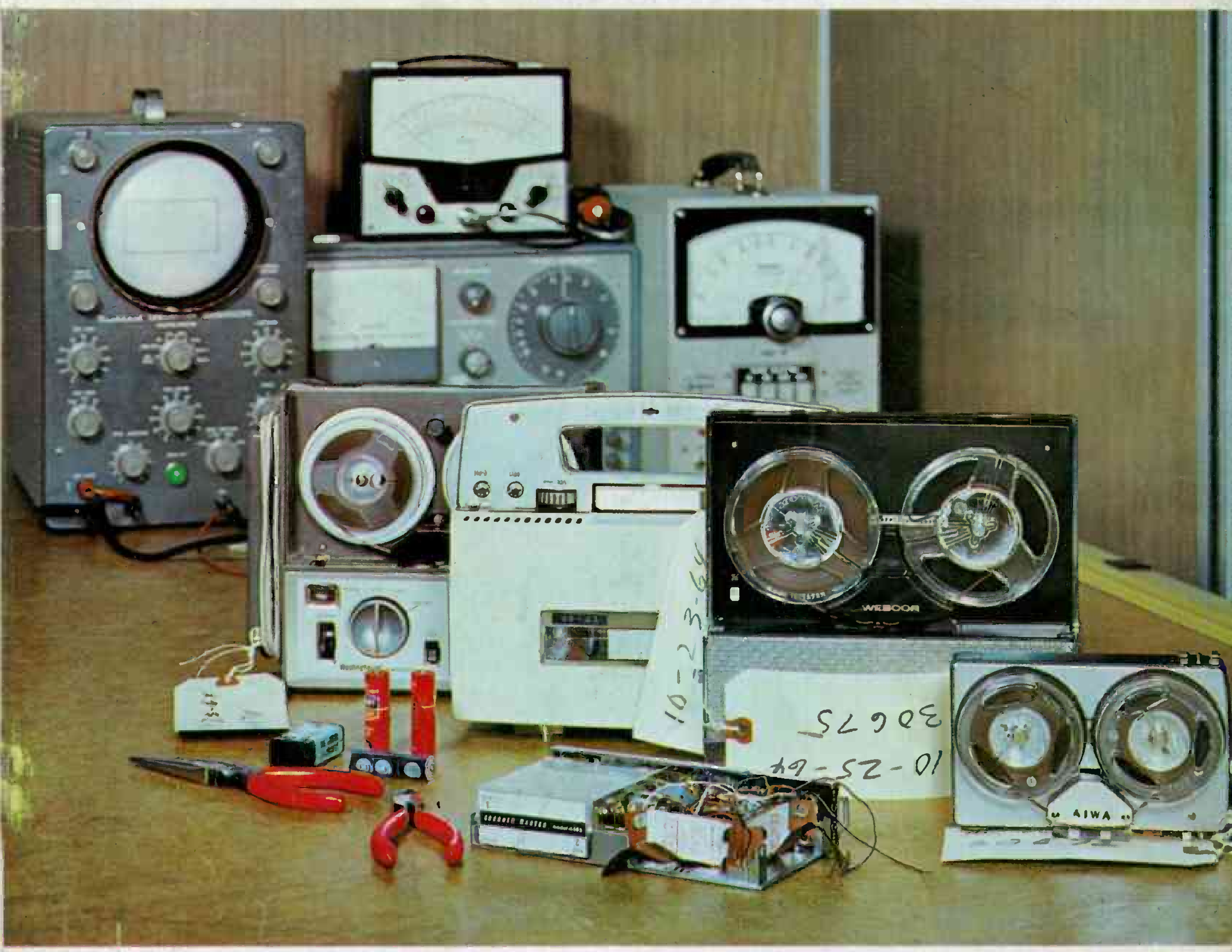
A HOWARD W. SAMS PUBLICATION

DECEMBER 1964/50¢

PF Reporter™

PHOTOFACT

the magazine of electronic servicing



- Find Profit in Small Tape Recorders
- Servicing Stereo Adapters
- The Knack of Filter Replacement
- Royal Road to Transistor Servicing
- Plus many more

How to replace top quality tubes with identical top quality tubes

Most of the quality TV sets you are presently servicing were designed around special Frame Grid tubes originated by Amperex. More and more tube types originated by Amperex are going into the sets you'll be handling in the future. Amperex Frame Grid tubes provide 55% higher gain-bandwidth, simplify TV circuitry and speed up your servicing because their extraordinary uniformity virtually eliminates need for realignment when you replace tubes.

Amperex Frame Grid Tubes currently used by the major TV set makers include:

2ER5 2GK5 2HA5 3EH7 3GK5 3HA5 4EH7 4EJ7 4ES8 4GK5 4HA5 5GJ7
6EH7 6EJ7 6ER5 6ES8 6FY5 6GJ7 6GK5 6HA5 6HG8 7HG8 8GJ7

If your distributor does not yet have all the Amperex types you need, please be patient—in some areas the demand keeps gaining on the supply.
Amperex Electronic Corporation, Hicksville, Long Island, New York 11802.

Circle 1 on literature card

1964 SUBJECT REFERENCE INDEX

To increase the usefulness of this year's Subject Reference Index, we have expanded the code of symbols as follows to identify regular department locations in the subject page listings: CCM, Color Countermeasures; CS Communications Supplement; Sym, *Symfact;* Sym Jr, *Symfact Jr.;* TE, Notes on Test Equipment; TS, The Troubleshooter; and VSS, Video Speed Servicing.

INDEX OF TITLES

Tarzian offers FAST, DEPENDABLE TUNER REPAIR SERVICE (ALL MAKES)

ONLY $9^{50} INCLUDING

ALL PARTS (except tubes) and LABOR

24-HOUR SERVICE 1-YEAR WARRANTY

It just makes sense that a manufacturer of tuners should be better-qualified, better-equipped to offer the most dependable tuner repair and overhaul service.

Sarkes Tarzian, Inc. pioneer in the tuner business, maintains two complete, well-equipped Factory Service Centers—assisted by Engineering personnel—and staffed by specialized technicians who handle ONLY tuner repairs on ALL makes and models.

Tarzian-made tuners received one day will be repaired and shipped out the next. Allow a little more time for service on other than Tarzian-made tuners.

Tarzian offers a 12-month guarantee against defective workmanship and parts failure due to normal usage. And, compare our cost of $9.50 and $15 for UV combinations. There is absolutely no additional, hidden charge, for ANY parts except tubes. You pay shipping costs. Replacements on tuners beyond practical repair are available at low cost.

Tarzian-made tuners are identified by this stamping.

When inquiring about service on other tuners, always give TV make, chassis and Model number. All tuners repaired on approved, open accounts. Check with your local distributor for Sarkes Tarzian replacement tuners, replacement parts, or repair service.

TWO SERVICE CENTERS TO SERVE YOU BETTER

See your distributor, or use the address nearest you for fast factory repair service

537 South Walnut St. Bloomington, Indiana Tel: 332-6055	10654 Magnolia Blvd. North Hollywood, Calif. Tel: 769-2720

SARKES TARZIAN, INC.

Bloomington, Indiana

MANUFACTURERS OF TUNERS . . . SEMICONDUCTORS . . . AIR TRIMMERS . . . FM RADIOS . . . AM/FM RADIOS . . . AUDIO TAPE . . . BROADCAST EQUIPMENT

Circle 2 on literature card

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A HOWARD W. SAMS PUBLICATION

PF Reporter™

PHOTOFACT

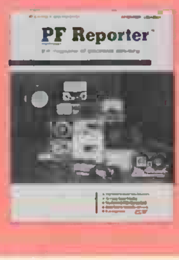
the magazine of electronic servicing

VOLUME 14, No. 12 DECEMBER, 1964

CONTENTS

ABOUT THE COVER

The small-sized tape recorders shown on this month's cover can be the source of large-sized profits. The holiday season will see a sharp increase in sales of personal portable recorders, each of which is a possible candidate for service. Join other successful technicians and follow the hints in the article on page 55.



QUESTION:

When it comes to electrolytic capacitors, why do more than half of the nation's Radio-TV Service Technicians prefer to do business with Sprague Distributors?

ANSWER:

Because they don't want makeshift substitutions or multi-rating "fits-all" capacitors. They insist on exact replacements, which are always available through Sprague Distributors everywhere.

SPRAGUE **TWIST-LOK**® CAPACITORS...
1863 different ratings and sizes...
the world's most complete selection of **EXACT** replacements!

Wouldn't you really rather have what the set manufacturer recommends? An exact replacement in capacitance, voltage, and size is easier to install and less expensive, in most cases, than substitutes!

We don't have to tell you that it's easier to service with *exact* replacements. And we don't have to tell you that it's better, too. When sets are designed, specific capacitance values are used for peak operation, so it takes *exact* replacements to restore original set performance.

And who better than Sprague knows which values and sizes are needed in the replacement market? Sprague, the world's largest component manufacturer, has the most complete specification file on original set requirements. That's why you're always right when you service with Sprague TWIST-LOK *exact* replacements!

GET YOUR COPY of Sprague's comprehensive Electrolytic Capacitor Replacement Manual K-107 from your Sprague Distributor, or write Sprague Products Company, 105 Marshall Street, North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

WORLD'S LARGEST MANUFACTURER OF CAPACITORS

65-127-63 R2

Circle 3 on literature card

For window-size blow-ups of this message, send 10c to Sprague Products Co., 105 Marshall St., North Adams, Mass., to cover handling and mailing costs.

Is "do-it-yourself" TV Service as dangerous as they say?

When a TV set starts "acting up," a tube is often involved. At least, that's where the trouble *appears* to be.

Some people will pull the back off the set, remove the tubes, and take them to the "do-it-yourself" tube tester at the neighborhood store. The test instrument shows which tubes are faulty (but not always—some faults do not show up on these testers). Replacements are purchased, then inserted into the set. Reception improves, and the trouble has been caught and corrected.

BUT HAS IT?

The self-service test instrument checks *tubes.* It can't test the *more than 500 other parts* in your set! It can't show you the *source* of the trouble that probably blew the tube. Neither can it show the damage often suffered by other parts due to the faulty tube.

Mere tube replacements do not always cure these trouble spots. Weak links continue to exist, *setting up chain reactions of damage, trouble, and expense!*

The total failure of many a good TV set can be traced directly to "do-it-yourself" tinkering.

Your TV set is the most complicated device you own—far more complex than even your automobile. When you need TV service, call an expert technician—your fully trained and experienced Independent Service Dealer.

AFTER ALL, YOU WOULDN'T ENTRUST YOUR JOB TO AN AMATEUR, WOULD YOU?

THIS MESSAGE WAS PREPARED BY SPRAGUE PRODUCTS COMPANY,
DISTRIBUTORS' SUPPLY SUBSIDIARY OF SPRAGUE ELECTRIC COMPANY, NORTH ADAMS, MASSACHUSETTS FOR . . .

YOUR INDEPENDENT TV-RADIO SERVICE DEALER

Circle 4 on literature card

Letters to the Editor

Dear Editor:

I've noticed lately the capacitor value abbreviation "pf" (picofarad) is being used in place of mmf (micromicrofarad) on wiring schematics and other electronics literature. My latest PHOTOFACT Folders and PF REPORTER issues use the mmf, as previously. Does the Sams Co. plan to adopt the pf symbol on their service literature? If so, when?

LEON HOWLAND
Indianapolis, Ind.

The electronics industry has finally agreed to general use of the pf abbreviation; pico is a prefix meaning 10^{-12} farad, which is equivalent to micromicrofarad. The mmf abbreviation has been phased out in favor of pf, starting with our January 1965 PF REPORTER *and* PHOTOFACT *Folder.—Ed.*

Dear Editor:

We were very surprised and disappointed to find that your July 1964 article "Aerosols In Servicing Chemicals" listed a great variety of cleaner-lubricant sprays but failed to make any mention of Channel Master *Shield* or Channel Master *Lectro-Mist.*

DANIEL S. ROHER
Advertising Manager
Channel Master Corp.

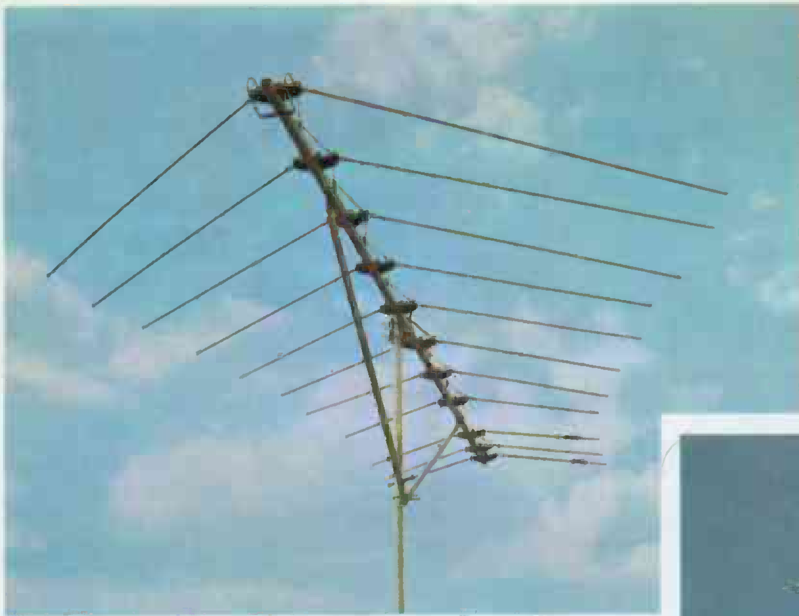
Your sprays certainly should have been listed, Dan. The oversight is ours. We suggest all readers who saved the July article add these two sprays to those mentioned.—Ed.

Dear Editor:

This may happen frequently, but to me it was uncanny. The same day I got your August 1964 issue of PF REPORTER, I had in the shop a G-E Model 21C135 set which showed exactly the same symptoms described in Symptom 3 of SYMFACT; sure enough, the 4700-ohm oscillator supply resistor was at fault. Three days later, I worked on another G-E, this time a Model 14T106; the symptoms were like those in Symptom 4 of August SYMFACT. You guessed it—the trouble was an open mixer plate coil, just as SYMFACT said. In both the above sets, the voltages and everything were just exactly as shown. Keep up the good work in this feature and the rest of PF REPORTER.

JAY F. SMITH
Amory Radio & TV
Chicago, Ill.

Very good, Jay. While circuit tolerances might cause slight variations from set to set and model to model, there is no guesswork in the preparation of SYMFACT. *Every symptom is experienced and analyzed thoroughly in our lab. This special method of preparation has paid off, and resulted in a considerable number of letters relating experiences like your own. —Ed.* ▲

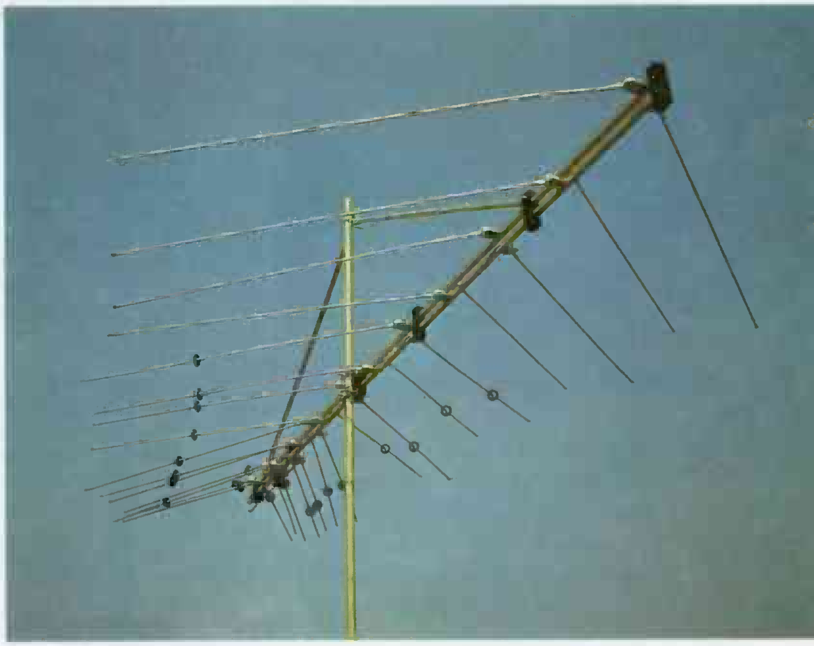


LICENSED UNDER ONE OR MORE OF U.S. PATENTS 2,959,081; 2,985,879; 3,011,168; 3,108,280; 3,150,376 AND ADDITIONAL PATENTS PENDING IN U.S.A. AND CANADA. PRODUCED BY JFD ELECTRONICS CORPORATION UNDER EXCLUSIVE LICENSE FROM THE UNIVERSITY OF ILLINOIS FOUNDATION.

ADVERTISED IN LOOK / Sunset

Model LPV-11

Model LPV-VU 15



You Can Rely on JFD Log-Periodic* TV

COLOR and

NEW—from the famous JFD R&D Laboratories in Champaign, Illinois — the authentic Log-Periodics with the engineering advances that outperform all others in COLOR, black and white—on VHF, UHF, VHF/UHF/FM!

WHY MORE JFD LPV LOG-PERIODICS ARE BEING INSTALLED THAN ANY OTHER VHF ANTENNA . . . The JFD Log-Periodic is a revolutionary new concept in antenna design. Its frequency-independent performance does not sacrifice gain, directivity, bandwidth or impedance match as other conventional antennas must on certain frequencies to achieve all-VHF-channel reception. Harmonically resonant V-elements operate on the patented Log-Periodic cellular formula $\frac{L_{(n+1)}}{L_n}=\tau$ to provide the same superb performance on every VHF channel—color or black and white—plus FM/Stereo.

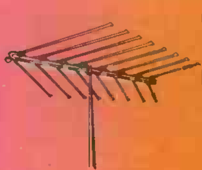
STOUTLY BUILT OF HEAVY WALL GOLD ALODIZED ALUMINUM . . . Inch for inch, ounce for ounce, JFD LPV Log-Periodics deliver more mechanical strength in less mass. Gleaming gold alodizing (the same used by NASA and the military services) does not insulate vital contact points as does anodizing. Instead, electrically conductive gold alodizing improves signal continuity.

DEVELOPED FROM RESEARCH PERFORMED AT THE UNIVERSITY OF ILLINOIS ANTENNA RESEARCH LABORATORIES . . . The JFD Log-Periodic is the commercial end result of six years of electronic research. No other design has undergone such intensive research and development by leading antenna scientists.

INSTALLED BY MORE WORLD'S FAIR PAVILIONS THAN ANY OTHER BRAND . . . The New York World's Fair House of Good Taste, Formica House, New York City Pavilion, House of Japan, Eastman Kodak exhibit, Florida and Hawaii Pavilions installed JFD Log-Periodics to assure best possible performance of their color TV sets. Millions of Fair visitors will remember and ask for the JFD Log Periodic LPV, paving the way for more sales by you.

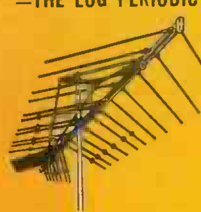
Selected by HGT

THE ONE AND ONLY ORIGINAL LPV LOG-PERIODIC FOR VHF CHANNELS 2 TO 13 & FM/STEREO



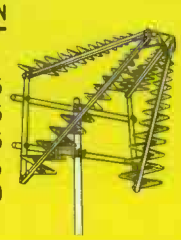
model	description	list
LPV17	18 Cells Directors	$59.95
LPV14	15 Cells Directors	49.95
LPV11	11 Cells Directors	39.95
LPV8	8 Cells Directors	29.95
LPV6	6 Cells	21.95
LPV4	4 Cells	14.95

NEW! THE FIRST COMBINATION VHF/UHF/FM/STEREO —THE LOG PERIODIC "ALL-VU"—WITH SINGLE LEAD-IN

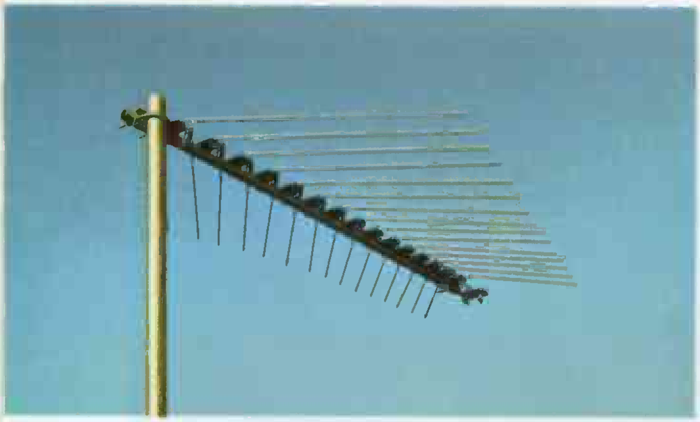


model	description	list
LPV-VU18	18 Cells	$69.95
LPV-VU15	15 Cells	$59.95
LPV-VU12	12 Cells	$49.95
LPV-VU9	9 Cells	$39.95
LPV-VU6	6 Cells	$27.50

NEW! LOG PERIODIC ZIG-A-LOG FOR PROBLEM "UHF" AREAS



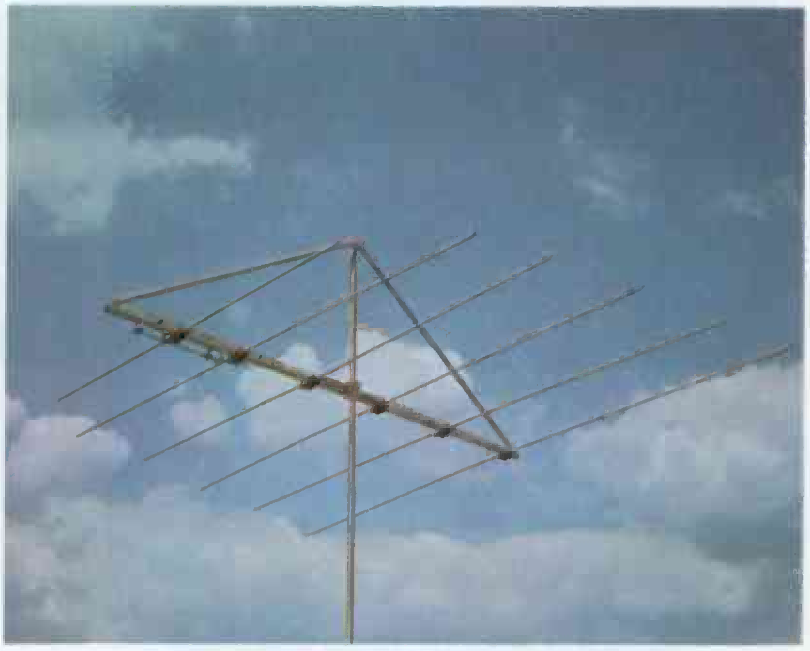
model	description	list
LPV-ZU20	E-Plane Stacked	$37.50
LPV-ZU10	1-Bay	$17.95



Model LPV-U15

Model LPV-ZU20 ZIG-A-LOG

Model LPL-FM6 FM/STEREO



antennas for the Finest Pictures In Sight-Black/White!

JFD FREQUENCY-INDEPENDENT LPV LOG-PERIODIC BREAKS THROUGH THE BANDWIDTH BARRIER FOR

GAIN: As high as 14 db (in model LPV17)—with extra gain on the high band where it is needed most.

BANDWIDTH: Frequency-independent log periodic design delivers broad band performance never before possible. Does not discriminate against any channel—or frequency.

RESPONSE: Consistently flat (± ½ db) across both low and high bands for the finest color reception.

DIRECTIVITY: No need to give up directivity to obtain bandwidth as other antennas do. Log-Periodic backfire horizontal radiation patterns, for example, are the narrowest of any all-channel antenna. Reject noise, ghosts, interference and other unwanted signals more effectively because: sharpness of beamwidth affects directivity more than any other factor.

VSWR: As low as 1.2 to 1 for maximum transfer of signal to line across the full bandwidth. Low VSWR's are typical of JFD LPV Log-Periodic antennas because of their constant 300 ohm impedance characteristic.

EVERY LPV YOU BUY EARNS YOU VALUABLE FAIR FESTIVAL POINTS . . . Each JFD Log-Periodic VHF, UHF, VHF/UHF/FM, or FM/STEREO you install includes Fair Festival certificates which you can trade in for **FREE** World's Fair tickets, trips or cash.

Whether it's VHF, UHF, VHF/UHF/FM, or FM/STEREO, JFD HAS THE LOG PERIODIC TO HELP YOU MAKE THE SALE OTHERS CAN'T!

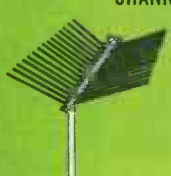
SEE WHY AT THE MOMENT OF TRUTH, THE PICTURE IS THE PROOF—THE JFD LPV LOG-PERIODIC WORKS BEST!

*Don't gamble on Log-Periodic "look-alikes" and imitations! Insist on the genuine LPV by JFD—exclusive producers of the pace-setting Log-Periodic antenna developed from research performed by the Antenna Research Laboratories of the University of Illinois.

JFD

JFD ELECTRONICS CORPORATION
15th Avenue at 62nd Street, Brooklyn, N. Y. 11219
JFD Electronics-Southern Inc., Oxford, North Carolina
JFD International, 64-14 Woodside Ave., Woodside 77, N. Y.
JFD Canada, Ltd., 51 McCormack Street, Toronto, Ontario, Canada

NEW! LOG PERIODIC LPV FOR UHF CHANNELS 14 TO 83 & VHF 7 TO 13



model	description	list
LPV-U21	21 Cells	$27.95
LPV-U15	15 Cells	$18.95
LPV-U9	9 Cells	$12.50
LPV-U5	5 Cells	$ 6.95

NEW! LOG PERIODIC LPL-FM STEREO

model	description	list
LPL-FM10	10 Cells	$49.95
LPL-FM8	8 Cells	$39.95
LPL-FM6	6 Cells	$29.95
LPL-FM4	4 Cells	$19.95

NEW! TELE-AMP ANTENNA AMPLIFIERS FOR VHF, UHF & FM

model	description	list
VUT-3	3-Transistor VHF/UHF/FM Amplifier	$49.95
VN-2	2-Nuvistor VHF Amplifier	$39.95
VT-2	2-Transistor VHF Amplifier	$39.95
VT-1	1-Transistor VHF/FM Amplifier	$34.95
UHT-1	1-Transistor UHF Amplifier	$39.95
FT-1	1-Transistor FM Amplifier	$34.95

Circle 7 on literature card

WHY...
SERVICE COLOR TV?

WHY WAIT?
YOU CAN MAKE
MONEY NOW!

...IF YOU'RE EQUIPPED – AND
A WIDE BAND SCOPE IS A MUST

★ 1,000,000 SETS IN 1964
★ 65% OF NBC PROGRAMMING* IN COLOR
★ NEW 25" SETS COMING THIS FALL
★ 2,000,000 ALREADY IN USE

*PRIME TIME

Only $199⁵⁰
MODEL 677

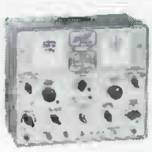
This Hickok-quality, full 5", wide-band scope – factory assembled, wired and calibrated can put you in color TV service . . . for less than $200.00.

- Rise time–less than 0.08 μsec.
- AC response–5 cycles to 4.5 MC within 3 db
- Vertical sensitivity–40 MV RMS/inch
- 5 times horizontal sweep expansion
- Sharp, bright (1600 volts anode potential) Trace with full astigmatic correction

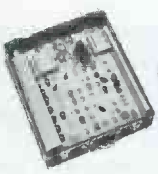
and, of course, it's . . .

HICKOK
COLOR APPROVED

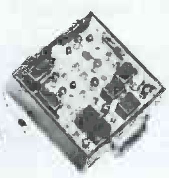
THE COMPLETE COLOR LINE



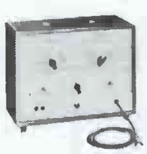
MODEL 615



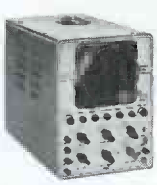
MODEL 656XC



MODEL 660



MODEL 661



MODEL 675A

THE HICKOK ELECTRICAL INSTRUMENT CO.
10566 DUPONT AVENUE · CLEVELAND 8, OHIO

Circle 8 on literature card

makes other tube testers

OBSOLETE

HICKOK

Model 800A

Honest tests on today's tubes demand 14-position selector switches. Compactrons, novars, 5- and 7-pin nuvistors, 10-pin headers, transistors and diodes, along with the older type tubes, can all be checked out — completely and correctly — including high sensitivity leakage and gas tests, with the truly modern Hickok Model 800A. This quality tube tester includes these other recognized Hickok-quality features: ***Hickok-developed G_m test on all tubes • Sensitive, instantaneous inter-element leakage and shorts test • Filament continuity test — and the original HICKOK roll chart subscription service keeps it up-to-date!***

Best of all, Hickok's low price for this portable do-it-all tester is only ***$199.95.*** *Available from stock at your franchised Hickok distributor.* ***Let him give you a demonstration.***

Ask to see these other Hickok instruments, too

677
Wide Band Oscilloscope

470A
Uni-scale VTVM

661
Color Bar Generator

THE HICKOK ELECTRICAL INSTRUMENT CO. • 10566 Dupont Avenue • Cleveland, Ohio 44108

Circle 8 on literature card

The Electronic Scanner

news of the servicing industry

Plant to Open

An ultramodern production plant will open early next year at Glasgow, Ky., in order to meet increasing demand for **Mallory** electrolytic capacitors. In his announcement, Mr. Mallory said, "We are demonstrating our faith in the growth of the capacitor business, and our confidence that we will continue to expand our market position despite foreign and domestic competition, by making an investment at Glasgow which, including equipment, will total nearly $2,000,000." The 85,000-square-foot Glasgow plant, scheduled for completion in April 1965, will be suitable for production of almost any kind of electrolytic capacitor. Employment may eventually reach 500.

Technical School Progress

Plans for the fall-winter program at **Sams Technical Institute, Inc.,** were detailed at the 111th Indiana State Teachers Convention. A new four-man advisory committee for the school will include the following prominent Indianapolis men: Edward D. James, president of Edward D. James & Associates; Albert L. Maillard, president and managing director of Electric League of Indianapolis; Leo H. Gans, vice-president and director, Education Division, The Bobbs-Merrill Company, Inc.; James A. Milling, president, Sams Division, and director, Howard W. Sams & Co., Inc. The committee will assist W. D. Renner, vice-president of vocational technical training, in overall future planning for the Institute. Also announced was the recent affiliation of STI with Indiana Northern University at Upland, Indiana. All work successfully completed at the Sams Technical Institute, Inc. can now be applied for credit toward a bachelor degree at the university. Enrollment at STI has climbed to over 600 this fall, equaling the enrollment of some colleges in the state. The Institute offers four separate two-year resident programs including Electronics Technology, Architectural Engineering, Tool Engineering, and Industrial Engineering. One current activity is an eight-week session of advanced training to keep practicing technicians informed on the most recent technological advancements in electronics. Courses on transistors and color television are available, with more to be added soon.

• *Please turn to page 24*

YOU CAN WIN THIS GREAT SPORTS CAR!

ENTER THE PHOTOFACT® "WIN-A-MUSTANG" CONTEST!

A PRIZE FOR EVERYONE WHO ENTERS!

FIRST PRIZE
New 1965 Mustang Sports Car

SECOND PRIZE
Luxurious Mink Stole

THIRD PRIZE
Ladies Elgin Diamond Wrist Watch

All entrants will receive a special gift just for entering this PHOTOFACT contest...

Contest ends December 31, 1964. Entry forms are available from your Sams Distributor or from Howard W. Sams & Co., Inc. (only one entry per contestant accepted). All you do is fill out the entry form, and have it validated by your Distributor. Winners will be determined by a drawing. *(Contest limited to U.S.A.; not valid where prohibited by State or local laws).*

DRAWING WILL BE HELD ON JANUARY 15, 1965

winners will be notified

Get Your Entry Form Today!

Enter this exciting contest now! Pick up your entry form at your Sams' Distributor, or send coupon below. Do it today! Everyone has an equal chance to win the drawing. All entries must be postmarked before January 1, 1965. Enter this worthwhile contest now!

CONTEST CLOSES DECEMBER 31, 1964

GET YOUR ENTRY FORM

DO IT TODAY!

Available from your Sams Distributor or send coupon

HOWARD W. SAMS & CO., INC., Dept. PFF-12
4300 W. 62nd St., Indianapolis, Indiana 46206

☐ **Send my entry form for the "Win-A-Mustang" Contest**
☐ I am presently a subscriber to a PHOTOFACT Service
☐ I am not a subscriber to a PHOTOFACT Service

Name____________________

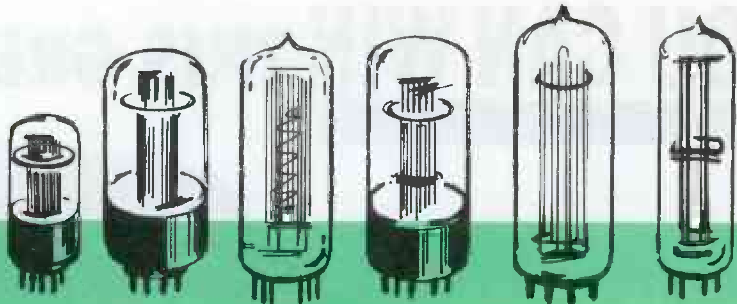
Shop____________________

Address____________________

City__________ State_____ Zip_____

My Distributor is:____________________

HOWARD W. SAMS & CO., INC.
INDIANAPOLIS, INDIANA 46206



STOCK GUIDE for RADIO and Hi-Fi Tubes

The 30 tube types listed in the "Types Most Often Needed" column will handle the great bulk of your radio, phono, and tape-recorder replacement needs. However, the increasing popularity of FM radio, including stereo multiplex, has led to the use of several new tube types. These new types and those listed in the "Secondary Stock List" have appeared in enough models to be worth keeping in stock if you do a considerable volume of radio and audio servicing. The last 12 tubes listed in the secondary chart are found mainly in imported European equipment. American substitutes are listed where possible. Tubes used in both American and foreign equipment are listed according to the American type number, with the European designation also given. Tubes designated *MPX* are used in multiplex equipment; *MPX misc.* means a tube is used in more than one multiplex-circuit application.

Several special classes of tubes have been omitted from these listings:

1. Obsolescent radio tubes, used mainly in sets more than 10 years old or in portables.
2. Common TV tubes that are used only occasionally in radio and hi-fi circuits—for example, 6BN8, 6EW6, and 6EA8.
3. Tubes used exclusively in auto radios.
4. Tuning-eye indicator tubes.

NEWLY INTRODUCED TYPES	
5BC3	rectifier
6AJ8	IF amplifier
6AY11	Ratio detector and AF amplifier
6BC7	Ratio detector and AM detector
6BH6	MPX misc.
6BJ8	MPX misc.
6BN8	MPX misc.
6CW5/EL86	AF output
6D10	MPX misc.
6DT8	FM RF amplifier and converter
6EQ7	IF amplifier
6ER5	FM RF amplifier
6ER6	AF amplifier
6FQ7	AF amplifier
6GM5	AF output
6GQ7	MPX misc.
6GY8	FM mixer and oscillator
6HA5/EC900	FM RF amplifier
6HS6	IF amplifier
6J9	MPX misc.
6KL8	AM detector-AVC-FM limiter
6KV8	FM RF amplifier and converter
9EA8	MPX misc.
12JN8	FM RF amplifier and converter
12KL8	IF amplifier and AM detector
14JG8	FM detector and AF amplifier
18GD6	AM IF amplifier
19EA8	MPX misc.
19GQ7	FM detector and AM detector
19HR6	IF amplifier
19HV8	IF amplifier-AF amplifier-AM detector
19JN8	FM RF amplifier and converter
20EZ7	AF amplifier
25F5	AF output
25F6	AF output
35DZ8	AF output
45B5/UL84	AF output
50HK6	AF output
6973	AF output

TYPES MOST OFTEN NEEDED	
5Y3	rectifier
6AQ5	AF output
6AT6	AM detector-AF amplifier
6AU6	IF-AF amplifier
6AV6	AM detector-AF amplifier
6BA6	RF-IF amplifier
6BE6	AM converter
6BQ5/EL84	AF output
6L6	AF output
6V4/EZ80	rectifier
6V6	AF output
6X4/EZ90	rectifier
12AT6	AM detector-AF amplifier
12AT7/ECC81	AF amplifier
12AU6	IF-AF amplifier
12AU7/ECC82	AF amplifier
12AV6	AM detector-AF amplifier
12AX7/ECC83	AF preamp
12BA6	RF-IF amplifier
12BE6	AM converter
25C5	AF output
25EH5	AF output
25L6	AF output
35C5	AF output
35EH5	AF output
35L6	AF output
35W4	rectifier
50C5	AF output
50EH5	AF output
50L6	AF output

SECONDARY STOCK LIST	
5AR4/GZ34	rectifier
6AB4	FM oscillator
6AQ8/ECC85	FM RF amplifier and converter
6BJ6	FM RF or IF amplifier
6BL8/ECF80	MPX misc.
6BM8/ECL82	audio amplifier and output
6C9	FM RF amplifier and converter
6CA4/EZ81	rectifier
6EU7	AF preamp
6EZ8	FM mixer and oscillator
6GY8	FM mixer and oscillator
6JK8	FM RF amplifier and converter
12AL5	FM detector
12AQ5	AF output
12DT8	FM RF amplifier and converter
12EQ7	AM IF and detector
14GT8	FM detector and AF amplifier
17C9	FM RF amplifier and converter
17EW8/HCC85	FM RF amplifier and converter
18FW6	AM IF amplifier
18FX6	AM converter
18FY6	AM detector and AF amplifier
19T8	FM detector and AF amplifier
32ET5	AF output
34GD5	AF output
36AM3	rectifier
50DC4	rectifier
60FX5	AF output
7025	AF preamp
7189A	AF output
7199	AF amplifier
7247	AF amplifier
7355	AF output
7408	AF output
7591	AF output
7695	AF output
EAA91	replace with 6AL5
EABC80/6AK8	AM-FM detector, AF amplifier
EBF89/6DC8	AM-FM IF, AM detector
EC92	replace with 6AB4
ECH81/6AJ8	AM converter, FM IF
ECL86/6GW8	AF amplifier and output
EF85/6BY7	IF amplifier
EF86/6267	AF preamp
EF89/6DA6	IF amplifier
EF94	replace with 6AU6
EL90	replace with 6AQ5
EL95/6DL5	AF output

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Write for Jensen Catalog 1090.

Nominal Size	Model No.	Magnet* Wt. Oz.	Imp. Ohms	List Price
3	3K7	.68	3.2	$3.80
3½	35K7	.68	3.2	3.80
4	4K5	.55	3.2	2.90
4	4K7	.68	3.2	3.55
5	5K5	.55	3.2	3.25
5	5K7	.68	3.2	3.85
5¼	525K7	.68	3.2	4.35
6	6K7	.68	3.2	4.35
7	7W3	1.00	3.2	6.55
8	8W3	1.00	3.2	5.85
10	10J10	1.73	3.2	9.00
12	12J10	1.73	3.2	10.50

*DP—Alnico 5 Magnets

Nominal Size	Model No.	Magnet* Wt. Oz.	Imp. Ohms	List Price
3x5	3X5K5	.55	3.2	$4.10
4x6	4X6K7	.68	3.2	4.80
4x8	4X8W3	1.00	3.2	6.00
4x8	4X8W9	1.00	8-10	6.00
4x10	4X10W3	1.00	3.2	6.50
4x10	4X10W9	1.00	8-10	6.50
5x7	5X7W3	1.00	3.2	5.35
5x7	5X7W9	1.00	8-10	5.35
5x7	5X7V3	1.47	3.2	5.40
5x7	5X7V9	1.47	8-10	5.40
6x9	6X9W3	1.00	3.2	5.95
6x9	6X9W9	1.00	8-10	5.95
6x9	6X9V3	1.47	3.2	6.40
6x9	6X9V9	1.47	8-10	6.40

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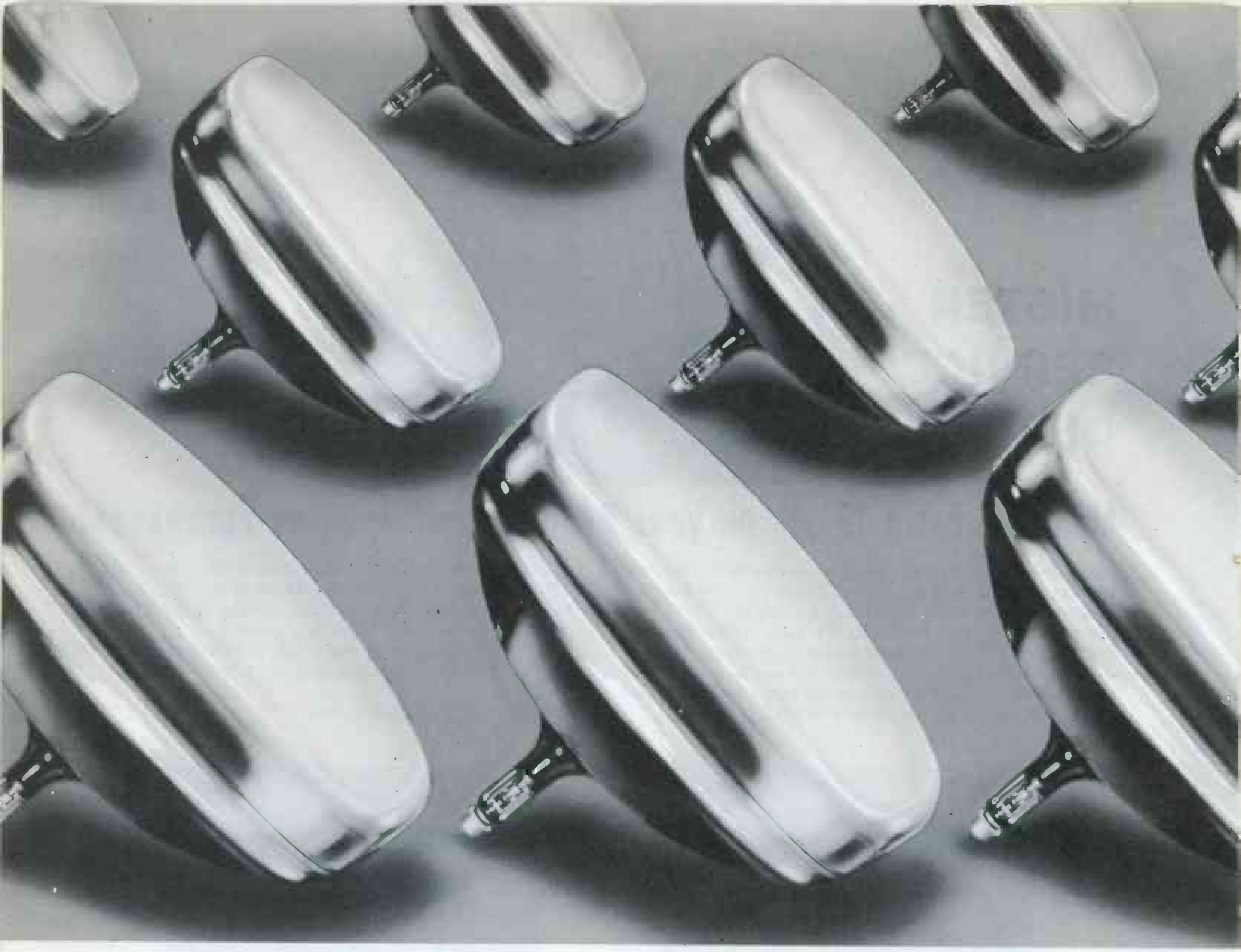
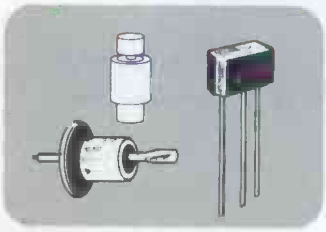
Canada: Radio Speakers of Canada, Ltd., Toronto • Argentina: Ucoa Radio, S. A., Buenos Aires • Mexico: Fapartel, S. A., Naucalpan, Mex.

JENSEN LOUDSPEAKERS

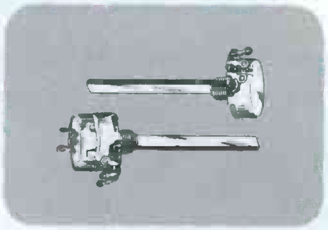
Circle 10 on literature card



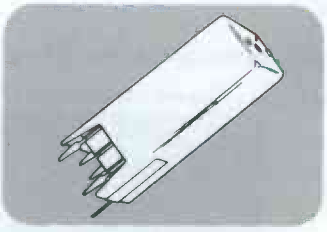
THE QUALITY OF YOUR SERVICE DEPENDS ON THE PARTS YOU USE...DEPEND



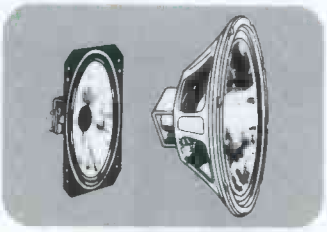
Diodes, Rectifiers, Condensers and Resistors
Complete variety for all makes and models.



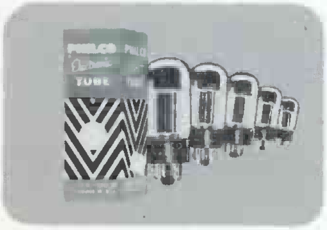
Universal Controls
With or without on-off switch. Standard taper, 3 inch shaft, half flat. 1 meg, 2 meg, 500 K. Complete selection. Fit Philco and other makes.



I.F. Transformers
For printed circuits, 4 lug, 5 lug or 6 lug types . . . to fit Philco or other makes. Dependable Philco Quality.



Replacement Speakers
All sizes, round, oval or rectangular types. 3.2, 8, 16, 20 ohms. From tiny 1¾" to giant 15" sizes.



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To fit any make, any model TV or radio, manufactured to exact Philco standards, thoroughly inspected. Original factory cartons.

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High gain type with 6 position switch for best possible signal selectivity. 3 section brass dipoles. Padded cast iron base.

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Philco TV and Radio Contact and Control Cleaner, Lubricant in self spray can, complete with protective cap and spray nozzle.

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Every CR Tube you replace represents a high-dollar service sale for you . . . and your customer. Play it safe with a brand that's known for Quality . . . PHILCO. All material and parts used in the manufacture of Philco Star Bright 20/20 Picture Tubes are new except for the envelope, which prior to reuse, has been inspected and tested to the same standards as new envelopes.

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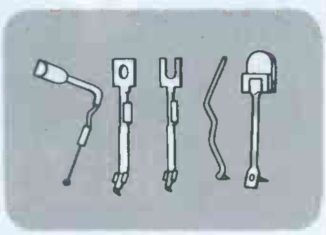

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Mustang Contest

Gail S. Carter, executive secretary of National Electronic Distributors Assn. (NEDA), will draw the names of PHOTOFACT® "Win-A-Mustang" contest winners on January 15, 1965. Top prizes in the contest, sponsored by the Distributor Div. of **Howard W. Sams & Co., Inc.**, and which ends December 31, 1964, will be two new Ford Mustangs. Open to both distributors and PHOTOFACT users, the contest prizes also include two mink stoles and two ladies' diamond Elgin wristwatches.

NARDA School of Management

Service managers and operators of service firms from 23 states met in September at Chicago's Allerton Hotel to concentrate on making their operations more efficient and more profitable. They spent at least two days studying financial statement analysis and productivity, how to set service rates and procure contract business, advertising, and record keeping. This group was participating in the 7th Annual **NARDA** School of Service Management.

The concern of good managers with productivity of their service technicians was covered by L. A. Porter, manager of field service, Whirlpool Corp. Porter related that experience shows an average of one hour is lost each day just in getting ready for the day's work— receiving work assignments, checking out parts, asking technical questions, or discussing bowling scores. Another area of lost time is in travel. With just ten minutes spent between calls, at least another hour a day is lost. Similarly, ten minutes lost because of lack of technical ability can amount to an hour or more a day. Among solutions proposed were careful assignment of work on the part of the manager, careful attention to the call-making procedure, and

Electronic Scanner

(Continued from Page 18)

UHF Seminar

A special UHF-TV seminar for Ohio dealers was held by **Gavin Instruments, Inc.**, to preview the introduction of Channel 22, WKEF-TV, to the Dayton market. According to Robert McDonald, Gavin sales manager, participating dealers were provided with a complete "UHF-TV Profile." This included technical data, programming material from WKEF-TV director George Mitchell (right), and a training session on UHF equipment and installations. Additional seminars are planned by McDonald and his staff.

Research Center

Research and advanced development facilities are being established in the Ft. Lauderdale area by **Astatic Corp.** In announcing the move, James Ross, chairman, said, "Astatic fully realizes that, to maintain its leadership in the field of acoustics, it must reinforce its technical effort by establishing applied research and advanced development facilities. For this, Astatic needs more than ever to attract highly skilled and qualified technical personnel. Such people are concentrated in electronic centers, one of which is in the vicinity of Cape Kennedy, Florida. A location slightly removed from Cape Kennedy, to get away from the merry-go-round atmosphere prevailing at the Cape, appears most attractive to serious-minded research workers. After conducting an investigation of available facilities, Astatic has concluded that the Ft. Lauderdale area offers all that is required."

In discussing "What the Service Manager Should Know About Financial Statement Analysis," Jules Steinberg, executive vice president of NARDA, presented the A-C-O formula as a means of "guesstimating" the proper percentage of costs to be spent for advertising." It is a simple rule of thumb," explained Steinberg. "The 'A' represents advertising, and 'C' the cost of selling, while 'O' represents cost of occupancy. These three expense factors should equal one-half your gross profit margin. If your gross margin is 25%, then rent, plus selling expense (salaries, commissions, promotions), plus advertising, should equal 12½% of total sales."

"Sell Service" Campaign

Radio, television, and phonograph service dealers in the Indianapolis area have been asking customers "What else needs fixing?" during a local tryout of an **Electronic Industries Assn.**-sponsored program to promote servicing and boost sales of replacement parts. The test run of the "sell service" program, brainchild of the EIA Distributor Products Div., involves Indianapolis distributors of replacement parts, who are urging service dealers to remind their customers that other radios, TV sets, or phonos lying unplayable about the house can be restored to working order through servicing. The distributor-dealer and dealer-customer persuasive efforts are backed by printed materials including lapel buttons and pocket protectors for salesmen and servicemen, self-sticking signs (photo) for shop windows, trucks, and tube caddies, and store banners for distributors. Based on weekly reports of the 13 distributors aiding in the Indianapolis test, EIA will decide shortly whether to extend the campaign nationwide. ▲

insuring that service trucks are equipped with the proper tools and parts to avoid costly callbacks.

"How To Establish Service Charges That Are Fair to the Consumer and Fair to Yourself," was the subject of an address by John Borlaug, national service manager, Sylvania Home and Commercial Products Corp. He explored advantages and disadvantages of pricing service by the hour and of flat-rate pricing. "Time spent in checking a circuit if you do not know what the circuit is supposed to do is time wasted. Don't charge your customer an hourly rate while your technician is learning how the circuit works—use flat rate charges tempered by local conditions. If you already know how the circuit works, your hourly rate applies and is fair to both you and your customer."

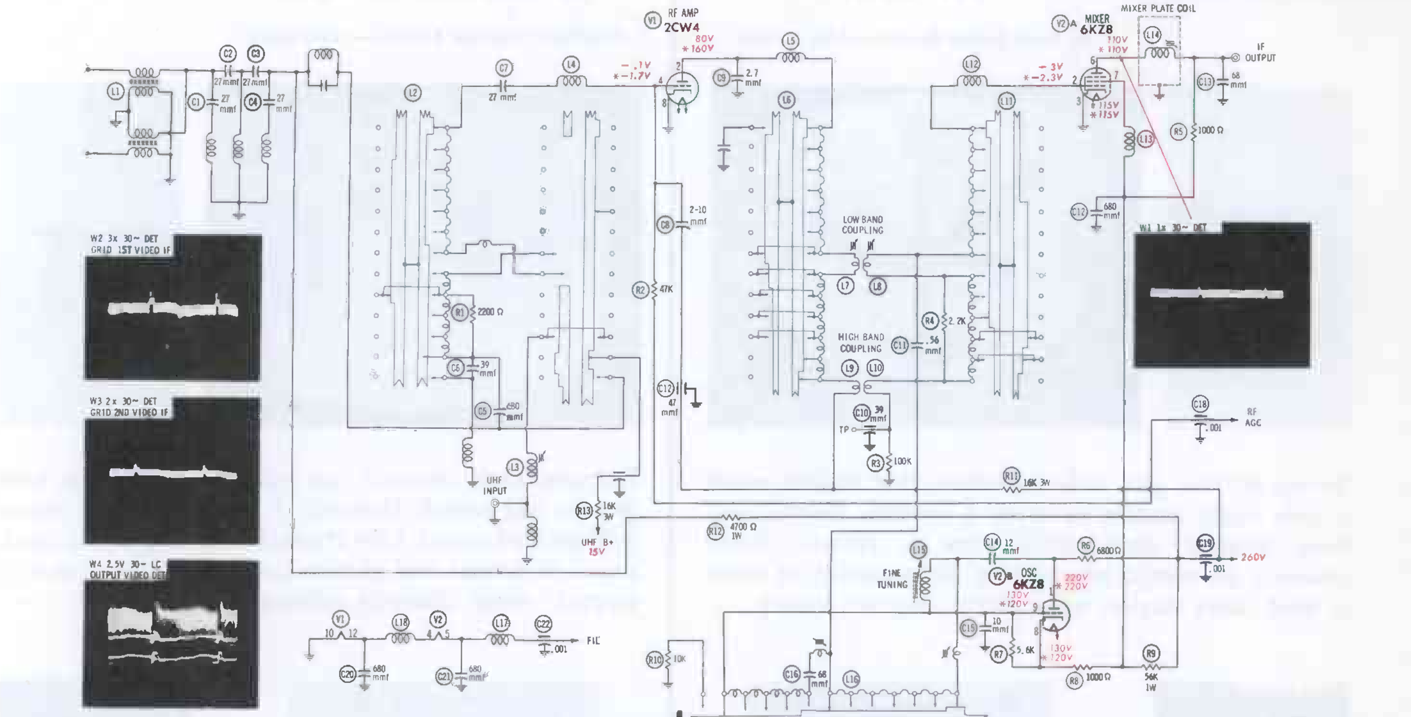
One of the more interesting facts learned at the School was that interest in service contracts is growing. More than twice as many of the attending service managers are now selling contracts, compared with those selling contracts last year and every man in the room except one expressed avid interest in the subject.

Through the years, recordkeeping has been a featured subject at the School of Service Management. This year, the subject was presented by dealer Ed Reich, president, Wholesale Television Service, Indianapolis, Ind. He pointed out that the key to efficiency is to know where everything is at all times. This is done basically with two forms, the job envelope and the order form. A 5" x 8" envelope is given to each serviceman in the morning, containing his assignments arranged in the order in which the calls are to be made. The front of the envelope provides space to list the job number, the name of the account, the time the call was made, the type of call (whether cash, charge, or contract), and the disposition of the call (whether customer-not-at-home, completed, or brought into shop). Finally, space is provided for listing the money collected. On the reverse side of the envelope, there is space for recording inventory usage during the day.

PF REPORTER Symfact™

Switch Tuner

Nuvistor RF Amplifier



DC VOLTAGES taken with VTVM, on inactive channel; antenna terminals shorted. *Indicates voltages taken with signal present—see "Operating Variations."

WAVEFORMS taken with wideband scope; TV controls set for normal picture. DET (detector), LC (low-cap), and DP (direct) probes are used where indicated.

Normal Operation

Switch tuner depicted above (from RCA Chassis KCS143F) features two improved tube types. A 2CW4 nuvistor functions as RF amplifier; its most notable improvement over other tube types is in signal-to-noise ratio. The 2CW4 has an all-metal case, very small heater and plate-power requirements, and controlled filament warmup time that especially suits it for series filament strings. Mixer-oscillator stage uses 6KZ8. Pentode section, used as mixer, has frame-grid construction and exceptionally high gain—approximately four times greater than that of 6EA8 or comparable type. Oscillator and mixer sections are connected in stacked B+ arrangement (leading to some unusual voltage symptoms); cathode voltage of oscillator section is applied directly to mixer plate and screen; R8-C12 decouple the two stages for RF signals. R9, between mixer supply and B+, helps compensate for any slight variation in oscillator cathode voltage, thus keeping voltage on mixer constant. Tuner is equipped for UHF reception; R10 disables VHF oscillator when channel selector is in UHF position. Signal path of this tuner is similar to turret tuner in August 1964 *Symfact*. Preset fine tuning is used here but does not mechanically adjust individual oscillator slugs; rather, it changes inductance of fine-tuning coil by sliding core in or out of coil form. Core in this arrangement is somewhat prone to break or become disconnected, disabling fine tuning; if this occurs, visual inspection of coil will reveal trouble.

Operating Variations

PIN 4 V1 — DC voltage is determined by AGC action and signal strength. Voltage varies from −.1 volt to −3.5 volts, depending on AGC setting and strength of station signal. −1.7 volts is typical.

PIN 2 V1 — Plate voltage changes as grid bias varies—goes more positive as bias goes negative. Without signal, voltage is 80 volts; with strong signal, increases to 200 volts. 160 volts is normal on plate of nuvistor.

PIN 2 V2 — Without signal, grid reads −3 volts; with signal, varies from low of −2 volts on strong station to high of −3 volts on fringe stations. Reads −2.3 volts with average signal.

PIN 1, 8, 9 V2 — Small difference in voltages with or without signal; practically no change on pin 1 (plate). Voltages on 8 and 9 decrease 10 volts with signal on mixer.

WAVE-FORMS — W1, W2, W3 are taken at mixer plate and in video-IF strip. Amplitude is small, but signal can be seen, evidenced by vertical sync pulses. Designation 2x, etc., indicates waveform amplitude compared with 1x amplitude of W1. W4 appears at video-detector output and amplitude depends on signal strength.

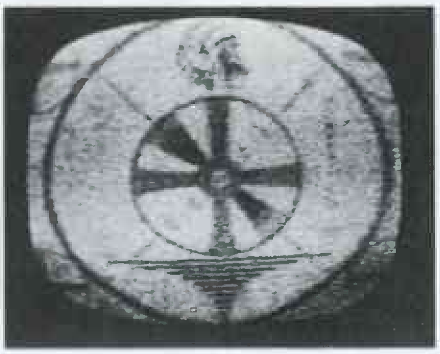
Picture Snowy

Fringe Channels Missing

R11 Open

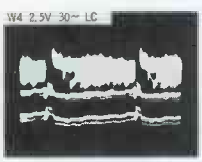
(RF Plate Supply Resistor—16K, 3 watt)

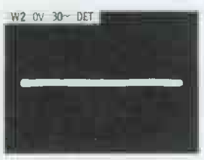
Symptom Analysis



Strong stations give little indication that trouble exists —only slight amount of snow is present. Normal stations produce considerable snow in picture; fringe channels are completely missing. RF amplifier in tuner is most likely suspect when picture appears snowy.

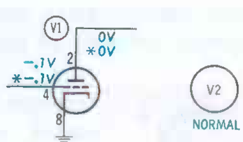
Waveform Analysis





Amplitude of signal at video-detector output (W4) is normal, but considerable snow ("grass") can be seen. Proves trouble is before video stages, in either IF strip or tuner. Loss of signal in W2 (first IF grid) proves trouble is prior to this point. Missing signal at mixer plate (W1) strongly indicates defect in tuner. Scope will not pinpoint defective component but is definite time-saver in isolating faulty tuner as most likely culprit.

Voltage and Component Analysis



Grid voltage on RF amplifier remains same with or without signal—proves there is no AGC voltage developed. Loss of plate voltage on V1 explains snowy picture—RF amplifier can't conduct. Gain in mixer and IF amplifier stages is sufficient to produce picture on normal or strong stations. Loss of RF amplification lowers signal-to-noise ratio in later stages thus causing snow (noise) in picture. Noise generated in RF and mixer stages, with little signal to override it, is amplified in high-gain IF stages.

Best Bet:* *VTVM will locate trouble.

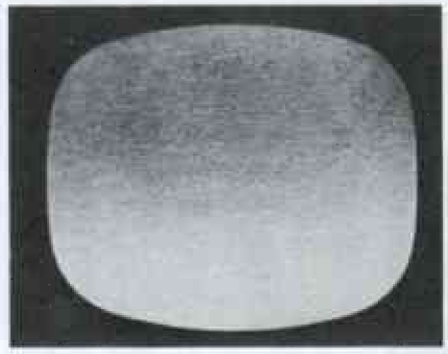
High Channels Lost

Sound Also Missing

R8 Increased in Value

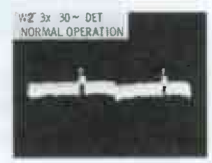
(Oscillator Cathode Resistor—1000 ohms)

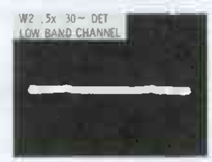
Symptom Analysis



Extreme high channels are completely missing both picture and sound; channels 7, 8, and 9 very snowy with garbled sound. Low channels only slightly affected; sound is normal and picture has some snow. Tuner is suspect—some channels missing, some present.

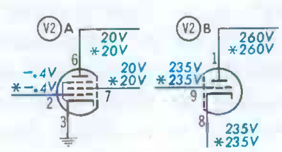
Waveform Analysis





With tuner on low channel, W2 shows some signal is passing tuner but amplitude is decreased considerably (compare to normal W2). With tuner on high band channels, W2 shows complete absence of signal. Scope is conclusive in isolating tuner. Oscillator stage is most logical point for voltage and resistance checks, as channels aren't affected equally. Oscillator defects are commonly more noticeable when tuned to high channels.

Voltage and Component Analysis



Voltages are incorrect on oscillator (V2B) with or without signal. All elements show increased readings, and there is only 25 volts between plate and cathode (normal is 100 volts), so oscillation has almost stopped. Plate and screen voltages on mixer stage (V2A) are greatly lowered, because resistance of their B+ supply path has increased—majority of small mixer current now flows through relatively high valve of R9 (56K). Lack of oscillator injection reduces mixer grid voltage enough to lower plate voltage even further to 20 volts.

Best Bet:* *VTVM for voltage and resistance.

SYMPTOM 3

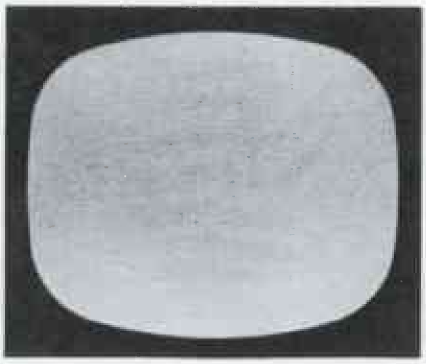
No Sound—No Pix

Only Slight Snow in Raster

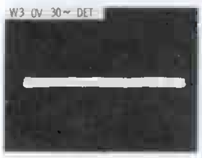
R6 Increased in Value

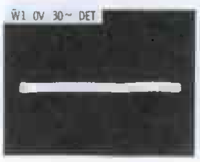
(Oscillator Plate Supply Resistor—6800 ohms)

Symptom Analysis



Only indication on screen is very slight amount of snow, whether tuned to active or inactive channel. Only sound heard from speaker is background noise. Clamping AGC line doesn't improve condition. Trouble could be in either IF amplifier stages or tuner.

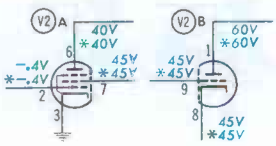




Waveform Analysis

Trouble in stages following grid of second IF amplifier can be rapidly discounted by viewing waveform at grid (W3)—no signal is present. Further clue to tuner trouble is provided by W2 (first IF grid); no signal here, either. Absence of signal at mixer plate (W1) probably means tuner is defective. When symptoms indicate possibility of tuner trouble, this sequence of scope checks isolates tuner more rapidly than does VTVM.

Voltage and Component Analysis



Oscillator plate voltage only 60 volts (normally 220) provides definite clue to trouble in oscillator supply circuit. Grid and cathode voltages on oscillator are also decreased, as are mixer plate and screen voltages. However, these are effect of trouble—not cause. With exceptionally high-gain 6KZ8 in mixer stage, it is possible and probable to get a picture with lowered voltages. Amount of increase in value of R6 determines exact symptoms—just a slight increase may produce snowy picture on some channels while others remain normal.

Best Bet: ***VTVM will find this one.***

SYMPTOM 4

Snow in Picture

Loss of Fringe Channels

L1 Open

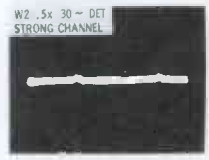
(Antenna Coils—Balun)

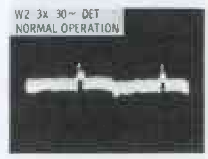
Symptom Analysis

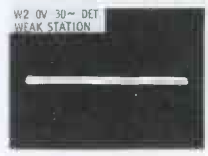
Strong local stations show little evidence of trouble being present. Stations with mediocre signal strength are quite snowy; both picture and sound are missing on fringe channels. Symptom is typical of failure in RF amplifier stage or antenna input network.

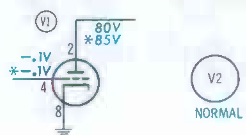
Waveform Analysis

Observing signal at grid of first IF amplifier provides valuable assistance in locating trouble in tuner. W2 (taken on strong local station) shows signal is passing tuner but amplitude is reduced—compare to normal W2. With receiver on fringe channels, W2 shows complete loss of signal. Even with antenna coils open, strong stations appear near normal because of excellent amplification and signal-to-noise ratio in nuvistor stage.









Voltage and Component Analysis

Pinpointing defective component from voltage readings is difficult. Without signal, all voltages are normal—thus eliminating suspicion of source voltage or plate supply resistor. Voltage stability also rules out probability of AGC defect. With information gained from above voltage measurements, it is logical to assume trouble is in signal path; best place to start looking is prior to grid of RF amplifier. If trouble is reported within few days after thunderstorm, antenna balun is certainly most likely suspect.

Best Bet: ***Ohmmeter and visual inspection.***

SYMPTOM 5

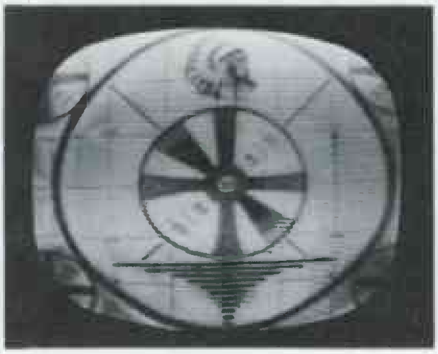
Fringe Channels Snowy

Local Stations Normal

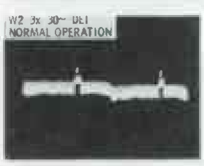
R5 Increased in Value

(Mixer Plate Supply Resistor—1000 ohms)

Symptom Analysis



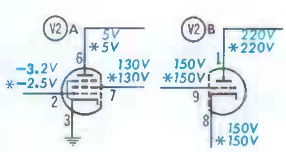
Fringe channels have considerable snow in picture; sound doesn't seem to be affected. Both picture and sound are normal on local stations. Symptom indicates loss of gain in either IF amplifier stages or tuner. Tuner is most likely suspect when snowy picture is symptom.



Waveform Analysis

Signal at grid of second IF (W3) proves loss of gain is in preceding stages; only very small sync pulse can be seen, thus clearing circuits following second IF. Absence of signal in W2 (see accompanying normal W2) confirms suspicion of trouble in tuner. Signal at grid of first IF is normally very low in amplitude; therefore, reduced gain in RF or mixer can result in no visible signal at IF grid—yet picture can be seen; may even appear normal on local stations.

Voltage and Component Analysis



Following information gained from scope analysis, voltage checks in tuner should prove most useful in locating defective component. Greatly reduced plate voltage on V2A is conclusive evidence of trouble in mixer stage. Voltages on V2B are increased, suggesting either increased value of R5 or reduced conduction in V2A. When mixer plate voltage is reduced, amplification is virtually lost. Normal picture on local stations is explained by high gain and signal-to-noise ratio of nuvistor and by high gain of IF stages.

Best Bet:* *Voltmeter Pins it down.

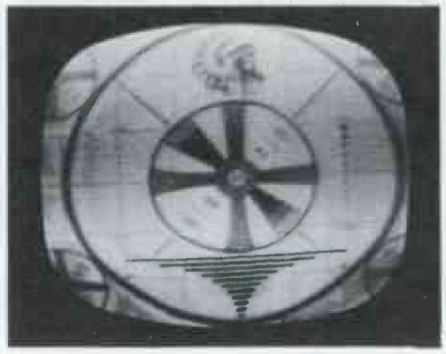
SYMPTOM 6

Slight Snow in Picture

Fringe Channels Missing

C10 Shorted

(Feedthrough Capacitor—39 mmf)

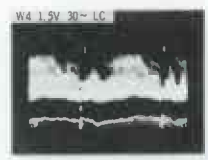


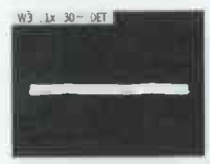
Symptom Analysis

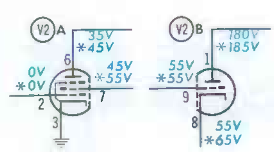
Local stations appear nearly normal; only slight snow is visible in picture—sound is okay. Fringe stations are extremely snowy or completely lost, depending on strength of signal. Trouble could be in tuner or in IF amplifier stages.

Waveform Analysis

Waveform at output of video detector (W4) is reduced in amplitude and contains considerable noise; proves trouble is in preceding stages, clearing video detector and output circuits. Reduced amplitude of W3 means trouble is prior to grid of second IF. No visible signal at first IF grid (W2) gives valid indication of trouble in tuner. Scope is much speedier method of locating defective tuner than are voltage measurements.







Voltage and Component Analysis

First logical step, following symptom clues and waveform analysis is voltage check of RF amplifier. Voltages on V1 are normal without signal; give same reading with signal, therefore trouble in this stage is unlikely. All voltages on V2A and V2B are reduced. However, most conclusive evidence of trouble is gained from zero reading on mixer grid (pin 2). Connecting VTVM to grid, and using external bias supply for negative grid voltage, you can quickly establish that grid is shorted to ground —meter still reads zero.

Best Bet:* *Voltage analysis; then ohmmeter or bias box.

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*Tests show the COLOR BRIGHT 85 tube is 43% brighter, on the average, than standard color picture tubes.

Measuring Lo-Q INDUCTANCES

Another use for your bench scope.

by Robert G. Middleton

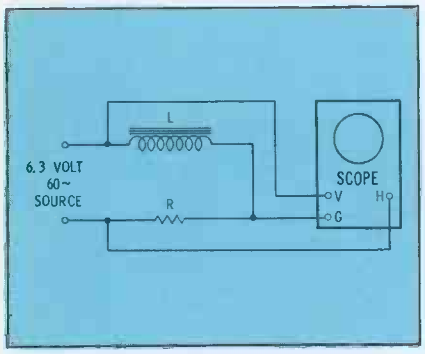

Fig. 1. Setup for impedance checks.

In a previous issue of PF REPORTER (March 1963), detailed information was given for testing medium- and high-Q inductors by "ringing." It was pointed out, however, that low-Q coils are often difficult to check with a scope, because the waveform is damped-out too quickly to be useful. Scope evaluation of low-Q inductors requires a different method.

Low-Q Measurement

A suitable test setup for displaying an impedance waveform that can be used to check low-Q inductors is shown in Fig. 1. The inductor under test is seen at L; resistor R is any fixed-value resistor that provides ample horizontal deflection voltage. In general, high-impedance inductors should be tested using a high value of resistance, because less current will flow.

What do impedance patterns look like? Three basic types are illustrated in Fig. 2. If the inductor "looks like" a resistor at 60 cps, a diagonal line is displayed on the scope screen. On the other hand, an ideal inductor (with no winding resistance) would display a perfect circle when the vertical and horizontal gains are equalized. Most coils, of course, have appreciable inductance *and* resistance and display an elliptical impedance pattern.

Reading the Pattern

Evaluate the impedance pattern using the procedure shown in Fig. 3. Center the waveform on the screen, using centering and gain controls, so it extends an equal number of squares up and down, and left and right, from the screen center-point. Any convenient settings of the scope's vertical and horizontal gain controls can be used. Now, count the number of squares from the center to the point at which the ellipse intersects the vertical axis—seven in Fig. 3. Also note the number of squares from the baseline to the top of the pattern—ten in Fig. 3. These two readings give the ratio of reactance to impedance. The ratio X_L/Z in Fig. 3 is 7/10. (X_L = reactance, and Z = impedance.)

Finding the Inductance in Henries

Of course, the information thus determined is comparatively useless

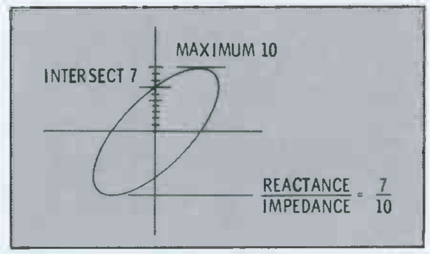

Fig. 3. Ratio of reactance-impedance.

from the servicing standpoint, because a technician generally desires to know the inductance of a particular coil. The inductance in henries is found by using an impedance triangle constructed as follows: First, draw a right angle on a sheet of paper, as shown in Fig. 4 (or linear graph paper could be used). Mark off seven units on the vertical axis. This leg corresponds to the seven squares (reactance) which were read on the scope screen. Next, mark off a 10-unit hypotenuse, as shown by the dotted line in Fig. 5. This is done most easily with a compass, although a ruler can be used. This completes the impedance triangle. The 10-unit leg corresponds to the 10 squares (impedance) which were read on the screen. The completed triangle shows the relative ohmic values of resistance, reactance, and impedance.

A numerical reference is obtained by measuring the winding resistance of the inductor with an ohmmeter. Since the resistance at zero fre-

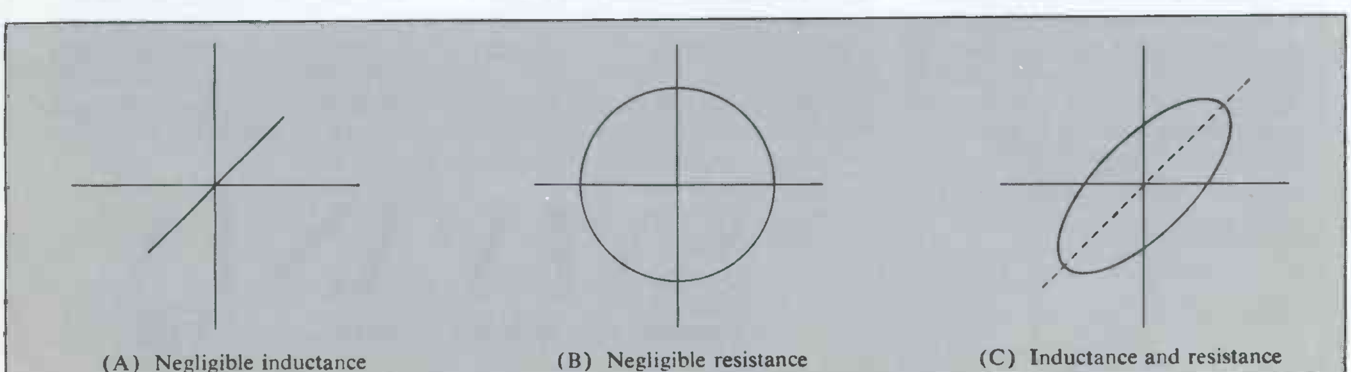

Fig. 2. Three basic types of impedance waveforms.

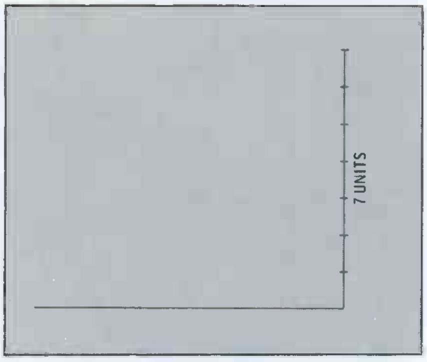

Fig. 4. Units indicate coil reactance.

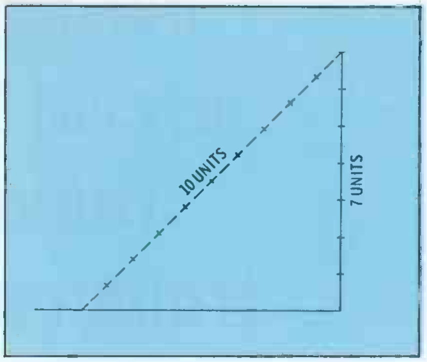

Fig. 5. Hypotenuse shows impedance.

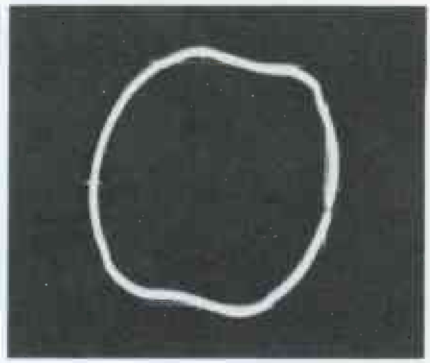

Fig. 7. Trace of distorted sine wave.

quency is virtually the same as at the 60-cps frequency of the source voltage in the test setup, this is the easiest method of completing the data. If a value of 50 ohms is measured, assigning the value of 50 ohms to the base (resistance) leg of the triangle will establish the reference; the other values can then be determined. In this example, the reactance line has the same length as the resistance line—hence, the coil in question exhibits 50 ohms of inductive reactance. Since, in a right triangle, the hypotenuse squared equals the sum of the squares of the other two sides, the impedance line (hypotenuse) gives a value of 70.7 ohms. ($50^2 + 50^2 = 2500 + 2500 = 5000$; therefore, the hypotenuse is $\sqrt{5000}$, or 70.7.)

The inductance of the coil can be determined from the reactance value of 50 ohms. Simply divide the inductive reactance by 377 (2π, or 6.28, times the 60-cps line frequency; $X_L = 2\pi fL$ and $L = X_L/2\pi f$ to find the inductance in henries; $50/377 = .132$ hy, or 132 mh. With this straightforward procedure, it is easy to find the inductance, impedance, and reactance of any inductor using only its scope pattern.

Finding the Power Factor

The power factor of a coil is simply R/Z, or resistance divided by impedance. In the example of Fig. 6, the power factor is 50/70.7, or .707. In general, the power factor will approach 1 if the inductance is negligible; on the other hand, the power factor will approach zero if the resistance is negligible.

Finding the Q Value

In case you wish to know the Q of the inductor, divide the reactance by the resistance ($Q = X_L/R$). In the example of Fig. 6, Q is 1; in other words, this is a very low-Q coil. Different inductors have widely varying Q values. If the resistance is negligible, the Q will approach an infinite value. On the other hand, if the inductance is negligible, the value for Q will approach zero.

Practical Considerations

Returning to Fig. 1, note that the AC source must be ungrounded to apply voltage across the resistor to the horizontal-input terminals of the scope. Hence, it may be necessary to use the heater winding of a small power transformer as a voltage source. An audio oscillator with ungrounded (balanced) output will also provide a good test voltage. The chief advantage of an audio oscillator is that it can be expected to have a good waveform, while the 60-cps signal from the power line is not always a pure sine wave.

It is essential to drive the test setup with a uniform sine wave; otherwise, the pattern will have the "bends" seen in Fig. 7, and proper evaluation of the waveform will be difficult. Most inductors will display an undistorted pattern when the source voltage exhibits a good waveform. However, there are exceptions—sometimes the core material in the inductor under test is poor. For example, core laminations may induce excessive hysteresis losses that will introduce an odd-harmonic distortion into the current waveform (applied to the horizontal-input terminals of the scope). This distortion is commonly called an "iron third harmonic." Such inductors cannot be checked accurately by the method described earlier, if the iron third harmonic is large.

Technicians using a scope to check inductors for the first time may encounter distorted patterns due to overloading and clipping, as illustrated in Fig. 8. To avoid this difficulty, adjust the step attenuator to as low a setting as possible and operate the continuous attenuator at as high a setting as possible. This prevents overdriving the input cathode-follower stage of the scope. In case the horizontal channel in your scope does not have a step attenuator, avoid overload by not exceeding a reasonable input voltage to the horizontal-input terminals. Choose the value of R in Fig. 1 that permits operation of the horizontal-gain control at a fairly high setting.

Most scopes, barring circuit defects, have good 60-cps response in both vertical and horizontal amplifiers. To be sure, make the test depicted in Fig. 9; a straight diagonal line should be displayed. On the other hand, an elliptical pattern (as shown) indicates a phase shift between the scope amplifiers, which

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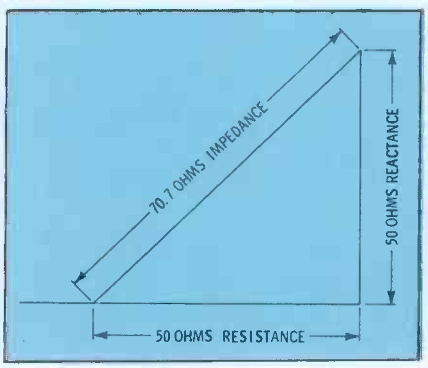

Fig. 6. Complete impedance triangle.

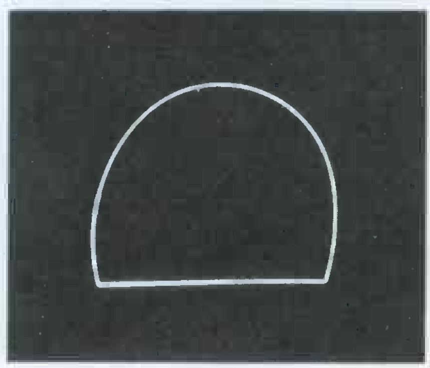

Fig. 8. Vertical amplifier overloaded.

curing aircraft radio troubles

Part 2

In the first part of this series, aircraft communication systems were discussed. In this concluding part, the most widely used radio navigation systems will be described.

Automatic Direction Finders

The primary airborne LF device today is the automatic direction finder, or ADF. Fig. 1 shows a typical ADF system such as might be found aboard a light business aircraft.

The ADF system shown consists of a carefully designed ferrite loop antenna and a sense antenna. Signals from these two antennas are combined in such a manner as to cause a servo to rotate the loop to a null. An indicator shows the direction of the loop, thus indicating the heading to any LF or broadcast station. Above the broadcast band, the reflection of sky waves makes ADF impractical. A great disadvantage of the low-frequency band is the presence of large amounts of atmospheric noise, particularly during electrical storms, and it is during stormy weather that aviation radio is most necessary.

VHF Omnirange

At the close of World War II, the sudden increase in air traffic resulted in studies to originate more effective means of radio navigation. The four - course low - frequency range systems ("beams") in use at that time were inflexible and subject to atmospheric noise under adverse weather conditions.

Shortly after World War II, a radio naviagation system utilizing VHF was developed. This modern system is called "very high frequency omnirange," sometimes termed "VOR" or just "omni." The system is used throughout the world except in the Iron Curtain countries. With this system, using a good omni receiver, a pilot may determine his bearing from an omni ground station within two degrees.

Fig. 2. VHF omnirange ground station.

Principles of Operation

To understand the principle of omnirange, imagine a beacon light arranged to rotate at constant speed. Another light is arranged to flash in all directions whenever the beacon points exactly north. By knowing the time required for a full rotation of the beacon and by observing flashes of the fixed light, an observer can determine his direction relative to the beacon.

The same principle can be applied to radio emissions. An omni ground station consists of an antenna system arranged to rotate a directional beam at 1800 rpm, or 30 revolutions per second. Thus, an observer located at any point will receive from this antenna a signal that appears to be amplitude modulated by a 30-cps tone. Another antenna radiates a reference signal uniformly in all directions. This reference signal contains a 30-cps signal that is in phase with the signal from the rotating beam only when the directional antenna points north of the station. The phase relationship between the two signals is different for each other point of the compass.

The reference signal must be radiated in some manner which will not interfere with the rotating pattern signal. This is done by amplitude modulating the station carrier with an audio signal at a frequency of 9960 cps. This subcarrier is then frequency modulated by the 30-cps reference signal.

A VHF receiver in the airplane receives the sum of all modulation components from the ground station. Voice modulation is used for identifying the particular station, for weather broadcasting, and for communication with other airplanes; this voice modulation doesn't affect performance of the omni as a navigation device.

An omnirange ground station is shown in Fig. 2. These stations operate unattended and are located at points throughout the country to form airways. There are two types of ground stations, low-powered "terminal VOR" (TVOR) and

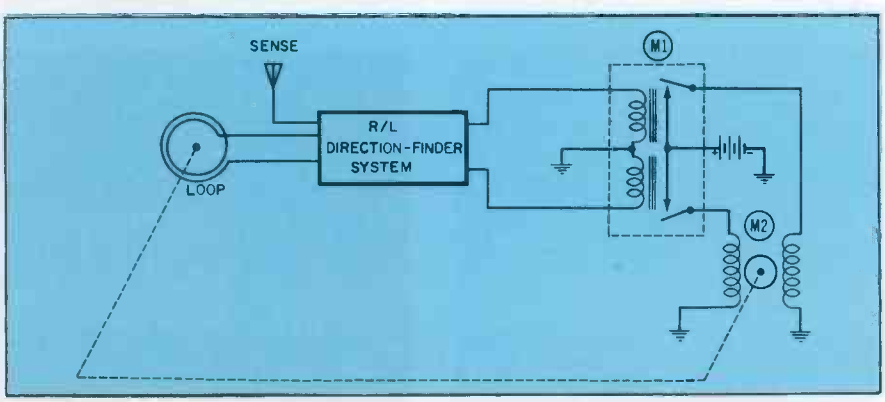

Fig. 1. Diagram of simple automatic direction finder system.

Introduction to equipment used in airborne communications.

by Keith Bose

higher-powered en-route stations. Terminal VOR is used near certain airports. Stations are normally operated by the FAA, although some states and private interests also provide omni service.

Omnirange Receivers

Omni stations operate between 112.0 and 117.9 mc. The sensitivity of a typical receiver for omnirange navigation is such that a 3-uv input signal modulated at 30% with a 1000-cps tone will develop 200 mw in a load, with a 6-db signal-to-noise ratio. AGC is incorporated to maintain not more than 3 db variation over an input range of 5 to 50,000 mv. Less expensive receivers are continuously tuned, but preferred types employ crystal-tuned channels.

Omnibearing instrumentation units are usually separate from the receivers. Fig. 3 shows the block diagram of a simple omnibearing instrument. Audio output from the detector of a receiver is fed to the unit. The detector output goes to two filters. One filter has a passband of 9480 to 10,440 cps, which separates the FM reference signal from the other signal components. The other filter passes only the 30-cps signal resulting from the rotating pattern of the distant station. The FM audio reference signal is first limited, and then fed to a discriminator which recovers the 30-cps reference signal. The signal from the low-pass filter passes to a phase shifter potentiometer (usually a resolver), and then both 30-cps signals are applied to a phase-differential detector.

The detector drives a galvanometer-type meter movement which gives a visible indication to the pilot. When the needle is centered, the setting of the phase shifter (sometimes called omnibearing selector, or OBS) indicates the bearing of the omni station. To fly on this bearing, the pilot keeps the needle centered. An airplane at any location can be "homed" to an omni station by turning the resolver until the phase-detector needle is centered and then turning the airplane to the heading indicated by the resolver.

The resolver phase shifter is calibrated so the proper omnibearing is indicated when the needle of the phase detector meter is zeroed. However, there are two points 180° apart where a null can be reached. Thus, an airplane may be either on the bearing or its reciprocal when the omni needle has been centered. In one case, the reference voltage lags the bearing signal (when flying FROM the station), and in the other case its leads (when flying TO the station). It should be noted that omnibearings refer to the bearing *position* of the aircraft relative

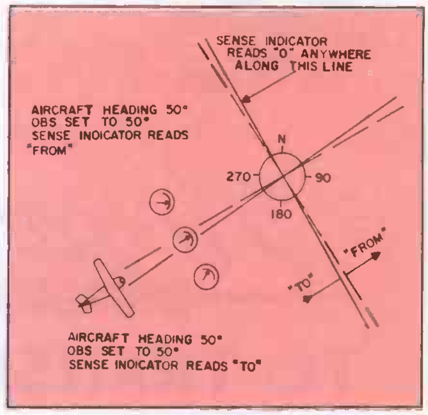

Fig. 4. TO-FROM indications in VOR.

to the station, *not* the heading of the airplane.

In order to determine if a bearing is TO or FROM a station, a fixed 90° phase shift may be applied to the reference voltage, and the resulting voltage is compared to the signal using another phase detector. Fig. 4 shows the phase relations arising from the TO-FROM bearings. The TO-FROM galvanometer movement is often arranged as a light metal "flag" moving behind a cutout on the face of the instrument.

A typical unit for light airplanes is the NARCO VHT-3 *Superhomer*. This unit, shown in Fig. 5, combines a continuously tuned VHF reciever, omni instrumentation circuitry, and a 12-channel transmitter, thus providing both communication and navigation in the same unit.

It is possible to arrange a servo loop to drive the phase-shift resolve of an omni indicator to null. Synchros can then be used to provide continuous readout on some suitable indicator. Fig. 6 shows an indicator known as a radio magnetic indicator (RMI). The rotating card of the

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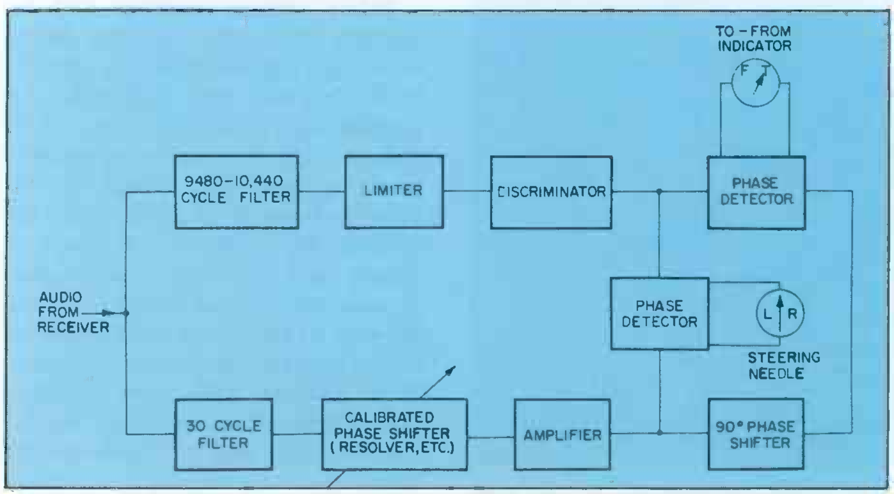


Fig. 3. Diagram of typical omnibearing instrument — called VOR device.

Fig. 5. Communication-navigation unit.

Shop Talk

by Allan F. Kinckiner

Royal Road TO TRANSISTOR SERVICING

The ever increasing number of transistorized portable radios in need of servicing present technicians with a charge-rate problem in addition to some strictly technical difficulties. The low purchase price of these sets condition the owners to expect low repair charges also. However, small size and other design features are often not conducive to rapid repair; thus service charges are often larger than expected by the customers. In view of this, some technicians refuse to work on these sets—an attitude that dilutes customer confidence. "Why," a customer might wonder, "should I trust my complex TV or hi-fi set to a shop that can't repair a small radio?"

Troubleshooting Methods

Rather than refuse to service transistor sets, a service-shop operator would do better to learn techniques that cut down troubleshooting time so that repair charges can result in profits and still be agreeable to set owners. While several troubleshooting techniques are useful, servicemen should recognize the limitations and advantages of each.

Total-Current Measurement

One common troubleshooting procedure starts with measuring total current. A milliammeter is inserted in one of the battery leads to compare operating current with total-current norms usually noted on receiver schematics. The variation (higher or lower) of the abnormal reading from the prescribed value can often be analyzed to indicate the probable defect. When an audio circuit or another stage in a set having low-value emitter or collector resistors is at fault, current measuring is fairly reliable—a trouble in these sections will result in definitely erroneous readings. For example, an open audio transistor will lower current demand by more than you might expect from disabling a single stage; conversely, a shorted transistor or one drawing too much current (in the audio stages) will be readily noted.

On the other hand, faults in stages where large-value resistors are used in the emitter or collector circuits will affect total current drain so little that the change cannot be detected by the total-current test. Fig. 1A shows the first IF stage of a Motorola 6X39A with normal operating voltages indicated. Normal current drain of the stage is computed from the voltage drop across R9 divided by the resistance of R9; I is 2.8 volts/2200 ohms = .0013 amps or 1.3 ma. When the transistor shorts, the battery voltage is impressed across R8 and R9 in series; current drain I is 6 volts/2420 ohms = .0025 amps, or 2.5 ma.

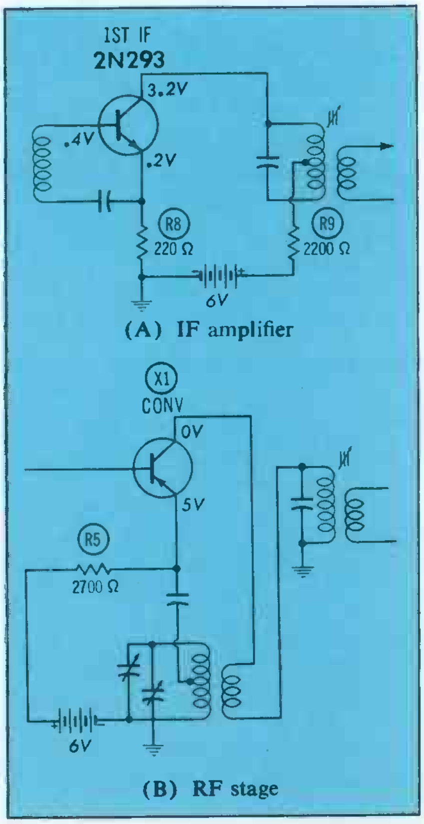


Fig. 1. Normal voltages in two typical RF and IF transistor circuits.

Thus with a shorted transistor an overdrain of slightly more than 1 ma results—very significant within the stage, but not too noticeable in a total-current reading that is perhaps 20 or 25 ma. This condition was actually experienced in the Motorola circuit shown, as was a similar condition in an Emerson 888 (Fig. 1B) in which the converter transistor shorted. The total stage current is that found by dividing the voltage drop across R5 by its resistance; normally this is 2 volts/2700 ohms, or .37 ma. With the transistor shorted, total supply voltage is impressed across R5. The resulting current through this resistor is 6 volts/2700 ohms, or 2.2 ma, again hardly noticeable when the reference point is at the power-supply input for the whole set. These examples clearly demonstrate one limitation of the total-current measuring technique.

Voltage Measurement

While voltage readings will invariably be helpful (if not necessary) in pinning down a specific fault, they are often misleading for preliminary troubleshooting. It is even possible to develop the habit of rambling from one voltage to another in hope of stumbling onto the trouble. If, however, for want of clearer understanding, a serviceman is prompted to read voltages, he will be wise to limit such measurements to the drops across emitter resistors. These readings will supply considerable information concerning transistor operation and also indicate the input- and output-load condition of each stage.

Even after the defect has been localized to one stage, voltage readings can be misleading. For example, consider the case of an RCA 1T4J (Fig. 2) in which the signal had been scope-traced to the first IF amplifier (X2) collector. There was no signal, however, on the base of second IF amplifier X3. The possibility of an open secondary in IF transformer L4 (my first suspicion) was sidetracked when a voltmeter reading showed an approximately correct voltage at the base of X3. Total loss of signal could result from a base-to-emitter short in X3; since such a transistor short would curtail current flow in the emitter resistor, a voltage reading was taken across R14. The subnormal voltage seemed to indicate such a base-to-emitter short, so the set was turned off in order to take resistance measurements. Resistance readings were perfectly normal—low resistance in one direction and high resistance in the other. If the transistor had been shorted, the resistance would have been low in both directions. Further resistance measurements did reveal, however, that the IF transformer secondary was indeed open. The approximately correct voltage found on the base, even with the source circuit open, is typical of the misleading indications frequently encountered in transistor-circuit voltage measurements. Similar conditions would be obtained should the emitter resistor open. Thus, with voltages measured at transistor elements, the source should be determined to avoid being misled by effects of shorted and open circuits.

Body Signal Injection

In troubleshooting vacuum-tube radios, it has become common practice to test the audio stages by touching the input grid with a screwdriver shaft or other instrument, while touching the metal with a finger. The resulting 60 cps hum from the speaker indicates signal continuity, while the loudness of the low-pitched noise suggests relative sensitivity of the audio stages. Applying this testing technique to the base of transistors, convenient as it is, has certain drawbacks. One limitation is imposed by the low input impedance of transistors, which may prevent manually induced hum from producing much sound from the

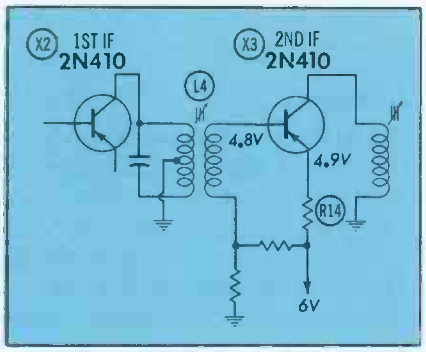


Fig. 2. Shorted IF transformer winding affects DC voltages only slightly.

speaker, even with good audio stages. In many cases, the noise produced from the speaker is too weak to serve as a dependable indication of relative sensitivity. There is another, more misleading limitation to the hum test in transistor circuits. Scratching the input (the transistor base or the hot end of the volume control) may generate noise more like RF static than like 60-cps hum. This noise can be detected by the ferrite loop, receive full amplification in the IF stages, and deceivingly suggest normal audio performance.

Generator Signal Injection

Audio and RF generators provide more reliable signals for troubleshooting transistor circuits, and permit far better determination of stage amplification than does induced hum. The RF signal generator already owned by most shops can be used as the test source, but many shops specializing in transistor radio servicing have invested in small noise generators specifically developed for the purpose. These noise generators develop, without bandswitching, a wide spectrum of signals from audio frequencies to more than 2 mcs.

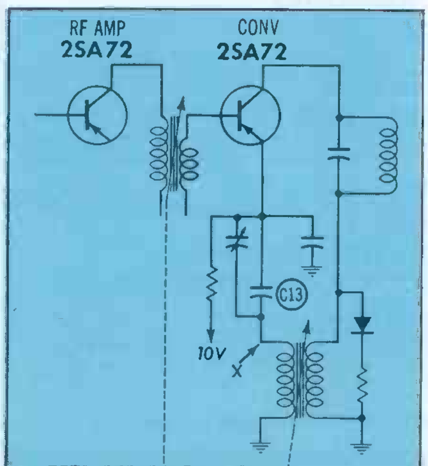


Fig. 3. A scoping point in typical auto radio transistor converter circuit.

Although signal-injection is often helpful in localizing a defective stage, certain troubles that occur in transistor radios are susceptible to shock excitation by sharp pulses from a test generator. For example, applying a generator signal to the volume control of a dead RCA portable shocked the set into operation; and the radio worked perfectly for several days to follow. In another case, an inoperative Motorola set came alive when a test signal was applied to the base of an IF transistor; this set also had to be turned on many times afterward before the trouble returned. After experiencing this same shocking condition (no pun) several more times where resin joints were responsible, I gently packed up my signal generator and retired it from servicing transistor receivers.

These diabolical intermittents were all successfully analyzed by means of scope tracing (see "Scoping in Transistor Radios in PF REPORTER, June 1964), as were other troubles that conventional troubleshooting failed to uncover.

Scoping Oscillators

When scope tracing across the oscillator tank of a Westinghouse receiver indicated a nonfunctioning circuit, my next check was of the DC resistance in parallel with the tuning capacitor. This is a reasonable procedure because it quickly indicates continuity in the coil. In this specific case, I read a dead short; the cause: a tinkering customer had tightened the trimmer and punctured the mica.

Auto Radios

Checking oscillators with a scope is not necessarily limited to portable radios; the method is also applicable to a great many other devices, including transistorized automobile receivers. The circuit point to scope in radios is the hot end of the oscillator coil—identified as point X in Fig. 3, the oscillator schematic of a Motorola CTA61. One such receiver had every indication of a defective oscillator stage; the strongest local station came in at two points on the dial, and no other stations were received. In spite of this, a 5-volt signal (Fig. 4) was seen on the scope screen at point X, contradicting the other clues.

Because the strong local station did crash through, I wondered if a freak demodulation was occurring in the RF stage. Voltage and resistance measurements subsequently indicated a shorted transistor. On replacing the transistor in the RF section, receiver operation was normal. A study of circuit conditions reveals the cause of demodulation in the RF section. The base voltage of the shorted transistor will remain close to 9 volts while the emitter drops to about 5 volts. With these voltages applied, the transistor will be severely reverse-biased and become a class-B demodulator.

Intercoms

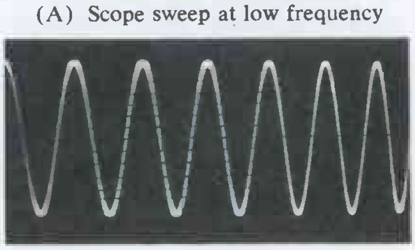
The General Electric W300A carrier-current transceiver found on the *Servicer* page of PHOTOFACT Folder 519 points up once again the value of scoping the oscillator tank signal. In a defective unit I was repairing, neither reception or transmission was possible. When I switched the unit to the transmit mode and scoped the oscillator tank circuit, no signal was found. This led to voltage measurement at the oscillator stage, which revealed a shorted transistor.

This particular transistor, a type RS 2358, was used as an RF amplifier for reception and as an oscillator for transmitting. Since it was not listed in any transistor replacement guide, I replaced it temporarily with an RF type having a BVce rating of −20 volts. With this replacement, the intercom operated, but with considerable distortion. Scoping the oscillator tank signal revealed a severely clipped sine wave of over 20 volts. When the correct transistor was installed, normal operation was restored; and I found a 15-volt pure sine wave at the oscillator tank.

Summary

This article has pointed out how time-proven troubleshooting methods, used for years in vacuum-tube circuits, may prove misleading when applied to transistor-radio servicing. The low-impedance of semiconductor circuits can mask changes in voltage and rule out induced-hum signal tracing. The inherently small current drain of low-power transistors causes total current methods to defy evaluation. Thus, in many cases, the only sure-fire procedure for uncovering elusive defects in transistor-radio circuits calls for the use of an oscilloscope. Not only is scoping a practical method for checking oscillators, it comes through with flying colors in tracing RF, IF, and audio sections. So, don't throw away your VOM's and VTVM's, but move that scope a little closer to the transistor radio bench, and scope your way to profit! ▲

(A) Scope sweep at low frequency



(B) Same signal swept rapidly

Fig. 4. Output waveform signals found in transistor radio oscillator circuit.

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NEW YORK HI-FI SHOW OPENS FALL SEASON

Transistorization and miniaturization were the key features of the equipment shown at the New York High-Fidelity Music Show in October. This annual affair is the national platform for launching new products by the many manufacturers who comprise the Institute of High Fidelity, Inc. Audiophiles and dealers await the unveiling of new trends and designs during the four-day showing. Two other Institute shows are held on the West coast at other dates, but the New York show annually introduces the greatest number of new products.

The trend toward miniaturization was apparent in the diminutive speaker cabinets and compact components and subassemblies displayed for 1965. Tape recorders were shown in greater numbers than ever before, with features that appeal more to the nonprofessional user than those of previous years. Here again, transistor applications offered important changes in operating efficiency, flexibility, and circuit reliability.

High-performance, portable phonographs, affording substantial power outputs never before supplied to the public, were exhibited by several manufacturers. These units are available in both wooden-cased types and luggage-styled portables. Transistor circuitry has permitted a substantial power increase in a far more compact package. In addition, new speakers and enclosures offer improved quality even with greatly reduced cubic content. Certain amplifier circuits have been redesigned to accent the characteristics of the new generation of speakers, with emphasis on good, clean bass response. The new compacts are in the $200 price range, but should attract the serious audiophile who demands audio excellence in a small, easy-to-place speaker system.

Component amplifiers and tuners of more conventional size also employ transistors this season. Prices are still above the tube types in general, but increased reliability has been proved by the manufacturer and accepted by the public. The smaller component units should provide a comfortable starting place for the new high-fidelity component buyer of 1965 who has a limited budget.

Speakers also appeared in the guise of table or hanging lamps, as all-weather units for outdoor use, and in new shapes and sizes more likely to entice feminine interest. One small, high-performance speaker system measures 10½" x 5½" x 7¼". While small systems outnumbered larger designs, the impressive quality demonstrated by multispeaker systems in larger cabinets attracted many critical listeners.

Complete transistorization of tuners and amplifiers was evident in several new product lines. The overall chassis size of component equipment has not been reduced appreciably, except in the case of the compact amplifiers, but manufacturers claim cooler operation now permits less conspicuous installation in locations where ample ventilation space was required for tube types.

Industry estimates of more than $100 million in sales for the next year were voiced by Walter O. Stanton, president of the Institute, and president of Pickering and Company, manufacturers of record-playing equipment. Mr. Stanton has watched the industry grow from annual sales of $25 million in the 1950's to its present level. Virtually all of the industry growth has occurred since the end of World War II as a direct result of consumer demand for better sound.

According to Mr. Stanton, 75% of the urban homes having high fidelity installations are still not equipped for two-channel stereophonic sound, and this represents a major growth area for the industry in 1965. ▲

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QUICKER SERVICING

SERVICING STEREO ADAPTERS

by Norman D. Tanner

FM stereo has been around for three and one-half years (the first broadcasts took place in June 1961), and has solidly caught hold of its market during 1964. What does this mean to the service technician? It means a good deal of equipment has been in use for some time now, and many additional units are being sold each and every day. So, get ready for more and more requests to service FM stereo receivers! The technician who best understands the operating principles of FM stereo reception is the one who will be able to repair these sets quickly, and consequently turn this activity into profit.

Several articles and books have been written dealing with the theory, operation, alignment, and other aspects of FM stereo receivers. It seems that in nearly all these writings, the importance of an FM stereo generator has been stressed. There is no doubt that such an instrument can often be mighty useful. However, *service* can be performed, and performed adequately, without a generator. A stereo transmission has all the signal components needed for checking stereo receiver operation. The main advantage of using a generator rather than a station transmission is the convenience of selecting specific components of the composite stereo signal. The remaining parts of a transmitted signal, of course, cannot be turned off. Therefore, to service stereo decoders without a multiplex generator, the technician must be able to recognize and concern himself with only the portions of the composite stereo signal which seem to be missing or improperly reproduced — a procedure quite similar to that of using video signals for servicing TV receivers.

The Transmitted Signal

To best be able to recognize these individual components at the receiver, let's briefly review the signals transmitted during a stereo broadcast and the importance of each.

The stereo signal must serve two purposes. First, it must provide the stereo listeners with separate left and right audio. Secondly, those listeners having *monophonic* FM sets must not encounter any interference from the additional second-channel information, and must still enjoy good quality mono FM when stereo is transmitted. Both these requirements are accomplished in the following manner:

Three separate signals are transmitted during an FM stereo broadcast. The main channel (L + R) — that heard on standard FM receivers — consists of frequencies between 50 cps and 15 kc. The difference

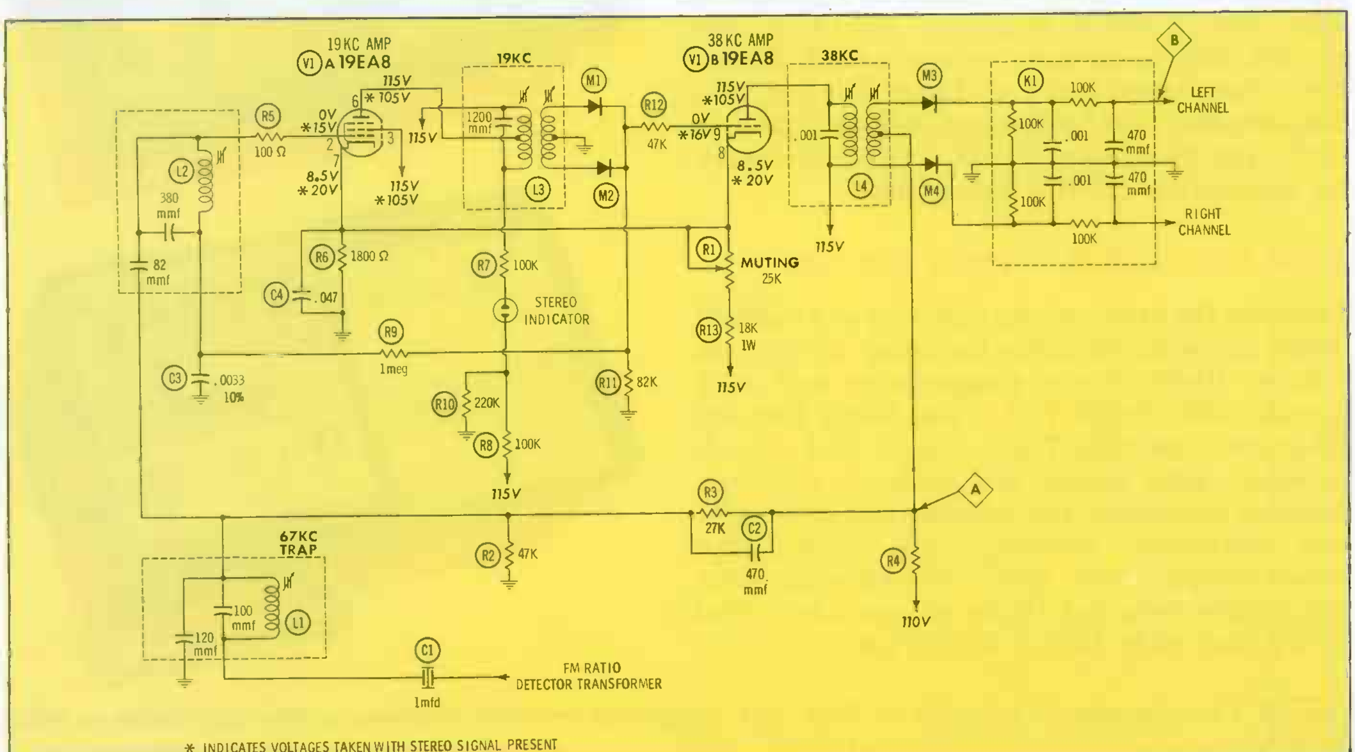
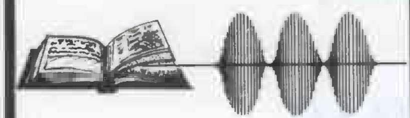


Fig. 1. Modern Stereo adapter circuit uses diodes to develop 38-kc carrier.

BOOK REVIEW



Mathematics for Electronics and Electricity; National Radio Institute Staff, John F. Rider Publisher, Inc., New York, New York; 250 pages, $3.95. In its five chapters and 250 pages, this paperback volume covers the range of mathematics from counting in the decimal system to the fundamentals of Boolean algebra. The first chapter, "DC Circuit Calculations," is in reality a review of simple arithmetic—the basic operations of addition, subtraction, multiplication, and division as applied to whole numbers, fractions, and decimals. Simple electrical circuits are used as a basis for examples—a technique used throughout the book. The second chapter explains square roots, ratios, and positive and negative numbers. Phasors (vectors) are introduced in this chapter, also; solutions of problems by graphical means and by means of the theorem of Pythagoras are explained. Chapter three explains simple algebra and the operator j. The fourth chapter introduces elementary trigonometry, exponential numbers, significant figures, and the use of graphs. The last chapter is devoted to binary arithmetic and Boolean algebra. The explanations of the various topics are brief but adequate for the purpose. The experienced engineer or technician may have little need for such a text, but the beginner or the person whose knowledge of practical mathematics has grown "rusty" should find it useful.

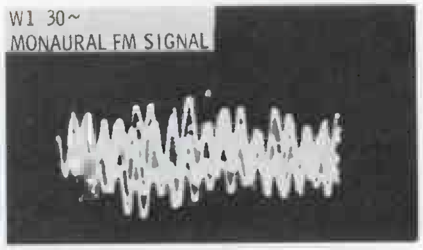


Fig. 2. Point A—monophonic FM signal.

signal (L − R) amplitude modulates a 38-kc carrier which is then suppressed (not transmitted). Only sideband pairs 15 kc above and below 38 kc are transmitted. Therefore, in the stereo receiver this 38-kc carrier must be redeveloped. To produce a 38-kc carrier within frequency tolerance and in phase with the original suppressed carrier, a third signal — the 19-kc pilot — is transmitted. Special circuits in the transmitter combine these components and they appear together at the receiver as the composite stereo signal.

Some stations also broadcast a fourth signal — background music service, or SCA — which ranges from 59 to 75 kc. Since this additional carrier is not suppressed at the transmitter, it must be removed by a filter network in the receiver to prevent "beat" interference with the L − R signal.

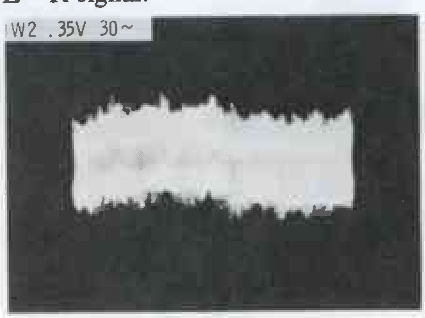
Enough on the signals that are transmitted. Now, let's see what happens to these signals in the stereo receiver.

Tracing The Composite Signal

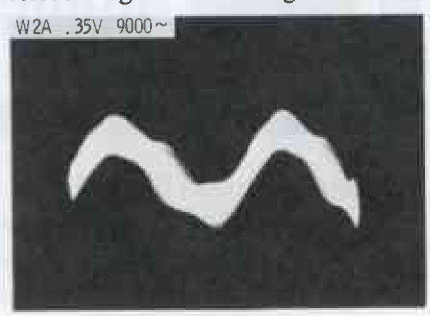
Fig. 1 shows a typical stereo adapter circuit. The composite signal is taken from the ratio detector transformer and coupled through C1 to the SCA filter. This trap is tuned to the center frequency of the SCA signal, 67 kc, and has a response sufficient to trap frequencies 5 kc above and below 67 kc. A defect in, or misalignment of, the 67-kc trap network will result in a "whistle" or other interfering noise from the speakers.

The output of network L1 (composite minus SCA subcarrier) is divided into two paths: The L + R (standard FM) and L − R signals are coupled to the center tap of the secondary winding of L4, while the 19-kc pilot is separated from the remainder of the composite signal and applied to the grid of V1A through tuned circuit L2.

Waveform W1 (Fig. 2), taken with the receiver tuned to a monophonic broadcast, shows the L + R signal present at point A. When a stereo signal is being received,



W2-scope set to 30 cps.



W2A-scope set to 9000 cps.

Fig. 3. 19-kc pilot signal at V1A grid.

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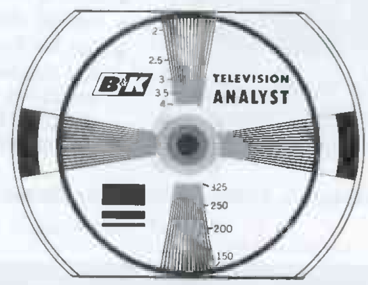

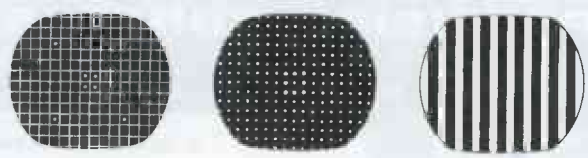

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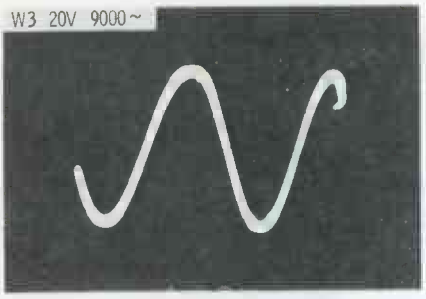


Fig. 4. Waveform at plate of 19 kc amp

L + R is again present at A, but accompanied this time by the other components of the composite stereo signal.

The signal at the grid of V1A is depicted in Fig. 3. (These and all remaining waveforms were taken with the receiver tuned to a stereo broadcast.) W2 and W2A are photographs of the same signal; W2 was taken with the scope sweep set to 30 cps, W2A with the scope sweep set to 9000 cps. In both waveforms you can see the 19-kc pilot as well as audio. W2A, however, is most important at the grid of V1A, since L2 is tuned sharply to pass 19 kc. The transmitted 19-kc pilot signal is intentionally very low

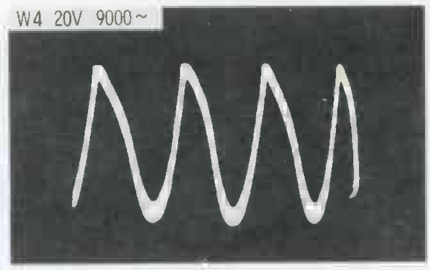


Fig. 5. Diode output — 38 kc sinewave.

in amplitude to prevent interference in mono-only receivers.

The plate signal of V1A (W3), shown in Fig. 4, is the amplified 19-kc signal. Notice the audio information is much less pronounced at the plate; this is because plate transformer L3 is tuned to 19 kc. Each side of transformer L3 secondary feeds a diode, while the center tap is grounded. The diodes are connected in doubler fashion to produce an output of 38 kc.

The output of the doubling diodes (grid signal of V1B) is shown in Fig. 5. This waveform (W4) was observed with the scope sweep set to 9000 cps. Proper doubling action can be checked very easily. Set the scope for two cycles of the 19-kc signal at the doubler input and then, without changing the scope frequency, check the doubler output; four cycles (38 kc) should be displayed. A good indicator of diode condition is the amplitude of the four pulses, which should be constant under normal conditions.

Considerable amplification (about 19 db) takes place in the V1B stage, where plate transformer L4 is tuned to 38 kc. The signal amplitude at the grid is 20 volts peak-to-peak, while the plate signal (Fig. 6) is 175 volts.

The waveforms (W6 and W6A) in Fig. 7 show the signal that appears at the junction of L4 and M3, consisting of L + R, L − R, and the reinserted 38-kc carrier. The matrixing of the audio signals (L − R and L + R) begins at this point and the corresponding junction of L4 and M4.

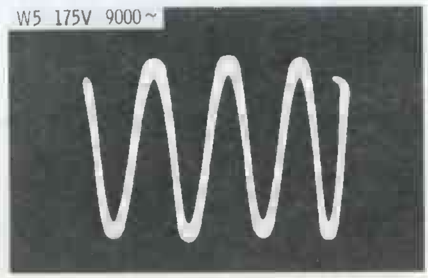
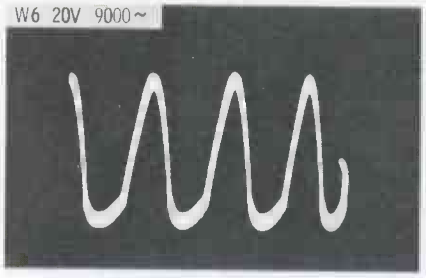
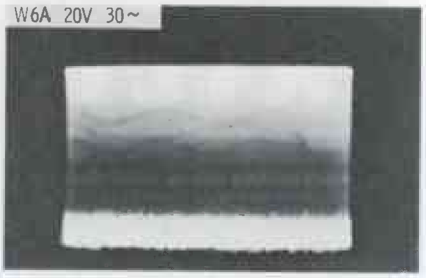


Fig. 6. Waveform at plate of 38 kc amp.



W6-scope set to 9000 cps.



W6A-scope set to 30 cps.

Fig. 7. Signal input to detector diode.

The outputs of M3 and M4 consist of 38-kc pulses whose amplitudes vary at an audio rate; M3 recovers the left channel audio, M4 the right. The 38-kc carrier still present (W7 in Fig. 8) is filtered by K1, leaving only the audio signals for application to audio amplifier stages. The signal taken at point B is W8 in Fig. 9.

Stereo Indicator

Many stereo receivers are equipped with a stereo indicator light. A popular version employs a neon lamp in the plate circuit of the 19-kc amplifier tube; a typical arrangement is shown in Fig. 1. The purpose of this indicator is to inform the listener when a stereo signal is being received—therefore, it should not light when the receiver is tuned to a monophonic signal.

One side of the lamp is connected to a fixed DC voltage, while the other side is connected to the plate of V1A through R7 and L3. When a stereo signal is received, a 19-kc pilot is present on L3. The peaks of this signal at the primary of L3 are sufficient to develop firing potential across the lamp circuit.

The muting control (R1) adjusts the cathode voltage and thus the bias on both V1A and V1B. Misadjustment of this control may prevent the neon lamp from firing (if the cathode voltage is too great), or allow it to fire when noise from an FM station is present (if the cathode voltage is too small).

Even with the muting control properly adjusted, the indicator may not light on some stereo stations; this is usually caused by an improper antenna system.

Summary

Once you have determined that a defect is present in the multiplex stages, isolating the defective circuit can be simplified by the signal tracing procedure we've given here. A waveform analysis of both plate and grid signals is a good starting point. Improper waveforms may be caused by either a defective component or misalignment of the associated coils. (A complete alignment procedure, and checks for individual coil alignment are given in PF REPORTER, July 1964.)

As was mentioned earlier, a station signal should prove adequate in servicing any FM stereo circuit. However, to assure proper separation of the audio signals a generator may be required; the varying levels of a broadcast just aren't suitable for this job.

The circuits in some receivers will not be identical to the one shown in Fig. 1. However, they all do the same basic job and their operation is similar. The most important circuit points to look for are the stage in which the 38-kc carrier is redeveloped and the network in which the L − R and L + R signals are matrixed. Once these have been recognized—and you know what the waveforms should look like—you're well on the way to faster stereo servicing. ▲

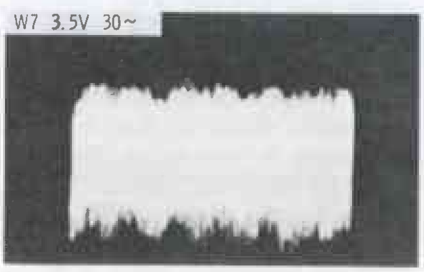


Fig. 8. Det output — 38 kc unfiltered.

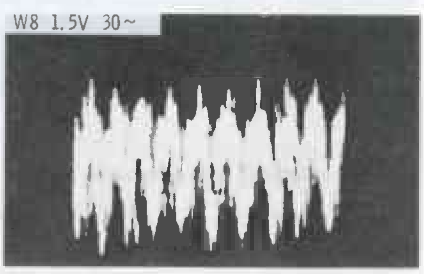


Fig. 9. Filtered output is pure audio.

KILL those CALLBACKS

by *Frank R. Perullo*

For almost 14 years, I've been in and out of homes repairing TV, radio, and hi-fi sets. Probably one of the more demoralizing things that can happen is to remove, repair, and reinstall a 13-year-old *Whatzis,* which calls for enormous physical exertion (the people who own such sets invariably live on the third floor and ask you to use the back entrance), and then receive a phone call the day after saying the sound has a crackle in it every hour or so. You try to explain that the set was repaired for some other trouble entirely unrelated to sound, but that's like telling the local gendarme you didn't see him signal you to stop.

So, now what? You *could* go back with a tube checker, hoping to detect leakage or some other weakness in the audio tubes; you *could* then set up shop in the parlor, with the customer glaring over your shoulder and silently thinking, "Who does this guy think he's kidding, turning knobs, tapping tubes, and making a big deal out of nothing, when all any good TV man has to do is reach in and take out the bad tube?" Or, you *could* go quietly back and remove the chassis, explaining that it was all your fault and the job wasn't quite complete. What's best?

Having approached this problem for years from every angle, I find the ultimate answer to be: Completely check out the whole set while it's in the shop. By doing this, you may spend an hour longer, but in the long run you're 'way ahead.

A Procedure

First, check every tube—including the picture tube. Right here, 80% of your present and future troubles are eliminated; you not only protect yourself, but you capture tube sales that might otherwise go to drug and retail stores. You also increase your own profit and at the same time insure yourself to a degree against those time-consuming and costly callbacks.

Next, clean every control in the set with any good control cleaner. This procedure takes only five minutes and is invaluable. Then, using a high-quality tuner cleaner, carefully wash down the tuner contacts. You are then ready to find out what is wrong with the set. Check all components visually. The condition of many resistors and capacitors can be evaluated by sight—for instance, a capacitor with wax leaking out or a scorched resistor. Get them out! They are no good, and will quite possibly have you doing the job over again in a week or two, if they are not replaced. If either fails after the set is returned, and the job has to be done over, you can figure a loss as high as $15 to $20 worth of valuable time that could have been applied more profitably.

Look at those resistors. Any change in color means that either the value has changed or is soon likely to because some other component is drawing an overload through it. Change that resistor! And look for the cause of overload.

Get used to looking at every tie point, ground point, and—especially on printed circuit boards—every solder joint. With practice, you'll be able to pick out cold-soldered joints, cracks in PC boards, and other little things that competent eyes notice quickly.

After the Repair

Next, turn on the set and—with proper blend of mind, instruments, and experience—you should be able then to locate the trouble and repair it. So the set is running and all you have to do is rush it back to the customer and collect. Whoops, not so fast! I'm quite sure most veteran servicemen have seen sets they've just repaired run beautifully for an hour or two, and then act worse than ever. The set should be run for a minimum of four hours. If you want to (although I don't think it necessary in all cases), operate the set at 100 volts AC for one half-hour and, if you suspect more hidden trouble, raise the input voltage to 125 volts AC for 10 minutes or so. (Of course, I'm assuming we all have variable transformers, which come in quite handy at times.)

After the "cooking" time is up, shut off the set for about 10 minutes and then turn it back on. If everything still looks good, you have an excellent chance of delivering the set and not seeing it again till it's due for another good going-over.

You now have done everything possible to eliminate unseen problems, and your customers will in the long run be glad they paid a few extra dollars for a *thorough* job; furthermore, you'll rest easier because you'll know you've given them a first-class job. At the same time, you've been building a reputation for being an expert television serviceman.

Philosophy of a TV Man

Television service is not like betting on a horse or like playing cards. We have thousands of different models to contend with, many of them designed by someone who never had to sweat out the humiliation we all experience at one time or another in our jobs.

For instance, you pry a tuner knob off the set and the pieces fall on the floor in front of the customer because it had a hidden setscrew you couldn't possibly see.

. . . Or a tube smothered by an immovable shield so that in trying to remove it you break the tube. Great for customer relations.

. . . Or the portable with a high-voltage lead that barely reaches the CRT, so when you reach in to remove it from the CRT your big paw has just enough room to squeeze that diabolic pincer-type connector that keeps slipping out of your grasp. You end up getting belted good and come out of the set with blood dripping off your hand.

. . . Or the 6AL5 that was cleverly put between the picture tube bracket and the high-voltage cable so that you have to put a mirror, a flashlight, and a tube holder all in the same spot while you spend ten precious minutes trying to replace the tube.

. . . Or the set with no name, model number, or tube layout, that bears no resemblance to any set you know of, but the customer will pay anything to have it fixed because it really is a *Whackeroo* built by *Whatzis* and designed by *Whichit* —or so his brother says, anyway.

. . . Or the set with an enormous sheet of boiler plate covering the back, so if you're not very careful it will slip out of your sweaty hands and shear off the CRT neck which extends three inches beyond the cabinet.

Yet try to explain any of these to poor Joan Doe. She not only won't but can't believe you. So, if you want to beat some of the odds against you on the next set you bring to the shop, do this:

1. Check all tubes and CRT.
2. Check all capacitors visually.
3. Check all resistors visually.
4. Check all solder joints.
5. Check and clean all controls.
6. If set is cranky, run it at high and low voltage by varying the voltage between 100 and 125 volts.
7. Also, don't forget to clean the CRT.

Experience Helps

I was working on a Sylvania portable that had already been toyed with by the customer's friend. Of course, I was a little apprehensive, but the customer pointed out that all the tubes had been checked and quite a few replaced. He was correct. There were about seven new tubes, but force of habit made me check the older ones. They were good.

After at least two solid hours of beating my brains, I finally decided my first impression was correct and the trouble was in the oscillator and mixer section of the tuner. Both tubes in the tuner were new, but I checked them in the tube checker; they checked "good." I had an identical chassis in the shop, so I decided to swap tuners. Well, this *had* to do it, thought I.

After soldering the last wire, I turned on the set and . . . oh, my aching back, still nothing. Even though the 5U8 was brand new, I decided to get another from my tube caddy; I did, but still got no pix.

Now what? I sat back, carefully reviewed my efforts, and studied the schematic, which brought me right back to the tuner. There was another set on the bench and I noticed it used a 5U8. Like the drowning man who grabbed the straw, I pulled that 5U8 out and put it in the portable. Lo and behold, we were back in business!

I now had two *new* 5U8's that were bad and an *old* one that had put us back in business. I just had to know what was going on, so back to the tube checker. The first tube checked okay, but I was interrupted by a phone call and left it in the checker. When I got back, I pressed the check button and the needle dropped quite steadily till it reached an absolute "no good" indication. This tube evidently failed only after it warmed up.

About a week later, I repaired a GE Model 17C103. I had not checked all the tubes, but the pix was beautiful. I thought perhaps I should let just this one go by. However, bitter experience has taught me that tubes are devilishly two-faced and can cause all kinds of headaches. Consequently, I wheeled the chassis over to the tube checker and went to work. The tubes were all perfect except for an intermittently shorted 12AU7; out it came and in went a good one. I'm quite sure that if this set had gone back, I would have been back in the customer's house losing time, money, and prestige.

I recently repaired a changer for slippage in the 33-rpm position. The trouble was a worn shaft, so I talked the customer into changing the whole speed-shifting unit. The unit was replaced, and I played a stack of records on it and rushed it right back. I played a record for the customer and felt a little proud that this job was air-tight. Oh yeah? Next day, the customer phoned to complain that, on 45-rpm records, the arm landed in the wrong position. I had to go back and finish the job, because I didn't do it right the first time. If I had checked all speeds, I would have saved at least 1½ precious hours I could have spent more wisely elsewhere.

Conclusion

We can't reeducate people to all our problems, so I've found a better way out of the callback problem: Make as complete a check as possible and charge a fair price for doing it. Yes, in the long run the public will gladly pay more for a complete, lasting repair, and will also tell their friends how, after having their set overhauled, it ran for months with no problems. I've found in my own business that I make more money, keep more friends (and customers), and save much more time by a complete overhaul. ▲

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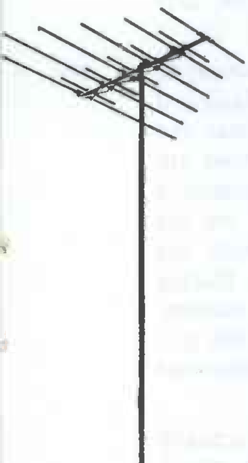

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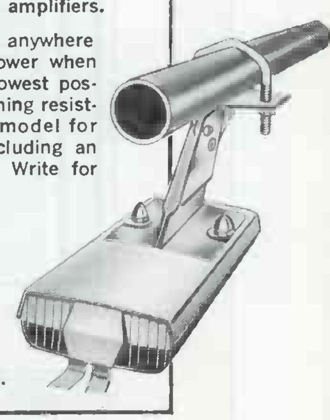

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The Knack of
FILTER REPLACEMENT

There is a right way — here's how to decide.

by Jay F. Shane

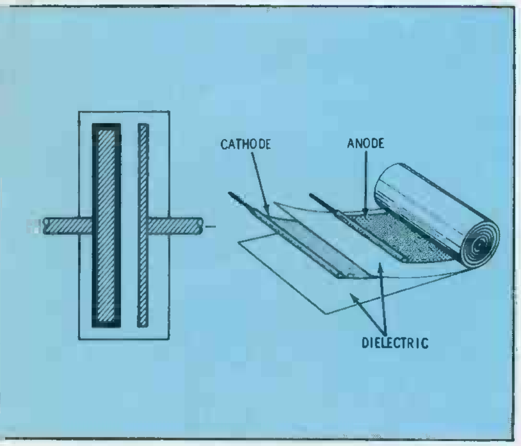

Fig. 1. Construction of an electrolytic.

Because of changing demands in the industry and the number of different circuit and chassis designs (despite the efforts of the EIA standards group) there is an almost unbelievable number of filter capacitor types. This multiplicity of types and values makes it practically impossible for even large distributors to stock a complete inventory of exact replacements. The television serviceman, therefore, is constantly plagued by not having a filter capacitor of the same size, type, and value as the defective component, especially for many older receivers. When this happens, a more specific knowledge of capacitor characteristics may help in selecting a suitable non-exact replacement.

Note: Materials for a portion of this article was adapted from the Howard W. Sams book "Understanding Capacitors" by William Mullin.

A standard tubular capacitor consists of two metal-foil strips separated by mineral-oil- or wax-impregnated paper and rolled tightly into a tubular configuration. Anode (positive) and cathode (negative) contact terminals are bound into the unit, one to each metal strip. This typical manufacturing technique provides units that nominally range from .001 mfd to 1 or 2 mfd; many are also available with a variety of dielectric materials other than paper in the same nominal range.

The electrolytic capacitor used in filter sections is of a far different nature, however, because much higher capacitance values are required. And, although their number may seem overwhelming, they are alike in using a thin film of aluminum oxide as a dielectric (in some electrolytics, tantalum oxide is the dielectric — the high price of these units, however, makes them seldom practical for replacement use). The standard electrolytic has an aluminum anode coated with the aluminum oxide film. The cathode of the electrolytic is actually a liquid electrolyte that consists of a solution of ammonium borate and boric acid, plus glycol to prevent freezing. A second aluminum conductor is embedded in the electrolytic to provide the cathodic connection. To ease manufacturing problems that would arise from using a free solution of the electrolyte, porous paper is impregnated with the solution so that the electrolytic is generally referred to as being "dry," although "damp" might be a more accurate word. Fig. 1 shows the theoretical symbol for and a simple assembly drawing of a typical electrolytic. The oxide film has a very high resistance to current in one direction and a very low resistance in the other. For voltage of one polarity, then, it acts as a dielectric and, in the other, acts as a conductor.

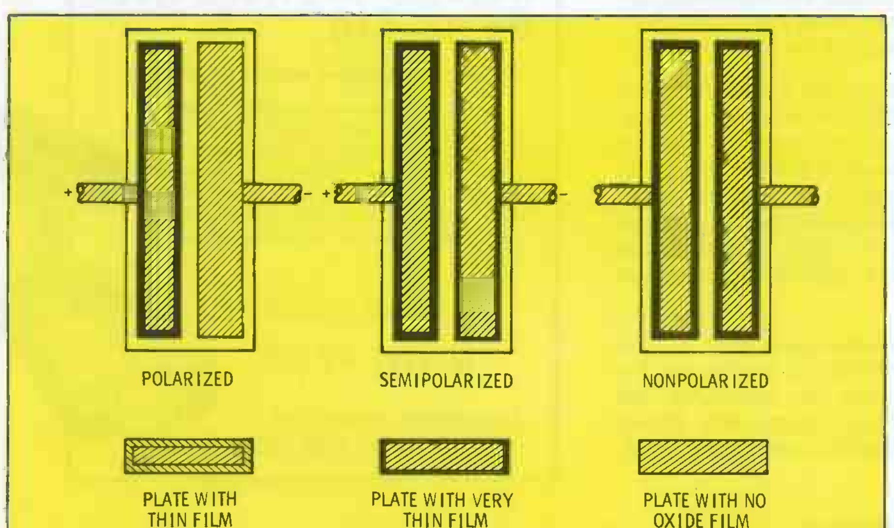

Fig. 2. The three basic electrolytic configurations.

There are three basic electrolytic styles: polarized, semi-polarized and nonpolarized. Fig. 1 illustrates the first. Symbols for all three types are shown in Fig. 2. The semipolarized type has an oxide coating on the cathode as well as on the anode, but one that is much thinner. During polarity reversals of low current, the film prevents damage to the primary anode that would otherwise destroy the oxide film.

The nonpolarized type is actually double-polarized, with both plates being coated equally, thus providing immunity to polarity reversals. This type is often used in AC motor-starting circuits. These basic electrolytics must be replaced type-for-type; that is, polarized for polarized, etc.

Now, with an idea of how these devices are constructed, we can determine factors that control their use in circuits where direct replacements are unavailable. Tolerances for electrolytics are established at 25°C and may typically be −10% to +50% for medium-to-high-voltage units. By this, then, a 100-mfd capacitor could range from 90 to 150 mfd and provide replacement for an original-value capacitor within that range under normal room-temperature operation.

A second factor to be considered is that the electrolyte varies in chemical proportion for electrolytics of different working voltages. It is not a good idea to use a 450 VDC unit in a circuit where the voltage is far below that level, because the oxide film will "deform" and reduce the total capacitance.

Something else to remember is that electrolytics will deform spontaneously while idle, and a full application of rated voltage will often cause the film to break down, permanently ruining the unit. It is always a good idea to reform *any* capacitor, before installing it, to avoid callbacks. This can be done using a capacitor checker or by applying voltage (approximately the rated working voltage) to the unit through a 1000-ohm, 5-watt resistor, allowing the charge to build slowly over a period of a few minutes.

The factors to consider in non-exact replacement of electrolytics, in view of what we now know of these capacitors, are: The type of polarization; the value, considering the broad allowance for tolerances; the correct voltage rating; and, the operating temperature.

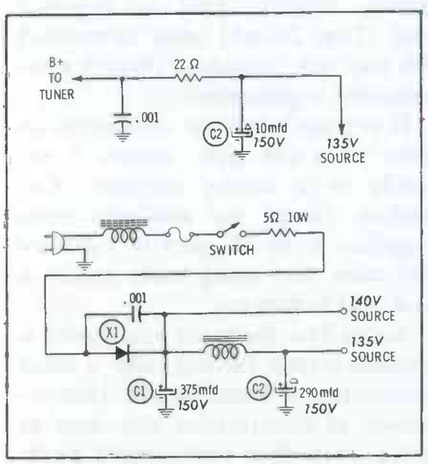

Fig. 3. Partial schematic of G-E chassis.

Case Histories

Fig. 3 shows the B+ supply of a GE Q2 chassis. The input filter (C1) is rated at 375 mfd at 150 VDC, required because of the 140-volt source developed by the rectifier. Several manufacturers show an exact replacement, but availability is often questionable at local distributor levels. Consulting a capacitor catalog, however, reveals several types you can substitute. There is, for example, a dual unit; 200-150 mfd at 150 volts DC. Tie the two sections together, and you get 350 mfd, well within tolerance. Or, select a second dual; 200-200 mfd at 150 volts DC. If dual-section electrolytics of this value are not available, then try a triple unit — 100-200-60 mfd at 300-150-150 volts DC, for example. This total value of 360 mfd is within acceptable tolerance.

The second filter of the Q2 chassis (C2) is a dual unit; 290-10 mfd at 150 VDC. The schematic (Fig. 3) shows the 10-mfd capacitor tied to the tuner B+ line which, in turn, is tied directly to the 290-mfd section for a total capacitance of 300 mfd in this filter. Here again, many other substitutes are available, using parallel arrangements.

Admiral's Chassis 16D9, 16E9, 16F9, 16UD9, or 16UF9 is about four years old and is very popular in motel installations. This receiver uses a 40-100-50 mfd unit at 350 volts DC. A replacement is listed, but, as we already know, listing and availability are often very different characteristics. The catalog shows at least three types, each of which can make an excellent replacement. There's a 40-80-40 mfd unit at 450-350-350 volts DC; a 40-40-80 mfd unit at 450-450-350 VDC, or a quad unit at 80-60-40-20 mfd and 350 VDC. The 20-mfd section can be tied to the 80-mfd section to total 100 mfd.

These chassis also use a "picture guard" circuit, Fig. 4. Experience has shown that any residual AC ripple component appearing on the B+ line will upset the "picture guard" circuit. The picture will usually be stable for a period from several minutes to a half hour long. It then gradually develops a slight curl, or wiggle, that may disturb the picture for a few minutes, then

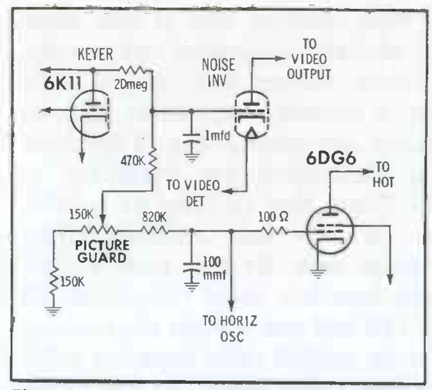

Fig. 4. "Picture guard" control circuit.

clear up.

If tube substitution and checking the keyer, noise limiter, and sync-separator voltages shows them to be normal in all respects, don't fight the circuit; change the filter. The power factor has probably risen sky-high with increased temperature; or, perhaps, leakage has developed between sections.

Points to Remember

A word of caution when servicing color receivers: Keep in mind that in chroma circuits electrolytics are often used as decouplers, and close tolerances are a prerequisite. The manufacturer uses optimum values, and he's well aware of the increase in capacitance due to ambient temperatures. He wants absolute filtering, excellent decoupling, and adequate bypassing to be maintained at all times. Changing values beyond a 10% tolerance in chroma circuits can and usually will affect color hue as well as color stability.

Remember, too: Do not substitute a *polarized* unit for a nonpolarized one. Disregarding this precept can cause a quick failure. You can make your own nonpolarized capacitors by tying two polarized units together, negative lead to negative lead. Two 20-mfd units connected this way will provide a 10-mfd nonpolarized replacement.

If you use a tubular electrolytic in place of a can type, anchor it securely to a nearby tie-point. Capacitor clamps are available from suppliers to fit all sizes of tubulars and cans, and using them makes a neat and secure job.

Just a few moments spent with a manufacturer's catalog, and a brief knowledge of some of the idiosyncrasies of electrolytics can help to make your filter replacement problems smaller and faster. ▲

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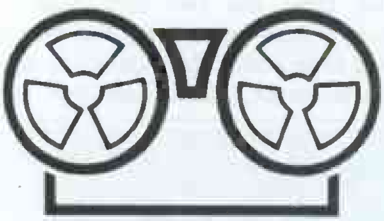


SMALL TAPE RECORDERS

There's money in servicing these inexpensive machines.

by Homer L. Davidson

Low-cost tape recorders—those in the $12.95 to $49.95 price range—are considered by many service technicians as a no-profit item, to be tolerated if need be, but certainly not welcomed. This shouldn't be so for you, provided you have enough knowledge of these units to service them speedily. Waste just a little time, and you must settle for doing either a poor job or a non-profit job.

When the small transistorized tape recorder, like that in Fig. 1, comes into the shop for repairs, there is only a narrow range of possible symptoms—the recorder is running too slow, has low or no volume, or has plenty of distortion. Actually, the small tape unit has only a handful of components. A transistor amplifier serves for both recording and playback, a small crystal mike and speaker are switched into the input and output of the amplifier, a small motor is operated from one or two flashlight cells to drive the tape reels, and one small recording head records and plays back the information on the tape.

Some faults in these little machines cause more than one symptom. If there is low volume and slow speed, for example, check *both* batteries. The 9-volt battery will cause low volume; most recorder amplifiers pull around 5 to 10 ma of battery current. There may be only one battery powering the small DC motor, although in those recorders that have two batteries in parallel (for motor power), batteries will last longer. The speed starts to drop when voltage on the flashlight cell drops to 1.25 volts, under normal load; most motors pull from 150 to 300 ma of current. Batteries are normally good for 30 to 50 hours of intermittent use.

Speed Problems

Let's look a little closer at the symptom "slow or no speed." If the batteries are okay, check the motor and rubber-reel turntables. These rubber-wheel turntables are driven directly by shafts of a small motor, which is mounted horizontally as shown in Fig. 2. Each end of the motor shaft uses friction to drive the rubber wheels. Fig. 3 shows a vertically mounted motor, and the small pulley that pushes against the edge of the rubber wheels. The bar-handled switch actually moves the motor from one reel-edge to the other when it is switched from "play-record" to "rewind."

If you suspect slippage, check the edges of the rubber wheels and see if perhaps grease is making them slip. Clean the rubber edges with alcohol or some other good cleaning fluid. Remove the C-washers from the top of the spindles and pull the rubber wheels off. (Some manufacturers don't use C-washers.) Look for grease on the bearings at the bottom of the rubber wheels. If the bearing grease has become dirty and caked, remove the old grease and apply *Vaseline* or a light oil. Use grease and oil sparingly. Before reassembling, use the cleaning fluid to clean off the motor pulley.

Some manufacturers say not to oil the motor itself. You can tell if the bearings are dry by pulling the motor away from the rubber wheels and turn the switch to "forward" position. Dry bearings will make a dry, chattering noise. A drop of light machine oil will help. Be sure to wipe off any excess oil that might flow onto the drive shafts, and clean them again with cleaning fluid. Fig. 4 shows one way to oil the small motor.

Sometimes, after hard use, the motor pulleys become shiny and slick. As a last resort, to increase friction and reduce slippage, apply a light coat of phono-wheel dressing to these pulleys. Do not apply any to the rubber wheels.

Make sure the motor fits snugly into its carriage, and that the pulleys are in the correct position when the switch is flipped to record or rewind. Clean the tape guide pegs with cleaning fluid, so the tape will move freely over them. You can notice if there is a great deal of drag on the head and guide pegs. Also, check the unit out with no tape in position.

The Recording Head

If the small recorder will not record or play back, first check the 9-volt battery. With the volume full on and the switch turned to play-

Fig. 1. Small recorders such as this are becoming fairly popular.

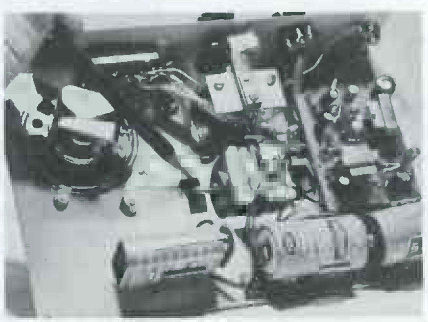


Fig. 2. Rubber-wheel turntables are driven directly from motor shafts.

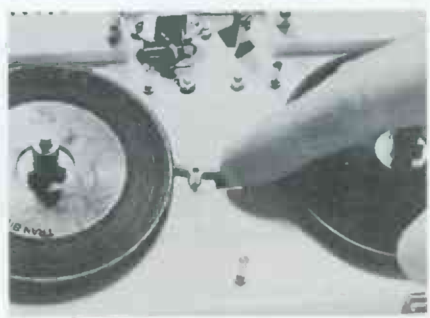


Fig. 3. Motor is mounted vertically in some miniature tape recorders.

back position, an audible pickup noise will be heard if the transistor amplifier is okay. If no noise is heard, the amplifier can be checked further by pulling the top guard piece off the recording head and touching a screwdriver to the unshielded side of the audio lead; a loud hum should be heard. An audio signal from a small harmonic generator, applied across the recording head leads, should be heard in the speaker. These tests should be made with the switch in playback position. The recording head is shown in Fig. 5. If a prerecorded tape is handy, place it on the rubber wheels and switch to playback. Now there should be results.

Fig. 4. Lubricants in pressure spray cans are handy for recorder service.

Suppose the amplifier is okay, but the unit still will not work. We already know the amplifier is good, so let's check the recording head itself. First, clean the front of the head with cleaning fluid. Next, measure it with your ohmmeter; its resistance should run from 450 to 900 ohms. Finally, make sure the tape moves past the correct portion of the head, in close contact. The pressure pad must hold the tape snugly against the head. Some small recorders do not use pressure pads; on units of this type, the two tape pegs are placed back far enough that the tape will drag across the face of the head. Furthermore, some recorders have rubber bumpers that lose shape and cause the head to tip, keeping it away from the tape. Some heads have an adjustment screw on one side that holds them in place.

If the tape doesn't move properly past the head, low volume will result, especially if the unit has a three-transistor amplifier. Either distortion or low or no volume may result from a defective recording-playback head. Fig. 5 also shows how to remove the head; merely remove two metal screws.

Fig. 5. Test amplifier section by touching metal to unshielded lead.

It is very possible that the recorder will not play back because the play-record switch was left in the record position during rewind and the recording has been accidentally erased. This can be done on the lower-priced units. On some models, you cannot rewind the recorder until the play-record switch is in the play position.

Many of the recording heads can be obtained from the distributor of small tape units, or substitute low-priced heads may be used. Be sure the new head has the correct impedance and that the mounting allows the tape to move past correctly. The new head may have to be raised or lowered with small fiber spacers. Check the resistance of a replacement head; it should match as closely as possible that of the original.

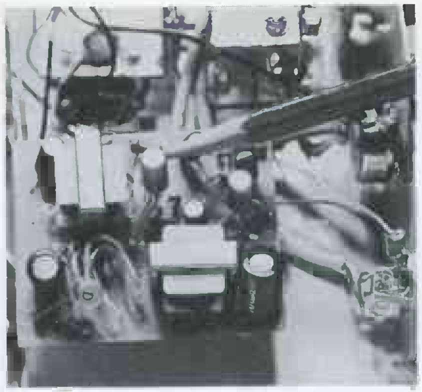


Fig. 6. Amplifier circuits are usually found on small printed circuit board.

Distortion and Low Volume

Distortion can be caused by a bad microphone, amplifier, or recording head, by poor speed regulation, or by low voltage. Improper speed will cause a form of distortion called wow and flutter. Be sure the slick and shiny side of the tape is not against the recording head; if the magnetic coating isn't directly against the head gap, low volume and distortion may result. The operator may have reversed the tape after it broke or when he started to rewind after the end of a reel.

Crosstalk distortion can occur when the erase magnet is not in place. This magnet should rest close to the tape when the switch is thrown to record. If the magnet is not in place, the messages will be recorded on top of one another. (One way to clear a tape is to unplug the microphone, switch the recorder to record, and run the whole tape through.)

Most of the amplifiers (Fig. 6) in these machines consist of three, four, or possibly five transistors. You need all the volume you can get on the three-transistor models, and every component must be up to snuff. Distortion, low volume, and no sound are the most common troubles. (Generally, amplifiers cause few troubles in tape recorders.)

Low volume can be caused by defective transistors, coupling capacitors, or 9-volt battery. The output stages in the better amplifiers are push-pull, and one defective transistor can cause low volume or distortion. Electrolytic coupling capacitors may start to leak or dry out and produce distortion and low volume.

Apply an audio signal to the input of the volume control (Fig. 7), with the recorder in play position. Trace the signal through each transistor stage and notice the gain in each. Clip the signal lead to the ungrounded side of the playback head; you should notice additional audio gain. Each stage can be checked until the one that introduces the distortion or low volume is found.

Conclusion

So you see, inexpensive transistor tape recorders are not so difficult to repair as your first impression might suggest. Only a few basic troubles are common, as has been shown. Using your sound understanding and your ordinary service equipment, you can turn these small units into large profits. ▲

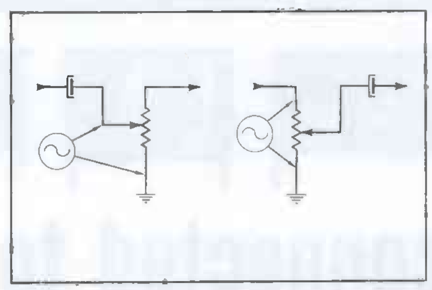


Fig. 7. Use audio signal generator to locate defective transistor stage.

Notes on Test Equipment

analysis of test instruments . . . operation . . . applications

by Allen B. Smith

Versatile Tester

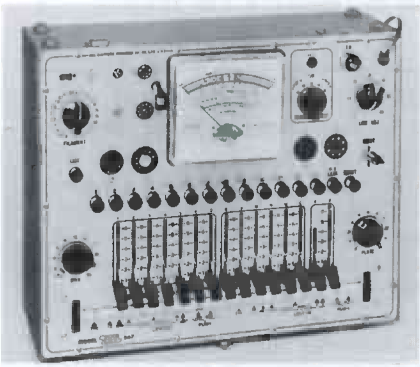


Fig. 1. Tube and transistor tester features pushbutton leakage test.

Many new home entertainment instruments (television sets, radios, and phonos) utilize transistorized circuits in whole or part. The EICO Model 667 Dynamic Conductance Tube and Transistor Tester shown in Fig. 1 enables the service technician to test both tubes and transistors in these units on the same portable test instrument. Ten different tube sockets accomodate most receiving tubes and a wide range of other types as well. A separate transistor socket will accept most replacement PNP and NPN transistors.

Tube types that can be tested by the Model 667 include: *novars;* 5- and 7-pin *nuvistors;* compactrons; 7-, 9-, and 10-pin miniatures; 5-, 6-, and 7-pin subminiatures; 8-pin subminiatures; octals; and loctals. Many other special tubes — small transmitting types, voltage regulators, cold-cathode rectifiers, eye tubes, ballast tubes, and others—can also be checked on the unit.

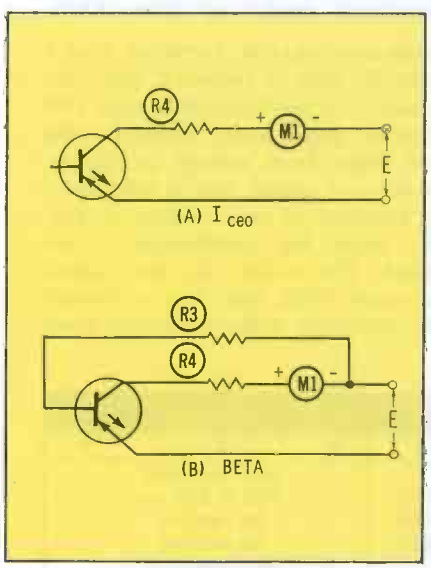


Fig. 2. Test circuits: I_{ceo} and Beta.

Tests performed include: interelectrode leakage; merit — a combination of emission and dynamic conductance; and, for transistors, leakage measurement of collector current (emitter grounded, no base signal) and current-amplification factor (beta.) Fig. 2 shows the two circuits used to check transistors.

Operation of this tester is straightforward and quickly set up for each test, once the technician takes time to read the instruction manual. Detailed step-by-step instructions for testing all tube types and transistors are given in the manual. Lever and pushbutton switches seem positive in action and of good quality.

There are several levers and pushbuttons whose operation will not be immediately apparent without reference to the manual. The V, C, and S levers, for example, determine voltage levels, cap connection, and variable meter sensitivity, respectively. In a second case, the roll-chart information for leakage tests (a series of several numbers) sometimes shows underlined figures; these are for testing heater-to-cathode leakage in indirectly heated tubes, and the H-K leak button must also be depressed during this test, or an inaccurate reading will be obtained. To obtain a high degree of flexibility, the manufacturer has chosen to use unfamiliar designations, but they are simple to understand if you have no aversion to reading instructions.

In the center of the *novar* socket is a second socket used to test miniature-base lamps (threaded or bayonet types). The inner wall of the socket is connected to ground, and the center contact is tied to the rotor of the filament-selector switch; the setting of that switch determines the voltage applied to the bulb. Testing several types of panel lights, and even a few Christmas-tree bulbs, showed us that faulty lamps can be quickly detected.

During evaluation in the field under

EICO Model 667 Specifications

Tube types tested:
5- & 7-pin *nuvistors; novars;* compactrons; 7-, 9-, & 10-pin miniatures; 5-, 6-, & 7-pin subminiatures; 8-pin subminiatures; octals; and loctals, plus other special types.

Tube tests:
1. Interelement leakage in ohms.
2. Merit test: emission reading for rectifiers & diodes, and dynamic conductance for triodes, tetrodes, and pentodes.

Transistor types tested:
NPN and PNP.

Transistor tests:
1. Leakage of collector current.
2. Beta (amplification factor).

Size (HWD):
6" x 15" x 12".

Weight:
20 lb.

Power Source:
105-130 volts AC, 60 cps; 10 watts (no tube), 50 watts (max).

Price:
$129.95 (wired); $79.95 (kit).

actual shop working conditions, the Model 667 tester was used by a technician in repairing various television receivers. Operation of the tester at first seemed a little cumbersome, but increased familiarity in setting the controls speeded the testing a great deal. More than 50 tubes (all known to be bad) were rechecked with the 667, and all were confirmed to be defective.

When analyzing the vertical-sweep circuits in a Philco chassis, he found roll-chart information on the output tube (12B4) was not listed, but was given in the supplement booklet. The manufacturer's manual, in a four-page procedure, gives a method for determining control settings to test unlisted types from manufacturers' specifications. The method is rather involved and would not normally be used; but, for emergency use, it does work. New roll charts are available from EICO at regular intervals, as new tubes come into common use.

For further information, circle 46 on literature card.

Bad Color CRT . . . or Circuit

Often, it's advantageous for the service technician engaged in color work to have a fast means to make dynamic checks on the operation of the color picture tube—without needing several meters and/or making checks directly in wiring circuits. The Mercury Model 900 Color TV Analyzer shown in Fig. 3, is designed to meet these requirements.

Fig. 3. New Analyzer is used to make operational checks on color CRT's.

The 900 is a self-contained unit, needing no power (internal or external) for its operation. The instrument connects in series with the picture tube, between the tube and the chassis; male and female plugs are included for this purpose. The only other connection necessary is to clip the ground lead from the unit to the TV chassis. Once connected, the instrument can be switch-operated to read voltage and current of each individual element, one color gun at a time. Operation of the test-set isn't difficult: A three-position COLOR GUN switch selects either the RED, GREEN, or BLUE gun to be tested. A six-position ELEMENT SELECTOR switch, with positions for METER OFF, HEATER, CATHODE, GRID 1 (control), GRID 2 (screen), and GRID 3 (focus). A spring-loaded PRESS FOR CURRENT pushbutton transfers the panel meter from voltage to current. The internal circuit, too, is automatically switched to read voltage or current, when the pushbutton is depressed. The meter has two scales; the upper black one is a combined volts-microamp scale, calibrated from

Table 1

Element	Voltage			Current		
	R	G	B	R	G	B
Filaments		180V			Not measured	
Cathodes	290V	290V	290V		200 to 250 μa	
Grid 1	180V	180V	180V		No reading	
Grid 2	700V	640V	680V		No reading	
Grid 3		4.5KV			Not measured	

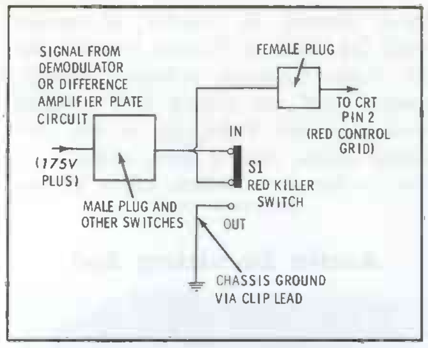


Fig. 4. Schematic of red killer circuit.

0 to 1000 volts or ua. Another scale — the lower red one — serves to indicate the focus voltage present on grid 3; it's calibrated from 0 to 7 kv. When the selector switch is in the METER OFF position, the meter movement is shunted to prevent possible damage during transportation of the unit.

An extra provision in the 900 is the inclusion of screen-killer switches. Three switches (RED, GREEN, and BLUE) are provided to bias off any single or combination of three color guns. Each slide switch has two positions — OUT, or IN — indicating the gun is off or on. We've shown a simplified schematic (Fig. 4) of the red killer circuit (the green and blue circuits are identical). With most color-killer switches, a 100K resistor is connected from the CRT grid to ground to bias off the gun; in this unit, the same thing is accomplished by a different method. The connection from the plate circuit of the demodulator (or color-difference amplifier) is DC coupled to the CRT grid; thus, B+ voltage on the plate (175 volts or more) is applied to the grid. As you'll notice in the schematic, the grid of the picture tube is connected to ground (via the clip lead) when the switch is in the OUT position; however, the switch simultaneously opens the B+ path, so the 100K resistors aren't needed.

We chose a new color receiver to give the unit a complete checkout in our lab. During the process, we found the operation of the unit was uncomplicated — both in connection time and in operational checks of the color CRT. Table 1 contains the results from the particular tube we tested. We noticed that, when the unit was connected, a slight smear of the video information occurred. This was probably caused by the additional capacitance of the leads and sockets. Convergence was equally affected; final convergence adjustments with the unit connected seem unadvisable. However, this shouldn't overshadow the main purpose of the 900 — dynamic checks of the picture tube and associated circuits, while the set is in operation.

Our field report on the Model 900 proved it to be helpful in servicing symptoms of the CRT or associated circuit failure. For example, a Zenith 29JC20 chassis was being serviced for a no-raster condition. Sound was okay, high voltage was present, and the CRT filaments were lit. The tester was connected, and a quick voltage test of the picture tube elements made. The technician noticed that cathode and screen voltages were okay, but the focus voltage on pin 9 was only 1 kv. This immediately cleared the video and other CRT circuits and led to a quick conclusion of trouble in the

"I figure I would save a little money by buying the antenna and putting it up myself."

focus circuit. A similar procedure could be used to isolate troubles to the video (cathode voltages wrong), control grid, or screen grid circuits (wrong screen voltages), if the occasion arises. And it does, often!

For further information, circle 47 on literature card.

Audio Servicing Aid

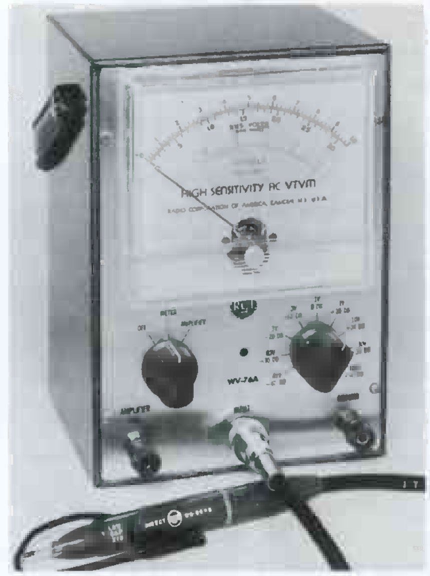


Fig. 5. High-sensitivity AC VTVM features switch operated LC probe.

There is a steadily increasing flow of high-fidelity audio equipment from the consumer to the service technician. Many technicians now realize that conventional audio troubleshooting-techniques are marginally useful in restoring an expensive, high-performance system to original specifications, because a critical audiophile with several hundred dollars invested in a music system can be painfully demanding; and, his satisfaction is your source of profit. The RCA Model WV-76A high-sensitivity VTVM (Fig. 5) should prove to be useful in any shop that intends to accept a heavy volume of audio repairs.

The VTVM can be used for checking the overall frequency response of an entire system or a single stage, for signal tracing, power and gain measurements, balancing push-pull stages, and for general audio-voltage measurements. The instrument also can be

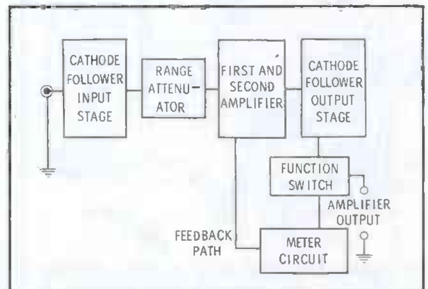


Fig. 6. Block diagram of new VTVM.

RCA WV-76A Specifications

Frequency Response:
WG-300B DIRECT
± 1 db 10 cps to 1.5 mc
WG-300B LO-CAP x10
± 1 db 10 cps to 500 kc

AC-Voltage Measurements (WG-300B DIRECT):
Ranges 0 to 0.1, .03, .1, .3, 1 volt; 0 to 3, 10, 30, 100 volts
Accuracy ± 5% (full scale)

DB Measurements (0 db = 1 mw into 600 ohms):
Ranges –40, –30, –20, –10, 0, +10, +20, +30, +40
Accuracy ± 5%

Input Characteristics:
At input connector
1 meg (shunted by 58 mmf)
WG-300B DIRECT
1 meg (shunted by 95 mmf)
WG-300B LO-CAP x10
10 meg (shunted by 13mmf)

Preamplifier:
Output voltage
.8 volt output for .01 volt input
Output impedance
less than 400 ohms
Gain 38 db on 10-mv range

Weight:
5 lb.

Size (HWD):
7⅜" x 5⅜" x 4¾".

Power Source:
105-125 volts AC, 50-400 cps; 35 watts.

Price:
$79.95.

used as a wide-range preamplifier with a gain of about 38 db. When used as an amplifier, the input signal is fed through the type WG-300B probe provided with the unit, and the output signal is taken from a terminal on the panel. Response is essentially flat from 20 cps to 500 kc. A block diagram of the WV-76A is shown in Fig. 6. The circuit is a simple, broadband voltage amplifier provided with a built-in meter-bridge circuit to read the established voltage.

The meter has two rms voltage scales (0-1 and 0-3) for voltage measurements and a separate scale for decibel measurements. A nine-position switch selects the proper range. A second switch slects the mode of operation: OFF, METER, or AMPLIFIER. Terminals are provided for amplifier-output and ground connections, and a screw-on connector accepts the probe.

Voltage measurements in AC circuits are straightforward using the WG-300B probe with its slide switch in the DIRECT position. With the probe switch in the LO-CAP x10 position, input resistance of the WV-76A is raised to 10 megohms, and the indicated scale reading must be multiplied by 10 to obtain the actual voltage.

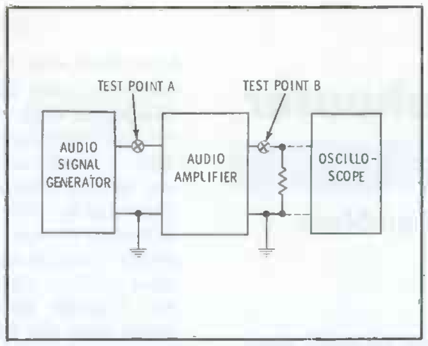


Fig. 7. Test setup for response checks.

When decibel readings are made, the actual scale value is valid only in the 0 DB position of the range switch: In all other positions, the meter-scale reading must be added algebraically to the decibel figure indicated by the range-switch pointer. Relative decibel readings for a given voltage value can be read directly.

Accurate frequency-response evaluation of amplifiers, preamps, tone-control circuits, and other audio devices can be made using the test setup shown in Fig. 7. The input level measured at test point A with the WV-76A is maintained at a standard voltage level (by manual adjustment) regardless of the input frequency, and the voltage output measured at test point B is plotted graphically in decibel reference. The scope is not absolutely necessary, but it does provide a means for observing when distortion of the sine waveform occurs. Response measurements made with the WV-76A are valid only for pure sine-wave signals. Complete step-by-step procedures for this test and others are given in the manual which accompanies the instrument.

Our lab experience with this unit left us convinced that the scale is easy to read, the controls are positive in action, and the instrument itself is straightforward in design and easy to use. The action of the switch on the probe seemed less than positive, however, and easily slipped out of position unless care was taken to avoid touching it in use. ▲

For further information, circle 48 on literature card.

now in our lab . . .

The latest test instruments being analyzed for future "Notes" columns:

Lectrotech Model V7 Color Vectorscope
RCA Model WT-115A Color CRT Tester
SENCORE Model PS127 Oscilloscope
Hickok Model 580 Tube Tester
Heath Model IM-13 VTVM

The Troubleshooter

answers your servicing problems

It Blew Up

A customer had a 21AT4 picture tube which imploded spontaneously. He said, "It sounded like a bomb had gone off in the room." After seeing the set, with the wires in the yoke cut from the explosion, I shrudder at the way some of these tubes are handled. Is there some information you can give me as to safety in handling and installing picture tubes? What could cause one to implode?

CLIFFORD TENNEY
Ronkonkoma, N. Y.

The implosion of a picture tube is a rare occurrence if correct handling precautions are observed. Of course, one will occasionally blow for unknown reasons, as in the case you mentioned. Usually, glass fatigue or a small, unnoticed scratch at a critical point on the tube is the cause.

Companies engaged in the manufacturing of picture tubes subject them to rigid tests of high temperature, air pressure, and many other severe stresses in an attempt to reveal any weakness that might cause the tube to implode.

A few simple rules to follow when handling, removing, or installing picture tubes are: Always wear safety glasses; don't set the tube down on a hard, rough surface: don't strain the neck of the tube; and, when you tighten the CRT mounting strap, tighten it for a snug fit but not so tight as to put a strain on the tube itself.

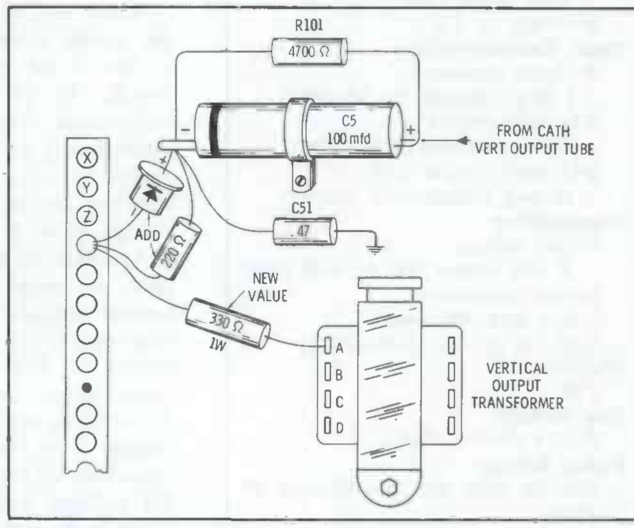
COLOR COUNTERMEASURES

Symptoms and service tips from actual shop experience

Chassis: Zenith 26KC20, 25LC20, 25LC30

Symptom: Lack of convergence control during top and bottom vertical convergence adjustments.

Tip: A slight circuit modification will in most cases simplify top and bottom convergence adjustment. Referring to PHOTOFACT Folder 705-4 and the drawing below, change R102, the 220-ohm resistor connected to terminal "A" of the vertical output transformer, to a 330-ohm, 1-watt unit. Wire the 220-ohm resistor (just removed) in parallel with a silicon rectifier (Zenith part #212-27), and connect this network in series with the 330-ohm resistor—observing polarity as shown. Connect the other end to the junction of 100-mfd electrolytic C5, 4700-ohm resistor R101, and .47-mfd C51. ▲



Aircraft Radio

(Continued from page 35)

Fig. 6. Radio magnetic indicator gives all information on a single meter.

instrument is positioned by a gyro-stabilized compass, thus providing continuous heading. Radio direction (ADF) is provided on a wide needle, and omni bearing appears on the narrow needle. Hence, a pilot receives all navigation information on a single indicator.

Instrument Landing System

The systems previously discussed allow an airplane to navigate point to point, but all-weather operations are impossible unless means are provided to facilitate a landing under conditions of minimum visibility. The instrument landing system (ILS) was adapted to worldwide standards after World War II. In this system, fixed beams which guide an airplane to the runway are radiated in two planes. It is usually unnecessary and undesirable for the aircraft to utilize the beams below a minimum ceiling of 200 feet; nevertheless, the fixed-beam system makes safe landings possible under almost all conditions.

The beam which allows the airplane to locate the runway laterally is called the localizer. The localizer ground antenna is usually located 1000 feet beyond the far end of the runway (opposite the approach end), and the center of the antenna array coincides with the center of the runway. The operating frequency is between 108 and 112 megacycles, and voice modulation is provided on the same frequency.

Vertical runway alignment is provided by a glide-slope beam lying in a plane usually inclined 3° from the runway. The glide-slope frequency is between 329.3 and 335 megacycles from an array located

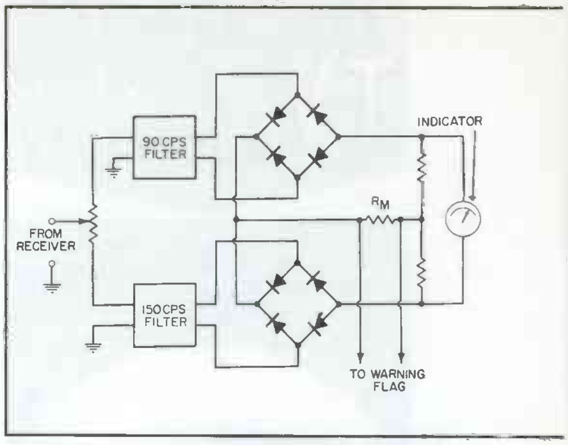


Fig. 7. A typical circuit for deriving glide-slope or localizer information.

approximately 750 feet beyond the approach end of the runway. Separate receivers and antennas are used to receive the two beams; however, to facilitate use, the localizer and glide-slope frequencies are paired together for any particular airport. In almost all cases, the same VHF receiver is used for omni and for ILS-localizer reception. When a pilot switches from one localizer frequency to another with a crystal-tuned VHF navigation receiver, relays are provided to also switch the glide-slope receiver to its correctly paired frequency.

Both the localizer and glide-slope beams appear as two narrow lobes which intersect on the correct course. One lobe in each beam is modulated with a 90-cps signal and the other with a 150-cps signal. The airplane flies along a path where the 90-cps and 150-cps signals are of equal strength.

A circuit for deriving glide-slope or localizer indication from a receiver is shown in Fig. 7. Audio output from the receiver is passed to two filters which separate the 90-cps and 150-cps components. The filtered signals are then rectified, and the resultant current energizes a galvanometer-type movement that provides the right-left or up-down indication to the pilot.

The presence of the 90-cps or 150-cps signal causes current flow in RM, and this current is used as an indication to the pilot that the system is operative. A solenoid placed across RM is energized when signal is present. A warning flag appears in a window cutout on the pilot's instrument when the solenoid is de-energized, indicating undependable signal reception.

Table 1. Marker Indications

Marker	Tone	Lamp Color
Airways (AM)	3000 cps	White
Outer (OM)	400 cps	Blue
Inner (IM)	1300 cps	Amber

Marker Beacons

The navigation systems discussed so far define paths along which an airplane may fly, but to complete a navigation system, a means must be provided to mark important points along the paths. Marker beacons operating on 75 mc are used for this purpose.

A marker beacon is simply a transmitter with an antenna array designed to radiate a sharply focused beam upward from the beacon location. Beacons placed along established airways (airway markers) are modulated with a 3000-cps tone. On an ILS system, one beacon (the outer marker) is placed about 4 miles from the runway on the localizer path and is modulated with a 400-cps tone. Another beacon (the inner marker) modulated by a 1300-cps tone is placed on the localizer path about 3500 feet from the touchdown point on the runway.

Marker equipment in the airplane consists of a 75-mc receiver and a means of converting the demodulated tone into sufficient power to light an indicator lamp—and provide aural output, if desired. A filter selects the particular tone, and a colored lamp lights (see Table 1).

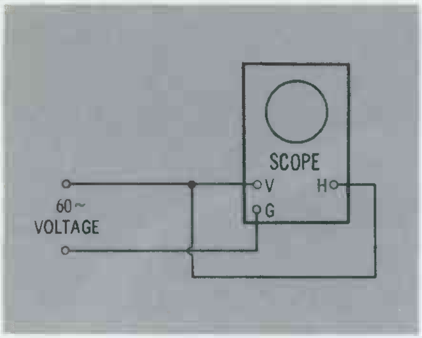
Marker-beacon receivers are usually simple crystal-tuned superheterodynes, and good use can be made of solid-state devices. For example, the Narco MBT-2 marker receiver utilizes transistor circuitry, measures only 1½" x 3½" x 6", and weighs only 18 oz.

Marker-beacon, omnirange, and glide-slope receivers make it possible for an airplane to fly between two points and make a safe landing under almost all weather conditions. These three devices are the minimum required for all-weather flying. More elaborate installations also include automatic direction finder and weather radar.

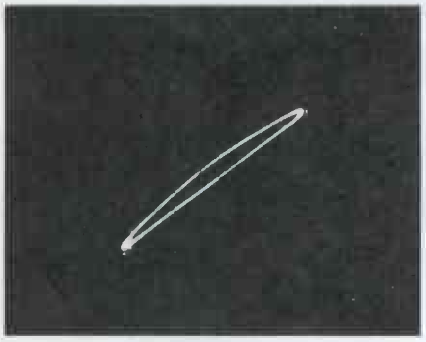
As aviation becomes even more extensive, the use of electronics in aircraft communication and navigation will also grow. Therefore, it will become increasingly important that the progressive technician stay familiar with this subject. ▲

Measuring Lo-Q

(Continued from page 33)



(A) Setup



(B) Waveform

Fig. 9. Check scope for phase shift.

will cause an error in pattern readings.

Phase shift in scope amplifiers at 60 cps is usually due to capacitor trouble. Perhaps a grid-coupling capacitor has lost part of its capacitance; or, the trouble might be caused by a bad screen-bypass, cathode-by pass, or decoupling capacitor. Some scopes have a low-frequency boost circuit; check the boost capacitor in such a case.

Another type of amplifier distortion, without phase shift, is illustrated in Fig. 10. Note, however, the distorted diagonal line which points to nonlinear amplification. Try clearing up the distortion by reducing the test voltage used in the setup of Fig. 9. If the diagonal line is still curved at this point, there is trouble in the scope amplifiers. The cause may be a weak tube or low plate-supply voltage. Also check for bias or screen resistors that may have changed value.

Conclusion

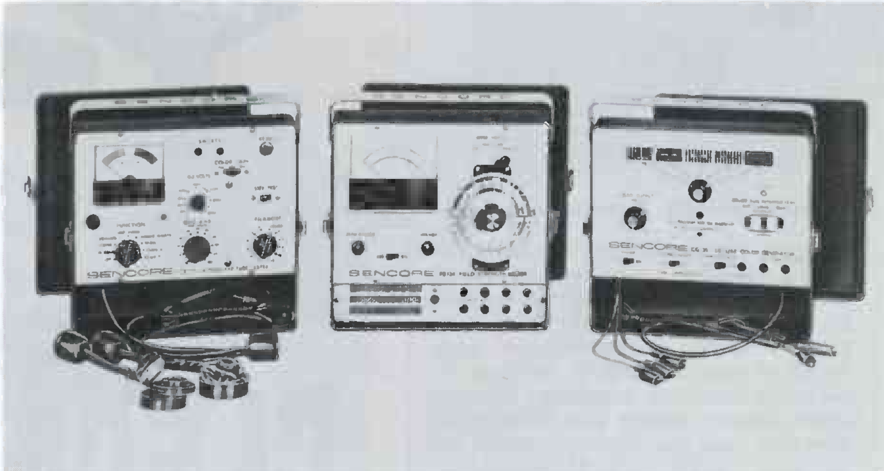
When properly performed, inductance checks using a scope are very useful in servicing work. Inductor measurements will show whether or not a unit is suitable for a given use. Tests made on inductors of known values will reveal shorted turns: Shorted turns *reduce* the inductance value and *increase* the power factor. Remember that the test procedure discussed in this article is most suitable for low-Q inductors. In the case of high-Q inductors, a ringing test is preferred. The reason for this is that it's difficult to read the impedance pattern for a high-Q inductor—the two values indicated in Fig. 3 will fall so near the same figure that error in observation becomes serious.

Fig. 10. Nonlinear amplifier pattern.

There is a "twilight" area between low-Q and high-Q inductors in which both methods leave something to be desired. In such case, try both ringing and impedance patterns, choosing the method which affords the least error. ▲

Product Report

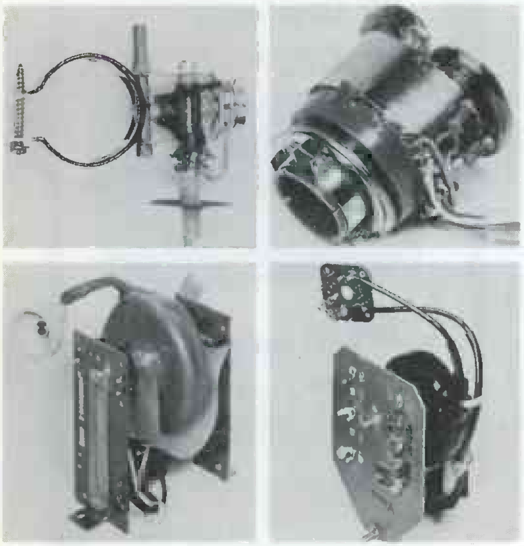
For further information on any of the following items, circle the associated number on the Catalog & Literature Card.



Look-Alike Instruments (116)

Three new testing units from **SENCORE, Inc.,** are housed in matched steel portable cases with removable covers. Covers are designed to be supported in an upright position (by the handles) when the instruments are placed on the bench; this permits easy viewing of operating instructions in the covers. The three new units are: an improved CRT tester, a solid-state all-channel TV field-strength meter, and a solid-state color pattern generator. None of the units requires warmup or stabilization time, and each has a compartment for storage of accessories and leads.

Coming . . . in
PF REPORTER
next month



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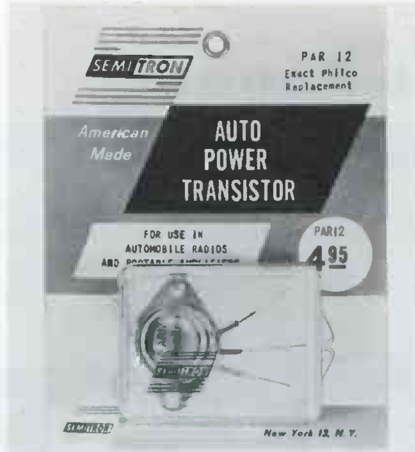


Replacement Transistor (117)

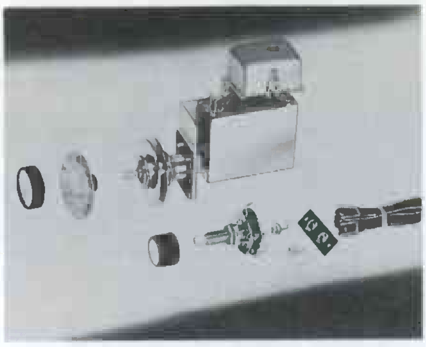
An exact replacement for the AR series power transistors, used in auto radios manufactured by Philco, is the Semitron Par 12 power transistor. The **Semitronics Corp.** transistor incorporates an extra length of insulated lead to facilitate installation, aluminum mounting clamps to insure positive contact with the external heat sink, and true hermetic sealing for reliability. List price is $4.95; net is $2.97.

Speaker Display (118)

Every "Celesta" series speaker is now being shipped in a box which converts into an attractive counter display. Both 8" and 12" **Utah** speakers are packed inside two-color cartons. The containers are only ½" larger than the speaker, requiring a minimum of counter space; also, the design techniques on both the inside and outside of the containers help to make the product sell itself.

Stereo Recorder (119)

The 1600 series of Designer tape recorders from **Roberts** have a frequency response of 30 to 18,000 cps at 7½ ips and a signal-to-noise ratio of better than 45 db. The new table models feature fewer and more high styled controls than last year's line, giving a slim appearance. If desired, the recorders may be wall-mounted or recessed flush in a wall.

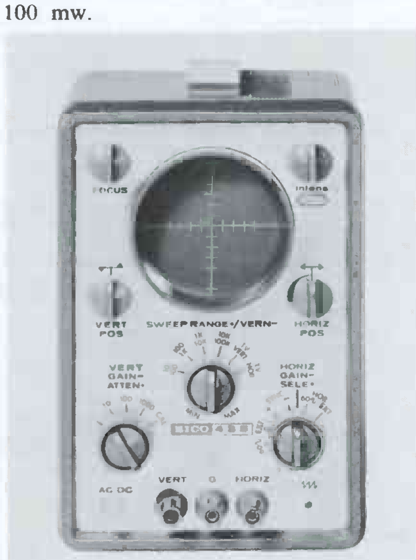


UHF Converter Kit (120)

A compact, all-transistorized UHF television converter kit, UCT-051, permits customized in-set conversion of all console and table model (and most portable) TV sets. The **Standard Kollsman** kit tunes all UHF channels and will operate with either series- or parallel-filament receivers. The UHF tuner is equipped with a transistorized IF ampifier which is tuned to feed channel 5 or channel 6 of the set's VHF tuner. The unit comes complete with installation instructions and mounting hardware.

Midget Radio Transmitter (121)

A shirt-pocket-size transmitter, capable of sending keyed signals across North America, weighs only 10 ounces including batteries. Developed by **RCA,** the transmitter operates on selected frequencies between 2 and 30 mc that are stabilized by body temperature. The user places a miniature metal container, linked to the transmitter, under his upper arm where a high degree of temperature stability exists. The crystal-controlled unit measures 2½" x 4" x 1⅛" and has a radiated power of 100 mw.



Small-Screen Scope (122)

A compact 3" wideband oscilloscope, suitable for servicing electronic equipment, including color and black-and-white television, is **EICO's** Model 435. The gun used in the flat-face CRT is the same as the one found in the 5" versions, thus giving greater sharpness and brightness to the smaller tube. This new instrument is priced at $99.95 in kit form and $149.95 in factory-wired versions. ▲

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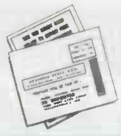

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50. *CORNELL DUBILIER*—16-page instruction booklet on proper installation and usage of antennas, and rotors.
51. *FINNEY*—Catalog No. 20-291 gives information on single channel couplers.
52. *G. F. WRIGHT*—Catalog sheets on guy wire used with outside antenna installations.
53. *JERROLD* — 16-page booklet describing latest TV-FM reception aids; includes antennas, antenna amplifiers, amplified couplers, UHF converters, and home distribution systems.
54. *JFD*—Literature on complete line of antennas for VHF, UHF, FM, and FM-stereo. Brochure showing converters, amplifiers, and accessories; also complete 64-65 dealer catalog.*
55. *MOSLEY ELECTRONICS* — Illustrated catalog giving specifications and features on large line of antennas for Citizens band, amateur, and TV applications.*
56. *MULTITRON*—Illustrated literature on FM stereo antenna No. MA-44.
57. *TRIO*—Brochure on installation and materials for improving UHF translator reception.
58. *ZENITH*—Informative bulletins on universal loudspeakers and a new line of log-periodic vee-type antennas for FM and monochrome or color TV.

AUDIO & HI-FI

59. *ADMIRAL*—Folders describing line of '65 equipment; includes black-and-white TV, color TV, radio, and stereo hi-fi.
60. *ATLAS SOUND*—New 1964 catalog No. 564 contains illustrations and specifications on PA speakers, microphone stands for commercial and industrial installations, and other new products.
61. *BENJAMIN*—Brochure on *Miracord* record changers and *Elac* phono cartridges.
62. *DUOTONE*—Reference wall chart for replacement phonograph needles; also catalog on line of accessories.
63. *EUPHONICS*—Literature sheets on new low-mass phono cartridge and ceramic microphone.
64. *GIBBS SPECIAL PRODUCTS*—Folders describing principles of sound reverberation and *Stereo-Verb* reverberation units for automobiles.
65. *JENSEN*—New 24-page catalog No. 165-K illustrates and describes speakers and speaker system kits.*
66. *NORTRONICS* — Engineering bulletins CEB No. 2 and CEB No. 9 give information on 3.75 ips tape operation and on silicon transistor recording amplifier.
67. *OAKTRON*—"The Blueprint to Better Sound" an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.
68. *OXFORD TRANSDUCER* — Product information bulletin describing complete line of loudspeakers for all types of sound applications, including replacements for public address and intercom systems.*
69. *PERMA-POWER* — New catalog sheet describing Ampli-Vox Model S-300 and Sound Crusier sound system Model S-310.*
70. *QUALITONE* — Information on selling diamond needles and earning free gifts.
71. *QUAM-NICHOLS*—Catalog No. 64 listing over 30 speakers and transformers for sound system applications.
72. *ROBINS*—Form No. 163D describes self-merchandising display of tape accessories.
73. *SAMPSON* — Full-color catalog pages showing new line of Waltham transistor radios, tape recorders, and portable televisions.
74. *SONOTONE*—Colorful brochure on new *Sonomaster* Model RM-1 speaker system.*
75. *SWITCHCRAFT*—New product bulletin No. 146 describing Q-G audio connectors.*
76. *UNIVERSITY* — Public address catalog and information on various types of microphones.
77. *WATERS CONLEY*—Catalog sheet showing new line of stereophonic and hi-fidelity phonographs.

COMMUNICATIONS

78. *AMECO*—New literature on 2 and 6 meter transmitter, and communications test equipment.
79. *PEARCE-SIMPSON* — Specification brochures on *Companion* II and *Escort* Citizens band transceivers.

COMPONENTS

80. *BUSSMANN*—Bulletin SFB listing complete line of Buss and Fusetron small-dimension fuses by size and type; indicates proper fuse holders and gives list prices.*
81. *ELECTRONIC DEVICES*—Bulletin on high-voltage selenium rectifiers for replacing rectifier tubes in color TV receivers.
82. *E-Z-HOOK*—Catalog sheets showing complete line of test connectors, cable harness binding posts, and test leads and clips.
83. *GC ELECTRONICS* — 68-page industrial catalog FR-65-1 showing newly introduced products.*
84. *INTERNATIONAL RECTIFIER*—Handbook with engineering data and specific applications for controlled rectifiers, zener diodes, and solar cells and photo cells.
85. *MUELLER*—Complete catalog No. 270 of electrical clips and insulators.
86. *ONEIDA*—Catalog on line of electronic components and replacement items.
87. *PERMACEL*—Bulletin describing line of plastic tape and plastic parts box.
88. *PRECISION RESISTOR*—Catalog No. 65 showing complete line of wire wound resistors.
89. *SARKES TARZIAN*—Handbook giving general descriptions of the construction, operation, and applications of silicon controlled rectifiers.*
90. *SPRAGUE*—Latest catalog C-616 with complete listing of all stock parts for TV and radio replacement use, as well as *Transfarad* and *Tel-Ohmike* capacitor analyzers.*
91. *TRW*—General catalog No. 164 covers all standard capacitors offered by company. Other technical information on tolerance, reliability, and other characteristics of capacitors.

SERVICE AIDS

92. *CASTLE*—How to get fast overhaul service on all makes and models of television tuners is described in leaflet. Shipping instructions, labels, and tags are also included.*
93. *OELRICH PUBLICATIONS* — 16-page catalog of TV service order forms, service call tickets, phone message books, and many other items.
94. *PRECISION TUNER*—Literature supplying information on complete, low-cost repair and alignment services for any TV tuner.*
95. *YEATS*—The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing feather-weight aluminum construction.

SPECIAL EQUIPMENT

96. *GREYHOUND* — The complete story of the speed, convenience and special service provided by the Greyhound Package Express method of shipping, with rates and routes.
97. *LECTROTECH*—Bulletins on new color TV test instrument, meter-protective devices, substitute for VTVM battery, and transistorized DC power supplies.*
98. *VOLKSWAGEN* — Large, 60-page illustrated booklet, "The Owner's Viewpoint," describes how various VW trucks can be used to save time and money in business enterprises, including complete specifications on line of trucks.

TECHNICAL PUBLICATIONS

99. *CLEVELAND INSTITUTE OF ELECTRONICS* — "Pocket Electronics Data Guides" with handy conversion factors, formulas, tables, and color codes. Additional folder, "Careers and Opportunities in Electronics," describes home-study electronic training program, including preparation for FCC license exam.*
100. *RCA INSTITUTES*—64-page book, "Your Career in Electronics," detailing home study courses in TV servicing, communications, automation, drafting, and computer programming; for beginners and experienced technicians.*
101. *HOWARD W. SAMS*—Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1964 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

102. *B & K*—Bulletin No. 124-R on new Model 1240 color generator. Catalog AP-21R describing uses for and specifications of Model 1076 Television Analyst, Model 1074 TV Analyst and Color Generator, Model 700 and 600 *Dyna-Quik* Tube testers, Model 445 CRT Tester-Rejuvenator, Model 960 Transistor Radio Analyst, Model 360 *V-O-Matic* VOM, Model 375 *Dynamic* VTVM, Model 1070 *Dyna-Sweep* Circuit Analyzer, and Model 230 Substitution Master.*
103. *EICO*—New 32-page, 1964 catalog of test instruments, hi-fi components, tape recorders, and Citizens band and amateur radio equipment.
104. *LAFAYETTE*—New 516-page catalog featuring stereo hi-fi, Citizens band, test equipment, radio and TV tubes and accessories, and much more.*
105. *HICKOK*—Complete description and specification information on newly introduced Model 662 installer's color generator, portable FM multiplex generator, Model 235A VHF-UHF field strength meter, and Model 800 tube tester.*
106. *JACKSON*—Complete catalog describing all types of electronic test equipment for servicing and other applications.*
107. *SECO*—New color folder describing complete line of test equipment, including color-bar generators, tube testers, and semiconductor testers.*
108. *SENCORE*—New color catalog on complete line of company products; oscilloscopes, generators, testers, and many others.
109. *SIMPSON*—Complete 16-page brochure on entire line of electronic test equipment; also, catalog on line of panel meters.
110. *STANDARD KOLLSMAN* — Literature on VHF to UHF translator.
111. *TRIPLETT*—All new test equipment catalog No. 46-T showing complete line of VOM's, tube testers, transistor analyzers, and signal generators.*

TOOLS

112. *ADEL*—Literature on "Nibbling Tool" that cuts, notches, and trims round or irregular holes to any size over 7/16"; ideal for radio chassis, templates, or shims.
113. *ARROW FASTENERS* — Catalog page showing three wire and cable staple-gun tackers with grooved blade especially for fastening of wires and cables up to ½" in diameter.
114. *CHICAGO MINIATURE*—Complete miniature lamp catalog, including sections covering subminiature, ultra-miniature, and new line of T-2 type lamps.
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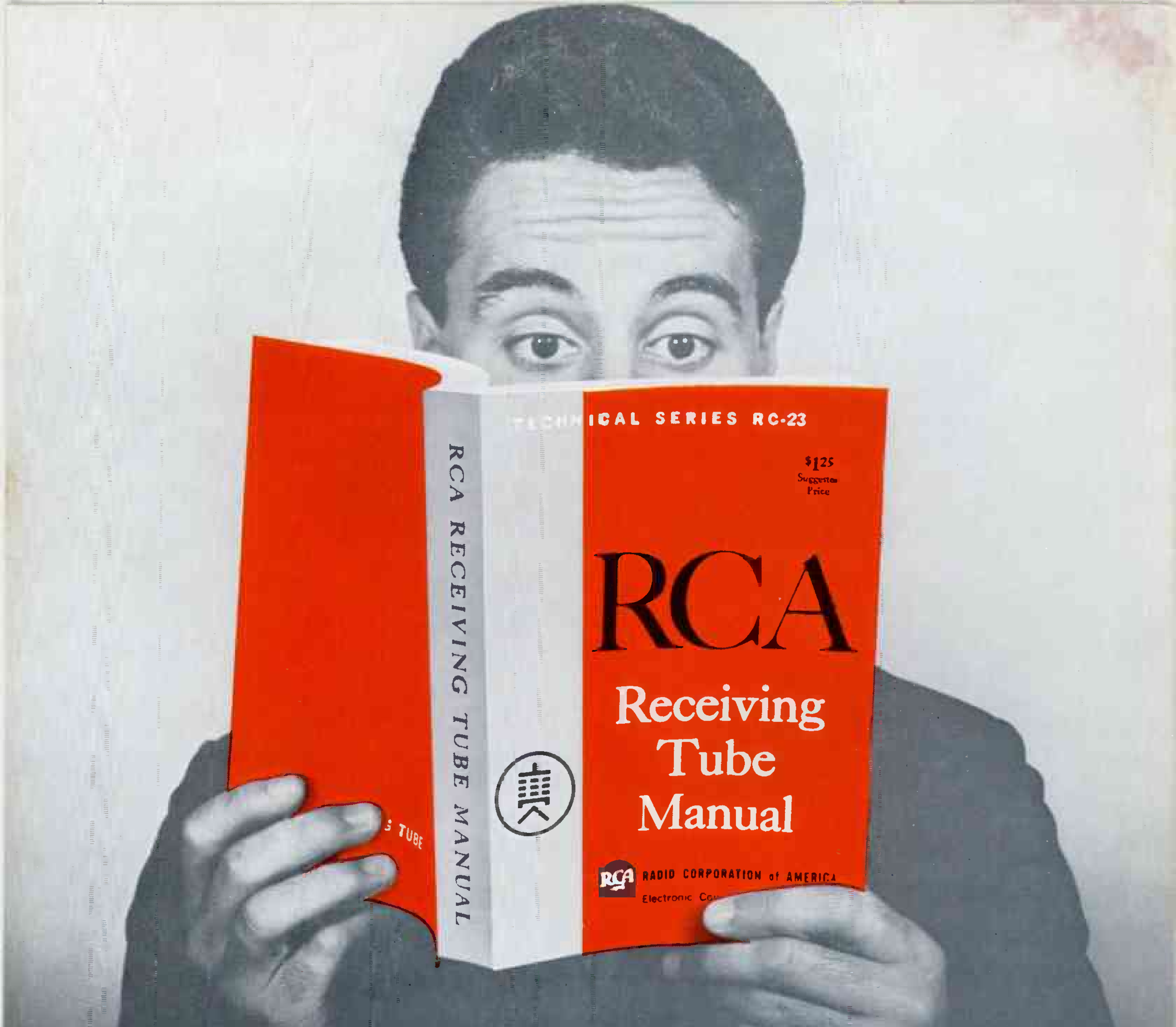

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