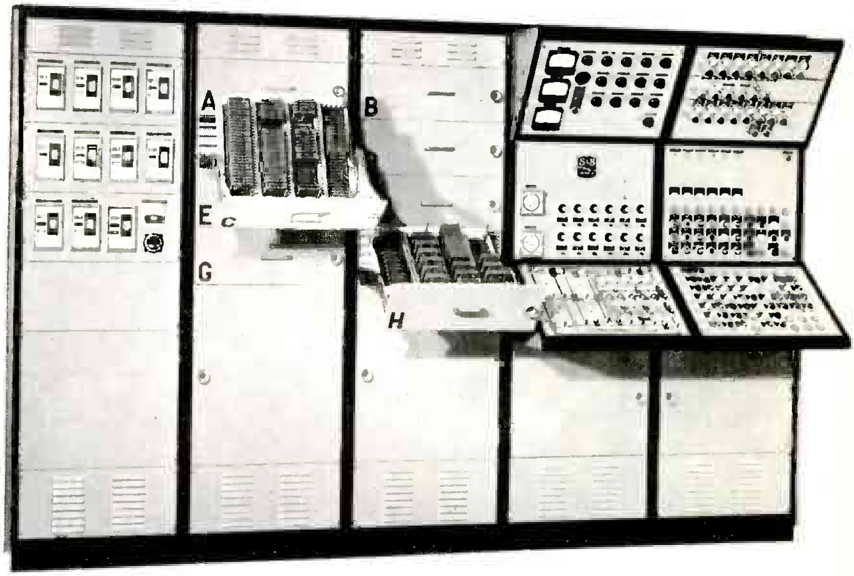

Fig. 6 A large industrial electronic system can control many functions simultaneously. Although each control circuit might be fairly simple, the total of all controls make up a very complex system. *(Courtesy of Versaframe Division of Design Products)*

Figure 4.

First, we must understand that a DC motor, which normally runs on continuous voltage and current, will operate at a slower speed, if the electrical power is applied intermittently. For example, you can slow a motor by switching the power on and off rapidly. This essentially is the method for digital control, although it is called "pulsed" DC current.

In Figure 4, the motor speed is sensed, and the error voltage used for control is returned to the pulse circuitry, where it determines the "duty cycle" of the pulse generator and shaper. In other words, it varies the "on" time versus the "off" time of the DC-voltage pulses.

Motor speed depends on the **average** DC current. Figure 5 shows how the average current value is affected by the width (duration) of the pulses of current.

Control summary

The three simple examples of motor control prove that such circuits can be rather complex. Further, the control systems become much more extensive and sophisticated when they are designed to control other machine operations and even whole processes.

However, these controls are only one type of industrial electronics. When many additional functions are added, the resulting system (see Figure 6) can be extremely complex and sophisticated. That is all the more reason to study and understand the individual circuits.

Transducers

If you need to control the speed of a motor or the temperature of an oven (or any other industrial functions), you must have the right kind of "transducer" to determine the state of the system being controlled. For example, you can't control the speed of a motor unless you can measure how fast it is running.

Transducers (sometimes called sensors) have been defined as devices that convert energy from one form to another. Of course, that is not possible (except for a few rare exceptions, such as the atomic bomb). To be precise, **a transducer is a device permitting**

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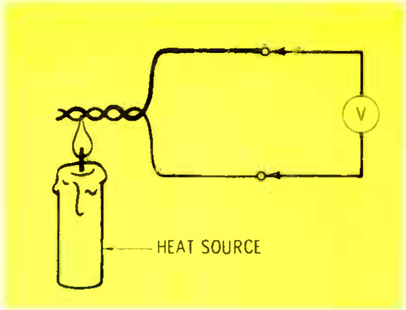

Fig. 7 Voltage is produced by the Seebeck effect when the junction of dissimilar metals is heated.

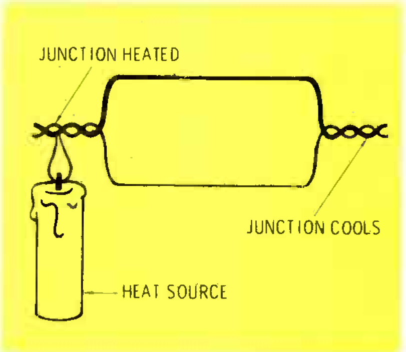

Fig. 8 The Peltier effect cools the opposite junction of two dissimilar metals when the first junction is heated. Cooling by this effect now is practical.

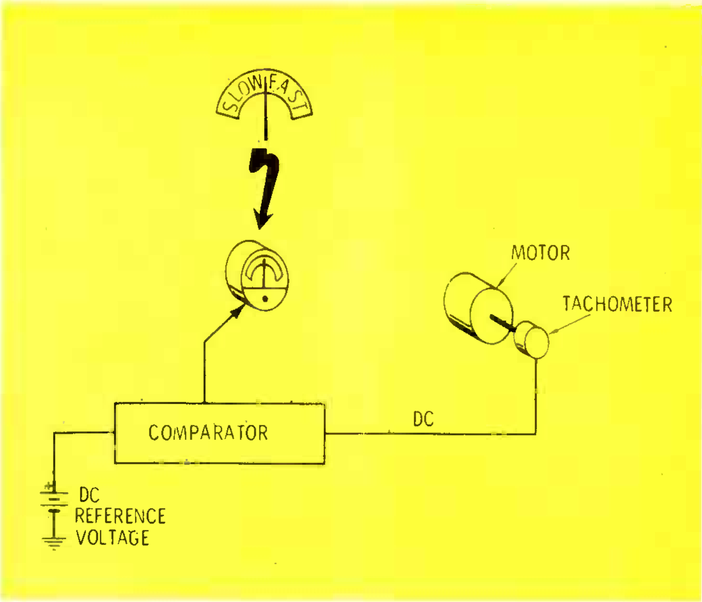

Fig. 9 A slow-fast speed meter uses some of the principles of Figure 3, except the relative speed is measured by the meter, and there is no automatic control.

Industrial

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the energy of one system to control the energy of another system.

A common example of a transducer is a loudspeaker, where the **electrical** energy controls the **sound** energy. Also, microphones use sound energy to control the amount of electrical voltage or energy.

Passive and active transducers

Usually, two basic types of transducers are used in industrial electronics. "Active" transducers generate a voltage (or current), while "passive" ones do not. (Purists say that current can't be generated; **only voltage can be generated**, and current results when the voltage reaches a resistance. That's true. But to save time and space, we'll continue to call it generated current.)

Passive transducers usually change the resistance, capacitance, or inductance in a circuit according to some change of the input energy.

Active transducers generate a voltage or a current that is proportional to the amount of input energy.

Generating A Voltage

There are six basic methods of generating a voltage, but not all of these ways are used in active transducers. The following is a brief review of the six methods.

Electrostatic voltage

When two different types of insulating materials are rubbed together, electrons can leave one surface and cling to the other. This makes a voltage difference between the two materials. It is called an "electrostatic" voltage.

Electrostatic generators easily can produce large amounts of voltage, but their current capacity is very limited. Electrostatic voltage can be used in a precipitator of dust or smoke particles, but the electrostatic principle is too inefficient for use in transducers.

Chemical voltage

A voltage can be generated chemically between two pieces of dissimilar metal that are immersed in an acid or alkaline solution. Auto batteries are one obvious example. However, the method does not lend itself readily for use in transducers.

Photoelectric voltage

Photoelectric transducers often are used for converting light to electricity or electricity to light. Such "optoelectronic" devices are employed extensively in industrial electronics.

Thermoelectric voltage

A voltage proportional to the amount of applied heat is the output of thermoelectric transducers.

There are two basic thermoelectric effects that you should know about. One is the **"Seebeck"** effect (see Figure 7). Whenever the junction of two dissimilar metals is heated, a DC voltage is available at the two ends. Some metals produce a voltage so small that it's barely measurable. Others can generate a useable amount of voltage. Some furnace safety controls operate this way.

Another thermoelectric phenomena is called the **"Peltier"** effect, as illustrated in Figure 8. When the junction of two dissimilar metals is heated, the opposite junction becomes cooler. For years, this was merely a lab curiosity, because the amount of cooling was small. However, refrigerators now are being made with Peltier-effect cooling.

Piezoelectric voltage

Certain crystalline materials will generate a voltage when their shape is changed. Quartz and barium titanate are two examples of piezoelectric materials. Rochelle-salts crystals and ceramic materials have been used in phonograph cartridges.

This effect is reversible. If a voltage is applied to a piezoelectric surface, the shape of the material will change.

Electromagnetic voltage

According to **Faraday's** law, when there is relative motion between a conductor and a magnetic field, a voltage will be produced in the conductor. The amount of voltage depends on the speed of their movement relative to each other, the strength of the magnetic field, and the number of conductors (turns of wire in the coil). AC and DC generators both operate by this principle. Many industrial transducers are electromagnetic in nature.

One application of an electromagnetic transducer is the tachometer shown in Figures 3 and 4. A tachometer converts the speed of rotation into a voltage, a current, or a frequency.

Figure 9 shows how a tachometer with a voltage output can be used to sense motor speed. The voltage is directly related to the speed of rotation (faster speeds produce higher voltages), and it is compared to a reference voltage. When the motor speed is too fast, the tachometer DC voltage is more positive than that of the reference, and the comparator will have a positive error-correcting output voltage. But, if the speed is too slow, the tachometer voltage is lower than the reference voltage, and the comparator output voltage will be negative. Correct motor speed gives the same comparator and reference voltage, so the comparator output voltage will be zero. A zero reading of the zero-center meter indicates correct speed.

The meter readout of Figure 9 is said to be an "analog" type, because the pointer deflection is "analagous" to the motor speed. A digital readout would display the actual motor shaft speed in the number of revolutions per minute.

Comments

Part 1 has defined some basic industrial electronic terms. Also, the range of subject matter that will be covered in this series has been explained. Next month, passive transducers will be examined, along with a review of basic (but often misunderstood) principles of inductance, capacitance, and resistance. □

The Future For Factory Technicians

Here is an analysis of the changing opportunities for technicians, from the viewpoint of a major manufacturer of high-quality test equipment. ***The repair of test equipment,*** *both at the regional service centers and the factory facilities,* ***is a part of industrial electronics.***

By Kenneth Jessen
Hewlett-Packard Company

What does the future hold for the electronic repair technician? To fully appreciate the answer to this question, one must understand some of the trends in the industry.

First, products are becoming more complex, forcing the technician to spend more time per repair. For example, the old discrete form of digital logic is fast yielding to microprocessor-based technology. With discrete logic, the elements required to perform a task were distributed throughout the product. A bad IC could be detected by simple troubleshooting techniques.

This calibrator is operating a calculator-controlled, automatic test system at the Hewlett-Packard plant in Loveland, Colorado. With the automatic system, the operator can run complete calibration and performance tests in ten to fifteen minutes, compared to an hour and a half for the same tests that are run manually. Some factory repair branches use similar systems to save time for the technicians, thus allowing more troubleshooting and component replacements to be done. Skilled technicians are needed in the factories to develop such systems.

With microprocessor technology, the logic is centralized. A digital feedback loop is used to send an address to an array of Read Only Memories (ROMs) then new instructions are sent back to the microprocessor. This sequence of new addresses and new instructions is repeated at megahertz rates. With existing tools, this technology makes it difficult to find individual defective components.

Another trend in the repair business is that the labor rates billed back to the factory for products in warranty have increased at a rate far greater than inflation would dictate. This has not translated into higher pay for the repair technician, however. A great deal of this trend has to do with rising overhead costs at repair facilities (such as shipping, telephone, heating, computer services, etc.)

The last element is a trend towards lower prices for electronic products. In the instrument business for example, a four-digit DVM costing well over $1,000 a decade ago now can be purchased with improved specifications, better reliability, and more features for around $400. More examples can be found in the consumer business with dramatic price reductions in hand-held calculators, CB radios, TV games, and so on.

The point is that increased complexity combined with higher labor rates has driven repair costs up. When combined with lower prices, rising warranty costs have put the manufacturers into a profit squeeze. Worst yet, customer complaints are growing as the cost of an out-of-warranty repair becomes a substantial percentage of the original purchase price. In analyzing repairs, it is the labor content that is causing the problem. In the instrument business, labor content runs 60% to 80% of the total repair cost. The major thrust on the part of the manufacturers is to make the repair activity less labor-intensive. This leads to the question: what will happen to the electronic-repair technician?

Automatic Testing

More than half of the time spent on the repair of an electronic

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instrument involves either verification of the fault or checking out the instrument after the repair is completed. These portions of the repair process are being automated through the use of computer or calculator-controlled automatic test systems. Not only does automation result in faster repair times, but the technician can be replaced by a nontechnical person to run the tests.

Centralized Repair

Hand-in-hand with automatic testing in the field comes centralization of repairs. The number of repair centers which a manufacturer elects to set up depends on the expected repair volume, sales distribution, and the versatility of the automatic-test system in terms of its ability to check more than one line of products.

It is only logical that a technician working on the repair of one line of products becomes far more efficient than the technician in a "one man" shop trying to repair a wide range of products. Data indicates that the volume of repairs is inversely related to repair time. Centralization is a simple means of increasing repair volume, but it also offers some other advantages.

The repair center can afford to stock a higher percentage of heavily-used replacement parts. A lot of the paper work such as billing, inventory control, and payroll can be done at a center on a computer far more efficiently than a small office can hope to do.

For the technician, the repair center can offer more opportunity for advancement, since larger organizations require more levels of management. The specialization which comes with centralization allows the technician to become closer to the factory. This has resulted in opportunities to move from the field into a position with the manufacturer.

Exchange Boards

An effective means of reducing the labor content of field repairs is to use an exchange program. The technician determines which module is bad in a product and ships the defective module back to the factory in exchange for a good one. At the factory, the defective module is inserted into the production process where it is remanufactured then placed back into the field.

This type of repair program began on a big scale in the computer industry, and was then extended to desk-top calculators. With increased complexity as evidenced by the use of microprocessor technology, board-exchange programs are becoming more practical for all types of electronic products. Unfortunately, this has reduced the technician's job to that of a board-swapper rather than being a highly-skilled detective able to hunt down a problem to the one bad component.

> *...products are becoming more complex, forcing the technician to spend more time per repair...portions of the repair process are being automated...Hand in hand with automatic testing in the field comes centralization of repairs.*

For example, one signal source involving new technology, if tested manually, requires 15 hours because of the numerous combinations of frequency and output levels. This same test can be done in 15 minutes automatically and with greater accuracy with the elimination of drift problems. The system automatically prints out the result of each test in the form of a test card.

There are several digital voltmeters where manual verification of the specifications requires an hour and a half. Automatic testing not only checks the specificiation, but the instrument can be completely calibrated, all in 10 to 15 minutes by a nontechnical person.

Automatic test systems which in the past had been restricted for use on the production lines in the factory now are rapidly finding their way into the field repair facilities. The effect on the repair technician has been to spend less time testing and more time on troubleshooting and repair.

When viewed from the customer's standpoint, module exchange has some advantages, such as making the cost of repair more predictable by reducing the labor content in favor of fixed material costs. For systems repair at a customer's facility, a board-exchange program is almost mandatory since the only fast way to make a repair is to the modular level. Even for bench repair, board exchange can greatly reduce turn-around-time, especially if the boards are in the form of a kit.

The Future

The increased cost of repair is forcing changes in the electronic repair business which will have far-reaching effects on the future of the repair technician. As mentioned, manufacturers are moving away from the small, local repair facility in favor of larger repair centers. The technician must be willing to specialize and move with this trend.

Increased complexity has forced many manufacturers to use a board-exchange program instead of component-level repair, and the technician must be willing to do more board swapping. On the bright side, the opportunities in the factory for good technicians is improving continually. Technicians with both traditional troubleshooting skills as well as programming knowledge are needed to develop automatic-computer or calculator-controlled systems for use on the production line. Skilled technicians are needed to turn on the products, diagnose failures, and make repairs.

Educational requirements will continue to demand a good background in the fundamentals, but new emphasis must be placed on the use of microprocessors. Some programming knowledge also is becoming more valuable.

In summary, the job market for technicians remains strong but there is a definite shift from careers in the field to the factory. □

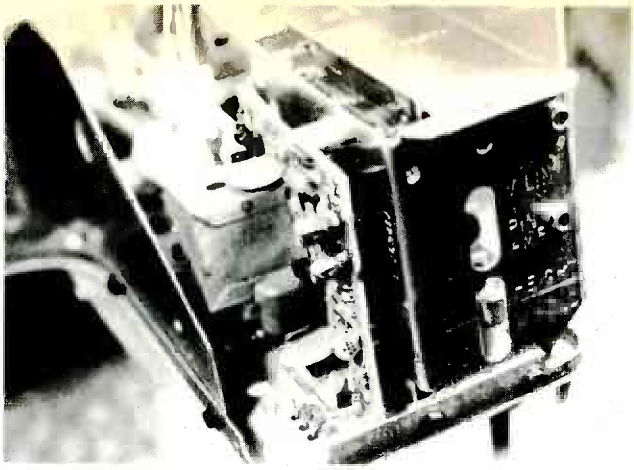
Get 'em while they're hot.

Raytheon is really hot stuff these days. Their RE semiconductors and receiving tubes are super values by themselves. And now with every kit you order, you also get a free Model TPS-2 Kidde dry chemical fire extinguisher. Now that's one red-hot deal.

The REK-2000 semiconductor kit is a hot item in its own right. It's a new 79 piece SupeRE kit with 24 drawers full of the 24 most popular replacement types, all interchangeable and cross-referenced right on the package. And the new Raytheon receiving tube kit has been packaged up to contain five each of 10 best selling types . . . and priced down to give you more profit.

Add a free Kidde fire extinguisher and you've got perfect protection for your home, office, boat, service shop or truck. Add it all up and you've got a sure-fire bargain. Order today from your Raytheon distributor or write Raytheon Company, Distributor Products Operation, Fourth Avenue, Burlington, MA 01803.

For More Details Circle (13) on Reply Card

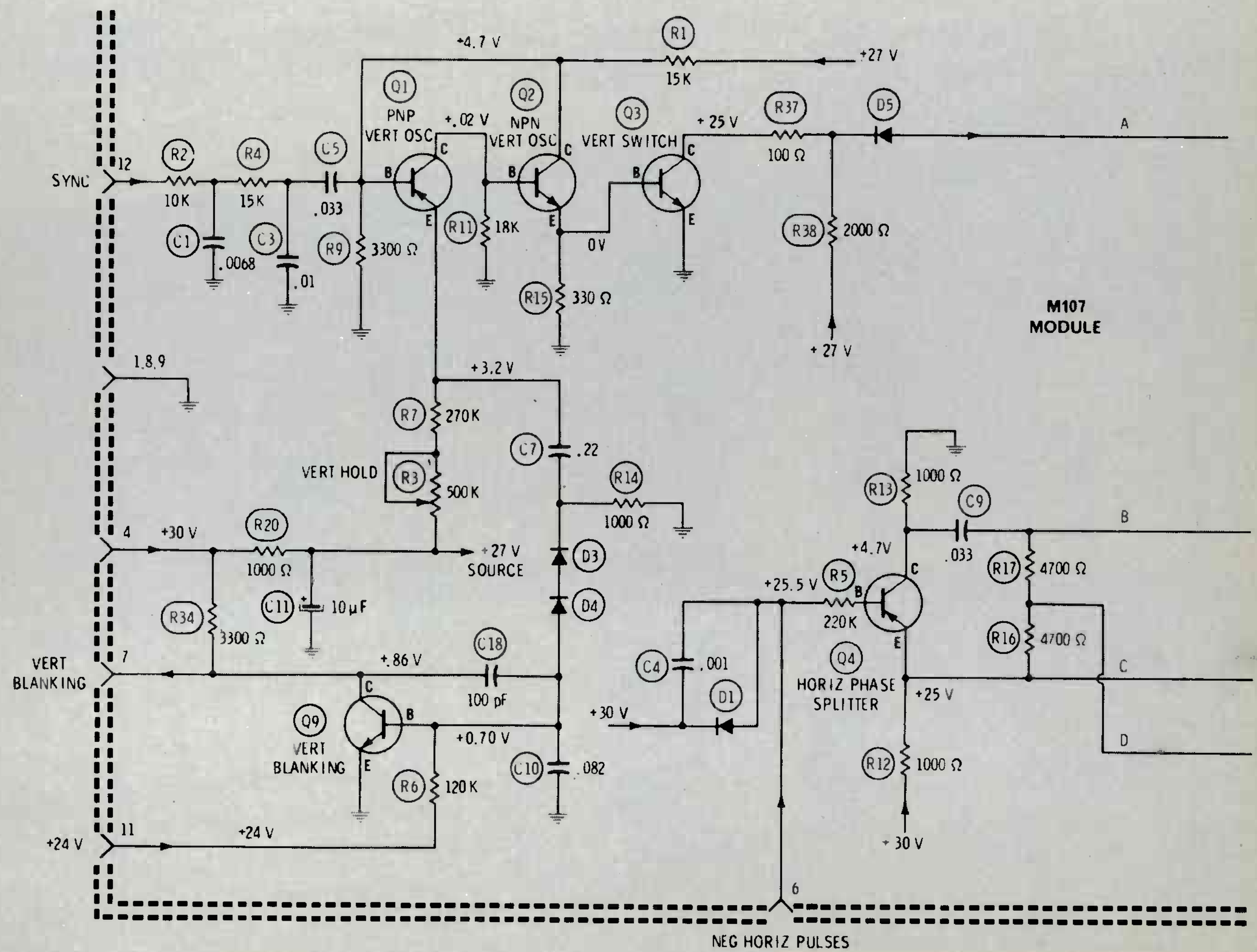


After the chassis of the Magnavox T995 has been tilted back to the service position, the vertical module is at the right edge of the chassis. Slots in the shield give access to adjustments for vertical linearity, pincushion amplitude, and height. The vertical-hold knob points down.

Some surprises are revealed in the vertical-sweep circuit of the Magnavox T995 chassis. For example, top/bottom pincushioning is corrected by producing a variable-amplitude variable-phase horizontal waveform, which is filtered and applied to the base of the vertical-output transistor.

Servicing Magnavox Modular Color TV, Part 2

By *Gill Grieshaber, CET*



Other models we have studied in this modular series have had complementary-symmetry two-transistor vertical-output stages, which either drove the yoke coils directly or through a large coupling capacitor. Circuitry of the vertical sweep in the **Magnavox T995 chassis** is completely different. The output is from **one** power transistor. An iron-cored choke carries the transistor current, while a large capacitor couples the AC signal to the yoke coils.

The other original feature is the method of correcting for the top and bottom pincushioning. However, all of these interesting circuits will be explained in the proper order.

Much of the vertical circuitry is on M107 module (see Figure 1).

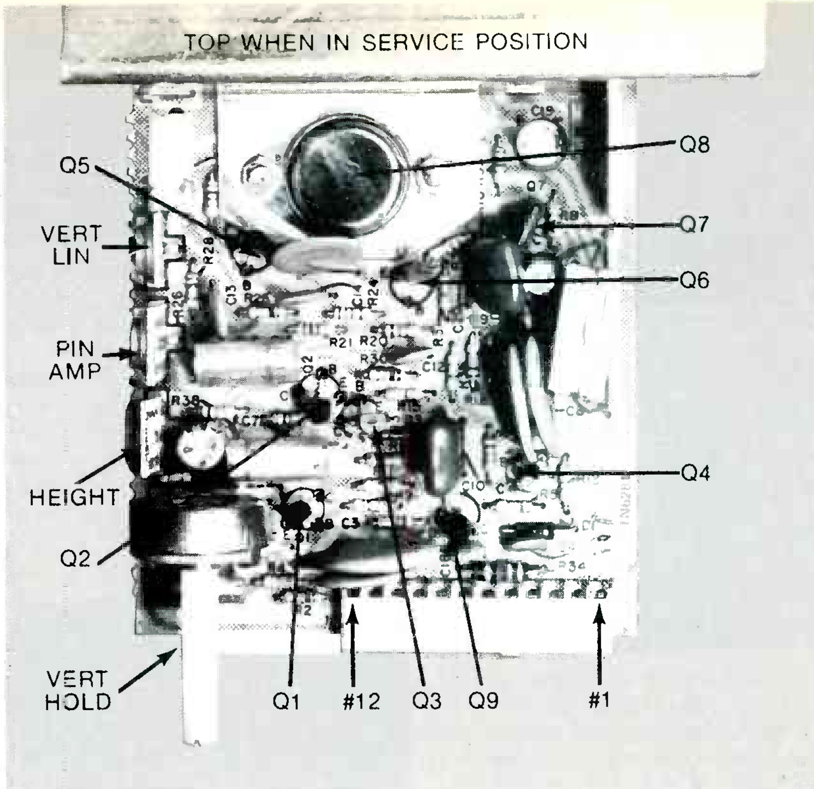


Fig. 1 Arrows point to the transistors on the M107 vertical module.

Vertical Oscillator

In Figure 2, Q1 (PNP) and Q2

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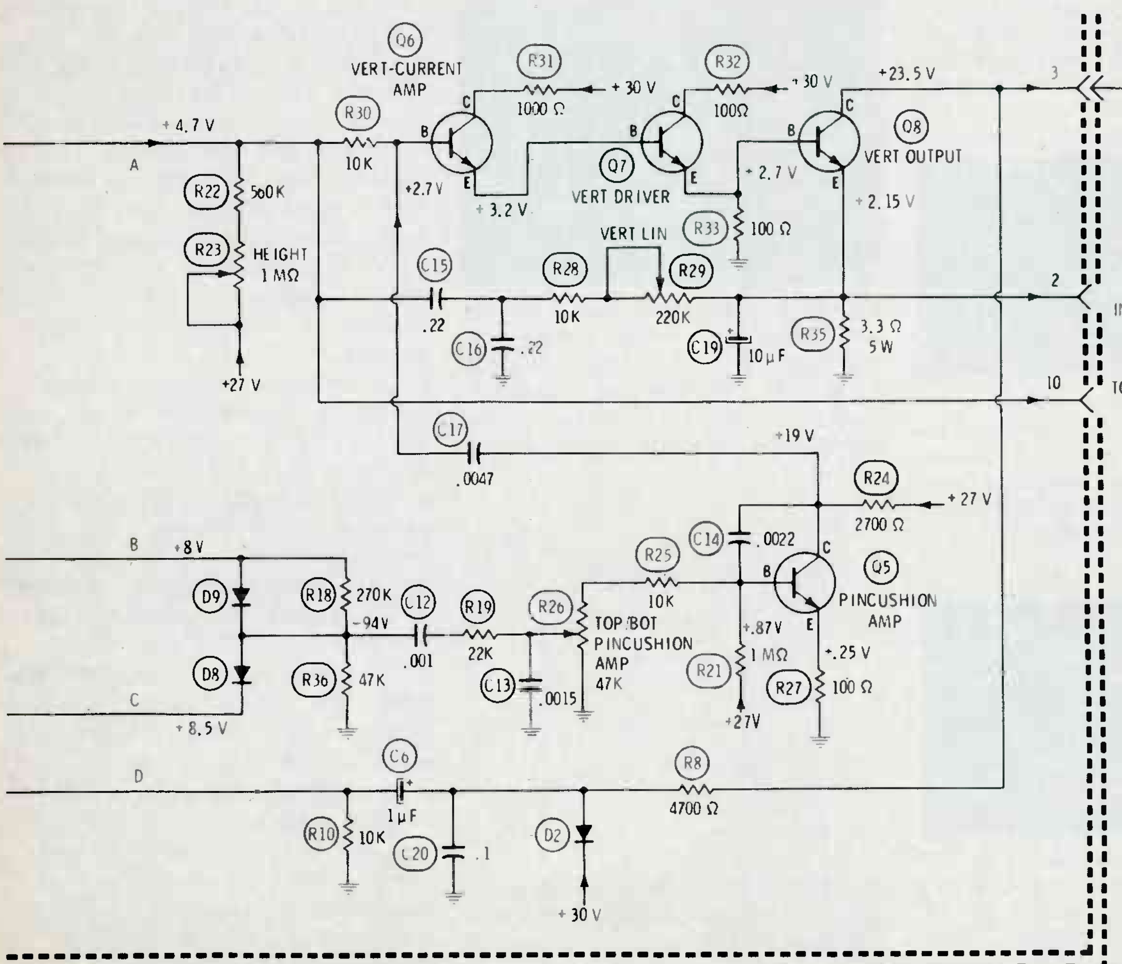

Fig. 2 The module circuitry includes: Q1 and Q2 oscillators; Q3 switching transistor; Q6, Q7, and Q8 amplifiers; Q9 vertical-blanking amplifier; plus Q4, Q5, and diodes D9 and D8 of the pincushion-correction circuit.

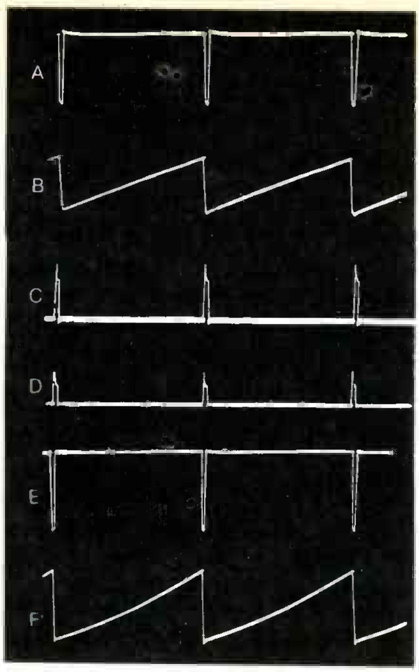

Fig. 3 These are the waveforms of Q1, Q2, Q3, and D5. (A) The base of Q1 has 4 VPP negative-going pulses. (B) Sawteeth of 4 VPP are at the emitter of Q1 (this is the circuit that determines the frequency of oscillation). (C) Positive 1-VPP pulses are at the Q1 collector and the Q2 base. (D) Smaller pulses of 0.6 VPP are at the emitter of Q2. (E) The collector of Q3 has 28-VPP negative-going pulses. (F) At the anode of D5, the pulses have been integrated into 4.4-VPP sawteeth.

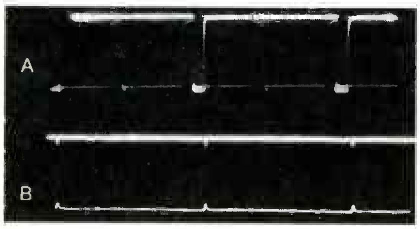

Fig. 4 Sync enters the module at pin 12. The amplitude is 24 VPP and the DC reading is +21 volts. Top trace is the sync viewed at horizontal rate, while the same sync at vertical rate is shown by the bottom trace.

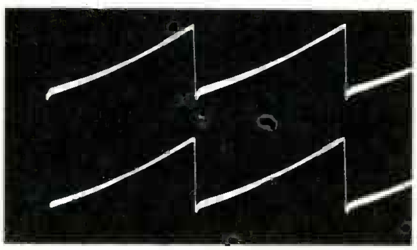

Fig. 5 Identical sawteeth of 4 VPP appear at the base and emitter of Q6, and the base and emitter of Q7. Figure 2 gives the DC voltages. These transistors are emitter-followers, which have a voltage gain of 1.

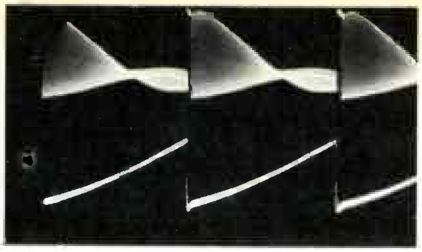

Fig. 6 Top trace is the 80-VPP waveform at the collector of Q8. The "wings" are the horizontal varying-amplitude varying-phase signal that corrects for top/bottom pincushioning. The bottom trace shows the 4-VPP sawteeth present at the emitter of Q8 (the base waveform is nearly identical). This waveform also goes to the power supply to correct side pincushioning (see last month).

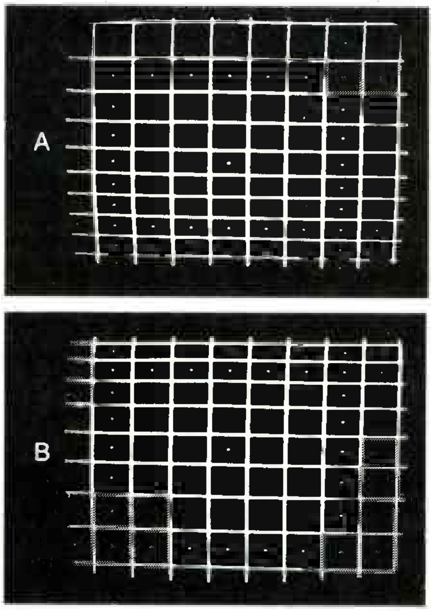

Fig. 7 (A) Clockwise rotation of the vertical-linearity control spreads the crosshatch at the top and compresses it at the bottom. (B) Counterclockwise rotation compresses the top and spreads the bottom of the picture.

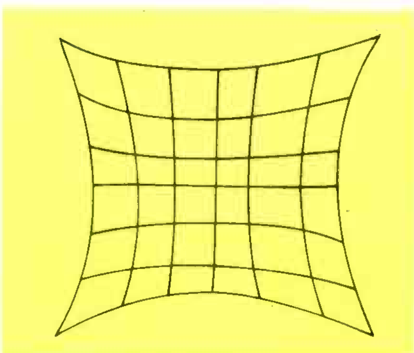

Fig. 8 Wide-angle deflection increases the apparent scan at the edges and corners of the picture tube, as illustrated by this exaggerated drawing.

Magnavox, part 2

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(NPN) transistors form a time-constant oscillator. Although the oscillation is triggered by the cross-connections of the bases and collectors (as is usual for multivibrators), this is not a multivibrator, and the frequency is not determined by the R/C values at the two bases. Instead, C7 and R7/R3 of the Q1 emitter circuit determine the oscillation frequency.

Oscillation

This is the sequence of the oscillator actions:

- When DC power is first applied to the vertical-sweep module, both Q1 and Q2 are cut off. The base of Q1 receives almost +5 volts from R1 and R9. However, the emitter voltage starts at about zero and rises slowly because of the time constant there (R7/R3 and C7). When the base is more positive than the emitter, Q1 is reverse biased, since it is a PNP type. The base bias of Q2 comes from the collector of Q1 when Q1 conducts; therefore, Q2 also is cut off.
- C7 begins to accept a voltage charge, and after 1/60th of a second, the emitter voltage of Q1 rises above the base voltage. This is forward bias (because an emitter that is more positive than the base is the same bias as a base that is more negative than the emitter), and Q1 begins to conduct a small amount of collector/emitter (C/E) current.
- Q1's current produces a positive voltage at the collector of Q1 and the base of Q2; therefore, Q2 also begins to draw C/E current.
- When Q2 draws current, the collector of Q2 becomes less positive, and because it is connected directly to the base of Q1, the base of Q1 becomes less positive. This is increased forward bias for Q1, which draws more C/E current. In turn, this forces Q2 to conduct harder, which forces Q1 to draw more current.
- The regenerative cycle continues rapidly, with each transistor causing the other to conduct more current, until Q1 becomes a near short circuit. This short bleeds the voltage from C7, dropping it to nearly zero volts. When the Q1 emitter becomes zero, Q1 is strong-

ly reverse biased, and stops all conduction. In turn, this stops Q2's conduction. When both transistors are cut off, it's the end of the first cycle of oscillation.

- C7 begins to charge until the voltage exceeds that at the base of Q1. This is forward bias for Q1, and it conducts a small amount, causing Q2 to conduct a small amount, then the Q2 conduction forces Q1 to draw more, etc. The series of actions continues until both transistors are saturated, bleeding C7 and stopping the current in both. That is the end of the second cycle of oscillation. Figure 3 shows the Q1, Q2, and Q3 waveforms.

Locking

Negative-going sync enters the module at terminal 12 (Figure 4). It is integrated by R2/C1 and R4/C3 and is applied to the base of Q1 through C5.

The integrated vertical sync forces the base of Q1 to become less positive just before it would do so from the normal oscillator action just described. In other words, the sync triggers the oscillator just slightly before the usual time, thus locking the vertical oscillator in step with the sync. Of course, this assumes that R3 (vertical-hold control) is adjusted correctly.

Vertical switch transistor

The output waveform from the oscillator is a series of very narrow positive-going pulses (see Figure 3) of a 60-Hz repetition rate. These are taken from the unbypassed emitter resistor of Q2, and are connected directly to the base of Q3. Now, Q3 has no other source of forward bias. Therefore, it is cut off, except during each positive pulse.

Q3 inverts (because the output is from the collector), so the collector waveform consists of strong negative-going pulses. However, that is **not** the waveform reaching the base of Q6, the current amplifier. Between those two points are R37, D5, C15 and C16. D5 allows only the negative pulses to go through, and the resistor versus C15/C16 integrates the pulses into sawteeth (Figure 3 waveforms).

Vertical amplifiers

Q6 is called a vertical-current amplifier. It amplifies current, not voltage, for it is an emitter follower with a gain of 1. The 4 VPP at the high input impedance versus the same 4 VPP at the low-impedance output is a gain of power. Also, more current is needed to supply the output signal at low impedance than is required for the same signal voltage at the higher-impedance base input. The stage, therefore, can be called an emitter follower, a current amplifier, or an amplifier of power (not voltage).

Adding to the confusion, Q7 is called a vertical driver, although it does exactly the same job of current amplification, except at a higher power level. Q6 is a small transistor, while Q7 is a TO-220 intermediate power type. Together they change the impedance in two steps, to reach the low value needed for driving the base of Q8, the power transistor.

The waveforms at the base and emitter of both Q6 and Q7 are identical (see Figure 5).

Vertical output

Both the base and emitter waveforms of Q8, the vertical-output transistor which drives the yoke coils, indicate that Q8 merely should amplify the sawtooth waveform. However, that's only partially true.

Figure 6 shows the emitter waveform (the base waveform is nearly identical) and the collector waveform. But, surprise! Did you notice the unbalanced butterfly wings in the collector waveform? They are from the pincushion circuit.

Perhaps you're wondering why these horizontal waveforms (that correct for the top and bottom pincushioning distortion of the raster) do not appear at the base of Q8. Well, they *do* show in the base waveform, but the amplitude is so low that they only seem to make the sawtooth line a little more broad.

Very little amplitude of the horizontal signal is needed at the base of Q8, because the emitter resistor (R35) is bypassed to the horizontal frequency by capacitor

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continued from page 33

C19. Therefore, Q8 has a high gain to the horizontal frequency.

On the other hand, the value of C19 is not sufficient to bypass vertical frequencies. A large sawtooth is developed at the emitter of Q8, and it subtracts from the base sawtooth. This is degeneration, which sometimes is called negative feedback, and *it reduces the gain at vertical frequencies*, thus requiring a large vertical waveform at the base to produce the proper amplitude at the collector.

Vertical Linearity

Linearity of the vertical sweep is adjusted by regulating the amount of emitter waveform that's fed back to the base signal, by way of C16 and C15.

Rotation of R29 changes the linearity at both the top and bottom of the raster, as shown by the pictures of Figure 7.

Basic Pincushion Information

Before we analyze the unusual circuit that corrects the top/bottom pincushion distortion, we need to review the cause and cure of pincushion.

A drawing of exaggerated pincushion distortion is shown in Figure 8. The reason for the extra scanning width and height involves wide-angle scanning of the yoke and picture tube. But the cause is not as important just now as is the cure.

Figure 9 shows how top/bottom pincushioning can be corrected by adding a horizontal-frequency current having a parabolic waveform to increase the height near the center of each horizontal scanning line. This seems simple; however, complications arise because the phase for top correction is opposite that needed for bottom correction, and maximum correction is needed at both the top and bottom, but none is wanted near the vertical center of the raster.

In all other color receivers, samples of horizontal sweep are filtered and switched (usually by saturable-reactor transformers) to provide the opposite phases of correction, and applied *directly* to the yoke.

This model Magnavox is very

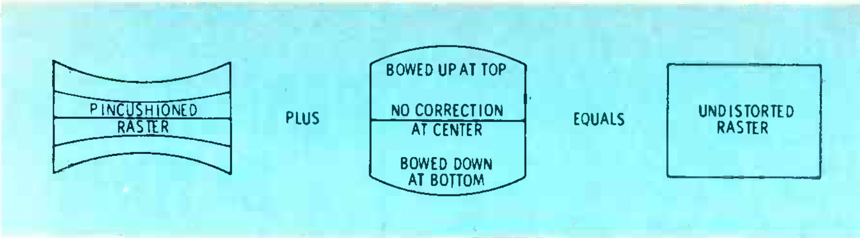

Fig. 9 Increasing the vertical height near the center of the horizontal lines cancels the pincushion. Most circuits correct the top and bottom separately with opposite-phase filtered horizontal-sweep signals.

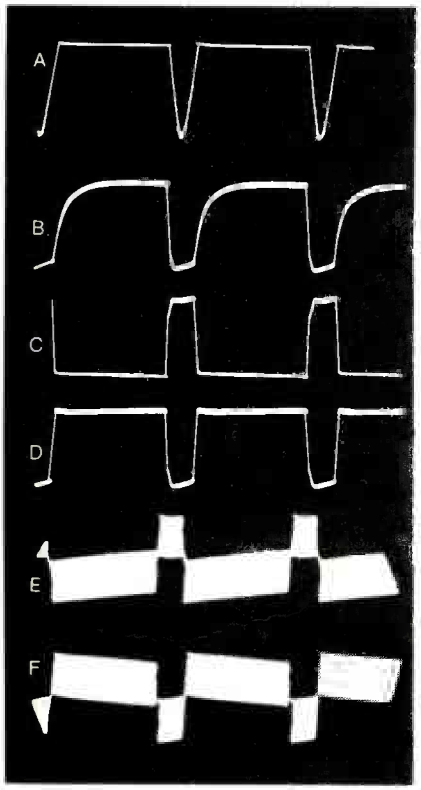

Fig. 10 These are the waveforms of the pincushion-correction circuit. (A) Negative-going 28-VPP horizontal pulses enter the module at pin 6. (B) The base resistor partially integrates the pulses when they reach the base of Q4. These pulses measure 19 VPP. (C) Pulse outputs from Q4 are nearly equal in amplitude and 180° out of phase. This is the positive 14 VPP collector pulses. (D) Negative 15-VPP pulses are formed at the emitter of Q4. (E) At the anode of D9 is this 25-VPP waveform. It is the same signal as in (C), but the trace is broadened by the vertical sawtooth signal that's applied to R16 and R17. (F) The 25-VPP waveform at the cathode of D8 is the same as (D), but with the vertical waveform added. The 60-Hz sawtooth makes D8 and D9 conduct alternately; therefore, the output at R36 changes in phase and amplitude. For all waveforms, the scope was set for the horizontal rate.

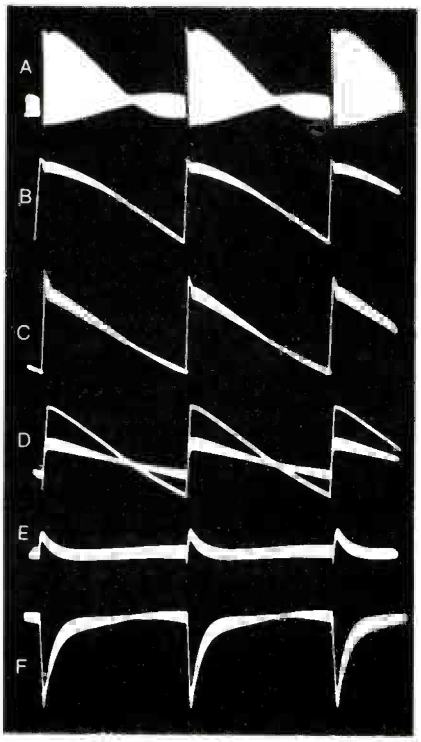

Fig. 11 This sequence shows how the vertical-sawteeth for D8 and D9 are made, and also gives the Q5 waveforms. (A) At Q8 collector, the vertical sawteeth have retrace pulses and the horizontal signals. (B) After filtering by R8/C20, a rounded sawtooth form of 26 VPP remains. (This waveform can be found at the anode of D2.) (C) Coupling capacitor C6 straightens the ramp of the sawtooth shape and reduces the amplitude at R10 to 15 VPP. (D) Output from D8 and D9 at R36 (13 VPP) has a small amount of vertical sawtooth, and strong horizontal pulses of alternate polarities. (E) After the pulses are filtered twice into approximate parabolas, the base of Q5 has this 0.1 VPP signal made up of 60-Hz ripple plus low-level horizontal parabolas that make the trace thicker. (F) The 1.7 VPP waveform at the collector of Q5 has the groups of horizontal parabolas that are coupled through C17 to the base of Q8. Notice the thinner base trace about midway between the vertical pulses. That's where the pincushion-correction signal is almost zero. All of these waveforms were made at the vertical rate.

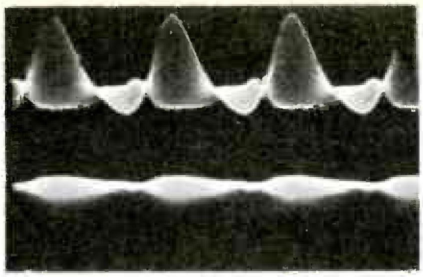

Fig. 12 Top trace is the Q8 collector waveform, and the bottom trace shows the Q5 collector waveform when the scope was set to the horizontal rate. To the eye, the "mountains" and "valleys" are made up of many traces of varying amplitude. Also, each mountain and valley has an opposite polarity of parabolic waveform.

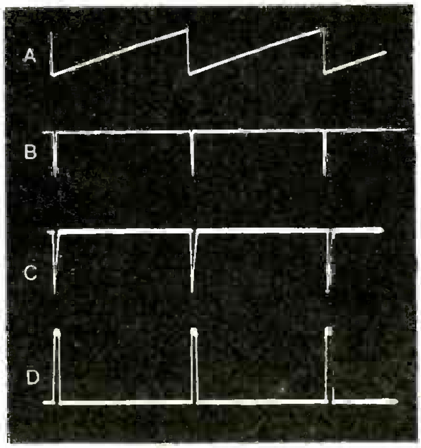

Fig. 13 This sequence shows the origin of the vertical-blanking waveform. (A) Top trace is the 4-VPP waveform at the emitter of Q1. (B) At the junction of C7 and R14, differentiation of the sawtooth produces narrow 2.5-VPP negative pulses. (C) After going through D3 and D4, and being filtered a bit by C18, the 1.9 VPP pulses at the base of Q9 are wider. (D) Clipped narrow pulses of 21 VPP are produced at the collector of Q9. These are ready for vertical blanking in the video circuit.

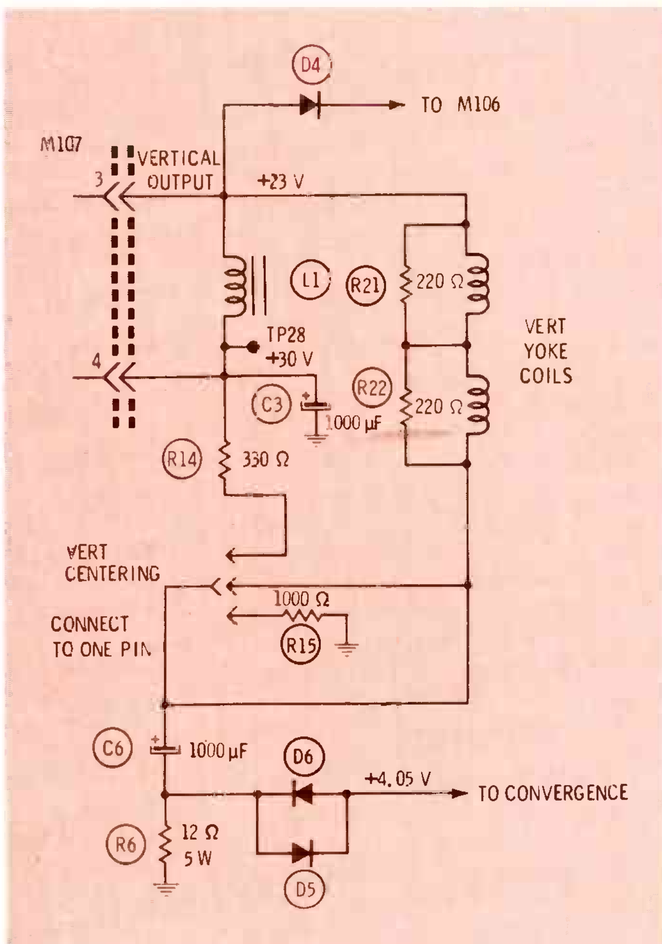

Fig. 14 This part of the vertical sweep (including the centering taps) is external to the module.

unique because the processed horizontal signal is amplified by the vertical-output transistor. Refer to Figure 2 for the schematic, and we'll show waveforms as we explain the circuit operation.

Magnavox Pincushion Correction

The pincushion-correction waveform for the base of the vertical-output transistor is made from out-of-phase horizontal pulses that are modulated by a vertical sawtooth. Refer to the waveforms of Figure 10, as we go through the various steps.

Negative-going horizontal pulses come into the module at pin 6. Diode D1 clips any positive peaks of the waveform that exceed +30 volts, since D1 is clamped to the +30-volt supply. The pulses are attenuated by R5 before they reach the base of Q4, the phase-splitter transistor. Pulse waveforms at the collector and emitter of Q4 are equal in amplitude, but opposite in phase. These waveforms are applied to diodes D9 and D8 through C9 and C8.

Now, in the absence of a vertical sawtooth at the midpoint of R17 and R16, the DC voltages from the diodes (and the AC waveforms) would cancel, leaving no AC and no DC voltages. This is the desired condition at the center of the vertical scan.

However, a vertical-sawtooth waveform is applied to the diodes through R17 and R16. Before continuing, we'll see how this sawtooth is produced.

R8 brings in a sample of the waveform from the collector of Q8 (the vertical output). D2 clips any waveform at the output of R8 that exceeds 30 VPP, and C20 removes the horizontal "butterfly wings" (which are the pincushion-correction waveform). The waveform at C20 is a slightly-rounded sawtooth (see the waveforms in Figure 11), which is made more linear by the coupling capacitor C6.

Because this sawtooth comes through C6, the zero line is in the horizontal center of the sawtooth waveform, thus producing equal-amplitude positive and negative peaks of the sawtooth. This is the sawtooth that comes to D9 and D8 through R17 and R16 respectively. The sawtooth upsets the AC and DC balance at the output (R36) of the diodes.

When the positive peak of the vertical sawtooth is at the diodes, it prevents D8 from conducting. At the same time, it adds to the wave-

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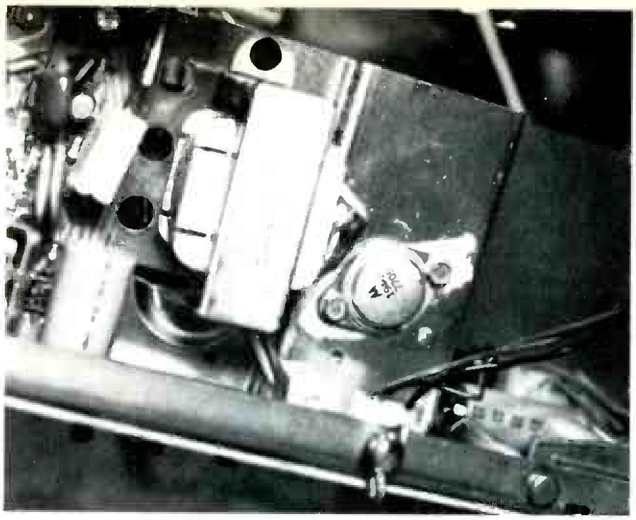
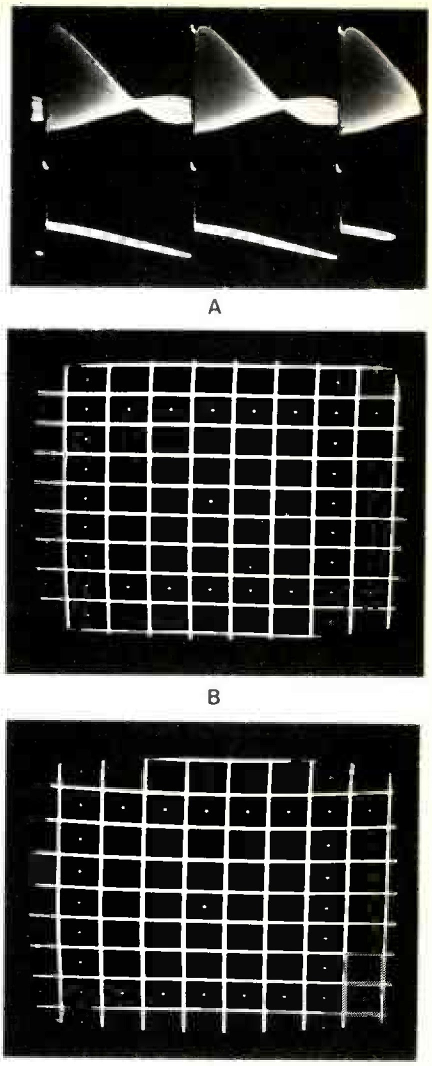


Fig. 15 L1 choke is mounted near the M107 vertical module.



A

B

C

Fig. 16 (A) Top trace of the waveforms shows the normal signal at the collector of Q8, including the pincushion-correction signal. When the base of Q5 was shorted to ground to eliminate the pincushion signal, the lower trace showed only the conventional vertical waveform. Photo (B) is a hatch-dots pattern with pincushion correction. Photo (C) is the same, but with the pincushion signal shorted out.

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form at the anode of D9. Therefore, D9 conducts strongly, bringing through horizontal pulses that are positive-going (also positive DC voltage).

During the negative peak, the operation is reversed. The negative peak blocks the conduction through D9, and makes D8 conduct more. Therefore, the output of the diodes at R36 has negative-going horizontal pulses and negative DC voltage. Of course, the alternate blocking and conducting of the diode conductions is not sharply off or on. Instead, the slope of the sawtooth gives a gradual action. This produces maximum horizontal pulses of one polarity at the top of the raster (start of vertical scan), decreasing amplitude toward the center, no pulses at the center of vertical scan, increasing amplitude of opposite-polarity pulses below the center, with maximum amplitude of opposite-polarity pulses at the bottom of the raster.

C12 blocks the DC and shapes the waveform, while R19 and C13 filter the horizontal pulses into sawteeth. (Before they reach the yoke, the sawteeth will be parabolas.) R26 adjusts the amount of pincushion correction. R21 supplies forward bias to Q5, the pincushion amplifier, which amplifies and inverts the horizontal sawteeth that are varying in polarity and amplitude. C17 couples these varying-amplitude varying-phase horizontal sawteeth to the base of Q8 through R25. Q8 amplifies the signal, but at the base and collector the waveform no longer is sawteeth. Capacitor C14 that's connected between collector and base acts as high-frequency feedback, changing the sawteeth to approximate parabolas. It's almost impossible to see these parabolas, because the amplitude changes so rapidly (see Figure 12).

The parabolas of varying amplitude are fed to the base of Q8, where they are amplified and are sent on to the vertical-yoke coils to correct the pincushion distortion.

Vertical-Blanking Pulses

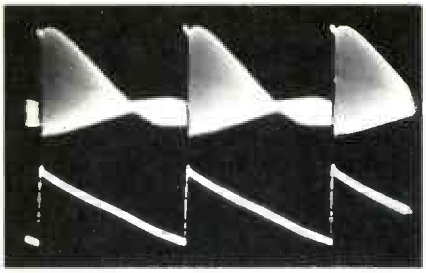
Narrow vertical pulses with straight, level lines between the pulses are needed in the video for vertical-retrace blanking. In the T995, they are made in an unusual way.

C7, of the Q1 emitter circuit, shapes the emitter waveform into sawteeth. But, C7 is not grounded directly, but rather through R14. These two parts form a kind of high-pass filter. Square-wave analysis proves that only the rising and falling edges can go through such a filter. In this case, the sawtooth has only one falling edge, and so each sawtooth develops a narrow negative-going pulse across R14 for each edge (see Figure 13 for the waveforms).

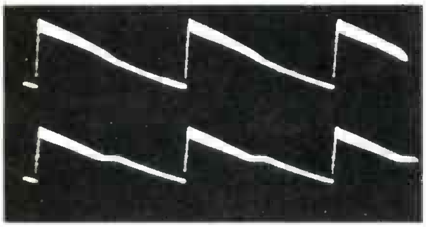
These negative-going pulses freely go through diodes D3 and D4 to the base of Q9, the vertical blanking transistor. (The +0.7-volt base bias can't go through **two** diodes, thus preserving the bias between pulses.) Q9 amplifies and inverts the polarity of the negative pulses; therefore, at the collector are developed strong narrow positive-going vertical pulses that are suitable for vertical-blanking uses.

Circuits Outside The Module

The choke that supplies the DC current for the collector of Q8, a clipping diode (D4), the vertical-yoke coils, and the vertical center-



A



B

Fig. 17 Diode D4 (Figure 14) clips the positive tips of the retrace pulses. (A) The top trace is the normal Q8 collector waveform at the anode of D4, while the small 3-VPP sawtooth at the D4 cathode is shown by the bottom trace. If D4 shorts, the symptoms will be unmistakable. The picture will be pulled down from the top for an inch or so, the vertical-blanking period will appear a few inches from the bottom of the picture, and the picture will be covered by strong retrace lines. (B) Top waveform is correct for the R6 end of D5 and D6 (see Figure 14). After a slice of the center is removed by the diodes, the 8-VPP sawteeth of the bottom trace remain, and they are sent to the convergence board.

ing circuitry are external to the vertical module (Figure 14).

L1 is the audio-type choke (Figure 15) that passes the current for Q8. It is much higher in inductance than the yoke coils that parallel it. The cold end of the yoke coil is bypassed to ground through C6 and R6. The waveform developed across R6 by the yoke current is sent to the convergence circuit through diodes D5 and D6, which are paralleled front to back.

Vertical centering

As is customary, vertical centering is adjusted by selecting the desired polarity and amount of DC current to flow through the yoke coils.

When the width jumper is at the center pin, no DC current flows, and there is no centering correction. When the jumper is connected to the top pin (Figure 14), the 30-volt supply through R14 furnishes current to Q8 through the yoke, and the picture is moved lower. But, if the jumper connects to the pin that has the 1,000-ohm resistor, the current from the +23 volts at Q8's collector flows through the yoke, moving the picture higher on the screen.

Proof Of Pincushion Correction

Waveforms and crosshatch pictures of Figure 16 compare normal pincushion correction to the absence of any correction.

D4 And Other Waveforms

Figure 17A shows the waveforms at the anode and cathode of D4, which is connected between the collector of Q8 and the +73-volt supply. Apparently, the function of D4 is to clip off the tips of any retrace pulses that exceed 73 volts. This protects the vertical-output transistor from excessive pulses that might destroy it. Check the diode (D4), whenever Q8 has failed.

Diodes D5 and D6 remove a slight bit of amplitude from the center of the convergence sawteeth, as shown in Figure 17B.

Troubleshooting

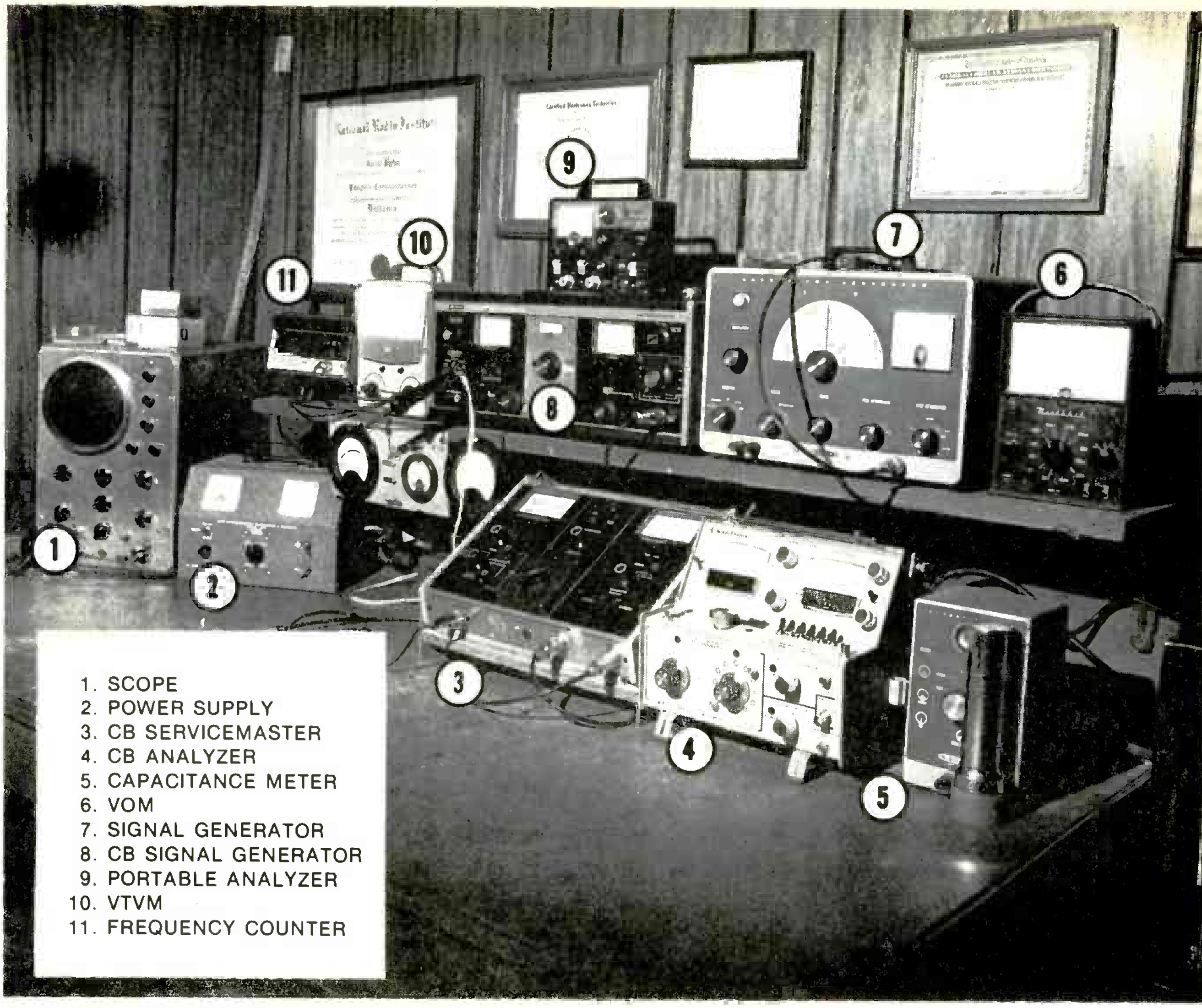
When you have a problem with vertical sweep, look first at the waveforms. For example, the oscillator and switch transistors operate with normal frequency and waveforms so long as the +27-volt supply reaches them. This is true even when the following stages are inoperative. Also, the Q6, Q7, and Q8 stages are not in a closed-loop or negative-feedback circuit; so, the failure of one stage does not affect the waveform of the previous one.

After the defective stage has been located with the scope, then resistance and voltage tests should be used to find the bad components. The vertical-hold control is on the module, and this reduces the chances of losing sweep from an open in that circuit.

Of course, most of the vertical circuitry is on this one module, and it can be replaced after you are certain the defect is there.

Next Month

Horizontal sweep and high voltage are the subjects of the Magnavox T995 chassis for next month. □



These are the instruments on Harold Kinley's CB bench. Conveniently located and technically adequate test equipment can increase the number of jobs finished per work day.

A Typical Day At The CB Bench, Part 2

By Harold Kinley, CET

General repair categories are discussed before additional typical case histories are presented. Also, suggestions are made about types of equipment needed and handy wiring of the CB test instruments.

CB Repair Categories

Repairs of CB radio transceivers tend to run in general categories, and the type usually can be identified by the original symptoms and the preliminary diagnosis.

Some of the common categories include:

- No receive volume, but the CB transmits normally. Most receiver defects don't affect transmit performance (except for modulation).
- Radio doesn't transmit, but receives all channels. This usually points to a defect in the RF driver or RF output stages. However, the shared oscillator has different frequencies for the two functions. Therefore, you can't rule out a synthesizer failure.
- Weak receive volume with a low-reading "S" meter usually hints of a problem in the RF or IF sections. Weak volume with an "S"

meter showing a strong carrier could indicate a problem squelch stage, or a bad transmit/receive contact.

- Audible distortion with both transmit and receive is certain to originate in the audio channel that provides modulation during transmit and speaker volume during receive. Sometimes an extra preamp is used for the microphone.
- Wrong frequencies are measured for some channels, but correct ones for others. If a synthesizer is used, this indicates a bad oscillator. With a Phase-Locked Loop (PLL), bad contacts of the channel switch are a possibility.

There are several other general symptoms, and you will learn them in a hurry after you start repairing CB radios on a regular basis.

Basic Tests

Preliminary troubleshooting to find the stage that has the defect includes these basic tests:

(1) signal injection from pulse sources or tuned generators;
(2) signal tracing by using tuned or untuned amplifier/demodulator/audio instruments;
(3) DC-voltage analysis; checking against the schematic, or judging by past results;
(4) analysis of waveforms (also, AC-voltage analysis), especially with stages handling audio or modulated-RF signals;
(5) in-circuit testing of transistors and diodes, either by curve tracer or ohmmeter; and,
(6) resistance measurements.

In addition, you sometimes should remove transistors and other components for more-accurate tests out-of-circuit.

Notice the similarity of these CB basic tests to those for AM and FM broadcast receivers. CB radios have some unique functions and circuits, but they are part of the radio family.

Test Equipment

Because of the tight specs for the oscillator frequencies, CB test equipment usually has crystal-controlled oscillators, or includes frequency counters.

Also, the transmit function requires meters to test VSWR, power output, and modulation. All three

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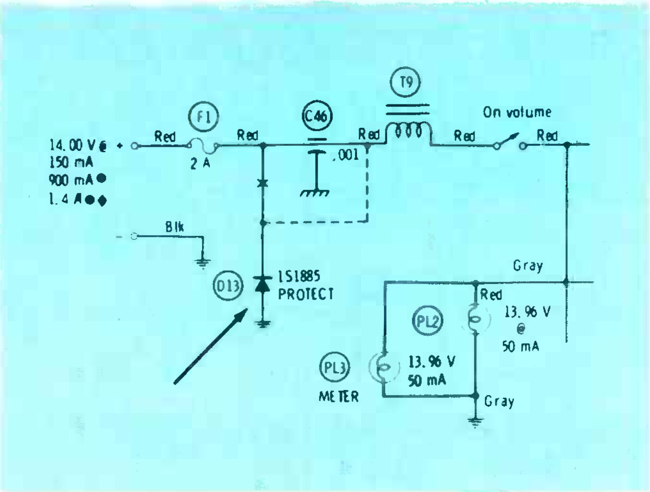

Fig. 1 A shorted polarity-protection diode caused blown fuses in this Ray Jefferson model CB805 (Photofact CB-105).

Tips For The Test Bench

Setting up a CB test bench is not particularly difficult, but there are several important considerations. With so many instruments needed for complete testing, advance planning of layout and cabling is vital. Equally valuable are items of equipment that combine several test functions, or have extra switches and plugs that permit you to reduce the number of cables, while keeping the essential few cables ready for instant and convenient use.

For transmitting, it's vital to use high-quality coax cable, and route it carefully. Coax changes characteristics if crimped by staples or when bent too sharply. In addition, certain lengths can cause the coax to act like a trap. Avoid lengths of around 6 feet. Don't splice coax, but use connectors for joining sections. "T" connectors allow multiple signal paths (for example, to VSWR meter and frequency counter) without problems. Mismatches from any of these potential headaches can produce false power and VSWR readings that raise questions and waste your time. Prevent such problems **before** they happen.

Scopes can't be beat for spotting audio distortion, or showing modulated-carrier waveforms. Remember that the transmit carrier has a frequency of approximately 27 MHz. A few scopes have bandwidth to 30 MHz or 35 MHz, and they are recommended for this kind of testing. On the other hand, some specialized items of test equipment include a down-converter for heterodyning the 27-MHz signals to a lower frequency that most service scopes can handle.

Of course, the brands and models of CB test equipment will depend on your personal preferences and the importance you place on the specs and accuracy of these instruments. But give the equipment a chance of performing at its best, by giving thought to efficient layout and cable wiring.

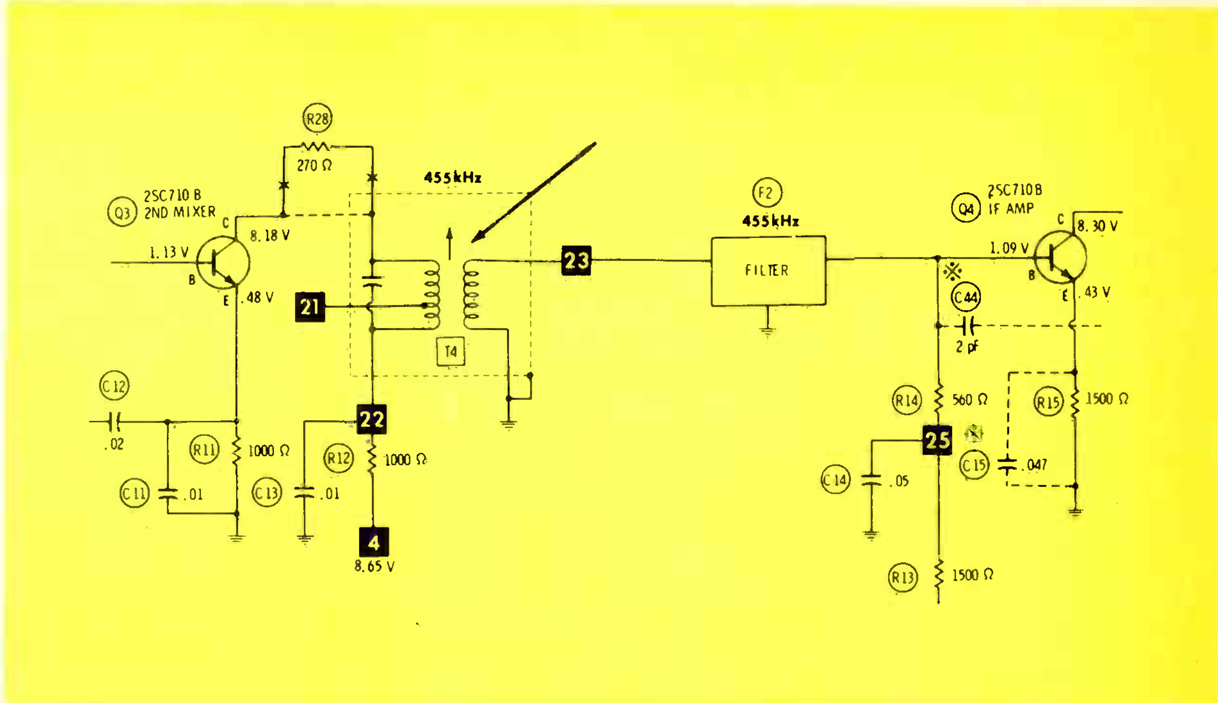

Fig. 2 Decreased RF gain of the model CB805 was caused by shorted turns of T4.

CB Bench

continued from page 39

tests often are made by one piece of equipment.

Except for these specialized items, the other CB test equipment is the same as that used for broadcast-band radios. Other helpful information is contained in the "side bar."

Case Histories

Here are a few more actual CB radio repairs to serve as examples of typical symptoms and troubleshooting.

Blows fuses
Ray Jefferson Model CB805
(Photofact CB Series 105)

The customer explained that he had connected the radio to a wrong-polarity battery, and afterward it blew fuses repeatedly.

This is a common problem. Many CB radios have a diode added for polarity protection. As shown in Figure 1, a diode is connected across the battery voltage with the cathode toward the positive supply. If the negative terminal of a battery mistakenly is connected, this is forward bias for the diode. It conducts heavily, blowing the fuse and protecting the transistors from polarity damage.

However, it's also common for the diode to short during the time of wrong polarity. Afterwards, the new fuse blows, regardless of the polarity.

I replaced the diode, and checked the old one on my curve tracer. It was shorted, as I had guessed.

Next, I applied power and checked the performance to determine if any other damage had occurred. The transmitter worked fine. But the receiver was below par.

Sensitivity checked very low, requiring about 100 microvolts or more for the audio tone to be heard. Also, the "S" meter gave little swing. These symptoms usually indicate trouble in the RF or IF sections.

I fed a modulated 455 KHz signal to the input side of the F2 bandpass filter (Figure 2), and noticed a weak signal. Evidently, the defect was between this point (Circuitrace #23) and the detector. The diagnosis was strengthened by feeding in the signal at the base of Q4, because the signal was normally strong.

However, before trying to find a filter in a junk radio, I decided to separate the filter from the previous wiring. I did this by cutting the foil at point 23. This time the signal came through the filter loud and clear. Suspicion now was directed to the interstage IF transformer, T4.

After T4 was replaced by another taken from a junk set, and the foil repaired by wire and solder, the sensitivity was normal. Evidently the coil had shorted turns. Following a touchup of the alignment, the sensitivity was good, measuring 0.62 microvolts.

The total charge for this job was $19.50.

Will not receive, but transmit is okay
Royce Model 1-600B
(Photofact CB Series 71)

Although the customer said the transmit function was normal, I started by checking it. In the past, I have wasted time looking in the wrong circuit after a customer gave me erroneous symptoms. However, this time the report was correct; transmit characteristics were okay.

When I fed in a 300-microvolt signal, the "S" meter gave a zero reading, and only a slight hiss came through the speaker. Modulation had been good during transmit tests, so the driver and output audio stages (Figure 3) were okay. And the hiss proved the speaker was working. This eliminated the audio circuits, except for the squelch, TR12, and the microphone switching.

I decided to move back a stage at a time. Through a small coupling capacitor, I injected an audio tone at the base of TR12, the first audio amplifier. No sound could be heard. However, the tone came through when it was applied to the collector of TR12. I checked the base voltage of TR12 while varying the squelch control. The voltage was very low, and it did not change with the setting of the squelch.

When I removed transistor TR12, it tested bad. After a new one was installed, the injected tone at the base produced a loud sound from the speaker.

Because there was no indication on the "S" meter and no sound with a 300-microvolt signal at the antenna connector, I next turned my attention to the RF and IF circuits. I injected a 455-KHz IF signal at point 29 of the schematic, which is the input side of the IF bandpass filter. Although the signal was audible, it didn't seem loud enough. Moving on to transistor TR4 (see Figure 4), the tone came through both the base and collector, but much louder from the collector. Evidently TR4 was not amplifying properly.

I removed TR4, and it tested defective. A new transistor cleared the problem of low IF sensitivity, but *overall* the receiver remained insensitive. Stage by stage, I started testing back towards the antenna. Everything seemed normal, until I reached the RF-amplifier transistor, TR1. Neither base nor emitter had any DC voltage.

A diode to protect the RF transistor from overload is wired from TR1 base to ground (Figure 5). In-circuit, it seemed shorted. I removed it to crosscheck, and it was shorted. While the diode was out of the circuit, I checked the sensitivity; but, it was low.

This directed suspicion toward TR1. Unfortunately, when I removed it and installed a new one, there was very little improvement. At this point, I nearly decided to stop testing. I doubted the customer would want to pay such a high bill. But, since I had found so many already, I reasoned that probably only a few defects remained. And I don't like to give up on tough dogs.

Continuing with the troubleshooting, I injected an RF signal direct to the base of TR1, and the volume was louder than when the signal was brought in through the antenna connector. Then I noticed switching diode D6 on the schematic (it is there to short out the RF signal during transmissions). Yes, it was shorted, too! For the moment, I clipped it out of the circuit, and found the sensitivity still below par.

Few parts in the RF stage remained untested, and I was forced to measure the resistances of coils and resistors. When I reached L1, I was relieved to find **the secondary winding was open.** I was lucky and located a similar transformer in another junker, but the ordeal was not over yet. The core of the replacement transformer was stuck, and couldn't be budged by the alignment tool. With my soldering iron, I carefully heated the core enough to loosen the wax, then I hurriedly aligned it before the wax hardened.

The sensitivity now was about normal, so I connected the shop antenna and heard a local CB

continued on page 42

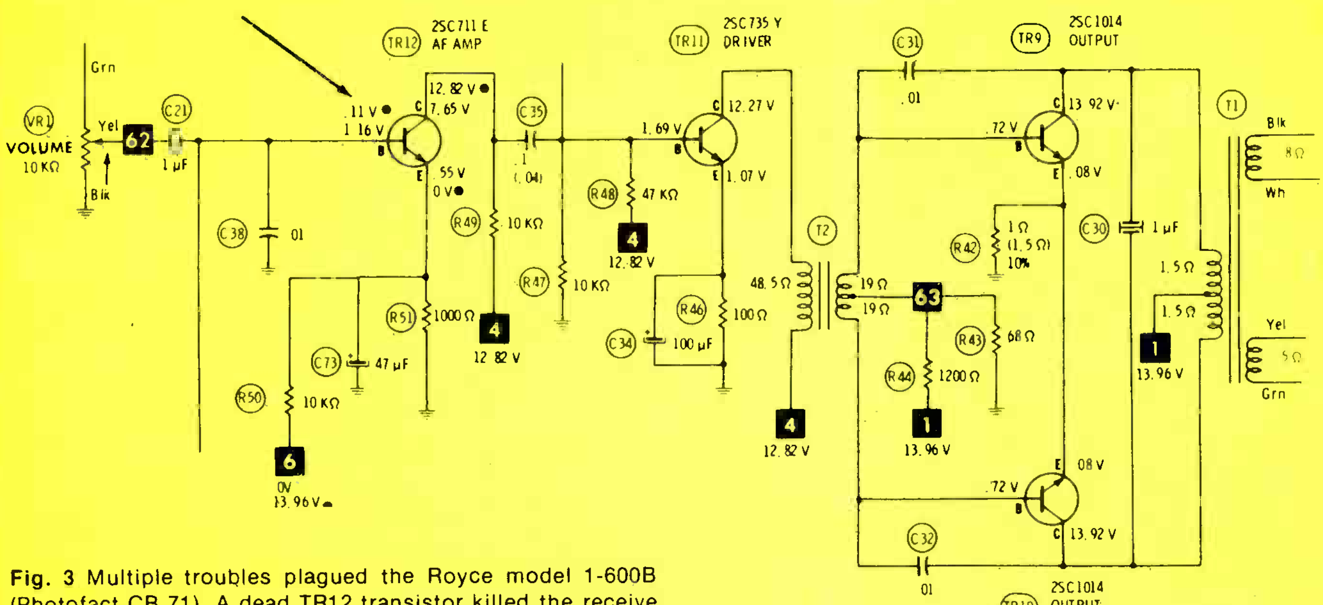

Fig. 3 Multiple troubles plagued the Royce model 1-600B (Photofact CB 71). A dead TR12 transistor killed the receive audio.

continued from page 41

operator on Channel 23. I gave him a call, but when I released the mike button, **the receiver seemed to have gone dead again.** Muttering a few choice remarks under my breath, I connected the test equipment, which verified that the set had very little sensitivity. I removed TR1, the RF transistor, and found it was shorted.

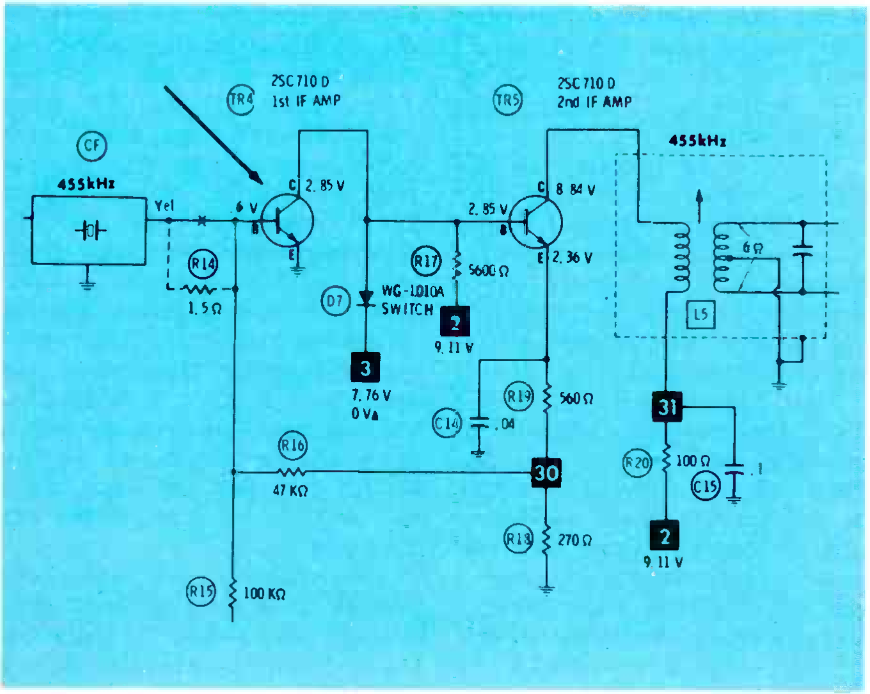

Fig. 4 A defective TR4 IF transistor reduced the sensitivity of the Royce. This bad transistor was found by signal injection.

As I was replacing TR1 for the second time, I remembered that I had *not* replaced the two diodes. Without these diodes, TR1 was being overloaded greatly during transmit mode.

I installed two new protective diodes, and was relieved to obtain normal receive and transmit operations.

Total cost of the repairs was $32.21, but it would have been higher except for the parts I removed from a junked radio.

This CB radio repair stands out in my mind as the one having the most separate problems, and where I goofed by not adding the protective diodes.

Comments

These case histories of typical repairs for CB transceivers should help you decide what tests to make, when you're confronted with similar symptoms.

Although the components and circuits are different from those of television receivers, the troubleshooting methods are just as logical. Follow these suggestions, and you'll soon be a CB-repair expert.

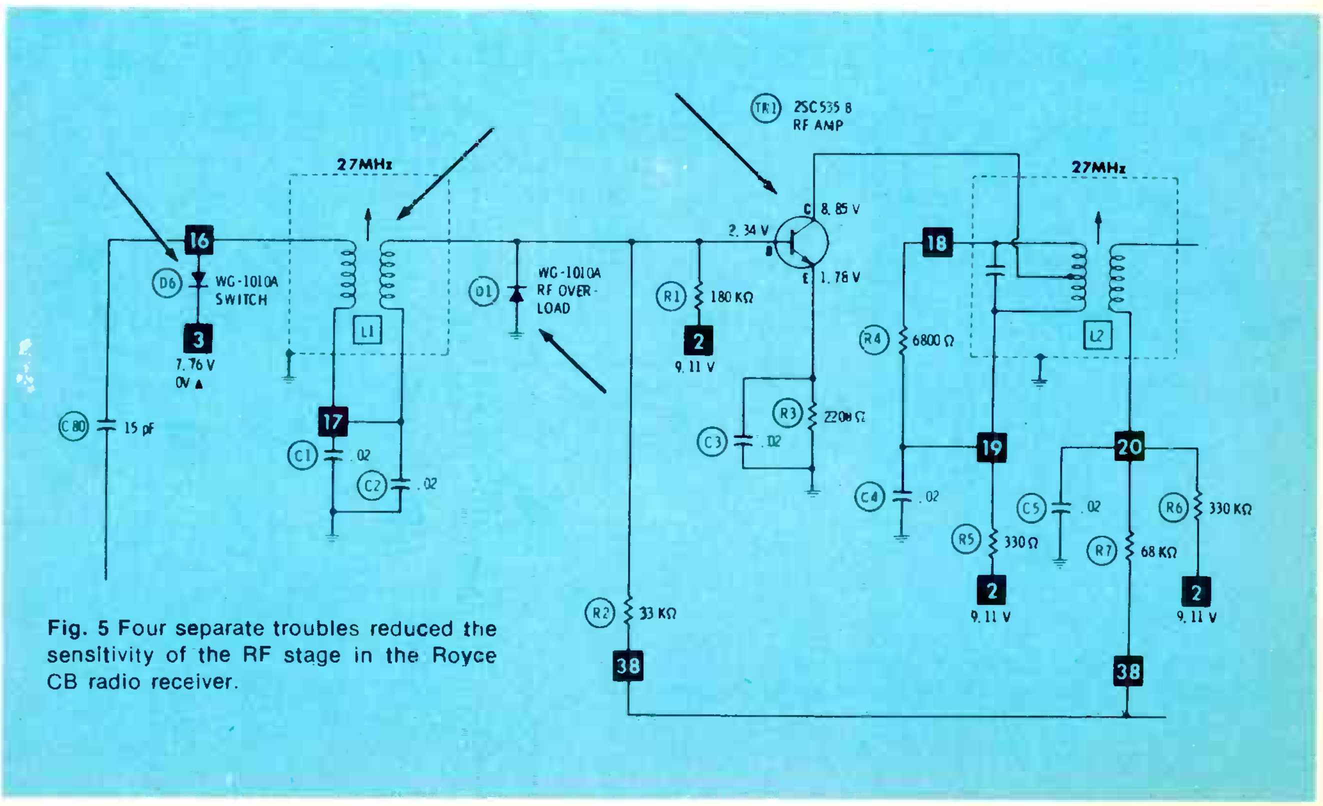

Fig. 5 Four separate troubles reduced the sensitivity of the RF stage in the Royce CB radio receiver.

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SENCORE CB42 AUTOMATIC CB ANALYZER

It's a CB Profit Center All in One Handsome Instrument

The CB service market is growing and more "on the ball" technicians are getting into the act every day. Competition for the CB business is getting tougher and you'll want to be sure you can compete. Knowledge alone won't be enough. You'll want to get ahead by simplifying your work to get the most jobs out with the least effort. You'll want to concentrate on your troubleshooting and not fiddle with 15 cable connections and 28 knobs on different instruments. So you will want to get an instrument that takes you from antenna input to speaker, and from mike to antenna load in one neat package.

To top that off, the complete CB42 is hundreds of dollars below the nearest competition, and thousands below most. We've got our competition beat, and you'll beat your competition, too, by saving these six ways with this CB42 Profit Center.

$AVE ON REPAIR TIME:

One simplified tester in a single case saves time on every test on any CB that comes in your door, including Single Sideband sets; you won't even need a scope.

$AVE ON READOUT TIME:

One direct-reading digital readout saves interpretation time and reading errors. You'll know the CB's frequency, generator frequency, Percent Off-Channel, positive/negative modulation and distortion, RF output, and audio output with a simple flick of a switch. Only the CB42 is this simple and complete.

$AVE ON CHANNEL CHECKING:

Simply rotate the CB42 and CB selectors through all 40 channels and read "percent off center frequency" on the direct-reading digital meter (.005% FCC maximum deviation) in less than two minutes for all 40 channels.

$AVE ON TIME CONSUMING CONNECTIONS:

Three cables, provided with your CB42, do the entire job; audio cable, transmitter cable, and receiver cable.

$AVE ON ANNOYING HOWL:

Why get a screwdriver in the back from the guy next to you, when you can substitute for that annoying speaker howl? Just plug the built-in, non-grounded speaker sub cable into the transceiver and quietly monitor the audio output on the meter.

$AVE ON BENCH SPACE:

The CB42 takes less than one-third the bench space of other equipment. You can even take it to the field with you, for on-the-spot mobile checks, since it is also 12 Volt battery powered.

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For More Details Circle (17) on Reply Card

Emerson-to-RCA Parts Cross Reference

By Frank Dickinson

Approximately four years ago, Emerson Radio ceased all home entertainment production. Although Emerson TV Sales Corporation still maintains a parts department (16th & Coles Streets, Jersey City, New Jersey 07302), reader Frank Dickinson of Stony Point, New York found that about 50% of the parts he ordered were no longer available. He therefore compiled the following cross reference from Emerson part numbers to RCA part numbers so parts could be ordered from local RCA distributors.

EMERSON #	RCA #	EMERSON #	RCA #
350972	502410	705074	109171
390771	112840	708424	113640
390772	112834	708425	077842
390773	112835	708426	103037
390774	112839	708427	109255
390775	112836	708428	105308
390776	112837	708429	101819
390777	112838	708430	113404
390778	112400	708431	113388
390780	112841	708432	105295
390781	112830	708433	109834
390782	112842	708434	112866
390784	113552	708438	112872
390785	112843	708439	112874
390786	113253	708440	112867
390787	113253	708441	109257
390788	113380	708442	109840
390789	106388	708443	100131
390790	105297	708444	112875
390791	113581	709007	109837
390792	106320	720469	109261
390793	105059	720471	112870
390794	106321	720472	106383
390795	109472	720474	109252
394254	109235	720475	113547
394255	109791	720476	112879
394260	102241	720477	113871
394261	112980	720478	112869
394262	105222	720479	112873
394263	105753	720481	112877
394264	105753	730118	113383
394266	104180	734223	112822
394267	103877	737049	112829
394268	105662	738195	113382
394269	109013	738196	113390
397116	106042	808022	109835
397171	112876	817123	113397
397173	109241	817124	113391
397174	106792	817125	112524
397175	109234	817127	113321
397187	107191	817128	113392
397176	100010	817129	105330
471478	102792	925584	112981
490779	113253	925585	112828
490792	106320	925586	112827
705047	109171	925587	112825
705048	100441	925599	109227
705049	109248		

photofact bulletin

TEKNIKA
CI-3149 1658-2

K MART
SKB1600/1900AD/AE/AF/AG/AH 1659-1

SEARS
528.4480/4481/4482 (Series) 1659-2

CORONADO
TV6-20486A/494A/502A 1660-1

SEARS
564.40190600 1660-2

PHILCO
Chassis A19-5 1661-1

TRUETONE
GCJ4721A-77 1661-2

ADMIRAL
Chassis Y-3 1662-1

SANYO
Chassis PD-74N00, PD-76N00 1662-2

PHILCO
Chassis A12-12 1663-1

TEKNIKA
CI-3169 1663-2

J C Penney
685-2012A, 2012A (855-0154) 1665-1

SYLVANIA
Chassis A12-6/-11/-13 1665-2

K MART
SKC1951A 1666-1

MAGNAVOX
Chassis T992-01 1666-2

GENERAL ELECTRIC
Chassis 19YC-2 1664-1

TEKNIKA
CI-2022 1664-2

ADMIRAL
Chassis 9M50 1667-1

TRUETONE
ADM1719B-77, ADM1719C-77 1667-2

ADMIRAL
Chassis 3M45-1A/-1C, 7M45-1A/-1D 1668-1

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Reports from the test lab

By Carl Babcoke

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.

Model 3435A digital multimeter from Hewlett-Packard has several unique features, such as auto zero, auto polarity for DC readings, automatic ranging (when selected), extra resistance ranges, internal charger with NiCad batteries, and several optional probes.

Digital Readout

The display has 3½ digits of 7-segment 0.3-inch red LEDs with automatic decimal placement. In addition, other LEDs light to show whether the voltage is millivolts or volts, the current is microamperes or milliamperes, and the resistance is ohms, K-ohms, or megohms. These are called annunciators. The display reads up to 1999 and then overranges.

Pushbuttons

On the left, six function pushbuttons select on/off, DC and AC volts, DC and AC current, or resistance measurements. Eight buttons select the range or allow auto ranging on volts and resistance readings. A separate input is provided for current ranges.

DC Voltage

Five DC voltage ranges are supplied, from 200 millivolts (0.2 volt) full scale to 2000 volts (however, the maximum input should not exceed 1200 total DC and peak AC volts to avoid damage to the meter). As is customary, these ranges actually read one count less than full display. In other words, the 2-volt range reads up to 1.999 volts, but anything higher activates the overload (the readout lights up "OL").

Basic accuracy of all but the 200 mV DC range is ±0.1% plus 1 digit, and the input impedance is 10 megohms for all DC ranges.

AC Voltage

The same five ranges are provided for AC voltage measurements. Input resistance is 5 megohms shunted by 50 pF for all ranges.

Frequency response was the best of any digital meter I have measured. H-P specs say the accuracy is ±0.3% ± 3 digits between 50 Hz and 20 KHz, and ±1.5% of reading ± 10 digits at 100 KHz. This sample tested better than those specs. In fact, it was difficult to detect any significant errors between 20 Hz and 100 KHz. There were no peaks anywhere. (Some digital meters have a noticeable peak in the supersonic range.) Model 3435A can be used for almost any audio work without the need for any correction factors.

Resistance Readings

In addition to the usual 2K, 20K, 200K and 2000K ranges, model 3435A has two lower resistance ranges (20-ohms and 200-ohms full display), and a 20-megohm high range.

Although the open circuit voltage across the test probes is about +4.4, the voltage does not exceed about 1 volt before overranging occurs. Therefore, germanium transistors can be checked for diode action, but most silicon devices check as opens. Resistance tests can be made in-circuit without significant errors from diode or transistor conduction.

Accuracy of the ranges from 200 ohms to 2000K ohms is ±0.2% of reading +2 digits, with slightly less accuracy on the 20-ohm and 20-megohm ranges.

Current Readings

AC and DC current readings were not tested, but the specs for DC current are ±0.3% of reading +2 digits between 200 microamperes and 20 milliamperes, and ±0.6% of reading +2 digits for the 2 ampere range.

AC current accuracy depends on the range, but never exceeds ±2% of reading ±4 digits. Frequency response is the same as for AC volts.

Accessories

Accessories for the H-P model 3435A meter include: a "touch-hold" probe (connect probe and press button on probe to hold the voltage reading after you remove the probe—a helpful feature); a HV probe for reading up to 40 KV; and a high-frequency probe for reading RF up to 30 V and 700 MHz (input impedance is 4 megohms shunted by 3 pF).

Comments

It's difficult for me to remain unbiased when I examine unusual or high-quality test equipment, and that includes the Hewlett-Packard model 3435A digital multimeter. It performs the usual five basic kinds of measurements with extreme accuracy. But, superiority of quality becomes evident in small things done extra well. The meter is heavy and ruggedly-constructed, with attention paid to many minor details that contribute to mechanical and electronic precision. □

The Hewlett-Packard model 3435A digital multimeter has all of the usual features plus: input protection; auto ranging (when desired; it's optional); annunciator lights to indicate the ranges; and an optional probe that holds the voltage reading after the probe is removed, when the probe switch is kept depressed.

productreport

These features supplied by the manufacturers are listed at no-charge to them as a service to our readers. If you want factory bulletins, circle the corresponding number on the Reply Card and mail it to us.

Alignment Tool Kit

A new six-piece alignment tool kit has been introduced by **Chemtronics.** The AK-6 kit handles most of the alignment jobs that electronic technicians commonly encounter.

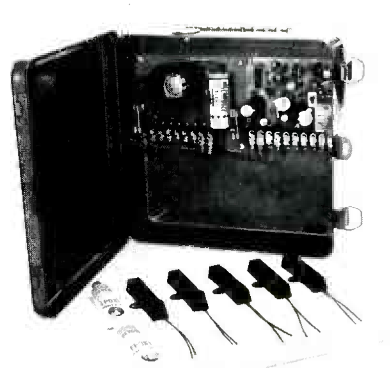
Each tool in the kit includes two to four alignment surfaces to cover a variety of alignment needs. Included are hexagonal, square and rectangular tips; screwdrivers; metal tips; and mini-nuts for use in mini-slot cores.

The AK-6 kit is available for $2.49.

For More Details Circle (28) on Reply Card

Stress-Detection Security System

Detection Security Systems has



developed a solid-state sensor which can be epoxied to any surface that flexes as a person walks on it, such as floor beams, joists, and stair treads. When an intruder comes in contact with any of these surfaces, the slight amount of flexure is detected by the transducer, whose signal is sent back to a signal processor, causing an alarm relay to trip.

A single "Stress Detector" can protect areas of as much as 100 square feet. The signal-processing amplifier used with the detection system contains digital recognition circuits and extensive false-alarm-prevention circuitry. In addition, the amplifier can be adjusted to trip only from a predetermined amount of flexure.

For More Details Circle (29) on Reply Card

Home Door Alarm

Mountain West has introduced a self-contained, easily-installed alarm system for door protection.

The C2 alarm, excellent for apartment dwellers, can be set to go off immediately after the door is opened, or after a 10-second delay, enabling a person to disarm the system when they enter.

Powered by 8 penlight batteries, or 20-to-10 VAC transformer (neither included), the unit measures 10"x1¾" x2¼". It comes with magnetic door actuator, key switch, two keys, and instructions. Suggested retail is $125.

For More Details Circle (30) on Reply Card

Semiconductor Guide

The 1977 semiconductor-replacement guide by **General Electric** is now available.

The guide (ETRM-4311N) features the expanded line of GE replacement semiconductors, including more than 300 products.

For More Details Circle (31) on Reply Card

test equipment report

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Tube Tester

The **Eico** Model 660 self-service tube tester tests more than 1700 different tube types, has over 65 tube sockets, and includes five custom pin straighteners. Only three controls need to be set to test for emission, shorts or gas tests. Step-by-step instructions are provided on the panel, and the meter is color coded and easy to read.

The Model 600 comes either as a counter-top unit or as a free-standing unit with an optional floor display stand and tube-storage cabinet. The panel itself is available as a replacement unit for Mercury Models 202 and 204.

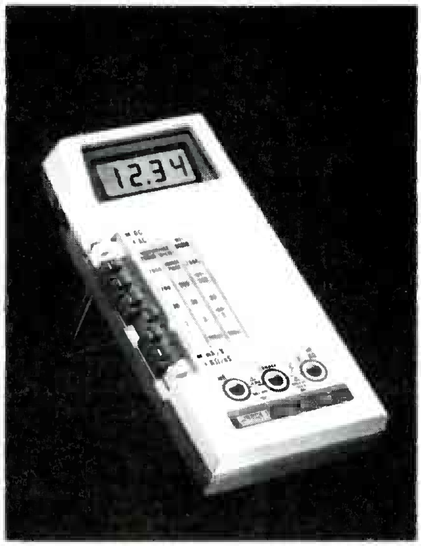
For More Details Circle (32) on Reply Card

Digital Multimeter

John Fluke Company has introduced a 3½-digit multimeter (model 8020A) designed for portable, high-accuracy measurements and priced at only $169.

In addition to the 0.25% accuracy of the standard AC/DC volts, current, and ohms ranges, model 8020A offers special conductance and diode tests. Alternate ohms ranges (marked by a diode symbol) have sufficient voltage to allow conduction for forward tests, while the other ranges have voltage that is insufficient for diode and junction conduction.

The conductance functions extend the instrument's ohms ranges from a maximum of 20 megohms in the ohms mode to the equivalent of 10,000 megohms in the conductance mode. By measuring conductance (inverse of ohms), the instrument is less susceptible to noise than if it measured ohms directly.



This new DMM function allows leakage measurement of capacitors, cables and circuit boards, and also can be used with a simple adaptor to measure transistor Beta and leakage.

Additional features include a typical battery life up to 200 hours with a 9-volt transistor battery, liquid crystal displays which can be read in bright light, and transient protection up to 6,000 volts with 300-volt overvoltage protection.

For More Details Circle (33) on Reply Card

Digital Multimeters

Keithley's new digital multimeters feature a 30,000-count display, large half-inch digits, automatic or manual range selection, high/low ohms, and 2- or 4-terminal resistance measurements.

Both the Model 172 and Model 173 measure DC voltages from 10uV per digit to 1200 volts, AC voltages from 10uV to 1000 volts RMS, and resistance from 10 milliohms-per-digit to 300 megohms. The 172 handles AC and DC currents from 10uA/digit to 2 amps, while the 173 offers a broader span of 10 nanoamps/digit to 3 amps.

The DMMs withstand 1200 volts peak on the DC voltage ranges, 100 volts RMS on the AC ranges, 250 volts RMS on ohms, and are fuse-protected on the current ranges.

The Model 172 has a suggested price of $499; Model 173 is $625.

For More Details Circle (34) on Reply Card

antenna systems report

These features supplied by the manufacturers are listed at no-charge to them as a service to our readers. If you want factory bulletins, circle the corresponding number on the Reply Card and mail it to us.

UHF Broadband Amplifier

Winegard has introduced a new UHF broadband MATV amplifier. Model DA-4300 delivers an output of 50 dB mV on each of five UHF channels at 0.5% cross-modulation. The high gain of +32 dB can supply usable levels, even with weak signal inputs.

The amplifier has a 20-dB variable gain control, allowing the installer to reduce the gain in areas where a strong signal might cause cross-modulation.

In a VHF/UHF area the DA-4300 can be used in conjunction with Winegard's DA-2300 or DA-2400 VHF/UHF broadband amplifiers.

The DA-4300 features 18 dB input per channel based on five channels at 0.5% cross-modulation. Noise figure is 10 dB average including UHF translator frequencies. Impedance is 75 ohms, and normal line power is required at less than 5 watts. Two F-59 connectors and a mounting bracket are included.

For More Details Circle (35) on Reply Card

Push-Pull MATV Amplifier

A new wide-band push-pull amplifier capable of handling up to 30 TV channels in a master-antenna TV system (MATV) has been developed by **Jerrold Electronics.**

The Gilbraltor Model 3770P-P amplifies the entire mid-band (120 MHz to 174 MHz) and super band (216 MHz to 300 MHz), as well as the low VHF band (54 MHz to 108 MHz) and the high VHF band (174 MHz to 216 MHz).

Push-pull design provides suppression of second order harmonics to -65 dB, making the 3770P-P suited as an MATV distribution amplifier served by a CATV feed. Output capability is +50 db/mV at -46 dB cross modulation with 12-channel CATV feed, and +56 dB/mV for seven-channel MATV operation. Gain is 40 dB and the gain

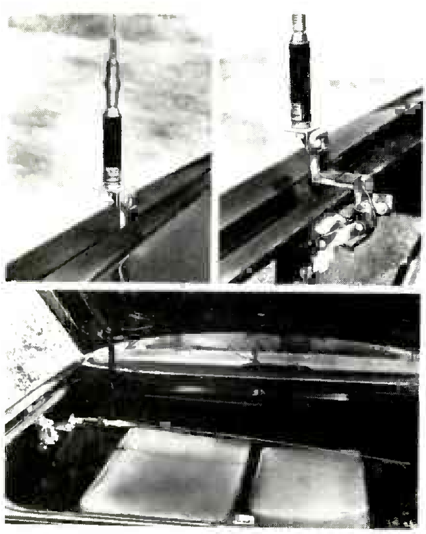
control range is 10 dB. Slope can be varied from 0 to 8 dB to compensate for various lengths of cable.

Suggested list price is $465.

For More Details Circle (36) on Reply Card

"Under Cover" CB Antenna

Channel Master has introduced a line of full-sized, 40-channel coil-loaded whip antennas that can be flipped down and hidden in the automobile trunk when not in use.

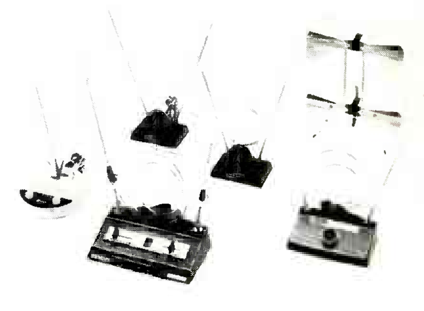


Base-loaded and center-loaded models are available, each mounted on a specially designed "Under Cover" bracket fastened to the lip of the trunk. The two-way bracket enables the CBer to mount the antenna in a vertical position, regardless of the slope of the car's rear deck, and also allows the antenna to be folded down into the trunk. Within the trunk, the bracket keeps the antenna suspended horizontally, so that it does not interfere with the storage of luggage.

For More Details Circle (37) on Reply Card

Indoor Antennas

"Color King", a new line of indoor antennas for improved TV and FM reception, has been introduced by



Antennacraft. The line includes four UHF/VHF/FM consoles, an FM stereo consolette, and a specialty UHF antenna for channels 14 through 83.

For More Details Circle (38) on Reply Card

CB Base Station Antenna

Finco has introduced the "Hornet Line" of 40-channel CB base-station antennas featuring four Stinger models.

The Stinger 100 is a 1/4-wave high-performance unit designed for optimum gain and features a low-profile radial concept for minimum mounting space requirements.

The Stinger 200 features a 1/2-wave vertical radiator and utilizes a "no power loss" impedance loop for matching.

A "static-charge decoupler" is featured on the Stinger 300, which has a full 5/8-wave vertical radiator.

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audio systems report

These features supplied by the manufacturers are listed at no-charge to them as a service to our readers. If you want factory bulletins, circle the corresponding number on the Reply Card and mail it to us.

CB Microphone

The **GTE Sylvania** SDX-100 CB microphone, with variable gain control, features electronic circuitry that processes the user's voice for maximum amplification without clipping. Up to a 4 dB increase in effective average modulated power can be achieved with negligible audible distortion.

All Sylvania CB microphones are available with Match-All adapters which minimize the necessity of wiring the microphone to a transceiver connector. The plug-in adapters fit most CB transceivers and an adapter guide identifies the correct Match-All adapter to use with individual CB set brands.

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Stereophones

Koss has introduced two new models in its Auditor Series of stereophones. The ESP/10 electrostatic stereophone, featuring an ultra-wide frequency response, has a suggested retail price of $300. The Dynamic/10, retailing for $85, has a frequency response range from 10 to 20,000 Hz.

The headphones plug into an electrostatic energizer unit which can be operated from amplifiers of 25 watts or less. The energizer, which accommodates two sets of headphones, has semi-peak reading level meters for each channel.

The E/10 energizer circuitry has an automatic overload device which pro-

tects the energizer by shutting it off when the audio input levels becomes excessive. The energizer pauses for three to four seconds, then resets itself. The LED indicator on the energizer's front panel lights when this occurs.

For More Details Circle (41) on Reply Card

Boom Extension

A variable-length extension assembly designed to increase microphone floor-stand height for group-recording, and widening the range of horizontal boom attachments, is available from **Atlas Sound.**

Designed to add up to 20" of adjustable height or length, Model EB-20 assembly includes a 5/8" diameter chrome-plated cold-rolled steel tube and is recommended for use with Atlas Sound models BB-44 and BB-1 boom attachments and all of the MS and CS series floor stands.

The extension assembly incorporates the Atlas Sound wear-proof grip-action clutch for positive locking control.

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The MARKETPLACE

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INCREASE YOUR INCOME! Rent Lease TVs: Anyone can! Easy to start and operate, part or full time; even from your home. Basic preliminaries $4.00. Perrys' TV Leasing, 308 N. Mcclelland, Santa Maria, Calif. 93454. 6-77-2t

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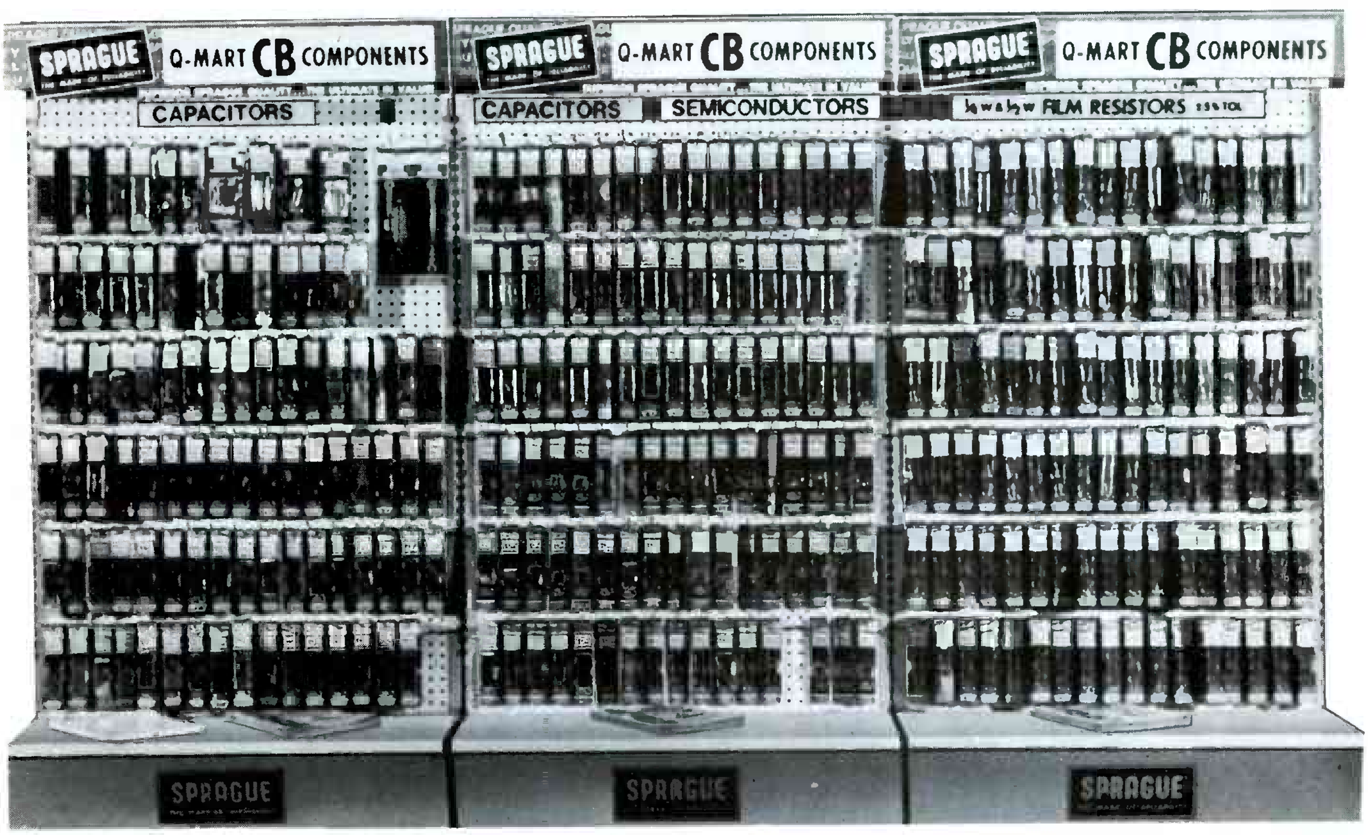

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