SEPTEMBER, 1971 75 cents

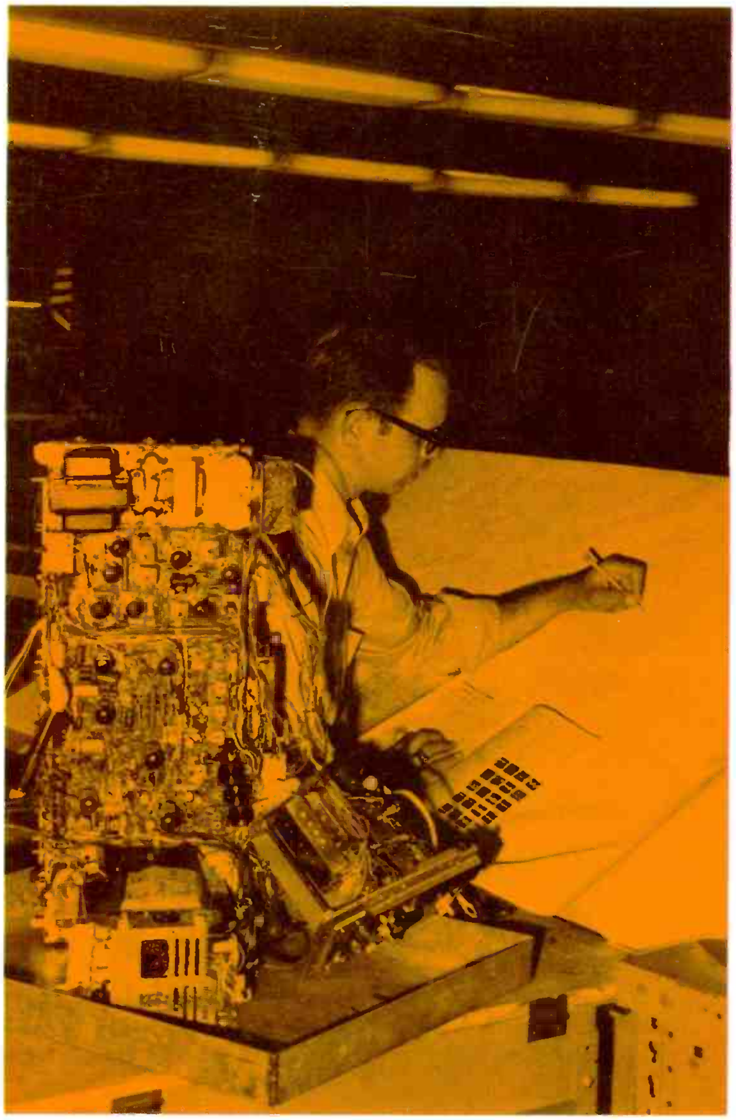
A HOWARD W. SAMS PUBLICATION

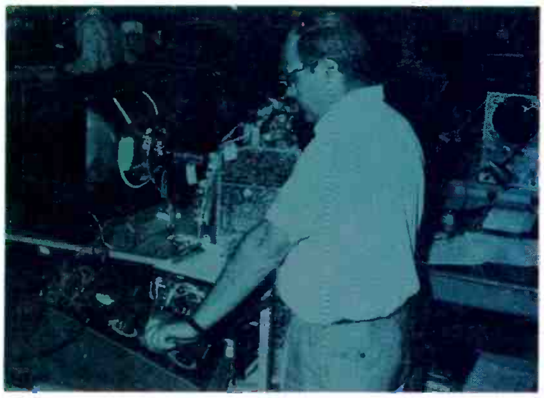
Electronic Servicing

25 ANNIVERSARY

How PHOTOFACTS Are Produced

Part of a special 25th anniversary report beginning on page 18





SERVICING TV:

Intermittent color, page 34

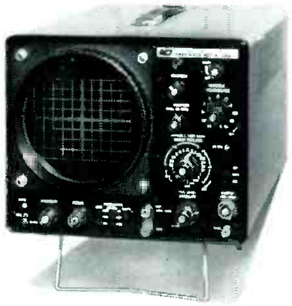
RCA's All-Electronic Tuner, page 46

Vertical sweep, page 52

This triggered sweep scope worries about your reputation

It isn't often you can find a single piece of test equipment that does just about everything for you. Lets you observe all TV waveforms, rock steady, makes instantaneous voltage measurements, makes waveform timing measurements, analyzes defective circuits, completely eliminates guesswork. It does so much, so easily, that your customer's sets are better aligned and adjusted, your customers are happier, and they tell others, bringing you more customers. And, if that isn't "worrying" about your reputation, it's the closest thing to it!

...and, it stands up for you too!



B & K Precision Model 1460 Triggered Sweep Scope: DC-10 MHz, all solid state, 10 Mv/cm sensitivity, TV-V and TV-H plus 19 calibrated ranges. $389.95

Alignment jobs that used to take hours, now take minutes with the new 1460 oscilloscope (coupled with the B & K Model 415 Alignment Generator). Simplified front panel controls; automatic triggered sweep and high sensitivity, wideband response let you concentrate on the service problems—not the test equipment. You can adjust and align every part of the set for peak performance. And analyze all receiver problems.

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So stop worrying. Let the new B & K 1460 scope do your worrying for you. It'll make a big difference!

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Circle 4 on literature card

September, 1971 • Volume 21, No. 9

Electronic Servicing

in this issue...

DEPARTMENTS

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Circle 5 on literature card

electronic scanner

news of the industry

I.S.C.E.T. Elects New Officers

The International Society of Certified Electronics Technicians (ISCET) elected new officers at their first annual convention, held in Portland, Oregon, July 18, 1971.

Elected Chairman was Darryl Widman, CET, Santa Barbara, California. Vice Chairman is Tom Bull, CET, Portland, Oregon. Secretary is J. A. Wilson, CET, Kent State University, Kent, Ohio. Re-elected treasurer was Leslie Nesvik, CET, Indianapolis, Indiana.

Rehired as Executive Director for the year is Ron Crow, CET, Iowa State University, who was the first Chairman of ISCET.

Sixty-five Percent of RCA Color Is All Solid State

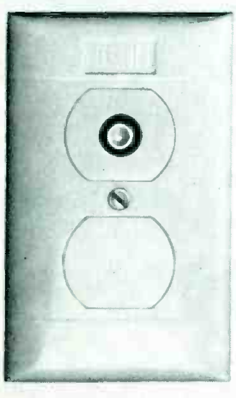
The use of all-solid-state chassis in 37 models of RCA's new color TV line has been announced by William H. Anderson, vice president, marketing, RCA Consumer Electronics.

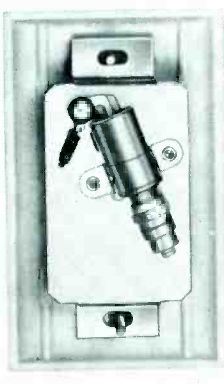
According to Anderson " . . . some 65 percent of the total RCA color TV line now consists of 100 percent solid-state models."

Patent Issued For Self-Terminating Antenna System Signal Outlet

The U.S. Patent Office has issued patent number 3,525,056 to Maqbool Qurashi of Jerrold Electronics Corporation for a self-terminating signal outlet for use in television antenna systems.

The outlet reportedly eliminates the possibility of signal degradation from standing waves on the coaxial cable drop by providing a 75-ohm termination when the TV set is disconnected from the outlet. It includes a built-in 75-ohm resistor and a switch actuated by the cable connector. The switch automatically terminates the line when a push-on cable connector is withdrawn.





As the connector is withdrawn the house drop is terminated before the connection between the set and the drop is broken, preventing the generation of momentary standing-wave interference when the set is disconnected or moved to another outlet.

Qurashi is manager of mechanical engineering at Jerrold's Research Laboratory.

New Sylvania Color CRT Reportedly Could Reduce Depth of Cabinets By Up To 4½ Inches

Sylvania has announced the develoment of a color picture tube that reportedly could reduce the depth of TV cabinets up to 4½ inches.

The new tube has a deflection angle of 110 degrees—20 degrees wider than color tubes currently used in most sets, according to Robert A. Starek, Product Marketing Manager of the Electronic Tube Division.

Mr. Starek said the 110-degree tubes will allow set designers to reduce the front-to-back measurement of TV cabinets from 3½ to 4½ inches, depending upon the size of the screen desired.

He said engineering samples already have been made available to set manufacturers, and that tubes will be offered in 19- and 25-inch screen sizes. The company could put the new tubes into production early next year, if demand warrants, he added.

Hitachi Opens New Sales, Service & Parts Facility To Service Midwest

Hitachi has announced the opening of a new sales, service and parts facility at 1400 Morse Ave., Elk Grove Village, Ill.

The new facility reportedly will serve the area comprised of Ohio, Michigan, Indiana, Wisconsin, Illinois, Missouri, Kentucky, Minnesota, North Dakota, South Dakota, Nebraska, Iowa, Kansas, Wyoming, Colorado, Utah and eastern Montana.

RCA Announces Price Increases on Receiving Tubes For Replacement Use

RCA has announced a 6.6 percent average price increase on receiving tubes sold for replacement use.

Joseph A. Haimes, Division Vice President, Distributor Products, RCA Electronic Components, said the price increases were effective August 16, 1971, and reflect higher labor and material costs.

These increases affect 382 of the approximately 1000 entertainment types and 146 of the 206 industrial types in the total RCA line of receiving tubes sold for replacement use.

EIA Consumer Electronics Group To "Beef Up" Service Training Program

Plans for increased activity in service-oriented projects reportedly were formulated at a meeting of the service committee of the Consumer Electronics Group of the Electronics Industries Association (EIA), in July,

(Continued on page 6)

(Continued from page 4)

and approved by the group's board of governors.

Jack Wayman, staff vice president of the Consumer Electronics Group, reportedly explained that the key elements of the program involve increased efforts in the areas of electronic service instructor training, career guidance, and an advertising campaign to help improve the consumer's image of the electronic service technician.

Over $100,000 of the revenues earned from the Consumer Electronics Show, conducted by the EIA group in Chicago in June, reportedly has been alloted for the program.

Motorola Booklet Suggests How Servicers Can Handle Service to Conform To New Song-Beverly Warranty Act of California

Motorola has prepared a special booklet suggesting how Motorola retailers and servicers handle consumer service of its products under the new Song-Beverly Consumer Warranty Act for the State of California.

The booklet has ten pages devoted to "adjusting to the new law" plus a four-page appendix containing the text of Chapter 1333, Senate Bill No. 272, State of California (the Song-Beverly Consumer Warranty Act).

In addition to the appendix, the booklet provides: customer satisfaction techniques for dealers and servicers and a listing of instruction materials and directories available to assist retailers and servicers, and names and addresses of Motorola distributors in California who can offer dealer and servicer assistance in product training, parts supply and other assistance.

Ed Gaiden, vice president and national parts and service manager of Motorola Consumer Products, pointed out that the Song-Beverly Consumer Warranty Act places California retailers, servicers, distributors and manufacturers under new legal regulations with respect to warranties. He said the booklet is offered to suggest guidelines but is not intended to serve as a comprehensive statement of the law nor as a legal treatise.

The booklet has suggestions for dealers when the customer is not pleased with product performance, complaints about service, or demands a refund or replacement.

Suggestions for the servicer in similar situations also are provided.

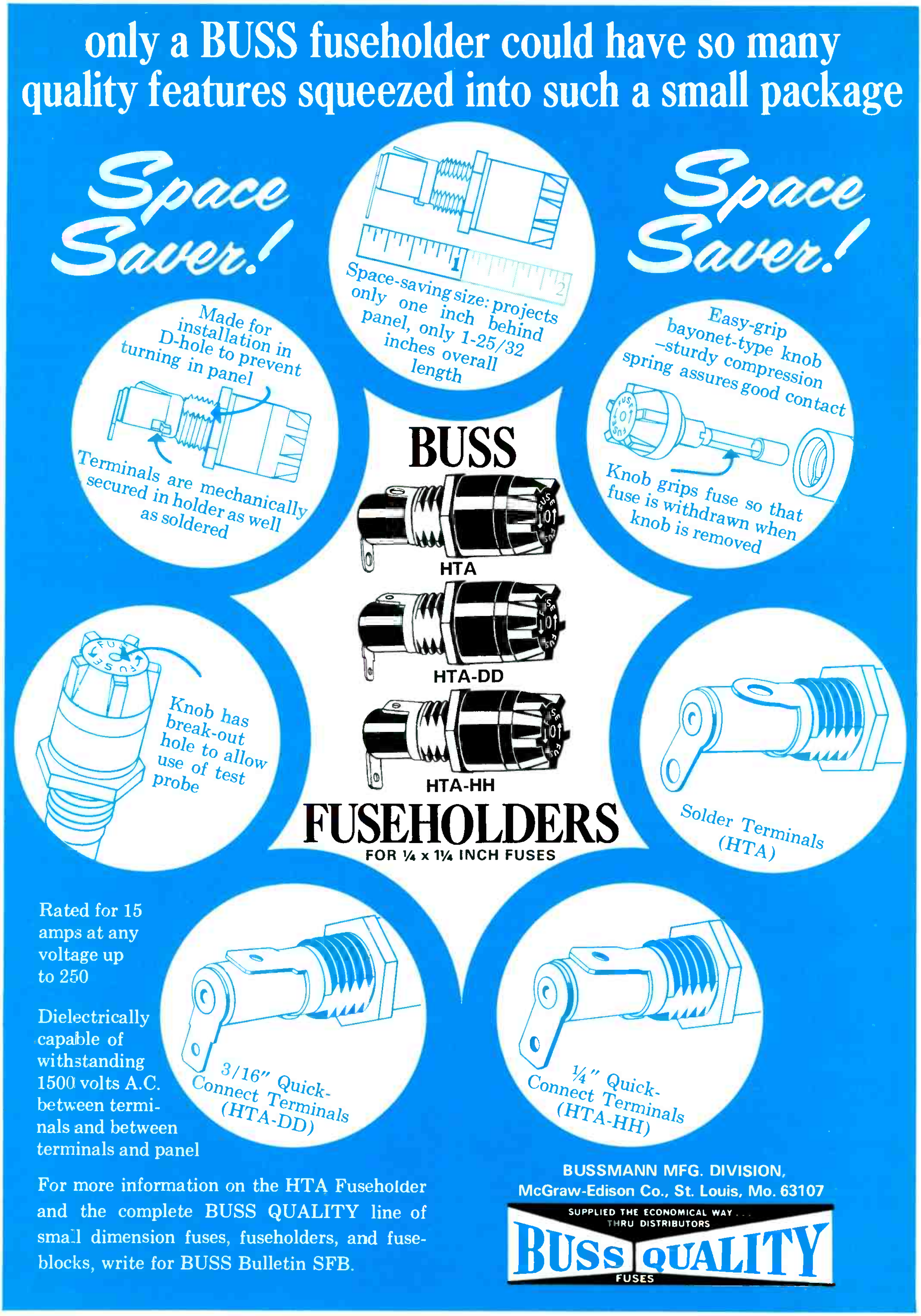
Copies of the booklet can be obtained by writing to Motorola, 9401 W. Grand Ave., Franklin Park, Ill. 60131.

EIA Publishes 1971 Electronic Market Data Book

The 1971 issue of the **Electronic Market Data Book** has just been published by the Electronic Industries Association (EIA).

Covering industry sales and trends through 1970, the 104-page book contains more than 50 charts and tables describing sales in the various segments of the industry.

(Continued on page 8)



only a BUSS fuseholder could have so many quality features squeezed into such a small package
Space Saver!
Space Saver!
Space-saving size: projects only one inch behind panel, only 1-25/32 inches overall length
Made for installation in D-hole to prevent turning in panel
Terminals are mechanically secured in holder as well as soldered
Easy-grip bayonet-type knob –sturdy compression spring assures good contact
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FOR ¼ x 1¼ INCH FUSES
Knob has break-out hole to allow use of test probe
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Rated for 15 amps at any voltage up to 250
Dielectrically capable of withstanding 1500 volts A.C. between terminals and between terminals and panel
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¼" Quick-Connect Terminals (HTA-HH)
For more information on the HTA Fuseholder and the complete BUSS QUALITY line of small dimension fuses, fuseholders, and fuse-blocks, write for BUSS Bulletin SFB.
BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis, Mo. 63107
SUPPLIED THE ECONOMICAL WAY . . . THRU DISTRIBUTORS
BUSS QUALITY FUSES

(Continued from page 6)

Included in the book are statistical data on consumer electronics, communications and industrial products, government products, components, world trade, industry employment and earnings.

Copies of the book can be ordered for $15.00 from the Publication Sales Office, Electronic Industries Association, 2001 Eye Street N.W., Washington, D.C. 20006.

Zenith Adds 90-day Free Labor To B-W Warranty

A new "consumer protection plan", which provides the consumer free labor during the first 90 days of b-w TV and modular and console stereo ownership, has been announced by Zenith.

The plan, which becomes effective with the 1972 model lines, provides:

- Replacement or repair of any defective parts required during the warranty period will be made without charge for these parts to the original owner.
- Replacement or repair of a defective black-and-white TV picture tube within one year of the set's original consumer purchase will be made without charge to the original owner for the tube.

"This plan, combined with previous plans—which covered color TV, radio, portable phonograph and tape units—extends across-the-board protection to consumer purchasers of the company's home entertainment products sold in the United States and Canada," said Walter Fisher, president of Zenith Sales Company.

In-home warranty service during the initial 90-day period of ownership is provided at no charge for color TV consoles, stereo consoles, color TV table models, 20-inch (diag.) and larger, and black-and-white TV consoles. The 14-inch through 19-inch (diag.) color screen sizes, all portable black-and-white TV sets, modular stereo, radio and portable phonographs are to be returned to the dealer for service.

"Service through the local dealer guarantees the dealer's after-sales responsibility and protects the vital consumer-dealer relationship during the complete warranty period," Fisher said. "It underscores our belief that local Zenith dealers, and their independent servicing contractors, have the customer's satisfaction uppermost in mind."

The color TV consumer protection plan, introduced in June, 1970, includes a 90-day service warranty for color TV sets, replacement or repair of a defective color picture tube within two years of the set's original consumer purchase without charge to the original owner for the tube, and replacement or repair of any other defective parts within one year of the original consumer purchase without charge to the original owner for these parts. In August, 1970, Zenith extended the 90-day labor warranty to radio, portable phonograph and tape products, with replacements or repair of parts required during the warranty period made without charge to the original owner.

To inform new Zenith owners of the expanded consumer protection plan, each product covered by the 90-day warranty is accompanied by a certificate which describes the program in detail.

Zenith's warranty programs are administered by individual Zenith distributors.

Wollensak Names Reller Tech Service Supervisor

3M Company recently announced the appointment of Ralph E. Reller to the position of technical service supervisor for its Wollensak line of products.

Reller previously was the field service coordinator responsible for relations with warranty stations who service Wollensak products.

Color and B-W TV Sales Up First Six Months of 1971

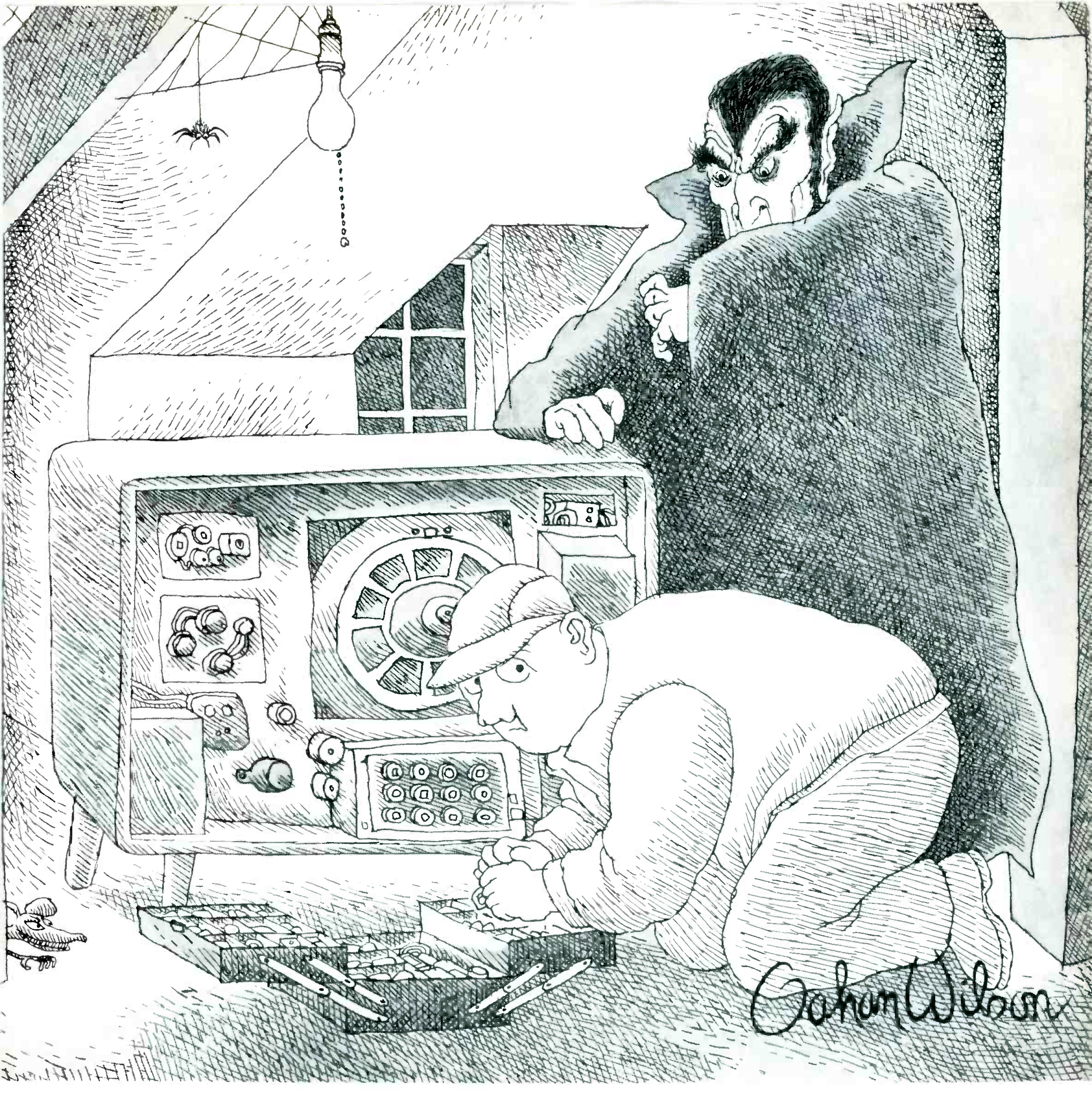
Sales of color TV receivers to dealers during the first six months of 1971 were up 25.4 percent over the sales for the same period in 1970, according to the Marketing Services Department of the Electronic Industries Association (EIA).

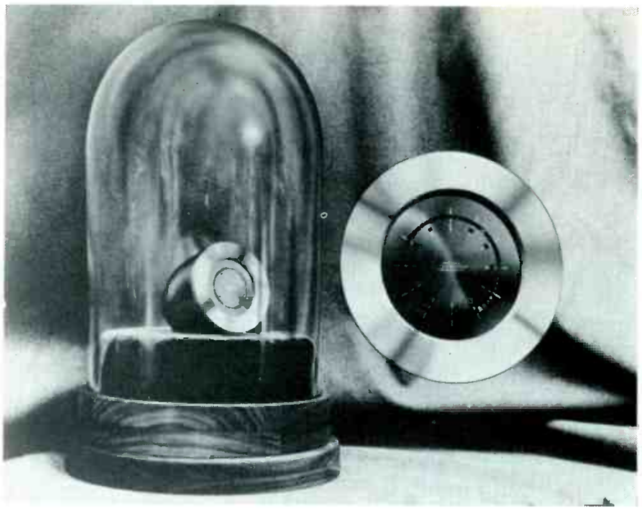
Total color TV sales during the first six months of 1971 were 2,482,076, compared to 1,979,533 for January-June, 1970.

B-W TV sales during the first six months of 1971 also were ahead of those for the same period in 1970. Total sales during the first half of 1971 were 2,171,246, up 8.9 percent over the 1,993,750 sold during the first half of 1970.

Six-month sales of radios and phonos also were up over last year—17.3 and 22.9 percent, respectively.

(Continued on page 10)


Gahan Wilson



(*Continued from page 8*)

All-Electronic Clock Has No Moving Parts

A unique timepiece which has no moving parts has been built by Motorola Semiconductor Products Central Research Laboratories.

Developed at a reported cost of $25,000 and displayed at the Electro-Optical Systems Design Convention in Anaheim, California, the new clock demonstrates what can be done with semiconductors and what could happen with the clocks and watches of the future.

This clock represents three departures from the conventional design. First, there are no moving hands; instead, there are 72 light-emitting diodes arranged in two circles.

The outside circle is made up of 60 diodes and marks the seconds and minutes. Each second or minute is marked by an apparently moving red light as the circuit switches power to the appropriate diodes in sequential fashion.

The inside circle of 12 diodes marks the hours in the same fashion.

With this arrangement, only 3 diodes are turned on at any one time. This is an important design aspect because the diodes draw current which, in the case of portable clocks, must be supplied by a small battery. With this newly developed system, it is expected that 2 small batteries can drive the clock for about one year before needing replacement.

The second departure from conventional design is that the mechanical movement has been replaced by tiny integrated circuits. These circuits provide the signals that turn on the appropriate diodes to indicate hours, minutes, and seconds.

The third departure is that the timing device is a quartz crystal instead of a tuning fork or a circular balance staff.

The light-emitting diodes, also manufactured by Motorola, are small pieces of special solid material (gallium arsenide phosphide) that glow bright red when a voltage is applied to them. They contain no filament or gas, as do more conventional light sources, but actually convert DC into red light.

Browne Re-elected NEA President

Norris R. Browne, CET, Houston, Texas, was reelected to another one-year term as president of the National Electronic Associations (NEA), at the Assocition's 7th annual convention in Portland, Oregon, in July.

Other officers elected include: Henry Hyde, CET, Omaha, Nebraska, secretary; Tom Cooper, CET, Marion, Indiana, treasurer; Jesse Leach, Linthicum, Maryland, Region 1 vice president; Charles Couch, Gainesville, Florida, Region 2 vice president (second term); Al Powers, Hamond, Indiana, Region 3 vice president; Charles Cave, Louisville, Kentucky, Region 4 vice president; Emmett Hughes, Hutchinson, Kansas, Region 5 vice president; Sid Sabel, Houston, Texas, Region 6 vice president; Enos R. Rice, Seattle, Washington, Region 7 vice president; and Virgil Gaither, Los Angeles, California, Region 8 vice president.

Total TV In Use In U.S.

There are 92.7 million television receivers in use in the United States, according to the most recent edition of **Television Digest Factbook.**

Included in this total are 61.4 million monochrome receivers and 31.3 million color receivers. ▲

readersexchange

Electronic technicians and owners or managers of electronic service shops who need assistance obtaining a part, service literature or any other item related to the servicing of electronic equipment are invited to use this column to inform other readers of their need. Requests submitted for publication in this column should be sent to: Readers' Exchange, ELECTRONIC SERVICING, 1014 Wyandotte St., Kansas City, Mo. 64105. Include a brief but complete description of the item(s) you need, your complete mailing address and how much you are willing to pay for the item(s). Individuals responding to a request in this column should write **direct** to the requestee.

Help Needed

I need the schematic for a RCA Voltohmyst Senior WV87A VTVM. I've written to RCA with no results.

Henri P. Manoski
6632 Melton Rd.
Gary, Ind. 46403

I need two ribbons for an old-style, medium priced, RCA ribbon-type microphone.

Peoples Radio Shop
6 South 9th St.
Columbia, Mo. 65201

I am in need of a 19X8 tube, which I can not obtain through local wholesale channels.

Central TV
Ingo F. Jaeschke
4719 52nd Ave.
Red Deer, Alta. Canada

I need a schematic and service manual for a Precision Model ES 520 oscilloscope. I will buy it outright or pay for a copy.

Joseph T. Beck
3810 Leila Ave.
Tampa, Fla. 33616

I need a replacement T2 audio oscillator transformer for a Precision signal generator, Model E-200-C.

Steve Topley
145 Quarry St.
Mount Pleasant, Pa. 15666

I need a schematic diagram for a Tone Funk Model U 2087 AM/FM shortwave radio.

I will pay for a copy of the diagram.

E. Bloom
Fanton Road
Danbury, Conn. 06810

I need the schematic for an Amphenol Model 860 Color Commander Generator. I also need information on replacement transistors for this unit.

I will make a copy of schematic and return original. Any help will be greatly appreciated.

Dan Recknor
2255 Dexter St.
Denver, Colo. 80207

I want to buy a used RCA Senior Voltomyst Model 980A. I understand the A model is no longer available.

Williams Radio & TV Service
106 South Jefferson St.
Lewisburg, W. Va. 24901

I am looking for a good used capacitor checker by Century Electronics. It has an electric eye, and the case measures 4 inches x 6 inches. I don't know the model number.

If anyone has a good one, please write.

Jag's Radio & TV
14 Rudolph Rd.
Forestville, Conn. 06010

I need a diagram for an Atwater-Kent Model 46, anyone having or knowing where I can obtain one, I will pay for all postage for having the copy sent to me.

Ray Pitts
Route #4, Box 463
Dalton, Ga. 30720

I recently acquired an Atwater-Kent Receiving Set, Model 20, that appears to be in excellent condition inside and out.

I would like to get a schematic or book of instructions for this radio. Any help will be greatly appreciated.

Clyde P. Gibson
Gibson Electronics
766 Normandy Court
Fairfield, Calif. 94533

I recently obtained a Precise Model 308 oscilloscope. I need a copy of the schematic diagram, the operation manual or a hand-drawn tube layout diagram for this particular model.

The manufacturer is listed as no longer having a mailing address. I will gladly pay the cost of said manual and information or copies of same.

Robert D. Shirley
6 Main St.
P.O. Box 61
Langley, S.C. 29834

I have a Simpson Model 330 tube checker which has no instruction manual, or cover. Anyone having either or both of these items, or any information on where they may be obtained for a reasonable price, may contact me.

David W. Loder
1035 N.W. 14th Ave.
P.O. Box 2847
Portland, Ore. 79208

The replacement picture tube no other color tube can replace!

ZENITH®

CHROMACOLOR®

Simulated TV picture

Now you can install the revolutionary Chromacolor picture tube in almost any brand of 23" (diag.) color TV. And let your customer see the difference: a new, sharper Chromacolor picture with greater brilliance, contrast and color definition.

Zenith pioneered, developed and patented (U.S. Patent No. 3146368) the Chromacolor picture tube. And only Zenith has Chromacolor.

Chromacolor is an easy sale because people already know of Chromacolor's superiority. (Last year, after the revolutionary new Chromacolor system was introduced, Zenith giant-screen color TV sets became the No. 1 best-seller!)

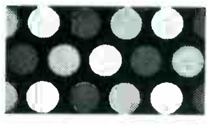
Full two-year warranty.

Here's your sales clincher: Chromacolor replacement color tubes are warranted for two full years. Exactly double the warranty period for most other replacement color picture tubes.

Give your customers the best — Chromacolor replacement color tubes. Only your Zenith Distributor has them.

TWO-YEAR WARRANTY

Zenith Radio Corporation warrants the replacement CHROMACOLOR picture tube to be free from defects in material arising from normal usage for two years from date of original consumer purchase. Warranty covers replacement or repair of picture tube, through any authorized Zenith dealer; transportation, labor and service charges are the obligation of the owner.



Zenith Chromacolor picture tube pinpoints the color dots on a jet black background and for the first time fully illuminates every dot.

ZENITH®

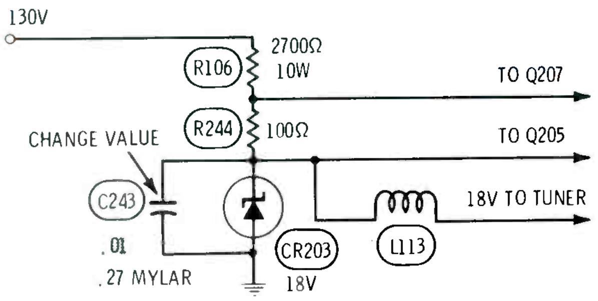
The quality goes in before the name goes on

Circle 13 on literature card

symcure

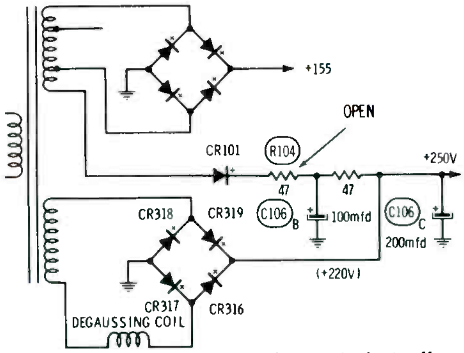
Symptoms and cures compiled from field reports of recurring troubles

Chassis—RCA CTC55
PHOTOFACT—Not yet available



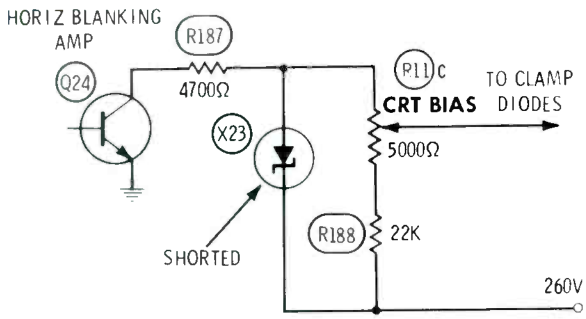
Symptom—Horizontal bending when line voltage low
Cure—Increase the value of C243 to .27mfd (Mylar dielectric)

Chassis—RCA CTC44
PHOTOFACT—Not yet available



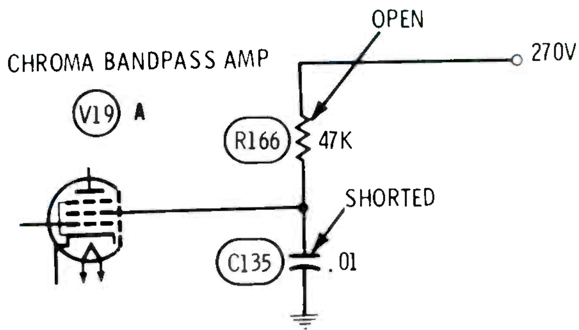
Symptom—Hum bars; degaussing not shut off
Cure—Check R104; replace, if open. Some voltage for the 250-volt supply is furnished by the degaussing bridge rectifiers

Chassis—RCA CTC44 and CTC40
PHOTOFACT—1111-3 for CTC40; not yet available for CTC44



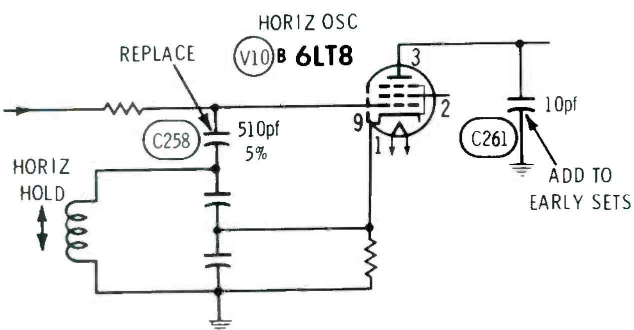
Symptom—Excessive brightness
Cure—Test zener diode X23; replace, if leaking or shorted

Chassis—Magnavox T933
PHOTOFACT—1005-1



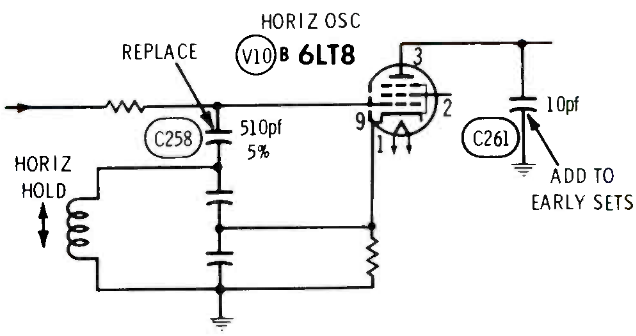
Symptom—Weak color
Cure—Test for shorted C135 and burned R166

Chassis—General Electric H-3
PHOTOFACT—1094-1



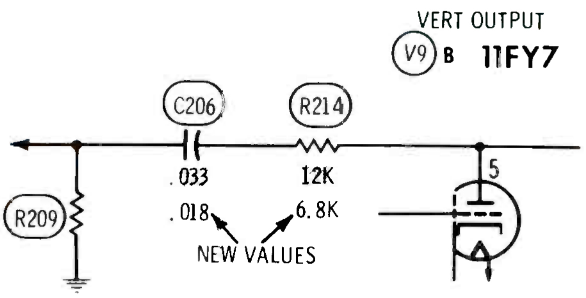
Symptom—Slight "piecrusting"
Cure—In early sets, add C261 (10 pf) between plate of V10B and ground

Chassis—General Electric H-3
PHOTOFACT—1094-1



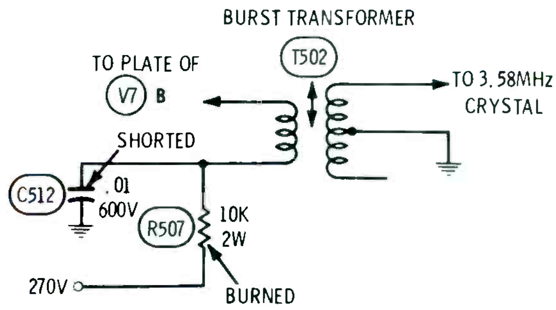
Symptom—Intermittent starting of the horizontal oscillator
Cure—Replace C258 (510-pf, 5-percent, polystyrene dielectric capacitor)

Chassis—General Electric H-3
PHOTOFACT—1094-1



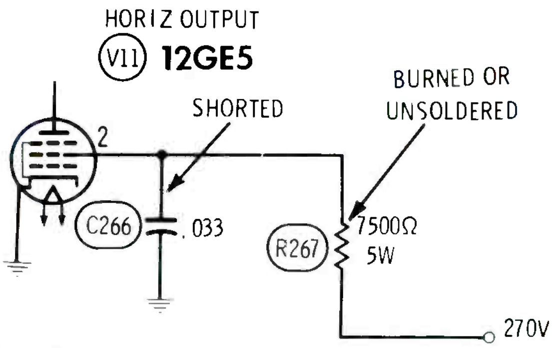
Symptom—Vertical "jitter"
Cure—Change C206 to .018mfd and R214 to 68K ohm

Chassis—General Electric H-3
PHOTOFACT—1094-1



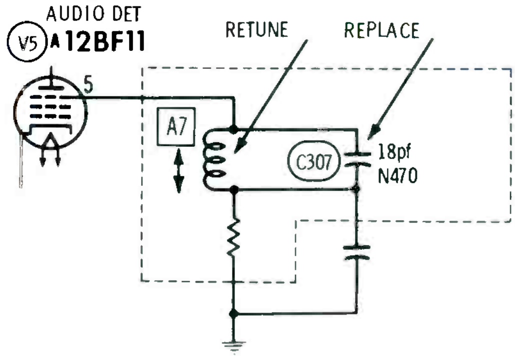
Symptom—No color
Cure—Test for shorted C512 and burned R507

Chassis—General Electric H-3
PHOTOFACT—1094-1



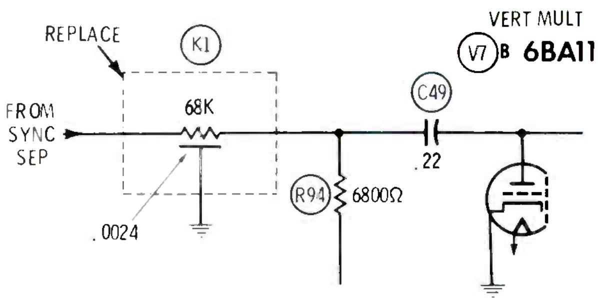
Symptom—No raster or high voltage
Cure—Test for shorted C266 and burned or improperly soldered R267

Chassis—General Electric H-3
PHOTOFACT—1094-1



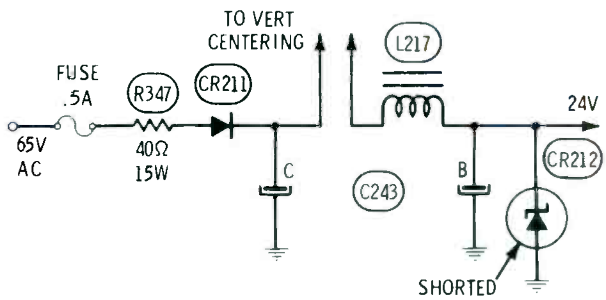
Symptom—Periodic buzz and distortion in audio
Cure—Replace C307 with a N470 type, and re-adjust A7

Chassis—Zenith 26KC20
PHOTOFACT—688-4



Symptom—Intermittent height
Cure—Replace capristor unit K1

Chassis—Zenith 4B25C19
PHOTOFACT—Not yet available



Symptom—Raster, but no picture
Cure—Test for shorted CR212 (in the 24-volt supply)

bookreview

Understanding Oscillators
(Catalog No. 20837)
Author: Irving M. Gottlieb
Publisher: Howard W. Sams & Co., Inc., Indianapolis
Size: 5½ x 8½ inches, 160 pages
Price: Softcover, $4.50.

This text provides a thorough, but concise, analysis of the basic theory of operation and typical circuits, applications and characteristics of most types of oscillators. Well-designed and smartly used illustrations plus a minimum of mathematics reduce the reading time needed for comprehension—a definite advantage for busy technicians.

Contents: Frequency-Determining Elements of Oscillators—Active Devices of Oscillators—Theory of Operation—Practical Oscillators.

Understanding Solid-State Circuits (Book No. 513)
Author: Norman H. Crowhurst
Publisher: TAB Books, Blue Ridge Summit, Pa.
Size: 5½ x 8½ inches, 192 pages
Price: Softcover, $4.95; Hardbound, $7.95.

A practical discussion of the characteristics of semiconductor devices and the circuits in which they commonly are used. A noteable feature of this text is the welcome absence of the usual lengthy discourse on the physical construction of such devices. Instead, the author takes up the subject at the point where most technicians' interest begins—how the device reacts to various voltages and currents.

Contents: The Devices—Linear Amplification — Power Amplification — Feedback—Sinusodal Oscillators—Function Generator Oscillators—Gain-Controlled Amplification—Control & Logic Circuits—Integrated Circuits. ▲

Now–Just 3 RCA Hi-Lite "V" Type Color Picture Tubes Replace 185 Types

Replaces 92 types

18VABP22
18VACP22
18VADP22
18VAHP22
18VAJP22
18VAQP22
18VARP22
18VASP22
18VATP22
18VBAP22
18VBCP22
19EXP22
19EXP22/
19GVP22
19EYP22
19EYP22/
19GWP22
19FMP22
19FXP22
19GLP22
19GSP22
19GVP22
19GVP22/
19EXP22
19GWP22
19GWP22/
19EYP22
19GXP22
19GYP22
19GZP22
19HBP22
19HCP22

19HCP22/
19HKP22
19HFP22
19HJP22
19HKP22
19HQP22
19HRP22
19HXP22
19JBP22
19JDP22
19JHP22
19JKP22
19JNP22
19JQP22
19JYP22
19JZP22
19KEP22
19KFP22
490AB22
490ACB22
490ADB22
490AEB22
490AFB22
490AGB22
490AHB22
490AHB22A
490AJB22
490AJB22A
490AKB22
490ALB22
490AMB22
490ANB22
490ARB22

490ASB22
490BAB22
490BCB22
490BDB22
490BGB22
490BHB22
490BRB22
490CB22
490CHB22
490CUB22
490DB22
490EB22
490EB22A
490FB22
490GB22
490HB22
490JB22
490JB22A
490KB22
490KB22A
490LB22
490MB22
490NB22
490RB22
490SB22
490TB22
490UB22
490VB22
490WB22
490XB22
490YB22
490ZB22

Replaces 22 types

19VABP22
19VACP22
21AXP22
21AXP22A
21AXP22A/
21AXP22
21CYP22
21CYP22A
21FBP22
21FBP22A
21FBP22A/
21GUP22
21FJP22
21FJP22A

21FJP22A/
21GVP22
21FKP22
21GUP22
21GUP22/
21FBP22A
21GVP22
21GVP22/
21FJP22A
21GXP22
21GYP22
21GZP22
21HAP22

Replaces 71 types

23VACP22
23VADP22
23VAHP22
23VALP22
23VAMP22
23VANP22
23VAQP22
23VARP22
23VASP22
23VATP22
23VAUP22
23VAWP22
23VAXP22
23VAYP22
23VAZP22
23VBAP22
23VBCP22
23VBDP22
23VBEP22
23VBGP22
23VBHP22
23VBJP22
23VBRP22
25ABP22
25ADP22

25AEP22
25AFP22
26AGP22
25AJP22
25ANP22
25AP22
25AP22A
25AP22A/
25XP22
25AQP22
25ASP22
25AWP22
25AXP22
25AZP22
25BAP22
25BCP22
25BDP22
25BFP22
25BGP22
25BHP22
25BJP22
25BMP22
25BP22
25BP22A
25BP22A/
25YP22

25BRP22
25BSP22
25BVP22
25BWP22
25BXP22
25BZP22
25CBP22
25CP22
25CP22A
25FP22
25FP22A
25GP22
25GP22A
25RP22
25SP22
25VP22
25WP22
25XP22
25XP22/
25AP22A
25YP22
25YP22/
25BP22A
25ZP22

Here's the way to save yourself time, give your customers faster service and improve your profit. Stock these three RCA Hi-Lite color picture tubes and have immediate replacements for the fastest moving industry types – 185 of them.

RCA Hi-Lite types are all new, made to OEM specifications and contain the newest RCA manufacturing technology, including Perma-Chrome and the latest X-ray attenuating glass.

It adds up to a big plus for you. Order these three RCA Hi-Lite tubes, and other types you may need, from your RCA Distributor. He also has the complete RCA Interchangeability Guide, available free of charge.

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RCA Electronic Components

25 ANNIVERSARY

HOWARD W. SAMS & CO.,INC.

PHOTOFACT Documents A Quarter Century of Technology

A 25th-anniversary report about PHOTOFACT and the company that developed and produces it, plus a description of how a PHOTOFACT Folder is produced. by J. W. Phipps

Twenty-five years ago, in June, 1946, the first PHOTOFACT Folder was published. Since then, over 49 million PHOTOFACT sets —representing over one half billion individual PHOTOFACT Folders —have been purchased by servicers of home entertainment electronic products.

A comparison of the contents of and the equipment covered by the first PHOTOFACT folder and one published in May, 1971,—exactly 25 years later—dramatically reflects the technological changes which have occurred in the home entertainment electronic industry during this quarter century—changes which have affected all elements of the industry—servicers, manufacturers distributors and dealers.

Then—1946

The first PHOTOFACT Folder covered Motorola table radio Model 65T21 and provided the radio repairman with:

- A schematic diagram;
- A voltage and resistance analysis chart;
- A categorized list of all parts, including descriptions and known available replacements;
- Alignment instructions;
- General characteristics and product information;
- Actual photos of the cabinet and top and bottom views of the chassis, with all components identified by numbers referenced to item numbers in the parts list—

all included on four pages.

According to PHOTOFACT, Model 65T21 was an AC-operated, two-band superhetrodyne radio with 53 individual parts and components, including 6 tubes.

Now—1971

PHOTOFACT Folder 1175-1, published in May, 1971, 25 years after the first folder, covers Motorola Color TV Chassis 18TS-929. This folder, representative of the extensive coverage of color TV chassis by PHOTOFACT, consists of 50 pages, which provide the technician with:

- A detailed main-chassis schematic diagram which folds out to 29 inches x 20½ inches and includes CIRCUITRACE numbers — for easy identification and tracing of circuitry—waveforms; identification of all components, adjustments and key test points; designation of modules; and alternate circuitry;
- Field-service instructions;
- Actual photos of the VHF and UHF tuners and all circuit boards and modules and front and rear views of the receiver, with all components, adjustments, CIRCUITRACE numbers and key test points identified by callouts referenced back to the schematic diagram;
- Detailed video IF and tuner alignment instructions, showing photos of the actual response curves which should be produced by the receiver;
- Schematic diagrams of all VHF and UHF tuners used with this chassis;
- Categorized lists of all components, parts and hardware, with all items identified by the component designations used on the schematic diagram and manufacturers part number, plus known available replacement parts identified by manufacturers' part numbers;
- Convergence adjustments, including a photo of the convergence panel, with all components and adjustments designated, and drawings which show which screen areas are affected by each of the various adjustments;
- Resistance measurement charts;
- Detailed procedures for performing all other service adjustments.

Motorola color TV chassis 18TS-929, used in 18-inch receivers, contains 413 individual electronic components—including 41 transistors, 2 integrated circuits 25 semiconductor diodes and 3 tubes (excluding picture tube).

Since 1946, the introduction of new types of products and substantial advancements in electronic technology have continued at a rapid pace.

First came b-w TV and the development of the transistor in the late '40's. Color TV, stereo and increased application of transistors and other discrete solid-state components followed during the '50's. Home and auto cassettes and eight-track tape players and the trend to modularization were introduced in the mid '60's, by which time stereo and b-w TV had been converted

Howard W. Sams & Co., Inc., the first product of which was PHOTOFACT, today also produces a variety of other authoritative service data and educational products and services for the electronic and other major fields—including law, agriculture, horticulture, insurance, medicine, business and literature.

Headquartered in this modern 250,000-sq. ft. building in Indianapolis, the company operates subsidiaries and offices throughout the U.S. and markets its products worldwide. In 1966 the company became a subsidiary of International Telephone and Telegraph Corporation.

Electronic-Oriented Products

The major electronics-oriented products of Howard W. Sams & Co. continue to be PHOTOFACT and the newer PHOTOFACT series of specialized manuals, which together cover over 86,000 models of consumer electronic products. Other electronic-oriented products and services of the company include:

Technical Books—Over 200 Howard W. Sams and Audel technical book titles which relate directly to the theory of operation and/or servicing of electronic products currently are available, plus many other titles which cover such electronic-related topics as appliances and motors, amateur radio, data processing, space technology and electricity.

Magazines—ELECTRONIC SERVICING (formerly PF REPORTER), directed to electronic technicians and owners or managers of shops which service consumer electronic products, and BROADCAST ENGINEERING, the technical journal of the broadcasting industry, and its Latin-American counterpart, RADIO Y TELEVISION, are produced by Intertec Publishing Corp., a Kansas City based subsidiary of Howard W. Sams & Co., Inc.

COUNTERFACTS—Used daily by over 1,500 electronic parts wholesalers, this by-product of PHOTOFACT provides continuously updated lists and cross references of replacement parts available from the major manufacturers of electronic components used in home entertainment and auto electronic equipment.

Technical Institutes—Sams Technical Institutes, now part of International Telephone and Telegraph Educational Services (ITTES), provide a variety of basic, advanced and upgrade electronic courses, including a two-year resident course which earns the successful student an Associate Degree.

Subsidiaries

The subsidiaries of Howard W. Sams & Co., Inc.—The Bobbs-Merrill Company, Inc., The Research & Review Service of America, Inc. and Intertec Publishing Corp.—reflect the company's important contributions in the areas of education and information services.

Education

The Bobbs-Merrill Company, Inc. publishes fiction, and non-fiction books for adult readers and young people, textbooks and materials for elementary and high schools, college texts and readings, and books for the legal profession. Founded in 1838, Bobbs-Merrill has a distinguished history as a publisher. Three books published by the company have won Pulitzer Prizes. Bobbs-Merrill became part of the Sams Company in 1958 and has offices in New York City and Indianapolis.

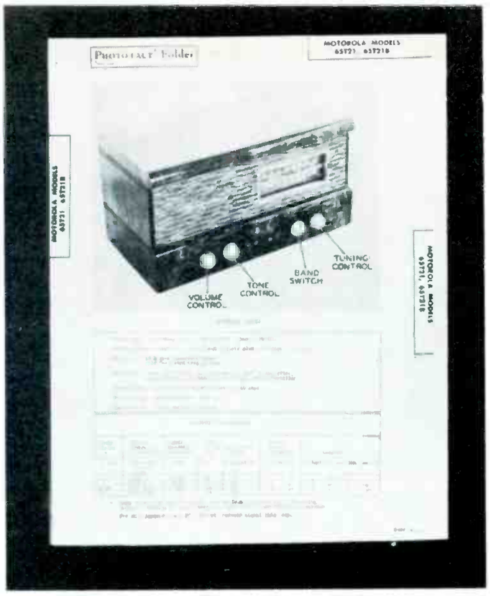
The Research & Review Service of America, Inc., located in Indianapolis, has been a member of the Sams Company since 1965. The company publishes books, periodicals, training courses, films and other materials for training and motivating insurance agents, stock brokers and similar professionals.

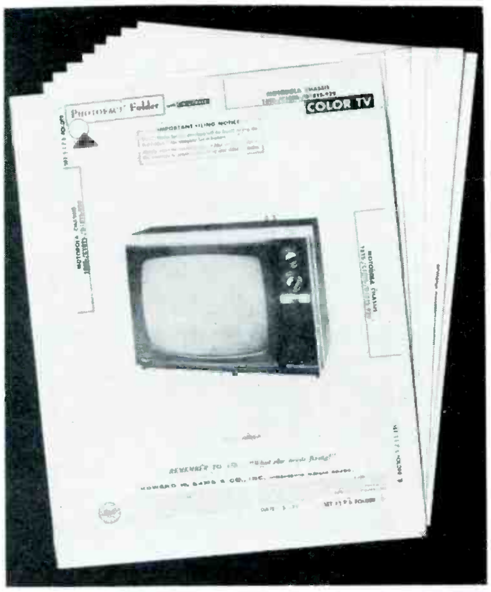
Information Services

Intertec Publishing Corp., Kansas City based publisher of ELECTRONIC SERVICING, BROADCAST ENGINEERING, RADIO Y TELEVISION and six other technical, trade and business magazines, also has a long and distinguished history in the field of publishing.

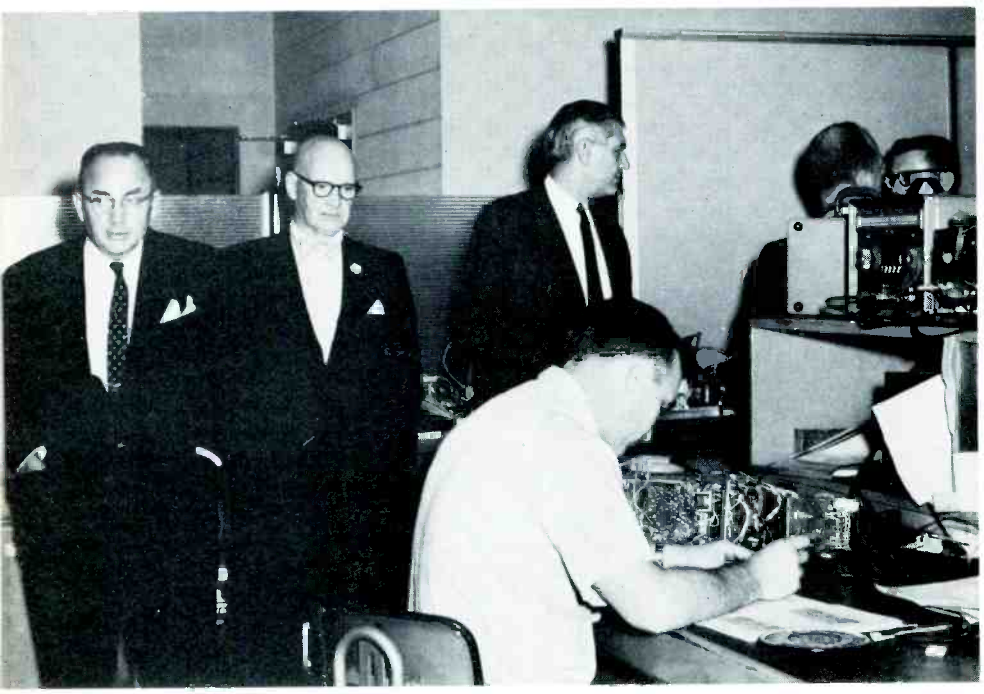
The company produced its first trade magazine, IMPLEMENT & TRACTOR, in April, 1886. This magazine, still the leading publication in the farm implement field, has since been joined by eight other magazines and a shop service for farm implement dealers—similar to that provided electronic servicers by PHOTOFACT—plus repair and service-pricing manuals for small-engine repair, and service-pricing and trade-in manuals used by farm implement dealers.

Magazines published by Intertec cover, in addition to electronics, such diversified fields as agriculture (AGRICULTURA de las AMERICAS and WORLD FARMING), commercial grounds maintenance (GROUNDS MAINTENANCE), horticulture (LAWN / GARDEN / OUTDOOR LIVING), commercial equipment leasing and capital financing (LEASING WORLD), and farm and industrial equipment retailing and repair (IMPLEMENT & TRACTOR, RED BOOK and I&T PRODUCT FILE).





Changes in the format and size of PHOTOFACT during the past 25 years reflect the increased complexity of home entertainment products. Shown in the top photo is the first PHOTOFACT Folder, a four-page publication which covered a six-tube, 2-band table radio consisting of 53 parts. PHOTOFACT Folder 1175-1, published in May of this year, has 50 pages. It covers a color TV set equipped with 413 individual electronic components, typical of today's designs.



Howard W. Sams (second from left), developer of PHOTOFACT and founder of Howard W. Sams & Co., Inc., is shown here with Harold S. Geneen, chairman of the board and president of International Telephone and Telegraph (ITT), shortly after the purchase of the company by ITT in 1966.

from tube to discrete solid-state designs.

In the past five years, we have witnessed the beginning of two other trends—the introduction and increasing use of integrated circuits in consumer electronics products, along with increased use of the modular concept of design.

Each of these new types of products and advances in technology have required either updating of an existing PHOTOFACT format or development of new coverage.

The Origin of PHOTOFACT

Immediately after World War II, consumer demand for new radios and replacement parts for older radios, with which consumers had been stuck for the duration of the war, plus new electronic technology developed during the war years, created a boom in the home entertainment electronic industry.

Striving to fulfill the demand for new radios and focusing increased attention, effort and money on the development of practical television systems and receivers, most electronic manufacturers relegated service information and replacement parts data to a step-child position. Although a few manufacturers made such information available, many produced only token amounts which failed to fill the need, and some produced none at all.

Howard W. Sams, at that time marketing division manager for a major manufacturer of electronic components, recognized the urgent need for more complete, accurate and timely service and replacement parts information. He also realized that much of the inadequacy of the small amount of existing service and parts data was attributable to the fact that it was published before the initial design of the equipment was finalized.

Mr. Sams decided that the solution to the problem required that an independent publisher procure the equipment after the design was finalized and the equipment marketed, and produce timely, standardized service and parts information based on a first-hand, detailed analysis of a production-run unit.

In 1946, Mr. Sams rented 5000 square feet of space in a building in Indianapolis, hired twelve employees and, on April 1 of that year, began developing PHOTFACT, the first of which was published in June.

How PHOTOFACTS Are Produced

HOWARD W. SAMS & CO., INC.

All information published in PHOTOFACT Folders is obtained from detailed, first-hand analysis of production-run receivers in the PHOTOFACT Division of Howard W. Sams & Co., Inc., in Indianapolis.

In a process which involves more than 250 technicians, illustrators, photographers, editors and a variety of other production and administrative personnel, and which can take as long as eight weeks, the circuitry and components of each receiver are substituted, photographed, traced, drawn and subjected to a variety of other forms of exacting measurements and observations.

The primary purpose of this careful analysis is to gather all the product information an electronic technician normally needs to efficiently service a home or auto entertainment or communications electronic product. This information includes uniform schematic diagrams, alignment and adjustment procedures and data, accurate component identification data and illustrations, and component replacement data.

The following paragraphs and illustrations explain how a PHOTOFACT Folder for a typical TV receiver is produced. Identical or similar procedures are used in the production of PHOTOFACT Folders and Sams specialized series of manuals covering other types of home and auto entertainment and communications electronic products.

Selection and scheduling of products to be covered

The first steps in the production of a PHOTOFACT begin long before the receiver actually arrives at the Howard W. Sams facilities. These first steps involve selection and scheduling of products for analysis.

In 1946, when PHOTOFACT coverage began, only three primary categories of entertainment electronic equipment were being marketed—phonographs and home and auto radios.

Today, there are seven primary categories of entertainment electronic equipment which together contain eighteen distinct types. Multiply these by the number of makes and distinct designs, and the proliferation of type, make and model of home and auto entertainment and communications electronic products being marketed today becomes evident.

To reduce the number of individual PHOTOFACT Folders required, but yet provide coverage of the majority of the sets sold and in use, PHOTOFACT has established a selection process based on 1) the volume of sales, 2) the retail value of the product and 3) combined coverage of models of the same make or manufacturer which employ identical or nearly identical chassis.

To qualify for coverage in PHOTOFACT or in an appropriate Sams specialized-series manual, at least 25,000 units of the product must have been sold nationwide or at least 10,000 units must have been sold in the three major market areas of the country.

The minimum acceptable retail values vary according to the type of product. For example, all products covered in PHOTOFACT Folders must retail for at least $49.95. This includes b-w and color TV, table-model radios, portable phonos and self-contained radio/phones. (Prior to January 1, 1971, the minimum acceptable retail value of such items was $24.95.)

To qualify for coverage in either the transistor radio or auto-radio specialized series, equipment must retail for at least $24.95. The transistor series covers both personal portable and combination radio/phono units. Both radio and tape players and combination units are included in the auto-radio series.

Other categories of equipment covered by the specialized-series manuals are: mass-produced modular hi-fi units retailing for between $89.95 and $500.00; reel-to-reel, cassette and eight-track tape recorders which retail for at least $24.95; and Citizens-Band units with outputs of 1 watt or more, which require a license (no minimum retail value stipulated).

Through continuous communications with set manufacturers, including visits of PHOTOFACT personnel to manufacturing facilities and attendance at trade shows and press briefings, the management of PHOTOFACT keeps abreast of the pending introduction of new models and chassis. From these, using the criteria just presented, management selects the chassis which will be covered in PHOTOFACT or the specialized-series manuals.

Once it has been determined which chassis will be covered, they are scheduled into the PHOTOFACT analysis line as soon as possible after they are made available by the manufacturer, or the availability date is known. If the chassis is merely an update of an existing design, the production run probably will be large and a set immediately will be made available to PHOTOFACT. However, if the design is new, the initial production probably will be limited to a small number of sets, which will be used to test the acceptance of the model and to "prove out" the design. If no major problems are encountered, the main production run usually begins between one and three months after the initial run. When a sufficient quantity of sets have been produced, a receiver is then made available to PHOTOFACT.

The goal of PHOTOFACT is to have a PHOTOFACT Folder available to servicers as soon after introduction of the chassis as is possible.

At present, PHOTOFACT Folders covering the receivers of major manufacturers are available to servicers as soon as three months after model introduction, and coverage of brands with less sales are completed not more than 12 months after model introduction.

All receivers supplied PHOTOFACT by manufacturers are selected at random from warehouse stocks of production-run units. Most are consigned to PHOTOFACT and, after analysis is completed, are reassembled and returned to the manufacturers, who sell the sets in their "family" stores or use them for testing or training.

Measurement of operating temperatures

Upon receipt by PHOTOFACT, the receiver is removed from the box and operated to make sure that it is free from defects.

Thermocouples then are connected to certain points on the TV chassis and to various components, to measure the temperatures encountered during four hours of normal operation. This information is included in the engineering data supplied participating replacement parts manufacturers.

Preliminary photography—front and rear cabinet shots

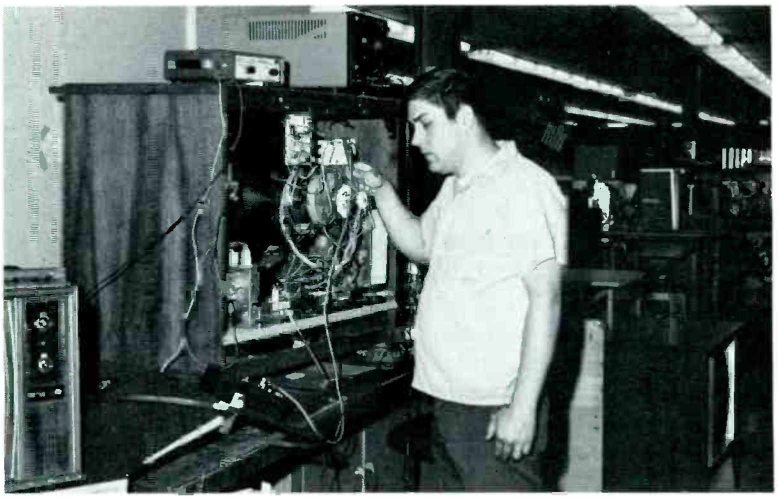
The cabinet back is removed, and the complete set, with the chassis still in the cabinet, is taken to the photo lab for front-and rear-view photos.

Picture tube and speaker replacement considerations

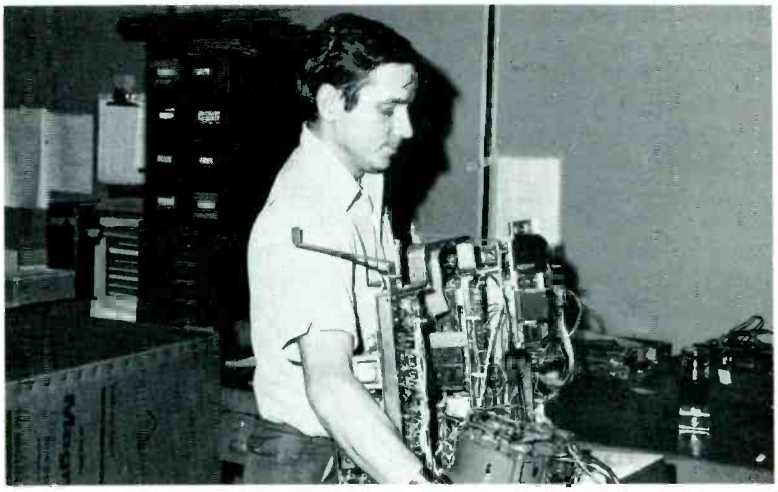
The receiver then is returned to the disassembly station, where, prior to removal of the chassis, it is again operated as a unit, to obtain the data needed to determine which of the available replacement picture tubes are suitable for use with this receiver. Such data includes the operating voltages and the physical dimensions of the tube, as well as any special mounting requirements.

At this same time, the physical and electrical characteristics of the speaker(s) also are noted and compared with those of available replacement speakers, to establish which will meet or exceed the replacement specifications.

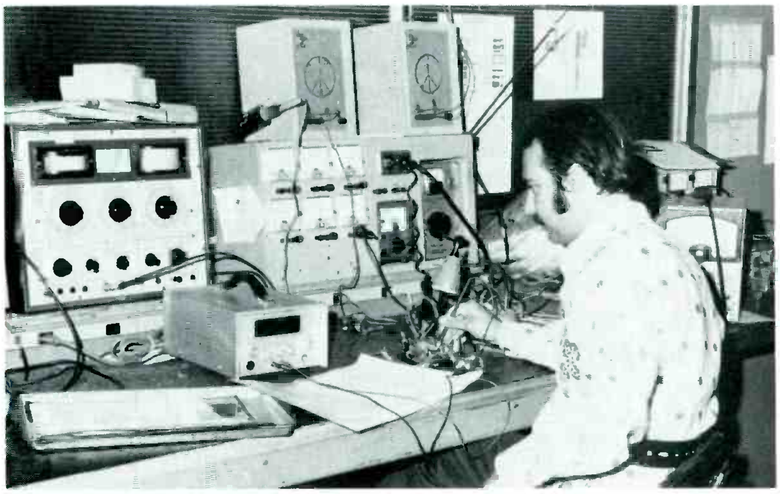
The PHOTOFACT analysis procedure is illustrated by these photos, which have been grouped to show the actual sequence of some of the many individual operations.



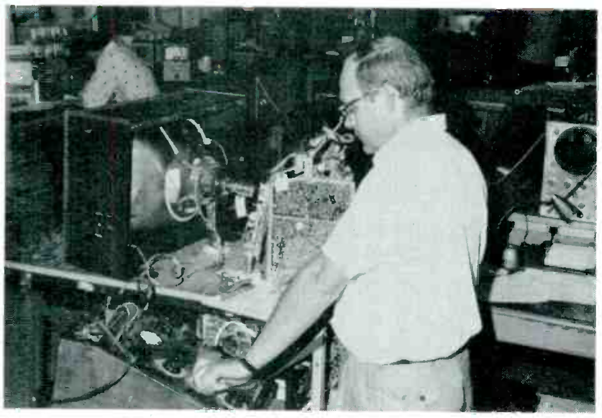
Picture tube data and convergence procedures



Removal and disassembly of chassis and subassemblies for photographing

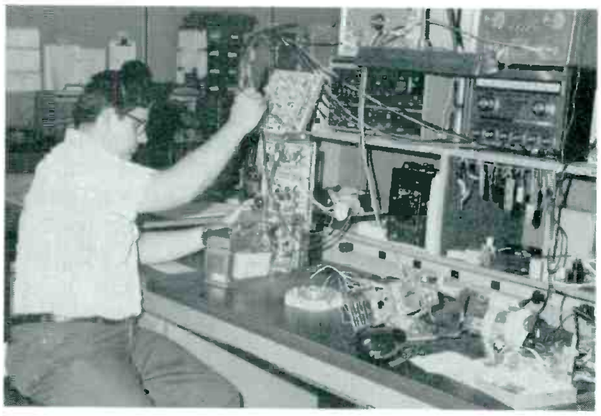


Voltage and resistance measurements



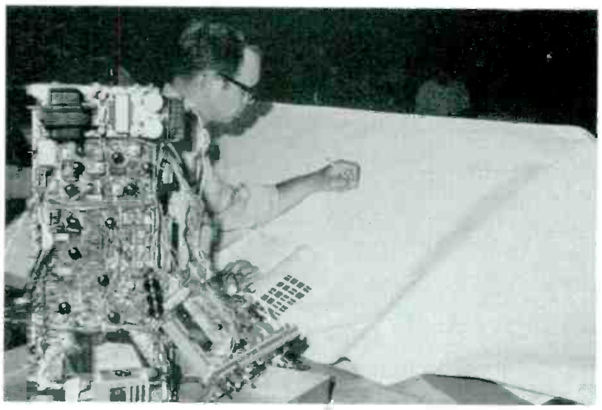
Sweep analysis

Individual component analysis

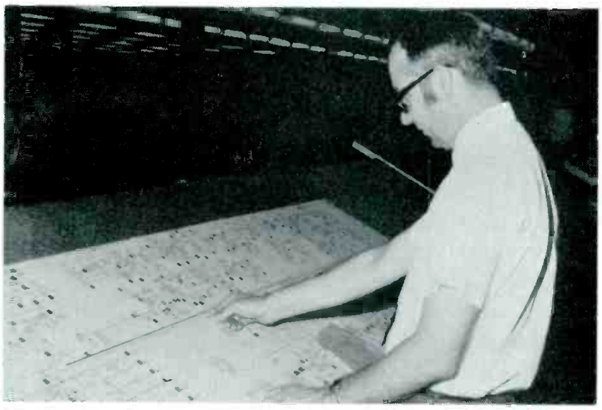


Alignment procedures and waveform photos

Preparation of circuit-board photos



Circuit tracing, schematic sketching, and component and circuit identification



Rechecking illustrations

Preparation of finished PHOTOFACT schematic

Preparation and editing of final copy and illustrations

Replacement Parts Data: An Important By-Product of PHOTOFACT analysis

Accurate data about the physical and electrical characteristics of the components used in production-run chassis are important by-products of the PHOTOFACT analysis process.

This information is supplied to the 38 major replacement parts manufacturers who participate in the PHOTOFACT engineering data program.

The engineering data provided these manufacturers by the PHOTOFACT division of Howard W. Sams helps assure the service industry a ready supply of replacement parts by keeping the replacement parts manufacturers abreast of the various types of parts needed and the incidence of the use of each.

The replacement parts manufacturers, in turn, provide PHOTOFACT with detailed specifications and samples of the parts they presently manufacture. PHOTOFACT uses this information, along with other data, to determine which of the available replacement parts equal or exceed the specifications and required ratings of the original components. These then are listed in PHOTOFACT as suitable replacement parts.

Set adjustments

Also prior to chassis removal, the convergence board and convergence yoke assembly are analyzed, to establish the most efficient and accurate setup procedures, including gray-scale, purity and convergence adjustments.

Measurement of static and dynamic voltages

The chassis is then removed from the cabinet, for easier access to key points in the circuitry, and reconnected to the picture tube through extension cables. The chassis is turned on and, with no external signal applied, is adjusted to produce a normal raster. (This establishes valid operating conditions which can be easily duplicated in any service shop.) DC voltages on the elements of tubes and transistors and at other key test points are measured and recorded for later application to the PHOTOFACT schematic.

A test signal then is applied to the receiver and the range of AGC voltages, and any other control voltages which vary according to the strength of the received signal, are measured and recorded. If the set is a b-w receiver, a test signal from a test transmitter within the Sams facilities is used. Color signals from one of a number of available makes of keyed color-bar generators are used for color TV analysis.

Resistance measurements

Resistance between tube and/or transistor elements and ground are measured and recorded next. Resistance measurements in solid-state circuitry are obtained with an ohmmeter which has a maximum of only .08 volt between the probe tips. (Such measurement criteria are noted in PHOTOFACT.)

Sweep analysis

The flyback, vertical-output transformer and yoke are analyzed next. Inductances and DC resistances are measured and recorded, and all electrical and all physical characteristics are compared with those of available component designs, to determine the most suitable replacements.

After the replacements for each have been selected, they are installed in the chassis and the chassis operated to insure that the selected replacements actually will perform satisfactorily in the chassis. Pulses, voltages and current are measured and compared and a visual check of the raster is made.

Tuner and chassis alignment instructions

The set next is aligned, if needed, using post injection of the markers, which is the marker application method designed into most of today's sweep/marker generators. The test or alignment instruments used at the alignment and other analysis stations are periodically rotated among the major makes of test instruments available to service technicians, to insure that the alignment and adjustment instructions and all other data published in PHOTOFACT are compatible with the test instruments available to service shops.

Using the manufacturer's alignment instructions as a guide, and making any changes needed to insure that the procedures can be accomplished with available service-type test equipment, the alignment specialist records the detailed information needed to later prepare step-by-step instructions for performing tuner, video IF and chroma circuitry alignment.

Response curve and key waveform photos

After he has determined that all tuned circuits in the tuners and chassis are properly aligned, the alignment specialist photographs the response curves, including appropriate markers. These photos of the actual response curves produced by the chassis are included in the chassis and tuner alignment sections of the PHOTOFACT Folder.

The alignment specialist next photographs the waveforms produced at key test points in the tuners and chassis. He also measures and records the PP voltage level of each waveform; these are later stripped onto the waveform photos before they are placed on the PHOTOFACT schematic.

At this point, all static and dynamic measurements which require operation of the chassis have been completed and the chassis can now be disassembled further. Between one and two weeks will have passed since the set first entered the PHOTOFACT analysis line, depending on the complexity of the receiver design.

Chassis, tuner, circuit boards and subassembly photographs

The chassis, tuners and associated subassemblies are now returned to the disassembly area, for preparation for photographing. This preparation includes removal of all shields, so that any circuitry and components that normally are hidden beneath them will be visible in the photographs and can be labeled for identification. The disassembled chassis and electrical subassemblies of the receiver are then transported to the photo lab, where they are photographed in as many positions as required to properly display and identify all circuitry and components.

Circuit tracing and sketching and assignment of component designations

After completion of photography, the chassis and related subassemblies are returned to the PHOTOFACT analysis line for tracing and sketching of all circuitry.

Using the manufacturer's data as a guide, a technician physically traces out each circuit and notes the actual electrical location and value of each component. He then sketches on graph paper the circuitry he has traced, adapting it to the uniform signal-flow layout used in PHOTOFACT schematics. When the circuitry and/or a component on the manufacturer's schematic differs from that actually in the chassis, the information on the manufacturer's schematic is indicated on the PHOTOFACT schematic as an alternate circuit and/or component.

The PHOTOFACT system of assigning component identification, CIRCUITRACE and test-point numbers by order of appearance and major section is used, except for components on circuit boards which have been assigned item numbers by the manufacturer and the number has been permanently positioned on the board next to the component. In such cases, the item number actually on the board—not that on the manufacturer's schematic—is used as the PHOTOFACT component identification number, or callout.

By this time, the photos of the chassis, circuit boards, tuners and other subassemblies will have been developed and printed by the photo lab. These are delivered to the technician, who attaches a clear plastic overlay on each of these photos and records on it the component identification, CIRCUITRACE and test-point numbers he has assigned the components and circuit points on that subassembly. This assures that the callouts on the photos will correspond to those on the PHOTOFACT schematic.

By the time the technician has completed the schematic sketch and the overlays on the chassis and subassembly photos, he will have traced out each circuit and checked each component at least three times. This repetition, which is part of the PHOTOFACT technique, helps insure exceptional accuracy.

The completed schematic sketch and the chassis and subassembly photos, with callout overlays, are delivered to the illustration department, which will use them to pre-

Additional Service Offered by PHOTOFACT

PHOTOFACT coverage of the majority of sets in use is accomplished by selecting equipment for coverage on the basis of 1) volume of sales, 2) retail value of product and 3) combined coverage of identical or nearly identical designs. This method of selection also helps reduce the cost to the servicer because it reduces the number of folders required.

To provide servicers at least minimum service information about the small number of sets not covered by PHOTOFACT Folders, the producers of PHOTOFACT continually source out, gather and maintain extensive files of manufacturers' data for many of these sets.

Although PHOTOFACT has not been able to obtain service information about all such sets, copies of the information which is available will be provided PHOTOFACT-OF-THE-MONTH subscribers for a nominal fee of 50 cents per request, to cover copying and mailing. Other servicers can obtain such information for $1.00 per request.

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"To realize efficiency in any servicing operation, the technician must be provided with service literature that accurately and clearly illustrates and identifies all circuitry and components, and outlines alignment and adjustment procedures which enable the technician to take advantage of all the time-saving features of the test instruments available to him."—PHOTOFACT Manager Joe Groves, a veteran electronic technician with first-hand experience as a service shop owner and manager.

To keep pace with technology and an expanding market, the PHOTOFACT division of Howard W. Sams has grown from a 12-man staff in 1946 (side photo) to an operation that involves more than 250 technicians, editors, illustrators and a variety of other production and administrative personnel. Shown in the upper photo is just part of the PHOTOFACT analysis area in the Indianapolis facilities of Howard W. Sams.

pare the finished art and photos which will appear in the PHOTOFACT. They also prepare a small duplicate of the schematic sketch, which is returned to the PHOTOFACT analysis line and placed with the chassis and associated subassemblies, so that future references to circuitry and components during subsequent analysis will correspond to the data on the finalized PHOTOFACT schematic.

Individual component analysis and selection of replacements

The chassis, tuners and all other subassemblies of the receiver now are processed through the individual component analysis section, in which the characteristics of all non-standard or limited-application components are analyzed, to determine which of the available replacement components of participating replacement parts manufacturers equal or exceed the ratings of the originals. The most suitable of the available replacement components are listed as recommended replacements in PHOTOFACT.

The individual component analysis section is divided into units which specialize in the analysis of certain types or groups of components. For example, the active components group checks the characteristics of tubes, transistors and semiconductor diodes. Other groups and/or stations check electrolytic capacitors, fixed capacitors, controls, power and special resistors, RF and IF coils, sweep circuit coils, filter chokes and fuses.

Final editing, proofreading and production

Finally, all of the data which have been gathered during the PHOTOFACT analysis process are compiled by a group of editors who recheck all information and illustrations for completeness and accuracy.

When all corrections and recommended changes and additions have been completed, and the format and layout have been checked and approved by the editors, the copy is typed and prepared for what is called the "production" phase.

Layouts of the typeset copy, with spaces for illustrations, are prepared. These are called "dummies".

This is followed by the "paste-up" stage, in which the typeset copy and illustrations are pasted down on large camera-ready forms, in accordance with the dummy layout. Once these are approved, they are photographed with a special camera.

The negative produced by the camera is used to make the final checking copy called the silverprint. After the silverprint is checked and approved, it is used in a photoengraving process to make the metal plates which are attached to high-speed presses. The printed forms, when folded and combined, are a finished PHOTOFACT Folder. ▲

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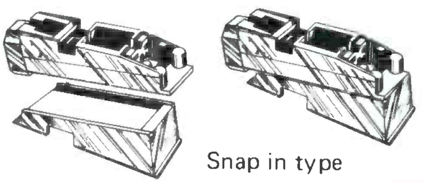

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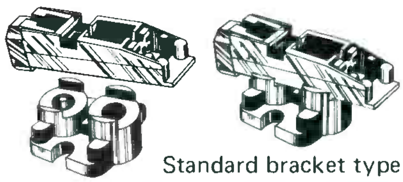

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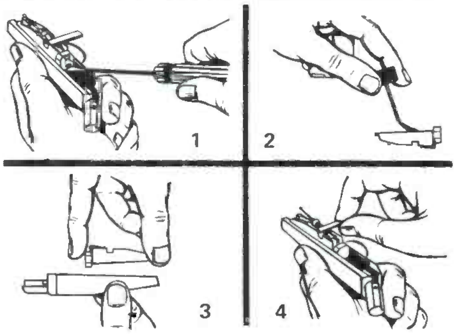

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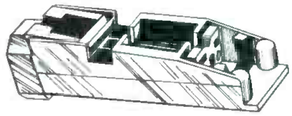

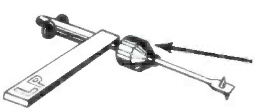

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Zener Diodes—Testing and Replacement

by Carl Babcoke/ES Technical Editor

Zener diodes are solid-state voltage regulators. They are used often as DC voltage regulators in the voltage supplies to low-level stages in FM receivers and solid-state television receivers, and as the source of a reference voltage in transistor-regulated power supplies. Because so many zeners are used in modern equipment, we need fast and accurate methods of testing them, and strong guidelines for selecting replacements.

Zener Diode Actions

A zener diode, when forward biased (anode positive, cathode negative), acts as a normal rectifier diode and provides a low internal resistance. When only slightly reverse biased (anode negative, cathode positive), the diode is nearly an open circuit. This action is identical to that of a normal rectifier diode.

If the reverse bias is gradually increased, as shown in Fig. 1, current flow increases very suddenly at a voltage called the "avalanche" point. A graph of this action is shown in Fig. 2. The voltage at which avalanche takes place is determined by the internal construction and the active materials used during the manufacturing process. One supply catalog lists general replacement zener diodes with nominal voltages ranging from 3.3 to 120 volts DC.

In addition, zener diodes are rated by maximum wattages, which should not be exceeded, if premature failures are to be avoided. A higher wattage rating should not be used for replacement zeners, for reasons which will be given later in this article.

Ohmmeter Tests

Test a zener diode with an ohmmeter exactly as you would a power supply diode. The only precaution is that the voltage of the ohmmeter battery should be less than the rating of the diode (most are).

Pre-set the ohmmeter for a low scale—we suggest X10—and measure the forward resistance by attaching the positive meter lead to the anode and the negative meter lead to the cathode. A low reading should be obtained. Reverse the diode leads. Any deflection of the needle now indicates a short or excessive leakage. Try a higher scale, perhaps X1000, for a more sensitive reading of the leakage.

If they have previously operated satisfactorily in the circuits under test, most zener diodes which pass this simple test will not be defective.

A more complete test is required to find the operating voltage for a zener, the ratings of which are not known.

A Variable-Voltage Test

Zener diodes for use in experimental circuits or diodes of unknown "avalanche" voltage rating can be tested by operation in the circuit shown in Fig. 1. The series resistance (which might, in some cases, be the internal resistance of the power supply) is necessary to prevent overload of the power supply and accidental burnout of the diode under test. The resistor also assures current regulation at the nominal voltage of the individual zener. Replacement zeners are usually available in ±10-percent or ±5-percent tolerances.

Connect the zener diode in the correct polarity and increase the supply voltage until a "plateau" is reached, as shown in Fig. 2. The nominal voltage rating is about the center of the plateau. Of course, the current should never exceed the

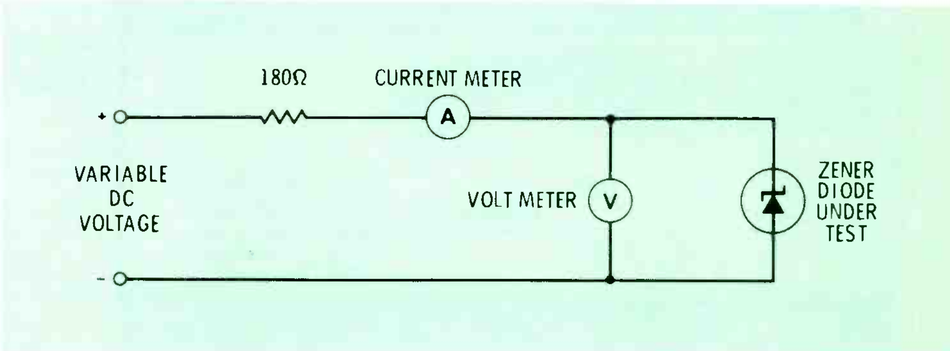


Fig. 1 Schematic of a circuit which can be used to test zener diodes by the voltage-current method.

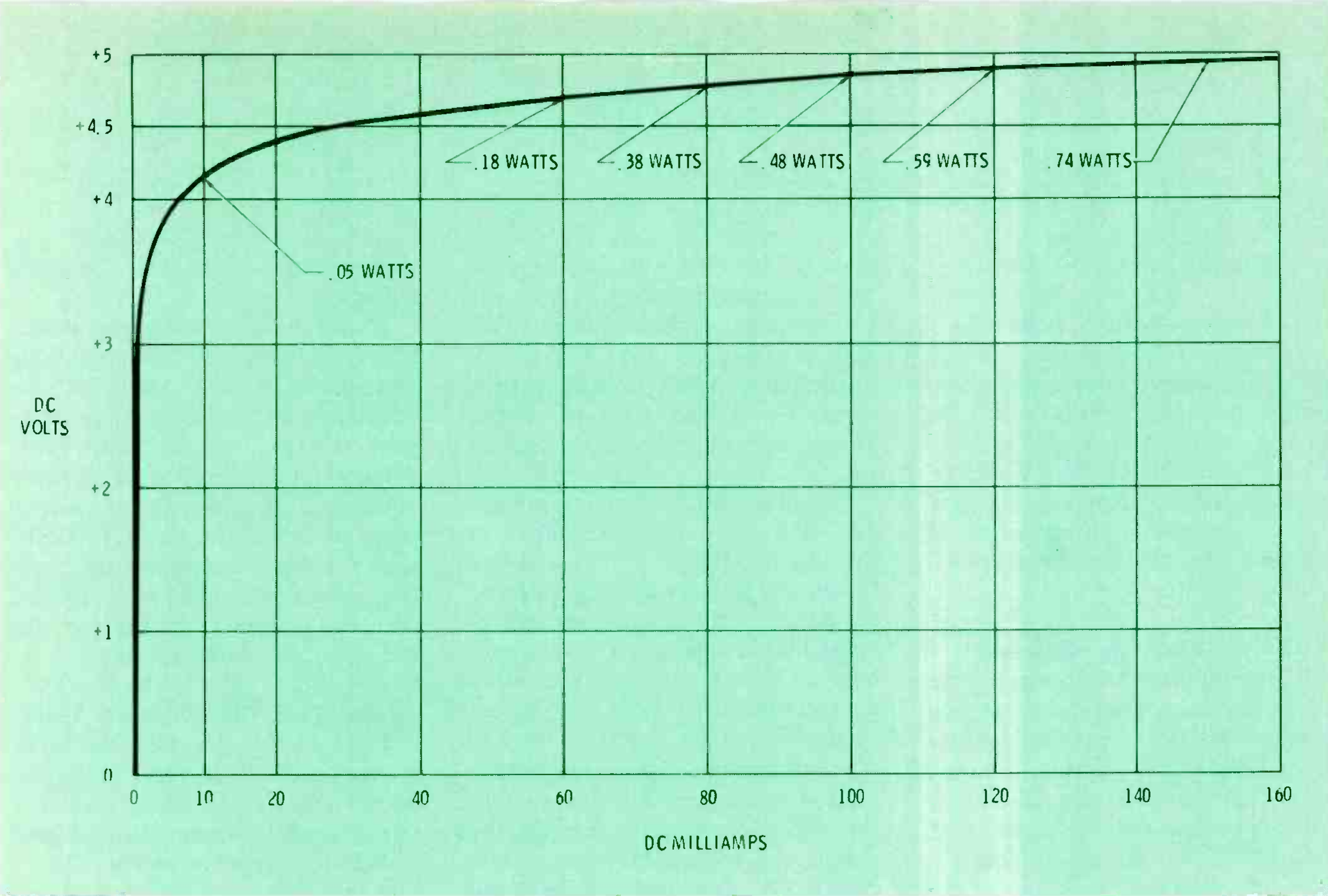


Fig. 2 Results of the voltage-current method of measuring zener diodes can be graphed. Shown here is the graph of an International Rectifier Z1102-C 1-watt zener diode. The nominal voltage rating is approximately in the center of the "plateau".

maximum rating of the zener diode.

Many manufacturers test zeners at 20 percent of the rated current. The diode which yielded the graph shown in Fig. 2 was rated at 4.7 volts and 1 watt. The maximum current was not listed, but was computed using the Ohm's law formula: Power (in watts)=EI. Because the power is 1 and the voltage (E) is 4.7, the maximum current (I) is .2128 amps, or 212.8 milliamps. Twenty percent of 212.8 milliamps is 42.6 milliamps, or approximately 40 milliamps, which should be the test current for the zener used in this example.

If you are testing zener diodes which are original components, the current meter reading can be omitted. Just do not increase the voltage any more than the minimum necessary to establish the plateau.

A fixed power supply voltage and a resistor substitution box or a variable resistor of the proper size to vary the current also can be used to test zeners. However, a smooth variation of current is more difficult to obtain, so this method should

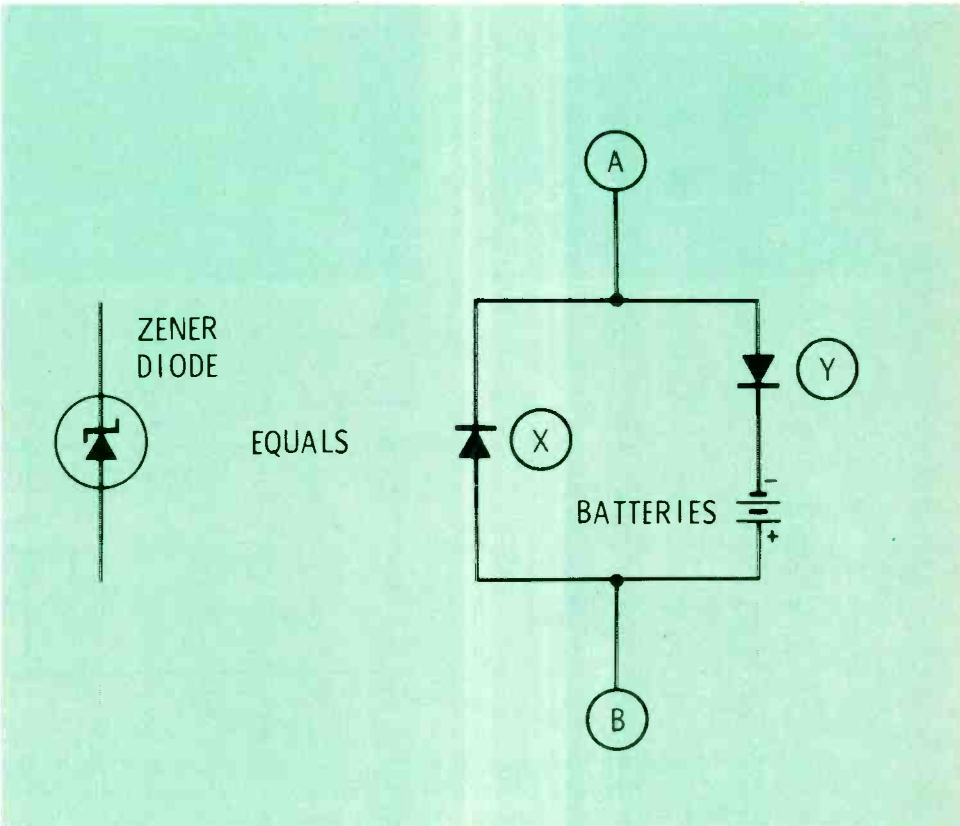


Fig. 3 A zener diode can be visualized as two rectifier diodes of opposite polarity connected in parallel, with a battery, used to provide a voltage delay, in series with one of them. Conduction can be obtained in either polarity, but at different voltages.

be considered a second choice.

Curve Tracer Tests

Tests of diodes and zener diodes using the Jud Williams and Eico transistor curve tracers were described in the March, 1971, issue of ELECTRONIC SERVICING. Accurate results demand that the gain of the horizontal amplifiers in the scope be adjusted to a known calibration.

Zener Tests By Clipping

By bending the truth slightly, we can visualize a zener diode as two rectifier diodes of opposite polarity in parallel, and with a battery, whose voltage is equal to the zener voltage, connected in series with diode "Y", as shown in Fig. 3. Let's imagine that we connect this zener-equivalent in series with a DC circuit which has 50 milliamps flowing in such a way that terminal "A" is negative. About .7 volt will be measured between terminals "A" and "B", because diode "X" is conducting and this is the voltage drop across it. Diode "Y" is reverse biased, and, therefore, non-conducting.

Imagine now that the terminals "A" and "B" are interchanged in the circuit. Diode "X" is reverse biased and non-conducting. Because the battery voltage is a constant reverse bias for diode "Y", it cannot conduct until the voltage drop across terminals "A" and "B" exceeds this voltage.

Assuming zero resistance in the battery and a large current, such as 50 milliamps, flowing through the circuit, the voltage drop across terminals "A" and "B" will be equal to the battery voltage plus the .7 volt barrier potential voltage of diode "Y". This sum is the zener voltage.

If the analogy stated previously is correct, a zener diode should clip both peaks of a sine wave to produce a square wave whose peak-to-peak voltage is equal to the zener voltage plus .7 volt (the forward voltage drop). We tested several zener diodes in the ELECTRONIC SERVICING laboratory to verify this asumption, and were pleased with the simplicity of the test and the accuracy of the results.

Results of The Clipping Tests

Figs. 4A and 4B show the waveforms produced by two individual zener diodes of different types. The circuit used to obtain these clipped waveforms is shown in Fig. 4D.

A good diode which is not a zener produced the waveform shown in Fig. 4C.

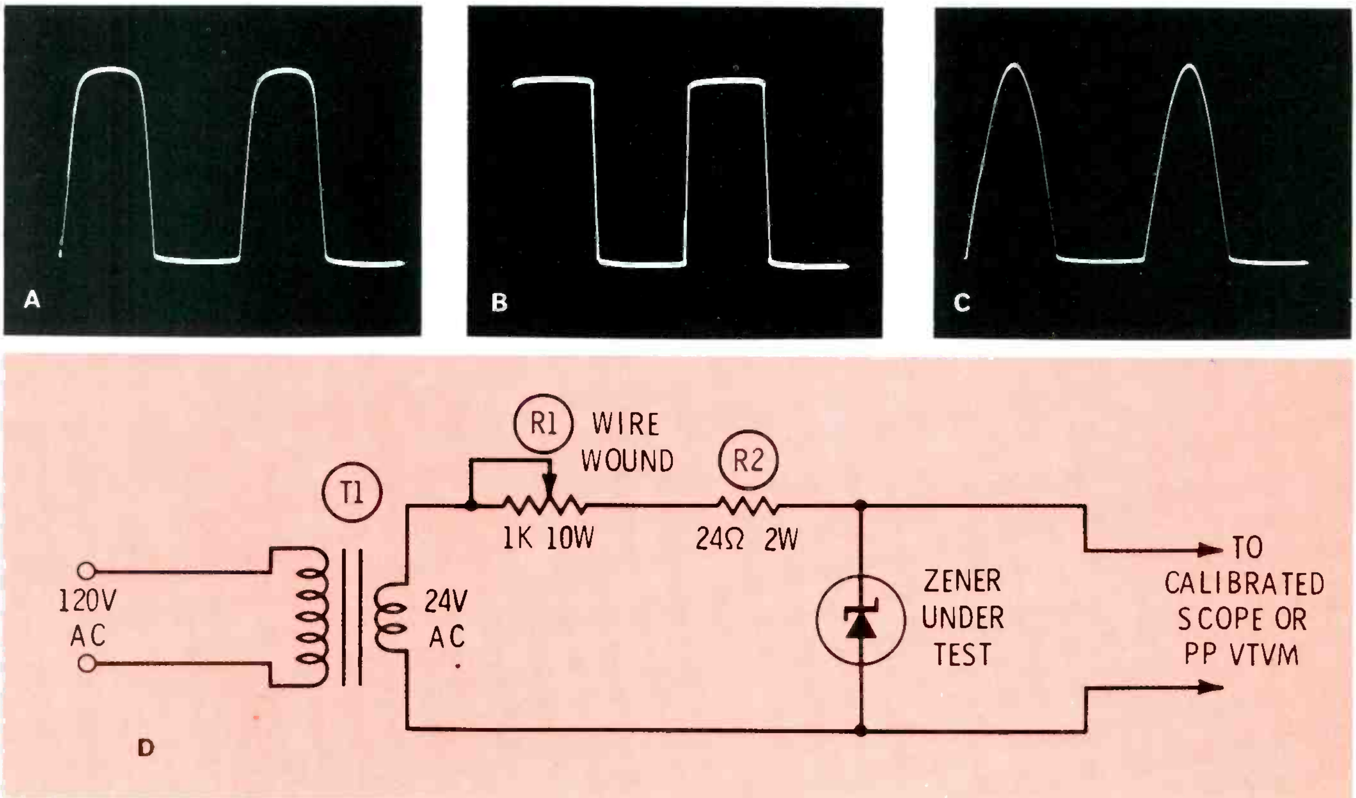


Fig. 4 Waveforms obtained when a zener diode is used to clip a sine wave. **A)** The high internal resistance of a 1-watt zener caused rounding of the corners of the waveform shown here (clipped by the zener action). **B)** A 2-watt zener diode, which has lower internal resistance, clipped the sine wave more symmetrically and gave a more accurate reading. **C)** A power supply diode clipped just one peak of the sine wave. **D)** Schematic of the circuit used to test the zener avalanche voltage by the clipping method.

The rounded top corners of the waveform in Fig. 4A were caused by the high internal impedance of a one-watt zener diode. Also, the amplitude changed somewhat as the input voltage was varied. When the top corners are rounded, a minimum resistance setting of R1 is recommended, because it sharpens the corners and minimizes amplitude changes. However, the more rounding of the corners, the less accurate the reading of the zener voltage.

The diode graphed in Fig 2 measured 5.6 volts in the clipping test. After subtracting .7 volt, the corrected zener voltage rating was 4.9 for this diode, rated by the manufacturer at a nominal 4.7 volts. I would rate it from the graph in Fig. 2 as 4.7 volts (the middle of the plateau at 80 milliamps). Rounding of the top corners caused the slightly inflated reading; however, the 4.9-volt reading is more than accurate enough for all normal servicing.

Even more accurate results were obtained during the tests of an exact replacement zener which was rated at 10 volts and 2 watts, although the current/voltage graph showed 8.7 at the usual test current (40 milliamps in this case) and 8.9 at the center of the plateau of the curve. The peak-to-peak reading during the clipping test was 9.7, from which was subtracted .7, to give a zener voltage of 9.0 volts. Although this differs .1 volt from the nominal rating obtained from the center of the voltage-current plateau, because of the higher voltage, it is a smaller **percentage** of error than the error of previous zener diode readings. Also, the amplitude or shape of the corners did not change with variations in R1 or the input voltage.

We recommend the clipping test to determine the true nominal rating of all zeners of one-watt rating and larger. Remember, the applied AC must be at least twice or more the voltage of the zener that is under test. The values given in Fig. 4D are sufficient for testing zeners up to a rating of approximately 12 volts.

Troubleshooting Zener-Regulated Power Supplies

The schematic of a typical zener-regulated voltage source is shown in Fig. 5. If the normal load current does not vary excessively and the zener current is near the center of the plateau, the regulation will be adequate for any normal line voltage variation or normal aging of components. However, as practical technicians, we are concerned with the effects and symptoms produced when these components become defective.

When the circuit is normal, an increase of 20 percent in the input voltage to R1 should cause an increase at the zener of about .1 volt. However, the current in the zener might double. There is no certainty that such a voltage increase would cause any of these components to fail, unless the zener current is raised above the maximum rating or R1 is heated enough to cause it to change value.

A lower value of R1 causes the same conditions as an increase in input voltage or line voltage. Such a change, in combination with an actual voltage increase, is likely to destroy the zener (cause it to short).

A higher value of R1 decreases slightly the voltage at the zener, but no change in performance should be noticed before the voltage at the zener drops 10 percent or more. At that point, regulation is nearly gone.

An open zener diode will cause an increase in the DC voltage to the load. In some cases, the supply voltage to R1 also will increase excessively and cause problems in related circuits. This can cause serious symptoms, for example, if a voltage to the AGC keyer is changed.

More important, in many cases, an open zener diode regulator can cause a primary symptom of hum or sweep instability because of signal and sweep voltages present on the B+ lines. A zener regulates voltage changes, and hum or sweep voltages on the supply voltage are reduced in the same way DC variations are minimized.

In one circuit, removal of the zener and substitution of a fixed resistor to restore the correct DC voltage increased the hum ripple by a factor of five.

Substitute The Zener With A Resistor

Because a zener is a "resistor" whose resistance changes according to the applied voltage, a variable or selected fixed resistor often can be substituted temporarily for the

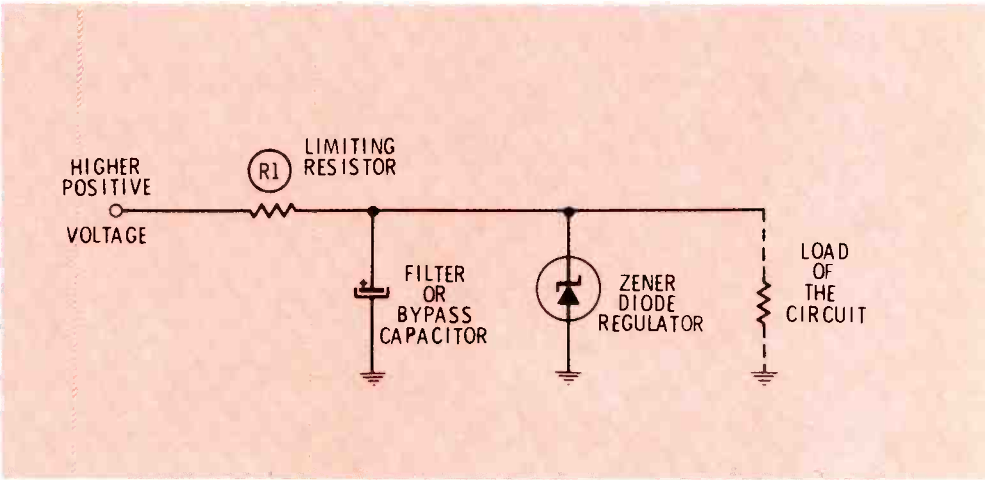


Fig. 5 Schematic of a typical power supply regulated by a zener diode. R1 limits the maximum current which can be drawn by the zener. The voltage across the load is regulated against input voltage changes or changes of the load current.

zener, to prove the condition of the zener. If the circuit functions better with a resistor which has been selected to provide the correct DC voltages, it is likely the zener is defective.

Summary

Four general methods of testing zener diodes have been presented. These methods include:

- Ohmmeter tests for forward conduction and reverse leakage (fast test)
- Current-vs-voltage measurements (slow but accurate)
- Curve tracer patterns (relatively fast; requires equipment)
- Clipped sine-wave measurements (fast and accurate).

In addition, defective zeners can often be found in-circuit by voltage and resistance measurements, or, when one is open, by the increase in both DC voltage and ripple.

All zener characteristics, except two, can be tested accurately enough, for all practical service operations, by these previously described methods.

There is no easy test to determine maximum wattage, or no convenient rule to specify what wattage zener to purchase for replacement in any particular circuit. Of course, it is best to follow the original specifications when they are known.

Do not replace a zener with another that has a **larger** wattage rating. It will operate on a wrong part of its curve and cause poor performance.

Internal impedance can be measured, but by a method too complex for service use. If one universal replacement zener fails to operate correctly and all other components are normal, it is possible that the internal impedance of the zener is wrong. Try a different type or brand. ▲

Intermittent Color—Causes, Cures and Troubleshooting Techniques

by Larry Allen

Troubleshooting missing chroma isn't too difficult. You just get out the scope and color-bar generator and trace the color as far as it goes, then fix whatever's blocking it, and you're home free.

Intermittent chroma is more difficult. You really have to use your wits. It also helps if you are familiar with some of the odd things that can kill chroma. Some of them are good candidates for intermittent defects. And, to make matters worse, some of these oddballs aren't even in the chroma-amplifying stages; they affect them from outside.

The block diagram in Fig. 1 should help uncomplicate some of the relationships encountered during chroma troubleshooting. The main path for color information originates at the video detector. Amplified along with sync and video, it comes to a chroma preamplifier stage. In some chassis, sync and video go through this preamplifier along with the chroma signal.

A chroma takeoff coil, tuned to 3.58 MHz (4.1 MHz in some sets), blocks all but the chroma sidebands. They go through the bandpass amplifier (which Motorola calls a **color IF** and which a few others call **chroma amplifier).** The bandpass transformer couples the color sidebands to the Color control, which feeds a portion of it to the demodulators.

Blocking the Color

That's the color signal path. Break it, and chroma disappears. All you see is a black-and-white picture.

The chroma path is blocked normally when no color signal is received. Without a color-sync burst, the killer/ACC detector lets the color killer operate. The killer applies a large cutoff bias on the bandpass amplifier, blocking any signal of any sort from getting through. That's normal.

But, you may ask, why block the color path when there's no color anyway? It's done so that no noise gets through to produce colored snow on the picture tube screen. However, what's important to **this** discussion is the fact that the killer stage **can** block off the bandpass amplifier. If it does it at the wrong time, you have a problem to solve.

The killer/ACC detector also senses the strength of the incoming burst signal. It develops a controlling voltage in the ACC stage (ACC stands for automatic color control). Applied to the bandpass amplifier, the voltage adjusts gain. The result is a relatively steady chroma output from the bandpass amplifier, even when the strength of the station signal varies.

What does this have to do with intermittent color? If the bias produced in the ACC stage somehow becomes too high, it cuts off the stage. The result is no color.

The killer/ACC detector stage receives inputs from the burst amplifier and from the color subcarrier oscillator. In some chassis, depend-

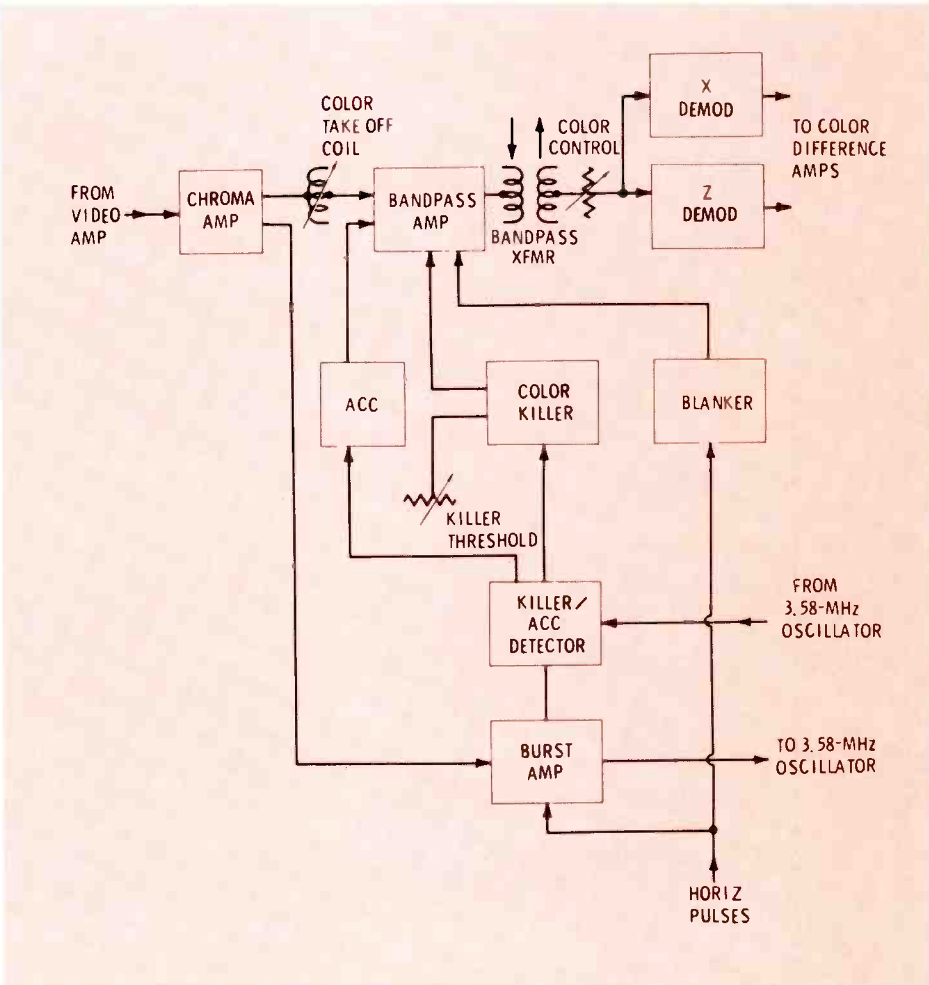


Fig. 1 This is the most common arrangement of stages in a chroma section. Some chassis might have a few more stages, like two bandpass amplifiers. The stage names might sound different: color IF, chroma amplifier, etc. But you'll find the relationships are remarkably the same regardless of who designed or who built the set.

ing on now these signals or voltages are applied, trouble in either of those stages might kill the chroma.

And there's the blanker. It shapes horizontal flyback pulses and applies them to the bandpass amplifier. They kill any possible noise from the chroma section during retrace on the screen. The blanker cuts off the bandpass amplifier only during the period when the flyback pulses are present. But if it puts a bias on the bandpass amplifier stage all the time, the blanker can block color.

Clamping: A Way to Troubleshoot

So you see, there are plenty of things that can stop color from getting to the demodulators. Those directly in the chroma path are easily located with a scope. Other troubles might be hidden away in auxiliary stages which directly or indirectly affect the chroma-path stages.

What do you do about those hidden faults? There are several approaches, but **clamping** is my favorite way to begin.

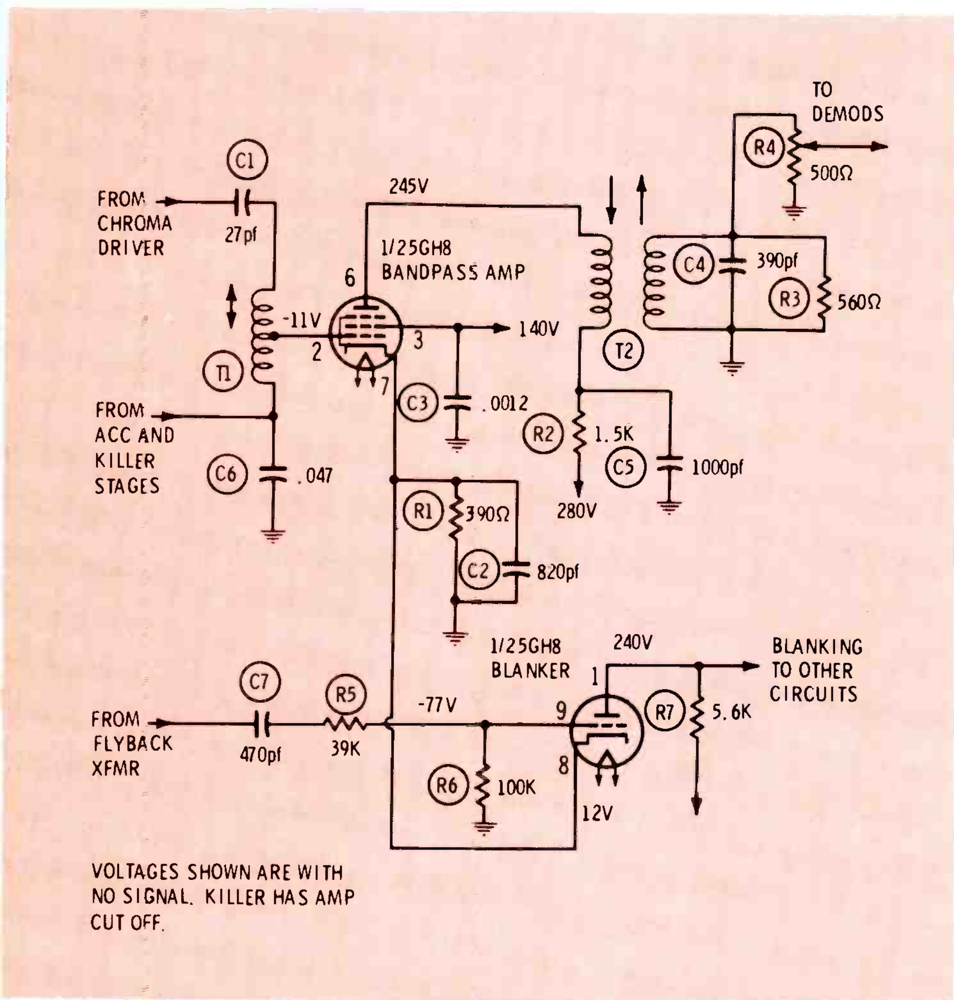


Fig. 2 Bandpass amplifier showing how the blanker applies its pulses to the cathode. Of equal importance in troubleshooting is the DC from ACC and color-killer stages.

Suppose that you know the bandpass amplifier is okay, yet that's where the chroma signal is disappearing. You have to decide whether it's the blanker, ACC, or color killer which is responsible. Use a DC voltage from an external power supply. Clip it into the bandpass stage, first at the blanker connection, then at the color-killer voltage line, finally at the input from the ACC stage.

Fig. 2 will give you a better idea of how this works. This is only one example; the principle works with any bandpass amplifier or chroma stage.

Set the supply for 4 volts DC. Connect it between cathode and ground. No matter what voltage the blanker is putting on the cathode, the clamp supply overrides it and sets the cathode at a normal 4 volts. If the color comes through now, you know to hunt for the trouble in the blanker.

Next, find the ACC input point. In the circuit in Fig. 2, it's applied at the same point as the killer voltage—the grid of the bandpass stage, through the 3.58-MHz takeoff coil. A good point to apply a clamp voltage is at the "bottom" of the coil, because it is well decoupled by the .047-mfd capacitor.

Set the clamp supply to zero or slightly positive and clip it across the capacitor (or ground to test point). The bandpass amplifier should conduct and pass the chroma signal. If so, it tells you that either the color killer or the ACC is biasing off the bandpass amplifier.

To determine which, you have to go back further. Take a look at the killer/ACC diagram in Fig. 3. Both circuits are activated by the DC grid voltage of the color subcarrier oscillator. If there's no burst (no color signal received), the voltage is only about –5 volts. With a color program, the grid develops from –6 to –9 volts. The exact value of the voltage depends on the strength of the burst signal.

Diode D1 is a doubler which rectifies the burst signal, to increase the applied negative voltage to a higher value (more negative). Without burst, the diode develops −10 volts. With burst, the voltage increases as high as −18 volts, always double the input DC voltage. If the bandpass amplifier is operating, this negative ACC voltage controls the gain; it is applied through R2 and the takeoff coil.

However, with no burst signal,

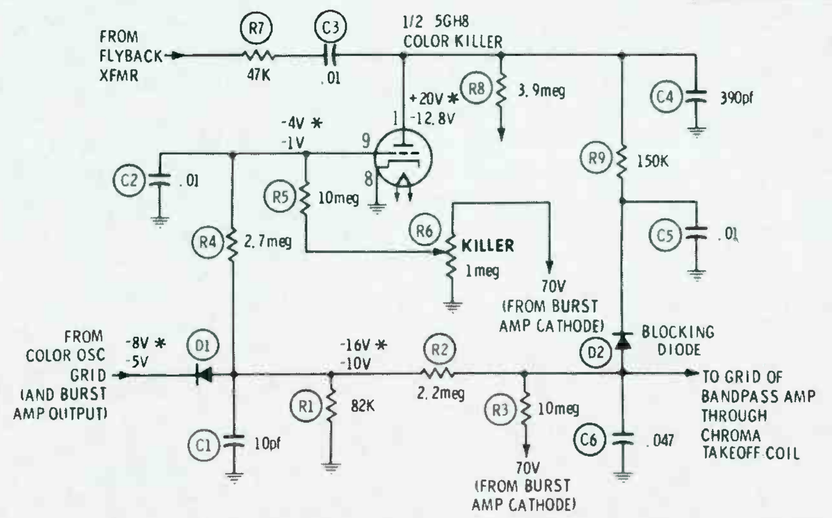


Fig. 3 The automatic color control (ACC) line is short and simple. It includes D1, R1, C1, R2, R3 (which brings in a "bucking" voltage), and C6. The color-killer stage is isolated from the ACC line by diode D2 whenever a burst signal is present and the plate voltage of the tube is positive.

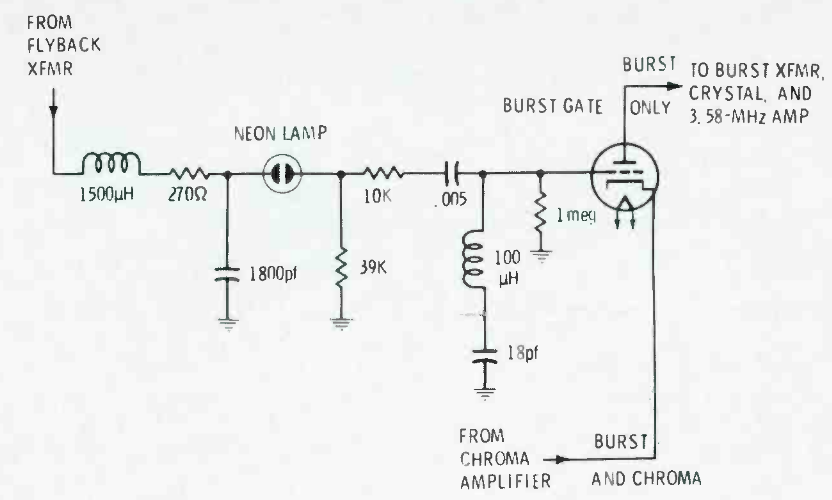


Fig. 4 Burst-gate stage in GE chassis has neon lamp input clipper. If the lamp doesn't fire, burst doesn't get through the triode. Without burst applied to the color-subcarrier amplifier, the demodulators can't produce color.

the –10 volts is almost canceled by the positive voltage from R6, the color-killer control. The remaining voltage is –1 volt, which lets the color killer conduct. The flyback pulses are rectified by plate-cathode action. The plate stays several volts negative. Diode D2 remains forward biased and passes the –12.8 volts to the grid of the bandpass amplifier. This blocks the color path when no color program is received.

Even without burst, you should be able to turn down the killer control enough to increase the negative voltage at the color-killer grid. At some point, the color killer cuts off, and the plate goes positive. D2 then is reverse-biased, and no cutoff voltage from the color killer can reach the bandpass amplifier. Consequently, only the ACC voltage controls its gain.

A burst signal increases the negative output of D1, cutting off the killer triode, which, in turn, lets the bandpass amplifier conduct, as described previously.

If you think the color killer is working overtime, connect your clamp supply at the junction of C5/R9/D2. Set the voltage for about 20 volts positive. This blocks the diode (if it's not defective). The bandpass amplifier should conduct. If so, the trouble probably is in the killer stage.

If not, perhaps the trouble is in the ACC line. Set the clamp supply to zero. Turn down the color-killer control all the way. Clip the clamp supply to the junction of R2/R3/C6/D2. If this turns on the bandpass amplifier, R3, R2 or another part in the ACC section might be faulty.

These clamping techniques are great for overcoming interaction that can complicate your troubleshooting. Just clamp each DC voltage to a value you know should make the stage function properly. Any other voltage level that's wrong will be apparent.

Some of the Worst Cases

Certain color faults are peculiar

to certain models. While the surest bet for chasing a color fault is a logical troubleshooting procedure, you can save time if you know the usual causes of some of the oddball troubles.

For example, certain Zenith chassis were equipped with a run of defective color controls. You get color saturation set, but it keeps changing. It may be sensitive to thumping, or it may not. Turning the control may even fix it momentarily, and you might not realize the controls are defective. A new control is the only positive cure.

Tubes are always a problem. For any intermittent, be sure you change all chroma amplifiers plus the blanker, color killer, and color subcarrier oscillator. In a few chassis, a dead color oscillator can't kill chroma, but change it, just to be sure.

Transistors contribute their share of intermittent color faults. Several hard-to-find cases have been traced to loose transistor sockets, or a poor connection between the socket and the circuit board.

Finally, look for components that are touching. In one off-brand that came into the shop, I encountered a frustrating case of intermittent color after warmup. But it cleared up, out of the cabinet. Back in, still okay. Delivered, it started cutting out again. Finally, I discovered the color oscillator was conducting intermittently. While probing around with my voltmeter, I found a resistor lead touching a capacitor lead. The fix was quick.

A similar problem occurred in a Sylvania chassis. The color usually stopped after several minutes of warmup, but sometimes it stopped right away.

With a color-bar signal applied and a scope monitoring the plate of the bandpass amplifier (it was like that in Fig. 2) and a voltmeter on the color-killer plate, I serviced another set while I waited. When color stopped, the killer was still okay. But the color-bar test signal was missing on the scope. It was also missing at the grid. At the input capacitor, it was okay. Resoldering the connections on the takeoff coil cleared up the trouble. Not being one to take chances, I replaced the coil anyway.

The color on the screen of an RCA CTC31 disappeared after the set was on a half hour or so. The trouble was traced, with a scope, to the second bandpass amplifier. Voltmeter checks revealed the plate wasn't getting DC voltage. An intermittent connection on the transformer primary was responding to heat in the chassis. The connection had never been soldered.

An interesting—if you consider puzzles interesting—case developed when a technician I know replaced the Tint control on a private-brand RCA model. Color suddenly became intermittent, cutting out whenever the chassis bolts were tightened. He asked for help.

First, I found that the color was being blocked by the color killer. I then traced the killer trouble to the killer detector. After considerable chassis-twisting, I determined that the defect was in the shielded cable between the Tint control and the printed board. I replaced it. The old one had been held in a bind and had been accidentally overheated when the new tint control was installed. The inner wire was touching the shield somewhere inside.

Why did a shorted tint control stop color? Because it's part of the circuit that includes the color-killer and oscillator-control phase detectors. The short affected the killer detector voltage, letting the killer cut off the bandpass amplifier.

The connection from the burst amplifier (Fig. 3) was the clue to one case that involved an Admiral chassis. Clamping showed that the trouble was in the ACC line. I traced the incorrect voltage to the cathode of the burst amplifier. A burned cathode resistor was intermittently changing value. When the value decreased, not enough positive voltage was applied to R2/R3, and the bandpass amplifier kept cutting off.

In some Sylvania chassis, the blocking diode (D2) has caused trouble. In two chassis involving intermittents, I never did find out what was wrong with the diodes. They measured normal. I didn't evaluate them with a curve tracer; it might have revealed the trouble. A new diode cured the problem each time.

In General Electric KC and KD chassis, a neon lamp is used as an input clipper for the burst-gating pulse (Fig. 4). If the neon lamp is defective, the pulse doesn't properly gate the burst. The output of this gating stage operates a subcarrier amplifier (these GE chassis have no color oscillator). Without the 3.58-MHz subcarrier, the demodulators can't perform their function. The result is no color. If the lamp fires only sometimes, color is intermittent, because the 3.58-MHz signal is intermittent.

A Westinghouse V2656 trouble was traced to a similar fault. No pulse was present to gate the burst amplifier, and the color killer reacted as if there were no color signal. The cause turned out to be a poorly soldered connection on the flyback.

Conclusion

Keep in mind, when you service intermittent color, that you should first determine if the trouble is in the chroma path or not. Once you know in which section or which half of the chassis to look, servicing is easier. Carefully study the schematic of the receiver before you go off on some tangent. Take into consideration the interplay among the various stages.

If you approach the job in a logical way, even an intermittent color problem can be solved in relatively short time. If the specific troubles and cures I've given don't help, use the step-by-step procedure I told you about early in the article.

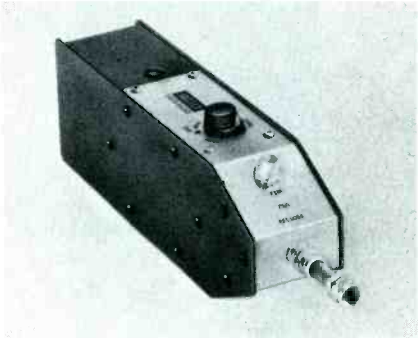
▲

test equipment report

MATV and CATV System Measurement Devices

A new portable device which reportedly makes possible the measurement of many cable system parameters without the need for the conventional oscilloscope/sweep generator method has been introduced by Sadelco, Inc.

The PORTA-BRIDGE is used



in conjunction with any VHF field-strength meter for the measurement of return loss, or VSWR, as well as the response, gain or loss of amplifiers, filters, cables and other CATV and MATV equipment, according to the manufacturer. It can also be employed to check the flatness of field-strength meters and make noise-figure measurements.

Return loss down to 40 dB can be measured with the PORTA-BRIDGE. The frequency range of the unit is 48-230 MHz, reports the manufacturer.

The unit weighs 1½ pounds, is battery operated and sells for $99.50.

Circle 40 on literature card

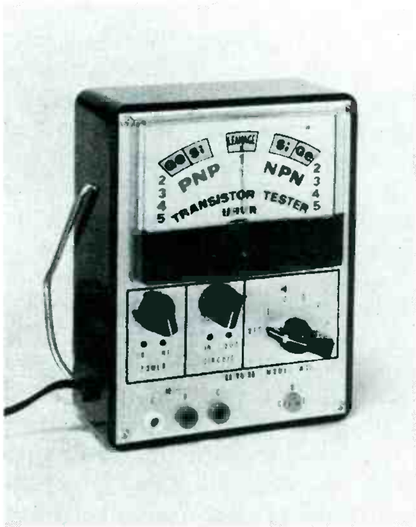
In- and Out-of-Circuit Transistor Testers

A meter-type transistor/diode tester, Model WT1, which indicates leakage, the emitter-base and base-collector characteristics, emitter-collector shorts, polarity (NPN or PNP) and the type (silicon or germanium), has been introduced by Wayne Electronics.

Testing is accomplished by either plugging the transistor into the socket on the tester or properly connecting to the transistor elements the external tester leads, positioning the two pre-set adjustments and then selecting the type of test with the five-position function switch. The leakage, characteristic, short, polarity or type is indicated on a direct-reading meter.

Diodes are tested by connecting the "E" and "B" external test leads of the tester to the cathode and anode of the diodes, respectively, and placing the function switch in position two. If the diode is not defective, the meter needle will swing to the right. It also will indicate whether it is germanium or silicon, according to the manufacturer.

Valid in-circuit tests reportedly can be obtained in circuits which present shunt resistances as low as 47 ohms across each junction and 15 ohms across the emitter to collector of silicon power transistors, and in circuits which present slightly higher shunt resistances across germanium types. In-circuit tests of transistors in direct-coupled and class-C circuits are inconclusive, according to the manufacturer.



The unit operates on AC, is eqiupped with a wire-type handle which serves as a tilt stand for easier viewing, measures 6¾ inches x 5¼ inches x 3 inches and weighs 3 pounds.

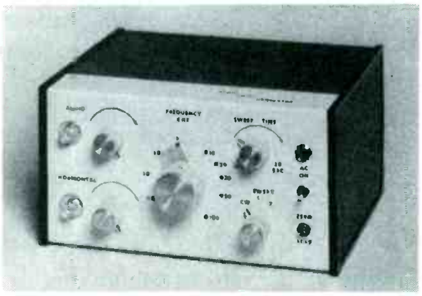
Price of Model WT1 is $69.95, complete with test leads and in-circuit finger probes.

Circle 41 on literature card

Audio Sweep Generator

An audio sweep/signal generator developed for use in the frequency range of zero to 100 KHz has been announced by Rameco Corporation.

The prime purpose of Model ASG-1 reportedly is as a signal source for measurement of the response characteristics of either active or passive circuits, with indication on a standard oscilloscope.



Other features and specifications of the instrument are:

Frequency Range—0 to 100 KHz.
Operating Modes—CW, Swept 1 (blanking) and Swept 2 (no blanking).
Sweep Width—0 to 100 KHz.
Output Amplitude—0 to 5 volts PP into 600 ohms.
Output Flatness—± 1 dB over entire range.
Variable Sweep Time—20 milliseconds to 20 seconds.
Blanking—available in swept mode for zero reference; output is symmetrical about zero.
Horizontal Output—0 to 8 volts peak, synchronized with sweep oscillator.
Power Requirements— 115 volts, 50-500 Hz.
Dimension— $8\frac{1}{4}$ inches x $9\frac{5}{8}$ inches x $4\frac{1}{2}$ inches.
Weight—$3\frac{1}{2}$ lbs.

Price of Model ASG-1 is $195.00.

Circle 42 on literature card

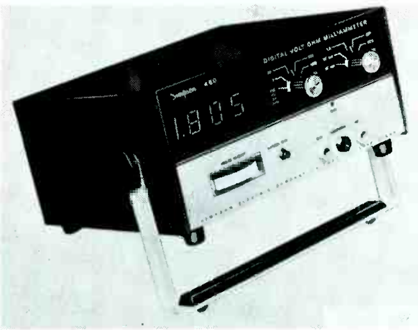
Digital AC or Battery Operated VOM

A digital VOM which reportedly combines high accuracy and multiple-range testing with non-blinking digital numerical display and front-panel analog meter readout has been introduced by Simpson Electric Co.

Twenty-six switch-selectable ranges are available; 5 AC and DC voltages; 5 AC and DC currents; and 6 resistance ranges, with accuracy from ± 0.1 percent of reading, ± 1 digit.

Numerical display is 3½ digit instant readout, with automatic over-range and "plus" and "minus" indication.

The analog meter of the Model 460 reportedly tells the approxi-



mate range of the digital readout, indicates peaks and nulls, and serves to test battery conditions.

The unit is fused for AC line protection and has color-coded input jacks for easy recognition. When the unit is operated on AC, the batteries recharge automatically.

The 460 measures 4 inches x 8½ inches x 7⅞ inches and weighs 6½ pounds. The price is $395.

Circle 43 on literature card

Compact VOM

The RCA WV-517A is a compact VOM which features a panel switch for convenient selection of all functions and ranges.

This instrument measures DC voltages from 0.01 to 600 volts, in six ranges; AC voltages (rms)

from 0.2 to 600 volts, in four ranges; DC current from one microampere to 300 milliamperes, in three ranges; and resistance from one ohm to five megohms, in three ranges; and decibels from –20 to +37.

The sensitivity of the WV-517A is 20,000 ohms-per-volt for DC measurements. and 10,000 ohms-per-volt for AC measurements. (Sensitivity on 0.3-volt range is 16,500 ohms-per-volt.)

The unit measures 4¾ inches x 3¼ inches x 1½ inches, weighs just over 1 pound and is supplied with test leads and two 1.5-volt penlite batteries.

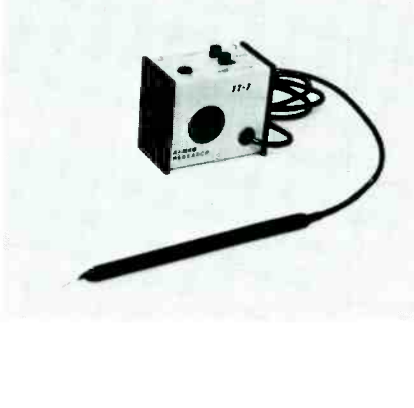
The price of the WV-517A is $18.00.

Circle 44 on literature card

Battery Operated Semiconductor Tester With Aural Indication

The TT-7, reportedly a new concept for testing transistors and diodes and troubleshooting solid-state equipment, has been introduced by Ramko Research.

With no clip leads to attach and no meter to watch, the TT-7 reportedly provides an anural dy-



Circle 23 on literature card

namic go/nogo indication of semiconductor status, in-circuit and out. The TT-7 also enables determination of transistor type (NPN and PNP) and unscrambles lead configuration on unmarked units, according to the manufacturer.

A special probe reportedly conforms to all transistor configurations and styles without adjustments.

Model TT-7 operates on two penlight battery cells and reportedly will operate for months without being turned off.

Model TT-7 sells for $16.95.

Circle 45 on literature card

Sine-/Square-Wave Generator

Model LAG-25, an all solid-state sine-/square-wave generator for testing audio equipment, has been introduced by Leader Instruments Corp.

Featuring a 20 Hz to 200 KHz range in four decades, the LAG-25 reportedly has a low distortion

sine wave and a fast-rise square wave. Calibration accuracy is ±3 percent (+2Hz) and is direct-reading, with a rated drift of less than 1 percent (±5 percent change in line voltage).

The LAG-25 reportedly can generate a complex wave output for IM distortion checks and can be synchronized from any external standard source.

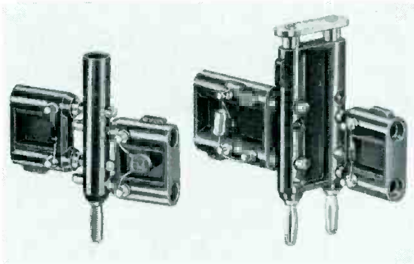
Model LAG-25 measures 7 inches x 11½ inches x 5⅛ inches, and weighs 5 pounds. The price is $99.50.

Circle 46 on literature card

Parallel Isolation Plugs

Pomona Electronics has announced a new line of series-parallel isolation plugs which are used to build voltage dividers, attenuators, and other networks used in electronic testing.

Model 3501 Single Plug and Model 3502 Dual Plug reportedly provide a top banana jack and an



upper pair of cross holes isolated from the lower pair of cross holes and banana plug.

Typical applications for both models, according to the manufacturer, include combinations of component-mounting plugs with circuits attached, shorting bars, or banana plugs with built-in resistors.

Pomona banana plugs are thermoplastic, molded directly to a metal body for strength, insulation, and moisture resistance.

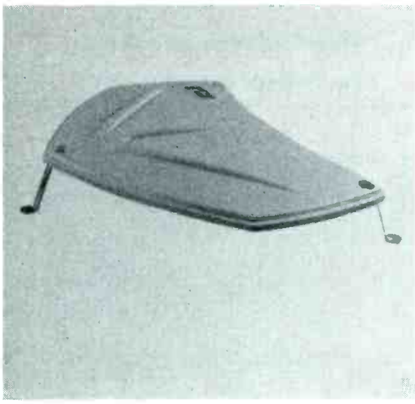
Model 3501 sells for $1.50; Model 3502 is priced at $3.25. ▲

Circle 47 on literature card

For more information about above products use reader service card

Integrated Color/B-W TV Antenna

A new type of color/b-w TV antenna, which is considerably smaller and lighter than an electrically equivalent standard antenna, has been developed by JFD Electronics.

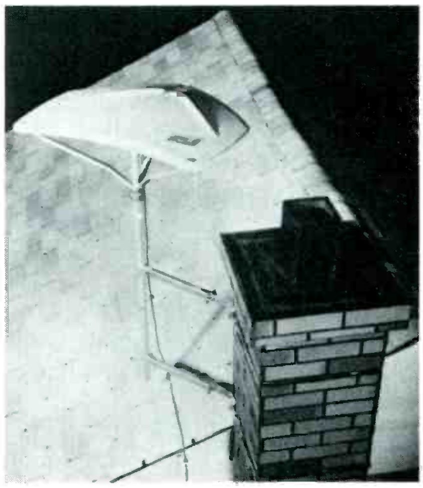


The unit, called STELLAR 2001, consists of a planar printed-circuit antenna and low-noise, solid-state amplifier, both of which are contained in a completely sealed, weather-protected, high-impact ABS housing which is 34⅛ inches x 27¾ inches x 3¾ inches. The whole unit weighs only 5 pounds.

Power for the solid-state amplifier is provided by a power-supply/signal-splitter unit, which is designed to be mounted on the back of a TV receiver. One 75-ohm coaxial cable transmits both the voltage from the power supply to the antenna amplifier and the received signal from the amplifier to the signal-splitter section of the power/splitter unit.

Because it is compact and light, the STELLAR 2001 reportedly can be installed both indoors and out—on roofs or in attics or crawl spaces. Brackets for each of these installations are provided with the antenna. Optional kits are available for mast, wall, side or peak-roof mounting.

The planar printed-circuit antenna section, which is the nucleus of the STELLAR 2001, is etched from solid copper. This technique, which translates conventional aluminum antenna elements to printed circuitry, reportedly was developed as the result of three years of research.



The signal output of this "integrated" antenna reportedly is equal to or larger than that of antennas many times larger than it. According to the manufacturer, factors which have significantly contributed to the reported high signal-to-noise level produced by the antenna are 1) directivity, 2) signal amplification at the point of reception, 3) proper impedance matching between the antenna receiving element and the amplifier, 4) use of amplifiers with linear transfer characteristics, and 5) use of reactive filters to separate frequency bands.

Price of the STELLAR 2001 is $75.00.

Circle 50 on literature card

Communication Antennas and Accessories

Four new monitoring antennas for use in the high-band and VHF ranges, and an accessory that permits dual-frequency reception from a single antenna have been introduced by The Antenna Specialists Co.

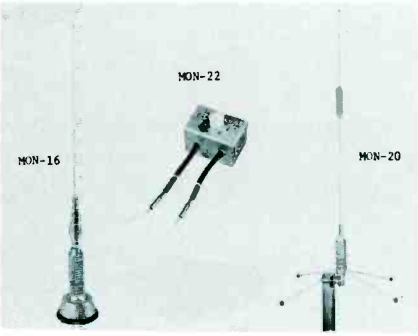
Model MON-21 is a 4-dB gain antenna for the 450- to 470-MHz range and features a "Quick-Grip", holeless trunk mount and solderless connections, according to the manufacturer.

Model MON-20, offered for base station applications, features 6-inch radials and stainless steel construction.

Models MON-21 and MON-20 sell for $24.95 and $32.95, respectively.

Models with 3-dB gain are also

offered in the 118-174 MHz range. Mobile Model MON-16 also utilizes a stainless steel shock spring and sells for $21.95. A base station unit, Model MON-17, features stainless steel construction of both radiator and radials, and sells for $29.95.



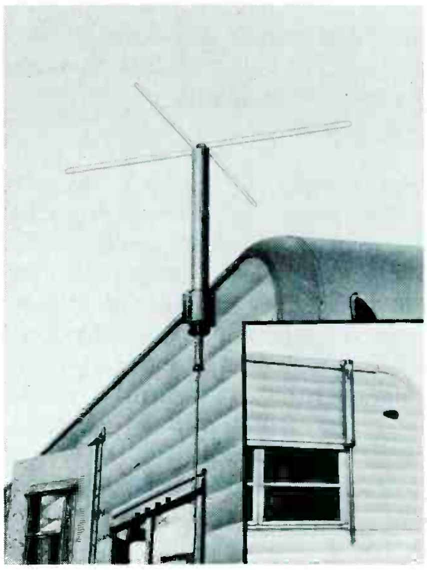
The "Signal-Splitter", Model MON-22, reportedly permits monitoring of low-band and high-band receivers from a single combination frequency antenna. The MON-22 sells for $13.95.

Circle 51 on literature card

Folding TV/FM Antenna For Mobile Applications

Travel-Tron, a TV antenna designed for installation on campers, trailers, mobile homes and boats, has been announced by Antenna Corporation of America.

The antenna reportedly folds similar to an umbrella and is capa-



ble of receiving color and black-and-white TV signals on all UHF and VHF channels, as well as FM. The antenna can be folded down in seconds and enclosed in a weatherproof tube cap, ready for traveling, according to the manufacturer.

The Travel-Tron Model AC-700K reportedly is rotatable, to pick up stations in all directions. Model AC-700K sells for $34.95.

Circle 52 on literature card

Two-Way Splitter for MATV

A new two-way, 82-channel hybrid Coloraxial splitter with a special bushing for faster installation in master antenna television systems is offered by Jerrold Electronics Corp.

Designed for use without cable connectors, the signal splitter reportedly accepts cable sizes from RG-59 through RG-6 (CAC, CAC-6). The bushing is sized for RG-59 cable. The frequency range is a reported 54 to 890 MHz.

Model 1563 splitter has splitting losses rated at 3.5 dB for VHF and 3.8 dB for UHF, with 18-dB isolation between outputs, according to the manufacturer.

Model 1563 sells for $6.95. ▲

Circle 53 on literature card

Circle 26 on literature card

RCA's All-Electronic Tuning—How Channels are Selected

by Bruce Anderson/ES Contributing Author

The electronically controlled VHF tuner used in the RCA CTC 47 chassis was described in an article in the December, 1970, issue of ES. This tuner has no moving parts; the desired channel is selected by energizing one of the 13 banks of switching diodes, which replace the conventional switches of the familiar mechanical tuner. How a particular set of diodes is selected and energized will be described in this article.

Because a basic knowledge of binary numbers and fundamental logic circuits is needed to understand the tuning system, a brief discussion of these subjects is presented first.

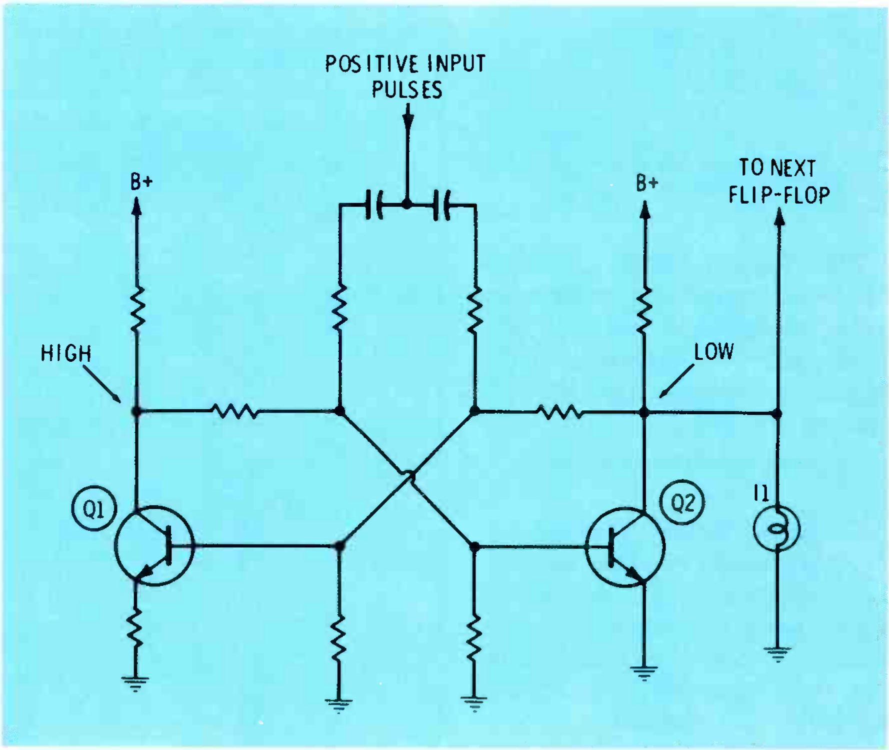


Fig. 1 The basic flip-flop multivibrator.

Binary Numbers and Counter Circuits

The binary system

Some scholars have speculated that our decimal system came into being when someone discovered that a system having the same number of integers as a person has fingers would be convenient. Whether or not this is true, it is a fact that decimal numbers are inconvenient to use in computer technology, because an electrical device has the equivalent of only two "fingers." A relay can be only open or closed, a transistor is much more reliable if it only operates at cutoff or saturation, and a mathematical statement, or equation, is either true or false.

Stated simply, the binary system of numbers follows all the rules of the decimal system, except that only two digits are allowed—the "0" and the "1". The binary system of counting and the decimal equivalents are shown in Table 1.

Logic circuitry

The usual circuit used to count the number of events, such as the number of cycles of output from an oscillator, the number of pulses from a telephone dial mechanism, etc., consists of a series of bistable multivibrators (commonly called flip-flops). A schematic of a typical flip-flop is shown in Fig. 1.

Because of the small resistor in the emitter circuit of Q1, when power is initially supplied to this circuit, Q2 always will saturate and Q1 will become cut off. This is a stable condition, because the high voltage at the collector of Q1 will continue to produce a saturating base current in Q2, and the low voltage at the collector of Q2 will allow no base current in Q1.

If a positive input pulse is applied, Q1 will be momentarily driven to saturation, causing its collector voltage to drop almost to zero. This reduces the forward bias on Q2, cutting it off. Immediately, the collector voltage of Q2 rises, maintaining Q1 in saturation. This new condition also is stable. The next input pulse will cause the conditions of Q1 and Q2 to reverse once again, returning to their original conditions.

Notice that the collector voltage of Q2 is low before any input pulses have been applied, and that it increases when the first, and each succeeding odd-numbered input pulse is applied. If an indicator lamp were connected to the collector, as shown in Fig. 1, it would light for each odd-numbered pulse. Referring to the binary table above, the lamp, I1, would light every time the last digit of a binary number is a 1 (odd number).

By connecting a number of similar flip-flops in cascade, binary numbers of any magnitude can be counted. The output of the second flip-flop will indicate the next-to-last digit, the third flip-flop will indicate the third-from-last digit, etc. If the output of the flip-flop circuit is to be used to indicate a number in the decimal system, four flip-flops will be required, because the binary equivalent of 9 is 1001, a four-digit number.

To convert outputs of the flip-flops to decimal numbers, a binary-to-decimal converter is required. This device, usually an integrated circuit, consists of ten gating circuits, each of which will produce an output only when its four inputs correspond to a specific input such as 0011 (3), 0101 (5), 1000 (8), etc. A decoder which will respond only to 0101 is shown in Fig. 2.

Table 1.

Binary Vs Decimal Number System

Binary	Decimal	Binary	Decimal
0	0	10001	17
1	1	10010	18
10	2	10011	19
11	3	10100	20
100	4	10101	21
101	5	10110	22
110	6	10111	23
111	7	11000	24
1000	8	11001	25
1001	9	11010	26
1010	10	11011	27
1011	11	11100	28
1100	12	11101	29
1101	13	11110	30
1110	14	11111	31
1111	15	100000	32
10000	16		

In Fig. 2, biasing resistors have been deleted for simplicity; however, this does not affect the basic method of operation. Q1 is an NPN transistor, and so it can conduct only when positive voltage (indicated by a 1) is supplied to its base. The same is true of Q3. Conversely, Q2 and Q4 are PNP transistors and can conduct only when there is low base voltage (indicated by 0). If any input were different from the one shown, at least one of the devices would be cut off and the output would remain at zero. When the correct inputs are supplied, all four transistors can conduct, and the output swings positive. This output might be used to energize an indicator lamp labeled "5", the decimal equivalent of 0101.

By combining four counter flip-flops and one ten-section decoder, it is possible to indicate all decimal numbers from 0 through 9.

Fig. 2 One section of a binary-to-decimal decoder.

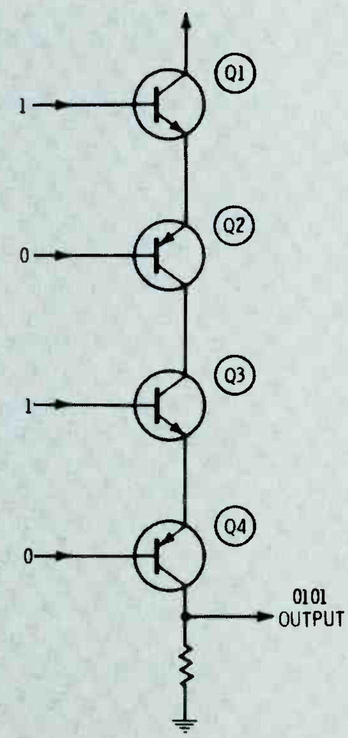


Table 2.

Counter Outputs

Counter A	Counter B	Counter C	Counter D1	Counter D2
0	0	0	0	0
1	0	0	0	1
0	1	0	0	1
1	1	0	0	1
0	0	1	0	1
1	0	1	0	1
0	1	1	0	1
1	1	1	0	1
0	0	0	1	0
1	0	0	1	0
0	1	0	1	0
1	1	0	1	0
0	0	1	1	0
0	0	0	0	1

Each of the ten decoder circuits could be used to light a lamp indicating its corresponding decimal integer. If the system is required to count from 0 to 99, the decoder output which indicates 9 can be coupled to another combination of counter flip-flops and decoder; a third set of counters and decoders will expand the system to 999; etc.

Electronic Sequencing

The tuner control of the RCA CTC 47 allows the user to energize whichever of the thirteen tuner control busses he desires, thus selecting a channel. A modified binary/decimal counting and decoding system accomplishes this function.

At the center of the electronic switching system is an electronic sequencer, consisting of a free-running multivibrator, a series of binary counters, and a pair of binary-to-decimal decoders. These are illustrated in the functional diagram of Fig. 3.

The free-running, or "clock", multivibrator operates at a frequency of about 320 Hz, and each counter divides this frequency by 2. Thus, the output frequencies of the counters, from left to right, are 160, 80, 40, 20, and 10 Hz. The last four of these counters are connected to the decoders. The first counter is necessary because the first half-cycle, or pulse, from the clock is randomly positive or negative. The counter is gated so that its output always goes from 0 to 1 to 0, regardless of how the clock starts.

Because the output of a counter can be either high or low, depending on which half-cycle of output is under consideration, it is simple to describe the output as being "0" or "1". Using this code, the conditions of the outputs of the counters are listed in Table 2. (The irregularity of the progression after the thirteenth count will be explained.)

Notice that the output conditions of the several counters is different for each step in the progression; the last step is the start of a new cycle of operation. If these outputs are fed to decoders, which consist of a group of gating circuits, a different terminal will be energized for each different set of input conditions.

In the CTC47 system, each of the two decoders is an integrated-circuit binary-to-decimal converter. These decoders, having more outputs than were needed, were chosen because they were already available, having been used as standard converters for computer applications.

Referring to Fig. 3 and Table 2, the ninth output from decoder 1 is used as a reset pulse, which forces counters A, B, and C to their zero condition and also flips counter D to the opposite condtion. The D counter switches power from one decoder IC to the other at this point, so that the ninth output from counter A appears as a short-duration spike and the tenth output is never generated.

Decoder 2 is switched on with the ninth count and produces outputs sequentially as the clock continues to run to the thirteenth count. The fourteenth count is used as a reset pulse, which forces all four counters back to their original condition, 0-0-0-0, which is the start of another complete sequence of operation.

The remaining four terminals of decoder 2 have no output, because the count never progresses far enough, and they are not connected.

The clock-counter-decoder system just described performs essentially the same function as would a continuously running motor geared to the shaft of a conventional tuner. If the outputs of the decoders are connected to the sets of switching diodes of the electronic tuner, each channel is selected in order, just as a free-running tuner motor will continuously select all channels in sequence.

In practice, it is necessary to interface the decoders to the tuner by means of power transistors, because the IC decoders do not have sufficient current-handling ability to operate the tuner diodes and also provide energy for channel indication and programming. Fig. 4 shows functionally two of these amplifiers, the channel-indicating system and the method of programming the system to stop on the desired channels. The circuits for channels 3 through 12 are identical to the ones shown for channels 2 and 13; the UHF channel system is slightly different.

Assuming all programming switches, S1 through S13, are open, the clock would continue to run and each channel would be selected in order, as just described. About one-tenth of a second is required for all channels to be selected.

Normally, several channels are available in an area, and the corresponding switches would be set to the closed position by the owner. Assume that the receiver is programmed for channels 2, 7, 11 and UHF. If these switches were closed while the clock was running, as soon as energy were applied to a closed switch, voltage would be fed back to the clock-control, developing a voltage which biases the clock into cutoff.

Because all the counters are simple flip-flop multivibrators, each one will continue whichever output (0 or 1) it was producing at the moment the clock was stopped. Therefore, the decoder continues to energize the channel on which the system is stopped, and the clock is held in the cutoff state. In this manner, the requirement for memory, which was discussed in the article about the tuner itself, is satisfied.

Channel indication

The requirement for channel indication is fulfilled simply by connecting a pilot lamp to the same line which drives the switching diodes in the tuner. Isolating diodes are used between the indicator lamps and the programming switches; otherwise, all the lamps of programmed channels would become energized, through their respective switches, from the channel bus which had been selected.

Manual channel change

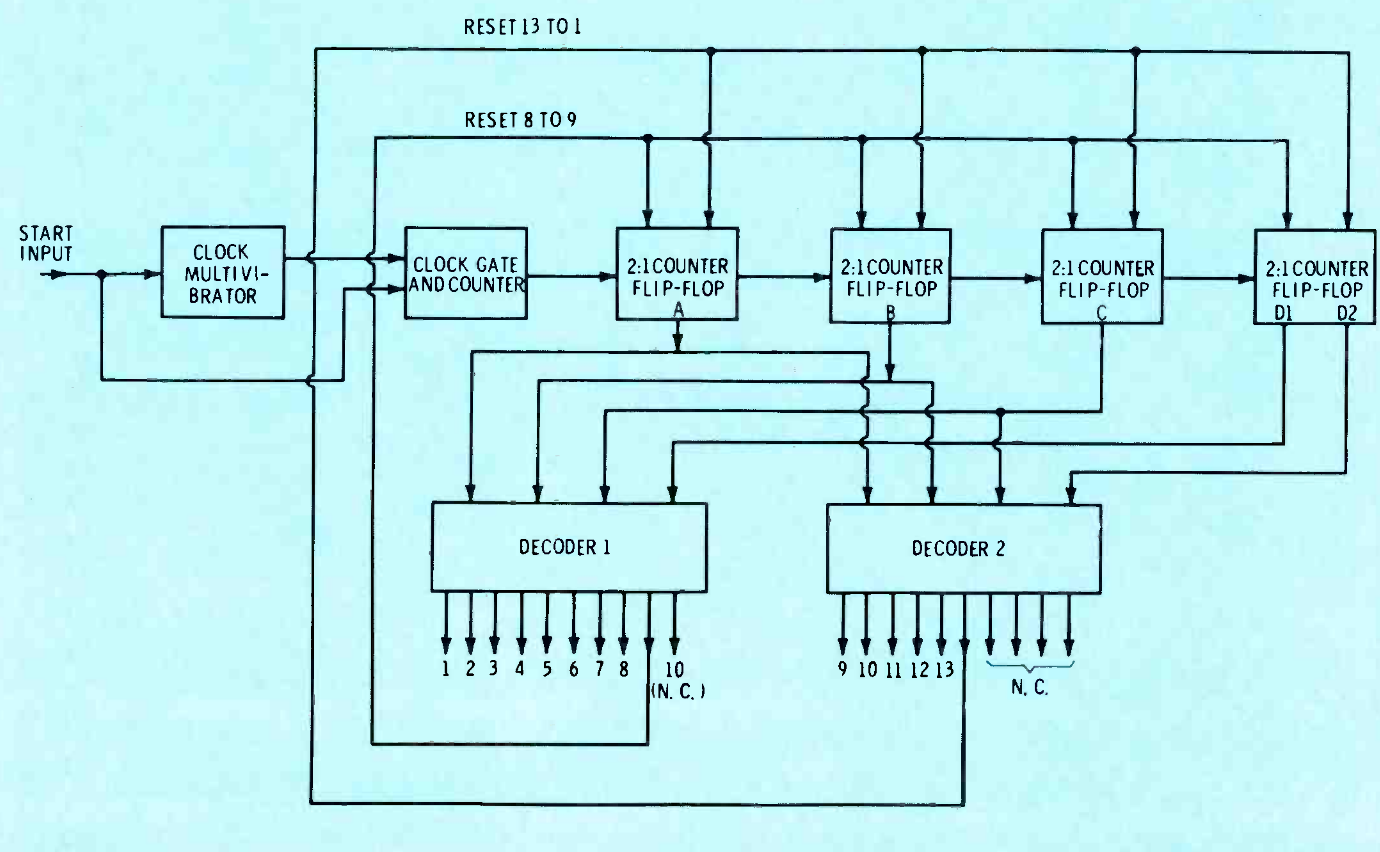
The third requirement, that of providing interfacing between the system and the operator, is provided by the channel-change switch. When this switch is closed momentarily, the cutoff bias for the clock is interrupted long enough to allow it to operate for at least one cycle. This causes the next higher channel to be selected momentarily. If this channel is programmed, clock cutoff bias is again developed, and the system comes to rest on this channel. If it is not programmed, the clock continues to run, advancing the tuner to each higher channel in order, until a closed program switch is energized and bias is reapplied.

Remote channel change

Space is not available to describe the circuitry of the clock-start circuit in detail; however, some of its features should be noted. Because the actuating mechanism is a simple switch, the circuit may be controlled readily by a remote system whose output is connected parallel to the local switch. This remote output is nothing more than a transistor which is driven to saturation when a remote-control signal is received.

To provide immunity to noise in the remote-control system, and also to prevent contact bounce in the local switch from actuating the channel-change system spuriously, an integrating circuit which produces no output unless the input is sustained for about 0.1 second is used. Further, to prevent the system

Fig. 3 The channel sequencing circuit of the RCA CTC 47.



from skipping channels if the channel-change switch is closed longer than is required to allow the system to advance to the next programmed channel, a coupling capacitor is used between the switches and the clock-control circuit.

UHF selection

To receive UHF, two distinct functions must be performed: The VHF tuner must be set to the IF frequency, and the UHF tuner must be energized. Only then can the UHF tuner be adjusted for channel reception.

There are two methods of setting the VHF tuner for UHF reception. One is to depress the VHF channel selector long enough or enough times to reach the UHF position. In this mode of operation, UHF is "just another channel". Alternatively, the UHF channel-change circuit may be activated, either locally or remotely, and the VHF tuner will switch directly to the UHF position, regardless of how many intervening channels are programmed. Of course, the UHF programming switch must be closed.

Notice that there are two UHF-related inputs to the clock-control circuit in Fig. 4, one from the UHF channel bus and the other from the UHF control system. When a UHF button is closed, this latter input to the clock control allows the clock to start and sets up a gating circuit which causes the clock to continue to run until inputs from both the programming-switch bus and also from the UHF channel bus are present simultaneously.

Clock control

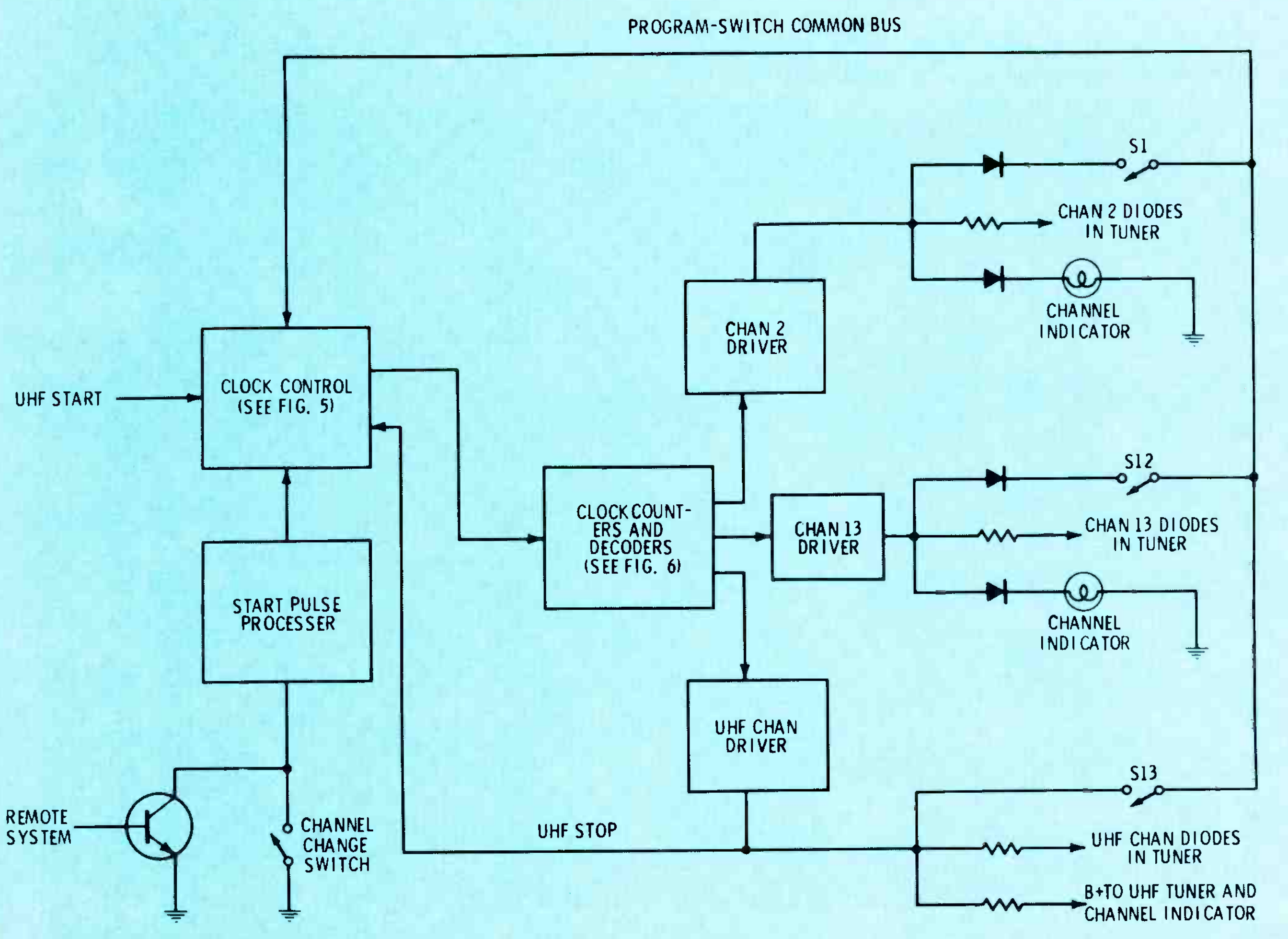
The clock-control circuit is shown in detail in Fig. 5. Transistor Q3415 is normally conducting, but when a VHF channel-change switch is closed (local or remote), a negative pulse from the start-pulse processer circuit (Fig. 4) turns it off momentarily. The increased collector voltage turns on Q3403 and drives it to saturation. Current paths are available through Q3403 and diode CR3406 to the program-switch common bus, which is positive when the system is at rest on a channel, and also to the 5-volt supply via diode CR3403, R3402, diode CR3401, and R3401.

The result of current flow through Q3403 is to reduce to nearly zero the voltage at point A; this causes the clock multivibrator to start.

As soon as the clock starts, the tuner is advanced to the next channel. If this channel is not programmed, the program-switch common bus is de-energized and the clock continues to run.

The start-switch pulse to Q3415 has a very short duration; but even after this transistor resumes conduction. the clock continues to run until a closed programming switch

Fig. 4 Channel-driver and clock-control circuits of the RCA CTC 47.



is reached. In the interim, current flow from ground, through R3416, CR3403, R3402, etc., holds the voltage input to R3404 at a low level, but not low enough to stop the clock. When a closed program switch is reached, the positive voltage on the program-switch common bus increases, cutting off CR3403, allowing the input to R3404 to increase to 5 volts, stopping the clock.

When a UHF channel-change control is initiated by the user, a different sequence of events starts the clock. The VHF-to-UHF start line is grounded, removing B+ from R3404. The only way that voltage can be restored is by way of the VHF-to-UHF stop line. This will happen only when the VHF tuner has sequenced to the UHF position, and then only if the UHF programming switch is closed. Otherwise, the clock will continue to run until the UHF button is released by the user.

VHF channel selection—next

Of course, the preceding sequence of operation provides only for tuning the VHF tuner for UHF reception. At the same time, the UHF tuning system must operate to select the desired UHF channel. The operation of this control system will be described in the next article about the CTC 47 all-electronic tuning system.

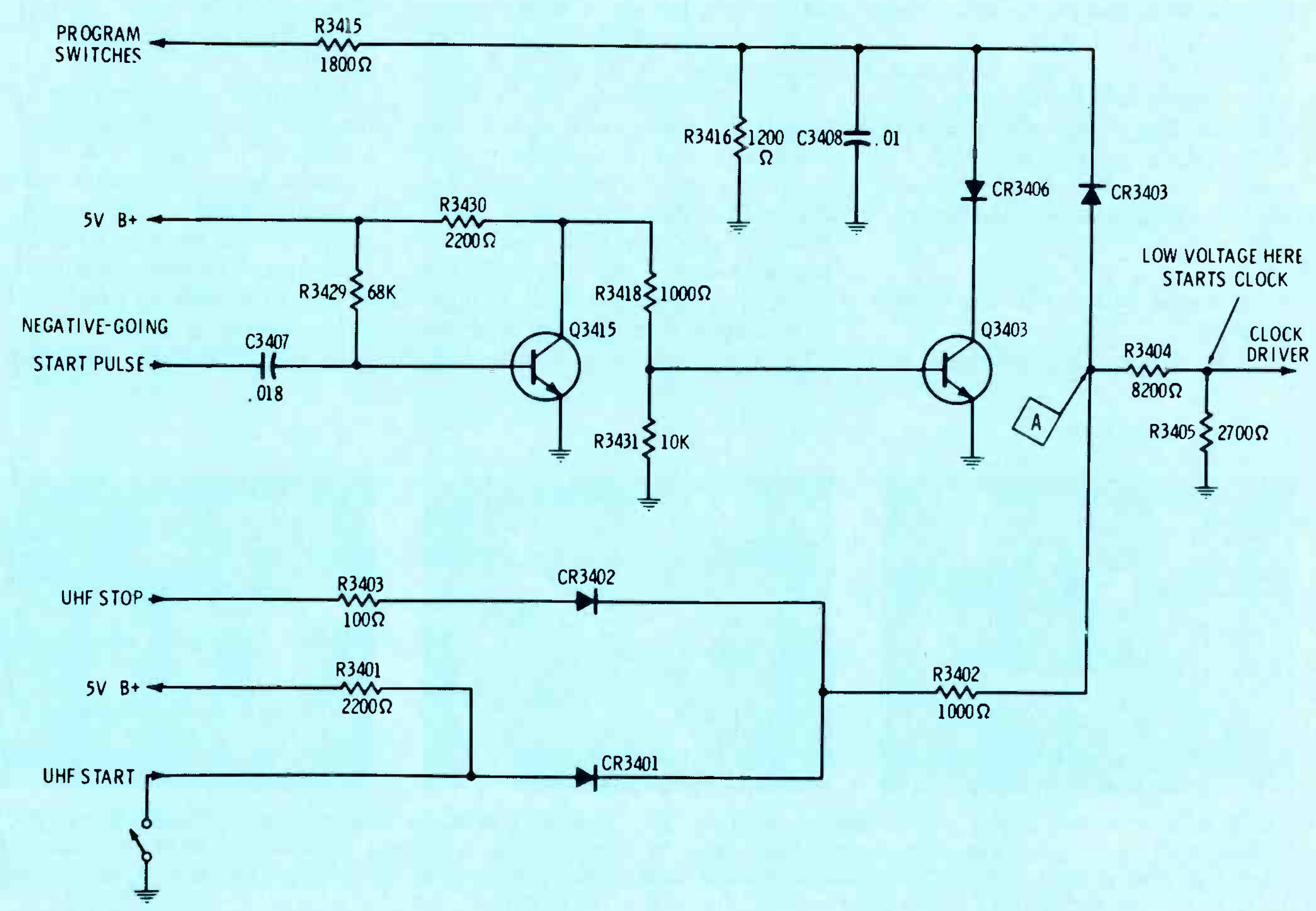
Summary

In the first article of this series, the electronically controlled tuner was described. In essence, switching diodes were substituted for the conventional switch of an ordinary tuner. The result of this change is that channels may be selected by applying a control voltage to the desired set of four switching diodes. Some of the advantages of this method of tuning are: quiet and rapid operation, freedom to locate the tuner anywhere in the cabinet, and the elimination of switch contacts in the RF circuit.

In this article, an electronic means of supplying voltage to the desired set of tuner diodes was discussed. The system uses circuitry similar in many respects to some of the elementary circuits used in computers, including a clock, binary counters, and binary-to-decimal converters. A brief explanation of these, as well as a review of the binary system of counting, has been presented. The remainder of the control system consists of the start and stop command circuits, all of which make up a logic system.

In the last of this series of articles, the method used to allow selection of UHF channels will be discussed. As we shall see, this is basically a signal-seeking type of system, similar to the one used in a signal-seeking radio, but with a number of refinements. ▲

Fig. 5 Clock-control logic circuit of the RCA CTC 47.



shoptalk

With Carl Babcoke
ES Technical Editor

Guidelines for troubleshooting vertical sweep defects, part 1

Preliminary observations, adjustments and diagnosis, plus familiarization with troubles and general techniques through analysis of actual case histories.

Preliminary Observations and Adjustments

Obtain a history

Some defects start by displaying symptoms such as rolling or intermittent height, but continue on to produce other symptoms, such as a complete loss of height. Ask the customer if there were any symptoms displayed in the past that were different from the ones presently displayed on the screen. These additional clues are valuable because they save diagnosis time and prevent callbacks.

Check control action but do not obscure symptoms

Make a rapid, but thorough, inspection of the raster. Lock in the picture by using the vertical hold control, and notice whether the locking is normal, weak or impossible to attain.

Slightly rotate the height and linearity controls in both directions and return them to the original settings. At this time do **not** attempt to correct for any height or linearity deficiencies, but do be alert for any erratic or intermittent operation of the controls.

Test (or replace) the vertical tube(s). In many cases, a tube replacement plus a readjustment of the height and linearity controls are the only repairs necessary. However, we need the added assurance that a new tube will nearly fill the screen without any radical changes of the height and linearity controls. This is not only to aid in the diagnosis, but it also avoids covering up serious linearity faults by driving them off the screen, and to make sure any possible borderline height condition is not obscured by excessive adjustments.

Make a Preliminary Diagnosis

Now is the time to make a preliminary diagnosis, if the simple tube replacement and control adjustments have not solved the problem.

Review in your mind the definitions of vertical performance:

- **Correct frequency** has been obtained when a single picture can can be made to roll down or flip up by use of the vertical hold control. The hold control merely varies the frequency and does not have anything to do with locking as such. However, the frequency

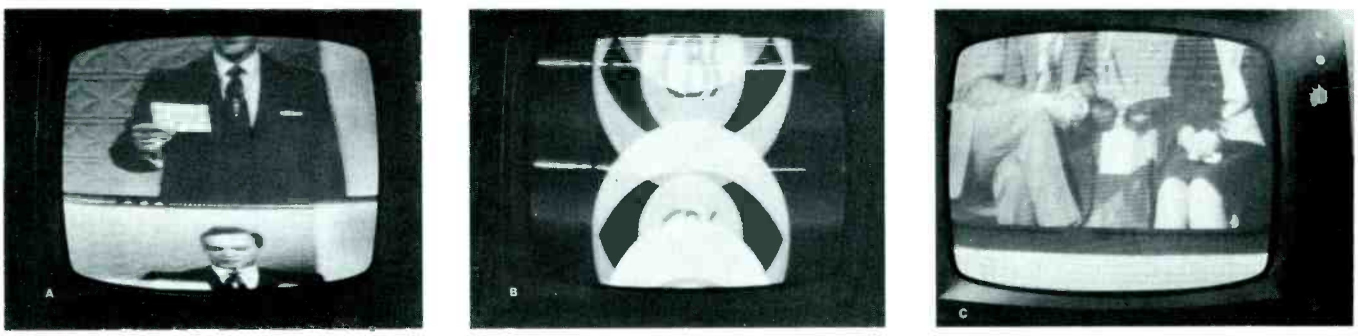


Fig. 1 Correct locking involves more than just stopping the picture from rolling—both frequency **and** phase must be correct. **A)** Sweep frequency of 30 Hz produces two complete pictures with the vertical blanking bar between them. **B)** Sweep frequency of 90 Hz produces part of three pictures that are overlapping. **C)** Sweep frequency of 59.94 Hz (color broadcast) but wrong phase produces one picture and the vertical blanking bar.

must be slightly below 60 Hz for locking to take place.

- **Locking** is achieved when the vertical sweep system is synced to the frequency **and** phase of the station sync signal. False locking can produce a stationary, nonrolling picture with two complete pictures, one above the other (30 Hz, shown in Fig. 1A), several pictures overlapping (90 Hz, as shown in Fig. 1B), or one normal picture that is "locked" solidly with the vertical blanking bar several inches from the bottom of the screen (correct frequency, but wrong phase, as shown in Fig. 1C). These are not the conditions meant when we refer to locking. True locking is more than obtaining a vertically motionless picture.
- **Height** is a comparison of the vertical size of the picture relative to the size of the CRT screen.
- **Linearity** refers to the comparative distance between the scanning lines, or spacing between horizontal lines in a crosshatch pattern displayed on the screen.

Many defects produce more than one symptom. For example, a defect which affects primarily the frequency often will change the height, especially if the oscillator frequency error is large. Or a defect that primarily changes the height also will cause rolling, until the hold control restores locking. When analyzing such troubles, first determine which is the **dominant** symptom.

Analysis of Actual Case Histories

Some vertical defects which actually have been encountered by the author are presented here, to illustrate proper diagnosis.

The schematic of the vertical sweep circuit used in a Sears Silvertone chassis is printed again, in Fig. 2, and will be used for reference in most of the following examples of vertical sweep troubles.

Repairs beyond minor adjustments and the replacement of tubes are assumed to be bench jobs, and will be diagnosed as such.

We suggest to outside men that they might save the bench men much frustration if they would write down the customer's comments about the trouble, a description of major symptoms displayed on the CRT screen, and their own preliminary diagnosis.

Picture rolls down

The customer reported that performance was normal and the vertical could be locked when the receiver first was turned on. However, after about 15 minutes of operation, the picture would roll down very slowly. Adjustment of the hold control would restore locking for several minutes before the rolling would start again.

After two hours of operation and several readjustments of the hold control, the hold control was at the end of its rotation and the picture was continuing to roll. By this time, secondary symptoms began to appear: the linearity was poor, the top of the picture was stretched and the bottom compressed.

Weak sync might account for the first two or three instances of rolling, because the normal tendency during warmup is for the frequency to increase (roll down), but this would not account for the drift which necessitated periodic adjustment of the vertical hold control to the end of the control's range. Neither would it account for the poor linearity exhibited after a thorough warmup.

The defect in this case is one that primarily affects the frequency. Further, it is triggered by heat and increases the frequency, two conditions which seldom are caused by a defective resistor. A gassy tube can cause all of these symptoms, but we assume that the tube has been replaced, because a small amount of gas isn't always detected by a tube tester.

Checking through the list of simulated defects and symptoms given in the SHOP TALK column last month, we find a leaky C38 to be the most likely defective part. C38 is a .01-mfd capacitor which couples the positive feedback signal to the grid of the oscillator tube. It is the main time-constant capacitor.

The picture flips up intermittently

The picture remained in lock for 12 to 15 seconds, then it would flip upward very rapidly for 4 or 5 seconds, and finally would lock normally. This sequence was repeated continuously.

When the picture flips up, the vertical system in the receiver is operating at a frequency lower than that of the vertical sweep system of the station. This is the normal condition when no sync is supplied to the vertical multivibrator.

One of the few defects that can cause such regular, periodic loss of sync is hum in the sync separator stage, or hum in the video supplied to the sync separator. Usually, such hum is visible on the CRT screen in the form of one or two rounded, dark horizontal bars. In this case, one hum bar could be seen drifting slowly down the screen. When it reached the bottom, the vertical would roll until the bar reappeared at the top of the picture.

Replacement of the 4CB6 1st IF tube, which had leakage between cathode and heater, cured both the visible hum bar and the intermittent upward flipping of the picture.

Height changes at the bottom

The picture, according to the customer's complaint, would intermittently jerk at the bottom and exhibit a black area where there was no picture. This seemed to be a rapid change in height.

In such cases, it is advisable to watch the picture but not attempt any adjustment until the receiver exhibits the trouble symptom(s).

Within a few minutes, the height suddenly decreased about 3 inches at the bottom of the screen, then instantly increased to normal size. Subsequent rapid changes of height occurred irregularly, and the amount of decrease was not always the same. At some settings of the vertical hold control, the displayed picture would not roll when the height changed. Such a small frequency change evidently was a side effect of the height variation, and was of no consequence.

Rocking the adjustment of the height control proved that the control was the source of the intermittent, because the slightest adjustment would cause radical changes in height. One squirt of tuner spray on the carbon element of the control stopped the trouble symptom. A new control was installed.

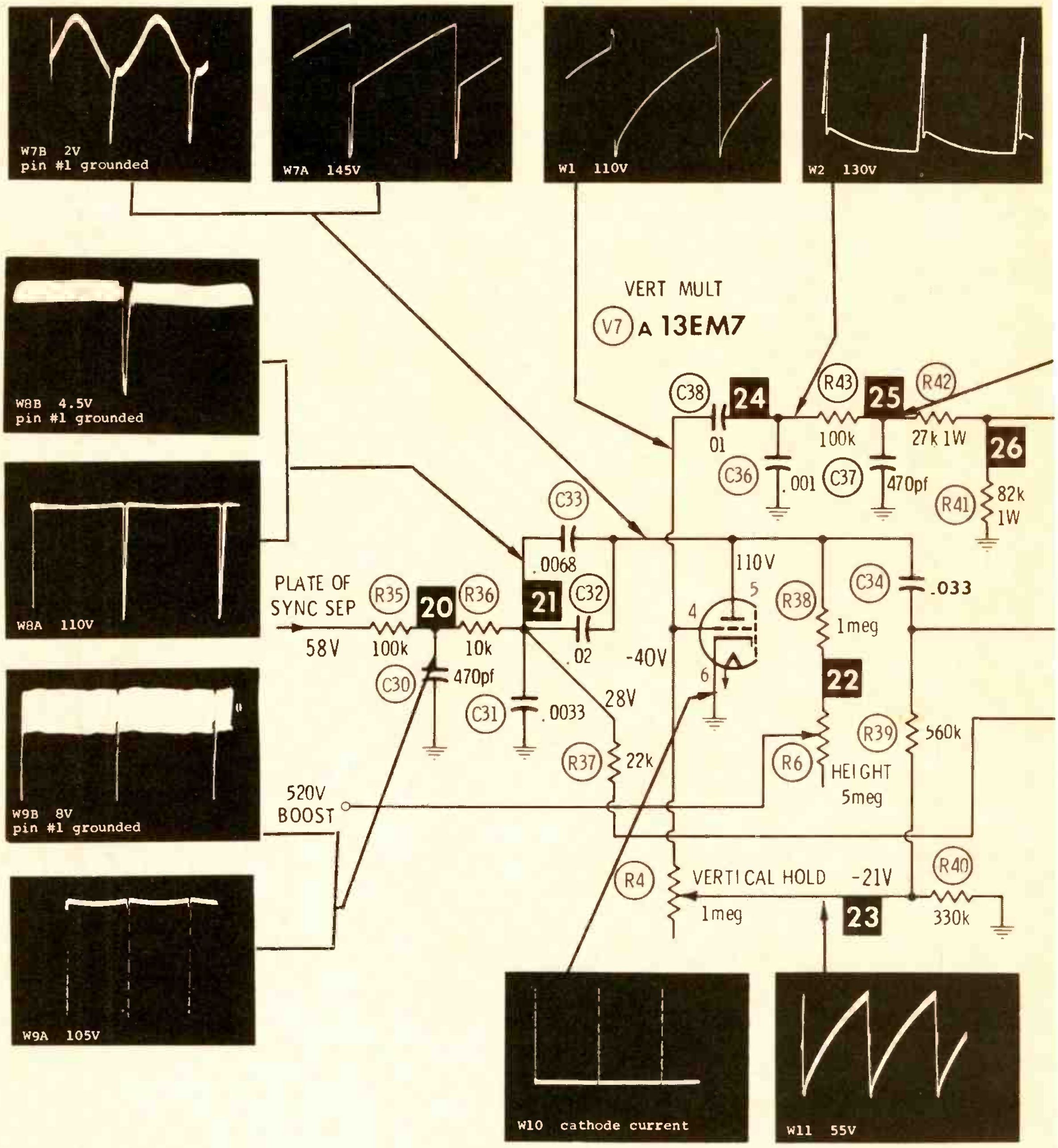


Fig. 2 Schematic of the vertical sweep circuit of the Sears Silvertone 528.51780 b-w television chassis.

Vertical far off frequency

My involvement with this trouble-shooting situation was the result of consultation with an experienced technician who had checked every part in the vertical circuit, and then, in desperation, had replaced most of the components. The vertical frequency was so high the raster was about half height, and showed several overlapping pictures, much like the condition shown in Fig. 1B.

After the technician's answers to my questions about the key voltages and parts values indicated nothing abnormal, I remembered one similar case where the cause was leakage from the carbon element of the hold control to its own shell. When unwired and tested, the control had provided normal readings.

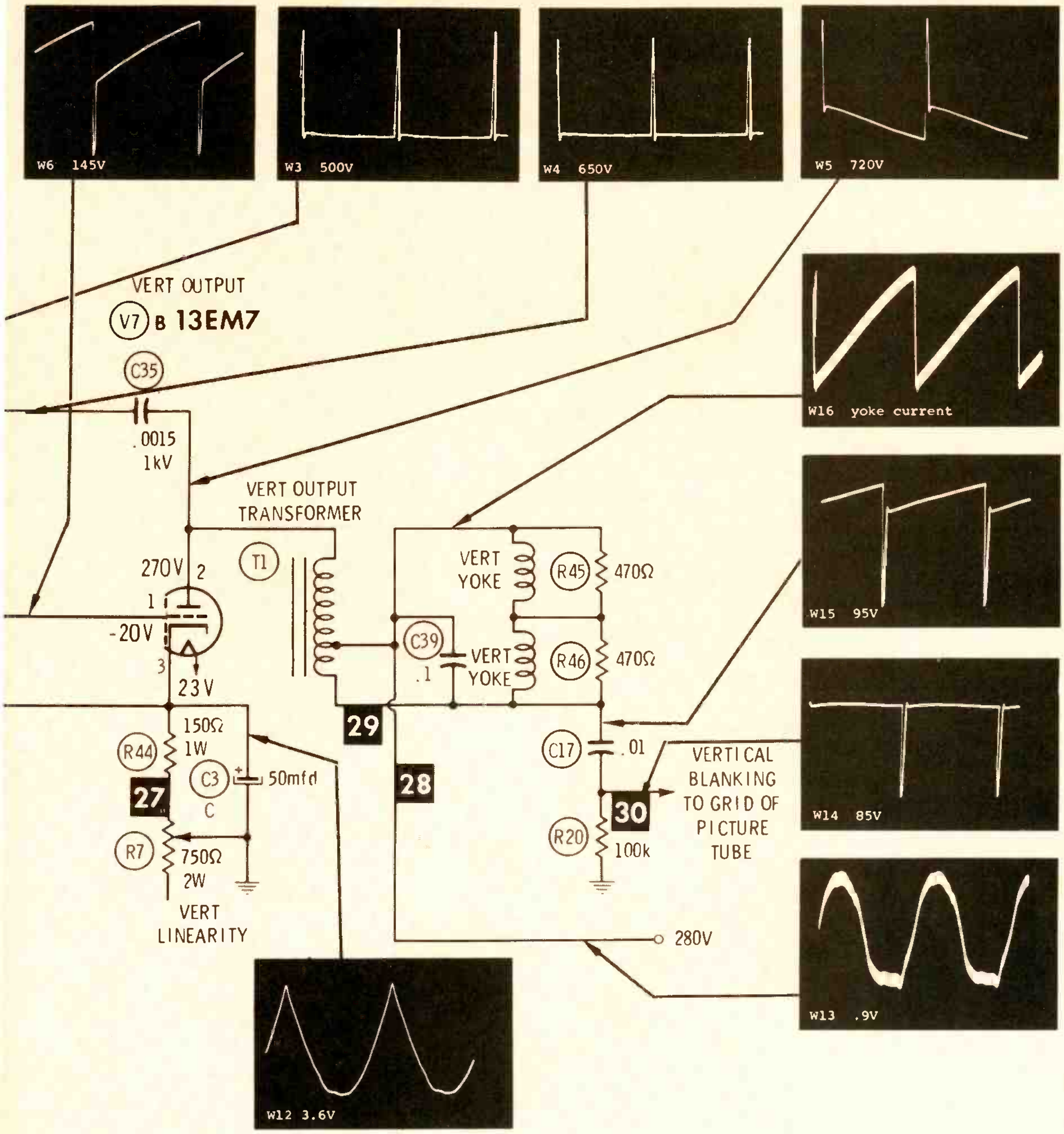
Subsequently, the same defect was found in this vertical hold control, and the installation of a new control solved the vertical frequency problem.

A good point to remember is that leakage can occur because of carbonization, moist soldering flux, moisture mixed with dust, or solder "splatters" between areas of the circuit where there is no component.

I won't soon forget the case where a power-line capacitor exploded and left a film of black carbon over the burst area of a chroma board. None of the circuits in that area functioned correctly. It was one case where a good visual inspection was more informative than instrument tests.

Intermittent loss of height

The height of the picture on a color receiver changed about twice



every second, from no height to a raster of about half the size of the 23-inch screen. Experience has taught me that this condition is often the result of excessive resistance from the cathode of the vertical output tube to ground.

Two resistive paths are used in this model: one returns through the convergence board to ground, and the other is a voltage divider which supplies the suppressor grid of the horizontal output tube with a small positive voltage, to help minimize snivets.

An ohmmeter measurement from the cathode of the vertical output tube to ground indicated 5.6K ohms—just the right value for the ground path through the convergence board. More ohmmeter tests showed that one of the voltage divider resistors—the one from suppressor grid to ground—was open. This defect, and the resulting off-beat symptom, has occurred in many models of color receivers.

Picture shrinks at the bottom

The TV receiver was operating

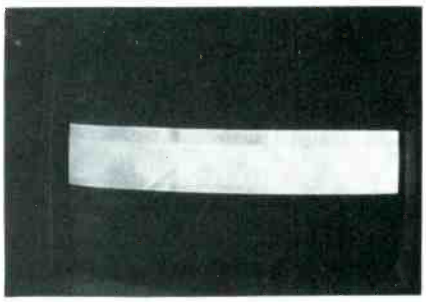


Fig. 3 A picture like this, which cannot be locked, yet does not have foldover or compression, is probably caused by a defect in the positive feedback circuit.

when the technician arrived. The height of the raster was reduced 4 inches at the bottom of the screen and was compressed at the bottom of the scan. According to the customer, the picture always had full height when the receiver was first turned on, then it would pull up gradually from the bottom. Sometimes, the picture would roll, but adjustment of the hold control easily stopped the roll anytime it occurred.

Table

Voltages In Feedback Network

Testpoint	PP voltage should be	PP voltage actually present
Plate pin 2	720	215
Circuitrace 26	650	195
Circuitrace 25	500	20
Circuitrace 24	130	8
Grid osc pin 4	110	8

Nearly every case of **gradual** loss of height **each** time the receiver is used is caused by a capacitor with leakage that increases as the ambient temperature increases.

Last month, in SHOP TALK, I listed two capacitors which significantly changed the height when resistors (simulating leakage) were paralleled across them. Those two were C32 (.02 mfd), the waveshaping capacitor, and C34 (.033 mfd), the coupling capacitor between the oscillator and the output stages.

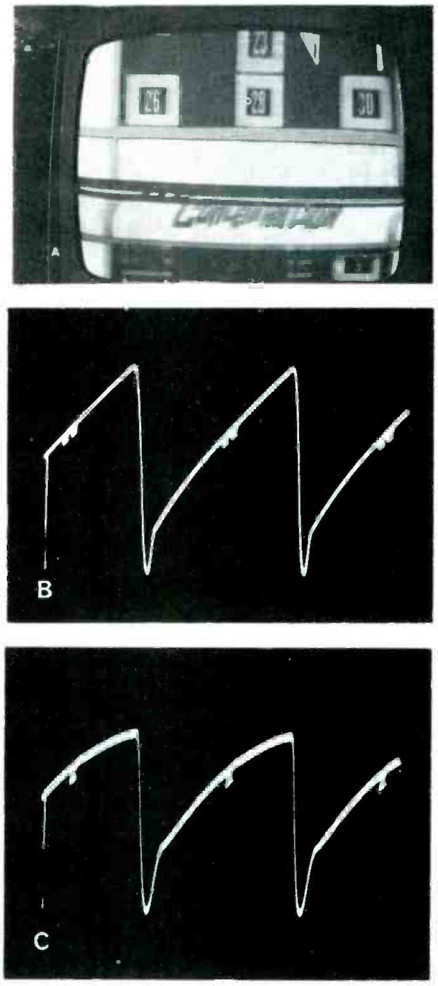


Fig. 4 Signal injection, using a 6-volt AC sine wave from the heater circuit in series with a .47-mfd capacitor, is an effective test. **A)** Picture obtained when the sine wave is injected at the grid of the oscillator. The picture continuously rolled down slowly. **B)** Waveform at the plate of the oscillator. Overload produces a waveform similar to that required. **C)** Waveform at the yoke; the voltage was 45 volts PP.

In this example, the defective capacitor was C32, and installation of a new one stopped the "creeping" of the height.

(Tip: A leakage test performed on **any** new capacitor before installation in a chassis is an excellent idea, because it can be low-cost insurance against callbacks. The capacitor should have several hundred volts applied across it, to simulate actual service conditions. A simple method for making such a test was given in Fig. 7 on page 36 of the July, 1970, issue of ELECTRONIC SERVICING.

Gradual loss of height

There was four inches of blackness at the bottom of the raster, even immediately after the receiver was turned on. The customer reported that the height had decreased slowly over a period of several months.

A new tube and adjustment of the height control changed the height very little.

Excessive weakness of the output stages will cause significant compression or foldover at the bottom of the screen when the height control is advanced. But this was not the trouble in this case.

An open cathode bypass capacitor (C3C, Fig. 2) could cause this trouble symptom, and it also might open gradually. If so, a large sawtooth (over 30 volts PP) should be present at the cathode. However, in this case, the scope showed a 3-volts parabolic waveform; therefore, C3C was not open.

Decreased output from the oscillator tube to the grid of the output tube might cause the loss of height. However, in this case, the normal PP voltage (145 volts) at the plate of the oscillator tube and the grid of the output tube eliminated such a source as the trouble.

The shape of the waveform at the plate of the oscillator was nearly normal, but the amplitude was only 65 volts PP. An ohmmeter test showed that R38, the 1 meg-ohm plate-load resistor, had increased to over 4 megohms. Replacement of the resistor plus normal height and linearity adjustments cured the trouble.

Picture three inches tall

The picture was about 3 inches high (see Fig. 3) and could not be locked in with the hold control. There was no foldover, but the hold control changed the height an abnormal amount. Nothing significant could be learned from the customer's report this time, except that the problem had started suddenly.

Two techniques used in sequence are effective in finding the source of the defect in cases of this type.

The first step is to inject a 60-Hz sine wave, taken from the heater circuit through a .47-mfd capacitor, into the control grid circuits of the vertical output and oscillator tubes, in turn, and notice the amount of deflection obtained.

The heater supply to the tuner tubes in the Sears chassis is 9 volts AC (6 volts AC serves the test just as well), and it was used as a convenient source of voltage. When this test signal was applied to the grid of the vertical output tube, the raster was about 5 inches high and folded over, exhibiting two overlapping pictures. This much height is about normal for the test.

Next, the test signal was applied to the grid of the oscillator tube. (The deflection is not a sine wave, as was the case when the same signal was applied to the grid of the output tube.) A picture of more than normal height (shown in Fig. 4) and with stretched-out linearity drifted slowly **down** the screen.

Scope waveforms (shown in Fig. 4) verified that the output of the oscillator tube and the voltage applied to the yoke both consisted of a combination sawtooth and pulse. The grid of the oscillator was peak rectifying the sine-wave input and causing a too-wide, but usable, pulse of plate current that was shaped into the approximate waveform required.

Results of the signal injection tests indicated that both stages were functioning well as **amplifiers.** Therefore, the defect causing the small, out-of-lock picture had to be in the positive feedback circuit, which consists of C35, R41, R42, C37, R43, C36 and C38. A series of ohmmeter tests of these parts quickly revealed that C37 had 4K ohms of leakage. The installation of a new capacitor restored normal sweep.

An alternate method of testing the positive feedback circuit and components is signal tracing, which is explained next.

How to measure voltages through the positive feedback circuit

The positive feedback circuit in most vertical sweep systems consists of several cascaded low-pass and high-pass filters. As many chances for loss of sweep exist as there are parts in the circuit.

If there is **no** height, yet signal injection tests indicate both stages produce good amplification, the 60-Hz test signal should be left connected to the grid of the oscillator during the tests of the positive feedback circuit. Somewhat different ratios of voltages will be obtained, but the basic principle is the same as the test described next.

If there is **some** height, use the AC voltages present in the sweep circuit for the test, instead of the injected test signal.

From the normal peak-to-peak voltages shown in Fig. 2, we know the ratio of the voltage at each point in the postitive feedback network relative to the voltage at the plate of the vertical output tube. Any significant deviation from these ratios should show where any loss of the feedback signal occurs.

(Many schematics do not give either the AC or DC voltages at the plate of the vertical output tube. This point is marked "Do Not Measure" in some schematics. We can understand this caution because of the B+ and high pulse voltages normally present there. However, I have been measuring these voltages in similar circuits for many years and have never damaged a scope or VTVM—or myself—as the result of such tests. If the test equipment is in good condition, I doubt that it—or you—will be harmed. In any event, peak-to-peak readings made there when the output is low because of a defect should be safe.

The accompanying table shows the normal peak-to-peak voltages in the Sears chassis and those which were present as a result of a defect in the vertical section.

It is apparent that the voltage at Circuitrace 25 is the first in the network to be abnormally low. Therefore, it is the point of suspicion. A few measurements with an ohmmeter uncovered a 4K-ohm leakage in C37.

If the peak-to-peak voltage at the output tube plate had been low, but **all** the readings along the feedback system had also been low in proportion, there is virtually no possibility that a parts defect in the positive feedback circuit was causing the reduced sweep.

Compression at top of screen

After he had remounted the convergence board following a routine convergence setup of a color TV, the outside man noticed that the height at the picture was reduced. In fact, there was extreme compression at the top of the picture.

The height and linearity had been normal at the start and during the convergence adjustments. The technician knew that very few component failures can cause compression at the top of the picture, and the timing of the malfunction was suspicious. Therefore, he began checking the convergence board, cable and wiring. In just a few minutes, he had located, near the convergence board, a wire that had been pinched between the board mounting bracket and the metal receiver cabinet.

Shorted turns in the winding of a vertical output transformer or an excessive load across a winding of the transformer, as in the case just described, will cause compression or foldover at the top of the picture, as shown in Fig. 5.

In color receivers, several windings of the vertical output transformer are used to supply the "tilt" convergence voltages. Shorts or component failures in the convergence circuit can excessively load these windings and cause compression at the top of the picture.

Next In Shop Talk

Specific techniques which have proved effective for tracking down vertical sweep defects will be presented in Shop Talk next month—including DC voltage analysis, signal injection, frequency analysis, ohmmeter tests and waveform analysis. ▲

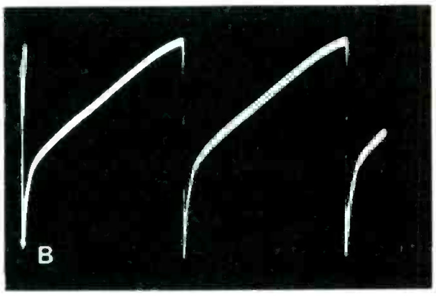


Fig. 5 Shorted turns in the winding of the vertical output transformer or an excessive resistance load across the transformer causes compression at the top of the raster. **A)** Typical compression at the top of the picture caused by an excessive resistance load across the vertical output transformer. **B)** Waveform at the yoke when there is compression at the top of the raster.

Servicing Today's P-A Systems

A look at recent changes and how they affect troubleshooting, system layout and component selection.

by Forest H. Belt

Public-address equipment, once called "P-A" setups, have a new name. Today, they're **sound reinforcement systems.**

But a fancy title isn't the only new look. Schools and churches once were the P-A technician's major customers. Now he caters to cultural groups as well. He supplies sound reinforcement for neighborhood theatricals, rock-music concerts (indoors and out), political stumping, campus demonstrations and for performers from out of town.

The basics are still the same: sensitive mikes, powerful amplifiers, faithful loudspeakers. But there's a raft of new hardware. Mikes have special directional and tonal qualities for varied situations. Amplifiers are tremendously powerful, and all but the cheapest are solid state. Even "ordinary" speakers must exhibit fidelity once required only in hi-fi music installation.

The **sound-reinforcement technician,** as he is now called, needs special awareness in four fields: 1) mike qualities and placement; 2) amplifier power and sound; 3) speaker sound, power, directionality and efficiency; and 4) acoustics, both indoor and out. With these four skills, he is an expert in **applications,** even when he's troubleshooting.

Knowing the Equipment

There are breakdowns. Electronic gadgetry generally is more dependable than ever. But "mechanical" bugs still abound.

Cables to mikes and speakers get pinched and twisted and broken internally, and plugs get fouled. Your ohmmeter is still the handiest tool to check continuity of center conductors, shields, and plugs, and to spot shorts in cables or connectors. Today's FET VOM's (Fig. 1) offer more versatility and convenience for the gadabout trouble-hunter than old VTVM's or VOM's.

Record players and changers still receive rough use. Cartridges get cracked, especially those feather-tracking stereo units for indoor systems. Reel-to-reel tape players are being rooted out by cassettes. But relax; cassette machines are handier to service than reel-types. (See "Servicing Cassette Player/Recorders", in the January, 1971, issue.) The cassette player will probably displace the record changer when more music becomes available on cassette cartridges.

There's big emphasis on high power and transistorization in amplifiers. Monstrous musical-instrument amplifiers, like the set pictured in Fig. 2, make up a significant portion of the work coming into sound shops nowadays. We have

Fig. 1 Volt-ohm-milliammeters with field-effect transistors, such as those shown here, give all the benefits of VTVM's, and add the current-measuring and portability advantages of regular VOM's.

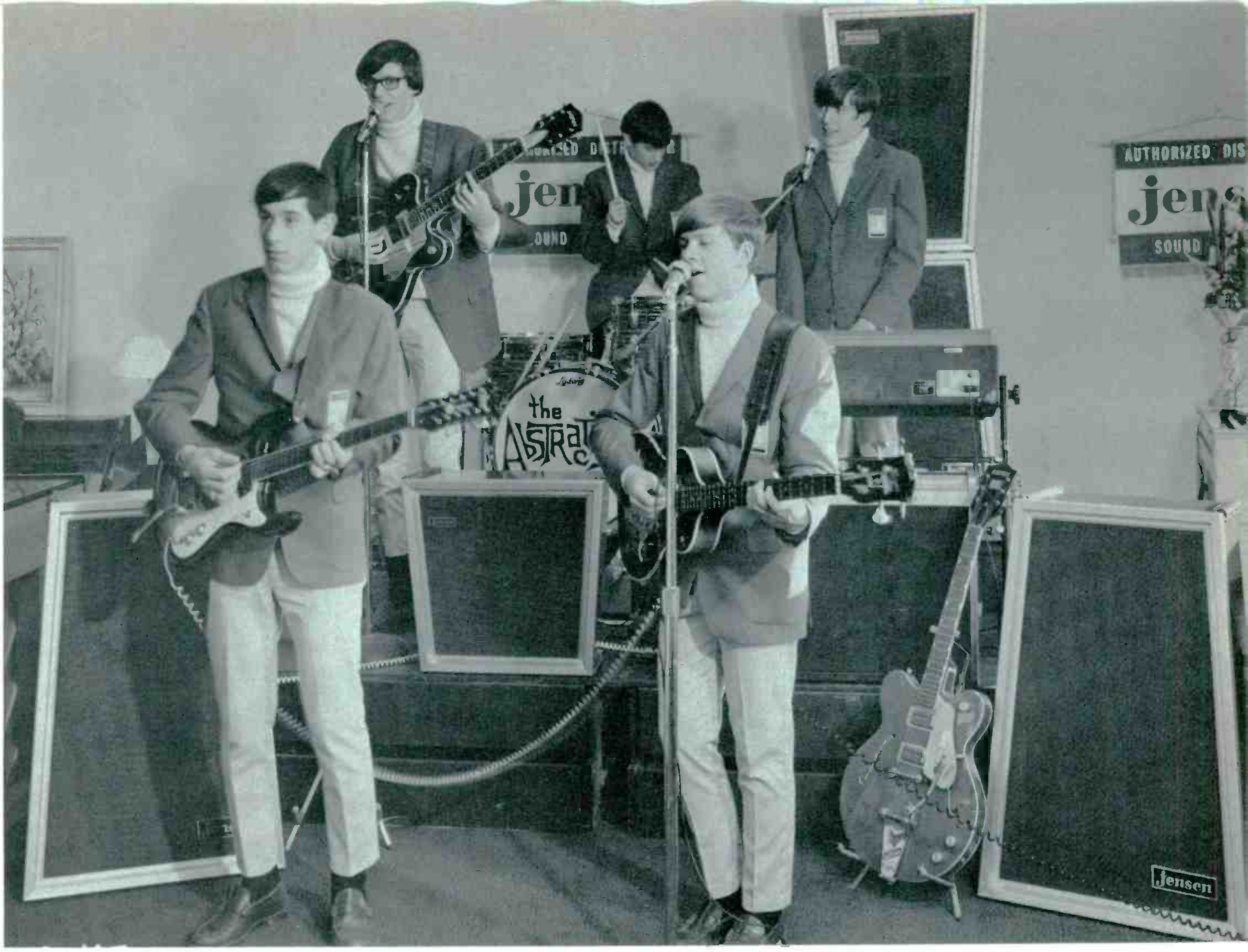


Fig. 2 High-power music amplifiers like those shown here have solid-state electronics that involve certain servicing problems, although they are generally more dependable than their tube-equipped counterparts.

amplifiers for electronic organs, and for dozens of musical instruments never before amplified. At least half of all amplifiers in use are for music (the other half for voice reinforcement).

About 60 percent of all amplifiers now are solid state. The most prevalent trouble in them is with the high-power transistors in the output stages. Although they are heavy duty, they are distressingly prone to breakdown.

Let some musician crank up the gain with a speaker disconnected, even for a few moments, and one or more of the output transistors is likely to pop. Or, let a wire or mike stand or guitar string fall against one of the speaker terminals and momentarily short it to ground—another power transistor (or two) goes kaput. Better amplifiers include 1- or 2-ohm, or fractional-ohm protective resistors in the emitter circuits of power transistors; unfortunately, they often burn open after the transistor is already damaged. (Many hi-fi amplifiers include speaker circuit breakers; most commercial sound amplifiers don't.)

High-Power Amplifier Designs

The most common types of high-power output stages are the **complementary-symmetry** and the **OTL,** which means Output Transformer Less. Actually, neither have output transformers; they drive speakers directly.

The complementary-symmetry type is shown in Fig. 3. It is driven directly by a single-ended driver stage. The speakers, however, are driven push-pull.

Notice that Q2 is NPN while Q3 is PNP. Both are connected as emitter followers, with the speakers as their load. Extra-large-value electrolytic C3 is the coupling capacitor. The diode stabilizes bias, to run the output transistors class-B.

Because the transistors are of opposite polarity, driving them in parallel effectively makes their outputs in push-pull. A positive half-cycle from the collector of the driver makes NPN transistor Q2 conduct more, but it cuts down conduction in the PNP-type Q3. A negative excursion does just the opposite; it forward-biases PNP Q3, while pushing NPN Q2 toward cutoff.

When Q2 conducts, a current amplified positive half-cycle is applied through C3 to the speakers. When Q3 conducts, a current-amplified negative half-cycle is applied through C3 to the speakers. They are fed push-pull.

The push-pull output makes transistor matching important. Harmonic distortion increases in push-pull stages if one signal excursion is

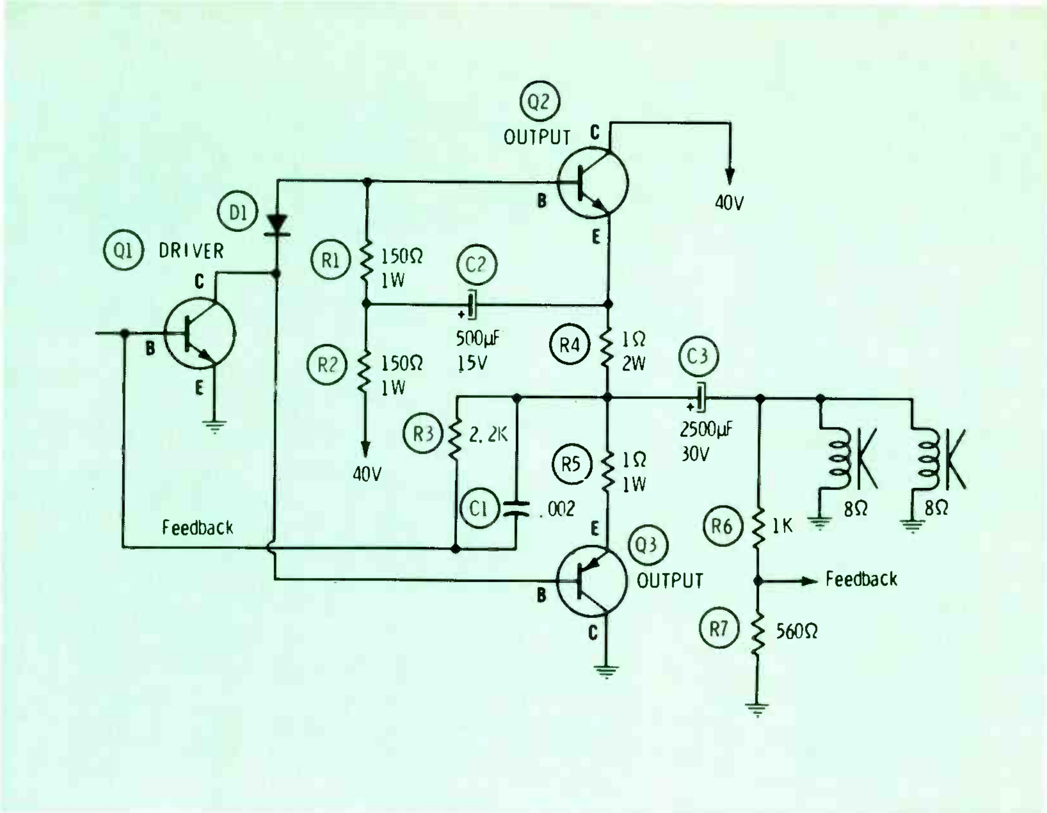


Fig. 3 Complementary-symmetry output stage draws its name from opposite-polarity transistors, which complement each other and drive speakers push-pull, without a transformer.

amplified more than the other. The transistors need equal current-amplifying characteristics. (More about transistor matching later.)

A much more powerful amplifier is diagrammed in Fig. 4. Notice that these transistors are **all** NPN types. At first glance, the speakers seem connected the same as for complementary-symmetry. But there are differences. For one, no coupling capacitor is needed. For another, and this is the most significant, the **collectors** of Q3 and Q4, not the emitters, feed the output bus (to the speakers). Also, note that the transistors are connected between B+ and B–, not ground. This is a typical OTL power stage.

A positive signal excursion from the driver stage applies a positive excursion to the base of Q1, through one seconday of the driver transformer. Q1 conducts more. An inversion winding on the transformer at the same time applies a negative excursion to Q3. Q3 is pushed toward cutoff.

The conduction in Q1 develops a positive excursion across emitter resistor R5. This is passed on to the base of Q2, and makes it conduct more, too. Both Q1 and Q2 thus draw positive-excursion current through the speakers.

At the same time, the reduced current in Q3 is driving Q4 into cutoff via the Q4 base connection across R7. Neither Q3 nor Q4 pulls any current through the speakers on this half-cycle.

A negative excursion from the driver puts a negative excursion on Q1 and a positive excursion on Q3. Q1 is cut off, and, in turn, cuts off Q2; no speaker current flows from them. However, at the same time, Q3 is being forward-biased, and current through it and, consequently, through Q4 increases. Both draw current through the speakers.

If you trace the electron flow during each condition, you find that the speakers receive current in one direction (from ground toward the transistors) when positive half-cycles are fed from the driver and in the other direction (from transistor collectors toward ground) during negative half-cycles. The result is a push-pull action that converts the powerful audio currents into sound.

The design of this stage protects the output transistors from damage by speaker-terminal shorts. The output bus stays at approximate DC zero, or ground, as long as the transistors are evenly matched. Even if they're slightly mismatched, the Bias controls can balance them for zero voltage on the output bus. Thus, the only current in the speakers is instantaneous current, during signal excursions.

The pots develop the bias because they are part of a divider between B+ and B–. The diodes across the pots provide temperature stabilization and prevent low-frequency audio signals from affecting bias.

The Power-Transistor Dilemma

Protection nowithstanding, the high peak power in some amplifiers just naturally destroys a certain number of output transistors. Finding the bad one isn't usually a problem. The emitter resistor generally opens too. Use your ohmmeter to verify that a suspected transistor is bad.

With a normal transistor, you get a high resistance reading between collector and emitter, no matter which way you hook up the ohmmeter leads. From base to either of the other two elements, you should find a low reading in one direction and a high reading in the other—a diode-type action. Fig. 5 shows you what's normal.

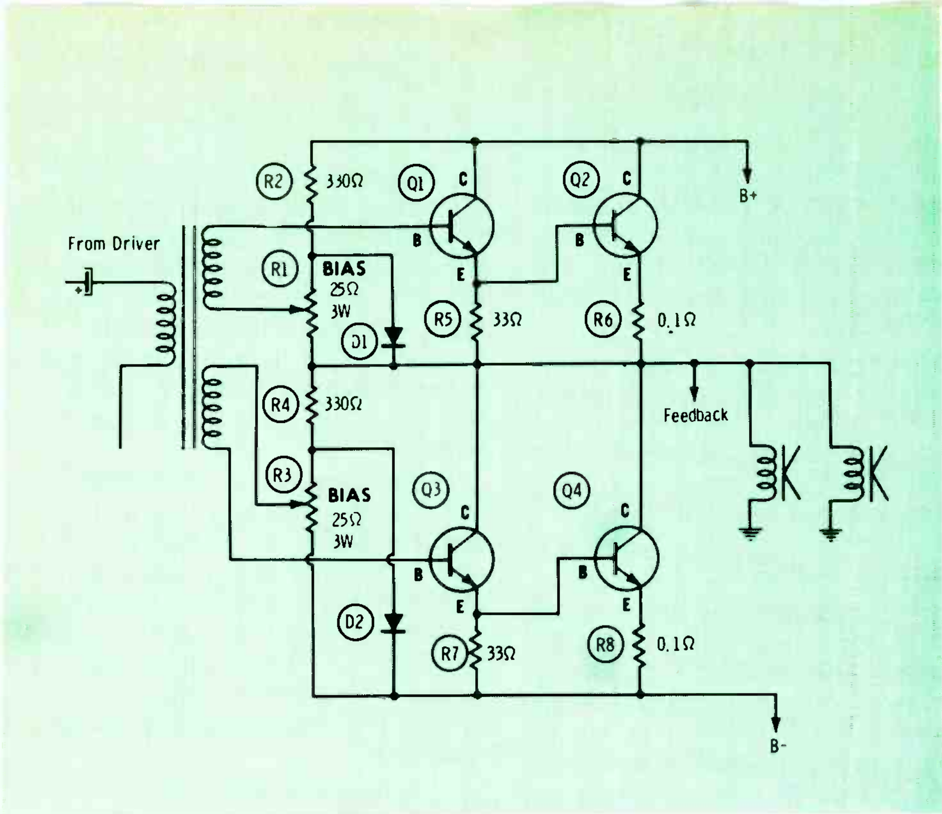


Fig. 4 Four-transistor design boosts output power even higher. Transistors are all NPN, but because they are driven by a special transformer they operate push-pull. The output is transformerless.

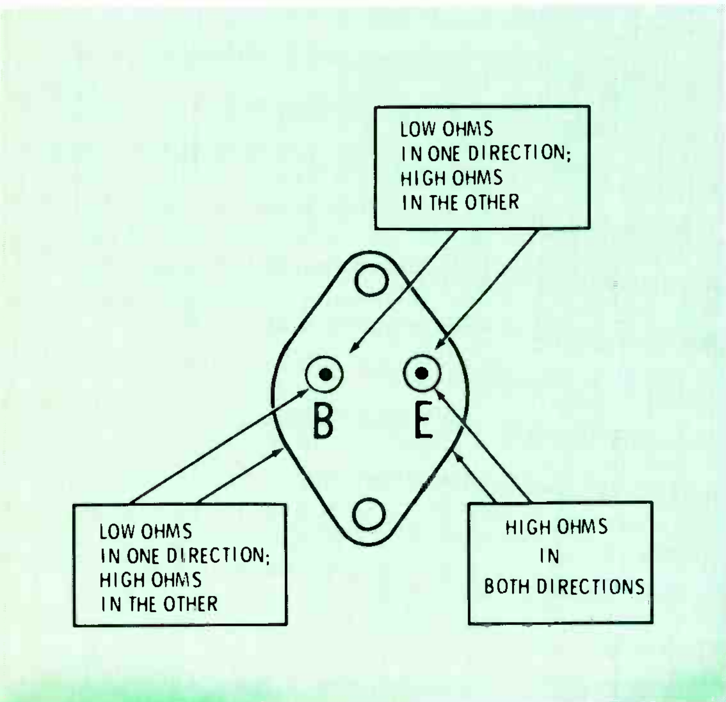


Fig. 5 Checking power transistor with an ohmmeter identifies shorted junctions or open elements. This is a quick diagnosis tool.

Disconnect the emitter and base leads while you make these measurements. The collector (usually the case of the transistor) is sometimes grounded and sometimes not. Check the schematic. Also, be sure the amplifier power is unplugged before you make any ohmmeter connections.

Once you discover a bad power transistor, finding a new one might turn the situation into a minor nightmare. Plenty of replacements are available, but not always under the name and number of the original. And there are some complicating factors.

As mentioned previously, the pairs of transistors in high-power output stages are matched. Because of the power peaks, you're asking for a callback if you substitute just any power transistor that seems to work. Even transistors of the same type number may not match as closely as required.

There are several ways to match power transistors. The first method should be used only if you don't have a better way: Measure the forward resistance (the low-ohms direction) from base to collector and from base to emitter. When you find two transistors in which **both** (not just one) of these resistances are alike, the dynamic characteristics are likely to be similar.

A much better way is with a transistor tester that measures beta. This isn't a dynamic measurement, but it approximates the "average" amplification of a transistor. Two transistors with the same beta reading usually are similar in operation.

A third way is new but rapidly becoming more popular. It's called **curve tracing.** It is a dynamic test of the transistor's base/collector transfer characteristic.

For this type of test, you need an oscilloscope. The transistor is connected to a test instrument called a curve tracer, which is, in turn, connected to the scope. When the controls are set properly, you see on the scope screen a display of transfer curves for the transistor (Fig. 6).

You then select two transistors that produce curves that are alike. The key parts of a curve are the knee and the slant. If transistors match up in this, they definitely operate alike in the circuit. For more about testing and matching transistors with a curve tracer, see the February, 1971, and March, 1971, issues of ES.

You can find usable replacements almost without regard to brand or type number. If you have one good transistor that operates normally in the amplifier, you need only match one to it and you have a suitable replacement.

Even better, match up several pairs of new transistors. Then you can have two ready to install anytime one transistor of a complementary or OTL pair burns out. This saves trying to match the one that's already in the amplifier. Be

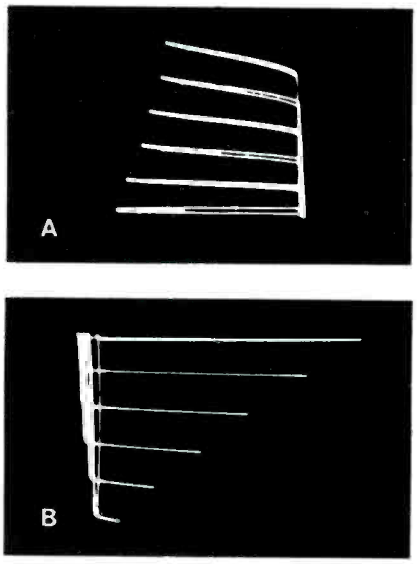


Fig. 6 If you can find two transistors whose characteristic-curve traces coincide, you can be assured they match dynamically. Traces shown here were produced by A) a 2N411 PNP germanium and B) a small NPN silicon.

Fig. 7 Single heavy duty speakers like this 250-watt unit are used in some music-amplifier setups. They can be driven by powerful auditorium-type amplifiers without becoming damaged by excessive peak-power.

sure your replacements have adequate power ratings—enough to carry the load and then some.

High-Power Speakers

Not long ago you had to carefully divide the total power of an amplifier among the speakers connected to it. A 100-watt amplifier might fracture the cone in an ordinary speaker. Sound columns and multiple trumpets were the order of the day.

Heavy power, single speakers are available now. They look about like the oldies, except they have big magnets. And, if you tore the wide voice coil apart, you'd see much heavier wire.

Fig. 7 is a photo of one—a 250-watt job that has become popular for music amplifiers. This speaker is 18 inches across, has a 3¾-lb. magnet imbedded in 12½ lbs. of magnetic structure, and a big 4-inch voice coil. The price is as big as the capability ($262 for this one), but it does the job with clean fidelity and in the long run is less costly than an array of lesser speakers.

Of course, you don't repair a speaker like this yourself. You send it back to the manufacturer—in this case, Jensen. Because of its heavy construction, you'll probably seldom have to send one back.

You still find trumpets in ordinary sound work. More and more, however, sound-reinforcement equipment is portable. It's portable, that is, if you have a truck to haul it and two men to lift it. But it's in cabinets that can be transported here and there. Huge speakers are reasonably weatherproof against mild weather, but don't leave them set up outside. Water damage to a $250 speaker and a $200 cabinet isn't anything you want every day.

More likely, for a permanent outside installation that demands fidelity, you'll use weatherproof sound columns. They are easy to install, can carry the load, and sound good. An installation like this in New York's Central Park could be heard by a crowd of 80,000 people, and suited even the trained ear of Leonard Berstein (after a few columns were moved around a bit).

Mikes and Acoustics

This facet of sound reinforcement demands experience more than any other. The mikes you choose depend on the program, on whether the performers move around or stand still, how large the pickup area is, whether the sound is to be monophonic or stereophonic, whether the wind is blowing, whether the acoustics are soft or hard, and perhaps a thousand other things. A whole book could be written on this one subject.

If you're new to sound reinforcement, there's a bit of practical advice. **Go places and listen.** Pay attention to microphone types and the sound they make. Listen through headphones from the amplifier so you hear the mike's pickup patterns—not the auditorium or arena acoustics. (You handle that with speakers.)

Accumulate direction-pattern and frequency-pickup data on as many mikes as you can. Then select about a half-dozen types that fit the situations you'll most likely encounter. Work with them. Practice different setups. Get to know their sounds and the positions that work best.

If you're lucky, you can learn from a sound technician who has experience. Guard against one thing, though: If he's an old-timer, he may be overlooking a lot of new gear that gives better sound than his "old standby" equipment. Study with someone who keeps up.

Summary

What has the preceding to do with troubleshooting? Just this: A serious number of sound-reinforcement problems stem from wrong installations. Many dollars have been spent in well-known auditoriums, correcting systems with poor sound. Troubles range from dead spots (fixed by better speaker placement) to feedback (usually fixed with better microphones).

Whatever the troubleshooting problem, knowing all the equipment, its limitations, and its possibilities is your best tool. Anybody that wants to can learn to fix the mechanical or the electronic **part** of a sound-reinforcement system. They become either mechanics or electronic technicians. A **sound reinforcement** technician does the whole job. ▲

product report

for further information on any of the following items, circle the associated number on the reader service card.

Two-Tone Sequential Decoder

A new, two-tone sequential decoder for use where 25 to 600 selective calling or control functions are required has been introduced by Dynacoustics, Inc.

The Model 201 decoder reportedly operates with all AM and FM two-way radio systems and other two-tone systems. It features a frequency range of 1200 Hz to 3000 Hz and an input sensitivity of 20 millivolts to 4 volts.

Frequency is determined by modular, plug-in networks, which can be changed without special tools. Each model comes with two networks; additional networks for any frequency between 1200 and 3000 Hz can be obtained readily from the factory.

Frequency stability of the Model 201 reportedly is ±.25 percent for temperatures from −25 degrees C to ±85 degrees C. The input impedance is greater than 1 megohm, and operating time is 250 milliseconds or less, according to the manufacturer.

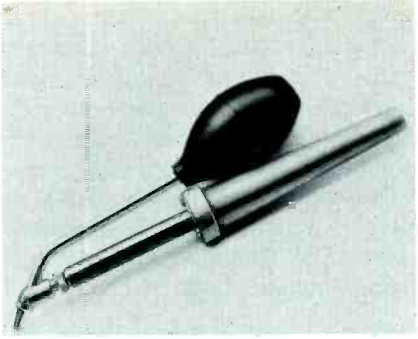
Design features of the Model 201 include the elimination of vibrating reeds and the use of silicon semiconductors and tantalum capacitors.

Operating voltage is 10 to 15 VDC. Power drain on standby reportedly is 30 milliamperes.

Model 201 sells for $125.00.

Circle 60 on literature card

Desoldering Tool



A new desoldering tool that utilizes vacuum and a hollow tip and which reportedly permits removal of soldered components from printed-circuit boards, conventional, or wired, circuit boards has been announced by Weller.

This tool may also be used for soldering and resoldering.

The unit includes a vacuum bulb, tip and a two-wire cord. Replacement tips are available in a variety of sizes.

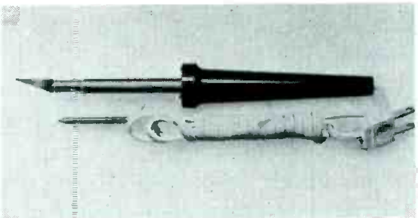
The DS-40 sells for $14.50.

Circle 61 on literature card

Hot Knife and Soldering Iron

A new, dual-purpose hot knife and soldering iron with a removable adapter chuck, holding a standard-type knife blade has been introduced by the Weller Div. of Cooper Industries, Inc.

When used as a hot knife, the 25-watt tool will cut most light plastics



and epoxies, strip insulation from wires, carve foam plastics, and cut and seal ends of plastic rope and woven plastics, according to the manufacturer. With chuck removed, the soldering tip, which is also supplied, may be screwed in.

Model SP23HK is $4.98.

Circle 62 on literature card

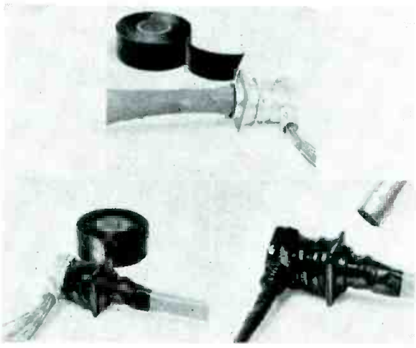
Shrinkable Electrical Tape

A new line of electrical insulating tape that reportedly shrinks, molds, encapsulates, water-proofs and remains flexible has been announced by Cole-Flex Corp.

The TYT 100 series has a reported operating temperature of −55 degrees C to +125 degrees C. When heated in excess of 121 de-

Circle 28 on literature card

grees, the tape will first start to shrink longitudinally to a maximum of 30 percent; the inner polyolefin liner will soften and flow into the tape wrappings; when cooled, the resulting fusion forms a tight mechanical fit, forming an encapsulating barrier, according to the manufacturer. The cooled wrap reportedly cannot be peeled off.



Type TYT 100 is applicable for insulating large unevenly shaped objects, and reportedly is ideal waterproofing tape for cable splices.

Width is ¾ inch. Thickness is .008 inch, nominal.

Type TYT 100 sells for $7.80 per 54-ft. roll.

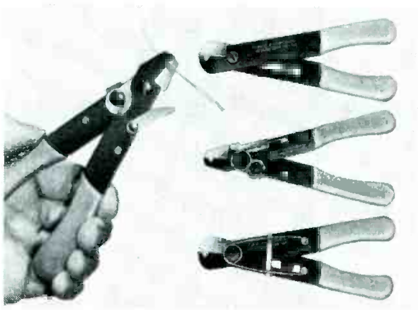
Circle 63 on literature card

Wire Stripper/Cutters

Three new models of wire stripper/cutters have been introduced by Xcelite, Inc.

The No. 100 has an adjustable screw stop for adapting the tool to different wire sizes.

No. 101-S reportedly is comparable to the No. 100, except for



spring-equipped, self-opening handles. A slip ring holds the handles closed when not in use.

The No. 103-S has a patented cam system for adjustment to various wire sizes. The cam will not move from its setting even when its screw is loosened, reports the manufacturer.

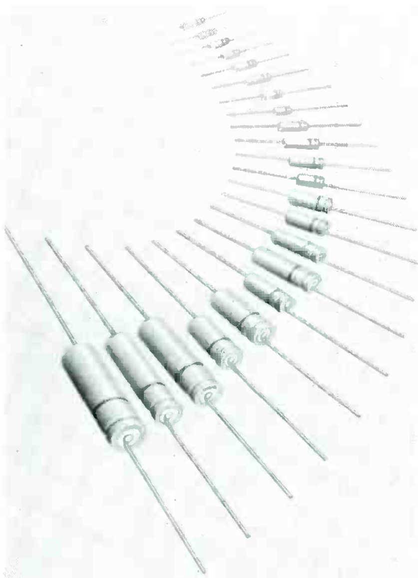
The new wire stripper/cutters sell for about $1.00 each.

Circle 64 on literature card

Low-Voltage Capacitors

Twenty-two new, metal-encased, tubular electrolytic capacitors have been added to the TVA ATOM® line by Sprague Products Company.

The new capacitors range in size from 11/16 inches in diameter by 2 5/16 inches in length to 1⅜



inches in diameter by 3⅛ inches in length, according to the manufacturer. Capacitance values range from 1,000 to 10,000 mfd, in a voltage range of 1 to 50 volts DC. ▲

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For more information about above products use reader service card

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I-222-A Signal Corp. Generator. 150 to 230 MHz, six crystal-controlled points. 8 to 15 MHz, two crystal-controlled points. Best offer. Joe Boehm, 3534 North Narragansett, Chicago, Ill., 60634.

Overstocked on recording tape. Must sell at cost. 1200' mylar, $1.50; 1800' polyester, $1.79; C-60, 77¢. All name brands, write for list. Community TV Systems, Box 3023, New Haven, Conn., 06515.

Obsolete radio and television tubes. Reasonable prices. Guaranteed satisfactory. Goodwin Radio Shop, Rankin, Ill. 60960.

RCA Oscilloscope type WO-505A, solid state, brand new $250.00. W. D. Shevtchuk, 1 Lois Avenue, Clifton, N. J. 07014.

Thousands of New Tubes 80% off, or trade for late test equipment. Abe's Rentals 1121 Edenfield Ave., Covina, Calif. 91722. 9-71-1t

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ANTENNAS

100. *Antenna Specialists Company*—announces a transmitter accessories catalog. The catalog includes a series of circulators, isolators, hybrid couplers, circulation terminations and harmonic filters.

101. *Jerrold Electronics Corp.*—Catalog S, titled "Systems and Products for TV Distribution," lists specifications of this manufacturer's complete line of antenna distribution products, including antennas and accessories, head-end equipment, distribution equipment and components, and installation aids.

102. *Russell Industries* — announces the availability of a complete line of telescoping antenna rods with swivel bases and sliding adapters for rods to disappear. This line is ideal for walkie/talkie and all portable radio applications.

AUDIO

103. *Altec Lansing*—introduces a 12-page brochure for information on sound systems in the sports and entertainment field, stadiums, automobile speedways, hotels, restaurants and other public entertainment facilities.

104. *Bell P/A Products Corp.*—new 6-page catalog gives detailed specifications and descriptions of the company's broad line of commercial sound components and special purpose sound system products.

105. *Duotone Company* — has made available a new color replacement needle wall reference chart. The chart covers almost all of the major manufacturers from American Microphone and Audax to Telefunken and Zenith. All categories are grouped according to manufacturer enabling quick and precise answers.

106. *E-V/Game, Inc., Div. of Electro-Voice* — has announced the new 32-page 1971 Catalog 71D, showing their complete line of record changer and tape record belts, drives and other related replacement parts. Features include: "Fraction to Decimal Equivalence Chart", and a 13-page Cross Reference Section.

107. *GC Electronics*—has made available a 52-page, two-color catalog, (FR-71-A) featuring 350 items for the music listener and hobbyist. Included in the booklet are a variety of TV antenna installations, acoustic-suspension loudspeaker systems, speaker switching devices, stereo headphones, microphones and accessories.

108. *Jensen Manufacturing Div.*—has issued an 8-page catalog, No. 1090-E, which describes applications of 167 individual speaker models. Special automotive, communications, intercom and weathermaster speakers, plus a complete line of electronic musical instrument loudspeakers are featured.

109. *Nortronics Co., Inc.*—has released a new Tape Head Replacement Guide which contains tape head replacements for over 2,800 domestic and foreign recorder models, a cross-reference to both model and head part numbers for reel-to-reel and cartridge recorders.

AUTO ELECTRONICS

110. *Littelfuse, Inc.* — has released a new 32-page, 1971 automotive replacement fuse guide for passenger autos, sports cars, trucks, and taxi cabs. Fuse descriptions and circuits they protect are included.

BUSINESS MATERIALS

111. *Mattick Printing Co.* — is offering a new catalog with over 300 styles of standard and imprinted business forms, used for shipping, accounting, inventory sales, purchasing, personnel, general correspondence and other areas.

CABLE HARDWARE

112. *Preformed Line Products Co.*—announces a six-page booklet describing and illustrating products used in fastening and holding dual and single coaxial cable and figure-8 cable.

113. *Electrovert, Inc.*—has announced a 16-page brochure describing their line of wire/cable harnessing, wire/cable marking and wire/cable accessory products. The differences and application advantages of each of the products is explained.

COMPONENTS

114. *Aerovox Corp.*—has made available a 20-page catalog of service replacement capacitors containing information and rating charts for electrolytic, paper/film, filters, ceramic, mica and AC capacitors.

115. *Arco/LDP Div. of Loral Corp.* — has published a new cross-reference guide and price book for its miniature aluminum electrolytic capacitors. The four-page publication includes specifications for the Arco/LDP line of Miniature Arcolytics, cross-references them by part number with similar products of other capacitor manufacturers.

116. *Burstein Aplebee* — announces a Guide to RCA Industrial Tube Products. The 31-page guide contains two major sections; Characteristics and Replacements.

117. *Essex International, Inc.*—announces their 24-page SC-5 RBM Standard Controls Catalog listing over 450 electrical/electronic relays and contactors.

118. *General Electric Tube Department* — has released a new 52-page Entertainment Semiconductor Almanac, No. ETRM-4311F. The almanac contains approximately 20,000 cross references from JEDEC, or OEM part numbers to GE parts numbers for universal replacement semiconductors, selenium rectifiers for color TV, dual diodes, and quartz crystals.*

119. *Loral Distributor Products* —has made available a 24-page electrolytic capacitor replacement guide. The catalog features replacement products by the original manufacturers part number.

120. *J. W. Miller Co.* — introduces a series of exact replacement coils for color TV and some black and white sets. Included in the series are convergence, stabilizer, chroma oscillator, balun coils and IF transformers.

121. *Motorola, Inc.* — has made available a 1971 HEP cross reference guide catalog, which lists replacements for over 31,000 different semiconductor device type numbers available through authorized HEP suppliers.

122. *Precision Tuner Service* — announces a new tuner parts catalog, including a cross reference list of antenna coils and shafts for all makes of tuners.

123. *RCA Distrivutor Products* —introduces a 72-page "SK Series Top-Of-The-Line Replacement Guide" (SPG-202L) which cross-references over 20,000 semiconductor device numbers. In addition a Solid State Quick Selection Replacement Chart (1L1367) listing 79 entertainment SK-Series devices is included. Price of this catalog is $.35.

124. *RCA Solid-State Division* has made available a new 28-page catalog describing the selection of RCA thyristors (triacs and SCR's), rectifiers, and diacs. Data for each type of device is arranged by series and in order of ascending current.*

125. *RCA/Solid-State Division* — announces a revised edition of the Power Transistor Directory, which reflects new product programs, as well as new product data. All product matrices have been updated to include the latest commercial types as well as preliminary data on developmental types, including RCA power transistors, both silicon and germanium. The Index of Types has been expanded to include DT types as well as JEDEC (2N-Series) types and RCA 40-K series types. Copies are $.40.*

126. *Semitronics Corp.*—has a new, revised "Transistor Rectifier, and Diode Interchangeability Guide" containing a list of over 100

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basic types of semiconductors that can be used as substitutes for over 12,000 types. Include 25 cents to cover handling and postage.

127. *Sprague Products Co.*—has announced a 40-page manual which lists original part numbers for each manufacturer, followed by ratings, recommended Sprague capacitor replacements, and list prices. More than 2,500 electrolytice capacitors are included.

128. *Stancor Products* pocket-size, 108-page "Stancor Color and Monochrome Television Parts Replacement Guide" provides the TV technician with transformer and deflection component part-to-part cross reference replacement data for over 14,000 original parts.

129. *Sylvania Electric Products, Inc.* — a 73-page guide which provides replacement considerations, specifications and drawings of Sylvania semiconductor devices plus a listing of over 35,000 JEDEC types and manufacturers' part numbers. Copies are $1.00.*

130. *Workman Electronic Products, Inc.*—has released a 32-page, pocket-size cross reference listing for color TV controls. 105 Workman part numbers are listed in numerical order with specifications and illustrations of the part.*

PICTURE TUBES

131. *General Electric* — a 12-page, 4-color, illustrated "Picture Tube Guidebook", Brochure No. ETRO-5372, provides a reference source for information about GE color picture tube replacements and tube interchangeability.*

132. *GTE Sylvania, Inc.* — has published an interchangeability guide listing 191 commonly used color TV picture tubes which can be replaced with 19 GTE Sylvania Color Bright 85® types.

SERVICE AIDS

133. *Chemtronics, Inc.* — has published a 6-page, 4-color, folder describing TUN-O-Brite chemical spray. Application uses are included.

TV ACCESSORIES

134. *Telematic* — introduces a 14-page catalog featuring CRT brighteners and reference charts, a complete line of test jig accessories and a cross reference of color set manufacturers to Telematic Adapters and convergence loads.

TECHNICAL PUBLICATIONS

135. *Chemtronics, Inc.* — has published a pocket-sized booklet describing typical thermal intermittents and how Super Frost Aid aerosol coolant will locate them. A step-by-step service procedure is outlined.

136. *Howard W. Sams & Co., Inc.* — literature describes popular and informative publications on radio and television servicing, communications, audio, hi-fi industrial electronics, including their 1971 catalog of technical books about every phase of electronics.*

137. *Tab Books* — has released their Spring, 1971 catalog describing over 170 current and forthcoming books. The 20-page catalog covers: schematic/servicing manuals, broadcasting; basic technology; CATV; electric motors; electronic engineering; computer technology; reference; television, radio and electronics servicing; audio and hi-fi stereo; hobby and experiment; amateur radio; test instruments; appliance repair, and transistor technology.*

TEST EQUIPMENT

138. *B & K Mfg. Div., Dynascan Corp.*—is making available an illustrated, 24-page 2-color Catalog BK-71, featuring B & K test equipment, with charts, patterns and full descriptive details and specifications included.*

139. *Bird Electronic Corp.*—announces a 4-page catalog, SF-71 listing new instruments for RF power measurements. Listed for the first time is the Model 3122 Monitor/RF Wattmeter.

140. *Eico* — has released a 32-page, 1971 catalog which features 12 new products in their test equipment line, plus a 7-page listing of authorized Eico dealers.

141. *Leader Instruments Corp.* —announces the 1971 Catalog of Leader Test Equipment. Test equipment included is the LBO-301 portable triggered-sweep oscilloscope, LSW-330 new solid-state post injection sweep/marker generator, and the LCG-384 mini-portable, solid-state battery operated color-bar generator.

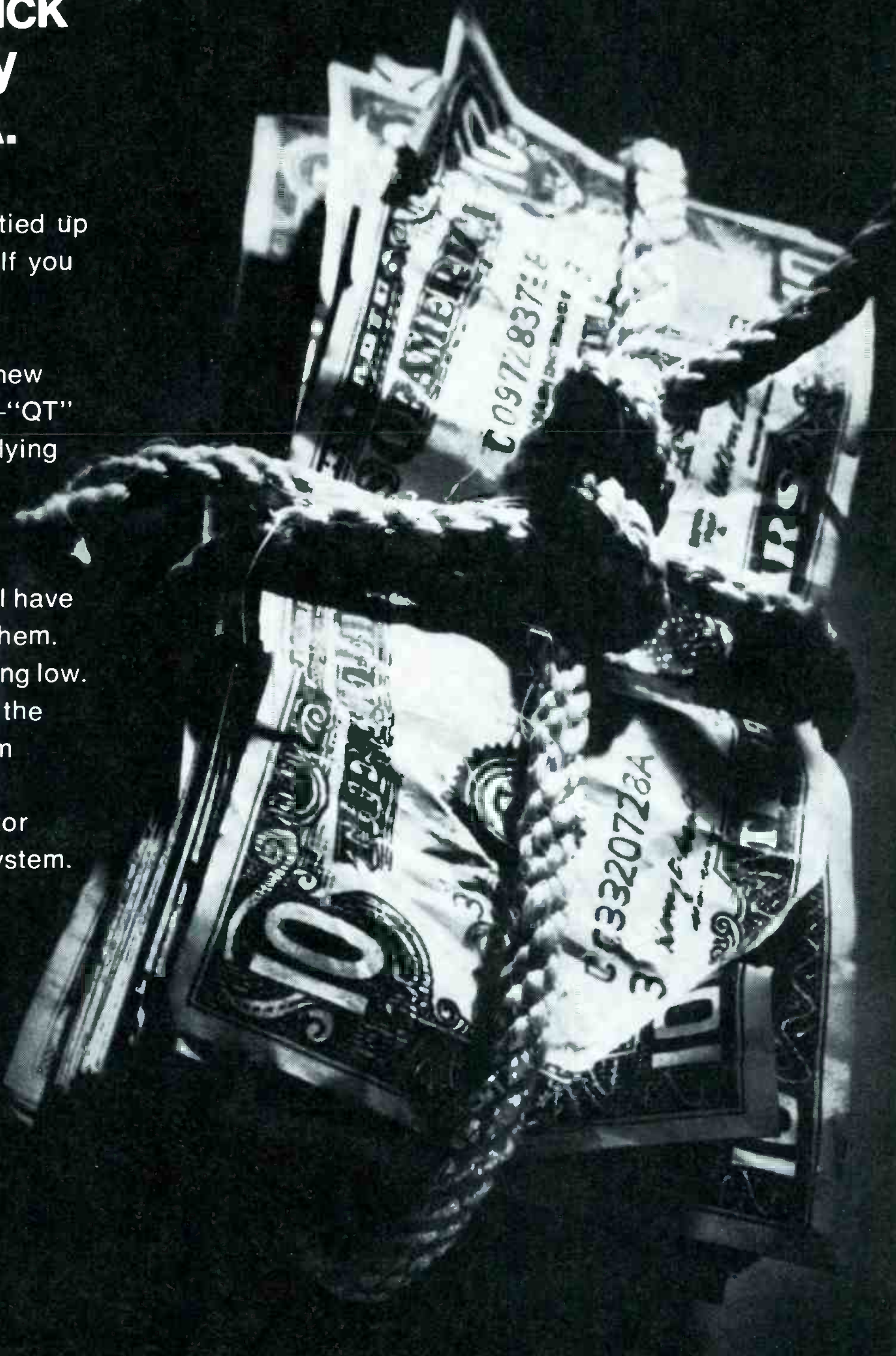
142. *Lectrotech, Inc.* — announces the 1972 catalog, "Precision Test Instruments for the Professional Technician". It contains specifications and prices on sweep marker generators, oscilloscopes, vectorscopes, color bar generators and other test equipment.

143. *Pomona Electronics* — has published a 60-page, 1971 catalog of electronic test accessories which contains more than 450 individual products, including 47 new items.

144. *Tektronix, Inc.* — has announced a 4-page brochure describing the 54 Series oscilloscope manufactured by Tektronix English subsidiary, Telequipment.

145. *Triplett Corp.* — Bulletin No. 51570, a 2-page technical bulletin which provides the specifications and price of Triplett's new Model 602VOM.

*Check "Index to Advertisers" for additional information. ▲



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