OCTOBER, 1970 ☐ 75 cents

A HOWARD W. SAMS PUBLICATION

Electronic Servicing

Transistor TV Servicing, page 52

Using the Stereo Generator, page 60

Contract Servicing 'Down Under', page 12

The RCA

blue and gold

Awards Program.

It's a continuous antenna-sales bonus you can't afford to miss.

What in the world would you choose if you had the whole world to choose from?

Maybe that's laying it on too much—but not that much, because the new Blue and Gold Awards can get you lots of things.

Sure, you have to do something, like sell RCA antennas and rotators. But that's easy.

And how can you call peeling off a sticker and slapping it on a card tough?

There's nothing easier—we've made it that way.

Here are just a few of the hundreds of items you can choose from: sailboats, mink coats, fishing and hunting equipment, jewelry, home furnishings—things you'd love to have but wouldn't buy for yourself.

So, talk to your RCA Parts and Accessories Distributor today. He has all the details.

RCA

Parts and Accessories

Circle 1 on literature card

Newest SAMS Books

Hi-Fi Stereo Servicing Guide

by ROBERT G. MIDDLETON. A complete guide to effective hi-fi and stereo servicing. Provides the basis for a full understanding of hi-fi tuner and amplifier circuitry and procedures for servicing this type of equipment. The proper use of audio test and measurement equipment and the basic principles of acoustics are also given. Covers all hi-fi components (except record players and tape recorders). Order **20785,** *only* . . **$3.95**

ABC's of Avionics

by LEX PARRISH. Provides a basic understanding of avionics—the electronic equipment used to insure the safety of crew and passengers. The type of equipment and the techniques employed in private aircraft operations are featured. Discusses requirements for basic communications, navigation aids, instrument flight aids, weather guidance, and flight control safety devices.
Order **20764,** *only* **$3.50**

Mobile-Radio Systems Planning

by LEO G. SANDS. Here is practical, basic information about various types of mobile-radio systems, how they work, their capabilities and limitations, system requirements, licenses, channels, band and frequency selection, transmitter-receiver selection, antenna systems, and accessories. Includes an invaluable system-requirements form for planning a mobile-radio system.
Order **20780,** *only* **$4.50**

Transistor-TV Servicing Made Easy

by JACK DARR. This practical guide will help you become skilled in the special techniques of transistor-TV servicing. Covers tools and equipment required; transistors and transistor-servicing techniques; power supplies; horizontal and vertical sweep circuits; video i-f and output circuits; agc and sync-separator problems; tuners; audio circuits; and selecting replacement transistors.
Order **20776,** *only* **$4.95**

Security Electronics

by JOHN E. CUNNINGHAM. Explains the operating principles of modern electronic devices and systems used to provide security against crime. Describes intrusion alarms and intrusion-detection devices. Includes chapters on the detection of hidden metal objects, announcement of detected intrusions, bugging, debugging, and speech-scrambling systems, and future developments.
Order **20767,** *only* **$4.50**

How to Hear, Police, Fire, and Aircraft Radio

by LEN BUCKWALTER. After World War II, police, fire, and aircraft radio moved to the less crowded vhf bands, and the "police band", which was found in many older radios, was silenced. Few listeners had receivers capable of covering the vhf band, because they were relatively expensive. With the advent of solid-state circuitry, a wide variety of relatively low-cost monitoring equipment is available. This book is a guide to the selection and use of vhf radio.
Order **20781,** *only* **$3.50**

101 Questions and Answers About Transistor Circuits

by LEO G. SANDS. Answers the most commonly asked questions about transistor circuitry. Explains transistor nomenclature, biasing, the three basic circuit configurations, input and output impedances, current and voltage gain, and other basic considerations. Covers power supplies and circuits; af circuits; rf circuits, and oscillators.
Order **20782,** *only* **$3.50**

1-2-3-4 Servicing Automobile Stereo

by FOREST H. BELT. This book first applies the ingenious "1-2-3-4" repair method to both mechanical and electrical equipment. It then proceeds to cover the electronic and mechanical principles of automobile stereo, fm multiplex and tape cartridge systems. Finally, the book shows how to apply the method to auto stereo systems.
Order **20737,** *only* **$3.95**

Aviation Electronics, 2nd Edition

by KEITH W. BOSE. This practical handbook for aircraft owners, pilots, technicians, and engineers explains the design, operation, and maintenance of aviation electronics equipment. Covers automatic direction-finders, distance-measuring equipment, omnirange, ATC transponders and weather radar, communications and instrument-landing systems, and related devices and systems used in aviation today.
Order **20743,** *only* **$9.95**

Questions & Answers on Short-Wave Listening

by H. CHARLES WOODRUFF. A helpful guide to the interesting world of listening afforded by short-wave receivers. Questions and answers cover international short-wave broadcasting, frequencies, and services; how short-wave is transmitted; how short-wave is received; and how short-wave receivers are constructed and operated.
Order **20783,** *only* **$3.50**

1-2-3-4 Servicing Transistor Color TV

by FOREST H. BELT. The "1-2-3-4 Method" is a simple, logical, step-by-step process that helps do the service job the right way and the easy way. In this book, the fundamentals of transistor color TV are covered, followed by a detailed explanation of how to apply the method for quick troubleshooting and easy repairs.
Order **20777,** *only* **$4.95**

North American Radio-TV Station Guide, 6th Edition

by VANE A. JONES. Lists all radio and TV stations in the U.S., Canada, Mexico, and the West Indies. Includes operating a-m, fm, and television stations, as well as those that are about to start operating, or are temporarily off the air. Separate listings arranged by geographical location, frequency (or channel), and call letters make this guide the most useful one available.
Order **20779,** *only* **$2.95**

HOWARD W. SAMS & CO., INC.

Order from your Electronic Parts Distributor,
or mail to Howard W. Sams & Co., Inc., Dept. **ES-110**
4300 W. 62nd St., Indianapolis, Ind. 46268

Send books checked at right. $________ enclosed
☐ Send FREE 1970 Sams Book Catalog

Name ____________________
PLEASE PRINT
Address ____________________
City __________ State ________ Zip ________

☐ 20785 ☐ 20777
☐ 20764 ☐ 20767
☐ 20780 ☐ 20781
☐ 20776 ☐ 20782
☐ 20743 ☐ 20737
☐ 20783 ☐ 20779

Circle 3 on literature card

October, 1970 • Volume 20. No. 10

Electronic Servicing

Formerly PF Reporter

in this issue...

DEPARTMENTS

Second class postage paid at Kansas City, Mo. and additional mailing offices. Published monthly by INTERTEC PUBLISHING CORP., 1014 Wyandotte St., Kansas City, Mo. 64105. Vol. 20, No. 10. Subscription rates $5 per year in U.S., its possessions and Canada; other countries $6 per year.

ELECTRONIC SERVICING (with which is combined PF Reporter) is published monthly by Intertec Publishing Corp., 1014 Wyandotte Street, Kansas City, Missouri 64105.

Subscription Prices: 1 year—$5.00, 2 years—$8.00, 3 years—$10.00, in the U. S. A., its possessions and Canada.

All other foreign countries: 1 year—$6.00, 2 years—$10.00, 3 years—$13.00. Single copy 75¢; back copies $1.

Robert E. Hertel, Publisher
Intertec Publishing Corp.
Subsidiary of Howard W. Sams & Co., Inc.

Do you choose capacitors the same way Fran French and Lew Russell do?

Then you're sure to pick Sprague Twist-Lok® Capacitors when you need twist-prong electrolytics.

Fran French and Lew Russell keep everything humming smoothly at Delaware Valley TV Service, Philadelphia, Pa. Fran, as Gen. Mgr., and Lew, as Shop Mgr., have had a lot to do with building this 13-man organization's reputation as specialists in color TV. With 20 years' TV servicing experience apiece, Fran and Lew agree about many things. One is twist-prong electrolytics.
Both prefer Sprague Twist-Lok Capacitors for reliability and availability.

Ask your Sprague distributor for a copy of Sprague's Electrolytic Capacitor Replacement Manual K-109 or write to:
Sprague Products Company, 105 Marshall St., North Adams, Mass. 01247.

SPRAGUE®
THE MARK OF RELIABILITY

P.S. **You can increase your business 7½% by participating in EIA's "What else needs fixing?" program. Ask your distributor or write to us for details.**

6S-8141

Circle 4 on literature card

letters to the editor

How to Speed Up Parts Availability

This is in rebuttal to the letter criticizing parts availability written by Mr. Jack R. Fink, which appeared in the July issue of ELECTRONIC SERVICING.

We have not had as many problems as Mr. Fink because we go about ordering parts in a different manner. Here are our replies to some of his complaints: (A) "A four-inch speaker on order from Motorola for 7 weeks." A four-inch speaker is a four-inch speaker; there must be at least ten manufacturers who can supply a speaker equal in electrical and physical characteristics to the original. (B) "Picture tube for a Motorola portable." Again, Motorola is not the only manufacturer of CRT's. (C) A head for a Dual 1009, which was said to be unavailable, can be obtained from Game Industries, Freeport, N.Y., as a standard stock item. (D) "A non-polarized capacitor." While it may be a difficult part to obtain, it can be made by connecting the positive leads from two filter capacitors together, thus creating two negative leads. That is, if you require 20 mfd, non-polarized, take the positive leads of two 40-mfd capacitors and tie them together, using the two in series. Need I go on?

Here are a few guidelines I have found helpful when dealing with manufacturers' parts departments:

1) Have an open account with the parts department. Try not to deal in cash in advance or COD's. We have found that orders become "shelved" in these cases.

2) Don't mail in orders; phone them in. Develop a personal relationship with one person in the parts department and stick to him or her. Here is an example: I placed an order to a manufacturer for a flyback transformer, but my regular "contact" was not in that day. I asked for a rush to be put on that order, knowing that the order might be "shelved". Three weeks later, no flyback had arrived. One phone call to my "contact" resulted in a delivery two days later.

One final comment, about Japanese parts: Try calling the "Japan World Trade Center" in New York. State the make of the radio or whatever kind of equipment you have, and they will furnish the name and address of the representative or the factory and the address of same.

I don't wish to offend Mr. Fink; however, I think his methods of ordering parts leaves something to be desired.

Stan Cmielewski
Newark, N.J.

Help Needed

I have been attempting to locate a source for a sound-actuated tunable conductive reed, which I need for an electronic device I invented. These electrically conductive reeds are about one inch long and can be tuned by means of a set-screw.

If anyone knows where I might be able to obtain one, please write. I would appreciate any help.

Henry A. Pellerin
22 Electric Avenue
East Greenbush, N.Y. 12061

We need the service data for a Play-Rite 8-band radio Model P-1600. It can be either battery- or AC-operated, and has 16 transistors. The words "Japan 403" also are printed on the bottom of the case.

Can anyone furnish wiring diagrams and alignment information for this radio? Any information will be appreciated.

Paul W. Curtis
Curtis Radio & TV
12 N.E. 6th Street
Milton-Freewater, Ore. 97862

I need a schematic diagram for Fidelity Intercom Model CH511C-2, 117 volts AC/DC, 34 watts. The name of the supplier on the intercom is C & H Supply Company, Dallas 7, Texas. Our correspondence with this company was returned by the post office.

E. O. Ross
1325 Grove Avenue
Racine, Wisc. 53405

We need the schematic and a parts source for Klemt Emolette Model BS-40, made in Germany. Any help will be appreciated.

Robert N. Gardner
Gardner Electronics
1115 Baker Street
International Village
Bakersfield, Calif. 93305

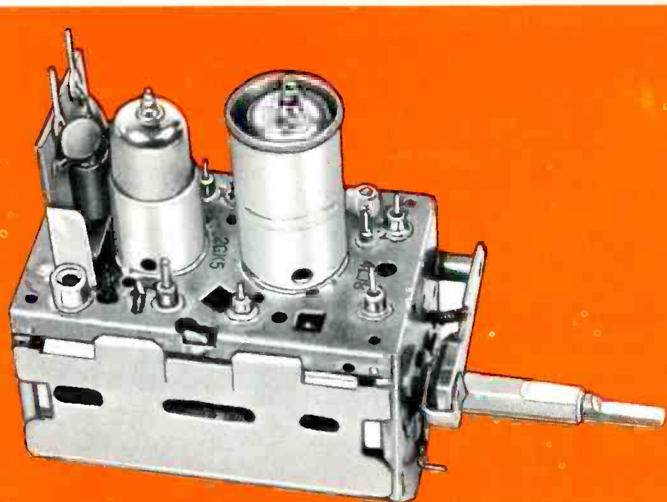
I would like to obtain a fibre (or metal) gooseneck horn to use with a Model 40 Atwater Kent radio, which has been restored to operating condition. Any information regarding such a horn, with or without driver unit, would be appreciated.

Victor Mantz
Radio-TV Service
Mission, Texas 78572

I would appreciate it if someone could help me find a 12FR8 tube for a 1962 Ford Fairlane 500 radio. I understand the tube no longer is in production.

Stephen Colquett
P. O. Box 848
Auburn, Ala. 36830

I need the schematics and service data on the Grundig Model TK-20 tape recorder and on the Cipher VII tape recorder.



$9.75

TUNER SERVICE CORPORATION

PROVIDES YOU WITH A COMPLETE SERVICE FOR ALL YOUR TELEVISION TUNER REQUIREMENTS AT ONE PRICE.

TUNER REPAIR

VHF Or UHF Any Type $9.75.
UHF/VHF Combo $15.00.

In this price all parts are included. Tubes, transistors, diodes, and nuvistors are charged at cost.

Fast efficient service at our 4 conveniently located service centers.

1 year guarantee backed up by the largest tuner manufacturer in the U.S.— SARKES TARZIAN INC.

All tuners are cleaned inside and out, repaired, realigned and air tested.

TUNER REPLACEMENT

Replacement Tuner $9.75.

This price buys you a complete new tuner built specifically by SARKES TARZIAN INC. for this purpose.

The price is the same for *every* type of universal replacement tuner.

Specify heater type

Parallel 6.3V
Series 450 mA
Series 600 mA

All shafts have the same length of 12″.

Characteristics are:
Memory Fine Tuning
UHF Plug In
Universal Mounting
Hi-Gain Lo-Noise

If you prefer we'll customize this tuner for you. The price will be $18.25. Send in original tuner for comparison purposes to our office in INDIANAPOLIS, INDIANA.

TSC

TUNER SERVICE CORPORATION

FACTORY-SUPERVISED TUNER SERVICE

MIDWEST . . . . . 817 N. PENNSYLVANIA ST., Indianapolis, Indiana . . . . . TEL: 317-632-3493
(Home Office)
EAST . . . . 547-49 TONNELE AVE., Jersey City, New Jersey . . . . . TEL: 201-792-3730
SOUTH-EAST . . 938 GORDON ST., S. W., Atlanta, Georgia . . . . TEL: 404-758-2232
WEST . . . . SARKES TARZIAN, Inc. *TUNER SERVICE DIVISION*
10654 MAGNOLIA BLVD., North Hollywood, California . . . TEL: 213-769-2720

Circle 5 on literature card

Help Needed

Also, I need a schematic on a battery eliminator for small-tube radios.

Can anyone help?

James C. Thurman
Route 1, Box 245A, SP-7
Willows, Calif. 95988

We need parts for the brand "Audition". Do any readers have information as to where we can obtain parts?

Gil Dylla
Gil's Radio & TV
2403 So. College
Bryan, Texas 77803

I need to know what tubes are used in a Silverline VHF converter Model 64-3-B. Any help will be appreciated.

D. L. Konicki
4443 N. Greenview Avenue
Chicago, Ill. 60640

I am in dire need of all the volumes, except Volume 4, of Video Speed Servicing by Samuel L. Marshall. I will gladly pay for them.

Thank you.

Frank Michuda
Route #1, Henry County
Springville, Tenn. 38256

I am very much in need of an instruction or operating manual for a Heathkit oscilloscope Model OM-3. Perhaps another reader has one I can purchase or borrow for reproduction.

William C. Loyd
1154 East Dade Street
Lake City, Fla. 32055

I urgently need a schematic, operating manual, tube layout chart or any other technical information about a Cromwell Model 252 radio. If another technician can help, I would sincerely appreciate it.

Riley's TV Repair
Riley Vance
18202 Shoshone Drive
Independence, Mo. 64058

Test Equipment For Sale

I have some radio and television test equipment for sale, some at half of the original purchase price. They all are in good operating condition, with complete original-factory service manuals and schematics.

The following are for sale:

1)	*RCA Oscilloscope Model WO-91A*	*$125.00*
2)	*Hickok Universal Crystal-Controlled Signal Generator Model 288AX*	*175.00*
3)	*Sencore Color-King Deluxe Color Generator Model CG-141 (new)*	*125.00*
4)	*Sencore Sweep-Circuit Analyzer Model SS117*	*45.00*
5)	*Mercury Oscilloscope/Vectorscope Model 3000 (new)*	*90.00*
6)	*Conar Instruments VTVM Model 211 (new)*	*25.00*
7)	*Jackson Sweep and Marker Generator Model TVG2*	*135.00*
8)	*Semitron Transistor Tester and Set Analyzer Model 1000 (new)*	*10.00*
9)	*Cornell-Dubilier Handicheck (in- and out-of-circuit capacitor checker) Model B-F-90*	*20.00*
10)	*Knight (Allied Radio) Flyback Checker*	*10.00*
11)	*Mercury Component Substitution Model 501*	*20.00*
12)	*EICO Signal Tracer Model 147A*	*25.00*
13)	*Lafayette Grid-Dip Meter Model TE-18*	*10.00*
14)	*RCA Senior Volt Ohmyst VTVM Model WV-98C*	*65.00*

William D. Shevtchuk
One Lois Avenue
Clifton, N.J. 07014

I have for sale an RCA Deluxe Color-Bar/Crosshatch Generator Model WR-64B.

This instrument has: a chroma control for checking color receiver sync-lock action; crystal-controlled synchronizing pulses; and panel switches for shorting out either the red, blue or green gun of a color tube. It is new, in excellent condition, and all service manuals are included.

For further information about this instrument, please contact me.

Bernard H. Serota
2502 S. Philip Street
Philadelphia, Pa. 19148

A Part-Time Technician Speaks Out

I am a part-time TV serviceman. My shop is in my home. I have been trained by one of America's leading electronic schools. I have as much high-quality electronic test equipment as any full-time shop in this area, and more than some. I am experienced. My percentage of callbacks is among the lowest in the area. More important, I am honest with my customers.

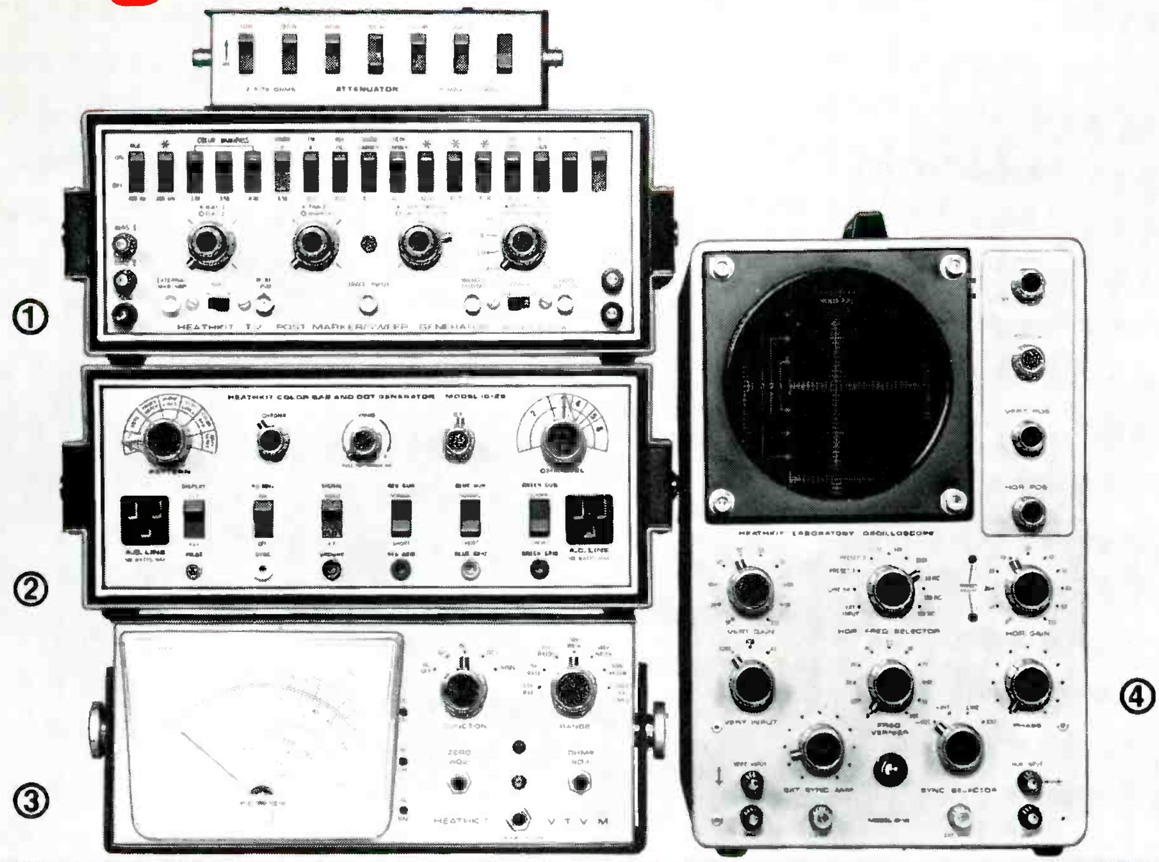
Yet, I am a part-timer. I deeply resent being classified in the same category as a "fly-by-nighter" by such self-styled experts as Joseph F. Sgarlat, Jr. (June 1970 Letters to the Editor). If Mr. Sgarlat's "effect-to-cause" reasoning in his TV work is as defective as the logic expressed in his letter, he has problems.

Most of us part-time TV repairmen are in this category because we wish to be. In most cases, including mine, TV repair is neither our sole source of income nor our sole interest. Many of us entered this field because of our love for theoretical electronics. We are not interested in mass production or "time-saving techniques". Because of our freedom from the pressure of quantitative output, we are able to give each repair job the careful, individualized attention that the full-time shop, with its high overhead, cannot dream of providing. Most of us do not charge less; we just give more. In either case, the customer is the winner.

It would be most interesting to see a survey of full-time shops versus part-time technicians in the areas of quality of repair and personal integrity. I am confident the results would surprise many of us.

Russell Harper
Gillham, Ark. ▲

stack these up against the others . . .



for just the price of other sweep-marker generators, you can get a bench full of Heathkit® color test gear

Stack These Up Against The Others . . . a high performance Sweep-Marker Generator, an accurate Color Bar-Pattern Generator, a versatile VTVM and a rugged, dependable Scope . . . all for only $347.40* . . . $50 *less* than the cost of other sweep-marker generators alone. At Heath, we still believe that you should be able to get a stack of gear without spending a pile of money.

1 **Heathkit IG-57A Solid-State Sweep-Marker Generator . . . $135.00*.** 15 crystal controlled markers for color bandpass, TV sound, IF, picture & sound carriers for channels 4 & 10, FM IF . . . new Video Sweep Modulation allows injection of chroma-sweep directly into IF amplifiers or thru antenna terminals . . . two built-in variable bias supplies . . . 400 Hz modulated or CW output of any individual marker . . . exclusive external attenuator . . . stable, linear sweep signals for the five most used frequency ranges . . . complete scope matching controls . . . quick disconnect BNC connectors . . . complete with all probes, test leads & terminated cables. 14 lbs. Assembled IGW-57A, 11 lbs. . . . $199.00*

2 **Heathkit IG-28 Solid-State Color Bar-Pattern Generator . . . $79.95*.** Produces 12 patterns plus clear raster . . . dots, cross-hatch, vertical & horizontal bars, color bars and shading bars in 9x9 or exclusive 3x3 display . . . all solid-state using computer-type integrated circuitry . . . variable front-panel tuning for channels 2 thru 6 . . . variable front-panel positive and negative video output . . . front panel negative going sync output . . . built-in gun shorting circuit with lead piercing connectors . . . switchable crystal-controlled sound carrier. 8 lbs. Assembled IGW-28, 8 lbs. . . . $114.95*

3 **Heathkit IM-28 "Service Bench" VTVM . . . $39.95*** Measures RMS DC & AC Volts from 1.5 — 1500 . . . AC P-P from 4 — 4000 V . . . resistance from 0.1 ohm — 1000 megohms . . . easy-to-read 6" meter . . . 10-turn vernier controls for zero & ohms . . . single test probe for all measurements . . . ±1 dB 25 Hz — 1 MHz response. 7 lbs. Assembled IMW-28, 7 lbs. . . . $59.95*

4 **The Heathkit IO-18 5" Wide-Band Scope . . . $92.50*** 5 MHz band-width . . . five sweep ranges from 10 Hz — 500 kHz . . . + or — internal, line or external snyc . . . two extra, presetable sweep positions . . . front panel 1 V P-P reference . . . Z-axis input . . . retrace blanking . . . 0-135° phasing control . . . frequency-compensated vertical attenuation. 24 lbs. Assembled IOW-18, 23 lbs. . . . $149.95*

Compare Heathkit performance and value . . . you'll see the others just don't stack up.

NEW

FREE 1971 CATALOG!

Now with more kits, more color. Fully describes these along with over 300 kits for stereo/hi-fi, color TV, electronic organs, guitar amplifiers, amateur radio, marine, educational, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

HEATHKIT
a Schlumberger company

HEATH COMPANY, Dept. 25-10
Benton Harbor, Michigan 49022

☐ Enclosed is $______________, plus shipping.

Please send model (s)______________
☐ Please send FREE Heathkit Catalog. ☐ Please send Credit Application.

Name______________

Address______________

City______________ State______________ Zip______________

*Mail order prices; F.O.B. factory. Prices & specifications subject to change without notice. TE-227

Circle 6 on literature card

electronicscanner

news of the industry

Precision Tuner Opens Massachusetts Tuner Repair Center

Precision Tuner Service, Indiana-based television tuner repair company, has opened a new repair center in West Springfield, Massachusetts.

Precision Tuner operates four other tuner repair centers: Bloomington, Indiana (home office); Miami, Florida; Longview, Texas; Turlock, California.

Murl Reeves has been appointed General Manager of the new West Springfield center.

ISCET Elects Crow Chairman

Ron Crow, CET, head of the Electronics and Technical Education Section of Iowa State University, was elected chairman of the International Society of Certified Electronic Technicians (ISCET) at the organizational meeting of the society in St. Louis.

Mr. Crow is a graduate of Iowa State University, Ames, Iowa, and Devry Technical Institute, Chicago.

NEA Elects Browne President

Norris R. Browne, CET, owner of Houston TV Service Company, Houston, Texas, and former secretary of the National Electronics Association (NEA), was elected president of that association at the annual NEA convention in St. Louis in July.

Mr. Browne is a past president of the Texas Electronics Association and a charter member of the International Society of Certified Electronic Technicians.

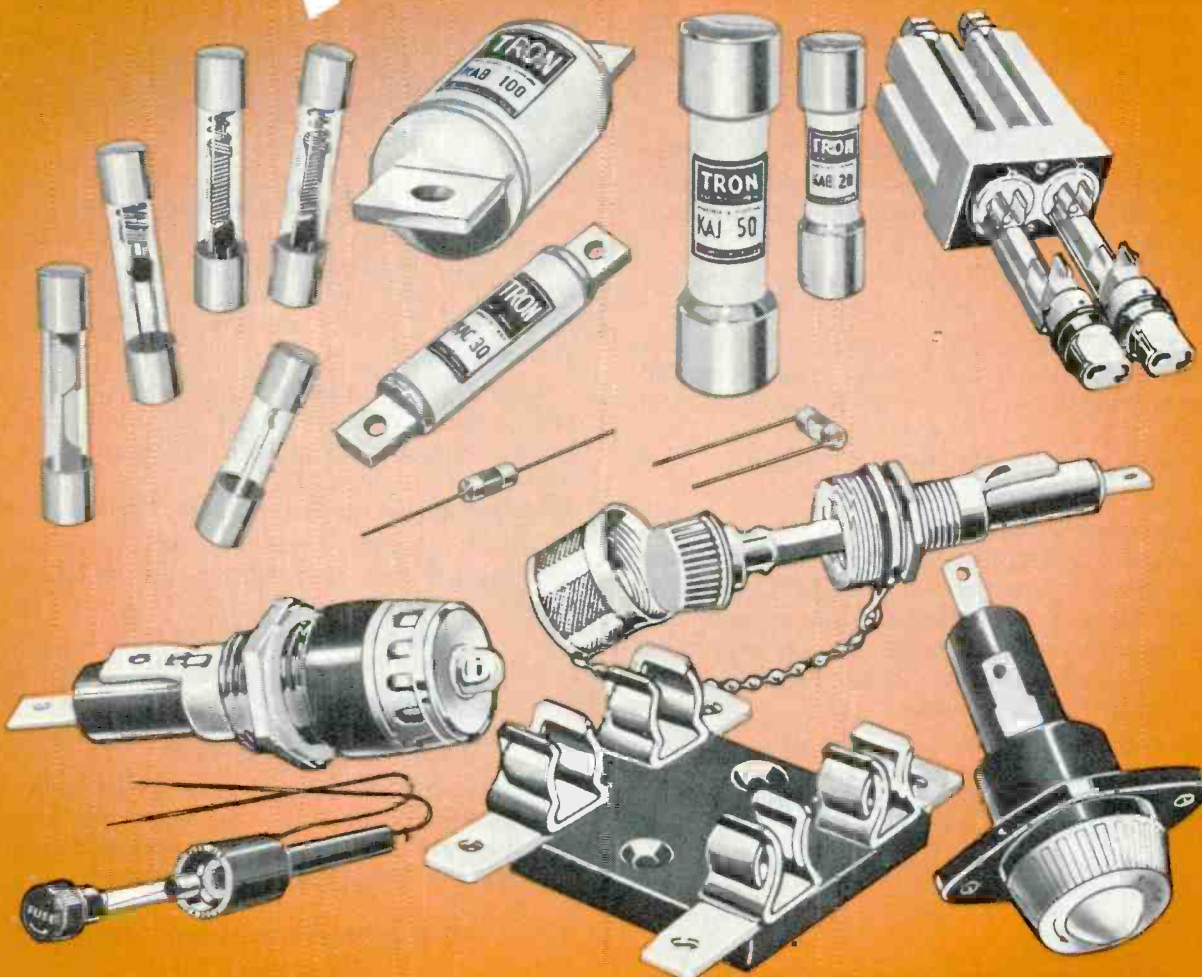
NATESA Restructured At Rescheduled Convention

The National Alliance of Television and Electronic Service Associations (NATESA), at a no-holds-barred meeting during its reinstated convention in August, reportedly has established a new organizational format under new officers.

Earlier, the NATESA annual convention had been postponed until October; however, Gerald Hall, then president of the association, canceled the postponement and rescheduled the convention on the original dates and at the original site, Chicago.

A new five-man governing council has been established, and will operate under a temporary organizational agreement and standard parliamentary law until a new set of bylaws is adopted. The council is comprised of: LeRoy Ragsdale, Fort Smith, Arkansas, President; Leo Shumanon, Boston, Vice President and President-Elect; Bob Harrison, Norfolk, Virginia, Secretary General; Tom Easum, Memphis, Tennessee, Treasurer; and Frank Moch, Chicago, Executive Director. Four council meetings will be held each year,

NAME YOUR REQUIREMENT



...in fuses, fuseholders, or fuseblocks
YOU'LL FIND THE ANSWER IN THE COMPLETE BUSS QUALITY LINE

You only have to look to one source — BUSS — for anything you need in protecting electrical and electronic circuits and components. BUSS covers the entire spectrum of fuses, fuseholders, fuseblocks, and related mounting hardware.

You can reduce procurement and inventory costs by making BUSS — the *quality* line — your single source. Write for BUSS Bulletin SFB and see for yourself.

BUSSMANN MFG. DIVISION
McGraw-Edison Co. St. Louis, Mo. 63107

SUPPLIED THE ECONOMICAL WAY . . . THRU DISTRIBUTORS
BUSS QUALITY
FUSES

Circle 7 on literature card

and travel expenses of council members will be paid by NATESA.

Divisions reportedly have been abolished under the organizational restructure, and voting will be by state, with representation "by choice of members".

The annual convention will be held each year at different locations throughout the country, and will be hosted by "volunteer affiliate associations". The 1971 convention will be held in Little Rock, Arkansas.

Finances reportedly is a major problem at this time, and the annual dues has been increased, by vote, to $35. According to Moch, those groups who already have paid annual dues of $25 per member will be recognized; however, the $10 per member deficiency must be paid within 30 days of the convention date.

The Television and Electronic Service Association of Milwaukee organized the 1970 NATESA annual convention.

Leader Warrants Parts 2 Years, Labor 180 Days

All models of Leader test equipment now are covered by a two-year parts warranty and 180-day labor warranty.

Leader will return a repaired in-warranty instrument prepaid, if the unit is shipped to Leader prepaid.

For warranty coverage, the registration card which accompanies all Leader instruments must be mailed by the purchaser within 10 days of the purchase date.

Motorola Receives NATESA "Friends of Service" Award

The Consumer Products Division of Motorola has been awarded the National Alliance of Television and Electronic Service Associations' (NATESA) "Friends of Service" award for the third consecutive year. The award is presented annually to the company that, in the opinion of NATESA, does an "outstanding job in service and service-support programs".

Shown here receiving the award from Frank Moch (center), executive director of NATESA, are Elmer Wavering, president and chief operating officer of Motorola, Inc., and Edward PP. Reavey, Jr., vice president and general manager of the Consumer Products Division of Motorola.

Fair Sex Fixes Television

Diana Ildefonso, who presently is receiving on-the-job training at Regal Magnavox Home Entertainment Center in Linden, New Jersey, reportedly is this country's youngest female television technician (or is that "technicianist"?).

Miss Ildefonso, a graduate of a Jobs Corps electronic course, will complete her training by attending classes in TV repair this fall at Union Country College.

Olympic Relocates Service and Parts Department

The service and parts department of Olympic International, Ltd. has been relocated to the following address:

Olympic International, Ltd.
Service Department
89-89 Union Turnpike
Glendale, New York 11227
Telephone (212) 441-6200

Correspondence, parts orders, in-warranty returns and all other action related to service and/or procurement of parts for Olympic consumer electronic products are now handled at the above address.

90-Day Warranty Labor Coverage Offered by Arvin

Ninety-day coverage of labor is included in the warranties of Arvin b-w and portable color TV receivers, as well as this manufacturer's radio, portable and console phonos and tape recorders.

Warranty labor reimbursement is not provided for console color TV receivers.

One-year warranty of parts is offered for all Arvin consumer electronic products.

Florida Passes License Law

The Florida State Senate and House recently passed the Florida Electronic Repair Act, according to a report in **ARTSD News,** official publication of the Associated Radio and Television Service Dealers of Columbus, Ohio.

The Act reportedly will become effective January 1st, 1971.

GE Offers 90-Day Labor Warranty

General Electric has joined the growing list of consumer electronic manufacturers who have added service labor coverage to their warranty programs.

The new GE plan provides 90-day free labor on all color and b-w TV receivers. In-home labor is covered for consoles and large-screen table models with screen sizes 20 inches or larger. Carry-in coverage is provided for portable and compact table models with 19-inch and smaller screen sizes.

Previous GE parts warranties are continued: color picture tube, 2 years; other parts, 1 year; and etched circuit boards, life of set. B-w warranties are: picture tube, 1 year; parts, 90 days, and etched circuit boards, life of set.

Germans Exhibit Video Player Disc System for TV

A phonograph-type video "player" system for b-w and color TV which employs a one-sided "video disc" has been developed and exhibited by Germany's Telefunken Decca and Teldec Companies, according to a report in the **New York Times** (submitted to ES by B. J. Brown of Trion, Georgia, who claims to have invented the video disc concept 33 years ago.)

The report states that the producers hope to have the new video player system, complete with a variety of discs, on the market within 18 to 24 months. Consumer costs of the units are estimated at about $150 for b-w television and about $300 for color TV receivers. Price of a 5-minute disc is estimated at less than $5.50.

The player's discs reportedly can be used with any TV system. Larger discs will run for 12 minutes, and an automatic record changer attached to the player will permit even longer programs.

U.S. Unit Sales of Renewal Color CRTs Up 21 Percent During First Six Months 1970; Monochrome Down 12.9 Percent

U.S. factory sales of color picture tubes for renewal purposes during January-June, 1970 period increased 21 percent over the sales of the same period in 1969, while factory sales of OEM color picture tubes declined 33.5 percent.

United sales of renewal monochrome picture tubes during the first six months of 1970 were down 12.9 percent from figures for the same period in 1969. OEM monochrome picture tube unit sales were down 25.9 percent.

Factory Unit Sales of TV Picture Tubes First Six Months 1970 and 1969*
(Hundreds of Thousands)

Market	First 6 Months 1970	First 6 Months 1969	% Change
MONOCHROME			
OEM	1,698	2,293	−25.9
Renewal**	256	294	−12.9
Export	56	151	−62.9
Total	2,010	2,738	−26.6
COLOR			
OEM	1,970	2,962	−33.5
Renewal**	415	343	+21.0
Export	145	69	+110.1
Total	2,530	3,374	−25.0

*Source: Electronic Industries Association's Marketing Services Division
**Excludes renewal non-reported (local brands)

▲

Contract servicing down under

by J. W. Phipps

Training and equipping the technician to perform nearly all servicing in the home instead of sending the set to the shop, seven-day-a-week service, customer relations traning of technicians, keeping the technician on the job and productively employed—all are essential elements of this Australian firm's approach to profitable contract servicing.

Hills Electronics, the largest independent television servicing company in Australia, is headquartered in Edwardstown, a suburb of Adelaide in South Australia, and operates TV servicing divisions in Adelaide, Melbourne (Victoria), Sydney (New South Wales), Brisbane (Queensland) and Perth (Western Australia). Hills also is engaged in the rental and sale of TV receivers and domestic antenna and MATV systems, as well as the manufacturer, sales, installation and servicing of VHF two-way radio.

The majority of Hills Service is on a contract basis. Service is provided on a 9:00 a.m. to 9:00 p.m. basis, Monday through Saturday and 1:00 p.m. to 9:00 p.m. on Sundays and public holidays. The only two days when service is not provided are Christmas Day and Good Friday.

Consumer service contracts account for about 66 percent of the service business of Australia's largest independent TV service company, Hills' Electronics.

To hold costs down and keep the price of their contracts competitive, Hills' trains and equips their technicians to do 97 percent of all servicing in the home. Removal of sets to the shop is kept at a minimum. Hill's also concentrates on keeping the technician out in the field, productively employed at what he was trained to do—service sets.

Hills' approaches to both contract and demand servicing were explained by Ian Adamson, director of the electronics division of Hill's, during a recent visit with the staff of ELECTRONIC SERVICING.

In-Home Servicing Is Encouraged

Because in-shop repairs increase the cost of contract servicing, Hills trains and equips field technicians to perform the majority of servicing in the home. According to Mr. Adamson, only about 3 percent of all of Hills' service calls require removal of the set to the shop.

Basic test equipment for Hills' field technicians includes a 40,000 ohms-per-volt VOM and a scope, plus a complete set of hand tools and service aids, and a loose-leaf folder of service literature on all TV sets in use in Australia. Average time for a home service call is about 38 minutes.

The emphasis on in-home servicing also requires that each field service vehicle be equipped with a parts inventory valued at $1100 to $1200 (Australian). Establishment of a realistic field inventory involved close scrutiny of parts usage over a long period of time, and is a continuing study.

Travel Time is Held to Minimum To Maintain High Productivity

Hills limits their area of operation to a 25-mile radius of each of the metropolitan areas they serve. Each metropolitan area is divided into districts, with a field technician assigned to each district, usually near his home. A central service center, complete with shop, office facilities, dispatch office and parts warehouse, is located in each of the metropolitan areas.

Field technicians come to the central service center only about once a week, to turn in the receipts they have collected for non-contract servicing and to restock their mobile parts inventory. Service calls are assigned the field technicians by the central dispatcher via two-way radio, with which each service vehicle is equipped. The field technician reports back to the dispatcher after each call.

Field Technician Support

Backing up the field technicians are pick-up and delivery vehicles and field engineers. When a field technician encounters a set that he knows cannot be repaired in the home by either himself or the field engineer, he reports this fact to the central dispatcher, who notifies the pick-up and delivery vehicle. This system keeps the field technician out in the field, doing the job for which he is trained.

When the field technician encounters a service problem beyond his abilities, he calls in a field engineer. Explaining the function of the field engineer, Mr. Adamson said, "For example, in the Adelaide metropolitan area we have four basic areas—north, south, east and west. In each of these areas we have a field engineer, who is a top-flight technician. All of our technicians are highly skilled, but the field engineer is even more skilled, and he carries additional test equipment. When one of the field technicians comes across a situation that is beyond his knowledge, he calls the base station and reports that the set can be fixed in the home, but he can't do it. We then send in the field engineer for the area, who, when he isn't involved in such special cases, functions as a field technician. Because of his additional ability and equipment, he usually can solve the problem.

"Or the trouble might be a customer relations problem. Although we train our fellows in customer relations, there are always instances in which personalities conflict. The field engineer, in addition to his superior technical ability, also is a supreme diplomat as well. He can say to the customer, 'My name is so and so and I'm a field engineer from Hills.' He has a bit of authority about him. So the customer then sees that we really care and are doing something special to solve the problem. Winning back a dissatisfield customer in this manner usually keeps that customer with you for life.

"To prevent the field technician from abusing this system, under the incentive program calling in a field engineer is considered by the company as equal to sending the set to the shop."

Restocking of Field Inventories

Hills presently uses two methods for controlling stocks and re-equipping the field technician with parts for his mobile inventory. Both methods are designed to keep the field technician out in the field. Mr. Adamson explains the systems:

"One method we are using in Brisbane and Sidney as an experiment seems to be working out okay, and we'll probably extend it to the rest of our operations. When a field technician calls in after completion of a job, he tells us what parts he used. We've got all of our parts coded under a seven-number system; the field technician gives us these part numbers over the radio. This information is recorded by the controller at the base station and is forwarded to the stores parts section, which prepares the technician's replenishment stock. The parts can be fed out to him by the pick-up and delivery truck, or he can pick it up himself when he comes in.

"In other states we are operating on a stores requisition basis: A copy of each job ticket is used as a stores requisition. During the field technician's weekly visit, he fronts up to the store (parts department) with the copies of his job tickets and the storeman fills out the order.

"I favor the first of these methods, because it spreads the work load, and the replenishment stock is ready when the field technician comes in for it. This method reduces paper work and technician waiting time. The

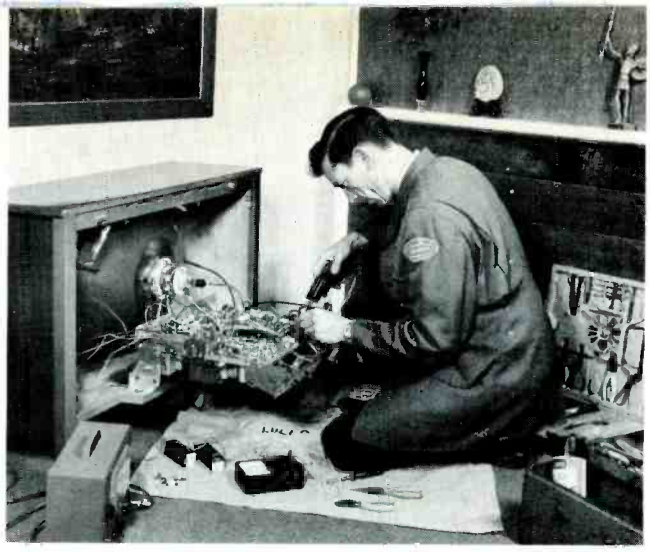


Fig. 1 Because removing set from home increases the cost of contract servicing, as well as causing customer dissatisfaction, 97 percent of servicing performed by Hills is accomplished in the home by field technicians, as shown here. Average time in home per call is 38 minutes.

Fig. 2 Field technicians receive and report on service calls, request assistance and order parts via 2-way radio, with which all Hills service vehicles are equipped. This procedure, plus an adequate mobile parts inventory and complete tools and test equipment, reduces non-productive time by keeping the technician in the field, doing the job he is trained to do—service sets in the home. Because of the size of the company, Hills has been assigned its own exclusive communications channel.

Fig. 3 Hills' service vehicle on country road outside Adelaide, South Australia. Average distance between service calls is 6 miles.

Fig 4 Uniforms and private usage of service vehicle are part of fringe benefits provided Hills' field technicians. Technician shown here beside Sidney Harbor Bridge is wearing optional summer uniform of shirt and tie with Bermuda shorts and long socks. Unique structure in distant background is Sydney's controversial opera house.

primary consideration is that the field technician is paid to service sets, and not to do a lot of paper work, which takes up productive time. Time spent doing anything else besides servicing sets is considered non-productive time under our incentive program. We strive to keep non-productive time to less than 10 perecnt of the technician's total time on the job."

Adequate Compensation and Reasonable Working Conditions: Musts for Retaining and Attracting Good Technicians

Although the shortage of skilled technicians in Australia is not as acute as it is in this country, the management of Hills recognizes the importance of retaining skilled employees, if for no other reason than the investment in them in both time and money spent for training.

Fig. 5 Inside Hills shop in Perth, Western Australia. Only 3 percent of Hills' total service volume is shop work; remainder is accomplished in the home. Workshop technicians receive about $65 per week. Incentive program gives field technicians opportunity to make considerably more than shop technicians. Shop work is flat rated at about $12 per hour. Workshops are located in each of the five major metropolitan areas in which Hills operates.

NOW you can measure resistors accurately IN CIRCUIT!

in solid state devices

FE20 HI-LO
with hi-voltage probe and large six-inch meter $129.50

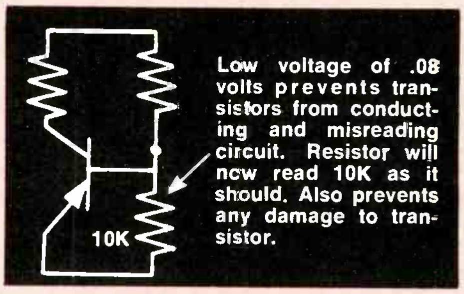
FE21 HI-LO with 4½-inch meter $99.50

WITH THE NEW HI-LO FIELD EFFECT MULTIMETERS

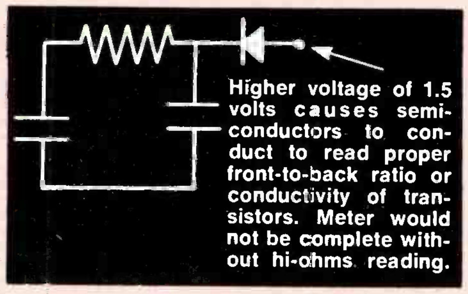
USES ONLY .08 VOLTS TO POWER OHMMETER TO PREVENT TRANSISTORS FROM CONDUCTING AND UPSETTING READINGS

Look at these extra features to see why the Hi-Lo meter belongs on your want list:

- Unbelievable specifications of 15 megohm input impedance on DC and 12 megohms on AC
- Laboratory accuracy of 1.5 percent on DC and 3 percent on AC
- 9 DC voltage ranges from as low as .1 volts full scale to 1000 volts
- 3 hi-voltage ranges of 3 KV, 10 KV and 30 KV
- 9 DC zero center ranges from .05 volts to 500 volts . . . a must for delicate transistor bias measurements
- 7 resistance ranges from 1000 ohms full scale to 1000 megohms
- 9 DC current ranges from 100 microamps to 1 amp
- Automatic built-in battery test . . . never a worry about rundown batteries, just push the switches under the meter and read.
- Standard .6 amp fuse to protect the ohms and milliamps scales if voltage or overload is accidentally applied. No more need to return the meter to factory for repair . . . just replace the fuse.
- Special probe with 100K isolation resistor in probe to prevent AC pickup or to prevent loading oscillator circuits. Leave in normal position for most tests.



Here is why you should have both Hi and Lo battery voltages for correct in-circuit resistance measurements in solid state circuits:



SENCORE INC. 3200 Sencore Drive • Sioux Falls, South Dakota 57107

Circle 36 on literature card

Fig. 6 General office at headquarters of Hills Electronics, Adelaide, South Australia.

"We have to provide a lot of benefits to our technicians to make sure that they stay with us. And also to attract other good-quality technicians to replace those we lose.

"There is always the tendency for a technician to think: 'Why can't I give this a go myself?' Over the years we have lost a number of technicians who have gone out on their own—and many are doing quite well.

"Also, it's not an easy job going into a customer's house and getting bitten by a dog—and sometimes even by the customer—and working long hours. After a fellow has been working in TV servicing for a number of years, he gets a bit tired. We've had cases where technicians have been prepared to lose $20 or $25 a week to switch to a government job in which he works only from 9 to 5, plus four weeks per year paid sick leave. Consequently, we've got to provide him with a good wage plus fringe benefits like clothing and a reasonably presentable motor vehicle which he's quite happy to take his family out in."

The base pay for Hills' field technicians is about $65 per week, but incentive earnings can increase this to about $100. (Remember, there is a difference between the purchasing power of the American dollar and that of the Australian dollar. The current rate of exchange is about 1.1215 Australian dollars for one American dollar; however, this does not necessarily reflect the comparative purchasing powers.)

Fig. 7 Ian K. Adamson, Director of Hills' Electronic Division.

In addition to base and incentive pay, Hills' field technicians also are permitted private usage of their service vehicles, and they are provided with uniforms—a choice of tailored shirts and pants or shorts and long socks in the summer, and the addition of a tailored blue blazer for winter wear. Because only a qualified technician is issued a blue blazer, it is a status symbol for the technician who wears one.

Hills' incentive program is based on the quantity and quality of servicing the field technician performs. Standards for both of these factors have been established by analyzing technician performance data accumulated over a long period of time. This data has enabled Hills' management to arrive at averages for both technician productivity and the incidence of callbacks.

Because the majority of Hills' servicing is on a contract basis, keeping the incidence of callbacks at a minimum is vitally important; callbacks not only reduce the profit margin of contract servicing, as with any type of servicing, but it also can force management to increase contract rates, which in turn reduces the competitive position of the company in obtaining new contracts and renewing those that have expired.

To encourage technicians to perform quality service under the incentive program, and thus keep callbacks at a minimum, Hills has adopted a demerit system based on the number of callbacks, and has trained technicians to routinely perform a preventive maintenance type of check-out procedure on each service call. To eliminate the need for technicians/management arbitration over callbacks, the company has established a policy under which any callback within a 28-day period after servicing is charged against the technician that performed the service.

Asked about the working hours of Hills' technicians, Mr. Adamson replied:

"Our technicians average about 52 hours a week, although basically they are required to work only 40 hours, from Monday to Friday.

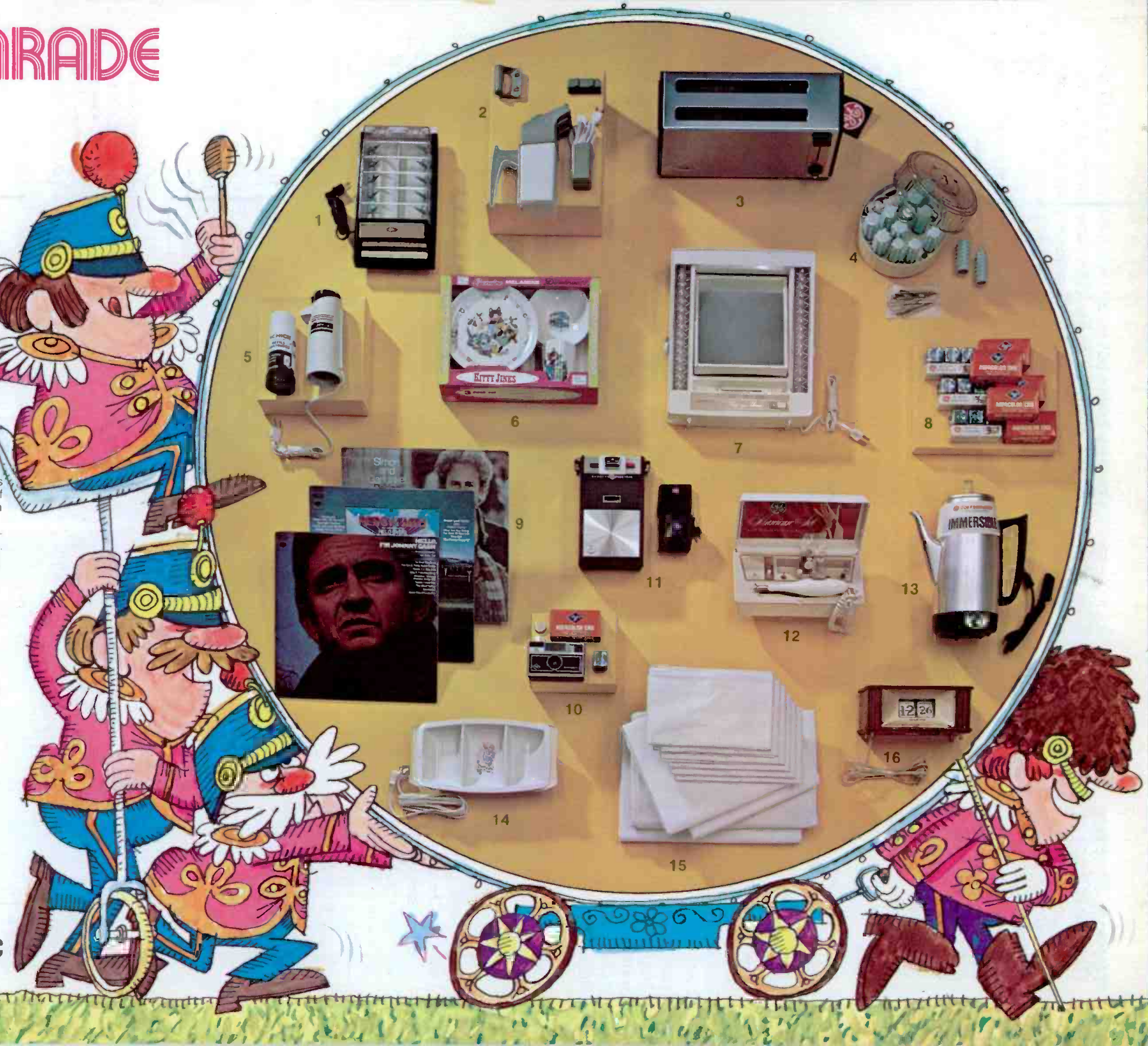
"For weekend service, which we provide our customers, the technician must be paid on an overtime basis—time and a half for the first four hours on Saturday and doubletime for the remainder of Saturday and all day Sunday. There are other ways overtime compensation can be handled, but we've tried most of them and they don't work out. For example, giving compensatory days off in the middle of the week."

Technician Training Includes Both Technical Proficiency and Customer Relations

Technical training in Australia is provided primarily through government-operated trade schools and an associated five-year apprenticeship program. Graduates of four-year secondary schools who are not over the age of 19 are eligible to attend government trade schools and the apprenticeship program.

Technical training includes both theoretical and practical training. Trainees are employed on a part-time basis in shops and attend formal classes the re-

PREMIUMS ON PARADE



You can make the parade of premiums come right to your home. Take your pick of anything in the parade – it's yours through your purchases of GE tubes.
Offer is for a limited time only. Ask your participating GE tube distributor for details today.

1. Presto® Deluxe Automatic Hot-Dogger – 125 Points
2. Osrow® Stanley Steamer – 150 Points
3. GE Four-Slice Toaster – 520 Points
4. GE Hair Curler – 255 Points
5. Schick® Electronic Hot Lather Dispenser – 275 Points
6. Child's Melamine Dinnerware Set – 50 Points
7. GE Lighted Makeup Mirror – 500 Points
8. Agfa Film & GE Cube Kit – 200 Points
9. Columbia Three Album Stereo Record Package – 260 Points
10. Agfa Camera Kit – 200 Points
11. GE Cassette Tape Recorder – 730 Points
12. GE Manicure Set – 445 Points
13. GE Coffeemaker – 425 Points
14. GE Baby Dish – 215 Points
15. Cannon Percale Sheets (4 each twin & double) & 6 Pillow Cases – 850 Points
16. GE Digital Clock – 370 Points

Tube Department, Owensboro, Kentucky

GENERAL ELECTRIC

288-35

mainder of the time.

Individuals must pay for the formal schooling, but, in turn, are paid for the time they spend in the shop receiving practical training.

Individuals too old to gain admittance to the government trade schools and associated apprentice program can obtain technical training through a "semi-government" institute. For example, in South Australia the Training Institute of Technology provides training in both TV servicing skills and management techniques. Adult trainees also receive their practical experience through part-time employment in shops.

Hills obtains technicians through both training systems. "All trade schools require practical experience," explains Mr. Adamson. "By the time the fellow completes his apprenticeship, he's not only knowledgeable about theory, but he's had practical experience, and is quite capable of fixing TV receivers. However, he hasn't learned customer relations, which we feel is an essential skill of field technicians.

"Even when a technician has completed his apprenticeship, we still do not send him out in the field by himself, even though he is technically qualified. First, we send him out with one of our experienced field technicians for a few months, to learn customer relations.

"Refresher and upgrade technical training also are a part of Hills' technician training program. The service manager in each area is responsible for such training. He either can do the instructing himself, or he can have a local trade school conduct a special refresher course tailored to meet our requirements.

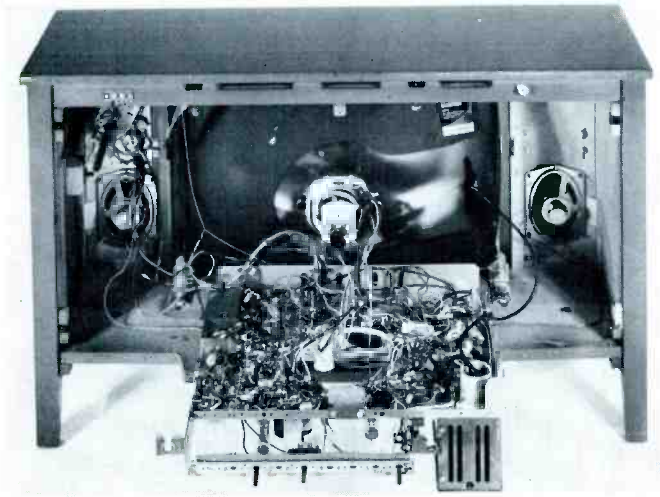
"Such training is conducted either after duty hours or during normal working hours, in which case we pay the man half salary as an incentive to attend."

Distribution of Parts

The distribution system in Australia basically is a three-step (manufacturer-distributor-servicer) system like its counterpart in this country. However, because of their large volume of business Hills Electronics purchases parts direct from manufacturers and, in fact, has established their own parts wholesaling operation, which buys parts both for use by their own service operation and for wholesale to other independent servicers.

Service Literature

Service literature, including manuals and schematics, generally is available in small quantities from Australian TV manufacturers, but because of Hills' large volume, and because they are committed to servicing all makes and models of TV, they have elected to subscribe to more detailed service literature produced by an independent publisher, similar to Howard W. Sams & Co., Inc., in this country. ▲



Shown here are front and rear views of a typical Australian TV receiver. Note how the vertically mounted chassis folds down and out for ease of servicing.

Transmission of black-and-white television began in Australia in 1956. At present there is no color TV broadcasting in "the land down under", but it is expected to begin within the next two years.

To date there are no all-solid-state TV receivers in Australia. The latest designs are hybrids (combination tube and transistors), with some modularization.

Nearly all TV receivers in use in Australia are designed and manufactured in Australia; there are very few foreign-made sets. During the early years of TV in Australia, there were about 27 manufacturers, each of whom produced six to eight models. This number has gradually declined, and now there are only about six major manufacturers—which, in a country with a population of only about 13,000,000, is still a relatively large number.

As in this country, there is very little standardization of major components for the various designs, except for VHF tuners and tubes. Most Australian TV receivers are equipped with a Philips tuner, although there is one other major tuner manufactuerer in Australia. There are only two manufacturers of receiving tubes.

Recurring troubles related to poor design, poor quality components or sloppy workmanship do not plague Australian servicers to the degree that they do American TV technicians. Commenting on the quality of the design and workmanship in Australian TV receivers and the incidence of recurring troubles, Mr. Adamson said:

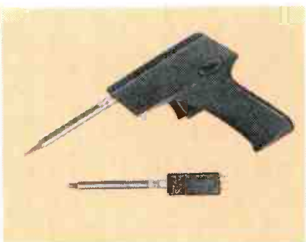
"Australian manufacturers aren't game enough to put out a model that isn't proven 100 percent. This might change with the introduction of color, because they will be trying to get them out as quickly as possible, to meet a new demand. But, at present, if an Australian manufacturer put out an unproven model, it could cripple him because Australia is a relatively small place and word gets around quick."

When your servicemen have to solder, make sure they...

SOLDER ONCE SOLDER WELL SOLDER WITH WELLER!

WELLER SPECIALIZES IN SERVICE SOLDERING TOOLS. Today's electronic products such as computers, office equipment, instruments, radios, televisions, hi-fi sets and other sophisticated equipment are manufactured with the use of highly specialized soldering tools - to assure optimum results. But . . . what about specialized soldering tools when these products require service soldering? Whether the servicing is done in a plant, shop or right in the field, you should get the same quality solder connection that your product received on the production line. Are your servicemen equipped with soldering tools that perform as well as those in your production line? If not they should be . . . it's costing you money!

Weller, world's largest manufacturer of soldering tools, offers a line of soldering tools designed specifically for servicing electronic products and equipment. Each Weller soldering tool is built to allow your serviceman to solder just once . . . solder fast . . . solder well. See that he solders with one or more of the following Weller Service Tools . . .



TEMPMATIC

- CONTROLLED, INTERCHANGEABLE PLUG-IN POWERHEADS - provide *proper* tip size, temperature, and capacity for *any soldering job* . . . big or small.
- PERMANENT-TYPE PLATED TIP - eliminates frequent tip changes.
- FAST HEATING - 8 seconds or less.
- LIGHTWEIGHT - no transformer.
- PISTOL GRIP - trigger operated.
- PORTABLE - for field or bench operation.

MODEL W-TCP-L

- CONTROLLED OUTPUT - provides proper temperature and capacity for any soldering job.
- EASY, QUICK CHANGE TIPS AND ACCESSORIES - maximum flexibility.
- ISOLATED LOW VOLTAGE SUPPLY - eliminates voltage damage to sensitive components.
- FAST RECOVERY - for maximum soldering efficiency.
- FLEXIBLE NON-BURNING CORD SET.
- IDEAL FOR BENCH OPERATION.

MODEL W-MCP

- SOLID STATE MINIATURE SIZED TOOL - for micro soldering and easy access to tight work areas.
- UNIQUE DESIGN - outperforms all other micro soldering tools.
- VARIETY OF INTERCHANGEABLE TIPS - micro sizes for miniature work.
- FIXED TEMPERATURE ELEMENT - assures proper tip temperature for the job.
- ISOLATED LOW VOLTAGE SUPPLY - eliminates voltage damage to sensitive components.
- FLEXIBLE NON-BURNING CORD SET.
- FOR BENCH OR FIELD OPERATIONS.

MODEL W-PS

- IDEAL FOR SIMPLE SERVICE SOLDERING.
- SMALL, HANDY (7-7/8" long) - easy to use and store.
- USEFUL IN CROWDED WORK AREAS.
- VARIETY OF EASY CHANGE WELLERCOTE TIPS - performs many soldering jobs, will not freeze, longer life.
- PORTABLE - for field or bench use.

"Send now for free Service Soldering Tool Selection Guide."

CONTACT THE DISTRIBUTOR, LISTED AT RIGHT, FOR ASSISTANCE IN THE SELECTION OF YOUR TOOLS AND ACCESSORIES.

Weller

INDUSTRIAL SOLDERING TOOLS

A DIVISION OF COOPER INDUSTRIES, INC.

100 WELLCO ROAD, EASTON, PA. 18042 • 215 • 258-5371

Circle 11 on literature card

13126 / 1M 770

PARTICIPATING WELLER DISTRIBUTORS

State	City	Distributor
AL	Opelika	Southern Elec. Corp.
	Tuscaloosa	Radio Parts Co.
AZ	Phoenix	Dalis Elec. Supply
AR	Little Rock	Carlton-Bates Co.
CA	El Monte	Claude Michael, Inc.
	Fresno	Dunlap Elec.
	Glendale	R. V. Weatherford Co.
	Inglewood	Newark Elec. Co., Inc.
	Los Angeles	Acme Industrial Supply Co.
	Los Angeles	Radio Products Sales, Inc.
	Palo Alto	Zack Elec.
	Sacramento	Dunlap Elec.
	San Diego	Claude Michael, Inc.
	San Francisco	Zack Elec.
	San Jose	Dunlap Elec.
	Santa Ana	Hurley Elec.
	Stockton	Dunlap Elec.
	Sunnyvale	Claude Michael, Inc.
CO	Denver	Electronic Parts Co.
CT	Waterbury	Bond Radio Elec., Inc.
DE	Wilmington	Radio Elec. Svc. Co., Inc.
FL	Miami	Elec. Equipment Co., Inc.
	Orlando	Hammond Elec.
GA	Atlanta	Jackson Elec.
	Atlanta	Specialty Dist. Co., Inc.
IL	Chicago	Allied Radio Corp.
	Chicago	EDI Elec. Dist., Inc.
	Chicago	Newark Elec. Corp.
	Harvey	The George Co.
	Peoria	Klaus Radio
	Rockford	J & M Elec., Inc.
IN	Indianapolis	Graham Elec. Supply Co.
	Indianapolis	RA-DIS-CO, Inc.
KY	Louisville	P. I. Burks & Co., Inc.
	Louisville	Peerless Elec. Equip. Co.
LA	Baton Rouge	Davis Whsle. Elec. Sup. Co.
	New Orleans	Columbia Radio & Sup. Co.
ME	Portland	DeMambro Radio Sup. Co., Inc.
MD	Baltimore	D & H Distributing Co.
	Bethesda	Empire Elec. Supply Co.
	Rockville	Pioneer-Standard
	Rockville	Capitol Radio Whslers., Inc.
MA	Boston	DeMambro Radio Sup. Co., Inc.
	Newton	Cramer Electronics, Inc.
	Worcester	DeMambro Radio Sup. Co.
MI	Adrian	Wedemeyer Elec. Sup. Co.
	Ann Arbor	Wedemeyer Elec. Sup. Co.
	Detroit	Radio Specialties Co.
	Jackson	Wedemeyer Elec. Sup. Co.
	Lansing	Wedemeyer Elec. Sup. Co.
	Oak Park	Newark-Detroit Elec., Inc.
MN	Saint Paul	Ragon Electronics, Inc.
MS	Jackson	Risher Radio Sup. Co., Inc.
MO	Kansas City	Beaver Drill & Tool Co.
	Kansas City	Burstein-Applebee Co.
	Saint Louis	Olive Industrial Elec., Inc.
NB	Lincoln	Scott Elec. Supply Corp.
NV	Reno	Dunlap Electronics
NH	Manchester	DeMambro Radio Sup. Co., Inc.
NJ	Hillside	Raysons Supply Co.
	Paterson	Roberts Tool & Supply Co.
	Saddle Brook	Thermotronics Co.
	Springfield	Federated Purchaser, Inc.
NM	Albuquerque	Electronic Parts Co.
NY	Bronx	Electronic Tool Co.
	Farmingdale, L.I.	Arrow Electronics, Inc.
	Farmingdale, L.I.	Harrison Radio Corp.
	Farmingdale, L.I.	Claude Michael, Inc.
	Long Island City	H. L. Dalis, Inc.
	New York City	Newark Elec. Center, Inc.
	Plainview, L.I.	Morris Abrams, Inc.
	White Plains	Westchester Elec., Inc.
	Yorkville	Valley Elec. Labs, Inc.
NC	Raleigh	S'east'n Radio Sup. Co., Inc.
OH	Cincinnati	United Radio, Inc.
	Cleveland	Pioneer-Standard
	Columbus	Hughes-Peters, Inc.
	Dayton	Pioneer-Standard
OK	Oklahoma City	Trice Wholesale Elec.
	Oklahoma City	Wholesale Elec. Supply, Inc.
	Tulsa	Trice Wholesale Elec.
OR	Portland	United Radio Supply, Inc.
PA	Allentown	A. A. Peters, Inc.
	Harrisburg	Pyttronic Industries, Inc.
	Philadelphia	Philadelphia Elec., Inc.
	Philadelphia	Radio Electric Svc. Co., Inc.
	Philadelphia	Simco Electronics, Inc.
	Pittsburgh	Cameradio Company
	Pittsburgh	RPC Electronics
	Reading	The Gec. D. Barbey Co., Inc.
	Scranton	Pursell Electronics Co.
	Warrington	U. S. Equipment
RI	Providence	DeMambro Radio Sup. Co., Inc.
SC	Columbia	Dixie Radio Supply Co., Inc.
TN	Knoxville	McClung Appliances
	Memphis	Elec. Comm. Whslers.
	Nashville	Electra Distributing Co.
TX	Austin	Hargis-Austin, Inc.
	Corpus Christi	Modern-Electrotex
	Dallas	Claude Michael, Inc.
	Dallas	Wholesale Elec. Supply Co.
	El Paso	Midland Specialty Co.
	Houston	Sterling Electronics Corp.
	San Antonio	Modern-Electrotex
UT	Salt Lake City	Standard Supply Co.
VA	Arlington	Arlington Elec. Whslers., Inc.
	Norfolk	Priest Electronics, Inc.
WA	Seattle	Seattle Tool & Sup. Co., Inc.
	Seattle	Western Electronics Co.
WV	Charleston	Mountain Elec.-Chemcity
WI	Madison	Satterfield Electronics

antenna systems report

Impedance Matcher

A new impedance matcher is now available from Avanti Research and Development, Inc.

Model AV-500 reportedly corrects a mismatch as high as 5:1. SWR can be tuned down to 1.1:1, to eliminate wasted power. A special "Pi" network is employed to make tuning easier and improve reliability, according to the manufacturer. Power handling is up to 500 watts, depending on coincident SWR.

To install the unit, the operator simply hooks up coaxial cable, and it is ready for use—no assembly is needed.

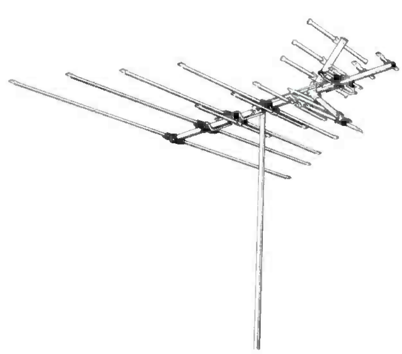
The impedance matcher sells for $15.95.

Circle 50 on literature card

New Antenna Line Announced

The Antenna Corporation of America has introduced a new line of antenna kits and accessories, which will be marketed under the name of Citation.

The UHF/VHF/FM antennas feature tetrapolse collector elements, dual-action director/reflector screens and die-cut impedance correlators.



Model AC-717, pictured here, features all-channel reception, with 13 VHF elements, 10 UHF elements, and 24 total active elements. It is equipped with a VHF/UHF band separator. Its boom length is 64 inches, and it has a turning radius of 63 inches.

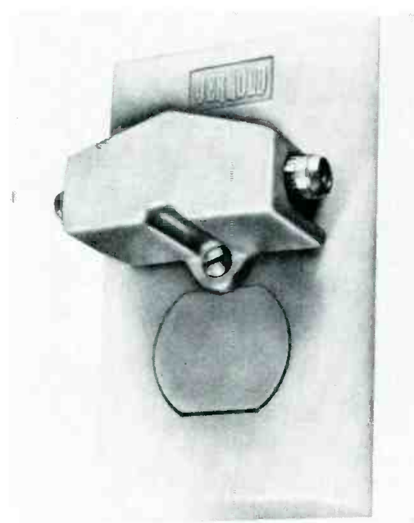
The list price is $29.95.

Circle 51 on literature card

All-Channel TV Splitters

A new type of all-channel signal splitter that connects two TV receivers to one ultra-tap (UT) is offered by Jerrold Electronics Corp.

The ultra-splitter, Model 1572G, plugs into a Jerrold outlet and then converts from a single outlet to a dual outlet. The unit is captivated by the same screw that holds a UT cover plate. The hybrid unit prevents interaction between receivers, mates with quickly connected "G" (gamma) fittings and is used for all-channel color TV, according to the manufacturer.



Splitting loss is 3.5 dB from 54 to 216 MHz and 3.8 dB from 470 to 890 MHz. List price is $9.25. ▲

Circle 52 on literature card

How to troubleshoot
"No High Voltage"

by Bruce Anderson **Part 2**

Servicing and circuit operation of solid-state high-voltage and deflection systems, including those employed in Motorola's Quasar and RCA's CTC40 color chassis.

In Part 1 of this series, the operation of the conventional horizontal-deflection and high-voltage system, which used vacuum tubes, was discussed. In this, the concluding article, various methods of utilizing solid-state devices to generate the horizontal yoke current and the high voltage will be discussed. Also, general troubleshooting techniques for those systems will be presented.

Since it makes little difference to the horizontal oscillator and AFC system whether it drives a vacuum tube or a solid-state output circuit, the discussion of these circuits in Part 1 is applicable to solid-state systems as well. The most important difference is that in most solid-state deflection systems loss of oscillator signal does not lead to the destruction of the output circuit. This is a decided advantage, since it makes repairs less costly; also, it allows greater ease of servicing, because the technician can make measurements at leisure, without the danger of further damaging the receiver.

At the present state of the art, there are two basic systems of horizontal deflection which use solid-state devices. One of these is the transistorized type of circuit; the second is a system which uses silicon-controlled rectifiers, SCR's. There are certain similarities between these two basic systems, and both are somewhat similar to the vacuum-tube deflection system. However, because of the differences which do exist between transistorized deflection and SCR deflection, their operation and the troubleshooting techniques for each will be treated separately.

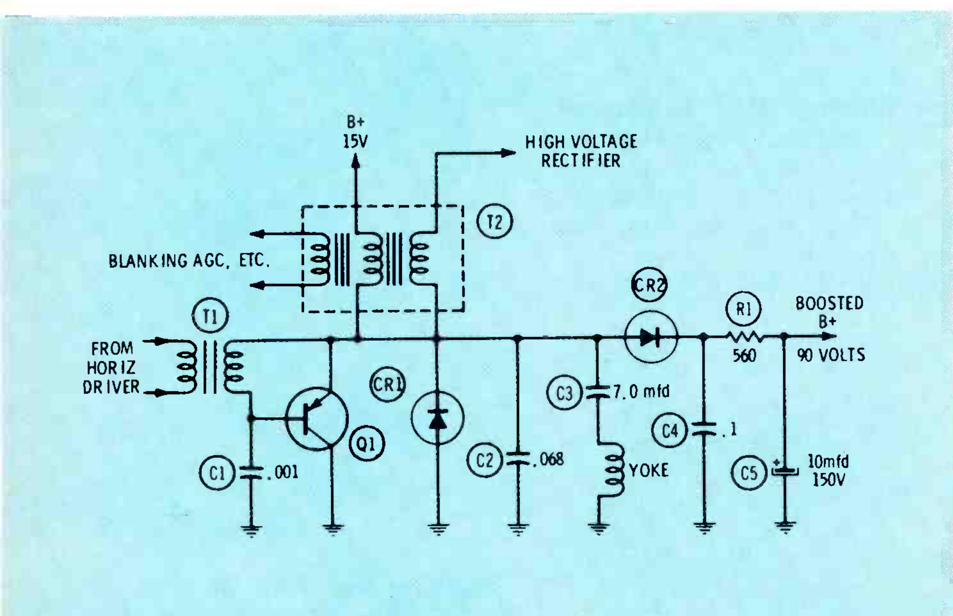


Fig. 1 Simplified solid-state deflection circuit for a black-and-white receiver.

Transistorized Deflection Systems

The circuit in Fig. 1 shows the essentials of a transistorized horizontal deflection system. Actually, only a few simplifications have been made to the complete circuit, which is used in the RCA KCS 157A chassis. In simplifying the schematic, two 3.5-mfd parallel-connected capacitors are shown as a single 7-mfd capacitor, C3; an auxiliary winding has been deleted from T2; and the two parallel-connected yoke windings are shown as a single coil.

Two important differences between the transistorized deflection circuit and the usual vacuum-tube circuit are immediately apparent. First, the damper diode, CR1 of Fig. 1, is returned to ground, instead of B+. The second difference is in the way the yoke and T2 are interconnected.

In a conventional deflection system, one of the important functions of the horizontal-output transformer is to match the high plate impedance of the yoke. In a transistorized system, this function is no longer necessary, because the impedance of the yoke can be made about equal to the output impedance of the horizontal-output transistor. An analogy can be found in audio-output circuits, where direct-coupled or capacitance-coupled outputs are common in transistorized systems.

Since the horizontal-output transformer is no longer a horizontal-output transformer, it should be called either the "high-voltage transformer", which is not completely true because it has other functions, or, preferably, the "flyback transformer". This perhaps is a minor point, but a lot of confusion about the purpose of the flyback transformer has arisen because of the misnomer.

Now that we have examined what the flyback transformer **does not** do, let's have a look at what it **does** do. Returning to Fig. 1, assume that there is no input to Q1. This will **not** cause anything to go up in smoke, as it would in a vacuum-tube circuit. After a short time, about 1 millisecond, the high sides of C2 and C3 will be charged to B+ through the primary of T2, and the system comes to rest. Diode CR1 cannot conduct because its cathode is positive with respect to ground, and Q1 is cut off because the emitter and base are at the same potential. There is some current flow through diode CR2, from the boosted B+ loads, but this is of no significance insofar as the operation of the circuit is concerned. Because there is no current flow in the yoke, horizontal scan is stationary at the center of the CRT.

Horizontal Scanning Action

Now, assume that Q1 is driven into conduction. C3 cannot discharge instantaneously, because its discharge current must flow through the yoke inductance. Accordingly, the current of C3 and the yoke increases until it is great enough to deflect the beam to the right side of the CRT. The current rise in an RLC circuit is approximately sinusoidal, but if the resistive element (the transistor) is progressively decreased by the drive pulse, yoke current can be made to increase linearly. When scan reaches the edge of the raster, a pulse from the horizontal oscillator and driver is coupled through T1, to cut off the output transistor, Q1.

With Q1 cut off, the former current path for C3 and the yoke is disrupted. If you have ever disconnected an inductance when there was a lot of current flowing through it, you should have a good idea of what happens next. The voltage at the emitter of Q1 rapidly increases from about zero to a high value (about +100 volts in this case), and this potential, less the supply voltage, appears across the primary of T2. This voltage is transformed to about 10.5 kv in the secondary of T2, and is rectified to produce the high voltage for the CRT. It also is rectified by diode CR2, producing the 90-volt boosted B+ voltage.

Now let's go back and see what has happened in the yoke circuit. After Q1 has been driven into cutoff, the only available path for the current of the yoke and C3 is through C2. Since the collapsing field of the yoke is the source of energy, the yoke can be considered to be a voltage source, with C3 and C2 acting as a capacitive voltage divider across it. Because the voltage across series capacitors is inversely proportional to their capacitances, the voltage across C2 is practically the same as the voltage generated by the yoke, which, of course, is the real reason for the retrace pulse that is generated at the emitter of Q1.

Remember, too, that the yoke is resonated by C2 and C3, so the current falls from its maximum value, when the beam is at the right edge of the screen, to zero, and then increases to about the same magnitude, but in the opposite direction, deflecting the beam to the left edge of the raster. In all, this requires about 10 to 14 microseconds, depending on the particular receiver.

At the time when current has reached maximum in the direction which deflects the beam to the left edge, the voltage across C2 (which always lags the current by 90 degrees) reverses polarity, going from positive to negative. This allows diode CR1 to begin conduction, effectively shorting out C2. The current through C3 and the yoke now flows through diode CR1, and decreases at approximately a linear rate, reaching zero in about 25 microseconds. This allows the beam to reach the center of the raster once more. The direction of travel is from left to right.

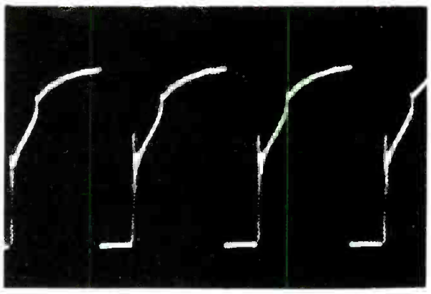


Fig. 2 Drive pulse for the horizontal-output transistor.

Without going any deeper into the operation of an LC circuit, let it suffice to state that when the current through the yoke and C3 reaches zero, it must reverse if a current path is available. Because diode CR1 is reverse biased at this time, and current flows in the opposite direction through it, a positive voltage begins to appear at the cathode of CR1 and the emitter of Q1. The horizontal oscillator output fed to the primary of T1 (see Fig. 2) is inverted in the transformer and is used to bring Q1 into conduction at this time. Thus, the same conditions exist as were assumed at the beginning of the discussion. The entire process is repeated indefinitely. Fig. 3 summarizes the sequence of events just described.

Troubleshooting

With this insight into the operation of the deflection system, it is possible to develop some reasonable troubleshooting procedures.

First, it should be determined whether or not a heavy overload on the power supply exists. If it does, the circuit breaker will trip each time the receiver is turned on. Not all cases of circuit-breaker tripping are the result of failures in the high-voltage system, of course, so the first step is to locate the general area of the short circuit. Disconnect the B+ lead from the flyback transformer, and if this clears the short, the trouble is in the horizontal deflection and high-voltage system.

Three spots are likely sources of a short circuit. These are the output transistor, Q1 and the two diodes, CR1 and CR2. To avoid the possibility of inaccurate results, it is a good practice to disconnect each of these before individually checking them with an ohmmeter.

The resistance from emitter to collector of the transistor should be several thousand ohms, regardless of meter polarity, and the resistance to either other element should be high when the positive meter lead is connected to the base.

The diodes should indicate a very high resistance when the positive meter lead is connected to the cathode and the negative lead is connected to the anode. With the meter connected in the opposite direction, the resistance will be only a few ohms.

Chances are that one of the three solid-state devices is shorted, but if they are good, one of the other components which provides DC blocking between B+ and ground must be at fault. These are C1, C2, C3 (which in an actual circuit might be two parallel-connected capacitors) and C4. Notice that C4 can short the supply voltage through diode CR2, and remember that a short in this capacitor can cause diode CR2 to fail. Therefore, if CR2 is shorted, check C4 before turning on the receiver after replacing the diode.

It is possible that either T1 or T2 is shorted to its core and thence to ground, but this is not very likely. Consequently, these should be checked last.

As will be discussed shortly, there are a lot of remaining components in the system which, if overloaded or shorted, will drastically reduce the high voltage but will not trip the circuit breaker. Before looking in that direction, however, it is good practice to make certain that the horizontal output stage has proper excitation. In a vacuum-tube system, loss of drive to the horizontal-output stage is rather spectacular (either the tube melts or the circuit breaker trips), but in solid-state circuits the only symptom is loss of high voltage. About the only way to check for drive is to use a scope, because there is no equivalent grid-leak bias developed in a solid-state output circuit. A horizontal oscillator which is operating far off-frequency might kill the high voltage, just as it will in a vacuum-tube circuit. This possibility was discussed in Part 1 and need not be elaborated on here.

Shorts in any of the components named above almost certainly will cause the circuit breaker to trip. If there is no high voltage, and the circuit breaker does not trip, it is still possible that a short exists, but this time it must be looked for further from the power supply. Good possibilities are C5 in Fig. 1, the high-voltage rectifier or any of the loads supplied from the boosted B+ supply.

The high-voltage rectifier often is a solid-state device, but don't assume that it can be checked with an ohmmeter. Actually, it consists of hundreds of diode chips in series, and the accumulated barrier voltages of all of them will exceed the battery voltage of an ohmmeter. Of course, if the ohmmeter indicates that the rectifier is shorted, it is bad.

The loads of the boosted B+ supply can be isolated by disconnecting all of them and then reconnecting them one by one. This is probably a surer method than trying to make ohmmeter checks, because the load resistances are generally not included in service literature, and also because a capacitor which breaks down only at or near rated voltage might be missed if an ohmmeter is used for testing.

Also to be checked are the various loads on the auxiliary windings of the flyback transformer. The easiest method is simply to disconnect all of them and see if high voltage is restored. If it is, start isolating by reconnecting them one at a time.

If all other possibilities have been exhausted, it is time to have a look at the yoke and the flyback transformer. An ohmmeter will suffice to check them for continuity, but it is of practically no value in locating a shorted turn, the usual trouble. A ringing test, as described in Part 1, is a reasonably good check; substitution is more certain, but more time consuming.

A flyback transformer can be checked with a drive pulse, if the proper test equipment is available. A check which some technicians use is to excite the primary from the audio oscillator operating at about 15.75 KHz. The step-up ratio of the flyback transformer can be estimated if the normal flyback pulse voltage (seen at the emitter of the output transistor) and the output of the high-voltage rectifier are known. By measuring the amount of test-signal input and also the amount of output from the high-voltage winding, it can be determined whether or not the step-up ratio of the transformer is normal. Don't try to be too exacting when calculating the ratio, if the transformer is bad, because there probably will be little or no output.

Quasar Horizontal Sweep Operation

Because the Motorola concept of servicing is to replace the module, exhaustive discussion of the troubleshooting techniques has little practical value, but the circuit does demonstrate a different way of utilizing transistors for generation of deflection and high voltage.

Fig. 4 is a simplification of the horizontal deflection circuit of the early Motorola Quasar chassis. Although its basic operation is the same as the circuit in Fig. 1, the differences are worth noting: Two output transistors are connected in parallel; this lowers the impedance and provides the additional current required for a color receiver. The transistors are NPN types instead of PNP; consequently, the emitters are grounded instead of the collectors, and conduction still takes place during the last half of the scan. There is no boosted B+ takeoff from the system, although diode CR2 is connected at the same point as diode CR2 in Fig. 1—in this circuit, it serves only to limit the positive swing of the flyback pulse, protecting the transistors from overvoltage.

An interesting feature of the circuit is the beam-centering system. Because the primary of T3 is

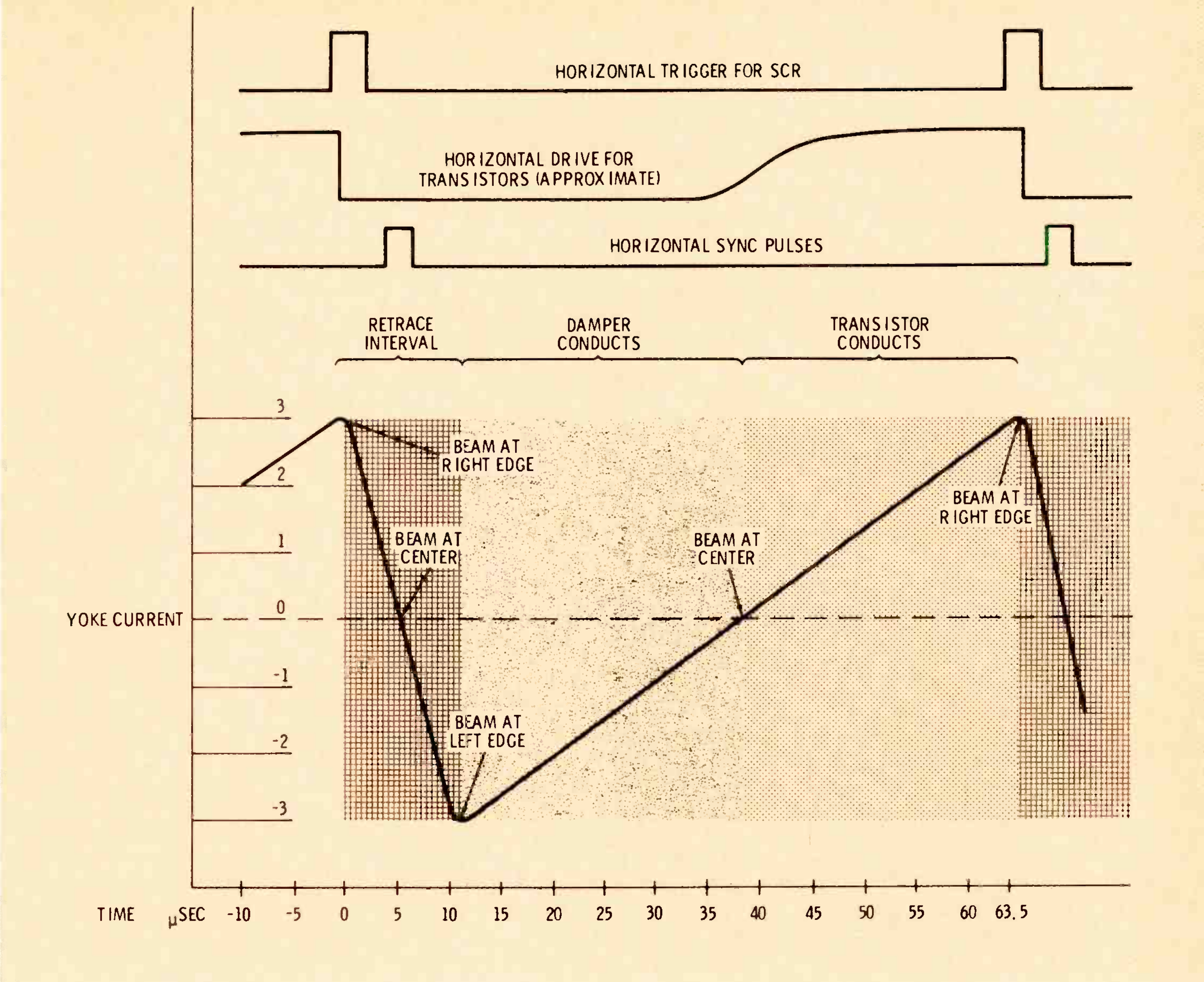


Fig. 3 Diagram showing sequence of action and related times in horizontal-deflection circuits.

connected across the yoke, the waveform of the current through it is similar to the yoke current, although it has less amplitude. The secondary of T3 and diodes CR3 and CR4 comprise a pair of half-wave rectifiers, with outputs of opposite polarities. Depending on the setting of the centering potentiometer, either a positive or a negative voltage is applied to the lower end of the yoke. Thus, a small bias current is produced in the yoke, to shift the entire raster either to the right or the left.

Troubleshooting

From the servicing standpoint, there is little difference between the circuit in Fig. 4 and the one in Fig. 1. There are, of course, two output transistors to be checked, but only one damper diode, CR1.

Problems can arise in the centering system which might cause the raster to shift off center, or a short might develop which would load the system to the point where there would be no deflection or high voltage.

SCR Deflection

Operation

RCA introduced a different type of deflection and high-voltage system in the CTC40 chassis. A simplified schematic of this circuit is shown in Fig. 5.

A convenient place to begin the explanation of this circuit is at a point in time about 5 microseconds before horizontal retrace begins. (This is the "–5" point in Fig. 3.) At this time, current is near maximum in the yoke and C3, and this current is flowing through silicon-controlled rectifier SCR2, which has been gated on by means which will be explained later in this article. Also, C1 and C2 have reached approximately their maximum charge from the power supply, and both SCR1 and CR1 are cut off. The trace now is near the **right edge** of the raster.

When SCR1 is triggered, it begins conducting, allowing C1 to discharge through the yoke, and cutting off SCR2 in the process. The resonant frequency of C1, the yoke and C3 is such that the current decays to zero in about 6 microseconds and then attempts to reverse. At this time the beam has returned to the **center** of the screen

Because SCR1 cannot conduct in the reverse direction, it cuts off. But current can flow through CR1, and so it conducts while retrace swings from the center to the **left edge** of the raster.

During the retrace interval, the yoke and C3 are operating at several times their natural resonant frequency; consequently, the inductive reactance is much greater than the capacitive reactance. Accordingly, the voltage drop across the yoke exceeds the drop across C3 by about 400 volts; this voltage is impressed across the primary of the flyback transformer, T3, and is stepped up to about 26.5 kv for application to the high-voltage rectifier.

Because the voltage across the yoke is 90 degrees out of phase with the yoke current, the voltage drops to zero at the end of the retrace time and reverses polarity. This brings diode CR2 into conduction, providing a circuit for the current in the yoke and C3, which decreases at a linear rate rather than sinusoidal, because of the linearity circuit. The conduction of CR2 also isolates the yoke from SCR1 and CR1.

During the **first half** of trace time, conduction is through the yoke, C3 and CR2, with the current gradually decaying to zero. At the **midpoint** of scan, the current reverses and flows through SCR2 instead of CR2. Conduction of SCR2 is made possible by a positive gate voltage from the secondary of T1. During scanning time, charging current for C1 and C2 flows through T1 and T2 toward B+, and this produces a positive output from the secondary of T1. (A pulse-shaping network between the secondary of T1 and the gate of SCR2 was deleted from the schematic, for simplicity.)

The charging circuit for C1 and C2 is resonant at a frequency which causes the voltage at the high side of these capacitors to reach the positive crest of a sine-wave segment about 45 microseconds after the end of retrace (at about the 55-microsecond point in Fig. 3). This crest voltage is about 300 volts, but it begins to decrease and reaches some lower potential by the time the next retrace cycle starts. The precise resonant frequency is determined by the amount of inductance of the saturable reactor, T2. If the inductance of T2 is made to increase, the resonant frequency of the charging circuit decreases, and the voltage on C1 and C2 reaches the crest value at a later time, perhaps at the 60-microsecond point in Fig. 3. Therefore, the voltage on C1 and C2 also will be increased at the start of retrace, and more voltage will be available to operate the deflection system. Conversely, a decrease in the inductance of T2 will produce an opposite effect.

The actual inductance of T2 is controlled by the collector current of Q1, the high-voltage regulator. When collector current increases, the core of T2 becomes more saturated, the inductance decreases, and the high voltage ultimately is lowered. The collector current of Q1 is proportional to the high voltage actually generated during the last retrace interval, because the voltage at the junction of C3 and the yoke regulates the high voltage. High voltage adjustment is provided by the potentiomentor and voltage divider between C3 and ground.

The flyback transformer has several windings on it besides the one shown in the simplified schematic in Fig. 5. The additional windings and taps provide filament power for the high-voltage rectifier, power for the focus and screen supply rectifiers, and control pulses for retrace blanking, AGC keying, burst gating, horizontal AFC and chroma blanking functions.

Troubleshooting

The servicing approach to RCA's SCR system is actually very similar to the service approach to a transistorized deflection and high-voltage system. Although there are more components in the SCR circuit, it is somewhat simpler to isolate component defects in it, so one system is about as easy to service as the other.

One common trouble symptom is power-supply overload accompanied by repeated tripping of the circuit breaker. This can be caused by a

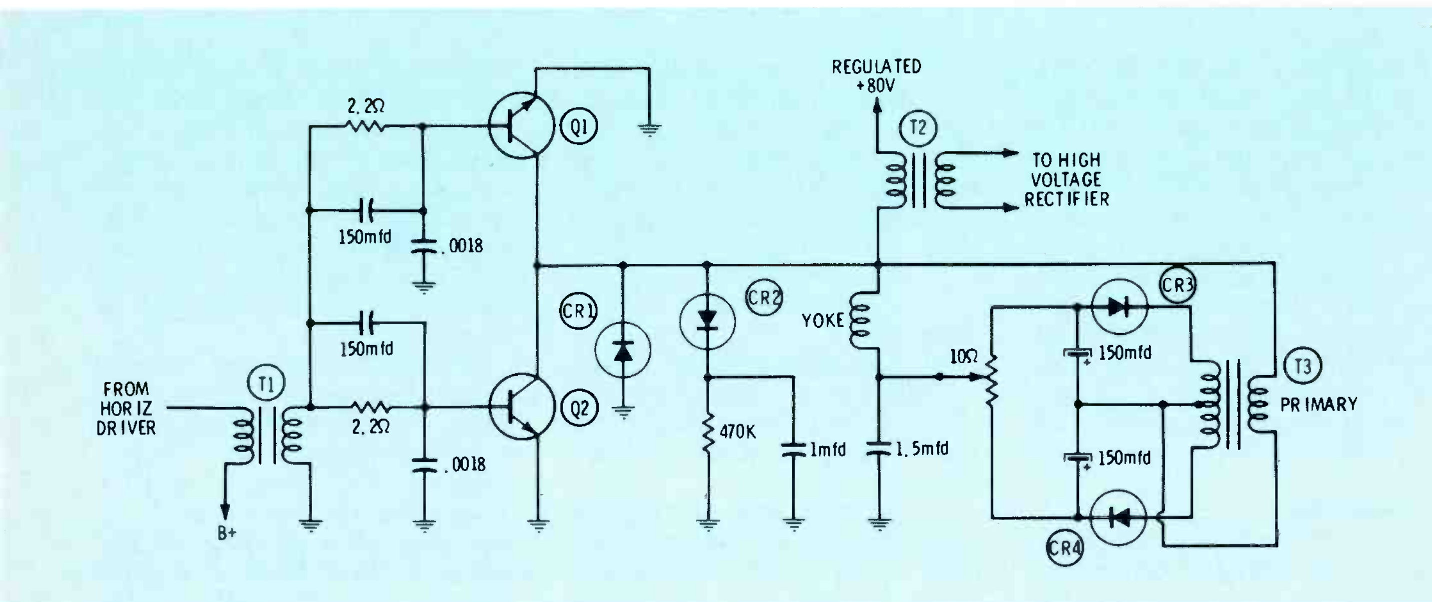
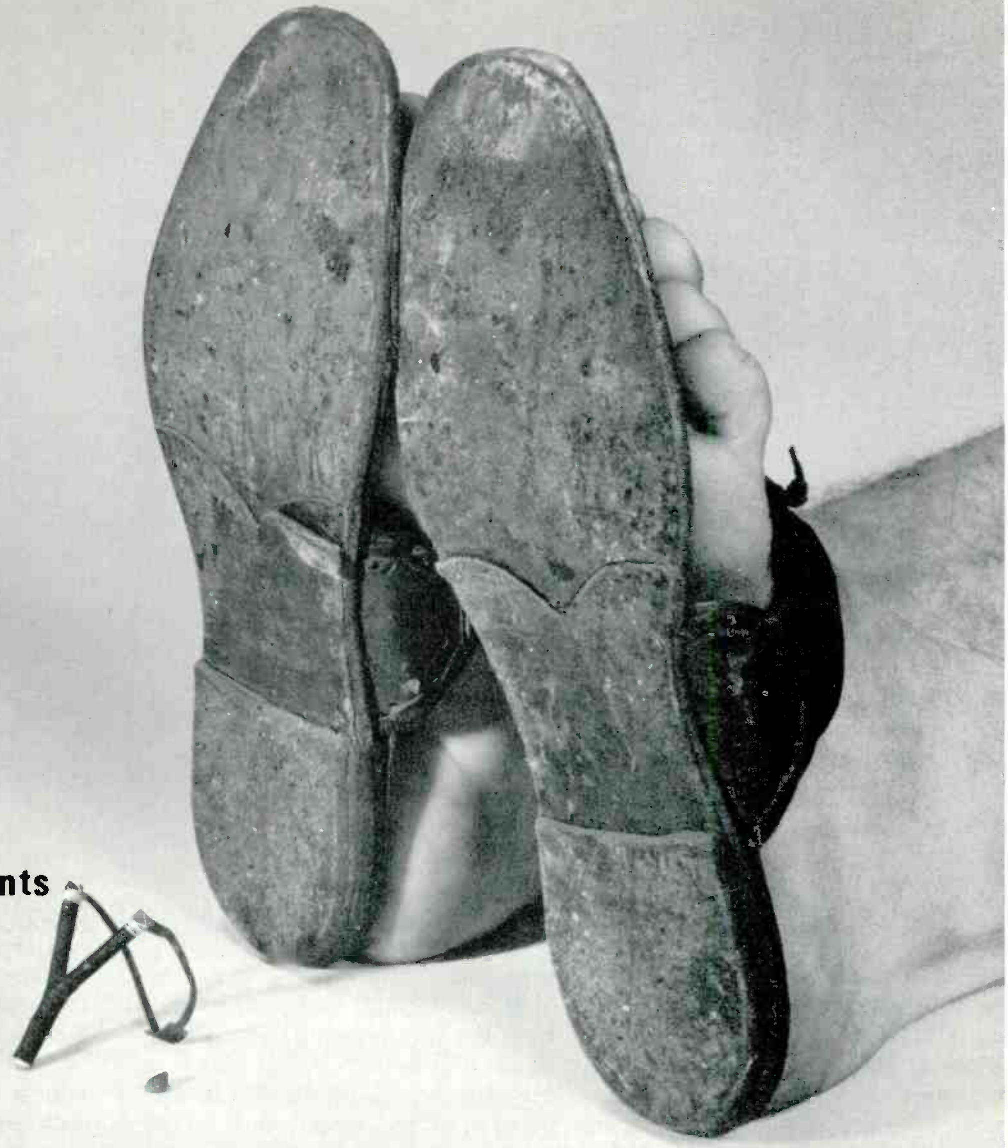


Fig. 4 Simplified solid-state deflection circuit for a color receiver, such as that employed in Motorola Quasar models.

Beat the giants



In spite of all the TV service giants there's still plenty of room for the independent service dealer...thanks to the Opti-Vue Color CRT with full three year warranty!

Opti-Vue not only gives your customer 1971-style color that's as good as anything the big guys have, but guarantees him up to 3 times his money's worth.

If he's thinking of junking his set he may think again when he hears about the three year deal. Then you've locked up his business whenever any other part of his set needs work.

That's how you can beat the giants...or become one!

OPTI-VUE Color and Black & White CRT's...with the 3 year warranty

CHANNEL MASTER

DIV. OF AVNET INC., ELLENVILLE, N.Y. 12428

Circle 12 on literature card

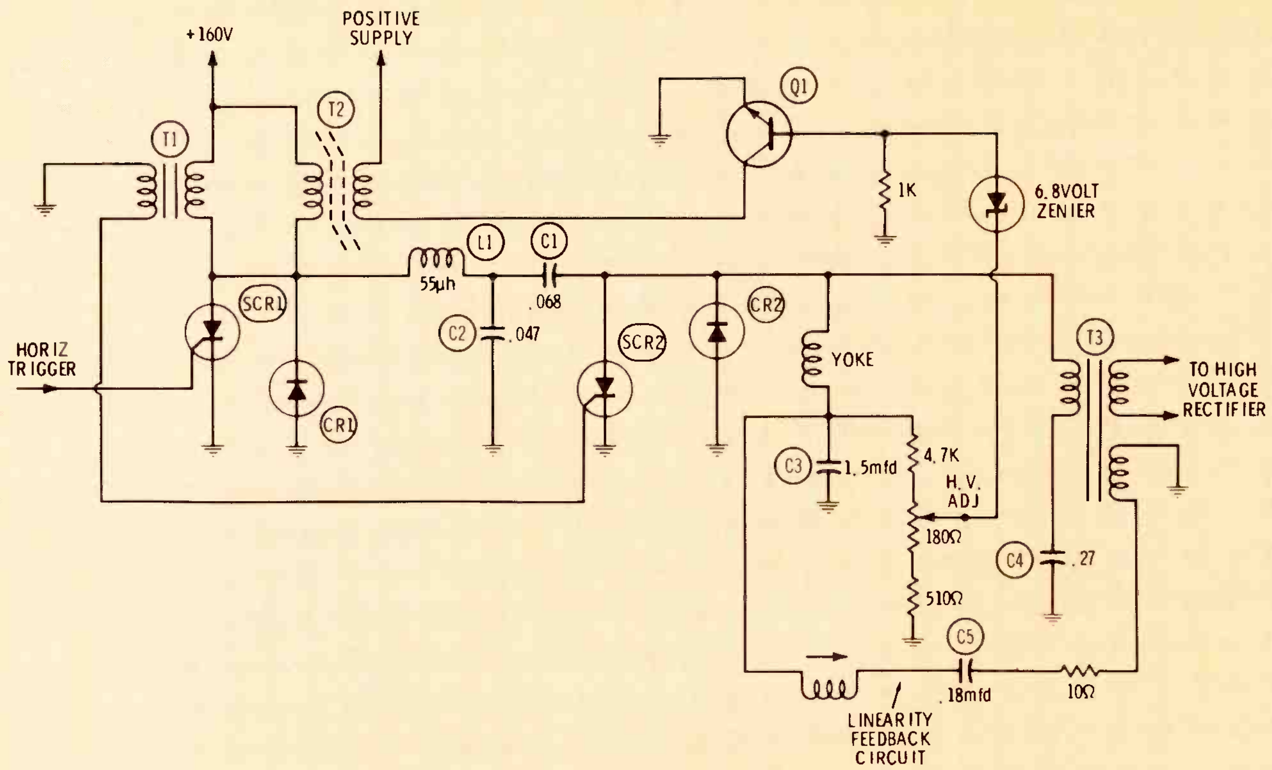


Fig. 5 Simplified deflection circuit for color receivers using SCR's, such as RCA CTC40 chassis.

number of shorted components elsewhere in the receiver, so the first step is to be sure that the **deflection system** is the actual trouble spot. One easy way to do this is to disconnect the power input to T1 and T2 and see if the short is eliminated. Because deflection power is interlocked through the yoke connector, this check can be performed from the top of the chassis by unplugging the yoke.

If the deflection system is shorting, or overloading, the power supply, either there is a DC short, or else there is severe AC overload of the deflection circuits. To determine which is the case, connect a jumper from the anode of SCR2 (Fig. 5) to ground. With the jumper in place, it is impossible for any yoke current to flow or for any energy to enter the flyback circuit. Then, if the power supply still is overloaded, the cause must be a DC short. Two likely prospects are SCR1 and CR1. Other possibilities are C1 and C2, as well as a couple of small filter capacitors which are in the circuit but are not shown in Fig. 5. Of course, the short could be located in L1, T1 or T2, but this is not very probable.

If connecting the jumper does clear the power-supply overload, the cause of trouble can be either an unstable or off-frequency trigger pulse to SCR1, a dead short on one of the outputs of the flyback transformer, a gassy 3CZ3, or a short in the transformer itself. The input trigger waveshape should be checked against the waveform shown in the service data, and also for correct frequency, as outlined in Part 1 of this series. Since this procedure is simpler than checking the flyback and its loads, it should be done first.

To check the loads on the flyback, first examine the circuitry for signs of arcs and overheating. There is a lot of voltage present in some of these circuits, as well as a lot of available power, and often a little "eyeballing" will save a lot of time. Next, disconnect the various loads from the flyback and check them for shorts. Some likely troubles are a shorted screen rectifier or a shorted focus rectifier.

If there is no high voltage and the circuit breaker does not trip, the high-voltage rectifier tube is the first thing to check. (This is not absolute, because the breaker **will** trip when the rectifier shorts.) If it is good, look for a shorted component such as SCR2 or CR2, or any other component which is roughly in parallel with them. (There are several, which are not shown in Fig. 5.) Remember, the resistance from cathode to anode of an SCR should be high, regardless of the polarity of the ohmmeter.

The high voltage of the CTC40 should be adjusted for 26.56 kv with the brightness at minimum. If this is not possible, it is probable that the regulator circuit is defective. A quick way is to disconnect T2 from the collector of Q1 and measure the high voltage. Because this will allow the high voltage to increase to about 30 kv if the deflection system is normal and line voltage is 120 volts, it is a good idea to reduce the line voltage to about 100 volts before making this test. Then gradually increase the line voltage while monitoring the high voltage.

If the high voltage does reach 26.5 kv before the line voltage is increased to about 105 volts, it is safe to assume that the deflection system is good and that the regulator is defective. Check the transistor, the zener diode and the voltage divider network in which the adjusting potentiometer is located. If the system will not develop rated high voltage when the regulator is disconnected, look for an off-tolerance capacitor in the deflection system. The four that are most likely to be causing the trouble are C1, C2, C3 and C4 in Fig. 5, although there are some others in the actual circuit.

Solid-State Rectifiers

Solid-state high-voltage rectifiers have been used for several years in black-and-white receivers, and now they are being used in color receivers as well.

The Motorola solid-state rectifier simply rectifies the high-voltage flyback pulse in about the same manner, and using about the same circuit configuration, as the familiar vacuum-tube circuit.

In the RCA system, a solid-state voltage quadrupler is used. The advantage is that the flyback needs to produce only about one-fourth as much voltage as before; but on the other hand, the quadrupler is larger and more expensive than the Motorola rectifier. Neither rectifier is repairable, of course, and substitution is the best method of checking them.

Summary

With the present state of the art, the only method found practical for generating high voltage is to rectify the retrace pulse from the horizontal-deflection system. (The Sony Trinitron is an exception, but that is another story.) Because of this, the general rule is, "Fix the horizontal deflection, and the high voltage will take care of itself." There are instances where high voltage fails without an accompanying loss of deflection (faulty high-voltage rectifiers and shunt regulators), but these are the easy ones that cause very little servicing difficulty.

Vacuum-tube deflection systems are relatively well standardized, so the servicing approach is always about the same. Check the drive to the horizontal-output stage; check the cathode and grid circuits of the output stage; check the loads on the horizontal-output transformer; and check the output transformer.

The most common solid-state deflection system uses a transistor instead of a tube as the horizontal-output device. This allows the circuits to be modified so that the damper returns to ground instead of to B+. Also, because the output impedance of the transistor is lower than the output impedance of a tube, the "output" transformer serves to generate high voltage and auxiliary pulses, and the yoke is capacitively coupled directly to the output transister.

Because high levels of self-bias are not required for the operation of a transistorized deflection circuit, loss of drive does not normally destroy the output stage. This is a decided advantage insofar as reliability is concerned, but it makes it necessary to use a scope to check drive. The transistor drive waveform is similar to the vacuum-tube grid waveform, except that once the transistor goes into conduction, there is very little additional increase in drive voltage.

The general approach to troubleshooting "no high voltage" is to determine whether the symptoms indicate a short of the power supply, an overload of the deflection circuit, or a functional failure without overloads.

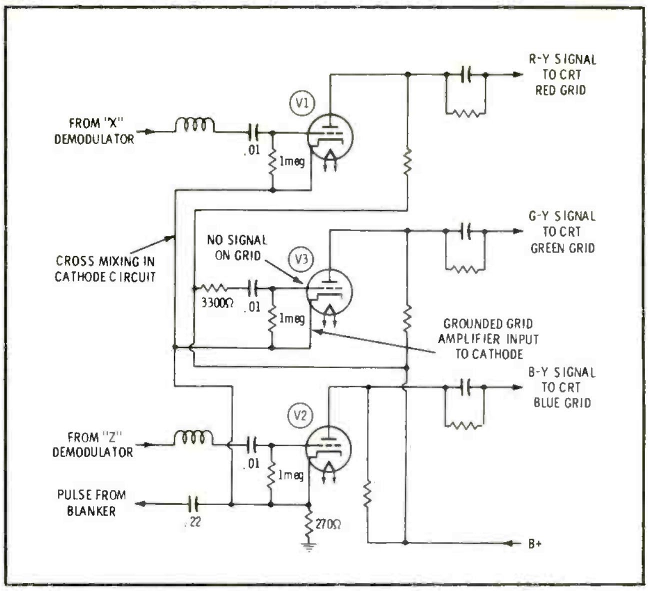
Power-supply shorts generally are the result of a shorted transistor, damper, or boosted B+ rectifier, or a shorted capacitor directly connected across one of these devices.

Deflection-circuit overloads usually can be traced to a short in some circuit connected to the boosted B+ supply, a short in some circuit connected to one of the auxiliary windings of the flyback transformer, or to shorted turns in the transformer or the yoke.

An open transistor or damper is a good possibility if there is no high voltage and no evidence of overload.

The deflection system using SCR's has some essential differences from transistor circuits, but the troubleshooting techniques are very similar. Because of its design, it is a simple matter to distinguish between power-supply shorts and overloads on the output of the deflection circuit, and this compensates for the additional complexity of the system. ▲

troubleshooter



Chroma Demodulation

I don't fully understand the difference between "X", "Z", R-Y, B-Y, "I" and "Q" demodulation, and would appreciate an explanation.

Harry Hershkowitz
Brooklyn, N. Y.

Without any matrixing, the outputs of R-Y and B-Y high-level demodulators are ready to be applied to the picture tube. Low-level demodulators need amplification, but without matrixing. The output signals from "X" and "Z" demodulators must be matrixed, or mixed together in the right proportion, to change them the slight amount necessary so they become R-Y and B-Y.

Theory calls for the 3.58-MHz color carriers supplied to the R-Y and B-Y demodulators to differ by 90 degrees in phase. "X" and "Z" demodulators are only about 75 degrees different in phase. "I" and "Q" demodulators are obsolete since they have not been used in color receivers since 1955, and therefore will not be discussed here.

The accompanying schematic should help to clarify one method of matrixing. Remember that the input to V1 and V2 is "X" and "Z", but the output is R-Y and B-Y. V1 and V2 share an unbypassed cathode resistor, where the two signals are mixed into −(R-Y + B-Y), which is +(G-Y). This small G-Y signal is applied to the cathode of V3, and it appears amplified but not phase-inverted at the plate, which is both AC- and DC-coupled to the green grid of the CRT. The common cathode resistor also injects some −(B-Y) into the R-Y cathode and −(R-Y) into the B-Y cathode to accomplish matrixing.

Don't confuse this matrixing of two chroma signals with the pre-CRT matrixing of the b-w video and the chroma signals, as the latter circuit is used in new transistorized receivers to eliminate the video output power amplifier.

Repeated Failure of High-Voltage Rectifier

We are servicing a Motorola TS914 color TV chassis, which is covered in PHOTOFACT folder 798-2. There is no raster, although the high voltage and low voltages are okay.

When I install a new 3AT2 high-voltage rectifier tube, it is nearly dead when I recheck it after about 10 minutes of operation. Can you tell us what is wrong?

Arthur R. Miller
Lafayette, Ind.

An extreme overload of filament voltage or plate current is necessary to ruin a 3AT2 in such a short time. There seems to be a contradiction of symptoms here, for you stated that the high voltage was okay.

Was the high voltage actually measured, or merely estimated using an arc? The arc test can be very deceptive because the high voltage can be AC, which will not permit a raster, yet will produce a large arc.

Did you check the 3AT2 tube before installation? Some tube testers indicate all high-voltage, low-current rectifiers as weak.

The TS914 varies the horizontal output tube grid bias to regulate the sweep and high voltage, and no high-voltage regulator tube is used. Any excessive current that might damage the rectifier must be CRT current, yet that seems unlikely because there is no raster. Also remember that loss of focus voltage will prevent a visible raster.

I suggest that you measure the high voltage with a DC probe while the base socket of the CRT is removed. Any large increases in high voltage as the socket is removed would indicate excessive CRT current; if this is the case, the other DC voltages on the CRT should be checked to find the reason. ▲

"Take it from me, there are lots of 'ups and downs' in the TV repair business!"

shoptalk

With Carl Babcoke
ES Technical Editor

Testing sweep transformers

Two bench-proven methods, including the advantages and disadvantages of both

Transformer and Inductor Tests

"Is the yoke or high-voltage transformer defective?" This difficult question confronts all technicians after preliminary tests for "no high voltage" have proven ineffective. Use of ohmmeters and flyback testers, educated guessing, "shotgun" parts replacements and other test methods have been tried with varying degrees of success.

"Ringing" tests have been extolled as the ultimate method for locating shorted turns in inductances. In the following paragraphs we will compare the ringing method and its results with a simple way of measuring the actual impedance of coils and transformers.

Ringing Tests

Ringing is the production of a damped wave train when a pulse is applied to a tuned circuit, as shown in Fig. 1. The higher the efficiency ("Q") of the tuned circuit, the longer the ringing persists. Shorted turns in the inductance will greatly lower the "Q" and shorten the ringing time. (I keep emphasizing "tuned circuit" because some other articles and books about this subject have mentioned only the "Q" of the inductance; a pure inductance without capacitance (even stray capacitance) will **NOT** ring.)

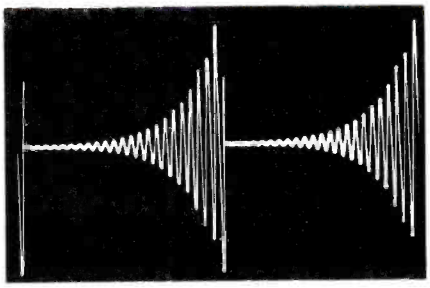


Fig. 1 Ringing of a pulse from one scope can be viewed on another.

A capacitor should always be used between the source of the pulse and the inductance to reduce the loading of the inductance by the source and the loading of the source by the inductance, and also to remove any DC voltage which might be present at the source take-off point. An inductance connected in the circuit might have a capacitor wired across it to form a parallel-tuned circuit. In that case, the capacitor in series with the source of the pulse from the test equipment functions as a coupling capacitor. Out of circuit, or if the inductance is not tuned otherwise, such as a yoke, the capacitor in series with the pulse source becomes the capacitance of a series-tuned circuit. Under these conditions, the size of the capacitor is critical. When checking components in horizontal circuits, I find best results are obtained by using a capacitor of approximately 56 pf, and then varying the pulse frequency to produce the standard ringing pattern.

Because a scope is used to view the ringing waveforms, and no other test equipment is needed, the ideal source of a pulse is the scope itself. If the pulse is supplied by the horizontal sweep of the scope, synchronization is automatic, without locking adjustments. Most scopes can produce a suitable pulse, or at least a sawtooth which can be differentiated into a pulse by the small coupling capacitor. There is one precaution: The pulse **cannot** be seen on the screen of the scope from which it is obtained because it occurs during the retrace time. Borrow a friend's scope, if necessary, to find a suitable pulse. The pulse should have a high amplitude and narrow waveform, for the best results. Either a positive or a negative polarity pulse is satisfactory.

Fig. 2 shows the circuit, the chassis location of the point to obtain the pulse and the waveform of the pulse from an Eico Model 465 scope. Fig. 3 shows the same for the RCA Model W0505A solid-state scope.

You will find it more convenient if you bring the pulse out to the front panel of the scope, where it always will be ready for instant use. One important precaution: Do **not** route the additional wiring or use a binding post near the vertical circuit wiring or input connector. This might cause waveform distortion when the normal functions of the scope are used. Some scopes have an additional ground post near the external horizontal input that can be insulated, disconnected from ground and used for the pulse output. Always re-label such panel changes.

and yokes

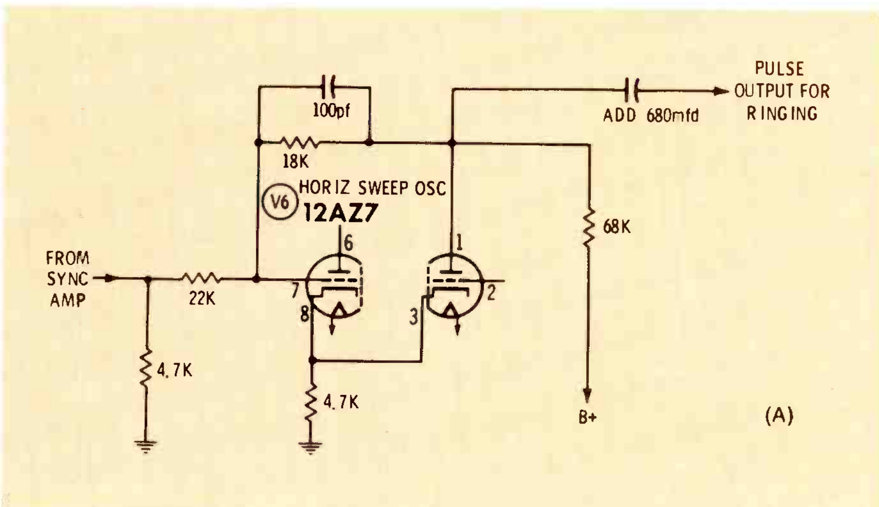
Using the modified scope to perform a ringing test is very simple. Fig. 4 shows the connections for yokes or transformers that are tested out of circuit.

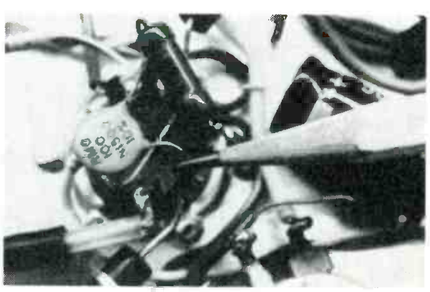
For an in-circuit test of a yoke or high-voltage transformer, such as those shown in the schematic of Fig. 5, just make certain the AC power to the receiver is off, connect the equipment ground to the set ground, and attach both the pulse wire with the 56-pf capacitor and the regular low-capacitance scope probe to the plate cap of the horizontal output tube.

The frequency selected by the horizontal sweep range switch and vernier control of the scope is very important. Fig. 6A shows the **compressed** display caused by a frequency of about 300 Hz. Fig. 6B shows the **expansion** effect of a frequency of about 9000 Hz. Neither display is an accurate indication of the condition of the component being tested.

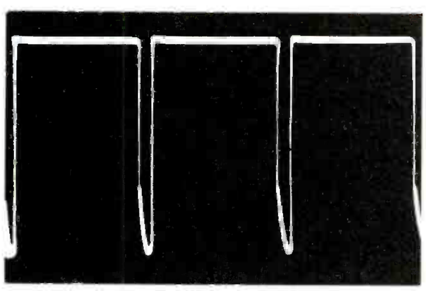
A pulse repetition frequency between 2000 Hz and 3000 Hz seems to be best for ringing high-voltage transformers, yokes, linearity coils, width coils, focus coils and horizontal oscillator coils. After you obtain a ringing waveform, properly adjust the scope height, then vary the horizontal frequency with the vernier control until the correct ringing waveform is obtained using a "standard" or known-good component. Without changing the scope controls, connect the suspected component and compare the waveform with that obtained from the "standard" part.

Fig. 7A shows the normal ringing of the circuit in Fig. 5. If this overall test rings as it should, there is no need to disconnect and separately test the yoke and high-voltage transformer. A shorted, two-turn loop around the high-voltage transformer core reduced the ring-





(B)



(C)

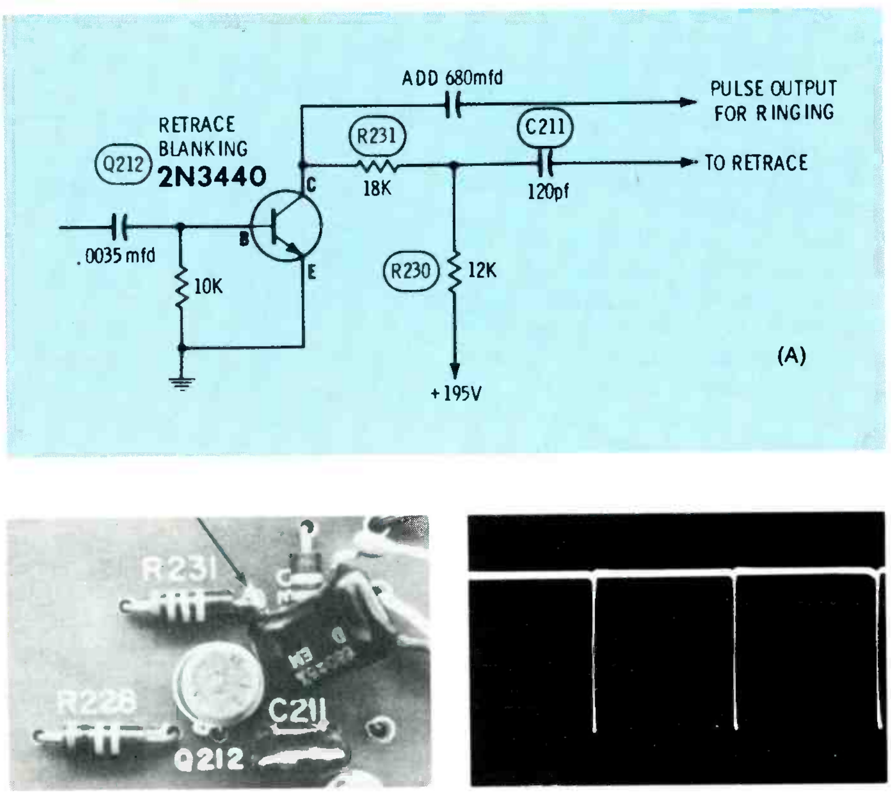
Fig. 2 Modification of an Eico Model 465 scope to obtain a ringing pulse. (A) Partial schematic of the horizontal sweep oscillator. (B) The pencil points to pin #1; add the 680-pf capacitor at this point. (C) Negative-going waveform of about 300 Hz.

ing to that shown in Fig. 7B, while a 15K short from the plate of the high-voltage rectifier to ground produced the drastically reduced ringing waveform shown in Fig. 7C.

Horizontal oscillator or sine-wave coils can be checked the same way, except that they should be removed from the chassis during the test. Fig. 8A shows the ringing waveform of a blocked-grid type of horizontal oscillator coil tested out-of-circuit. Fig. 8B is the same coil with a 56K-ohm resistor in parallel. An identical waveform is obtained without the 56K-ohm resistor, if two turns of insulated wire are wound around the coil and the ends shorted together.

Under ideal conditions, a ringing test is sensitive enough to indicate even just one shorted turn in the primary winding of a high-voltage transformer. But insurmountable difficulties are hidden in the word "ideal". If a technician always has an exact yoke or transformer that could be instantly compared (perhaps with a selector switch) with the one under suspicion, and if all the transformers had precisely the same air gap in the core, then such accuracy could be obtained.

In practice, it is not that easy. For example, the "bad" waveform in Fig. 7C, which represents many shorted turns in the high-voltage transformer, can be easily changed into the "good" waveform in Fig. 8A by a very slight adjustment of the horizontal frequency vernier control of the scope. Recording the knob settings on tape stuck to the panel of the scope helps, but not enough. A scope's sweep is designed to be locked by manual adjustment,



(B) (C)

Fig. 3 Modification of an RCA W0505A scope to obtain a ringing pulse. (A) Schematic of the retrace blanking transistor circuit. (B) The arrow points to R231, where the 680-pf capacitor should be added. (C) Negative-going waveform of about 2500 Hz.

You can earn more money if you get a Government FCC License

...and here's our famous CIE Warranty that you will get your License if you study with us at home

Cleveland Institute of Electronics

WARRANTY

OF SUCCESS IN OBTAINING A GOVERNMENT FCC LICENSE

A Cleveland Institute of Electronics FCC License course will quickly prepare you for a Government FCC License. If you don't pass the FCC exam after completing your course, CIE will refund all your tuition. You get an FCC License...or your money back!

NOT SATISFIED with your present income? The most practical thing you can do about it is add to your Electronics know-how, pass the FCC exam and get your Government License.

The demand for licensed men is enormous. Today there are over a million licensed broadcast installations and mobile transmitters on the air, and the number is growing constantly. And according to Federal Law, no one is permitted to operate or service such equipment without a Government FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Opportunities in Plants

And there are other exciting opportunities in the aerospace industry, electronics manufacturing, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal Government's FCC exam and getting your License is widely accepted proof that you know the fundamentals of Electronics.

So why doesn't everybody who "tinkers" with electronic components get an FCC License and start cleaning up?

The answer: it's not that simple. The Government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. That's to take one of the FCC home study courses offered by the Cleveland Institute of Electronics.

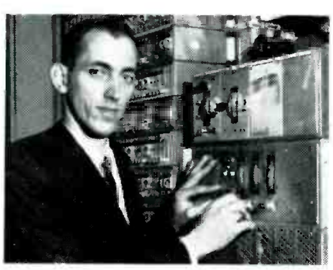
CIE courses are so effective that better than 9 out of every 10 CIE graduates who take the exam pass it. That's why we can afford to back our courses with the iron-clad Warranty shown above: you get your FCC License or your money back.

Mail Coupon for Two Free Books

Want to know more? Send the coupon below for free copies of our school catalog, "How To Succeed In Electronics," describing opportunities in Electronics, together with our special booklet, "How To Get A Commercial FCC License." If coupon has been removed, just send your name and address to us.

ENROLL UNDER NEW G.I. BILL
All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box in coupon for G.I. Bill information.

Matt Stuczynski, Senior Transmitter Operator, Radio Station WBOE: "I give CIE credit for my First Class Commercial FCC License. Even though I had only six weeks of high school algebra, CIE's lessons made Electronics easy. I now have a good job in studio operation, transmitting, proof of performance, equipment servicing...and am on my way up."



Thomas E. Miller, Jr., Engineer, Indiana Bell Telephone Company: "I completed my CIE course and passed my FCC exam while in the Navy. On my discharge, I was swamped with job offers from all over the country. My only problem was to pick the best one, and I did—engineer with Indiana Bell Telephone. CIE made the difference between just a job and a management position."

CIE **Cleveland Institute of Electronics**
1776 East 17th Street, Cleveland, Ohio 44114

Cleveland Institute of Electronics
1776 E. 17th St., Cleveland, Ohio 44114

Please send me without cost or obligation:

1. Your 40-page book "How To Succeed In Electronics" describing the job opportunities in Electronics today and how your courses can prepare me for them.

2. Your book "How To Get A Commercial FCC License."

Name________________ Age______
(Please Print)

Address________________

City________________

State________________ Zip______

☐ **Check here for G.I. Bill information**

Accredited Member National Home Study Council
A Leader in Electronics Training...Since 1934

PF-64

Circle 20 on literature card

and is not drift-free; consequently, just normal frequency drift and adjusting errors are enough to prevent accuracy in setting the sweep frequency. Without a source of stable frequency, a sample part or a standard is necessary; otherwise, the accuracy is so poor the test can be used only for a rough good/bad test.

Ringing From Square Waves

Greatly improved accuracy can be obtained in ringing tests if you use a square-wave generator, which usually has good frequency stability, as the source of the pulses instead of the scope. After you have determined the optimum frequency to be used during tests of different components, the generator can be adjusted to the same exact frequency each time.

But remember this important difference: The generator should be adjusted for **one-half** the frequency normally used for ringing. Coupling a square wave to an inductance through a small capacitance forms a very effective high-pass filter. At the inductance, the waveform without ringing would be a positive-going pulse for the leading edge and a negative-going pulse for the trailing edge of the square wave. Both of these pulses ring the tuned circuit; therefore, each square wave produces two ringing waveforms, similar to those in Fig. 1. You might have to experiment to find the best value for the series capacitor.

Adjust the scope for no less than two ringing waveforms, because the waveshape and amplitude of the ringing initiated by the positive pulse might not be the same as that of the negative pulse. Normal scope locking must be used with this method.

Impedance Tests

Another test that is as sensitive to shorted turns as is the ringing test, yet does not have the drawbacks of the ringing test, is an easy method of checking the impedances of inductances.

A sine wave of the normal operating frequency is applied to a voltage divider consisting of a fixed resistor and the unknown inductance. This resistor (a 100K-ohm audio taper) is varied until the sinewave voltage across it is the same voltage as was across the unknown inductance. The dial of the variable resistor directly reads the impedance in ohms (at that frequency) of the inductance. Impedance is the inductive reactance plus the DC resistance of an inductance.

Fig. 9 shows the test setup, and a few extra parts that make the tests more flexible and accurate. Of course, this test method works satisfactorily even if you use clipleads instead of switches, and a resistor substitution box instead of a calibrated variable control, but it is not as convenient, and you are not likely to use the method regularly if it is difficult to employ.

The switches, control, other parts and wiring could be assembled in a small metal box and kept ready for instant use. Also, a simple single-frequency audio oscillator could be built in the same box, for complete flexibility. The oscillator would furnish 15000-Hz sine wave, and the 60-Hz signal could be obtained easily from the heater winding of a power transformer. Later, I'll tell you how to check audio transformers, for which you will need 400 Hz.

Place white paper behind the knob of R4, for a dial scale. Use the center and low lugs so that high resistance is obtained in a clockwise direction. Calibrate R4 by measuring it with your ohmmeter and marking your own calibration on the paper dial scale. Keep in mind that readings below 10K ohms are vitally important, and fewer calibrations are needed above that point (imitate an ohmmeter scale).

The fixed resistor of the voltage divider (R1, R2 or R3) increases the accuracy when it is equal or greater than the impedance to be measured; however, if it is too large, it will reduce the signal too much on lower impedances. The approximate ranges are as follows:

- R1 (100K)—for testing impedances between 20K and 100K (example: testing high-voltage transformers out-of-circuit).
- R2 (24K)—for testing imped-

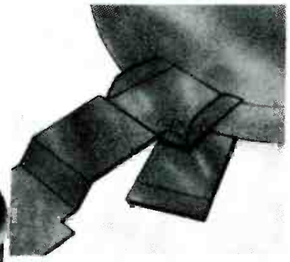
NEW!

TUN-O-BRITE

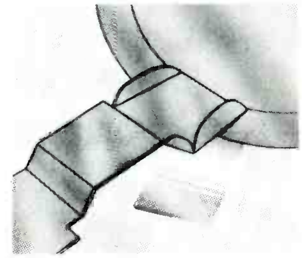
the heavy duty tuner spray with built-in polishing action!

BT-8 8 oz. $2.39
BT-16 16 oz. $3.49

SEE THE DIFFERENCE

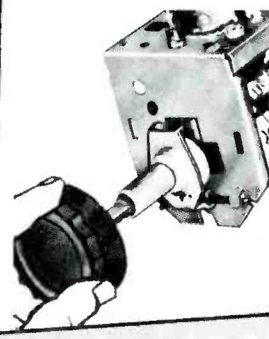


This tuner contact has been sprayed with an ordinary tuner cleaner. It looks clean, but close examination would reveal minute areas with corrosion and dirt.



This tuner contact has been sprayed with new TUN-O-BRITE, with its built-in brighteners. It is not only clean, it has been polished shiny. There is absolutely no dirt or corrosion left to spread. What's more, the contact is protected by a film of ultra-long-lasting lubricant.

FEEL THE DIFFERENCE



The extra heavy duty lubricant used in TUN-O-BRITE makes any tuner slide from channel to channel smoothly. Your customer will feel the difference immediately. When he sees bright, clear pictures on every channel and feels how smoothly the channels change, he'll know you've done something almost miraculous to his tuner.

SAVE $4.78

WHEN YOU BUY THIS 6-PACK!

AVAILABLE FROM YOUR CHEMTRONICS DISTRIBUTOR

CHEMTRONICS

CHEMTRONICS INC 1260 RALPH AVENUE BROOKLYN, N. Y. 11236

Circle 21 on literature card

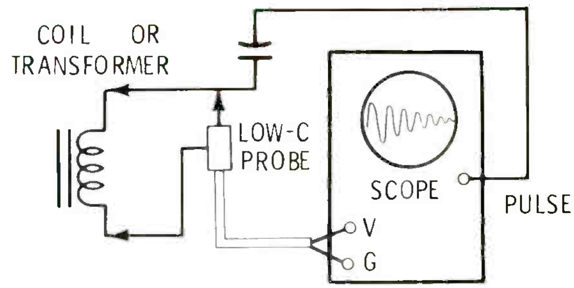


Fig. 4 Test setup for using the modified scope to ring an out-of-circuit coil or transformer.

ances between 3K and 20K (examples: yokes and transformers measured in-circuit, horizontal output tube plate to ground).

- R3 (4.7K)—for testing impedances between 0 and 5K (examples: width coils, focus coils, linearity coils, horizontal oscillator coils and most yokes out-of-circuit).

To minimize waveform changes caused by different loads and impedances, the oscillator should have good output regulation (negative feedback or damping) and should have an output impedance no higher than 600 ohms. Most oscillators intended for stereo servicing are suitable. The **exact** frequency is not critical, but AC impedance does vary with frequency. Therefore, always set the generator or oscillator to the same dial mark each time so the readings will be comparable.

The step-by-step procedure for testing the impedance of the horizontal windings in a deflection yoke is as follows:

- Position S1 to select R3.
- Adjust the audio oscillator for the dial mark nearest to 15000 Hz.
- Before the test leads are connected to the out-of-circuit yoke, select the "U", or unknown, position of S2, and turn up the output

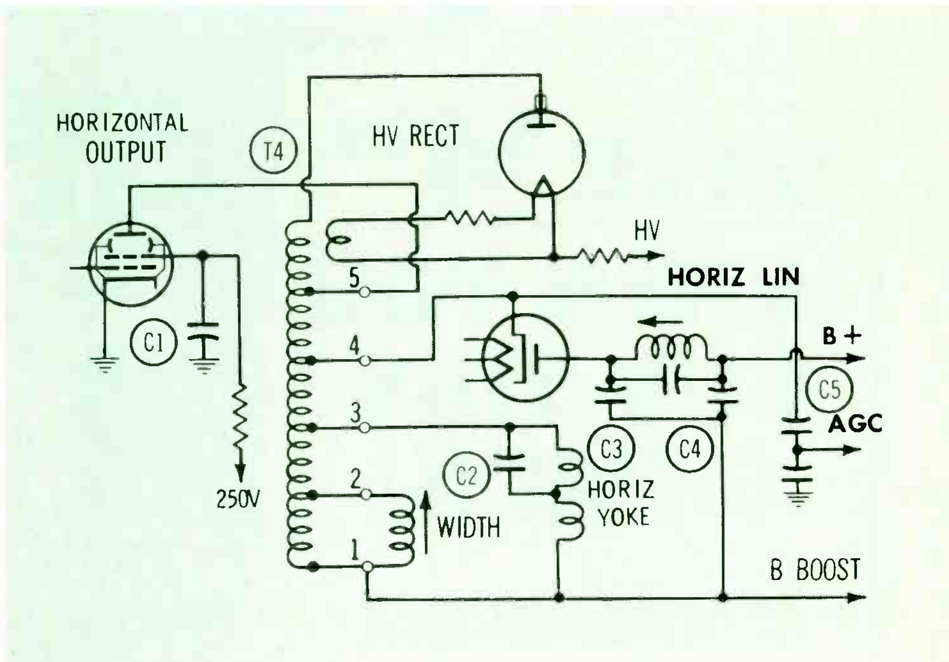
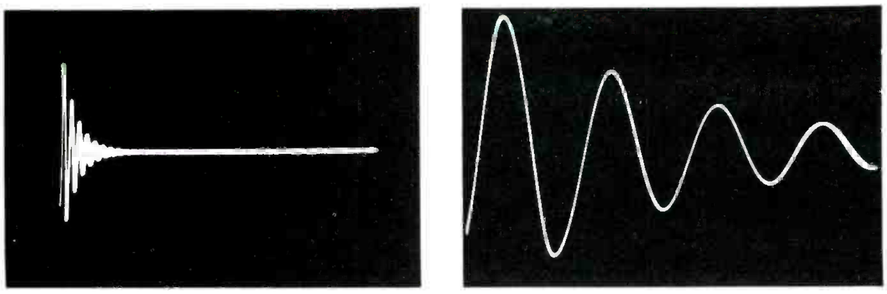


Fig. 5 Typical autotransformer-type TV horizontal sweep circuit. The yoke and high-voltage transformer are tested in circuit, from the plate of the horizontal output tube to ground.



(A) (B)

Fig. 6 Examples of wrong scope sweep frequency. (A) 300 Hz; much too low. (B) 9000 Hz; much too high.

control on the oscillator to any voltage between 5 and 15 that does not cause visible distortion.

- Adjust the scope for a normal stable pattern, and calibrate the vertical amplifier.
- Connect the yoke to the "unknown impedance" terminals, and measure the p-p voltage across it.
- Select position "C" (calibrate) of S2, and adjust R4 until the scope reads exactly the same p-p signal as was measured across the yoke.
- Read the impedance in ohms from the calibrated dial.

Included in the circuits I have tested with this method was one similar to that shown in Fig. 5 (but without the width coil), whose normal impedance from the plate connector of the horizontal output tube to chassis measured 7500 ohms. A shorted two-turn winding around the core of the high-voltage transformer brought the reading down to 4800 ohms, a very definite change, while a plate-to-cathode short across the damper reduced the impedance to nearly zero. Of course, a shorted C5 or a burned width coil also would drastically reduce the impedance to near zero. On the PHOTOFACT schematic for that set, I have written "7500 ohms-15 KHz in-circuit" at the plate of the horizontal output tube. This enables me to check all other receivers using the same chassis for shorted turns in the high-voltage transformer and yoke, and without using sample parts for reference.

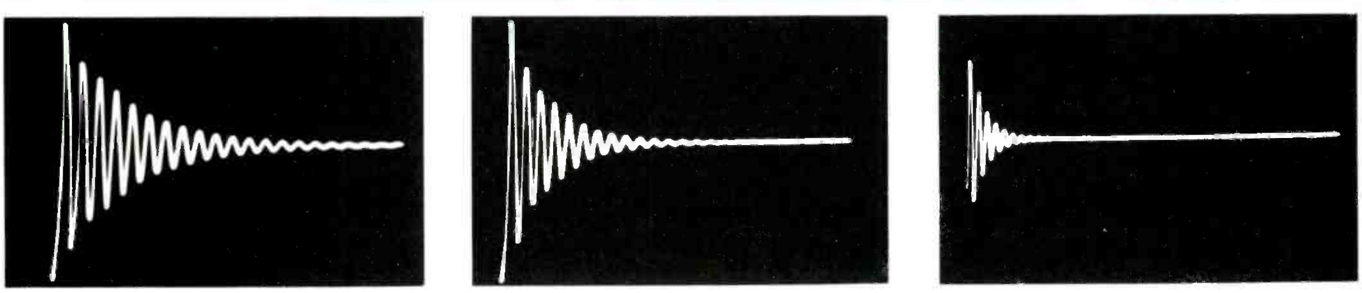
The impedance of high-voltage transformers out of circuit is measured between the B-boost terminal (#1 in Fig. 5) and the plate cap of the horizontal output tube. The impedance of most transformers will be above 50K ohms when there are no shorted turns and the air gap in the core is correct, under 10K ohms with a few turns shorted, and much less when many turns are shorted.

If you have a known-good sample yoke or a previous impedance reading of one, the horizontal windings of deflection yokes can be checked so accurately that it is usually possible to predict the width it will give.

I remember one certain model of a "price leader" TV (to phrase it delicately) in which many of the sets soon developed about one-half inch loss of width on each side of the picture. The cause was traced to the yokes. Impedance tests indicated that a yoke which produced full width measured about 2000 ohms, and a yoke that produced a narrow width measured about 1800 ohms. No ringing test can detect this small a difference! A VTVM, FET meter or an amplified AC meter should be used for an indicator instead of a scope whenever such accuracy is necessary.

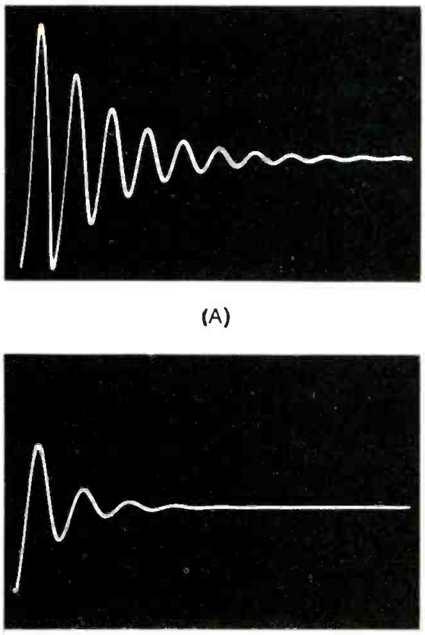
The impedance of most audio transformers can be tested using this same method. Two conditions are different: The audio oscillator should furnish 400 Hz, and the transformer should have normal loading, or a resistor to simulate normal loading.

For example, suppose we want to test an audio output transformer needed for an older AC/DC radio. The transformer should have a primary impedance of 2500 ohms



(A) (B) (C)

Fig. 7 Ringing waveforms of normal and defective horizontal circuits. (A) Normal circuit and ringing waveform. (B) Reduced ringing caused by a two-turn short. (C) Greatly reduced ringing caused by many shorted turns.



(A)

(B)

Fig. 8 Ringing waveforms of a horizontal oscillator coil. (A) Normal coil and ringing out of circuit. (B) Reduced ringing caused by a 2-turn short, or a 56K-ohm resistor in parallel with the coil.

when the secondary is loaded with a 4-ohm resistor. Connect the 4-ohm resistor across the secondary and measure the primary impedance, which should be slightly over 2500 ohms.

Remember that the impedance of a transformer is the inductive reactance plus the DC resistance of the winding under test. A very low reading indicates shorted turns, reversed primary and secondary, or the wrong turns ratio; an abnormally high reading probably indicates an open primary winding, a defect best found with an ohmmeter.

Comparison of Ringing and Impedance Tests

Ringing tests usually require a minor modification to bring out a horizontal sweep pulse from the scope circuit. The scope is the only major item of equipment required, and every shop should have one already. Some of the tests can be done satisfactorily in-circuit; others should be done out-of-circuit. Each test is simple and can be performed quickly.

The major drawback of the ringing method is the inherent variables that can change testing conditions and, consequently, the results. Also, there is no data produced which can be recorded for use during a future diagnosis of the same chassis. Interpretation of the waveform is difficult, and accuracy is often low because a slight difference in the pulse repetition frequency will change the pattern radically. An instantaneous change from the inductance under suspicion to a known-good identical one can provide good accuracy. A ringing test accomplished without a standard part or a known sweep frequency should be used only as a good/bad test for a transformer

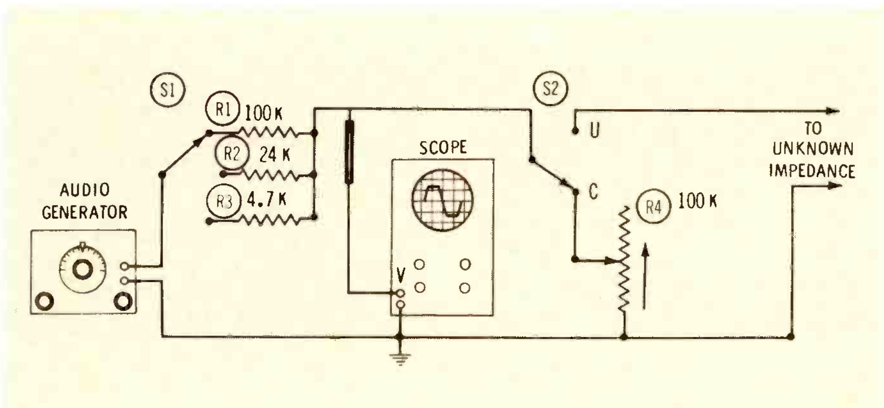


Fig. 9 Test setup to measure impedances between 1000 ohms and 100K ohms at the correct scanning frequency.

or coil suspected of having many shorted turns.

Impedance tests are more sensitive in detecting as few as one or two shorted turns in a coil, and the results are measured in ohms, which can be recorded for use as a future reference. Carelessly performed impedance tests might give an accuracy no better than ±20 percent, which is sufficient for many diagnostic purposes. But by using the same test equipment and adjusting it the same way each time, it should be possible to consistently repeat impedance readings with about ±5 percent accuracy.

Virtually no ratings for these TV sweep components presently are included on schematics, but you can write on the schematics for future use the normal readings you obtain. After some experience with this method, you probably will know the approximate impedance of most sweep components, and you will be able to dispense with testing of known-normal components.

The only drawback to this system of checking impedance is the requirement of an audio oscillator (or generator), although most shops have, or should have, a sine-/square-wave generator for use in stereo servicing.

Solid-State Tests

Because of the damper action of the transistors and diodes, transformers, coils and yokes used in solid-state equipment should be removed and tested out of circuit, whether the ringing or impedance type of test is employed.

Next Month

Shop Talk next month will discuss various speedy methods for testing transistors and diodes.

As more solid-state components are used in more television receivers, such time-saving techniques become more valuable, and even necessary. However, equally important, the limitations and shortcomings of each type of test must be understood. Next month, we'll take a look at both the advantages and the inherent limitations of such tests. ▲

Transistor Substitution

A review of important characteristics you should consider when selecting a substitute.

by Wayne Lemons

The number of transistor types now in use makes it virtually impossible to stock all the original type numbers. Even stocking a portion of them ties up considerable capital in transistors that might or might not be needed.

Not too long ago, when germaniums were the only kind of transistors used, several manufacturers marketed eight to ten replacement units that would fill 90 percent of the replacement needs. Today, with silicons added to the replacement lists, 30 general replacement types are needed to fill the majority of requirements. Whether you use the suggested replacements cross-referenced by several manufacturers, or whether you categorize your own replacement types, the information in this article should make selection of transistor replacements less of a guessing game.

PNP or NPN

How can you be sure you are selecting the right replacement? The simple and most practical way is to check manufacturers' cross-reference charts, like the ones shown in Fig. 1. Find the original transistor type number and then check for the replacement recommended.

If the replacement guide is not available, or if you cannot tell what the original part number was, then you will need to find out as much as you can about the characteristics of the original. First, is it an NPN or PNP? If you have the schematic, you can determine this by the di-

Type To Be Replaced	RCA Replacement Type	Type To Be Replaced	RCA Replacement Type	Type To Be Replaced	RCA Replacement Type	Type To Be Replaced	RCA Replacement Type
2N564	SK3004	2N639	SK3009	2N990	SK3006	2N1130	SK3004
2N565	SK3004	2N639A	SK3009	2N991	SK3006	2N1136	SK3009
2N566	SK3004	2N639B	SK3009	2N992	SK3006	2N1136A	SK3009
2N567	SK3004	2N640	SK3008	2N993	SK3005	2N1136B	SK3009
2N568	SK3004	2N641	SK3008	2N994	SK3008	2N1137	SK3009
2N569	SK3003	2N642	SK3007	2N1000	SK3011	2N1137A	SK3009
2N570	SK3003	2N643	SK3007	2N1007	SK3009	2N1137B	SK3009
2N571	SK3003	2N644	SK3007	2N1009	SK3003	2N1138	SK3009
2N572	SK3003	2N645	SK3007	2N1010	SK3011	2N1138A	SK3009
2N573	SK3004	2N647	SK3010	2N1011	SK3009	2N1138B	SK3009
2N574	SK3004	2N648	SK3010	2N1012	SK3011	2N1144	SK3003
2N574A	SK3004	2N649	SK3010	2N1014	SK3009	2N1145	SK3003
2N576	SK3011	2N650	SK3004	2N1017	SK3011	2N1146	SK3009
2N576A	SK3011	2N650A	SK3004	2N1018	SK3011	2N1146A	SK3009
2N578	SK3005	2N651	SK3004	2N1020	SK3009	2N1146B	SK3009
2N579	SK3005	2N651A	SK3004	2N1021A	SK3009	2N1146C	SK3009
2N580	SK3005	2N652	SK3004	2N1C22	SK3009	2N1147	SK3009
2N581	SK3005	2N652A	SK3004	2N1022A	SK3009	2N1147A	SK3009
2N582	SK3003	2N653	SK3004	2N1023	SK3006	2N1147B	SK3009
2N583	SK3005	2N654	SK3004	2N1029	SK3009	2N1147C	SK3009
2N584	SK3003	2N655	SK3004	2N1029A	SK3009	2N1149	SK3020
2N585	SK3011	2N657	SK3005	2N1029B	SK3009	2N1150	SK3020
2N586	SK3005	2N659	SK3005	2N1029C	SK3009	2N1151	SK3020
2N587	SK3011	2N660	SK3005	2N1030	SK3009	2N1152	SK3020
2N588	SK3006	2N661	SK3005	2N1030A	SK3009	2N1153	SK3020
2N588A	SK3006	2N662	SK3005	2N1030B	SK3009	2N1157	SK3012
2N589	SK3009	2N663	SK3009	2N1030C	SK3009	2N1157A	SK3012
2N591	SK3004	2N665	SK3009	2N1031	SK3009	2N1159	SK3009
2N592	SK3005	2N669	SK3009	2N1031A	SK3009	2N1160	SK3009
2N593	SK3005	2N677	SK3009	2N1031B	SK3009	2N1162	SK3009
2N594	SK3011	2N677A	SK3009	2N1031C	SK3009	2N1162A	SK3009
2N595	SK3011	2N677B	SK3009	2N1032	SK3009	2N1163	SK3009
2N596	SK3011	2N677C	SK3009	2N1032A	SK3009	2N1163A	SK3009
2N597	SK3005	2N678	SK3009	2N1032B	SK3009	2N1164	SK3009
2N598	SK3005	2N678A	SK3009	2N1032C	SK3009	2N1164A	SK3009

UNIVERSAL REPLACEMENT TRANSISTORS

JEDEC TYPE OR PART NO.	GE REPLACEMENT	JEDEC TYPE OR PART NO.	GE REPLACEMENT	JEDEC TYPE OR PART NO.	GE REPLACEMENT	JEDEC TYPE OR PART NO.	GE REPLACEMENT
2N2187	GE-21	2N2354	GE-8	2N2672	GE-9	2N3083	GE-17
2N2188	GE-9	2N2357	GE-3	2N2673	GE-17	2N3115	GE-17
2N2189	GE-9	2N2358	GE-3	2N2674	GE-17	2N3116	GE-17
2N2190	GE-9	2N2360	GE-9	2N2675	GE-17	2N3128	GE-17
2N2191	GE-9	2N2361	GE-9	2N2695	GE-21	2N3129	GE-17
2N2192	GE-17	2N2362	GE-9	2N2696	GE-21	2N3132	GE-16
2N2192A	GE-17	2N2363	GE-9	2N2706	GE-1	2N3133	GE-21
2N2193	GE-17	2N2370	GE-21	2N2708	GE-17	2N3134	GE-21
2N2193A	GE-17	2N2371	GE-21	2N2711	GE-17	2N3135	GE-21
2N2193B	GE-17	2N2372	GE-21	2N2712	GE-20	2N3136	GE-21
2N2194	GE-20	2N2373	GE-21	2N2713	GE-20	2N3137	GE-21
2N2194A	GE-20	2N2375	GE-1	2N2714	GE-17	2N3148	GE-25
2N2194B	GE-20	2N2377	GE-21	2N2715	GE-17	2N3209	GE-21
2N2195	GE-17	2N2378	GE-21	2N2716	GE-20	2N3213	GE-16
2N2195A	GE-17	2N2387	GE-20	2N2717	GE-9	2N3214	GE-16
2N2196	GE-17	2N2388	GE-20	2N2728	GE-4	2N3215	GE-16
2N2197	GE-17	2N2389	GE-20	2N2729	GE-17	2N3217	GE-21
2N2198	GE-20	2N2390	GE-20	2N2730	GE-4	2N3218	GE-21
2N2199	GE-9	2N2393	GE-21	2N2731	GE-4	2N3219	GE-21
2N2204	GE-12	2N2394	GE-21	2N2732	GE-4	2N3226	GE-19
2N2205	GE-20	2N2395	GE-21	2N2784	GE-17	2N3232	GE-14
2N2206	GE-17	2N2396	GE-20	2N2793	GE-4	2N3235	GE-14
2N2207	GE-9	2N2397	GE-20	2N2801	GE-21	2N3241	GE-20
2N2209	GE-9	2N2398	GE-9	2N2802	GE-21	2N3241A	GE-20
2N2210	GE-4	2N2399	GE-9	2N2803	GE-21	2N3242	GE-20
2N2212	GE-3	2N2400	GE-1	2N2804	GE-21	2N3245	GE-21
2N2225	GE-1	2N2401	GE-1	2N2805	GE-21	2N3250	GE-21
2N2234	GE-20	2N2402	GE-9	2N2806	GE-21	2N3251	GE-21
2N2235	GE-20	2N2411	GE-21	2N2807	GE-21	2N3267	GE-20
2N2236	GE-20	2N2412	GE-21	2N2831	GE-17	2N3289	GE-17
2N2237	GE-20	2N2413	GE-17	2N2836	GE-3	2N3290	GE-17
2N2240	GE-20	2N2423	GE-16	2N2837	GE-21	2N3291	GE-17
2N2241	GE-20	2N2424	GE-21	2N2838	GE-21	2N3292	GE-17
2N2242	GE-17	2N2425	GE-21	2N2857	GE-17	2N3293	GE-17
2N2244	GE-17	2N2427	GE-21	2N2861	GE-21	2N3294	GE-17
2N2245	GE-17	2N2428	GE-2	2N2863	GE-21	2N3297	GE-19
2N2246	GE-17	2N2429	GE-2	2N2865	GE-17	2N3304	GE-21
2N2247	GE-17	2N2430	GE-8	2N2869	GE-3	2N3305	GE-21
2N2248	GE-17	2N2431	GE-2	2N2869/2N301	GE-3	2N3306	GE-21
2N2249	GE-17	2N2447	GE-2	2N2870/2N301A	GE-3	2N3307	GE-21

Fig. 1 Shown here are portions of two cross-reference charts published by manufacturers (RCA and GE).

rection of the emitter arrow; as shown in Fig. 2, if the arrow is pointing "out", it is an NPN, and if pointing "in", a PNP. (Some technicians remember this by using this little saying: PNP for "**P**ointing **'N P**roper" and NPN for "**N**ot **P**ointing **'N**".)

A second method of checking the type (it's possible for the draftsman to draw the arrow wrong, or you might not have a schematic) is to determine the polarity of the collector-to-emitter voltage. If the collector is negative relative to the emitter (not necessarily to ground), the transistor is a PNP. If the collector is positive to the emitter, the transistor is an NPN (Fig. 3). You can remember which polarity is which by recalling that the **middle** letter of the type designation indicates the collector to emitter polarity—negative for P**N**P and positive for N**P**N.

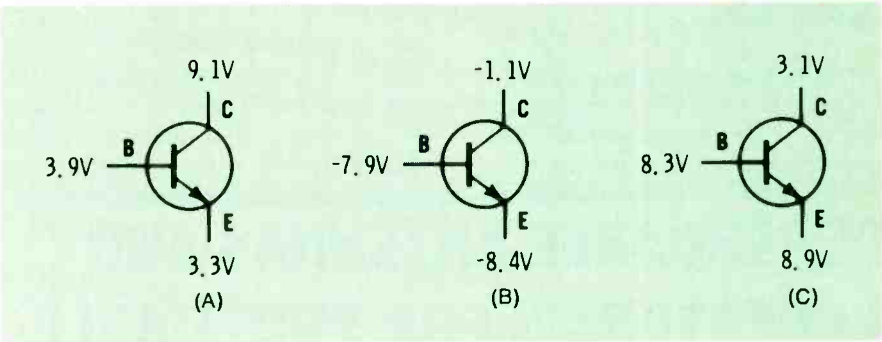


Fig. 3 Which of the above transistor symbols is incorrect, assuming that the voltage readings are correct? The answer is **C**. Note that the collector is actually more negative than the emitter; this wound indicate that the transistor symbol should be a PNP, with the arrow pointing in.

Is It Germanium or Silicon?

If the type number is lost, or you have no cross-reference information, the best way to determine whether a transistor is a silicon or germanium is by the amount of base-to-emitter bias. The bias for a germanium type will be 0.2 volt or less, while the silicon will have a bias of 0.4 volt or more. (This will not hold true always, because certain circuits, such as sync clippers or oscillators, can have little or no DC bias, or they might even have reverse bias when operating normally.)

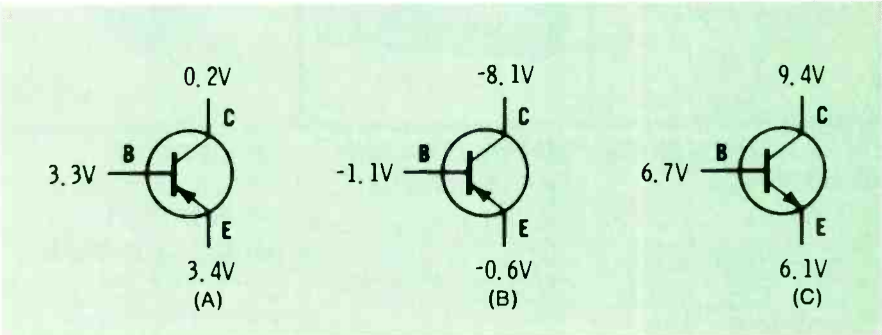


Fig. 4 Which of the above transistors are silicons? The Answer: B and C., because both have more than 0.4 volt base-to-emitter bias.

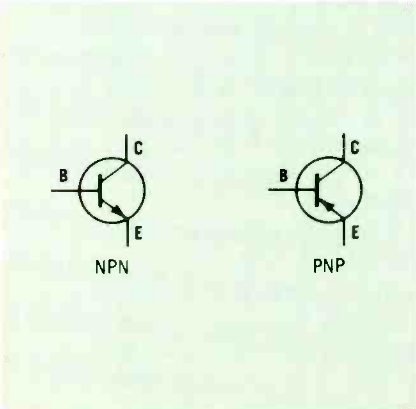


Fig. 2 The direction of the emitter arrow indicates whether the transistor is an NPN or PNP. Other checks will verify this, as pointed out in the text.

The above information should be obtained from the schematic (as in Fig. 4), because you won't be able to take an accurate bias reading if the transistor is defective. Usually, though, you can expect all transistors in a particular design to be either germanium or silicon, especially if they are in the same type case. In this event, you can measure the bias on other transistors to determine how much bias to expect on the defective one. But even here there are pitfalls, because in a DC-coupled circuit, the bias on all transistors will be changed when one transistor fails.

Another way to determine whether the transistor is germanium or silicon is the design of the circuit itself. (Again, this is not absolute, but at least it is a good clue.) For example, which one of the circuits in Fig. 5 almost surely uses a silicon transistor? The answer is B, because there is no emitter resistor. Only a silicon, with its excellent stability, can be operated safely without a protective emitter resistor. Also note that there is only one base bias resistor. This, too, is permissible in silicon transistor circuits, because of the low internal leakage of silicons, and because they have minimal change in leakage within a reasonable change in ambient temperature.

The circuit in Fig. 5A **could** be using a silicon transistor, but is more apt to be using a germanium. Some designers continue to use the conservative design of the germanium circuit for silicons, but these are gradually disappearing.

Selecting a Replacement

There are several manufacturers who cater to the replacement transistor market, and it seems foolhardy not to take advantage of their experience by buying the transistors which they have selected as ideal replacements, and by using their cross-reference charts.

You will find, once in a while, that a designated replacement will not take the place of the original in some particular circuit. It is almost impossible for a manufacturer to design a complete line of transistors that will replace every transistor in any type circuit with perfect results in all cases. You must recognize that there are a few exceptions to each of the rules that apply to replacements.

The main rules that you should always obey are:

- the replacement transistor you select should be of the same general type as the original
- it should be designed to operate in the same general kind of circuit
- the collector-to-emitter voltage rating should be high enough.

For example, you should not try to replace a germanium with a silicon, nor the other way round, nor should you try to replace an NPN with a PNP. You should not replace an FM RF amplifier with an AM Mixer type, nor an IF amplifier with an AF type. (Though, in the latter case, it often is permissible to substitute in the opposite direction; that is, replace a transistor of a "lower" type with one of a "higher" type. For example, an audio amplifier transistor can be replaced with an IF amplifier type, or a low-frequency transistor can be replaced with one meant for higher frequencies.)

What About Gain?

So many factors enter into the calculation of stage gain that the actual DC gain, as read on a tester, can be meaningless. The voltage gain is important in a voltage amplifier, yet that same transistor is not a good choice for a transformer-coupled audio driver, in which current, or power, gain is desired.

The beta (gain) of different RF amplifier transistors might vary considerably, but in some cases the one with the lower beta might actually function a little better in-circuit. For this reason, replacement transistor gain is usually not considered critical. Current gains will range around 70, but might drop to as low as 40 or so for power amplifiers, or up to 140 or 150 for some mixers, RF and IF amplifiers, especially silicon types.

The gain of a particular transistor seldom will change during its lifetime; consequently, as long as a transistor has gain, it usually can be assumed that the indicated gain is normal. This is particularly true of silicon transistors, which seldom develop troublesome leakage. Germanium transistors sometimes develop an apparent change in gain due to a change in leakage resistance.

What About Leakage?

The maximum permissible leakage in a transistor circuit depends a great deal on the impedance of the input circuit. For example, if the DC resistance of the input circuit is 5K ohms or less, more transistor leakage can be tolerated than if the DC resistance is one megohm.

Germanium transistors, even of the same type number, have different amounts of leakage, which always increases as the temperature increases. On the other hand, silicon transistors normally have almost no leakage, and remain stable over a wide temperature range. As a matter of fact, silicons seldom have, or develop, any significant leakage, unless they go **completely** bad, in which case they become shorted, or nearly so.

Other Considerations

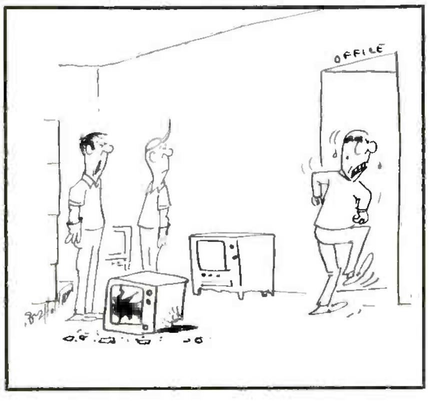
Four-lead transistors often are found in older high-frequency equipment, such as FM tuners or radios. The fourth lead usually is connected from the metal case of the transistor to common, or ground, in the circuit. In most instances, a four-lead transistor can be replaced with a three-lead one, as long as it is the same general type. Connect the replacement leads to the emitter, base and collector terminals, and disregard the fourth wire connection.

Today, most new solid-state circuits use silicon transistors, and you can expect good uniformity and, thus, interchangeability among units of the same general type; for example, an NPN FM amplifier used as the replacement in one make of radio would replace, in just about every case, an NPN FM amplifier in another make radio. Consequently, if you have some exact replacements in stock, you can use them in the same stages in other makes of equipment, to help relieve stocking problems.

Take special care when replacing transistors in DC-coupled, or "stacked", circuits, such as those used in the audio amplifier stages of auto radios. Tack in the replacement temporarily, and take collector-to-emitter voltage reading of each stage to see if they correspond closely to the original readings. If they do, and the gain and fidelity is good, the replacement then can be installed permanently.

Be sure that the voltage rating (Vceo) of a replacement transistor is at least a little above the supply voltage used for that particular stage. Be particularly careful about transient voltages, such as can occur when connecting or disconnecting a transistor while the power is turned on. Transients are one of the biggest causes of transistor failure.

Don't overload a transistor—even a temporary short can permanently



"That's all the boss ever thinks about, profit!"

damage it. Keep the current below the rated limits, or the transistor might be ruined instantly.

When installing transistors on a heat sink, be sure to install properly the necessary mica- or oxide-coated washers, and insulators. Also, always add a thin coating of a special oxide-filled silicone compound between the transistor case, the insulator and the heat sink on the chassis to improve the transfer of heat from the transistor to the heat sink. The correct type of silicon compound is available at nearly all electronic parts distributors.

Compare the lead arrangement of the replacement with the original transistor—it could be different. If it is, bend the lead wires on the requirement so that they will correctly fit the holes in the printed board without touching the other leads.

You should always recheck the alignment of any RF circuit in which you install a new transistor, even with an "exact" replacement transistor. Usually, if the replacement is suitable, you will not need to make any drastic change, but a check and touch-up is recommended to insure peak performance.

If you are not sure about a particular replacement, it's a good plan to "tack" it in before making the installation permanent. It usually is easier to tack in the replacement on the print side of the board, but be sure you have removed the original transistor. If the circuit functions as required after a check-out, install the transistor permanently on the component side of the board.

To prevent callbacks, always allow a circuit to perform normally for at least 30 minutes before returning it to the customer.

Soldering Precautions

When soldering leads on a replacement, it's always a good idea not to apply heat for any longer than absolutely necessary, especially if the leads are short. This is because the short leads will conduct the heat into the transistor itself, and possibly damage it. If possible, you should grasp the transistor leads with a pair of long nose pliers, which will act as a heat sink to reduce the amount of heat reaching the transistor. Unfortunately, it often is impossible to use any type of heat sink because of the crowded location of the transistor. The following tips can prevent possible trouble in any case:

- Don't let the soldering iron touch the transistor leads for more than 8 to 10 seconds, especially if the leads are a half-inch or shorter.
- Leave the leads as long as feasible when soldering in the replacement. However, pay particular attention to correct lead length in UHF circuitry.
- Use a small soldering iron with a small tip.
- If possible, grip the transistor lead with a pair of long-nose pliers between the body of the transistor and the point being soldered. ▲

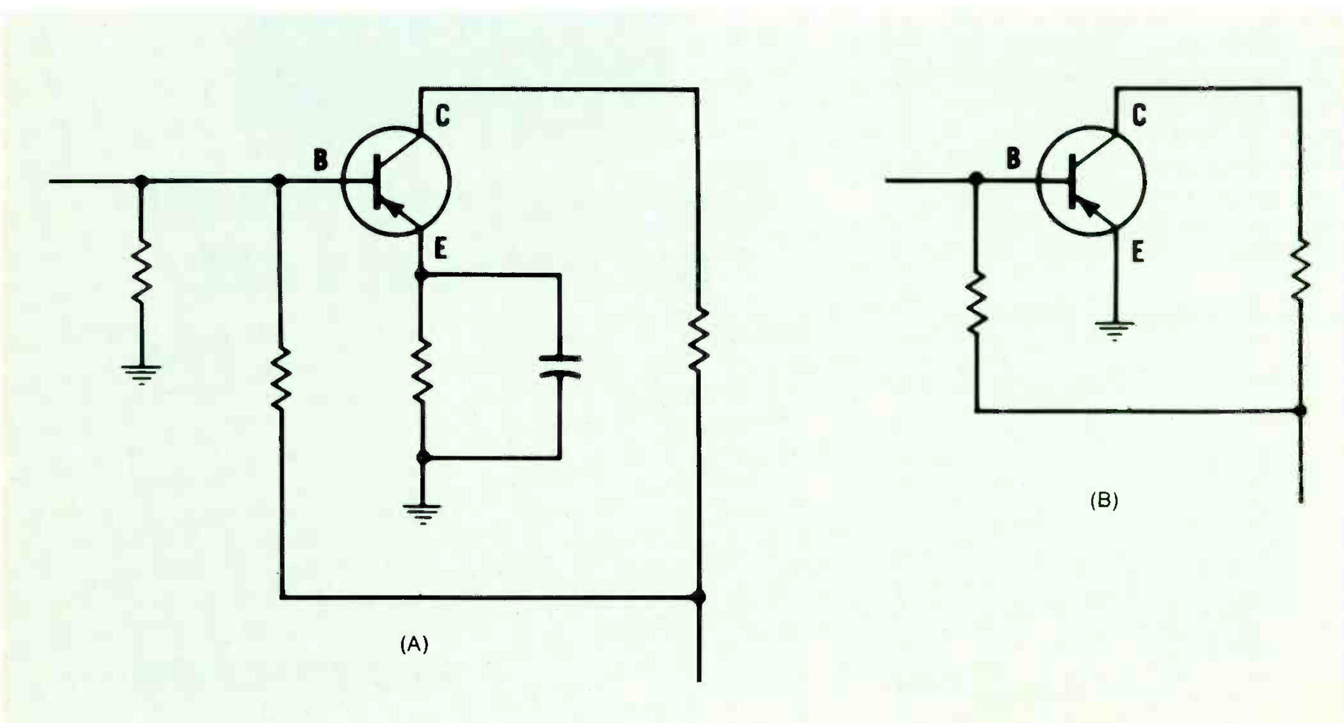


Fig. 5 Which of these circuits most likely uses a silicon transistor? The answer is B. See text for complete explanation.

B & K Precision
Model E-200D RF Generator

NEW GENERATION FROM B&K

Go ahead. Compare them with any others. These new all solid state Precision generators from B&K do more things and do them better. Because B&K makes products that really work.

Take the Model E-200D RF generator, for instance. You get wide-range coverage from 100 KHz to 216 MHz in 5 bands. A completely shielded RF output provides continuously variable monitored attenuation . . . calibrated to less than a microvolt on fundamentals to 54 MHz. And built-in crystal calibration assures you of frequency accuracy.

You get a giant 5" vernier dial with anti-backlash 12:1 gear ratio. So it's easy to obtain and repeat the results you want.

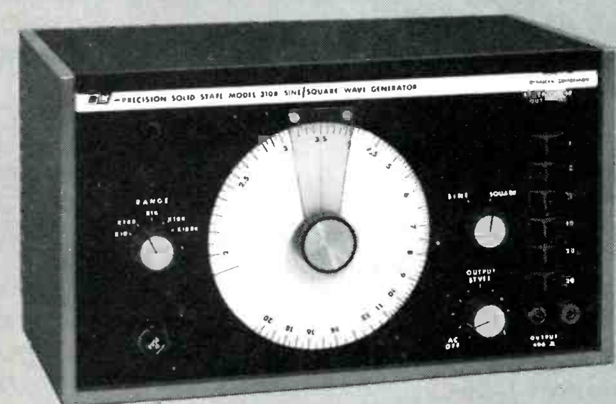
Or consider the Model E-310B. This new sine/square wave generator gives you step attenuation of both outputs.

And a variable control lets you adjust continuously from maximum down to less than 0.25 millivolt.

It also features extended frequency ranges: 20 Hz to 2 MHz for sine wave, 20 Hz to 200 KHz for square wave. Plus constant-voltage output over each band and band-to-band.

Both new generators are based on earlier models that made us famous. Now you can have all the additional benefits only transistors make possible.

See the new solid state generation from B&K at your local distributors. Or write us for complete details.



B & K Precision
Model E-310B Sine/Square Wave Generator

B & K Precision
MODEL E-200D RF GENERATOR $159.95

Other features:
- Four outputs: unmodulated RF, modulated RF (400Hz), externally modulated RF, 400 Hz audio signal.
- Covers full VHF TV range; can be used as crystal-calibrated marker (100 KHz to 54 MHz on fundamentals, 54 to 216 MHz on harmonics).
- FM and TV channels identified on dial.
- Three-wire AC line cord.
- RF cable.

B & K Precision
MODEL E-310B SINE/SQUARE WAVE GENERATOR $119.95

Other features:
- All solid state—100% silicon transistors.
- Continuously variable output control plus accurate 6-step attenuator for precise voltage division of both sine and square wave outputs.
- Fast square wave rise time (less than 100 nanoseconds).
- Wide range permits low frequency RF applications.
- Large 5" dial with vernier tuning for maximum accuracy
- Three-wire AC line cord.

B&K

Products of DYNASCAN CORPORATION
1801 W. Belle Plaine, Chicago, Ill. 60613
The professional test equipment

Circle 39 on literature card

Transistor TV servicing techniques

by Jack Darr

Transistor Facts and Fallacies

Transistors are **NOT** immortal. They do break down, like most other parts. They do short, open and leak; but they do seem to be **definite** about it. Based on my experience, transistors seldom become **intermittent.** Intermittent conditions generally are found in loose solder connections, wiring and the same old troubles we have dealt with for so long.

Most transistors are not "delicate". Some writers used to tell us that an ohmmeter would blow a transistor. Possibly so, but I have never seen it happen. Transistor operating voltages are going higher all the time, so that you can use an ohmmeter with reasonable caution. Later, we will discuss how to use the ohmmeter to service transistor television.

Transistors are **NOT** always cool in normal operation. If you think so, touch the power transistors of a large audio amplifier. Many of them run too hot to touch. This is why **heat sinks** are used.

"Transistors are current amplifiers." From this often-repeated statement, we would think that the only way we could test transistors would be to break the circuit and insert a current meter in series with it. However, since the current always slows through resistors somewhere in the circuit, our old reliable method of **voltage measurements** will still be just as useful as it always has been. If the current through a resistor is correct, the voltage across it also will be correct (until somebody repeals Ohm's law). So, a voltmeter will provide just as much information as it ever did.

DC Voltages on Transistors

You might have learned that transistor voltages are very critical. They are, when you consider the DC voltages on the transistor, using the emitter as the reference point. The base-emitter voltage is the **bias,** which is used to control the conduction of the transistor. This is critical, for it takes only a few tenths of a volt to switch a transistor from cutoff to full conduction. This is in contrast with tubes, which usually require several volts to switch from cutoff to saturation. The emitter-collector voltage is not as critical, and in many transistor circuits it has a relatively wide tolerance range.

There is one other fact which you should remember: When a vacuum tube is at zero bias (grid and cathode at the same voltage), it is usually drawing current. Many tubes will go into saturation at zero bias. However, when a transistor is at zero bias—same voltage on base and emitter—it is cut off and no current is flowing (see Fig. 1). In many applications, such as sync separators, the transistor normally operates in this condition. The signal develops the forward bias.

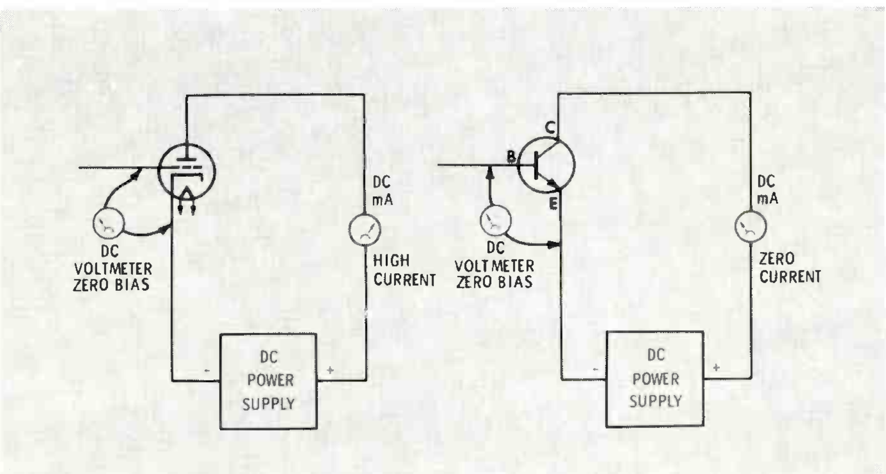


Fig. 1 A tube and a transistor operated at zero bias. (A) Tube draws current at zero bias. (B) Transistor is cut off at zero bias.

Tolerance

We can tolerate **reasonable** variations in the DC supply voltage, compared to the normal voltages shown on the schematic. Such variations can be caused by changes in the AC line voltage, which affects the DC power supply; changes in signal strength; and several other similar changes. Like most other electronic equipment, a transistor-TV set has to be able to operate over a fairly wide range of supply voltages. A **normal** variation should not interfere with the performance of the various circuits. To determine whether the voltage variation, as you find it, is within tolerance, simply measure the **performance** of the circuit. In other words, is it amplifying, detecting, or doing whatever it is supposed to do?

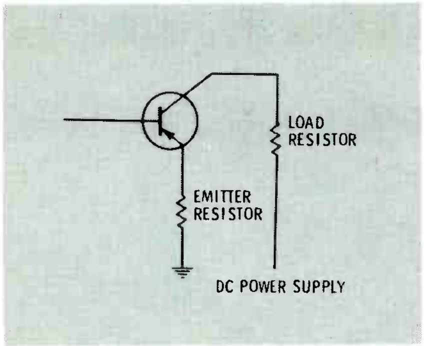


Fig. 2 A common-emitter stage.

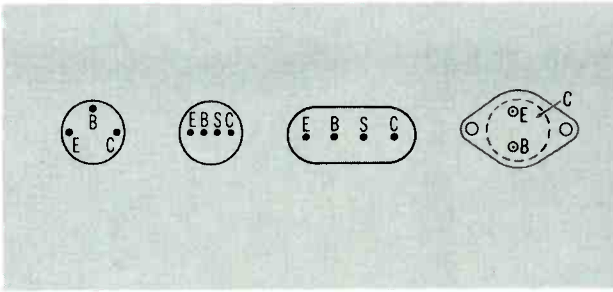


Fig. 3 Four commonly used transistor basing diagrams.

Abnormal Voltages

When you have **real** trouble in a transistor circuit, it will be relatively easy to identify. An abnormal voltage should quickly lead you to the defective component. A shorted or open transistor, for example, will result in abnormal voltages at a specific point in the circuit. Voltages which are **far** from normal mean trouble. Voltages which are only a "little bit off" usually are insignificant.

Using the "voltages-far-from-normal" symptom, you often can locate such confirming clues as burned-out resistors in the power-supply circuits. To find the defect, turn off the power and start circuit tracing with the ohmmeter. This is the same method that we have used for years and will continue to use, because it is the most effective.

You will find in transistor TV the same type of clues that you have been using to service tube-type equipment. For example, if the emitter resistor in the common-emitter stage shown in Fig. 2 is burned, you know that only one thing can cause it—a shorted transistor. There is nothing else in the circuit to cause excessive current through the emitter resistor. It is comparable to a burnt cathode resistor in a tube circuit. The load resistor in Fig. 2 also could be damaged by a shorted transistor.

The best way of checking any kind of circuit is by **performance.** In a transistor circuit, signal tracing is often the most satisfactory. If the ratio of input signal to output signal is close to normal—that is, if the stage has about normal gain—the stage probably is okay. If you find normal input signal and no output at all, the stage is defective. Since a transistor is primarily a current-amplifying device, the voltage gain will depend on the load impedance. If a particular stage has a very low load impedance, the gain will be correspondingly small. Remember, a common-collector transistor stage is just like a cathode-follower stage in tube circuitry: It will have a gain of less than unity (1). Therefore, when a common-collector stage shows no gain, it probably is okay. However, if you do not find an output signal, the stage probably is not operating. This is especially true if you are looking for a defect which has caused a **complete loss** of sweep, sound, etc. If you have such a symptom, then you usually will find a stage which has an input signal but no output signal.

Transistor Basing Diagrams

Fig. 3 shows some commonly used transistor basing diagrams. You will find the fourth lead is used only in the metal-cased transistors, in which it normally is connected to the case and is grounded for shielding.

Many U.S. manufacturers are printing transistor and part identification information on the foil side of printed-circuit boards. With this information, you very quickly can locate particular transistor terminals. Fig. 4 shows the parts-identification information on a printed-circuit board. By comparing the part numbers on the schematic with those on the printed-circuit board, you can find your way around without too much trouble.

It is not always easy to identify transistor elements by measuring the DC voltages present on them. (You almost always can find the plate or screen of a tube in this manner, because of the relatively high voltage on it.) Fig. 5 shows two commonly used supply-voltage arrangements for an NPN transistor. In Fig. 5A, the negative side of the power supply is connected to ground, and the emitter is nearly at ground potential. In Fig. 5B, the positive side of the power supply is grounded, and the collector is at ground potential. However, the voltages measured in respect to the emitter will be the same in both cases. Once you locate the emitter, the other two elements usually can be identified by voltage readings, unless the stage is defective. Arrangements similar to the ones shown in Fig. 5 are used for PNP transistors also, except that the polarity of the supply voltage is reversed.

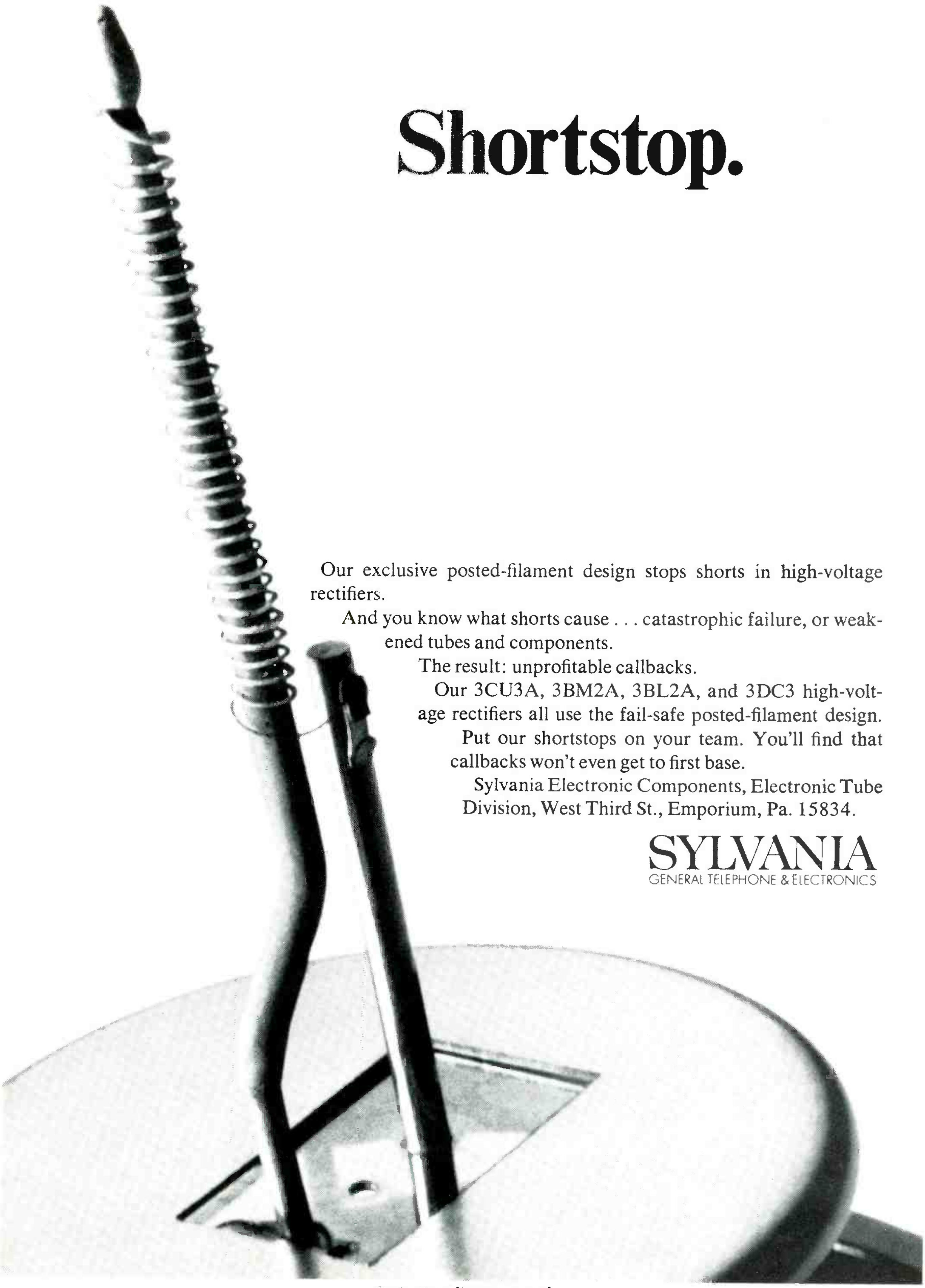
Circuit Testing Techniques

Because of the construction of most transistor TV's, signal tracing has proven to be the most efficient method of testing. In most cases, you cannot easily pull out a transistor to test it, then put it back, as you can a tube. Therefore, check a given stage or section to find out if it is functioning, before removing parts for testing.

Signal Tracing

This basic principle of signal tracing is to determine if a given stage —a video amplifier stage, for example—has both an input signal and an output signal. If the normal input signal is 1.0 volt p-p, and the normal output is 50 volts p-p, feed in a 1.0-volt signal and use your oscilloscope

Shortstop.



Our exclusive posted-filament design stops shorts in high-voltage rectifiers.

And you know what shorts cause . . . catastrophic failure, or weakened tubes and components.

The result: unprofitable callbacks.

Our 3CU3A, 3BM2A, 3BL2A, and 3DC3 high-voltage rectifiers all use the fail-safe posted-filament design.

Put our shortstops on your team. You'll find that callbacks won't even get to first base.

Sylvania Electronic Components, Electronic Tube Division, West Third St., Emporium, Pa. 15834.

SYLVANIA
GENERAL TELEPHONE & ELECTRONICS

Circle 40 on literature card

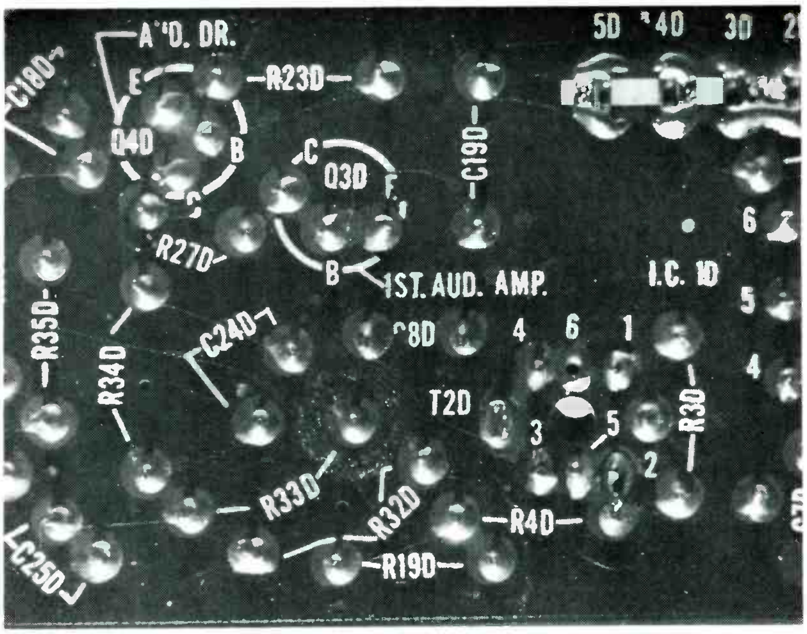


Fig. 4 Part identification information printed on the foil side of a printed-circuit board.

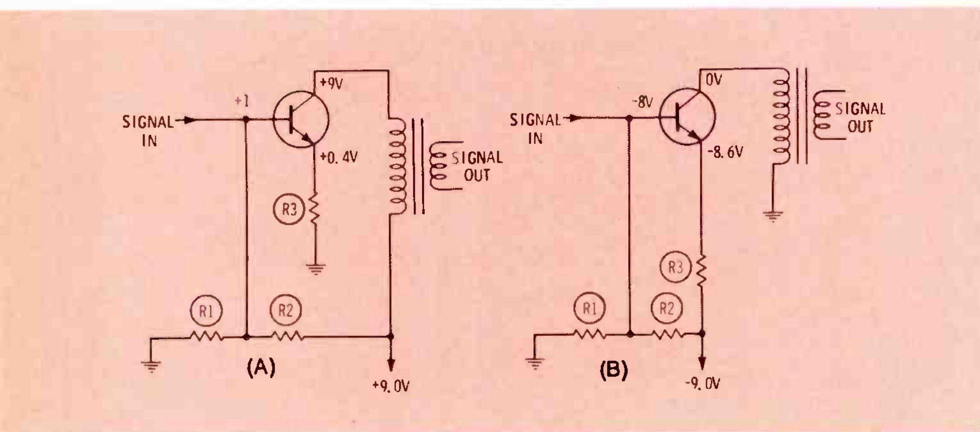


Fig. 5 Two supply voltage arrangements used for NPN transistors. (A) Power supply with negative ground. (B) Power supply with positive ground.

to measure the output signal. If you have approximately a 50-volt output signal, the stage probably is functioning properly.

You can use a station signal in many cases to make a few key measurements. For example, if there is a 1.0-volt p-p video signal at the video detector output, you can be relatively certain everything **ahead** of this point is okay. If this signal is not present, go back to the stages ahead of this point and find the trouble. In this case, it will not be necessary to check the video output stages, because they do not have a normal input signal.

The scope is the principal instrument used in this type of signal tracing. However, do not be too critical of the shape and content of the **waveforms.** Your main concern, at this time, is the presence or absence of a normal signal.

Besides showing you whether there is a normal signal at a given point, the scope can locate other troubles. For example, it can detect signals floating around at places where they should not be. The oscilloscope is the only instrument that can do this. In a set with "mysterious oscillations," beats, instability, and so on, observe the DC power supply circuits for any sign of a signal. An open filter capacitor can let a signal get into the power supply. Because the power supply is common to all stages, the unwanted signal will show up at a lot of places where it should not be, and can cause all kinds of trouble. The DC power supply circuit should produce a clean, straight "DC line" on the scope, even with the vertical gain of the scope advanced.

The only pitfall of this test is stray pickup from other circuits, especially the sweeps. Avoid this by using a well-shielded scope probe. If your scope is very sensitive, you also might have to shorten the ground lead to get rid of stray pickups. Check for stray pickup by holding the probe near the test point. Note the shape and amplitude of the **normal** stray-field pickup at that point. However, if you are testing a DC supply line, this pickup should disappear the instant you touch the probe to the terminal. If the filters are good, they should make the impedance to ground from this point very low, so that, with respect to an AC signal, you are actually grounding the probe tip. Because large filter capacitors are used in transistor-TV circuits, the impedance from any point in the DC power supply to ground should be only a few ohms. With an impedance that low, not much signal should be developed across it.

There is one precaution which I will repeat several times: When a ripple or unwanted signal is found floating around on the DC supply lines of a tube-type set, it is common practice to bridge a new filter capacitor across it, which should eliminate the ripple. Do **NOT** use this method in transistor-TV servicing. The filter capacitors used in transistor circuits are very large ones. If you bridge one of these across a circuit **with the power still**

on, the resultant charging surge can damage the transistors, or it can trip the circuit breaker. As I have said before, transistors do **not** take kindly to transient surges, so avoid them.

The proper way to bridge filter capacitors in transistor TV is to **TURN THE SET OFF** before putting the test capacitor across the suspected capacitor. Then, turn on the set. Since transistor circuits do not require warmup, you will not lose a bit of time—and you might save yourself a lot of trouble.

Ohmmeter Tests in Transistor Circuitry

There are a number of quick ohmmeter checks you can make on transistors. However, you need to know the polarity of the ohmmeter voltage. In other words, determine whether the red test probe is positive or negative. In almost all volt-ohmmeters and vacuum-tube voltmeters, it will be negative. In a great many solid-stage voltmeters, the red ohmmeter probe will be positive. In some instruments, such as the Triplet 310-F, the polarity of the ohmmeter voltage can be reversed at the probe-tips, with the "+ Volts, – Volts" switch.

If you will remember that all transistors can be thought of as three diodes, this will make testing them easy. A resistance reading from base to collector should produce a high reading; reversing the ohmmeter probes should produce a low reading. This holds true for any combination of the transistor terminals. If you read a short both ways on any pair of terminals, the transistor probably is shorted. Check the circuit to make sure. In some cases, a very low resistance will be present in the circuit itself, across the terminals you are testing. If so, for an accurate test, you will have to remove the transistor from the circuit. In many cases, removing one end of a shunting resistor will isolate the transistor, and complete removal of the transistor will not be necessary.

You can identify the polarity of a transistor with an ohmmeter, as shown in Fig. 6. If you connect the negative lead of the ohmmeter to the base, you should get a low-resistance reading to both collector and emitter, on all PNP transistors. A low-resistance reading to the collector and emitter, with the positive ohmmeter lead connected to the base, indicates an NPN transistor. In both cases, reversing the ohmmeter probes should produce a high-resistance reading.

The actual resistance reading will vary with the type of transistor. Most silicon transistors have a very high back resistance (ohmmeter battery is reverse biasing the transistor), which can be as high as several hundred thousand ohms. The forward resistance will be much lower. There always will be a very obvious difference in forward and back resistance, and this "diode effect" is the key clue. Germanium transistors will show a lower forward resistance and a lower back resistance than silicon transistors, in most cases.

If you get the same resistance in either direction, something usually is wrong. In all types of bipolar transistors (meaning all kinds except field-effect transistors), a shorted transistor usually will read practically zero resistance in both directions. This is especially true of the larger power transistors you will find in horizontal and vertical sweep circuits, and audio output stages. They usually become a dead short and are easy to identify from the burned resistors, blown fuses, etc., they leave in their path.

You should look for the diode effect in all in-circuit transistor testing. Because of the wide variation in transistor resistances, normal "resistance-to-ground" analysis is inconclusive. If you find what seems to be a dead short in a circuit, reverse the ohmmeter probes. If the short disappears, leaving a fairly high resistance, chances are you are reading across a forward-biased diode somewhere in the circuit (it might even be the junction of another transistor). You might find several diodes in the circuit, which can give you the same kind of misleading readings. Diodes are used as gates, clamps, and even for coupling in a lot of circuits. If you know they are there, you should not have any trouble. The diode can even be a rectifier in the DC power supply. If you get what looks like a dead

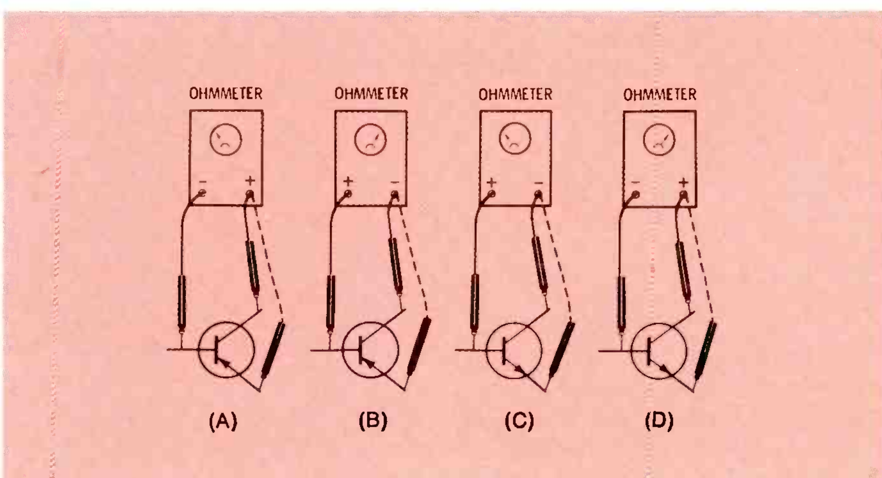


Fig. 6 Identifying transistors with an ohmmeter. (A) PNP transistor reads low resistance to collector and emitter with negative lead of ohmmeter connected to base. (B) PNP transistor reads high resistance to collector and emitter with positive lead of ohmmeter connected to base. (C) NPN transistor reads low resistance to collector and emitter with positive lead of ohmmeter connected to base. (D) NPN transistor reads high resistance to collector and emitter with negative lead of ohmmeter connected to base.

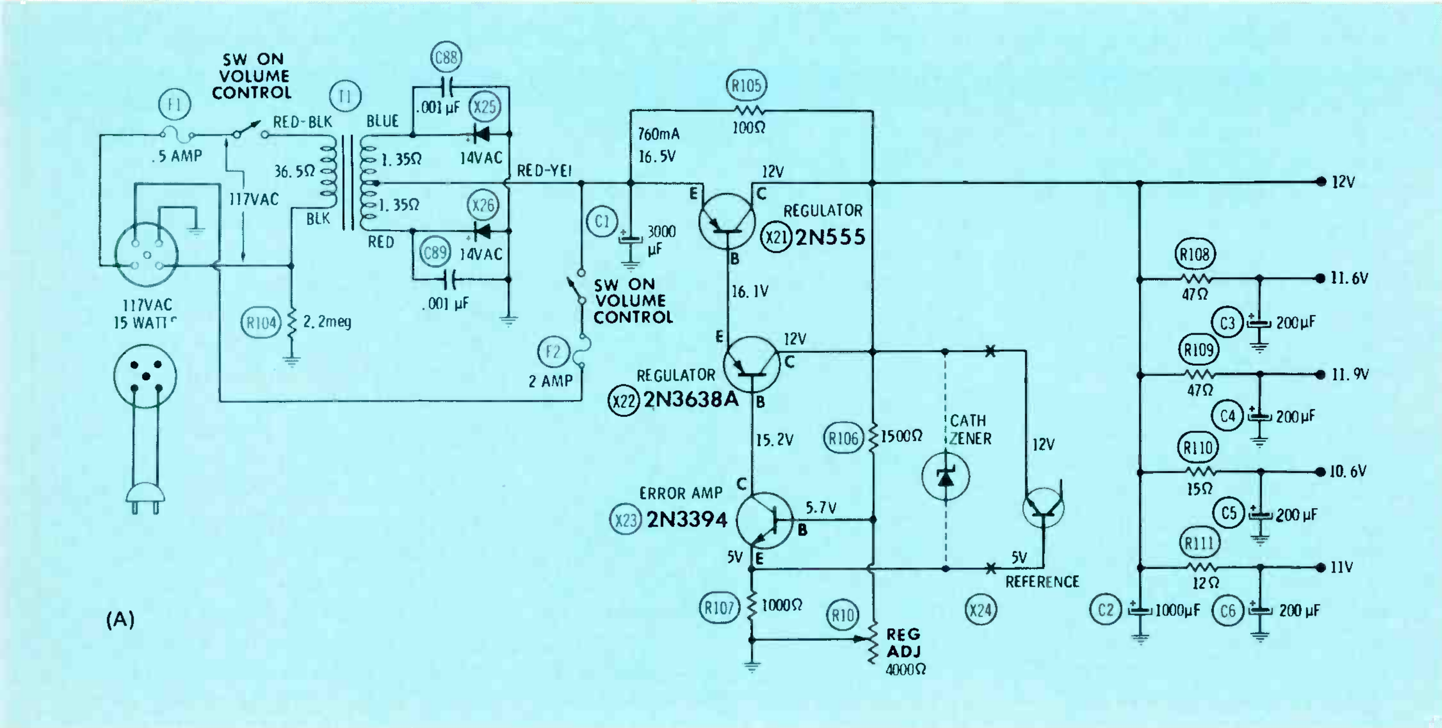
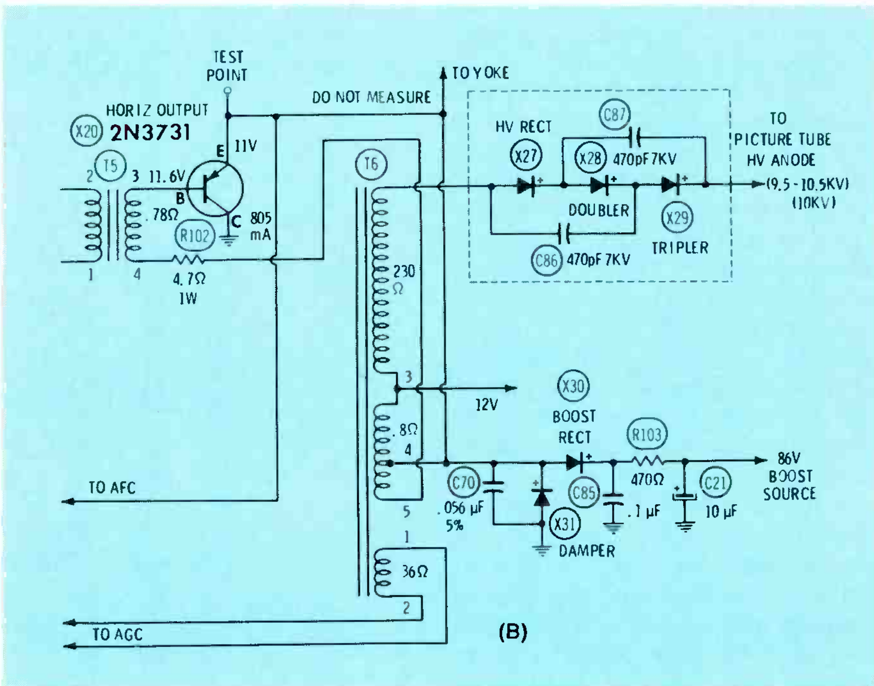


Fig. 7 Power-supply and horizontal-output circuits used in General Electric TV chassis. (A) Regulated power-supply circuit. (B) Hoirzontal-output circuit.



short on one of the DC voltage supply lines, turn the ohmmeter around and check again. If your ohmmeter was forward biasing one of the rectifier diodes, you were getting a false indication of a short. This is especially common in power supply circuits using a half-wave voltage doubler.

In a tube-type set, with a blown fuse, your normal test procedure should be to start checking through the power-supply circuits, looking for a point which showed a very low resistance to ground. When you find this point, you usually will have located the short circuit which blew the fuse. However, the low-voltage circuits used in transistor TV **normally** will have a very low resistance to ground, which can mislead you. In actual practice, you will find resistances of 20, 30 and 40 ohms to ground. This usually would indicate a **short** in **tube** circuitry, but not in transistor circuits.

For example, let us consider a General Electric TB chassis transistor TV. Fig. 7 shows the DC power supply and horizontal output circuit for this set. Note that the +12-volt DC supply source is connected directly to the emitter of the horizontal output transistor, through a very small winding on the flyback. You must take this transistor into account when making resistance measurements in the power supply.

The actual resistance you read through a transistor junction, in many cases, will depend on the battery voltage and polarity of your ohmmeter. In practically all VTVM's, the black lead of the ohmmeter (common) is connected to the positive battery terminal. A positive ohmmeter voltage on the collector (ground) of the PNP horizontal output transistor, shown in Fig. 7B, gives you the **lowest** reading when the ohmmeter battery **forward biases** the junction of the transistor. In this circuit, the damper diode also will affect the resistance reading across the +12- volt source.

One helpful method, when checking for power-supply shorts, is to disconnect the DC power-supply lead connected to the horizontal output stage, vertical output stage, etc., at the output of the power-supply voltage regulator. If there is no regulator, disconnect the power-supply lead at the output filter. Now, you can check from the power-supply lead of each circuit to ground, and perhaps get some more useful information. For example, if you get a zero reading to ground both ways on the power-supply lead to the horizontal output transformer, there is reason to suspect that the output transistor or damper diode is shorted.

The method of disconnecting various circuits can speed the task of finding a short. Connect a DC voltmeter to the open output lead of the power supply, and turn the set on. The power supply should remain at its rated output voltage, even under no-load conditions, if the voltage regulator is working. If the DC voltage goes up to its rated value and stays there, you have cleared the power supply from suspicion, and have eliminated one of the major causes of trouble.

If the power supply shows a short, and it does use a voltage regulator, disconnect the input to the voltage regulator and check it again. This test will isolate the trouble to the power supply itself or to the voltage regulator circuit. A collector-emitter short in the series regulator transistor should not blow the fuse. However, you will have no regulator action at all, and the output voltage will be much higher than it should be. An open series regulator will cause the DC voltage at the output to be zero, with normal input voltage. A base-collector short in the series regulator transistor will probably blow the fuse, and possibly burn out one or more of the small error-amplifier transistors, zeners, etc.

With the power-supply output lead to a given circuit open, you can put a milliammeter (or an ammeter, in some cases) in series with the circuit being supplied, and read the current. This should tell you which circuit is shorted.

Just as in tube-type sets, there are certain places where you will find the great majority of short circuits. In transistor-TV circuitry, these will be the high-current transistors, such as the horizontal and vertical output transistors, the audio output transistors and the regulator transistor. These cause the majority of dead shorts, since they usually are connected directly to the DC power source. Smaller transistors short, too, but there almost always will be resistors in the circuit between the power supply and the short. If one of these is burned, go straight to the cause of the short, by simply looking on the load side of the burnt resistor.

Quick Checks

There are many "quick checks" for servicing transistor-TV circuits. Key voltage readings will tell you instantly whether a stage is working or not. However, the actual test procedure depends on the type of circuit used.

In amplifier stages, you will find the common-emitter circuit most often used. Fig. 8 shows a typical IF amplifier stage. In this circuit, there is a small resistor between the emitter and ground. If you want to know whether the IF stage is working, just read the emitter voltage on the transistor. If this is within 10 percent of the voltage given on the schematic, the stage is working and is amplifying the signal.

If the transistor is defective, the emitter voltage will be incorrect. For example, if the voltage is given as

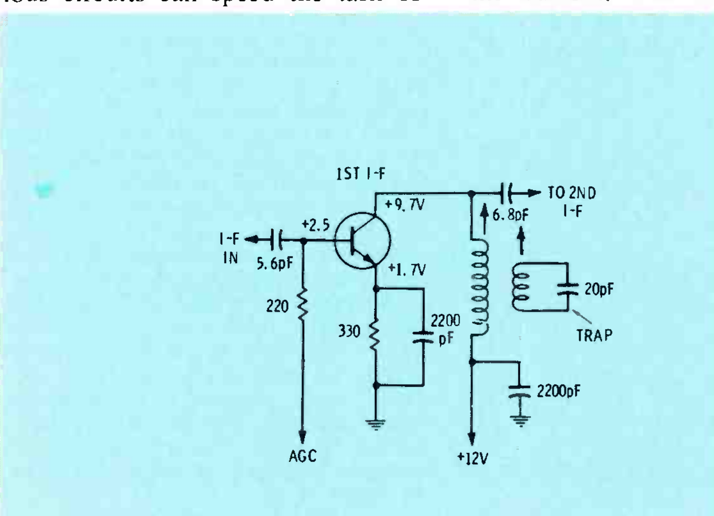


Fig. 8 Typical NPN transistor IF amplifier.

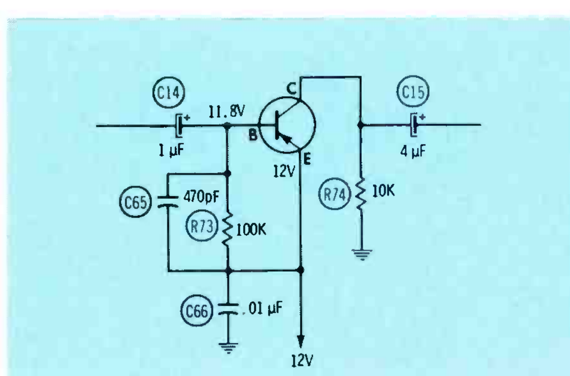


Fig. 9 A PNP sync separator stage.

1.7 volts, and you read zero volts, the transistor is not conducting at all. It is open internally, or biased to cutoff by a circuit defect. If you read the full collector voltage on the emitter, the transistor probably has a collector-to-emitter short. However, in some cases, a bias defect could cause the transistor to conduct excessively. This means that its effective collector-emitter resistance drops to a very low value and the emitter voltage will approach the collector voltage. In small-signal transistors, the high current caused by excessive conduction usually will be enough to overload the transistor and cause it to short out.

If the circuit is connected so that the DC supply voltage is applied to the emitter and base, with the collector circuit going to ground through a load resistance, you can use a similar test to determine if the stage is working. Such a circuit is shown in Fig. 9. Suppose the collector load resistance is 10K ohms, and the collector voltage is 1.0 volt. From Ohm's law, the normal collector current is 0.1 ma.

If the collector shows zero voltage, we know that there is no collector current flowing. The transistor is either open, biased to cutoff, or the collector load resistor is open. The bias can be determined very quickly by subtracting the base voltage from the emitter voltage. If the emitter and base voltages are exactly the same, the transistor is at zero bias and is cut off completely.

In Fig. 9, if the collector voltage is too **high,** there is excessive collector current flowing. This means either a shorted transistor, or too much forward bias. For this PNP transistor, the forward bias is **negative.** If this was an NPN transistor, too much **positive** voltage on the base would cause excessive current to flow in the collector-emitter circuit.

If the collector is connected to a low-resistance load, such as the primary of an IF transformer (Fig. 10), you will not get much of a voltage drop at the collector. Therefore, you simply read the voltage drop across the resistor in the emitter circuit. There might be a DC voltage on the emitter, but look for the voltage drop across the series resistor, which will be in the emitter circuit. This is exactly the same test you have used many times on tubes, when you read the voltage drop across a **cathode** resistor to find out how much **plate current** was being drawn. The plate-cathode circuit of any tube includes the plate, cathode and the power supply. Transistor circuitry is exactly the same. The collector-emitter circuit includes the collector, emitter and the power supply. You can determine current through the whole circuit by reading the voltage drop across any known resistor in it.

Testing Transistors

Servicing transistor TV does have one definite advantage over tube-type servicing: A transistor does not get weak, as a tube does. The output of a tube gradually drops as the cathode emission decreases. A transistor with a given beta (gain) still has the same beta until it becomes completely inoperative. A transistor can short, leak or open, but it will not get **weak.** Low output usually is caused by incorrect DC voltages, open coupling capacitors, etc. Weak signals can be caused by an open balun coil, bad RF transistor or IF transistor, and conditions where one amplifier stage is completely dead, with the signal leaking through to another stage.

The nearest thing to a weak transistor you will find is one which has leakage. This can be either collector-to-base leakage or collector-to-emitter leakage. Either one will upset the bias, and reduce the gain of the stage. When this happens, you will find normal supply voltages, but the DC voltages on the transistor itself usually will be incorrect.

The only practical check for leakage is to take the transistor out of the circuit. There almost always will be shunt paths in the circuitry which will keep you from getting an accurate in-circuit leakage test. In other words, a transistor tester usually will show you that there is leakage during an in-circuit test, whether this is a true leakage or not.

Transistor leakage has its worst effect in circuits such as sync separators, AGC keyers, and the like. The proper circuit action of these stages depends on the cutoff point, which is badly upset by leakage. With silicon transistors, widely used in such circuits, a leakage as small as 10 μa can cause complete failure of operation.

The preceding article has been adapted from a new Howard W. Sams book titled **"Transistor TV Servicing Made Easy"** (Catalog No. 20776), by Jack Darr; Copyright 1970, Howard W. Sams & Co., Inc., Indianapolis.

Written to help the experienced television technician become skilled in the techniques of transistor TV servicing, the content of this book is based on Mr. Darr's extensive personal experience in consumer electronic servicing. Jack Darr began servicing radios in 1927, and has been engaged in the electronics field since. Besides owning a service shop, he also is a well-known and highly respected author of many well-received books and articles about electronic servicing.

This text covers all the facets of transistor TV servicing, from test equipment, tool and service-aid requirements (Chapter 1) to transistor replacement (Chapter 10). Between these two chapters are sandwiched servicing techniques (Chapter 2, from which was taken the material in the preceding article) and a concise, but complete, analysis of the circuit operation and servicing of the individual circuits in a transistor TV, from DC power supply (Chapter 3) to audio circuits (Chapter 9). Also included are chapters on the sweep, vertical, video, AGC and sync separator circuits, as well as the tuner.

A valuable source of direct-from-the-bench, practical service techniques, this book is considered "must reading" for all electronic service technicians. ▲

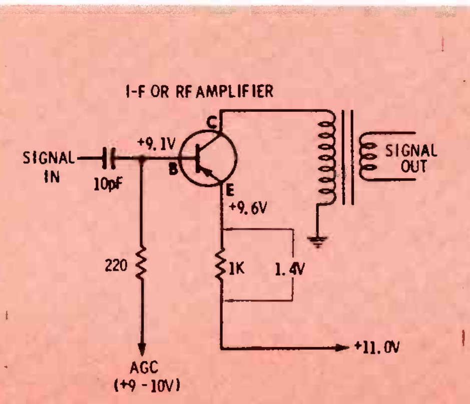
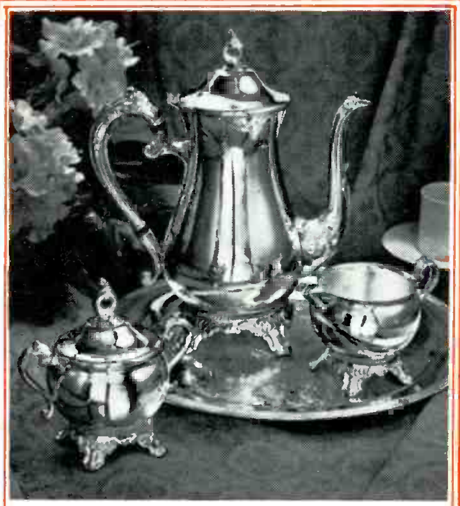


Fig. 10 Measure voltage across emitter resistor to determine collector-emitter current.

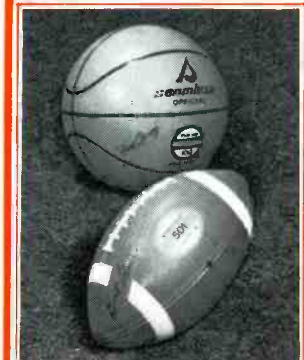
BRING ON THE GIFTS WITH RCA

All these attractive gifts are available with your purchases of RCA entertainment receiving tubes from your local participating RCA tube distributor. See your participating RCA tube distributor for complete details . . . and bring on the gifts at holiday time!



Westchester by Gorham Silverplated 4 Piece Coffee Server (1A1877) This elegantly styled set includes coffee server with 9 cup capacity, a sugar server, a 6 ounce creamer with cap, and a beautiful oval tray.

Oster Deluxe Beauty Salon Hair Dryer (1A1874) Ladies can enjoy professional hair drying right in the home. Gentle filtered air, adjusts to cool, warm, medium or hot, provides quiet, fast drying.



Bob Cousy Professional Basketball (1A1880) The players in your family will appreciate the basketball endorsed by Mr. Basketball himself. Hide-toned, official in size and weight.

Bart Starr Official Size Football (1A1879) Boys will get a charge out of playing with the football endorsed and approved by the great Green Bay Packer quarterback, Bart Starr.

Mickey Mouse Folding Alarm Clock (1A1875) Kids will love this one. Mickey Mouse points out the time with his animated hands in this uniaue 40 hour folding-case alarm clock.

"Spartan" Wrist Watch (1A1878) For boys *or* girls, the "Spartan" by Vantage is a "this-minute" watch with wide band, heavy link styling that is very much part of the contemporary youth scene.

The New Kodak Instamatic X-15 Self Powered Flash Camera Kit (1A1876) The Magicube Type X is the newest, easiest way to take great flash pictures every time. No flash batteries are required in this new breed of camera.

Electronic Components, Harrison, N.J.

RCA

The stereo generator—

Selection and application

Facts you should consider when selecting a stereo generator, and, after you've made your choice, how to properly use it to align and troubleshoot FM stereo systems.

by Leonard Feldman

If you've tried to align stereo FM circuits using "off-the-air" signals, you've probably decided it can't be done. Circuits are entirely too critical, and, unlike the early days of stereo FM, broadcast stations today seldom provide left-only or right-only signals which you can use as a "test signal". For proper alignment of stereo FM receivers, a stereo FM signal generator is a must.

Before you decide which of the many stereo generators will best serve your needs, there are a few things you should know about the types available. **After** you've decided on the make and model, there are a few more things you should know to make your investment pay off. Both the before- and after-purchase tips are the subjects of this discussion.

Selecting One of Two Basic Types of Generators

The earliest stereo FM generators offered to service technicians and engineers usually provided a composite stereo signal only. The single signal available at the output of these generators included the right proportions of 19-KHz pilot carrier, a left-only or a right-only audio signal (internally supplied by means of an audio oscillator with one or more selectable frequencies), and, sometimes, a means for externally modulating the composite signal by means of a separate audio oscillator.

Later, manufacturers combined the composite signal generator with built-in RF oscillators which could be FM-modulated by the composite signal. Usually, the RF oscillator section provided a non-attenuatable RF output signal of several thousand microvolts.

Such a high-amplitude RF signal is fine for making quick checks of the overall performance of a stereo FM tuner or receiver, but is not suitable for stereo sensitivity measurements or any "weak signal" alignment work such as would be necessary when working on quality, high-fidelity equipment. Also, the RF frequency of the all-in-one generator usually is pre-set to about 100 MHz, with a fine-tuning control which permits changing frequency only a few hundred KHz in either direction. Unless you are in a very poor FM reception area or have a shop equipped with an expensive "screen room", the middle of the FM frequency band in your area probably is loaded with station signals which would tend to interfere with your measurements.

If you already own a decent FM generator **capable of being externally modulated** by frequencies up to 67 KHz, purchase a stereo generator which provides **only** the stereo composite signal. If you don't own an FM generator, choose a stereo FM generator which produces its own RF signal.

If you have a good FM generator, first determine how many volts (rms) it takes to externally modulate it to full 75 KHz deviation. Some generators require only one or two volts of external audio for full external modulation, while others require as much as 10 volts rms. Make certain that the stereo generator you buy provides sufficient amplitude of composite stereo signal to fully modulate your FM generator.

Another important point to consider is the **separation capability** of the generator. Some inexpensive stereo generators provide a maximum separation capability of little more than the minimum 30 dB required by the FCC for all stations transmitting stereo programming. Some of the better stereo tuners and receivers boast separation capabilities of 40, and even 45, dB—a claim you will never be able to veritfy with a generator that puts out a signal with inherent separation no better than 30 or 35 dB.

Finally, you must decide how important it is for you to be able to check separation at **all** frequencies (and even demonstrate stereo programming to your customers using your stereo generator). While some generators have enough built-in audio frequencies to check separation at low, middle and high ends of the audio band, not all have additional provisions for external application of left and right programming of your choice.

Checking Out the Generator

Regardless of which type generator you select, the first thing you should do is verify its rated performance. Using a stereo tuner or receiver for this purpose is rather meaningless, unless you are absolutely certain of the specifications and state of alignment of the tuner or receiver. Instead, make a few

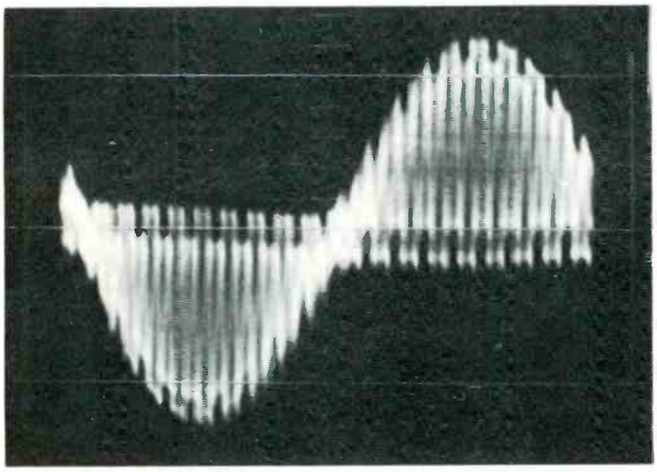


Fig. 1 Scope photo shows one complete cycle of composite stereo signal, with left-only (or right-only) 400-Hz audio signal applied.

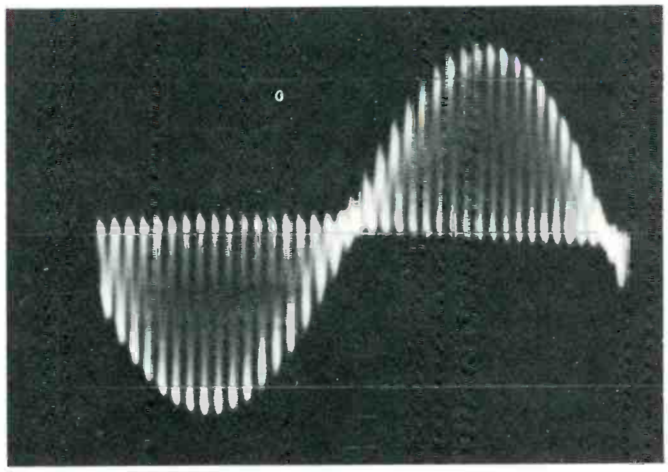


Fig. 2 Composite stereo signal of Fig. 1, with 19-KHz pilot carrier omitted.

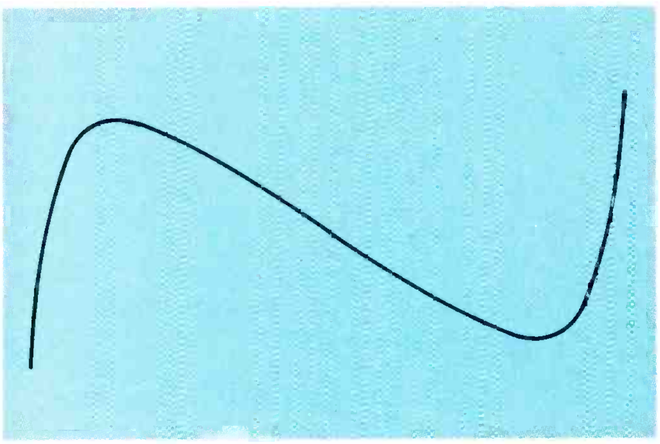


Fig. 3 Main-carrier contribution to composite signal of Figs. 1 or 2 consists of an audio sine wave at 400 Hz.

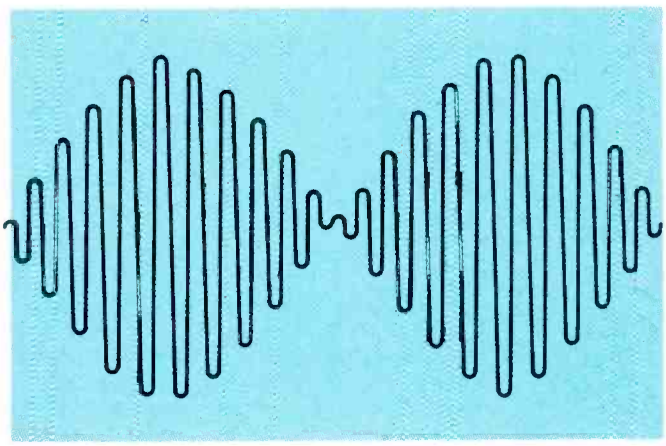


Fig. 4 Subcarrier contribution to composite signal of Figs. 1 and 2 consists of upper and lower sidebands; 38-KHz sub-carrier is suppressed. Actual frequencies present are 37.6 and 38.4 KHz.

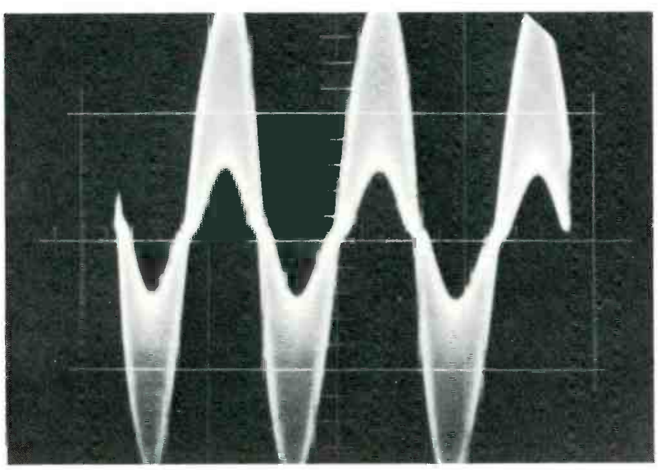


Fig. 5 Insufficient subcarrier contribution to composite signal, because of either scope roll-off or incorrect generator adjustment, results in distorted waveform shown here.

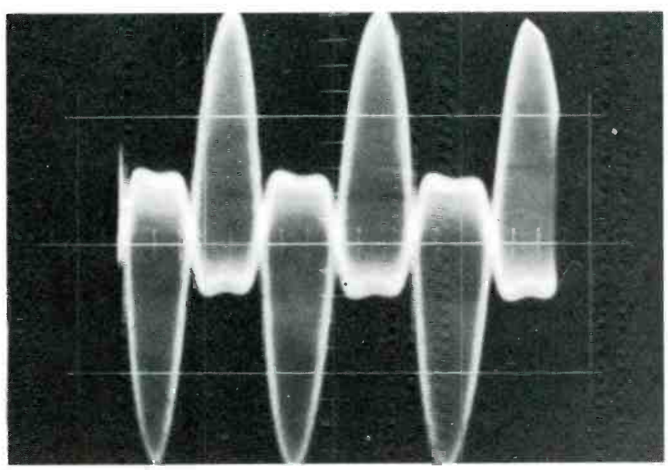


Fig. 6 Too much subcarrier contribution, compared to main channel signal, results in distorted composite signal shown here.

simple oscilloscope measurements.

Fig. 1 is a photo of a composite left-only stereo signal scoped at the output of a stereo generator. The audio frequency is 400 Hz, and riding above it is the ever-present 19-KHz pilot carrier signal. Fig. 2 shows the same display, with the 19-KHz pilot carrier turned off. When setting the level of 19-KHz signal, remember that it should be about 8 to 10 percent of the amplitude of the total composite signal, with full modulation.

The composite waveform in Fig. 2 can be thought of as consisting of a main channel sinusoidal wave, as shown in Fig. 3, plus an AM-modulated 38-KHz carrier, with the carrier itself suppressed and only the upper and lower modulation sidebands remaining, as shown in Fig. 4. When these two components are added together, the result is the waveform in Fig. 2, in which the sidebands contain frequencies above and below the 38-KHz suppressed subcarrier, depending upon the modulating audio frequency. For example, if a 15-KHz tone is to be transmitted (the upper limit of FM fidelity), the sidebands generated will be 38 KHz $\pm$15 KHz, or 23 KHz and 53 KHz.

The scope used to observe these and other waveforms associated with stereo FM must have perfectly flat response and phase shift characteristics to at least 53 KHz, if meaningful observations are to be made. If the scope used for viewing the modulated signal previously described rolls off above, say, 20 KHz, the sideband amplitudes will be too low compared to the audio sinewave of the main channel, resulting in a waveform like that in Fig. 5. If such a waveform is seen on a scope that is known to have acceptable flat response, the trouble is in the generator itself, and corrective steps should be taken to restore a flat "baseline" to the composite signal waveform. (Methods for aligning your particular stereo generator usually will be detailed in the instruction manual supplied with the equipment, since each type of generator follows a different design scheme.)

The converse defect—low frequency response attenuated with respect to high frequency response—can cause an equally distorted composite waveform, such as that shown in Fig. 6. In this case, the "main channel" contribution is too great in amplitude with respect to the sub-channel sidebands, and the stereo FM generator should be realigned properly.

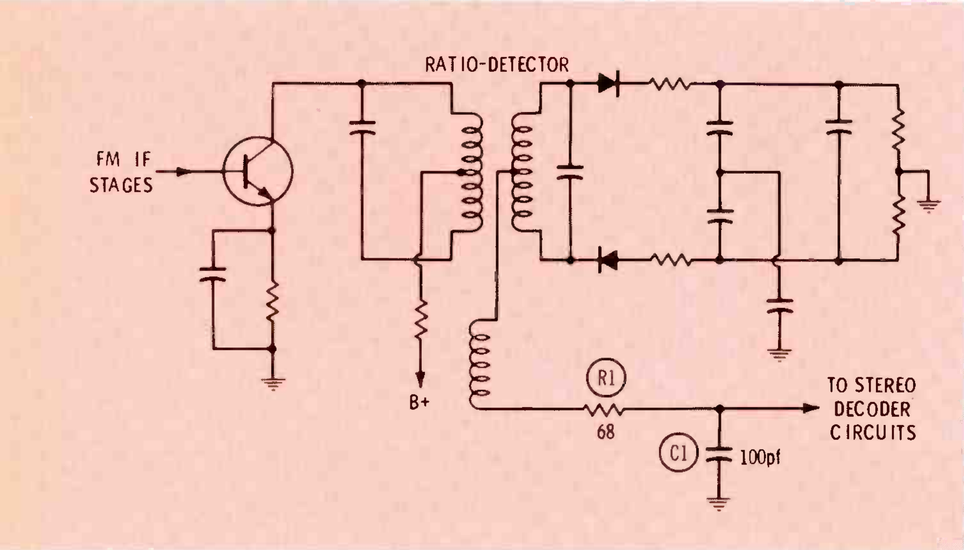


Fig. 7 Partial schematic of typical ratio-detector circuit. R1 and C1, as well as stray capacitance, can cause roll-off of subcarrier sideband amplitude.

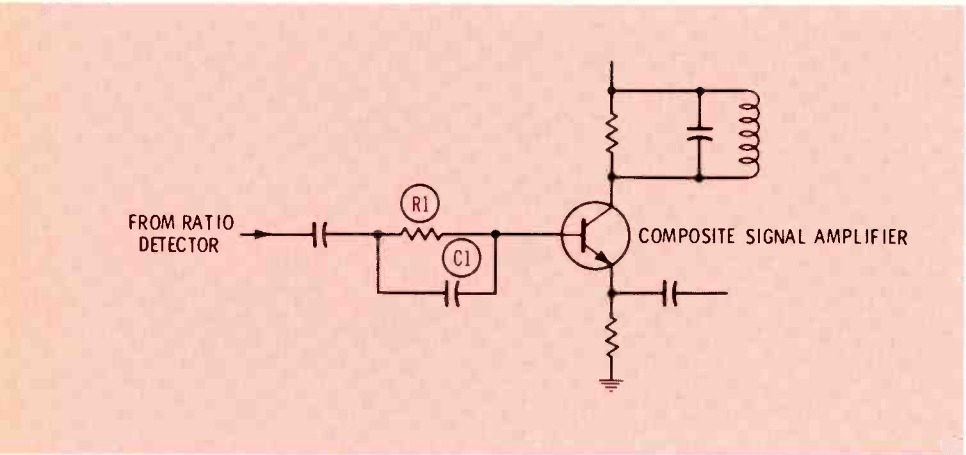


Fig. 8 Compensating network R1-C1 is often placed ahead of decoder circuit input to boost high frequencies previously attenuated at ratio-detector output.

Using the Stereo Generator

The reason we don't recommend separate analysis of the decoder circuitry of a tuner or receiver, but instead suggest **overall** RF application of the stereo signal, will be apparent from the partial schematic shown in Fig. 7. This diagram shows the output circuit of the ratio detector, where the composite signal normally is obtained and from where it is fed to the decoder circuitry. The combination of R1 and C1, at the output of the ratio detector transformer, plus any stray wiring capacitances in the surrounding circuitry, can cause some attenuation of the higher frequencies contained in the recovered composite stereo signal, resulting in a detected composite signal very similar to that shown in Fig. 5. Normally, a designer faced with this problem will compensate for this roll-off in response by including an equalizing, or high-frequency emphasizing, circuit right at the input of the decoder, as shown in Fig. 8 (in which the compensating components are R1 and C2).

Other frequency and phase corrective networks also might be placed further on in the decoder circuitry. If a generator that produces a perfect composite stereo signal was connected at the input of the decoder circuit, the resulting separation measured at the left and right output terminals of the decoder would be **far from perfect,** because the decoder was actually designed to compensate for an **imperfect** composite signal, such as it normally receives from the "imperfect" IF and detector circuit preceding it. For this reason, it is much better to use the composite signal of your generator as a modulating signal for your FM generator, and then feed the modulated RF signal to the antenna terminals of the tuner or receiver under test. A complete test set-up is shown in Fig. 9.

Setting Up Proper Stereo Signal Modulation

We have already discussed the technique of setting the 19-KHz pilot carrier to the proper level with respect to audio level of the composite signal. At this point you might think that it now only is necessary to hook up the composite signal to the external modulation terminals of the FM generator and "crank up" the total composite amplitude until the modulation meter reads 75. This is not so.

Because of the complex nature of the composite signal, a conventional AC meter will not read the usual rms value (or 0.707 of one-half the p-p amplitude), but instead will read a much lower value. Thus, if you were to increase total signal amplitude until the modulation meter reads 75 KHz you would really be overmodulating the RF generator by a wide margin. The correct way to establish proper amplitudes of modulation using an external stereo composite signal involves the following step-by-step procedure:

1. Apply only 19-KHz signal, increasing the level until the RF generator's modulation meter indicates approximately 7 KHz.
2. Turn off the 19-KHz signal and apply an L-R (mono) audio signal, increasing its level until 68 KHz of modulation is indicated.
3. Turn on 19-KHz signal again and switch stereo generator mode to "L only" or "R only", without changing any audio levels.
4. In all probability, the modulation meter will now read about 45 or 50 KHz, but don't be concerned—you're actually applying full modulation of the **composite** stereo signal.

Step-by-Step Performance Analysis

Once you've established correct modulation of the FM generator with the stereo generator, the FM generator is connected to the antenna terminals of the tuner or receiver under test, and all subsequent tests and observations therefore will take into account the entire tuner, including all the complex relationships between regular tuner performance and stereo performance, and not just stereo decoder circuitry. For example, many modern stereo tuners are equipped with a threshold adjustment, which determines when the tuner will switch from "mono" to stereo reception, based upon signal strength, quieting or other factors. You can easily check this point by reducing the output of the FM generator (do **not** touch the stereo generator controls) until the stereo light goes out, or until you hear an audible indication that stereo separation has been eliminated. If too much (or little) output is required to "trigger" the switching action, it might be a fault of the threshold adjustment (if one is provided in the decoder circuitry) or it might be caused by poor sensitivity of the tuner circuitry ahead of the decoder. Further investigation will be needed to determine which is the case, using signal levels and conditions recommended by the manufacturer of the product. If you had tried to test the switching action by applying a composite stereo signal **directly to the decoder,** the poorly aligned or insensitive condition of the front end would not have been discovered.

It is a good idea to look at the detected composite waveform at the output of the FM detector in the

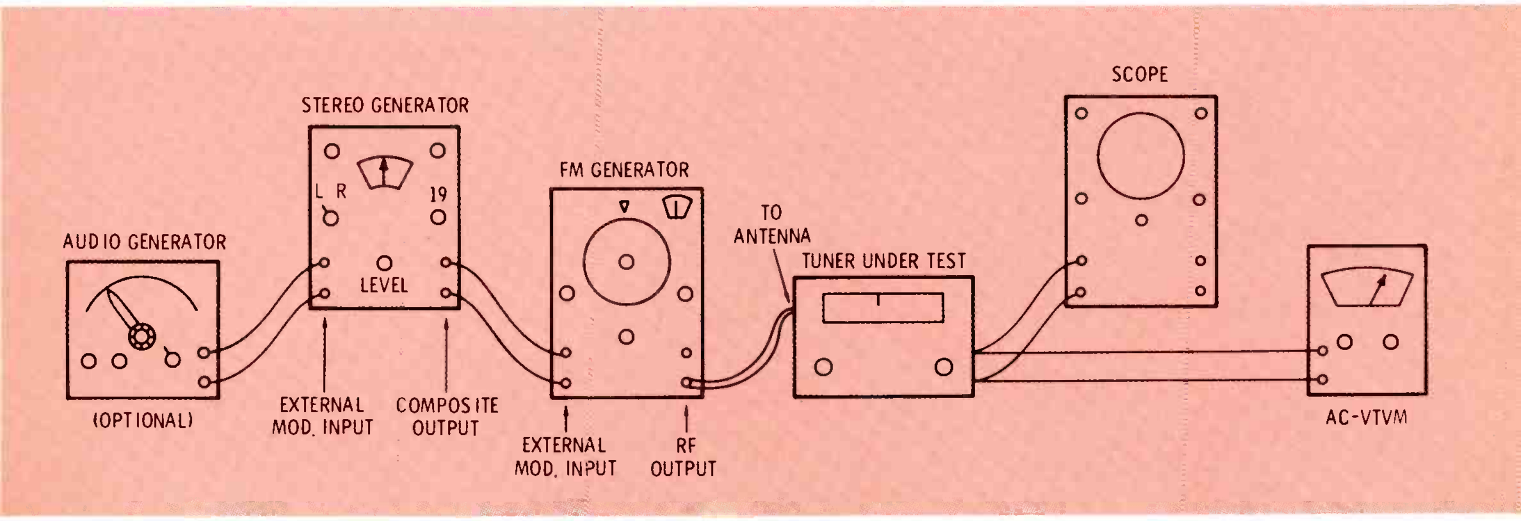


Fig. 9 Block diagram shows test setup recommended for checking and aligning the stereo portion of a stereo FM tuner or receiver.

main section of the tuner. It probably will resemble Fig. 5 instead of Fig. 6, for reasons already mentioned. After compensation (usually at the output of the first amplifying or isolating stage of the typical decoder), the composite signal probably will look more like Fig. 6 because **over-compensation** often is applied to compensate for subsequent attenuation of high frequencies in the final stereo demodulator circuitry that follows.

Other points along the circuit you should observe and adjust are the output of the 19-KHz amplifier (peaked to maximum, using a scope or, depending upon the circuitry, the stereo indicator light itself), the 38-KHz doubler tuned circuit (also peaked for maximum indication) and the 38-KHz demodulation transformer or autotransformer (peaked for maximum or for best separation).

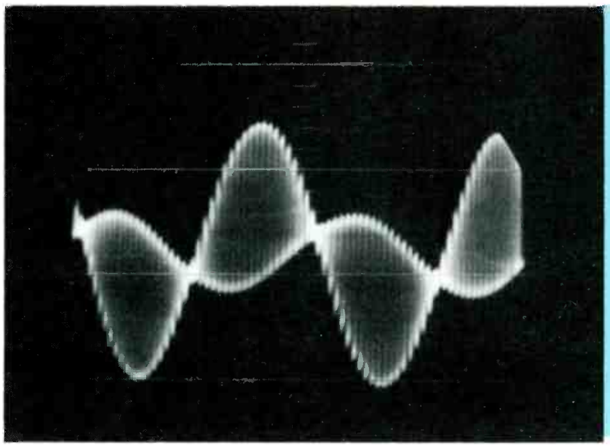


Fig. 10 Scope photo shows effect of phase error on composite signal, which often occurs at higher audio modulating frequencies. 19-KHz signal component has been omitted for clarity.

SCA Interference

Most stereo decoder circuits are equipped with one or more filters to eliminate cross-talk from any background-music (SCA) programming, which is transmitted with the public stereo broadcast, but on a separate subcarrier, usually 67 KHz. The traps included in most stereo decoder circuitry are designed to filter out this interfering signal.

While many stereo generators are equipped to produce a 67-KHz signal, others require the separate introduction of this additional signal by means of an audio oscillator connected externally. If such is the case with your generator, the 67-KHz signal applied to it should be just enough to cause a main-carrier modulation of 10 percent (7.5 KHz), with all stereo signals temporarily removed. After this level has been established, the 19-KHz pilot carrier should be added, and the waveform present at the **output** of any SCA filters in the tuner or receiver should be observed on a scope. Adjust all SCA traps for minimum 67 KHz signal, making sure you do not mistake the 19-KHz signal for 67-KHz, since both frequencies will be present. Ordinarily, if the residual 67-KHz signal is 34 or 40 dB lower than the peak composite stereo signal, it will not be too offensive to the listener.

(Contrary to our earlier statement, the SCA is one adjustment that is more effectively made from "off-the-air" programs than with test equipment, because the actual SCA subcarrier is FM modulated by the secondary background music program, so that the frequency of the subcarrier is actually moving back and forth at an audio rate from about 63 KHz to about 71 KHz. The modulation of the subcarrier is what causes the "swooshing" sound which we have come to identify as SCA interference—not the mere presence of a subcarrier itself. It therefore is good practice to give the SCA traps a final touch-up while listening to a stereo station that also transmits a background music program.)

Final Separation Measurements and Adjustments

After adjusting all the tuned circuits in a stereo decoder, you might find that there also is a small trimming potentiometer which further optimizes separation. This "pot" should be adjusted while observing the "R" output of the decoder circuit with an L-only signal at some mid-frequency (around 1 KHz) applied to the system. Then reverse the procedure, observing "L" output while an R-only signal is applied. If measured separation is not the same for both channels, it is better to "compromise" the adjustments so that separation is balanced. For example, it is better to have 30 dB separation at both outputs than to have 40 dB from "L" with only 20 dB from "R".

Separation is measured by first applying an "L" signal and reading "L" output as a reference, then switching to an applied "R" signal and recording the number of dB below the first reading that is now obtained. You can repeat separation measurements at all audio frequencies, from 50 Hz to 15,000 Hz, but don't be surprised if the separation readings obtained at the frequency extremes are much poorer than those obtained at mid-band. This is particularly true at the higher frequencies where, in addition to amplitude discrepancies between the main-channel and sub-channel components, there also might be **phase** discrepancies.

An example of phase error between main and sub-channel components of the stereo composite signal is shown in Fig. 10. Such a waveform also will cause poor separation. In fact, the FCC, in specifying tolerances for stereo FM broadcasting, insists that the phase error between main- and sub-channel components not exceed 2 degrees for any audio frequency from 50 Hz to 15,000 Hz. Maintaining such limits, as well as an amplitude discrepancy no greater than 3.5 percent, assures separation of at least 30 dB at all frequencies used.

Summary

The right stereo generator, used in conjunction with a good FM signal generator, can reduce stereo multiplex servicing to a few simple waveform observations and adjustments.

Troubles in stereo FM receivers often are the result of faults in the tuner section rather than in the stereo decoder circuitry. The ability to analyze tuner performance along with stereo performance as they relate to each other is essential for effective servicing of modern stereo high-fidelity systems. ▲

product report

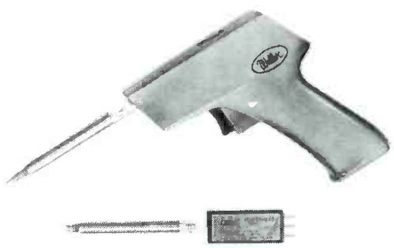
for further information on any of the following items, circle the associated number on the reader service card.

Soldering Gun

Weller Electric Corp. has announced the availability of a transformerless, pistol-grip soldering gun.

Tempmatic GT7A has an interchangeable, plug-in powerhead which automatically regulates the temperature of the 3/16-inch workpoint so that it does not significantly exceed 700 degrees F, according to the manufacturer. An extra 600-degree F, 1/8-inch workpoint also is available.

The powerheads incorporate Weller's closed-loop output control circuitry, which reportedly protects components from heat damage.



The tool is comprised of a basic trigger-operated handle which accepts the plug-in powerheads, Weller states that integral soldering points have special coating to eliminate corrosion and to assure a life expectancy of 30,000 soldering connections.

The tool, designed for 120-volt, 60-Hz operation, has a list price of under $10.00, including one powerhead.

Circle 60 on literature card

Shear Cutter

A new cutting tool, which reportedly provides a shear cut and eliminates distortion of the material being cut by providing full peripheral support during cutting, is now available from Techni-Tool, Inc.

The tool, designated the #2020 Shear Cutter, is capable of handling wire, pins and tubing up to .073 inch in diameter, ribbon up to .020

inch X .100 inch. The standard model has six holes: .073 inch, .064 inch, .052 inch, .040 inch, .032 inch, .025 inch and a ribbon slot measuring .020 inch X .100 inch.

The price is $35.00.

Circle 61 on literature card

Desoldering Tool

Edsyn Inc. has introduced "Soldavac", an economical desoldering tool.

The tool is loaded by pushing the plunger tab forward until it latches. When latched, an audible click will be heard and the lever located at the top of the tool will raise up briefly.

productreport

(continued)

After the Soldavac is loaded, the solder joint is heated with a soldering iron, and as the solder melts, the tip of the Soldavac is pressed lightly against the solder joint and the yellow trigger lever is depressed.

This desoldering tool, which weighs 3 oz., sells for $2.95 in quantities of 1 to 25.

Circle 62 on literature card

Mobile Parts/Work Station

A movable combination parts storage and work station has been introduced by Bay Products Division of American Metal Works, Inc.

The work station consists of a

Bay Small Parts Cabinet attached to a Bay Service Truck with a heavy-duty steel top working station. The cabinet shown contains 18 drawers and 54 adjustable-length compartments, each 5½ inches wide and 2½ inches deep. Two cabinets also can be placed back to back facing each side of the service truck. The mobile truck measures 36 inches X 24 inches X 36½ inches with 5-inch rubber tire casters.

The total list price of the Bay Mobile Work Station is $97.15. ▲

Circle 63 on literature card

advertisers' index

Circle 27 on literature card

Circle 28 on literature card

catalogs literature

ADVERTISING

100. *Jerrold Electronics Corp.*—has made available a 10-page booklet, "Retail Advertising Guide for Dealers," which offers pointers on selection of advertising media, how to prepare ads and hints on creating ads with an underlying theme.

101. *Seton Name Plate Corp.*—Catalog No. 70-B illustrates Seton's line of identification labels, ad posters, truck signs and other identifying products.

ANTENNAS

102. *Cush Craft* — has issued their new Amateur Antenna Catalog, which includes photographs and specifications on more than 50 amateur antennas and accessories.

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

104. *Vikoa, Inc.* — is making available a 64-page, illustrated catalog covering their line of wire and cables and IDS/MATV equipment. Hardware, accessories, connectors and fittings and an index also are included.

COMMUNICATIONS

105. *Sonar Radio Corp.* — Catalog titled "Sonar Business Radio, FM Monitor Receivers and CB Equipment" lists specifications and prices of this manufacturer's line of transceivers, receivers and communications accessories.

COMPONENTS

106. *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.

107. *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.*

108. *Ohmite Manufacturing Co.* — Catalog 300B, titled "Component Selector", is a 36-page shortform catalog which provides specifications and quick-delivery data about this manufacturer's line of resistors, rheostats / potentiometers, trimmers, potentiometers, top switches, variable transformers, relays, solid-state power controls, and RF chokes. Also listed are radial- and axial-lead resistors, precision Determohm® resistance decade boxes and thru-bolt mounting brackets for tubular resistors.

HARDWARE

109. *Atlee Corp.* — Catalog C70 lists specifications of standard hardware available from this manufacturer, including component holders, clips and circuit-board holders.

RETAIL

110. *North American Electronnics, Inc.*—8-page brochure details Mass Merchandiser Electronic Centers which include antenna kits, speakers, headphones, microphones, radio and components. Resale price and dealer net of each item are included in the brochure.

SERVICE AIDS

111. *Chemtronics Inc.* — is releasing the 8-page 1970 edition of "Electronic Chemical Products Made Exclusively for the Industry", Catalog No. 7071, which covers Chemtronics' complete line of aerosol and bottled chemicals used to speed servicing.*

TECHNICAL PUBLICATIONS

112. *Howard W. Sams & Co., Inc.*—literature describes popular and informative publications on radio and television servicing, communication, audio, hi-fi and industrial electronics, including their 1970 catalog of technical books on every phase of electronics.*

113. *Sylvania Electric Products Inc., Sylvania Electronic Components Div.*—has published the 14th edition of its technical manual, which includes mechanical and electrical ratings for receiving tubes, television picture tubes and solid-state devices. The price of this manual is $1.90.*

114. *TAB Books* — has released their 16-page, illustrated spring, 1970, catalog, describing over 125 current and forthcoming books.

TEST EQUIPMENT

115. *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.*

116. *Mercury Electronics Corp.*—14-page catalog provides technical specifications and prices of this manufacturers' line of Mercury and Jackson test equipment, self-service tube testers, testers, test equipment kits and indoor TV antennas.

117. *Sencore, Inc.* — has issued its 12-page 1970 catalog, Form No. 517, which describes the company's complete line of test instruments, and features 5 new instruments, with performance data and prices included.*

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

CUT TV ALIGNMENT TIME IN HALF!

with the all new
SENCORE SM158

SPEED ALIGNER

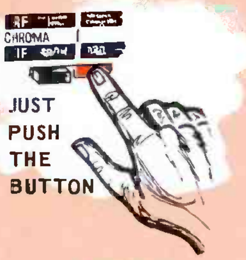
and at $120.00 less than competition!
only $275.00

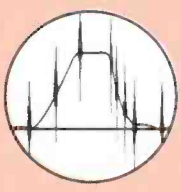
Here are 7 Reasons why we call the SM158 the Speed Aligner

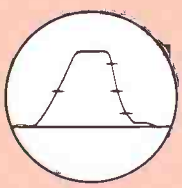
AUTOMATIC ALL CRYSTAL CONTROLLED MARKERS: You will never spend any more time looking up marker frequencies or interpreting them when you own an SM158; they are automatic. For example, want the chroma carrier on any RF curve, IF curve, or chroma curve, simply push the chroma carrier marker button. Want the sound, video, adjacent carrier markers or any other marker on any curve, just push the button as directed on the panel. The SM158 is fast and saves you time . . . that's why we call it the speed aligner.

UNLIMITED MARKER AMPLITUDE: The marker height control is like a powerhouse; crank it up as far as you want, even to the point where the markers are larger than the scope screen, without upsetting the response curve. Each marker is crystal controlled on fundamental frequencies and post-injected so that you may place all markers on the curve at unbelievable heights without affecting the curve in the least. That's why we call the SM158 the speed aligner.

EASY TO CONNECT: Just four connecting cables clearly marked TO TV and TO SCOPE. It takes just seconds to connect . . . that's why we call the SM158 the speed aligner.







TWO EXTRA VHF CHANNELS: Competition has only two VHF channels; the SM158 has an extra high channel and an extra low frequency channel to prevent any co-channel interference. The SM158 is interference-free . . . that's why we call it the speed aligner.

PLENTY OF SWEEP WIDTH: A full 15 megahertz sweep signal, constant on all IF, chroma and RF curves, provides adequate sweep width to cover new solid state IF amplifiers. Competition covers only 12 megahertz. The SM158 gives you the full picture the first time . . . that's why we call it the speed aligner.

GENERATES A ZERO REFERENCE BASE LINE: You know where zero is with the SM158. All alignment instructions show a base line, yet some competitors do not generate a base line. You can follow TV manufacturers' instructions to the "T", easier and faster with the SM158 . . . that's why we call it the speed aligner.

SWITCHABLE HORIZONTAL OR VERTICAL MARKERS: want to tilt markers 90 degrees so you can view markers better in traps or for leveling? Merely pull the MARKER HEIGHT control out and markers appear horizontally — a real plus feature.

THE IDEA PEOPLE

SENCORE

3200 Sencore Drive
Sioux Falls, South Dakota 57107

Circle 37 on literature card