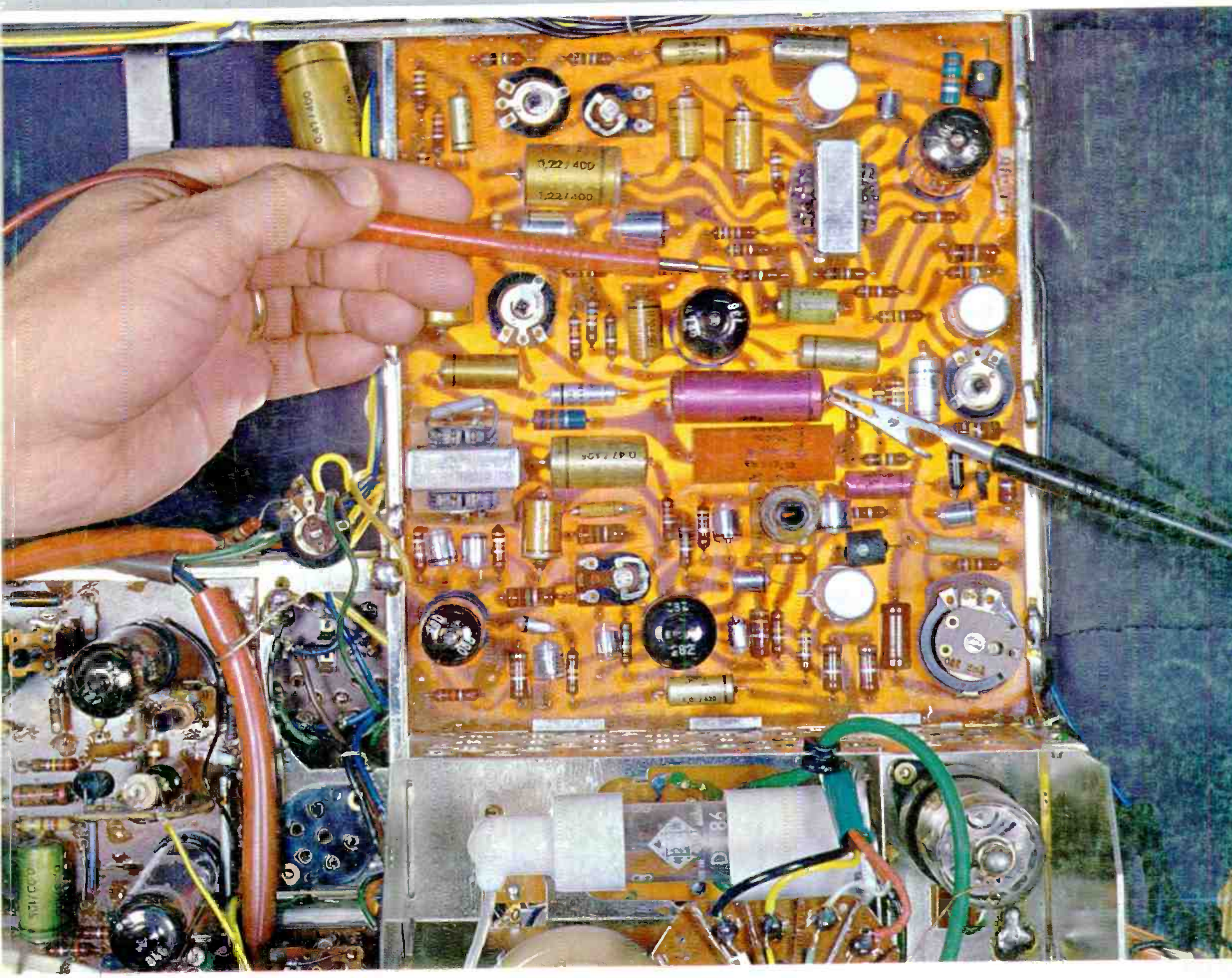
A HOWARD W. SAMS PUBLICATION

APRIL 1965/50¢

PF Reporter™

PHOTOFACT

the magazine of electronic servicing



- Evaluate Tubes In-Circuit
- Advanced Techniques for Future Servicing
- AGC Servicing Magic
- Stock Guide for TV Tubes
- 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.

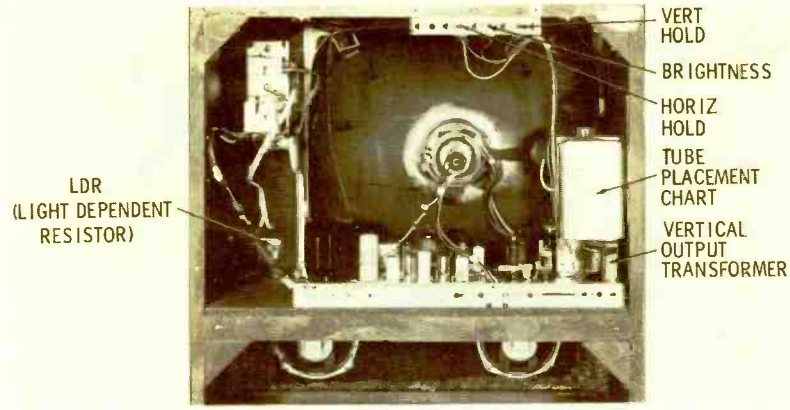
Amperex Frame Grid Tubes currently used by the major TV set makers include:

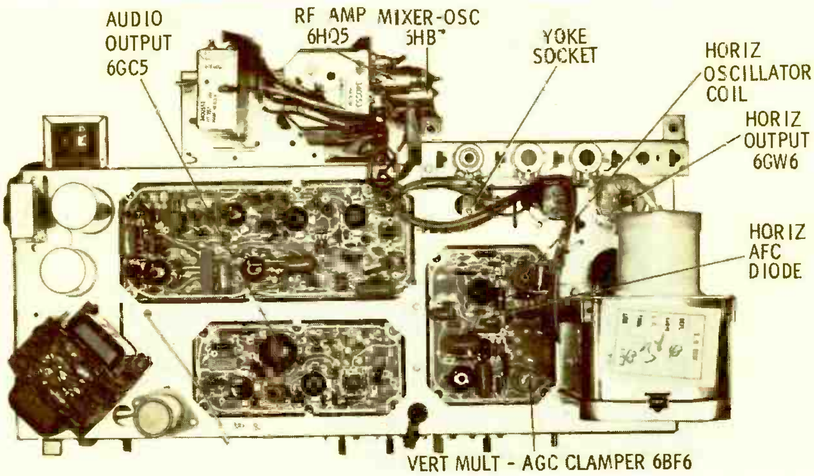
2ER5	2GK5	2HA5	3EH7	3GK5	3HA5	4EH7	4EJ7	4ES8	4GK5	4HA5	5GJ7
	6EH7	6EJ7	6ER5	6ES8	6FY5	6GJ7	6GK5	6HA5	6HG8	7HG8	8GJ7

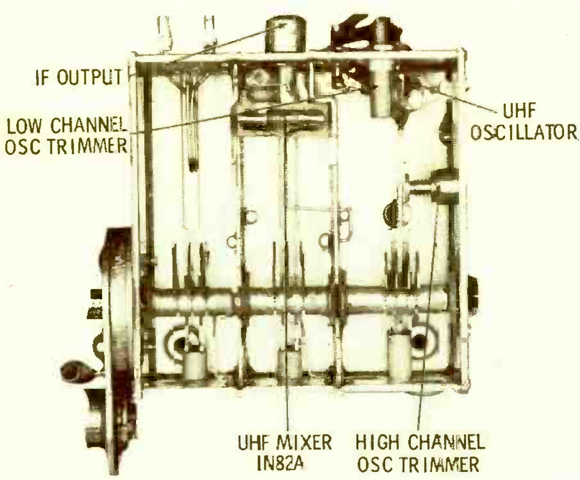
If your distributor does not yet have all the Amperex types you need, please be patient—in some areas the demand keeps gaining on the supply.

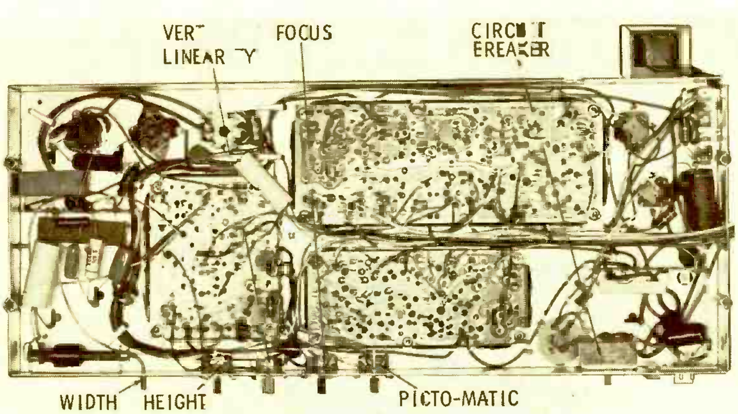
Amperex Electronic Corporation, Hicksville, Long Island, New York 11802.

Circle 1 on literature card









Airline Model GST-4615A

Included in Airline's '65 model line is the 23" console pictured above which has a chassis considerably different from those found in previous sets sold by Montgomery Ward. The horizontal chassis contains 14 tubes mounted on three individual printed-circuit boards which are held by the main chassis frame. Most of the tubes are familiar types; however, it would be wise to check your stock for the 6GC5 uses as audio output, the 6EM5 vertical multivibrator/output, the 6BF6 AGC clamper/vertical multivibrator, and the 6GW6 horizontal output. Also, don't overlook the VHF tuner tubes—6HQ5 RF amplifier and 6HB7 mixer/oscillator. The transistorized UHF tuner uses a 24T002 as the UHF oscillator and a 1N82AG crystal diode as the mixer. (The transistor and the diode are both shown in one of the photos.)

The low-voltage supply is transformer powered and has two silicon rectifiers in a half-wave voltage-doubler arrangement. Overload protection is provided by a circuit breaker; a 5-ohm, 10-watt surge-limiting resistor protects the silicons in case of current surges. A filament fuse link protects the transformer in case of excessive filament current.

This receiver is equipped with a "Picto-Matic" (automatic brightness) circuit which consists of an LDR (light-dependent resistor) that varies the DC voltage on the CRT cathode as the ambient light level changes. A manual control is also provided; its adjustment controls the CRT screen voltage. The correct setting of the manual control is accomplished by first turning it fully clockwise, then adjusting the brightness and contrast controls for a normal picture in semi-darkness. If the picture is too light, under normal lighting conditions, the Picto-Matic control is turned counterclockwise until the contrast-to-brightness ratio remains constant throughout the normal ambient light range of the room. This control (as are the focus, vertical-linearity, height, and width controls) is adjustable from the rear of the receiver.

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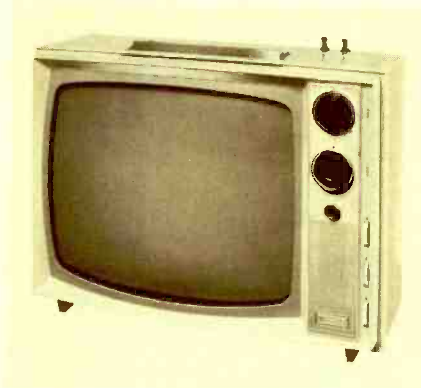


General Electric Model M403AVY Chassis DA

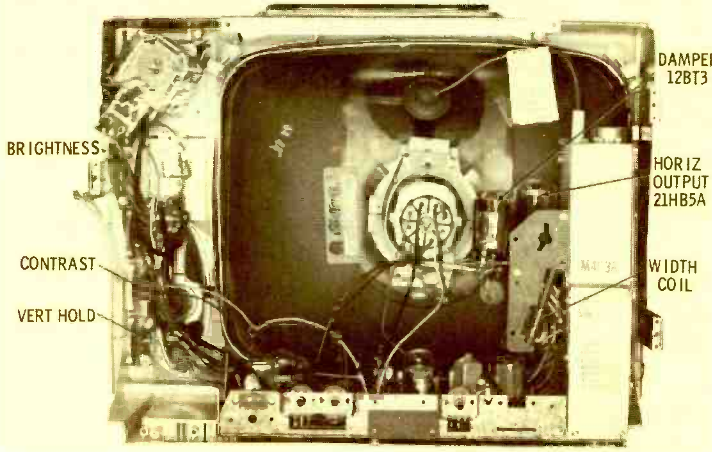
The 19" portable shown above, which has only 12 tubes including the CRT and VHF oscillator/mixer, is an indication of the simplified circuitry in the modern television receiver. This set has one large printed-circuit board with the majority of components mounted on it. The horizontal-output and damper circuits are mounted separately on a small subchassis located above the board.

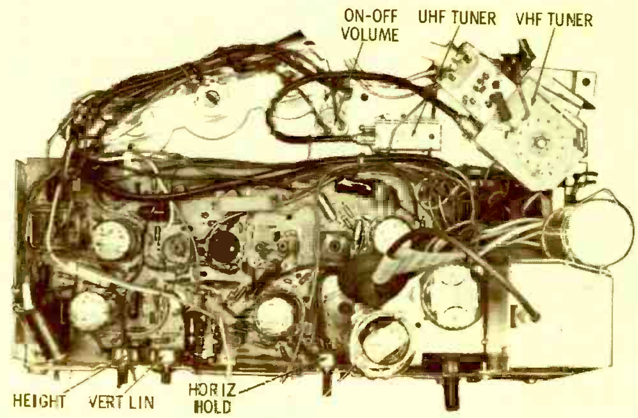
The use of compactrons has contributed to the smaller number of tubes. First and second video IF functions are combined in a 11AR11 (the third video IF/AGC keyer is a 6JN8—not a compactron). A 15BD11 operates as video output/sound IF amplifier/sync separator, and the audio detector/output action is provided by a 17BF11. Vertical sweep is derived from a 17JZ8 which operates as multivibrator output, an 8B10 serves as horizontal AFC/multivibrator, the horizontal-output tube is a 21HB5A, the damper a 12BT3, and the high-voltage rectifier is the old and familiar 1K3. A 19DVP4 fits into the CRT socket, while the VHF tuner uses a 3GK5 as an RF amplifier and a 6EA8 performs as the mixer/oscillator.

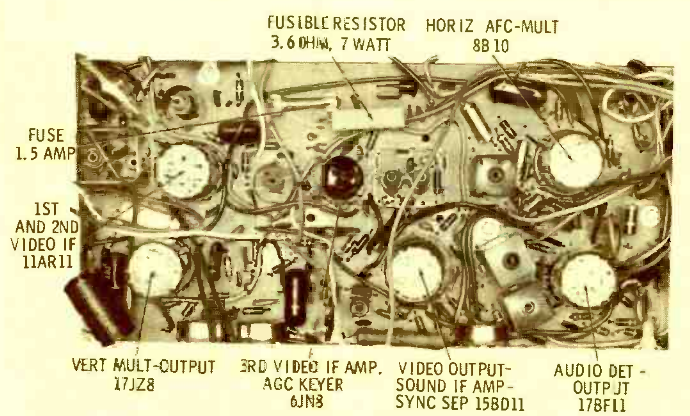
No power transformer is used in this set; B+ is derived from a single silicon rectifier protected by both a 1.5-amp fuse and a 3.6-ohm, 7-watt fusible resistor. The 450-ma series filament is unprotected.

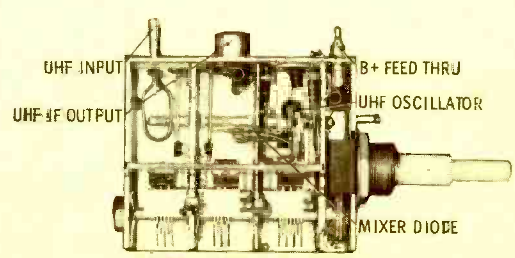
The UHF tuner is continuously tunable from 470 to 890 mc; output IF frequency from the oscillator (an NPN transistor) to the VHF tuner is 45 mc. The manufacturer recommends using silver-bearing solder when replacing any of the uninsulated ceramic-disc capacitors in the UHF tuner. A piece of this solder is packed with the General Electric replacement.

The customer operating controls, the VHF/UHF channel-selector and fine-tuning, on-off/volume, contrast, brightness, and vertical hold, are on the front of the cabinet. On the rear apron of the chassis are the adjustments for height, vertical linearity, and horizontal hold. A width coil provides for that adjustment, when necessary. No adjustment is provided for the AGC voltage or picture-tube focus.

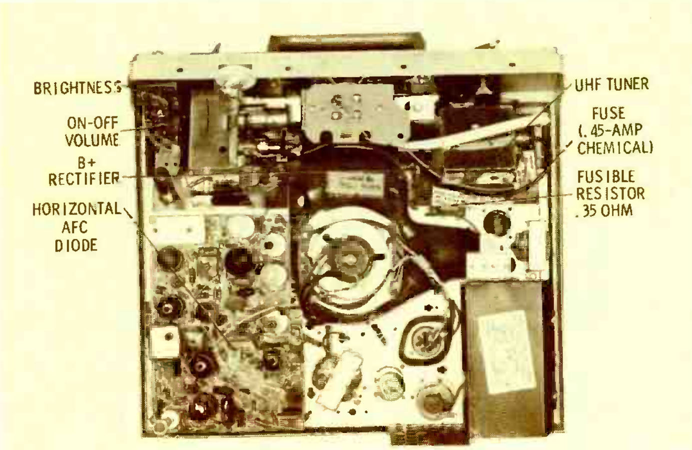


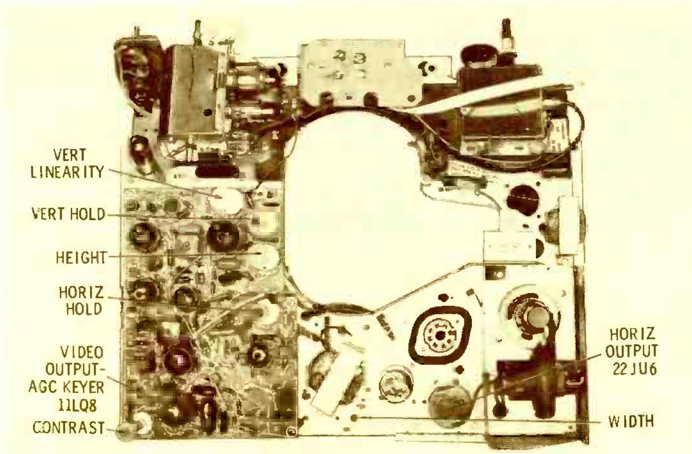


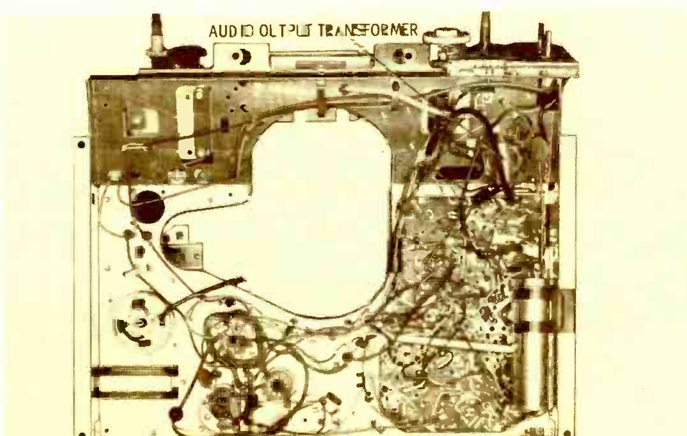




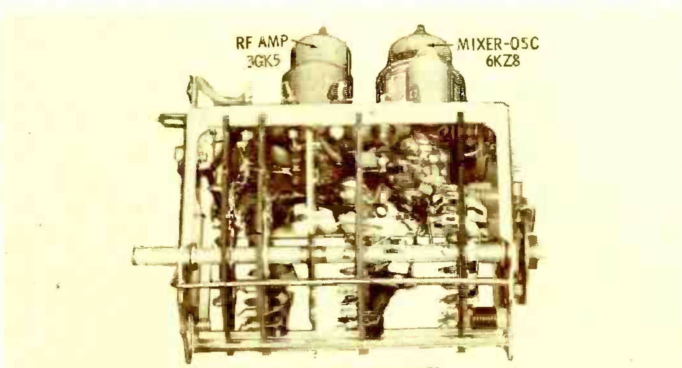
INTERNAL VIEW OF UHF TUNER



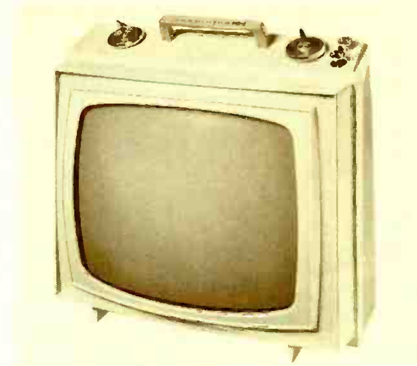




REAR VIEW OF ENTIRE CHASSIS



INTERIOR VIEW OF VHF TUNER



RCA Model AF-020J Chassis KCS152A

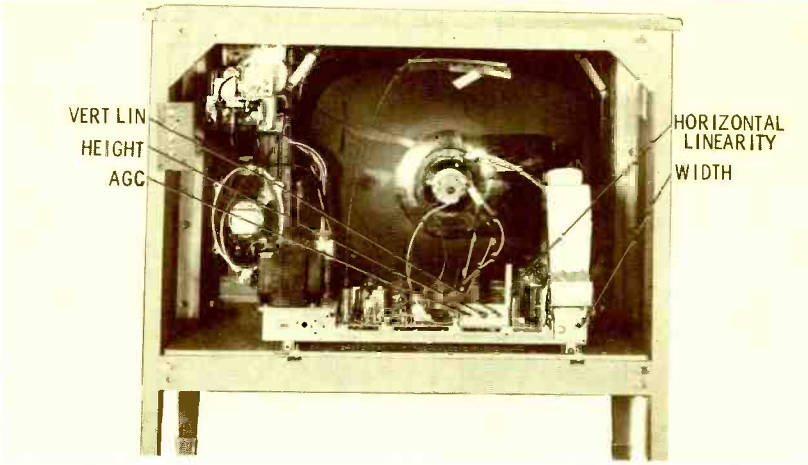
For the second successive year, RCA has added a 16" portable to their line of black-and-white receivers. The series-filament chassis shown here is quite similar to the KCS146 chassis of a year ago and is equipped with carrying handle and built-in monopole antenna for VHF. Terminals are provided for connecting either VHF or UHF external antennas.

Only one printed-circuit board is used, and there are several new tubes (all having 450-ma filaments) found in this chassis. The CRT is a 114° 16AYP4; a 4JD6 and a 4JC6 (both high-gain pentodes) are used in the two-stage video IF strip. The video-output stage uses the pentode section of a 11LQ8; the triode section of this same tube functions as the AGC keyer. The vertical-sweep section consists of a 15KY8. The horizontal-output tube is a 22JU6, while the damper is a 17BS3. The VHF tuner utilizes a 3GK5 for RF amplification; the functions of mixer/oscillator are performed by a 6KZ8—the 6KZ8 has considerably more gain in the mixer section than tubes of earlier vintage. The oscillator in the UHF tuner is an NPN transistor (RCA part number 113938).

Low voltage is developed from a single silicon rectifier (1N3194) as the sweep-output tubes operate from a lower-than-normal B+ voltage. The B+ side of the silicon is fused with a .45-amp chemical fuse. The AC side has a .35-ohm fusible resistor (Part No. 942924-4) in series with one side of the line. Any of these components may be replaced by removing the cabinet back—it isn't necessary to remove the chassis. No protection is provided for the series filament string.

Adjustments of vertical-hold, vertical-linearity, contrast, height, and horizontal-hold controls may be made from the rear of the receiver. These controls are made accessible by nonmetallic knobs which protrude through the rear cover of the cabinet.

Located around the neck of the picture tube, to the rear of the centering magnets, is a "spot-optimizer" magnet. This magnet shouldn't require adjustment unless it is moved accidentally or the picture tube is replaced. If adjustment should become necessary, tune the receiver to an unused channel and adjust the magnet for best detail in the center portion of the screen.



Sylvania Model 23L133CU Chassis 585-1

Part of Sylvania's 1965 line is the above-pictured 23" consolette. This transformer-powered set uses, as do many other large-tube models, the 585-series chassis. The receiver uses a total of 15 tubes including the 23BGP4 picture tube, the 6GK5 RF amplifier, and the 6GJ7 mixer/oscillator. A 6EH7 and a 6EJ7 serve as the first and second video IF amplifiers respectively. A 6JT8 functions as video output/sync separator (previously a 'CS6 was used as sync separator). Operating as AGC keyer/sound IF amplifier is a 6KD8, while a 6DT6 and a 6AQ5 function in the audio detector and audio-output stages.

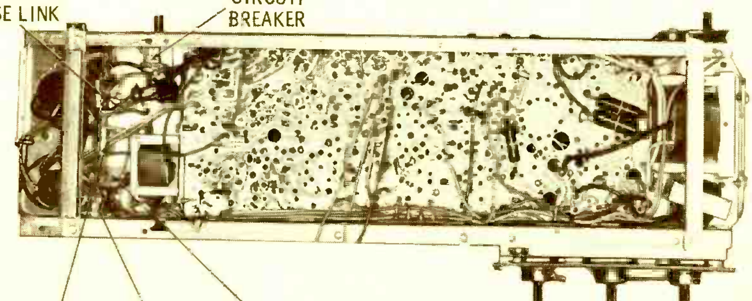
In the sweep circuits, we find a 6FM7 compactron operating as vertical multivibrator/output. The horizontal multivibrator is a 6FQ7, the horizontal output a 6GJ5, and the damper a 6AY3. The high-voltage rectifier is a 1B3/1G3. Rounding out the tube complement is the 5BC3 low-voltage rectifier.

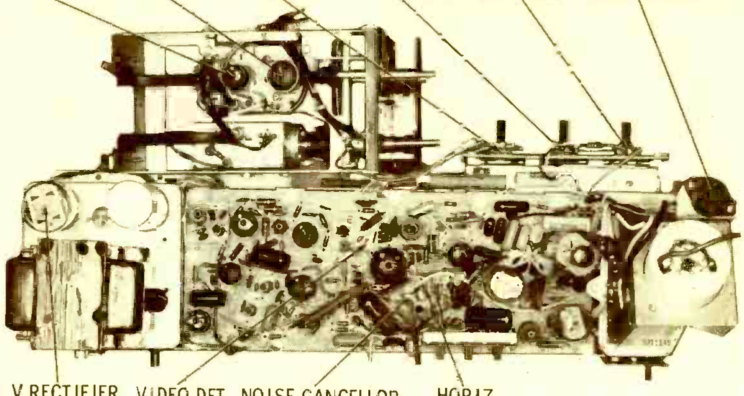
Two NPN transistors are used: One is used as the UHF oscillator, and the second functions as a noise gate (canceller) located in the cathode circuit of the sync separator. Other semiconductors include the two 1N4092 signal diodes used in the horizontal AFC circuit and the 1N295 video detector.

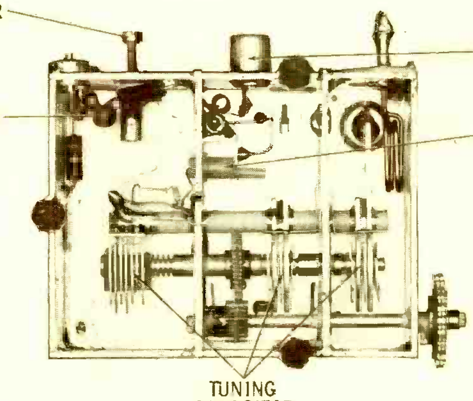
Protective devices in the low-voltage power supply consist of a circuit breaker connected from the tap of the secondary winding of the power transformer to ground and two #28-size wire links, one in series with the parallel filament string and the other in series with one side of the AC line.

In addition to the normal operating controls, adjustments are also provided for width and horizontal linearity. To adjust the linearity coil, it is necessary to remove the rear cabinet cover. The correct focus-anode potential may be obtained by connecting a jumper from pin 4 of the picture tube to B+, boost, or ground.

An interconnecting plug and suitable sockets are provided for the deflection yoke and tuner subassemblies. The video IF input cable also plugs into the main chassis. A halo-light socket is available for models having this added feature.







See PHOTOFACT Set 648, Folder 2

Mfr: DuMont **Chassis No.** 120642, -643

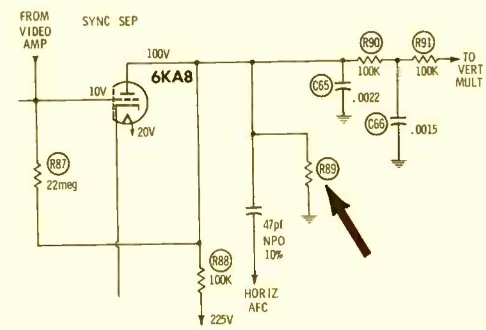
Card No: DM642-1

Section Affected: Vertical sync.

Symptoms: Vertical hold unstable.

Cause: Insufficient output from sync separator; remedied by circuit modification.

What To Do: Change R89 to (100K, ½ watt); remove C65 (.0022 mfd) from circuit.



Mfr: DuMont **Chassis No.** 120642, -643

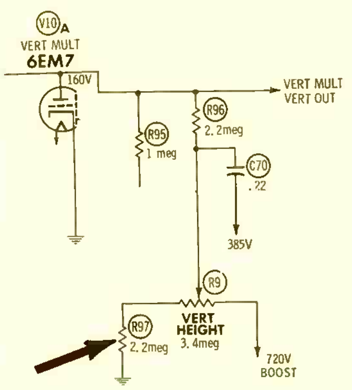
Card No: DM642-2

Section Affected: Raster.

Symptoms: Insufficient vertical sweep.

Cause: Vertical linearity circuit resistor increased in value.

What To Do: Replace R27 with a (2.2 meg, 2 watt) resistor.



Mfr: DuMont **Chassis No.** 120642, -643

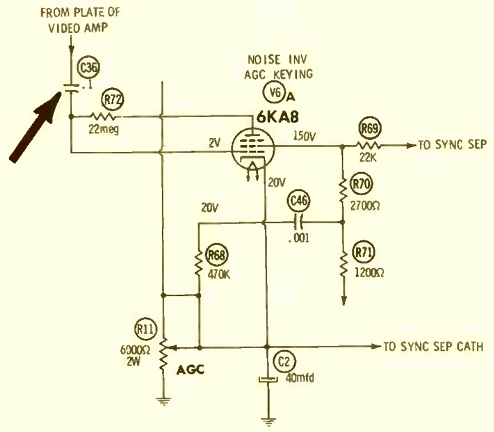
Card No: DM642-3

Section Affected: Vertical sync.

Symptoms: Erratic vertical hold; grid voltage (pin 6) of 6KA8 increases.

Cause: Leaky coupling capacitor.

What To Do: Replace C36 (.1 mfd).



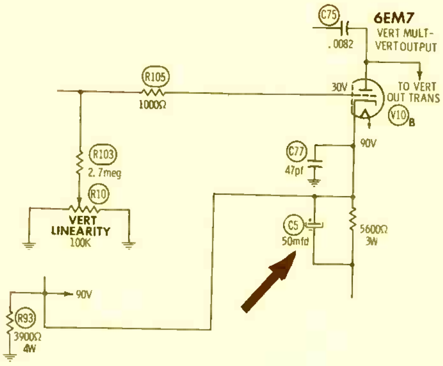
See PHOTOFACT Set 648, Folder 2

DuMont

VIDEO SPEED SERVICING

See PHOTOFACT Set 648, Folder 2

See PHOTOFACT Set 648, Folder 2



Mfr: DuMont **Chassis No.** 120642, -643

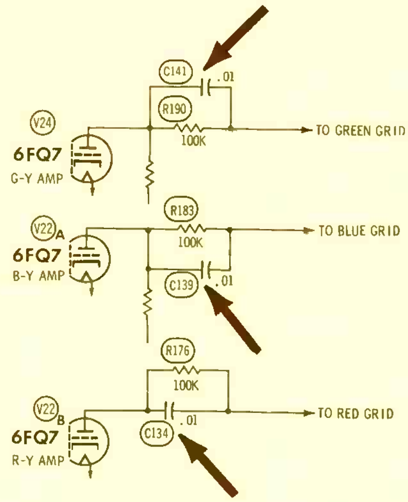
Card No: DM642-4

Section Affected: Raster.

Symptoms: Loss of vertical sweep.

Cause: Open cathode bypass capacitor.

What To Do: Replace C5 (50 mfd 100 V).



Mfr: DuMont **Chassis No.** 120642, -643

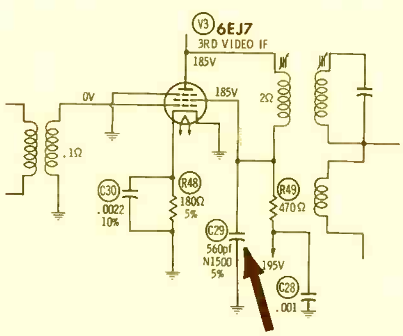
Card No: DM642-5

Section Affected: Pix.

Symptoms: Impurity; cannot be corrected with usual adjustments. Part of either red, blue, or green line may be missing at low brightness with Normal-Service switch in "Service" position and screen controls properly adjusted.

Cause: Open coupling capacitor to control grid of CRT.

What To Do: Replace coupling capacitor C134, C139, or C141 (.01 mfd).



Mfr: DuMont **Chassis No.** 120642, -643

Card No: DM642-6

Section Affected: Sound and pix.

Symptoms: Weak or complete loss of video and sound; voltage on plate and screen decreases.

Cause: Shorted video IF screen by-pass capacitor.

What To Do: Replace C29 (560 pf—500V, N1500, 5%); also R49 (470 ohms).

See PHOTOFACT Set 698, Folder 4

Mfr: Philco **Chassis No.** 14M91

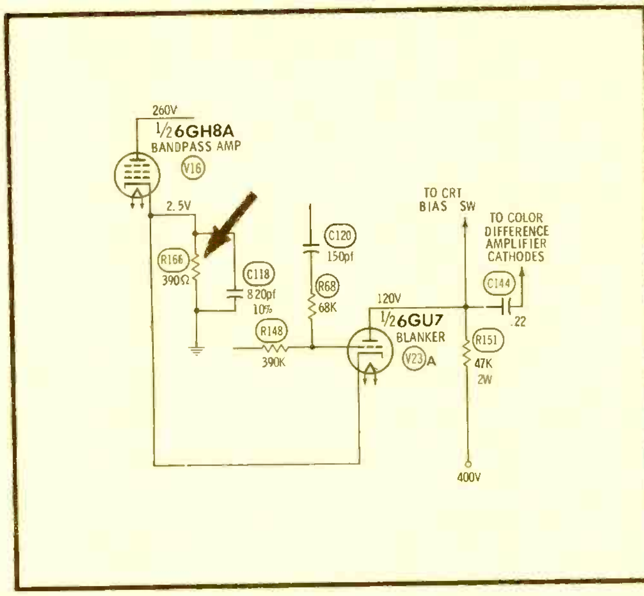
Card No: PH 14M91-1

Section Affected: Pix.

Symptoms: No color, insufficient brightness; brightness control has little effect.

Cause: Open common cathode resistor of Blanker and Band-Pass Amplifier.

What To Do: Replace R166 (390 ohms).



Mfr: DuMont **Chassis No.** 14M91

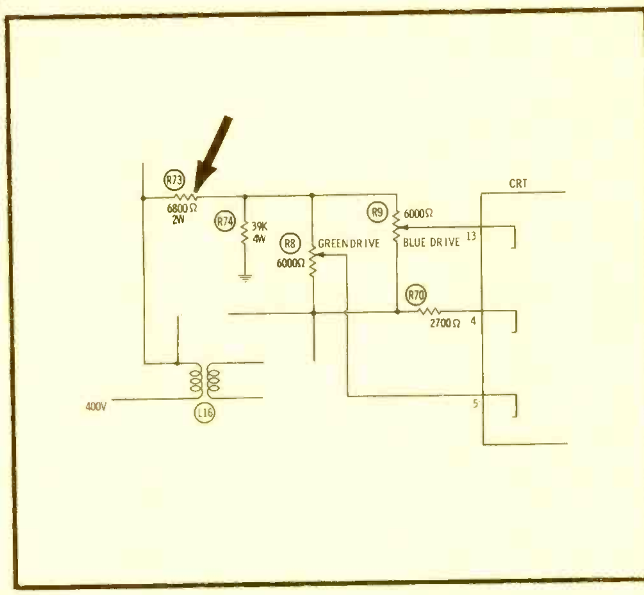
Card No: PH 14M91-2

Section Affected: Pix.

Symptoms: Severe blooming even at low setting of brightness control.

Cause: Open CRT cathode biasing resistor—decreases voltage on each cathode and causes excessive beam current.

What To Do: Replace R73 (6800 ohm, 2 watt).



Mfr: Philco **Chassis No.** 14M91

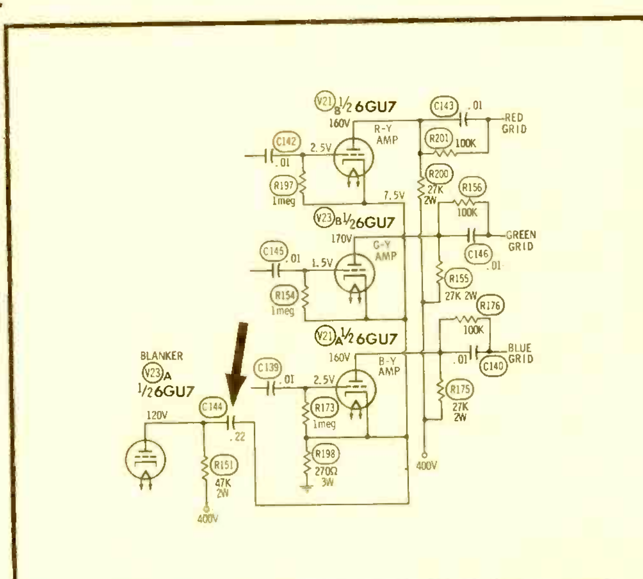
Card No: PH 14M91-3

Section Affected: Pix.

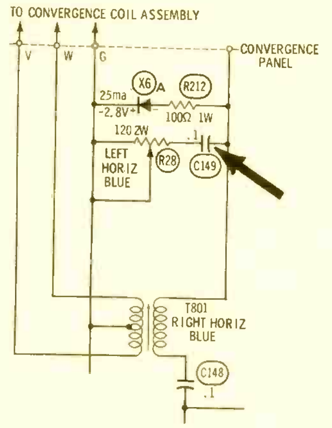
Symptoms: Insufficient brightness even with controls at maximum.

Cause: Open coupling capacitor from Blanker to Color Difference Amplifiers. mfd).

What To Do: Replace capacitor C144 (.22 mfd).



See PHOTOFACT Set 698, Folder 4



Mfr: Philco **Chassis No.** 14M91

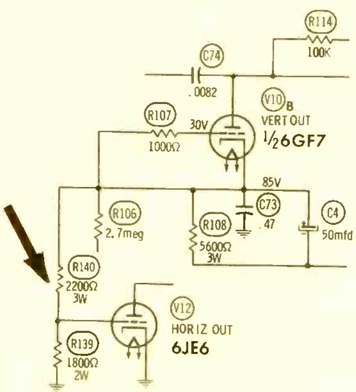
Card No: PH 14M91-4

Section Affected: Raster (Convergence).

Symptoms: Poor convergence of blue horizontal lines on both sides of screen; worse on left side.

Cause: Open wave shaping capacitor in blue horizontal dynamic convergence circuit.

What To Do: Replace C149 (.1 mfd).



Mfr: Philco **Chassis No.** 14M91

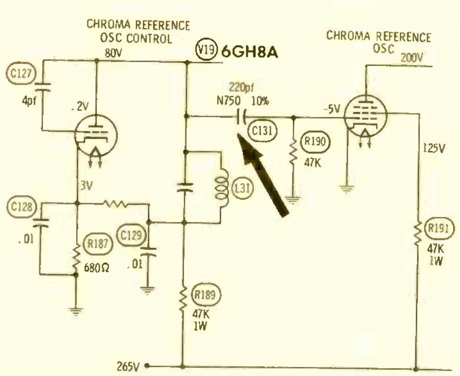
Card No: PH 14M91-5

Section Affected: Raster.

Symptoms: Insufficient height.

Cause: Open resistor in vertical output cathode bias divider network.

What To Do: Replace R140 (2200 ohm, 3 watt).



Mfr: Philco **Chassis No.** 14M91

Card No: PH 14M91-6

Section Affected: Color pix.

Symptoms: Black and white reception normal; no color, except possible green on strong station.

Cause: Leaky coupling capacitor from plate of reactance tube to grid of oscillator.

What To Do: Replace C131 (220 pf).

Circle 2 on literature card

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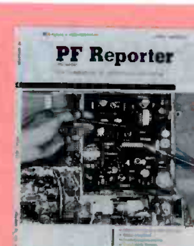
the magazine of electronic servicing

VOLUME 15, No. 4 APRIL, 1965

CONTENTS

ABOUT THE COVER

Printed circuits boards and miniaturized components are no longer strangers to most servicemen, but these techniques are only forerunners of things to come. Designs using micro-miniaturized modules are not as far in the future as one might think. The progressive serviceman must be ready for them. To get a head start, turn to the article on page 36.



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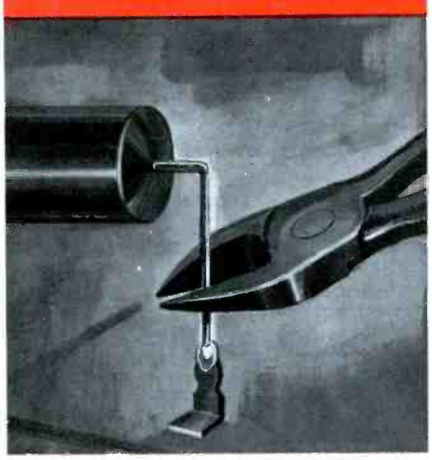
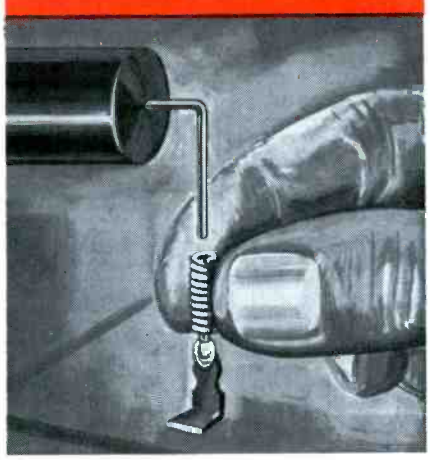
A Snip Lead



B Slip on QUIG



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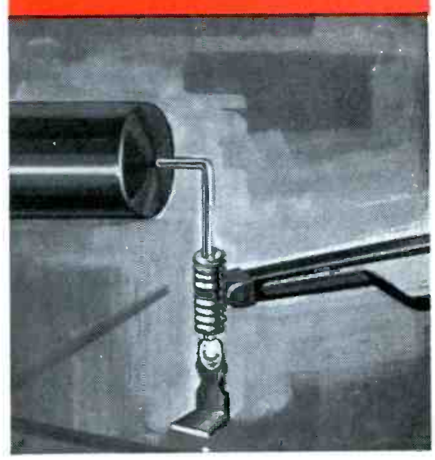

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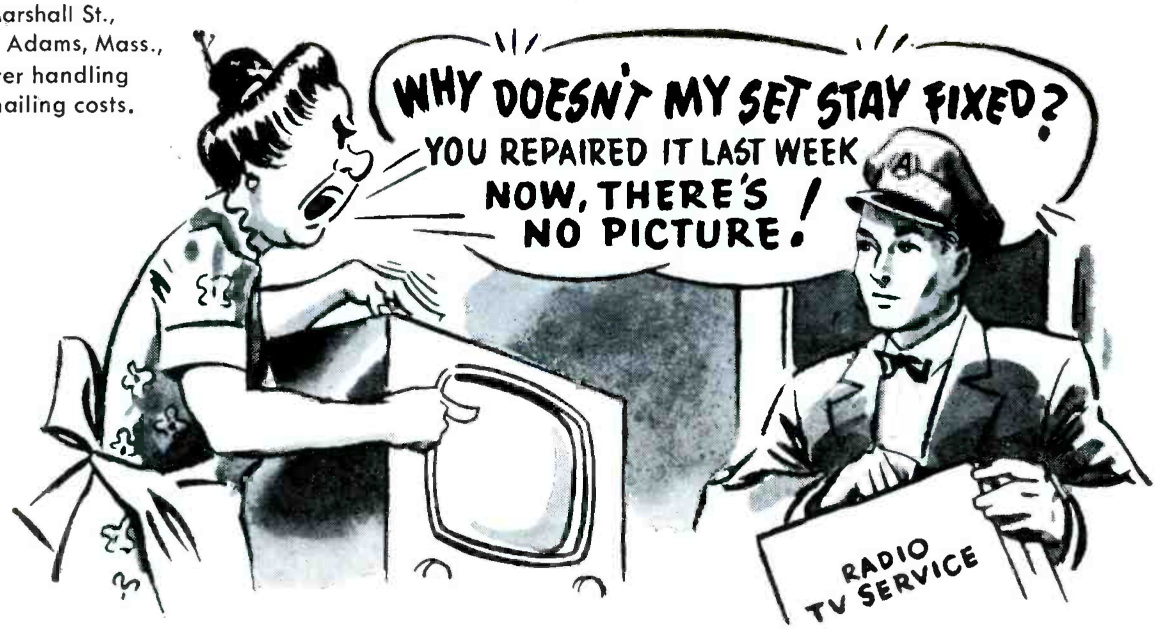

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999 times out of a thousand, when this happens . . . *don't blame your service technician!*

The repair to your television receiver made several days ago or even several months ago probably had no relation to the new trouble that developed today.

Actually, there are more than 300 electrical parts in even a small table model television receiver. Trouble in any one of them might cause the picture or sound to disappear or to be received poorly.

Take your automobile for instance. Tuning up the motor today is no guarantee against a tire blowout tomorrow!

Such a thing is easier to understand because most of us are more familiar with automobiles than with today's highly complicated TV and radio sets. But such unconnected troubles occur in TV and radio nevertheless—and because they are so hard to explain in non-technical terms, it is always embarrassing to your service technician when they do.

His continued business existence is based on gaining the full confidence of you and other set owners like you. He isn't in business to "gyp" you or to overcharge you. His success is based on doing each and every job to the level best of his ability, at a fair price for his skilled labor. It's only when you patronize the shops that feature "bargains" at ridiculously low prices that you need worry. Good radio and TV service can't be bought on the bargain counter! Set owners who recognize this aren't likely to get "gypped."

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

6S-5101

Circle 4 on literature card

Letters to the Editor

Dear Editor:

The illustration on page 52, December 1964 PF REPORTER, showing the construction of an electrolytic capacitor, is in error. The anode is okay, but the "cathode" is merely a cathodic connection, while the "dielectric" should be labeled "porous paper impregnated with electrolyte." The actual dielectric is the oxide film which forms on the anode.

The second paragraph on page 53, relating to the use of electrolytics at lower-than-rated working voltages, requires a little clarification, too. There is no longer any valid electrical reason for not using an over-rated electrolytic; modern methods of construction have eliminated the deforming prevalent in early electrolytics. However, a higher-rated unit costs more; so, for economy's sake alone, the technician is best advised to use a low-voltage electrolytic in low-voltage circuits.

WILLIAM F. MULLIN

Marketing Manager
P. R. Mallory & Co., Inc.
Indianapolis, Indiana

Dear Editor:

In regard to your article on electrolytics in the December PF REPORTER, I think the statement concerning the use of higher-voltage electrolytics in low-voltage circuits is in error. I've been assured by the distributor sales manager of a large manufacturer of capacitors that it's perfectly okay to make a substitution of that nature. Please let us know what you find out upon checking further.

JERRY RIES

Bud Electronic Supply Co.
Danville, Illinois

Thanks, fellows, for calling these matters to our attention. In the days when many of us were repairing only radios, and when production and design techniques were less dependable than they are today, we had the problems noted in the article. Modern equipment and quality-control programs, however, have eliminated this old annoyonce. Tests prove that electrolytics of quality manufacture may, indeed, be substituted in lower-voltage circuit without detriment.—Ed.

Dear Editor:

Our town is being considered for a CATV system, and our city council will be deciding the issue. We local servicemen want to know whether or not we should fight CATV.

PRESTON E. DAVIES

Hampton, Va.

Dear Editor:

We would like to have your unbiased opinion on whether or not CATV would be a good thing for our community. Isn't it going to mark the end to hopes for UHF TV?

HOMER HARTWELL

Galion, Ohio

You've got a hot one there, fellows. We can't definitely say whether or not CATV is good for any particular community. This problem must be settled by the opinion and choice of people who will be affected by CATV when and if it comes to their town. We made a report on CATV in the July 1963 issue, and another in the February 1965 issue. Both give an idea what we found in areas where CATV exists. Whether CATV will harm UHF is debated hotly; it has had an effect in some localities, none in others. At the present time, the FCC is investigating the pro's and con's of cable TV, and their final ruling will govern the outcome. It is doubtful that the FCC will leave any broadcasting medium uncontrolled. CATV, like many other businesses, is offering a service for sale; the final choice of whether or not to buy still remains in the hands of the consumer wanting or not wanting the service. Get all the information you can. Write to National Community Television Association, Inc., 535 Transportation Building, Washington 6, D. C.; National Association of Broadcasters, 1771 N Street, N.W., Washington 6, D. C.; Federal Communications Commission, New Post Office Building, Washington, D. C. 20554; and TAME, Suite 1228, 1001 Connecticut Avenue, N.W., Washington, D. C. Each has its own viewpoint. After examining all sides of the question, draw your own conclusions. Don't be swayed by any single presentation, but form your judgment on the basis of all the facts.—Ed.

Dear Editor:

My congratulations on the fine article expressing what the relationship should be between hams and TV servicemen ("Radio Amateurs Aren't So Bad"—September 1964 PF REPORTER). It hits the nail right on the head.

ERNEST C. BLIND

W7DDQ
Manager
C & G Electronics Co.
Centralia, Wash.

Perhaps the battle lines can now be erased, Ernest. We've always felt some technicians were overlooking a good source of income by trying to pretend hams don't exist.—Ed.

Dear Editor:

Just a note of appreciation for the valuable information you convey to us independent servicers. Such articles as "Solid State Rectifiers Come of Age" (September 1964), "Transistorized UHF Tuners" (September 1964), and your regular PF REPORTER SYMFACT—these articles and others too numerous to mention are mentally or physically filed away for use as troubleshooting requires them. Keep up the good work.

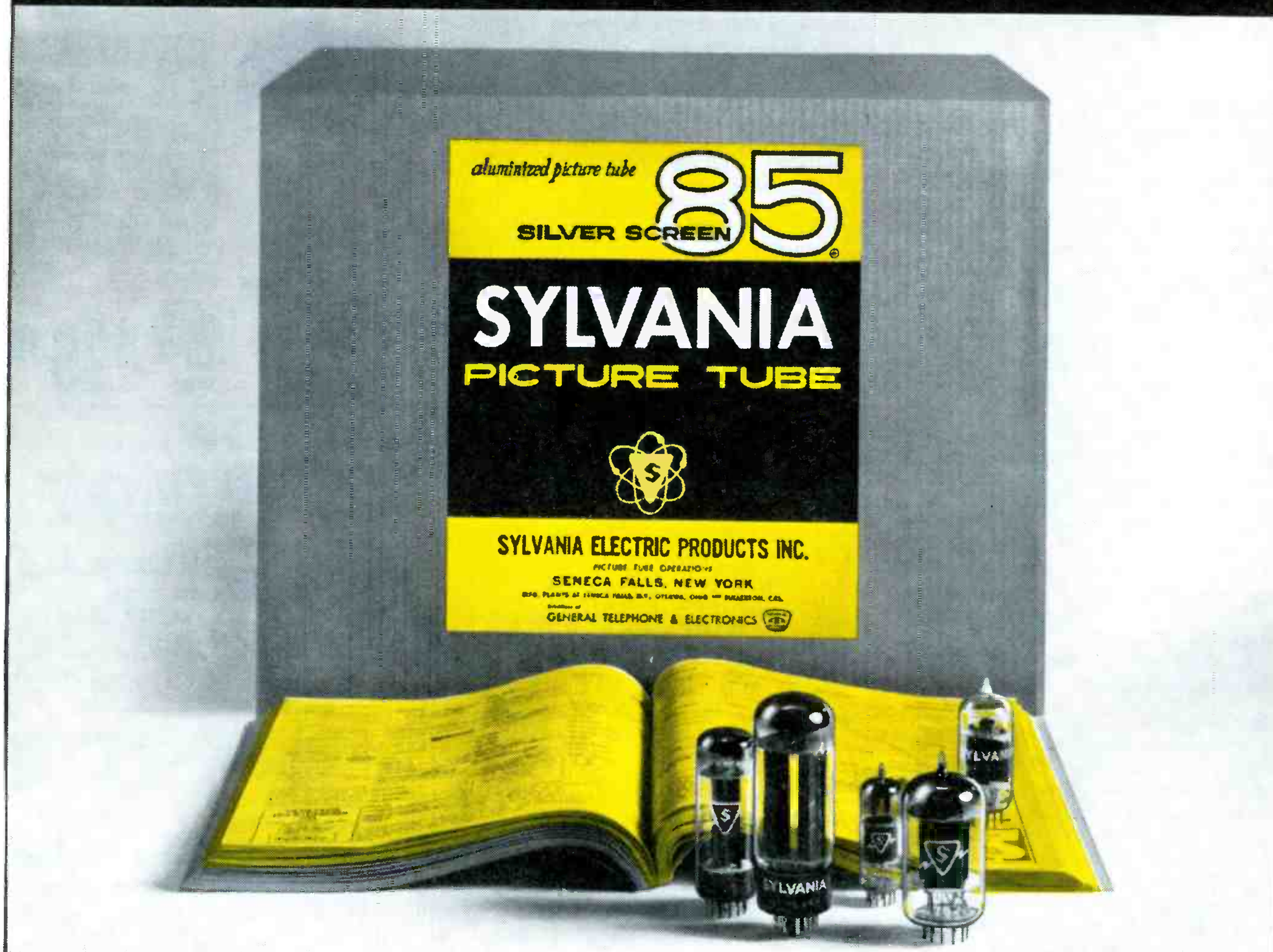
JAMES W. ZAWILLA

Benton Harbor, Mich.

Letters such as yours, Jim, are what keep us striving every month to bring you the kind of articles you and our tens of thousands of other readers need.—Ed. ▲

Circle 5 on literature card

you get **PRODUCT PLUS** *from your Sylvania Distributor*



Now your Sylvania Distributor can put you in The Yellow Pages

The Yellow Pages are the first place people look *when they want to buy.* Studies show that 90% of all telephone subscribers consult their Yellow Pages when they want to find a local source for products and services. It's a fact: your potential customers let their fingers do the walking when a TV set needs professional servicing.

Here's a special program that means more customers and extra profits for you. *Our* ads appear in *your* local Yellow Pages, directing customers to you. Your Sylvania distributor can show you how your own listing may be part of the Sylvania ad.

The new Sylvania Trade Mark Heading will be seen—it's big, attractive, and descriptive. It tells customers that you sell the dependable line of radio and TV tubes, including famous SILVER SCREEN 85® and *color bright 85®* picture tubes.

Your Sylvania distributor has full particulars on how you can share in this program designed especially for you. Check with him today.

Electronic Tube Div., Sylvania Electronic Components Group.

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

Circle 6 on literature card

The Electronic Scanner

news of the servicing industry

Mobile Field-Service Corps

Standing in front of the company's new Research and Engineering building, are six service engineers of the **Delco** Division of the General Motors Corp. These six field engineers—equipped with 1965-model radios, films, tools, and test equipment—will conduct training sessions at various Delco dealerships across the country. Included in the program will be theoretical and practical discussions of new equipment, as well as troubleshooting information for all existing models. Appearances of the corps of roving technical experts will be scheduled through the Delco Division's zone service managers.

Expands Integrated-Circuit Program

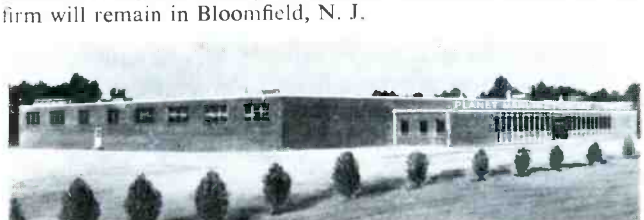
The Semiconductor Division of **Sylvania Electric Products, Inc.** has earmarked the expenditure of several million dollars for a major expansion of manufacturing, engineering, and research facilities for integrated circuits.

Richard M. Osgood, vice president and division general manager, said the first phase of the expansion program involves the allocation of about 50% of the division's main facility at Woburn, Mass., for the integrated-circuit operation. In order to provide this additional space, all nonmanufacturing operations have been moved from the Woburn plant to other divisional facilities in Wakefield, Mass.

The decision to expand Sylvania's integrated-circuit operation was based on the fast growing market and the increased demand by customers in the field of computer integrated circuits. Sylvania's circuits are made on a silicon base by a monolithic epitaxial technique. With the completion of the first phase of the expansion program, Sylvania will have a facility with a capacity in excess of 100,000 circuits per month. Plans are underway to add other digital, linear, and multi-chip lines of integrated circuits.

Manufacturing Facility for Electrolytics

A new plant in Roxboro, North Carolina has been opened by **Planet Mfg. Corp.** The new facility, comprising a floor space of 46,000 sq. ft., will be devoted entirely to the manufacture of electrolytic capacitors and has been designed to lend itself to continuous production flow from aluminum-foil etching to shipping of the completed product. The new plant features automated manufacturing equipment. Corporate offices of the firm will remain in Bloomfield, N. J.



• *Please turn to page 24*

247 WAYS TO MAKE MORE

From now on, color-TV work is going to bring in a bigger and bigger part of your income. And RCA has EVERYTHING to make color-TV service MORE PROFITABLE for you.

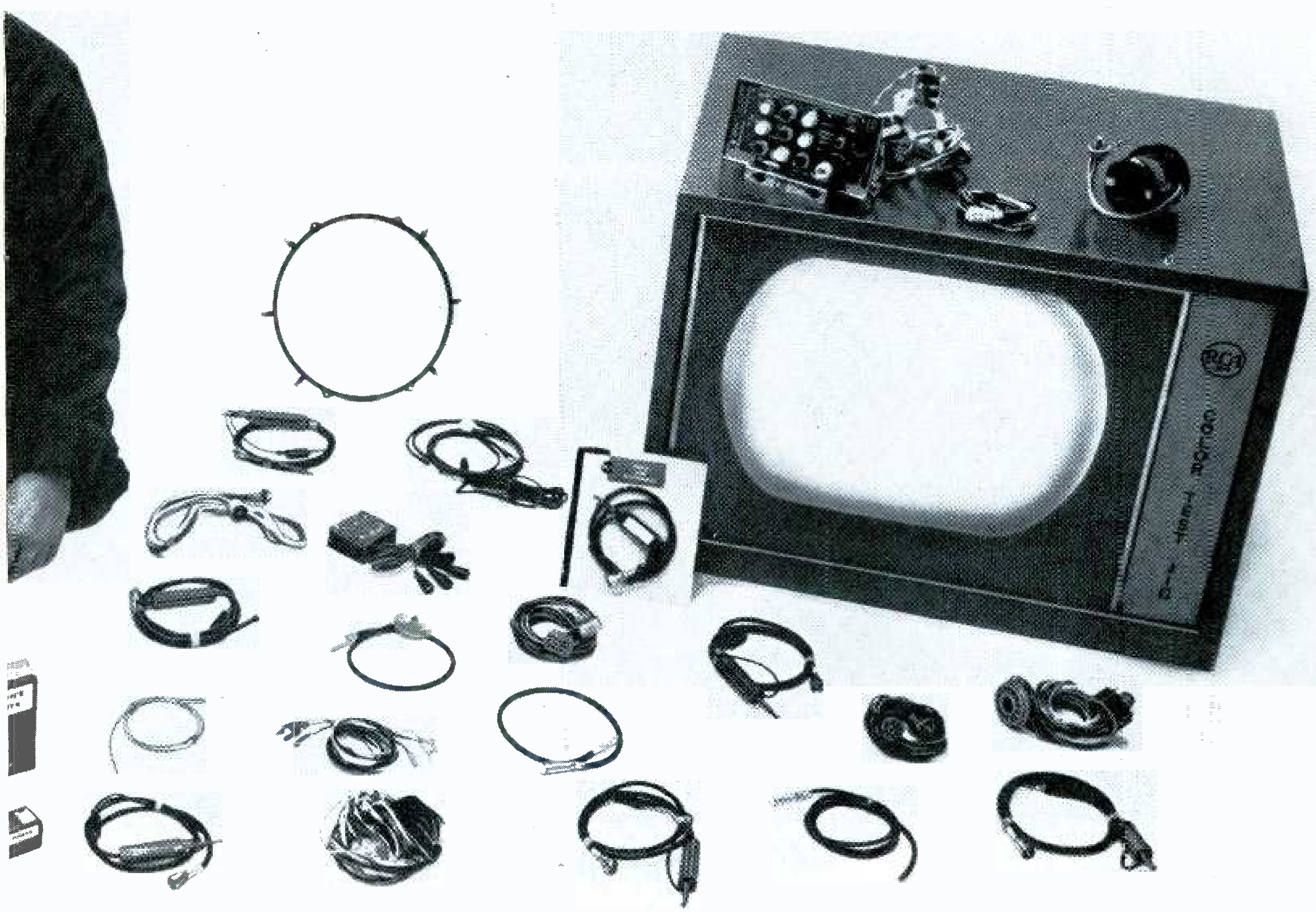
To save you money and manhours.

To increase your efficiency so you can get more jobs out in the same time.

To eliminate those time-wasting extra phone calls and trips to the distributor.

Take the famous RCA Color-TV Test Jig (large unit at right). *It cuts manhours in half* on a color house call. Without it, when you have to pull a set into the shop, it takes two men. With it, it takes just one (you pull the chassis only—leave the color tube and the cabinet). That means MONEY *. . . extra money for you.*

Take the RCA Color Parts Rack (large unit at left). The rack is FREE when you buy the basic complement of 120 most-needed color service parts. Keeps your color parts neatly organized, all in one place. Simplifies restocking, lets you know what you're short of. No more running out of a vital part just when you need it—which slows down a job.



MONEY IN COLOR-TV SERVICE

That means MONEY... *extra money for you.*

Take the other color service parts arrayed in the photo and listed at right. Degaussing coils, transformers, chokes, yokes, connectors, cables, replacement parts... each with a special function to save you time, to increase the quality and accuracy of your work, to help you cut down on call-backs. That means MONEY... *extra money for you!*

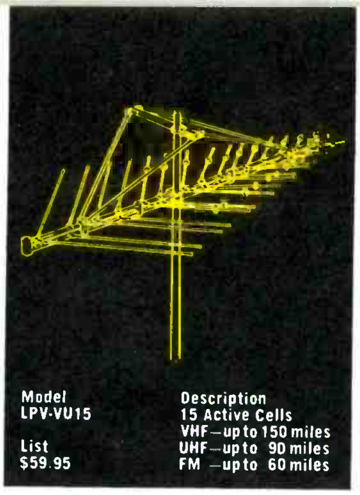
245 specialized color service parts in all. The Rack and the Jig make it 247. And all of them mean MONEY... *extra money for you.*

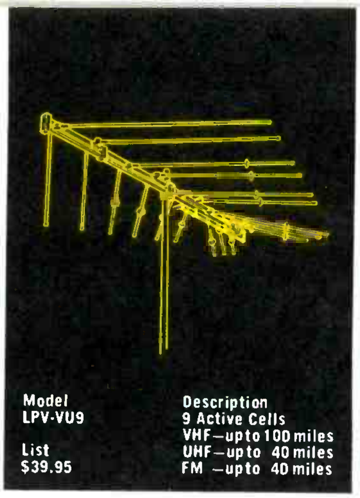
RCA PARTS AND ACCESSORIES, DEPTFORD, N. J.

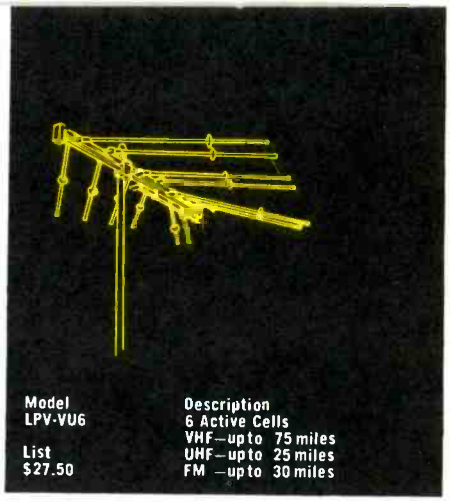
RCA ®

The Most Trusted Name in Electronics

RCA Parts and Accessories for color-TV service include: *Color Test Jig*—to test all RCA color-TV chassis • *Color Parts Rack*—sturdy, well-organized unit containing complement of 120 most-needed color-service parts • *Degaussing coils*—to demagnetize picture tube and chassis • *Special-purpose extension cables*—to extend kinescope socket, deflection yoke, convergence magnet and kinescope high-voltage leads when chassis is removed from cabinet for servicing • *Special alignment probes*—video detector test blocks, IF test blocks, sound detector test blocks, mixer grid matching pad, tuner IF input head • *High-voltage interlock plug*—to by-pass high-voltage shorting switch • Plus sockets, transformers, fixed and variable capacitors, reactors, resistors, diodes, switches, coils... EVERYTHING to save you time and make *more money for you* in color-TV service.







Who Says

You Can't Have Everything You Want in a TV Antenna?—

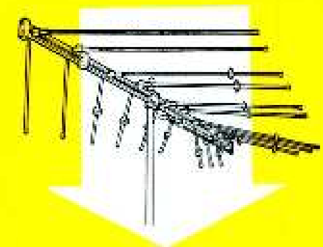
VHF? UHF? FM Stereo? Single Down-lead?

You most definitely can—when you install the remarkable new

JFD LPV-VU LOG-PERIODIC

FEATURING THE CAP-ELECTRONIC DIPOLE

The World's first all-channel VHF/UHF/FM/Stereo antenna (with single Down-lead) is here. (And only JFD has got it!)



You can't satisfy today's complex VHF/UHF/FM reception needs with yesterday's antennas. Today's "VU" TV sets call for a single all-powerful all-band antenna that delivers the signals you need for picture-perfect reception on all channels 2 to 83—plus FM Stereo.

That's why smart installers and dealers are switching to the new JFD LPV-VU. This newest antenna advance from the JFD Champaign, Illinois R&D Laboratories, teams (1) the acclaimed JFD Log-Periodic concept with (2) a totally new antenna design principle—the *capacitor-coupled electronic dipole.*

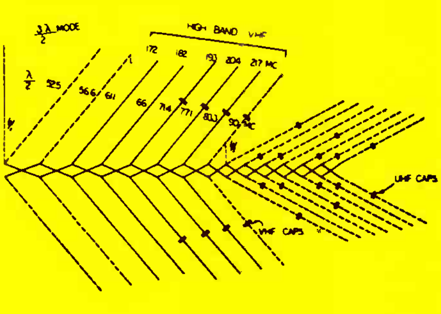
Result? More driven elements than ever before possible for the most efficient performance ever on VHF, UHF, FM/Stereo—from *one* antenna, **with one lead-in.**

And you can choose from five gold alodized LPV-VU Log-Periodics to satisfy every location, any budget: model LPV-VU-18, LPV-VU-15, LPV-VU-12, LPV-VU-9 and LPV-VU-6.

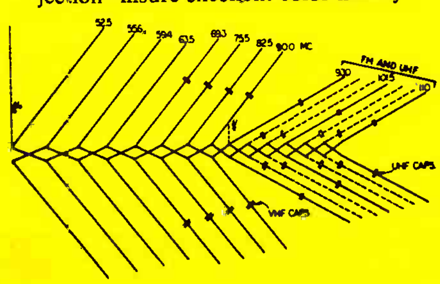
New from JFD—another outstanding advance in dipole design, the *capacitor-coupled electronic dipole!*

By introducing parallel plate capacitors into predetermined positions along the dipoles, and by precisely adjusting the value of each capacitance:

1. *More* dipoles are made to resonate on the high VHF band with a corresponding increase in gain.



2. *Higher mode* operation in UHF band achieves higher gain on channels 14 to 83—equal or better than that of parabolics. Improves FM stereo performance.
3. *More uniform* gain across each band, with narrower beamwidths. High front-to-back ratios greatly improve ghost rejection—insure excellent color fidelity.

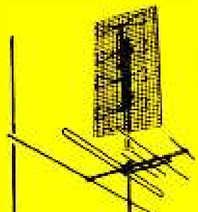


PLUS . . .

1. *Patented frequency independent Log-Periodic design* maintains same high performance efficiency regardless of station or band tuned in.
2. *Only one downlead needed.* A JFD AC80 splitter, included with each LPV-VU, permits you to tie directly into VHF, UHF and FM set inputs.
3. *New low-impedance twin crossarms* function as crossed feeder harness. Step up gain and improve signal transfer.

LPV-VU OFFERS NEW *MECHANICAL* ADVANCES, TOO!

■ Twin square aluminum crossarms. ■ Stainless steel terminals. ■ Oversized unbreakable Celanese "Fortiflex A" insulators. ■ Solid aluminum bus bar transformers. ■ Tubular crossarm supports on larger LPV-VU's. ■ Double U-bolts with 4 serrated-gripping profiles for 6-inch gripping span. ■ Electrically conductive gold alodizing.



INSTALLER BEWARE!

Don't spoil your VHF reception!

Addition of a separate UHF antenna to a present VHF installation may cut the VHF signal being delivered to your set. Incoming signals from a VHF transmitter may be scattered from the UHF antenna. Scattering produces less signal and multiple signals which cause ghosts.

SO WHY USE TWO WHEN ONE *LPV-VU* WILL DO?

Install the *all*-channel JFD LPV-VU and get the best VHF and UHF from *one* antenna with *one* down-lead!

A SPACE-AGE PRODUCT OF THE WORLD'S GREATEST TV/FM ANTENNA LABORATORIES

This newly completed laboratory, located on a ten acre site in Interstate Research Park, in Champaign, Illinois (home of the University of Illinois) marks a milestone in antenna history. It is dramatic proof of JFD leadership in antenna technology. Its fully staffed and equipped engineering staff, under the supervision of Dr. Paul E. Mayes, is blazing new trails in antenna design. This priceless know-how is built into each LPV-VU you sell.

The JFD LPV-VU is adapted from the geometrically derived Log-Periodic antenna formula developed 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

SEE YOUR DISTRIBUTOR. WRITE FOR BULLETIN 806 FOR COMPLETE DETAILS.

Circle 8 on literature card

STOCK GUIDE FOR TV TUBES . . .

This list omits more than 100 of the rarest TV tube types, which many shops find impractical to stock. To simplify the chart as much as possible, common radio and hi-fi tube types used in TV combinations are omitted.

New tube types introduced this year are listed in the separate chart; to help you decide whether to stock these tubes, each listing specifies receivers using that particular type. If you're specializing in one or two brands, you'll pick new tubes listed for those sets and stock your shelves and caddy accordingly.

In the main chart, the figures under "Caddy Stock" suggest a stock of approximately 300 tubes (other than tubes for color sets) which should account for close to 90% of your replacement needs. As with the rare-tube listings, you may want to carry more of a particular type if it is used in receivers you service often. We've removed some of the older types, such as 6V6, 6W4, and 6BZ7, and replaced them with more current types; also included are some that appeared in last year's new-tube list—if they were used in sets again this year. Most-used UHF tubes are also included. Tubes marked with an asterisk (*) are used also in color sets.

The figures under "Shelf Stock" are a suggested backup stock, if you're located near a parts distributor. If you can replenish your tube supply only once a week, you may wish to stock extra of the more common types.

Your volume of business will naturally determine your actual shelf stock, too. Keep in mind three main factors that will influence the demand for various tubes:

1. Relatively high failure rate of power-output and similar tubes.
2. Your specialization in certain makes of sets.
3. Average age of sets containing a particular tube type.

Temporary substitution of available types for rare types, as outlined in the Howard W. Sams book, *Tube Substitution Handbook, Vol. 8*, can also help you reduce stock requirements.

Another way to ease tube-stock headaches is to use only the latest -A or -B versions of various tubes. Types in common use are listed in the chart.

TUBE TYPE	SHELF STOCK	CADDY STOCK	TUBE TYPE	SHELF STOCK	CADDY STOCK	TUBE TYPE	SHELF STOCK	CADDY STOCK
1AD2	1	1	3HG8	1	1	6AC7	1	1
1AU2*	1	1	3HM6	1	1	6AF3	1	1
1B3GT	5	2	3HT6	1	1	6AF4B*	2	1
1G3GT	2	1	4AU6	1	1	6AF11	1	1
1J3	2	1	4BL8*	1	1	6AG5	1	1
1K3	3	1	4BQ7	1	1	6AG7*	1	1
1N2	1	1	4BU8	1	1	6AH5	2	1
1S2A	1	1	4BZ6	2	2	6AH6	1	1
1V2*	2	1	4CB6	1	1	6AK5	1	1
1X2B*	2	1	4CS6	1	1	6AL3	1	1
2AF4	1	1	4DK6	2	1	6AL5*	2	1
2AH2	1	1	4DT6	1	1	6AL11*	1	1
2AS2	1	1	4EH7	1	1	6AM8A	2	1
2CW4	1	1	4EJ7	1	1	6AN8*	1	1
2CY5	1	1	4GK5	1	1	6AQ5A*	3	3
2DS4	1	1	4GM6	1	1	6AR11	1	1
2DZ3	1	1	4GZ5	1	1	6AS5	1	1
2DZ4	1	1	4HA5*	1	1	6AS8	1	1
2FH5	1	1	4HM6	1	1	6AU4GTA*	2	2
2FS5	1	1	4HS8	1	1	6AU6A*	3	2
2GK5	2	2	4HT6	1	1	6AU8A*	1	1
2GU5	1	1	4JC6	1	1	6AV6*	2	2
2GW5	1	1	4JD6	1	1	6AW8A*	3	2
3A3*	1	2	4KN8	1	1	6AX3	1	1
3AF4	1	1	5AM8	1	1	6AX4GTB	3	3
3AJ8	1	1	5AQ5	2	2	6AY3	2	2
3AL5	1	1	5AT8	1	1	6AZ8*	1	1
3AT2*	1	1	5AU4	1	1	6B10	1	1
3AU6	2	1	5BC3	1	1	6BA6	3	1
3AW3	1	1	5BR8	1	1	6BA11*	1	1
3BN6	2	1	5CG8	3	2	6BC8*	1	1
3BU8	1	2	5CL8A	1	1	6BD11	1	1
3CB6	2	2	5DJ4	1	1	6BE3*	2	1
3CS6	1	1	5EA8	1	1	6BE6	2	1
3CY5	1	1	5EW6	1	1	6BF11	1	1
3DG4*	2	1	5FG7	2	1	6BG6GA	1	1
3DK6	2	2	5GH9	1	1	6BH9	1	1
3DT6*	1	1	5GM6	1	1	6BH11*	1	1
3DZ4	1	1	5HG8	1	1	6BJ3	2	1
3EH7	1	2	5JV8	1	1	6BJ8	1	1
3EJ7	1	2	5KD8	1	1	6BK4*	2	1
3FS5	1	1	5KE8	1	1	6BK7B	1	1
3GK5	2	2	5U4GB*	8	3	6BL7GT	2	2
3GS8	1	1	5U8	2	2	6BL8*	2	2
3HA5	1	1	5V3	1	1	6BM8A*	1	1

TUBE TYPE	SHELF STOCK	CADDY STOCK
6BN4	1	1
6BN6*	3	1
6BN8*	1	1
6BQ5*	3	2
6BQ6GTB	5	3
6BQ7A*	2	1
6BR8A	1	1
6BU8	3	2
6BX7GT	1	1
6BY6*	1	1
6BY8	1	1
6BZ6*	8	4
6C4*	1	1
6CB5*	1	1
6CB6*	3	3
6CD6GA	2	2
6CG7*	6	2
6CG8A*	5	2
6CL6*	1	1
6CL8A	1	1
6CM7	2	2
6CN7*	1	1
6CQ8*	1	1
6CS6*	2	1
6CU5	2	1
6CW4*	1	1
6CW5*	2	1
6CX8	1	1
6CY5	1	1
6DA4	1	1
6DE4	2	2
6DE6*	2	1
6DE7	2	1
6DK6*	2	2
6DM4	3	2
6DN7	1	1
6DQ5*	2	1
6DQ6B*	5	3
6DR7	1	1
6DS4*	2	2
6DT5	1	1
6DT6A*	2	2
6DV4*	1	1
6DW4*	1	1
6DX8*	1	1
6DZ4	1	1
6EA8*	3	2
6EB8	2	1
6EH7*	3	2
6EH8	3	2
6EJ7*	3	2
6EM5	1	1
6EM7*	2	2
6ER5	1	1
6ES8	2	1
6ER7	1	1
6EV7*	1	1
6EW6*	2	2
6EW7	2	2
6EZ5*	1	1
6FD7	1	1
6FG7*	2	1
6FH5*	1	1
6FM7*	2	1
6FQ7*	5	2
6FS5	1	1
6FV8	1	1
6FY5	1	1
6FY7	1	1
6GB5	1	1
6GC5*	1	1
6GE5	2	2
6GF7*	3	2
6GH8A*	3	2
6GJ5	1	1
6GJ7*	1	1
6GK5*	3	2
6GK6	1	1
6GL7*	1	1
6GM6*	3	2
6GN8	2	1

TUBE TYPE	SHELF STOCK	CADDY STOCK
6GT5	1	1
6GU5	1	1
6GU7*	3	2
6GV5	2	1
6GW6	1	1
6GW8	2	1
6GX6*	2	1
6GY5	1	1
6GY6*	1	1
6GZ5	1	1
6HA5*	1	1
6HA6	1	1
6HB5	2	1
6HG6*	2	1
6HD5	1	1
6HE5*	3	2
6HF5*	3	2
6HF8	1	1
6HG8	1	1
6HJ8	2	1
6HK5	1	1
6HL8*	1	1
6HS8*	2	1
6HZ6*	1	1
6HZ8	1	1
6J6	2	2
6JB6	2	1
6JC6*	2	1
6JC8	1	1
6JE6*	3	2
6JE8	1	1
6JH6*	3	2
6JH8*	3	2
6JN8	1	1
6JT8*	1	1
6JU8*	3	2
6JV8	2	1
6JZ8	1	1
6K6GT	1	1
6KA8*	1	1
6KD8	1	1
6KT8*	1	1
6KU8	1	1
6KZ8*	1	1
6Q11(6K11)	1	1
6RK19	1	1
6S4A	1	1
6SL7GT	1	1
6SN7GTB*	2	1
6T8*	1	1
6U8A*	1	2
6U10*	1	1
6X8A*	2	2
7AU7	1	1
7GU7*	1	1
7GV7	1	1
8AW8A	2	1
8B8	1	1
8B10	1	1
8BE8	1	1
8BQ5	2	1
8CG7	1	1
8CW5	1	1
8CW8	1	1
8CX8	1	1
8DX8	1	1
8EB8	1	1
8EM5	1	1
8ET7	1	1
8FQ7	2	1
8GJ7	1	1
8GN8	1	1
8JV8	1	1
8JZ8	1	1
8KA8	1	1
9A8	1	1
9AU7	1	1
9GV8	1	1
10AL11	1	1
10CW5	1	1
10DE7	2	1

TUBE TYPE	SHELF STOCK	CADDY STOCK
10DX8	1	1
10EG7	1	1
10EM7	1	1
10EW7	1	1
10GK6	1	1
10HF8	1	1
10JA8	1	1
10JY8	1	1
10KU8	1	1
11AR11	1	1
11JE8	1	1
11KV8	1	1
12AF3	2	1
12AL11	1	1
12AT7*	1	1
12AU7	1	2
12AV5GA	1	1
12AX4GTB	3	2
12AX7*	2	1
12AY3	1	1
12AZ7A*	1	1
12B4A	2	1
12BE3	1	1
12BH7A*	2	2
12BQ6GTB	2	2
12BY7A*	2	1
12C/-CU5	3	1
12CA5	2	1
12DB5	1	1
12DQ6B	3	2
12DT5	1	1
12FX5	1	1
12GC6*	1	1
12GN7*	1	1
12GT5	1	1
12GW6	3	2
12SN7GTA	1	1
12W6GT	1	1
13CM5	1	1
13DE7	1	1
13DR7	1	1
13EM7	2	1
13FD7	1	1
13GB5	2	1
13GF7	1	1
13J10	1	1
15BD11	1	1
15CW5*	2	1
15DQ8*	1	1
15HB6*	2	1
15KY8	2	1
15LE8*	1	1
16A8*	1	1
16AQ3	1	1
16GK6	1	1
17AX4GT	1	1
17AY3	3	2
17BE3	1	1
17BF11	1	1
17BS3	2	1
17C5	1	1
17DE4	1	1
17DM4A	1	1
17DQ6B	2	1
17GJ5	2	1
17GV5	1	1
17JB6	1	1
17JZ8	2	1
19AU4GTA*	1	1
21GY5	2	1
21HJ5	1	1
22BH3	2	1
22DE4	1	1
22JG6	2	1
25AX4GT	1	1
25BQ6GTB	1	1
25CD6GB	1	1
33GT7	1	1
33GY7	2	1
50C5	2	1

• ***Please** turn to page 87*

Want to make your shop more profitable?

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Large-Scale CATV Modernization

One of the nation's largest operators of CATV systems, **H & B American Corp.,** has announced a major modernization program. Five systems will be completely rebuilt, one will be partially rebuilt, and one new system will be installed. All systems will use solid-state equipment.

According to Leon Papernow, vice-president of operations, this modernization is being undertaken to provide subscribers with more program variety and improved picture quality. Once the changeover is completed, all seven systems will be capable of carrying up to 12 TV channels, plus 20 FM stations.

To implement the program, H & B has purchased from Jerrold Electronics, in the largest single equipment-purchase contract in the history of CATV, enough solid-state equipment to send signals through more than 500 miles of cables.

The five systems to be rebuilt around Jerrold 12-channel solid-state gear are: Ukiah, Cal.; Reno, Nev.; Margate, Ventnor, and Longport, N. J.; Dubuque, Iowa; and Wenatchee, Wash. Dothan, Ala. will be equipped with new solid-state trunkline amplifiers, and a completely new system will be installed in the Santa Ynez Valley, in Cal. H & B American Corp. owns 29 CATV systems serving more than 83,000 subscribers in 44 communities.

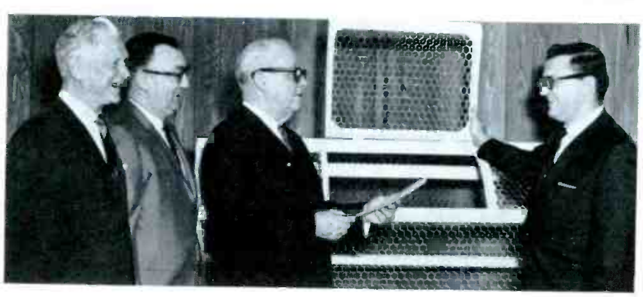
New Family of Semiconductors

A new family of solid-state electronic devices developed by **RCA Electronics** will make possible a new generation of transistorized AC-DC radios and phonographs, according to RCA sources. The new devices are designed to be line operated, thus avoiding the additional cost and bulk of circuit components such as power transformers and voltage-dropping resistors normally required to power AC-DC transistor sets. Complete solid-state circuitry in line-powered equipment has been generally limited to larger, higher-priced home instruments. The new, low-cost, hermetically sealed semiconductors make possible all-

Mustang Winners

Prize winners in the Sams PHOTOFACT sales contest have been announced by Howard W. Sams, chairman of the board and president of **Howard W. Sams & Co., Inc.** Names of the winners were drawn by Mr. Gail S. Carter, executive vice president of NEDA, at the January contest luncheon in Indianapolis.

Grand-prize winners of Ford Mustang automobiles were Ralph E. Denenburg, service technician of R & D TV, Philadelphia, Pa. and Joe Taylor, distributor salesman for Tri-State Distributing Co., Greenville, Miss. Second-prize winners of luxurious mink stoles were technician Joseph Jiminez of Jiminez TV Sales & Service, Haywood, Cal. and R. Kuttruf, distributor salesman for H. L. Dalis in Long Island City, N. Y. Third awards were won by Francis C. Wolven of Saugerties, N. Y. and Stan Lesser, another distributor salesman for H. L. Dalis; each received a diamond-set Elgin ladies' watch. All six winners were notified by phone immediately following the drawing.



In the photo, Gail Carter draws the winners' names for Jack W. Merritt, vice president sales, of the Sams Co. Looking on at left are J. A. "Shine" Milling, president of the Sams division and a director of the company, and Thomas V. Surber, sales manager, distributor division.

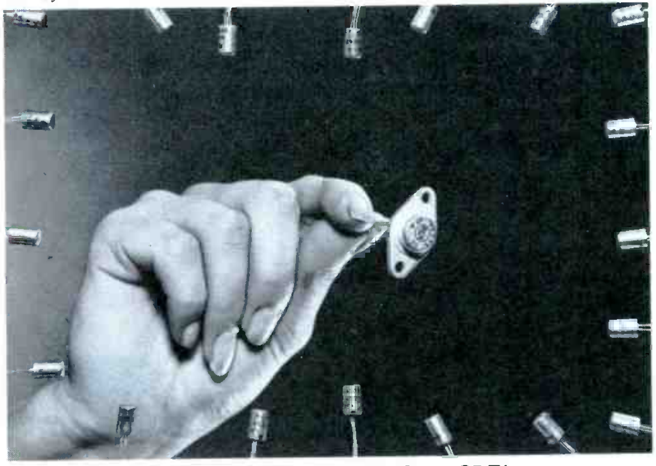
tube and placed it into production at National Video Corp. This same engineering team will set-up the new facility which, beginning next year, will be capable of producing any size rectangular color tube, but will start with the 23″ size, Mr. Wavering revealed.

To provide facilities for the new tube plant, some 60,000 sq. ft. of Motorola's Franklin Park, Illinois site is being cleared. The Consumer Products Division's Parts and Service Department, now occupying this space, will be moved to another building in Franklin Park recently acquired by Motorola. The vacated Parts and Service Department building will be enlarged and remodeled to accommodate the processing and control equipment required for the production of the rectangular color-picture tubes.

To Double Capacity

Doubled production capacity, made possible by a new addition slated for completion in the spring of 1965, is anticipated by **Winegard Co.,** a leading producer of TV antennas and other TV- and FM-reception equipment. The new addition, which includes modern research laboratories, is the fourth and largest facility expansion in the company's history. The new structure will be devoted primarily to antenna production. ▲

solid-state, line-operated broadcast-band radio receivers and phonographs in the medium and lower price ranges. The new semiconductor package consists of four transistors and one silicon rectifier, all designed for use in circuits operating directly from the 117-volt AC line.



To Manufacture Color CRT's

The 23″ rectangular color-television picture tube used in its current line will be manufactured by **Motorola, Inc.,** according to Elmer H. Wavering, president of the corporation. National Video Corp. is currently sole supplier to Motorola of this color-picture tube.

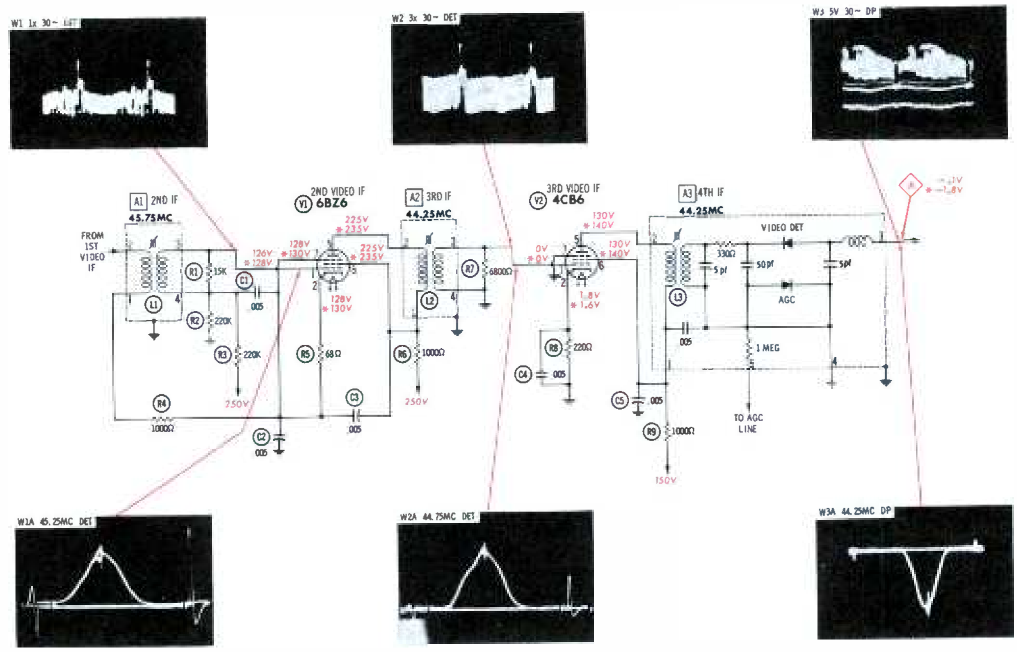
The Motorola move into picture-tube manufacturing will release National Video Corp. to serve the requirements of its other customers and will, at the same time, provide a second source of supply to serve Motorola's expanding tube requirements.

Motorola engineers designed the first 23″ rectangular color

PF REPORTER *Symfact*™

Stagger-Tuned IF

Second and Third Stages



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 on CRT. DET (detector) and LC (low-capacitance) probes used where indicated.

Normal Operation

Stagger-tuned IF strip shown here (from Airline Model 2485) uses single-tuned transformers in all stages. Some receivers use overcoupled (double-tuned) transformer in final stage. First IF coil (not shown) is peaked to 43.25 mc, second to 45.75 mc, third to 44.25 mc, and final to 44.25 mc. Thus, low side of curve is peaked by first stage, high side by second stage, and center by third and final stage; result is flat overall response more than 3 mc wide at 50% points. First and second stages are in stacked B+ arrangement; plate current of second IF tube also flows through first. Stacked-stage operation was covered in October 1963 SYMFACT. Otherwise, circuit operation is similar to any video IF's. All response curves were taken with VHF oscillator disabled and sweep generator (set to center frequency of 44 mc) connected to mixer-grid test point in tuner. Marker was obtained from external signal generator, using marker adder. Sweep generator output was kept as low as possible and external bias was connected to AGC line to prevent overloading of IF stages; scope vertical gain was set to obtain workable response amplitude. Scope horizontal input was connected to horizontal output of sweep generator. Detector probe was used to obtain all waveforms except those at point A. Designation 3x indicates W2 is three times amplitude of W1. All waveforms within IF strip are shown positive in polarity because detector probe used detects only positive swing of RF signal. High-gain scope is necessary to view low-amplitude signals in IF.

Operating Variations

PIN 1 V1 DC voltage increases slightly with signal present. Primary concern is difference in potential between grid and cathode — normally −2 volts, more negative on strong station.

PIN 5, 6 V1 Plate and screen voltages increase when station signal is tuned, as conduction of tube is reduced. Nominal reading with signal is 235 volts, but may increase to 245 with extremely strong signal fed to antenna terminals.

PIN 2 V2 Cathode voltage of V2 determines bias on stage as grid is virtually at DC ground — only resistance is less than 1 ohm in secondary winding of L2. Voltage is less with signal.

PIN 5, 6 V2 Plate and screen voltages of V2 follow same pattern as those of V1. Tube current decreases with signal; therefore, voltages increase—normal reading with signal is 140 volts, but may increase to 145 with strong local station.

WAVEFORMS Amplitudes of W1, W2, and W3 are dependent on strength of incoming signal and thus AGC voltage. Amplitudes of W1A, W2A, and W3A are determined by generator output level and value of external bias applied to AGC line. Normal amplitude of W3 is 5 volts, but may range from 3 to 7.

SYMPTOM 1

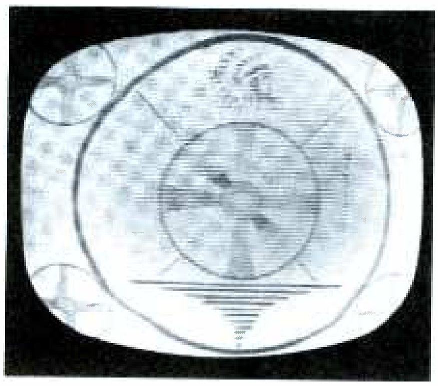
Picture Weak

Reduced Sound

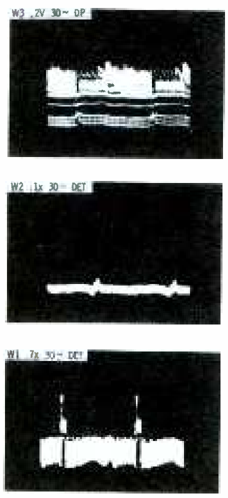
R5 Increased in Value

(Cathode Resistor — 68 ohms)

Symptom Analysis



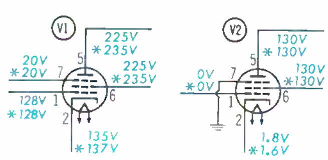
Contrast control is operative but picture has weak or washed-out appearance even at maximum setting of control. Sound may be acceptable but requires nearly maximum setting of volume control. No snow is seen in picture; therefore trouble in IF stages is suspected.



Waveform Analysis

Video-detector output (W3) is greatly reduced in amplitude — only .2 volt p-p, normal is 5 volt. Trouble is further isolated by below-normal amplitude of signal at grid of V2; only minute vertical sync pulse can be seen. Grid signal of V1 is slightly reduced in amplitude, but not nearly so much as W2, thus indicating trouble is probably in second IF stage. Scope won't pinpoint faulty component, but notice how quickly it isolates stage.

Voltage and Component Analysis



Voltage readings on V2 aren't unusual; however, close evaluation does offer slight clue in localizing defect. Plate and screen remain same, with or without signal; indicates signal isn't reaching grid, and trouble is in previous stage. Pin 7 of V1 has most unusual reading — only 20 volts. This is definite indication that R5 has increased in value. Trouble can be found with voltage measurements alone; but time can usually be saved by isolating stage with scope, then using voltage or resistance checks to locate component.

Best Bet: Scope followed by meter checks.

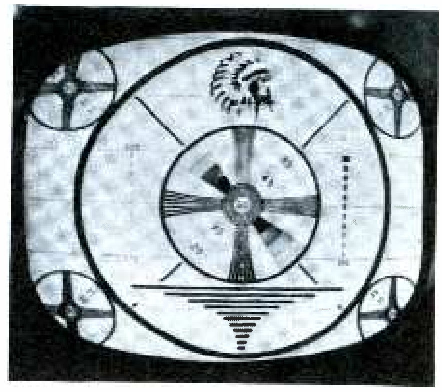
SYMPTOM 2

Video Weak

Fringe Channels Missing

R2 Decreased in Value

(Grid Resistor — 220K)

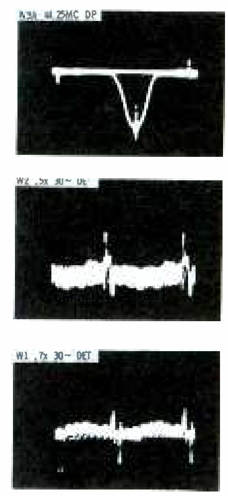


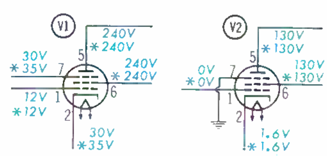
Symptom Analysis

Strong stations produce weak and washed-out picture. Fringe channels are completely missing, both picture and sound. Rotating AGC control proves of no value — doesn't change indication. Contrast control is operative, indicating video output is probably okay.

Waveform Analysis

Trouble may be isolated to IF stages either with scope and station signal or with scope and sweep generator. In either instance, significant indication is reduced amplitude of signal at output of video detector (point A). Grid of V2 (W2) shows same loss of amplitude as preceding stages. Above-normal amplitude and abnormal shape of W1 is explained by fact that AGC voltage is reduced or missing at grid of first IF causing excessive amplification.





Voltage and Component Analysis

Voltage measurements on V2 give same indication as in Symptom 1 — means signal is greatly reduced or missing at grid. Significant clue is only 12-volt reading on pin 1 of V1. Voltage divider R2 and R3 should place about 125 volts on grid; either increase in value of R3 or decrease in R2 is likely cause of reduced voltage. Resistance checks from grid to ground will isolate R2. Voltages on pin 2 and pin 7 are also reduced considerably but are result of low grid voltage and don't actually contribute to loss of amplification.

Best Bet: Scope — then usual VTVM tests.

SYMPTOM 3

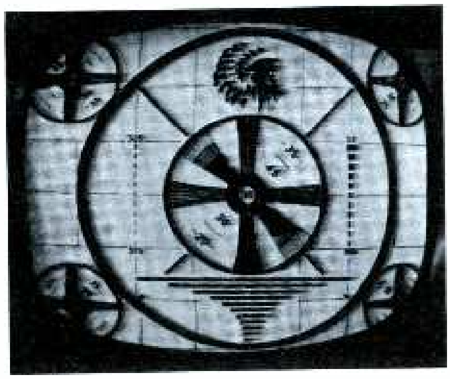
Video Weak, Smeared

Buzz in Sound — Sync Critical

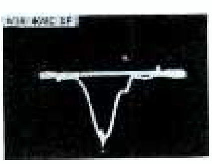
Open Connection, Pin 2 of L2

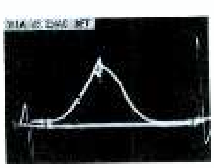
(Third Video-IF Transformer)

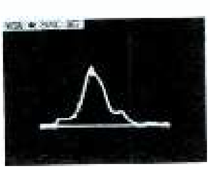
Symptom Analysis



Video is extremely weak and badly smeared; sound level is reduced and is accompanied by annoying buzz. Picture intermittently loses sync, both vertical and horizontal. Symptom gives indications that misalignment may be responsible, so trouble is most likely in IF stages.



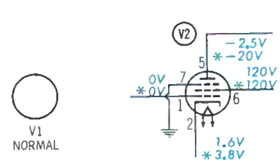




Waveform Analysis

When alignment faults are suspected, it is good idea to check overall response. W3A shows response curve is abnormal in shape and center of curve is now at 46 mc. Adjusting A3 alters response but normal curve can't be obtained. A quick check of W1A indicates tuner and first IF stage are okay — response curve is normal. W2A is of low amplitude, shape is distorted, and marker is at 46.25 mc. Good clue is that A2 has virtually no effect.

Voltage and Component Analysis



Trouble can be found with VTVM but requires circuit analysis and close examination of DV voltages. Indications, with or without signal, are low conduction — proven by increased reading on plate and screen and decreased voltage on cathode. Of utmost importance is −.2 volt on grid, with signal present—should be zero, as DC resistance from grid to ground is normally less than 1 ohm. Negative voltage gives clue that secondary of L2 may be open; resistance checks from grid to ground prove this is true—meter reads 6800 ohms,

Best Bet: Alignment check; then resistance measurements.

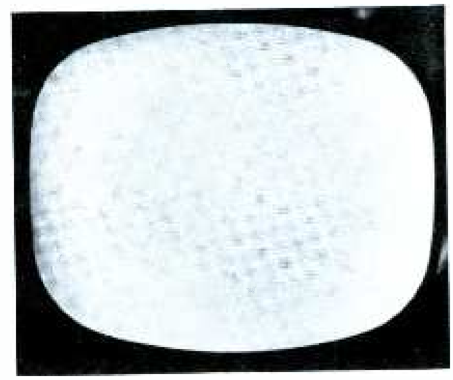
SYMPTOM 4

Picture and Sound Missing

No Snow in Raster

L3 Primary Open

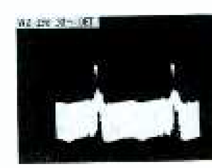
(Final IF Transformer)



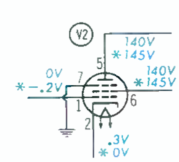
Symptom Analysis

Picture and sound are completely missing on all channels. No snow can be seen in raster; symptom indicates trouble in either mixer/oscillator or video-IF stages. Contrast or AGC control have absolutely no effect. First step is to ascertain if trouble is in tuner.

Waveform Analysis



Input to second IF stage (W1) has normal content; proves tuner and first IF stage are normal (increased amplitude is due to loss of AGC voltage). W2 indicates defect is further along — it has normal content and amplitude is in correct proportion to W1. Video detector output (W3) and plate signal of V2 (not shown) prove signal isn't reaching these points. Scope won't pinpoint component, but rapidly isolates trouble to third video-IF stage.



Voltage and Component Analysis

Considering information gained from scope analysis, voltage checks on V2 should reveal source of trouble. Most unusual reading is negative voltage on plate — minus 20 volts with signal, 2.5 without. With screen voltage near normal, primary of L3 has to be open. Negative plate voltage is usually sign of open circuit between plate and B+ source. Resistance measurements from plate to B+ will confirm L3 is open. When this trouble occurs, good idea is to replace tube or at least check to make sure it hasn't been shorting.

Best Bet: Scope to localize — VTVM to pinpoint.

Picture Weak or Missing

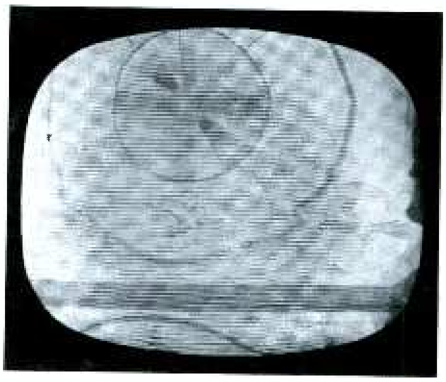
SYMPTOM 5

Horizontal Sync Critical; Audio Weak

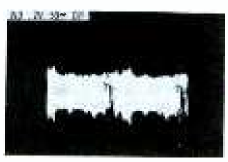
R8 Open

(Cathode Resistor — 220 ohms)

Symptom Analysis



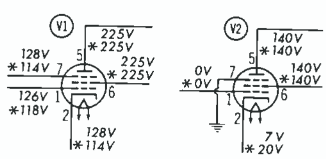
Strong local stations produce weak, washed-out picture; horizontal sync is touchy; audio is weak, accompanied by slight buzz. Fringe channels are missing, both picture and sound. Contrast control seems operative; AGC control has no effect. Trouble is probably in IF or tuner.



Waveform Analysis

W1 again proves trouble isn't in tuner or first IF stage, content is normal and amplitude is increased because AGC section receives false indication, as if antenna signal level were reduced. W2 at third IF grid further isolates trouble, as it too is okay. Low .2 volt p-p in W3 proves trouble is in final IF stage. Plate of V2 (not shown) contains only small amount of video—thus narrowing search to components associated directly with V2.

Voltage and Component Analysis



With signal, voltages on V1 aren't exactly right; negative 2-volt potential between grid and cathode is changed to positive 4 volts, causing tube to amplify more than normal. Best voltage clue is at cathode of V2 — it measures 20 volts with signal, 7 volts without. With cathode resistor open, inserting VTVM between cathode and ground causes slight cathode current to flow through meter — accounting for positive potential. Increase in value of R8 would cause similar symptom, but picture wouldn't be so weak, nor sync so critical.

Best Bet: Scope followed by voltage readings.

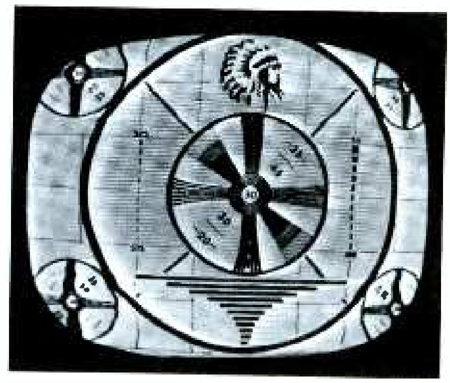
Ghosts in Picture

Slight Buzz in Sound

SYMPTOM 6

L2 and L3 Misaligned

(3rd and 4th IF Transformers)

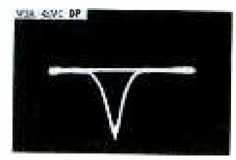


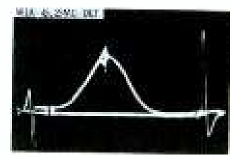
Symptom Analysis

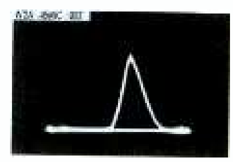
Strong stations produce multiple ghosts in picture; weaker channels give weak, washed-out appearance. Fine tuning is extremely critical; adjusting it causes images to move across the screen (commonly called *tunable ghosts*). Symptom is indicative of improper alignment.

Waveform Analysis

Overall response (W3A) is sharper than normal; of equal importance, center of curve is now at 45 mc—normal is 44.25 mc. Valuable assistance in locating trouble is gained from W1A: it is normal—misalignment must be in third and/or final IF. W2A appears to be near normal; however, amplitude is increased and marker is at 45 mc. Increase in amplitude isn't readily evident; however, shape and marker position are of extreme significance.







Voltage and Component Analysis

Improper alignment can't usually be detected with either voltage or resistance checks. However, VTVM can be useful at point A, when individual coil frequencies are known, for prepeaking IF coils. This is done by setting marker generator to frequency of individual stage and adjusting respective coil for maximum indication on meter. It is usually necessary to retouch coils using scope for best overall sweep response, but meter can be used for initial adjustments to prepeak coils if frequency is known.

Best Bet: Alignment equipment is necessary.

AGC servicing magic

A choice selection of techniques that make locating these defects easier.

by Carl Babcoke

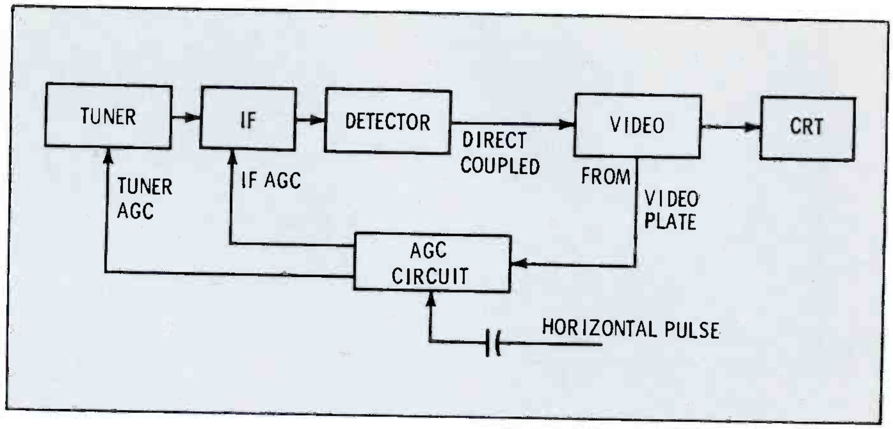


Fig. 1. Block diagram of typical AGC system from television set.

Magic is something we don't regard too highly, except as entertainment, in this enlightened age. There is, however, a simple formula that works almost as if it were magic to change those AGC "tough dogs" into good old American folding money. The only items necessary are a VTVM and a chart made from this "magic" formula. Does that sound impossible or too optimistic? Better give it a good try before you decide. The magic method tells you only which *stage* is at fault—not necessarily the exact part—but, finding the stage is usually the hardest part, anyway, with AGC faults. How many times have you mentally kicked yourself for wasting time working in the wrong circuit? Those of you who are impatient may want to turn right to the chart; however, so you can make allowances for circuits that are slightly different, we suggest you read the information which follows.

Fig. 1 shows the partial block diagram of a typical TV receiver. The main function of the tuner, IF's, and AGC is to deliver an undistorted video signal of constant amplitude from the video detector. This is amplified and used for sound, sync, and picture information. This output signal may be the most important one in the entire set, but its DC component seems to be sadly neglected during most AGC troubleshooting. If the detector voltage falls too low, the AGC reduces bias on the RF and IF stages in compensation. If the detector voltage rises, the AGC acts to decrease it by increasing RF and IF bias voltages. Sounds very simple and foolproof. Why is it, then, that we have such puzzlers as these—?

1. A negative voltage at the IF AGC pickoff point, even when the AGC keyer tube is removed from the socket?
2. Normal snow on a very weak signal, none on a strong signal, but lots of it on a moderate signal.
3. An acceptable picture on a weak signal with *either* RF or IF AGC, but overload *or* snow on a strong signal.

Two AGC Functions

Our understanding of the basic AGC function also may be confused, because the RF stage requires a nonlinear AGC voltage. For the highest signal-to-noise ratio (least snow) on weak signals, the RF AGC voltage should be very low; but, for strong signals, it should be higher than that applied to the IF stages, in order to prevent overload of the mixer. This means there must be two separate AGC distribution circuits; one for the RF's and one for the IF's.

Now, let's review AGC theory. Fig. 2 is the AGC circuit of an imaginary modern receiver. Briefly, here is how it works: The output of detector X2 has negative-going video and a negative DC voltage which is directly coupled to the grid of the video amplifier. When the grid of V1 goes more negative, the plate becomes more positive. Its signal is coupled, through an isolation resistor, to the grid of AGC keyer V2. The cathode of V2 is clamped at the level of the low B+ so that, when the grid becomes more positive, the bias is reduced

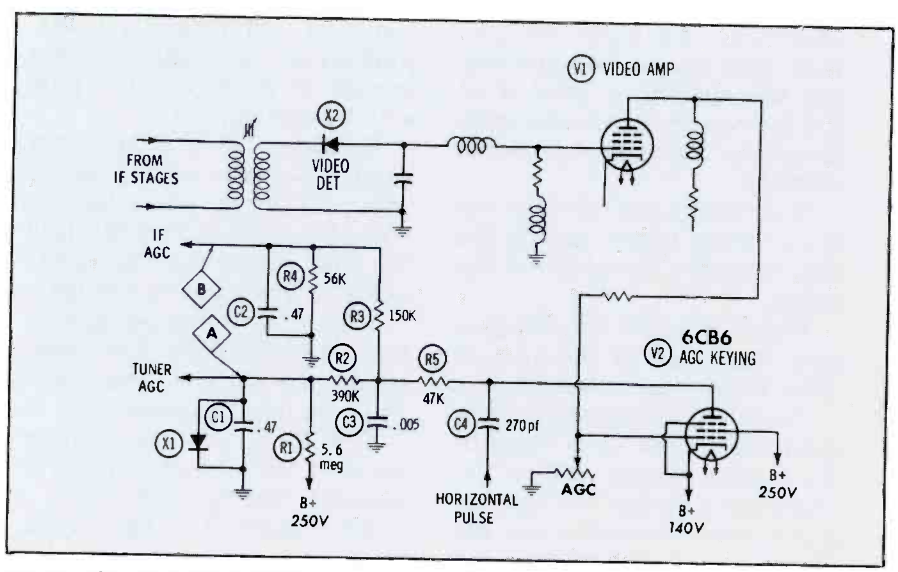


Fig. 2. The way AGC works can be seen by examining this schematic diagram which shows a portion of the circuit of a hypothetical modern television receiver.

Fig. 3. Shot of cream-dessert commercial shows normal-contrast picture.

and the tube conducts more heavily during each horizontal-sync pulse. Thus, the keyer tube acts as a grid-controlled rectifier to produce a negative voltage that increases with an increase in the detector voltage. The advantage here is that a −2-volt signal at the detector results in approximately a −30-volt signal at the keyer plate. The AGC voltage which appears at the plate of V2 is filtered and applied to both the RF and the IF stages.

The nonlinear AGC voltage required for the RF's is developed by adding the negative AGC voltage (through R2) to a fixed positive power-supply voltage (through R1). Thus, we would expect the RF AGC to be positive on weak signals and negative on strong ones. This would be true without the clamping action of X1. The diode clamps whenever the voltage at point A goes positive; therefore, the voltage stays either zero or negative. (Some late-model sets depend on diode action of the RF-tube grid to keep this voltage from swinging positive.) The RF AGC voltage is zero until the negative voltage from the plate of V2 rises higher than the applied B+; then, beyond that point, the AGC voltage at point A rises more rapidly than does the IF AGC voltage at point B.

The full AGC voltage is excessive for application to the IF's so a simple voltage divider (R3 and R4) reduces it to the proper amount. The RF AGC and the IF AGC both reduce receiver gain until the detector DC voltage is correct. Now we have gone full circle from detector back to detector. Not only must the AGC keep the detector voltage constant, but it must tailor the ratio of RF-to-IF AGC voltages to prevent the highly diverse problems of snow and overload.

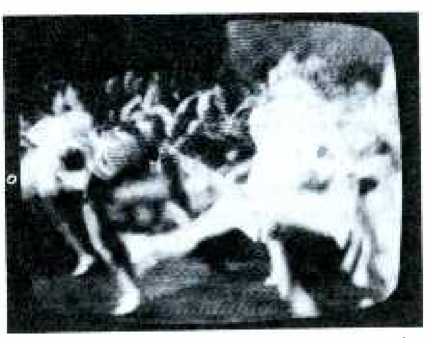


Fig. 4. Set in normal operation in a strong overloaded-signal location.

Troubleshooting AGC

The troubleshooting tips given in Table 1 are derived from the basic functions of the AGC systems and from the following additional precepts:

1. Removal of the last IF tube should give zero video-detector voltage, and also should give zero tuner and IF AGC (unless the signal is strong enough to cause grid rectification of the first IF tube). So, we can say that all three voltages low means loss of gain.
2. Removal of the video tube would cause excessive AGC voltages and zero detector voltage—usually a blank raster as well.
3. Too great a reduction of either or both AGC voltages can cause overload.
4. No AGC at all may cause a blank raster by producing so much detector voltage that the video tube is biased to cutoff, thus showing symptoms similar to those of No. 2.

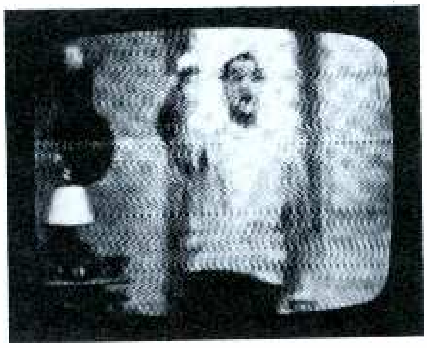


Fig. 5. Set with an AGC problem in a normal-signal location overloads.

Twelve of the most-likely-to-occur problems were selected for Table 1. There are columns for visual symptoms from face of the CRT, both AGC voltages, and detector voltage; the last column shows the location of the defect and makes a guess as to the bad part.

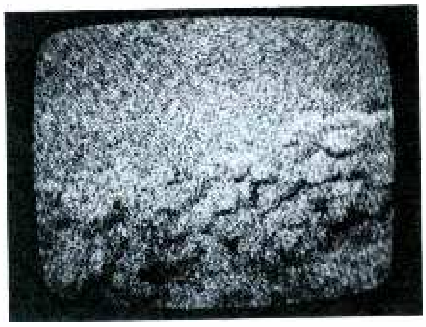


Fig. 6. With RF stage dead, tuner AGC measures zero, snow is very bad.

The important thing about these voltages is NOT their exact value, but their relative value compared to normal AGC-circuit voltages. It may seem that the list merely substitutes one mass of confusion for another, but, with only a little practice, you can use it to be certain of your diagnosis. Symptom No. 3 is a common one when an outdoor antenna is used with high-gain sets of today. Do not try to modify the circuit to eliminate the overload; use a loss pad between the antenna and the tuner instead. After you have checked the chart, examine these examples of actual case histories solved through its use:

1. Color receiver with weak contrast and little sync. Detector voltage very high and RF and IF AGC voltages both low. Trouble: Open video amplifier plate-load resistor.
2. Old b-w receiver with blank white raster and no sound. Detector voltage zero, RF and IF AGC voltages very high. Trouble: Open resistor causing AGC-keyer cathode voltage to be greatly reduced.
3. New b-w receiver with weak gain on distance and overload on strong local channel. RF, IF, and detector voltages low. Had a little snow off channel. Diagnosis: IF or mixer low in gain. Trouble: Mixer-injection volt-

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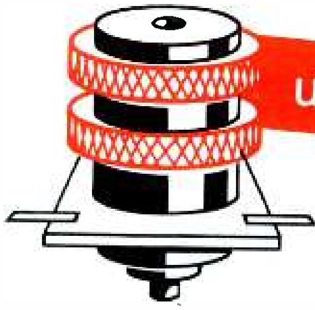
Fig. 7. With reversed AGC diode, the sync is lost, set overloads heavily.



unwinding the mystery of COILS

Facts you need to know about inductance

by Rufus P. Turner

The newcomer to electronics learns early that a magnetic field, consisting of lines of force, surrounds any current-carrying wire (Fig. 1A). He learns also that this field, collectively called *magnetic flux*, becomes stronger when this wire is wound into a coil (Fig. 1B), and that it becomes strongest when an iron core is inserted into the coil (Fig. 1C).

Later, he makes these further observations: (a) When direct current flows through the coil, the field expands out from the coil when the current starts, remains stationary about the coil as long as the current is constant, and collapses back into the coil and disappears when the current stops; and (b) when alternating current flows through the coil, the field alternately expands and collapses, reaching maximum and zero levels in step with the AC cycle.

These apparently simple effects of electromagnetism are basic phenomena in electricity and electronics. They lead directly to the properties of *induction* and *inductance*, which underlie the action of the coil (or inductor), one of the three basic components of electronic circuits.

Properties of Coils

Induction is the ability of a current-carrying coil to induce a voltage in a nearby coil although there is no physical connection between the two. The only requirement is that the coils be coupled; that is, they must be physically located close enough together that the field, surrounding the current-carrying (primary) coil, passes through the turns of the other (secondary) coil. When the field from the primary coil expands, the voltage induced in the secondary has one polarity; as the field collapses, the voltage reverses polarity.

There can be no induction unless the current, and consequently the magnetic flux, is changing. For this reason, induction is commonly associated with alternating or pulsating current. (With smooth DC, induction occurs only the instant current is switched on or off and ceases when current flow is steady.

The action just described is called *mutual induction* because it exists between two coils. Mutual induction is the heart of transformer action. A second variety, *self-induction*, is the property of a single coil. Self-induction occurs in the following manner: When current starts to flow through one turn of a coil because of an applied voltage, the expanding field cuts through the adjacent turns; the cumulative effect induces a voltage across the coil the same as in a separate coil. However, the polarity of this induced voltage is opposite to that of the applied voltage—therefore they tend to oppose each other. For this reason, the induced voltage is called *counter emf*. (electromotive force). Self-induction is the heart of single coil operation.

For a given applied voltage, the strength of the counter emf depends upon physical dimensions and characteristics of the coil, but especially upon the number of turns—the more turns, the greater the counter emf, providing other factors are equal. The electrical property of a coil, which takes into consideration dimensions and wire characteristics, is *inductance L*. (L is measured in henrys, millihenrys, and microhenrys.) The inductance of a straight wire is quite small; of a single-layer coil, much higher; of a multilayer coil, still higher; and of a multilayer coil with iron core, highest of all.

Since the counter emf tends to oppose current flow, a short, specific interval passes—after voltage is applied—before the current flowing through a coil reaches its maximum value. A more technical way of saying this is: The voltage across the coil leads the current by 90°; or, current lags the voltage by 90°. Fig. 2 illustrates these phase (current-vs-voltage) relationships for a perfect coil. As the flux expands about the coil, energy is stored in the magnetic field; as the flux collapses into the coil, energy is returned to the circuit in which the coil is connected. Thus, no energy would be expended in operating an ideal coil. However, the wire in the coil has some resistance, and resistance consumes power. Therefore, a coil can't be perfect and the actual phase angle is something less than 90°.

From the foregoing discussion, it should be clear that because of self-induction, a coil opposes the flow of alternating current and introduces a phase shift. It is this opposition, called *inductive reactance*, (X_L), which makes the coil invaluable in electronics. Inductive reactance is expressed in ohms and varies directly with inductance (L) and frequency (f). The higher the frequency the higher the counter emf. Numerically stated, $X_L = 2\pi f_L$; X_L is in ohms, f in cycles per second, and L in henrys.

Types of Coils

The principal types of RF and IF

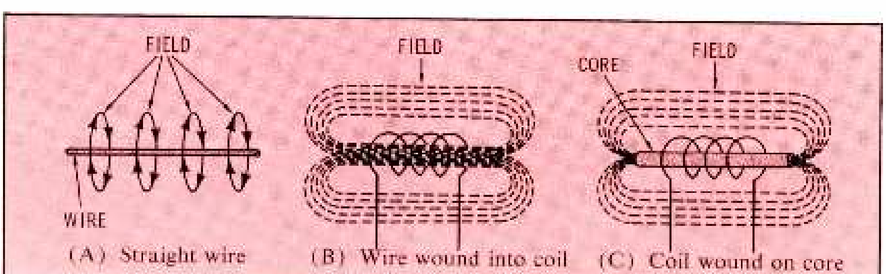


Fig. 1. Strength of magnetic field varies with different types of coils.

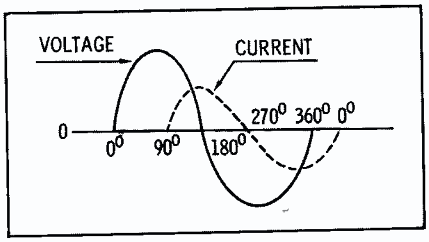


Fig. 2. Voltage leads current by 90°.

coils in present use are shown in Fig. 3. The simplest type (Fig. 3A) consists of a few turns of stiff wire wound into a spiral. Because of its form, this type is called "airwound" or "self-supporting." For mechanical rigidity, it is limited to few turns of reasonably small diameter. Single-layer airwound coils are commonly found in the tuned circuits above 10 mc.

When the number of turns and the ratio of coil diameter to wire diameter are large, the coil must be wound on a supporting core (or form) of insulating material—usually a cylinder, rod, or bobbin. Figs. 3B, 3C, and 3D show these types. In Fig. 3B, turns of insulated wire are wound tightly side by side in a single layer on a cylindrical form. In Fig. 3C, the turns are evenly spaced in a single layer on a cylindrical form. In order to obtain high inductance, many turns are close-wound in several layers on a spool or bobbin as shown in Fig. 3D. Similarly, in Fig. 3E many turns are wound in layers but are crisscrossed in each layer instead of being wound side by side. The anchoring effect of this crisscross (universal) winding holds the coil together, after cementing, without bobbin flanges. A dowel or small-diameter tube may be used for basic support, as shown in Fig. 3E. This type of coil is often supplied without any such form, having been slipped off the original winding core after cementing.

These types (covering an inductance range of .1 microhenry to 750 millihenrys) are found in RF and IF stages as tuned-circuit inductors, RF chokes, antenna coupling inductors, loading coils, interference-filtering inductors, and wavetrap inductors. The inductance may be increased by inserting iron or ferrite core into the coil. This core is arranged so it will move in and out of the coil, by means of screw action, thus allowing the inductance to be varied smoothly. A core of nonferrous metal, such as copper or brass, will reduce inductance. Coils used at audio frequencies require high inductance (1 to 5000 henrys). They need many turns in a number of layers, either on a soft iron core or on one of the special magnetic alloys. Such coils are normally used in power-supply filters, wave filters, audio couplers, dividing networks, audio phase shifters, audio chokes, tone controls, or time-delay circuits.

Coil Quality Factors

Like other components, a coil can be good, mediocre, or bad. Some coils are good in one application and yet unsatisfactory in another. *Storage Factor*—The primary requirement of a coil is that it provide reactance (a function of its inductance at the operating frequency). Although it is undesirable, a coil does display a certain amount of inherent resistance. A useful figure of merit (Q) therefore is the ratio of this desired reactance (X_L) to the undesired resistance (R): $Q = X_L/R$. Since X_L contains a frequency term ($X_L = 2\pi f_L$), a coil may have a high Q at one frequency but not so high at another. Therefore, coils for a given application should be checked for storage factor (Q) at their normal operating frequency. Resistance here means AC resistance (not reactance) and not the simple DC resistance (R_{dc}) which can be measured with an ohmmeter; however, at low audio frequencies, the AC resistance may be equal to R_{dc}. The AC resistance is the total of all *in-phase* resistance components and is due to DC resistance of the wire, skin effect, losses in the insulation of the wire and in the supporting core, and losses in a shield or chassis. Since it is usually impossible to measure this R value directly with any simple instrument, Q is best determined with a Q meter.

Coil Resistance—The DC resistance of a coil, aside from the AC resistance discussed above, must be considered in many applications—especially in audio design where coils are large; audio coils contain several hundred feet of wire and are likely to have significant DC resistance. This resistance should be as low as possible, preferably less than .01% of the reactance, and may be measured approximately (but closely enough for most practical purposes) with an ohmmeter. A more accurate measurement can be made with a DC resistance bridge.

Distributed Capacitance—Adjacent turns of a coil also act like the two plates of a simple capacitor. Thus, a phantom capacitor is present between turns of a simple coil and between adjacent layers of a multilayer coil. Such capacitance effects are termed *distributed capacitance*, and must be as low as possible in a good coil. Since it acts in parallel with the inductance of the coil, it creates a self-resonant frequency, which in many applications will make the coil useless. To minimize distributed capacitance, the turns of a single-layer coil are separated (Fig. 3C), and those of a multilayer coil are crisscrossed (Fig. 3E) to minimize their adjacency.

Skin Effect — At high frequencies current tends to concentrate near

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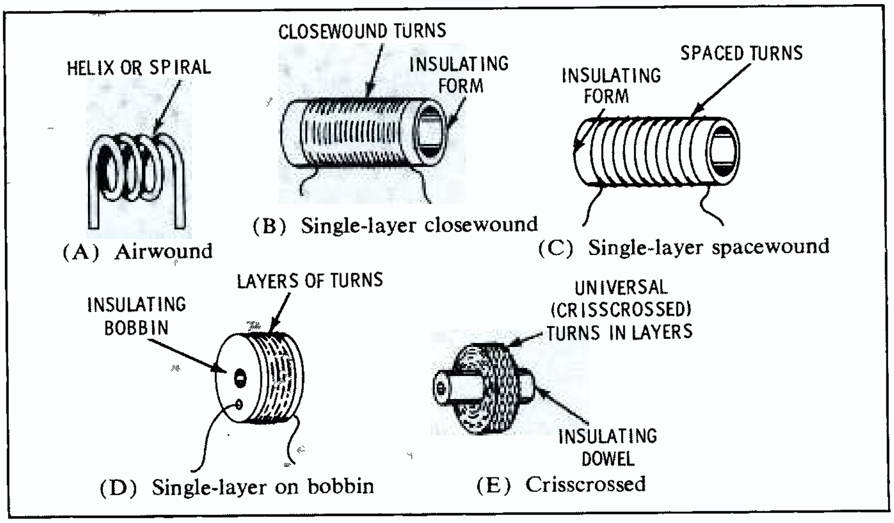


Fig. 3. Depending on application, coils are wound in several configurations.

Advanced Techniques

FOR FUTURE SERVICING

by Forest H. Belt

In the March issue, our annual Test Equipment Special Issue, the article "Learning About Triggered - Sweep Scopes" introduced you to a scope more sophisticated than any you've probably used before. That article, this one, and several to come in future issues are the beginning of a program that will greatly advance your ability as a service technician. Your survival in business may depend on how well your service techniques keep up with the expanding electronics technology.

Your need to learn advanced servicing methods doesn't stem from any lack of home-entertainment equipment. Indeed, there are more types and more sets than ever. Rather—the need arises because of rapid developments in every phase of electronics. Not only are new devices being built and sold to your customers, but the old standby's—radio, TV, hi-fi—are taking on a new appearance inside.

Modular construction has already begun. Printed component units have been around for years, and sealed, encapsulated blocks containing several ordinary components are in regular use. In sets of the future, groups of components "grown" on a single substrate layer will take the place of present - day component packages. Complex little passive networks of all sorts will be combined into small, simple-looking modules with two, three, or four terminals—or even more.

How do you service a set that's full of these little blocks of parts identified only by a number? Deciding what's in the module may be tough, but diagnosing a fault in one is likely to be even worse.

Such unorthodox testing requirements necessitate analytical procedures quite different from the single-component tests you're familiar with. We've found that the one type of testing which is most suitable for analyzing multipart component modules employs *square-wave ringing tests.*

To comprehend the advanced servicing technique of square-wave testing, you need first to know the structure of the square wave itself—its characteristics and peculiarities—and how it is affected by resistance, capacitance, and inductance. You'll need also to understand the wideband triggered scope that will be the instrument of analysis. Finally, you'll want to learn the basic steps toward setting up for quick square-wave analysis.

This article will describe the square wave in detail. Along with some early comments on triggered scopes, there'll be some later information on displaying the square wave to best advantage on the scope. Study carefully this article and the "Triggered - Sweep Scopes" article in the March issue. Both will form the basis for your understanding of several subsequent articles on this new system of component and circuit testing.

A Word on Scopes

Don't let the thought of a triggered-sweep scope scare you. Once you learn all it can do, you'll probably want one for ordinary servicing. The quality and stability of the display you see on a wideband triggered scope may spoil you for an ordinary service-type scope.

Fig. 1 presents a comparison of television horizontal and vertical sync pulses displayed on: Fig. 1A—an ordinary service scope; Fig. 1B—a wideband, high quality service scope; Fig. 1C—a "low"-cost triggered-sweep scope; and Fig. 1D—a lab-type, wideband (DC to 30 mc) triggered-sweep scope. It is easy to see the difference in waveform fidelity; not portrayed in the pictures is the increased stability of the latter two displays.

The cost of a triggered-sweep instrument may leave you a little awed. A lab-type model for servicing use can cost from $500 to $1600. Less expensive types can cost as little as $200 in kit form—actually not as much as higher-priced service-type scopes.

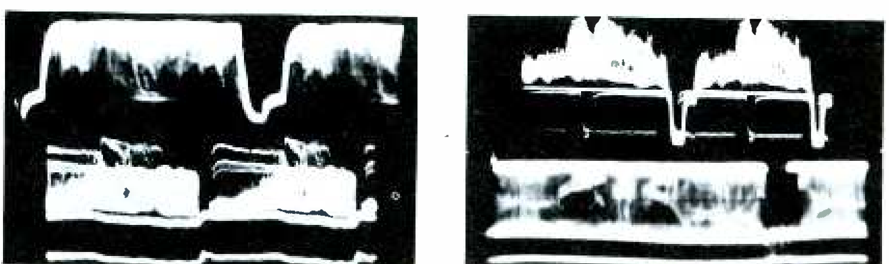
For careful analysis of square waves, in the manner we'll be discussing in subsequent articles, you'll want a triggered scope with bandwidth capability from DC to 30 mc.

Fundamental Precepts

There'll be two forms of troubleshooting you'll use with sets incorporating integrated microcircuits (modules).

Localizing or isolating a fault to a particular stage can be accomplished by conventional signal-tracing or injection procedures. Little will it matter what's in a module; you'll know what its function is and treat it accordingly. You'll expect an amplifier to increase the signal amplitude or power from input to output; an oscillator to produce a waveform of certain shape and frequency; a frequency divider to accept signals of one frequency and produce those of some submultiple; and so on.

Pinpointing trouble within a stage module will be complex, if not impossible; but it's also unnecessary in most cases. If any portion of the microcircuit is faulty, the entire module will have to be replaced anyway. Thus, pinpointing techniques will be helpful primarily in *passive* networks. It will sometimes be necessary to analyze passive microcircuits and other systems rather thoroughly just to discern whether they're working correctly or not. The square-wave analysis techniques you're going to learn will make it easy for you to diagnose faulty component modules in a minimum of time.



(A) Ordinary service type (B) Wideband service type

Fig. 1. Video waveforms taken with scopes of differing bandwidth styles.

As you'll presently see, square-wave analysis isn't limited to the study of passive networks. Anything but! Audio, video, and other amplifying systems can be analyzed very quickly by this method, no matter what the structure or composition of their stages.

Square Waves

In preparation for learning square-wave analysis, you must develop a working knowledge of the square-wave signal itself. Shape is not the only characteristic that stamps the square wave as unique among waveforms.

A square wave is formed of a fundamental sine wave plus an infinite number of its odd-order harmonics. Fig. 2 shows the basic combination of frequencies that form a square wave. Notice that the third harmonic has only one-third the amplitude of the fundamental, that the fifth harmonic bears only one-fifth the amplitude, and so on through all the succeeding odd harmonics. Beyond the ninth harmonic, amplitude is comparatively small; although necessary to the completeness of the waveshape, harmonics beyond the ninth aren't considered especially significant in tests. Thus, the usefulness of a square wave for frequency-response testing extends only to about ten times the fundamental frequency. Even-order harmonics (second, fourth, sixth, etc). are canceled in square-wave formation, netting zero effect on the waveshape.

Because all the peaks and valleys in a perfectly formed square wave are filled, the effective energy in the wave is equivalent to the peak value: this merely verifies that the *rms* value of a square wave is equal to its peak value (a sine wave is only 70.7% effective—its rms value is .707 times its peak amplitude).

Before we examine other characteristics, you should become familiar with some of the terms associated with square waves. The diagram in Fig. 3 will aid you in understanding the significance of various parts of a square wave.

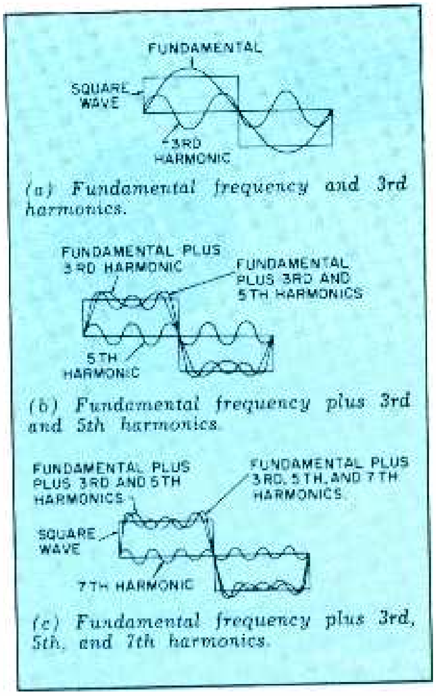
No voltage can rise from zero to its peak value instantaneously; the very short time it takes for the square-wave voltage to reach its peak value is called *rise time*. The shorter the rise time, the more perfect the square wave, and the more vertical the leading edge (rise). In practice, rise time of square waves is stated as the time required for the voltage to rise from 10% to 90% of the measured peak value. Some square waves may rise in milliseconds (msec), good quality ones in microseconds (usec), and high-quality square waves may rise from 10% to 90% in mere nanoseconds (nsec).

The time required for the square-wave voltage to decay—again measured between 90% and 10% — is called the *fall time*. This is the seemingly straight right-hand side (trailing edge) of the waveform.

The flat top portion—called the duration of the square-wave pulse—is a measure of one-half the *period* of the square wave, and is related directly to the fundamental frequency. The period is measured from the start of one rise to the start of the next. The theoretical duration of the flat top is expressed by the relationship $T = \frac{1}{2}f$ where T = time and f = frequency. As we've pointed out, however, rise and fall times consume a tiny portion of the duration of each square wave, so the actual flat top is slightly shorter than the theoretical pulse duration or, stated another way, slightly less than one-half the total period. The rise time is included in considering theoretical duration of the active pulse; fall time is counted as part of the "off" time.

No circuit is perfect, and those in square-wave generators are no exception. As a consequence, there can be certain slight abnormalities in the square wave. Among these are preshoot, overshoot, ringing, rounding, and tilt—all shown (exaggerated) by dashed lines in Fig. 3.

Preshoot is the result of circuit capacitance which receives a small charge the instant the square wave starts, seeming to reduce the "off" level briefly before the rise begins. The



(a) Fundamental frequency and 3rd harmonics.

(b) Fundamental frequency plus 3rd and 5th harmonics.

(c) Fundamental frequency plus 3rd, 5th, and 7th harmonics.

Fig. 2. Square-wave structure, elements.

significant characteristic of preshoot is its amplitude.

Overshoot is the result of normal and stray circuit inductances, which tend to counteract any sudden change —a sort of electronic inertia. Thus, when the rise suddenly ceases, any stray inductance in the circuit tries to keep it rising, and a little pip shoots out beyond the normal flat-top level. As with preshoot, the important factor of overshoot is amplitude.

If inductive effects in the circuit are proportionately significant, the overshoot may not settle back onto the flat-top portion quickly enough; if it doesn't, what results is termed *ringing*. In the matter of significance, the duration of ringing and its natural frequency are more important than its amplitude; until the ringing is damped out, the square wave doesn't have a flat top, and the unwanted, natural ringing frequencies are being added to the otherwise symmetrical odd-harmonic combination that normally forms the square waveform. The shorter (faster) the damping time, the better the square wave.

A slightly different form of flat-top distortion is called *anticipatory ringing*. Whereas ringing is an undamped oscillation triggered by overshoot, anticipatory ringing is the result of a parasitic oscillation which occurs if the flat top is sustained over a period too long for the circuit parameters. Overpeaking at a naturally resonant frequency can cause a stage to generate this form of square-wave distortion.

Rounding is an effect caused by too

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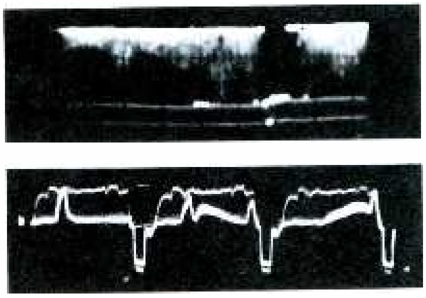
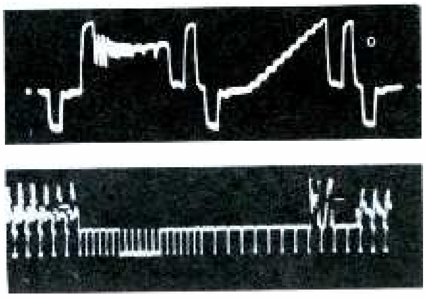


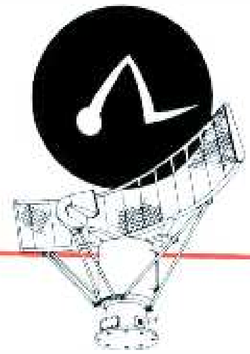
(D) Wideband triggered type



(C) Ordinary triggered type

The waveforms appear progressively better as the scope's quality is improved.

Servicing Industrial Electronics
by
Forest H. Belt



Radar Maintenance is EASY

In the February issue, we discussed *who* needs radar service, *what* radars need service, *when* they must be serviced, *where* service must be performed, and *why* there is a need for competent technicians. You were shown the test equipment and inventory needed to offer this service. In this part, we shall look over typical radar systems and discuss *how* they operate.

Most radar systems in marine use today are basically alike. There are variations in older sets, but we shall expend our efforts toward learning generally how radar systems operate and how to service them.

The System

The block diagram shown in Fig. 1 represents the layout of most modern marine radar systems. The sequence of events taking place in a radar system begins in the timer oscillator, sometimes called the Pulse Repetition Frequency oscillator. The output of the PRF oscillator is amplified and shaped into a triggering pulse, then fed to the modulator tube.

The modulator is our first encounter with a special-purpose type tube. This tube must handle extremely large amounts of power that begin suddenly, last for the duration of the transmitter pulse, and just as abruptly end; therefore, a thyratron is well-suited to the application. Exactly what tube is used varies, depending on the power of the radar transmitter, but common types are: 4C35, KU-99 (3C45), and 4PR60.

The modulator thyratron is fired by the brief trigger pulse, and its output is developed across a delay line, or pulse line. The length of the pulse is determined by the design of the pulse line, which controls the point at which the thyratron is extinguished. The high-amplitude, carefully timed pulse is applied to the *magnetron,* exciting it into oscillation.

The magnetron is capable of high-power oscillation at the microwave frequencies used in marine radars. It is especially able to start and stop oscillations quickly with timed pulses of the type furnished by the modulator. Magnetrons used in marine radar systems are: 2J42, 2J55, and 725A, all for the frequency range around 9375 mc. In some lake- and ocean-going radars, the 2J70 magnetron is used; its frequency is near 3070 mc. Radar systems operating at a frequency of 9375 mc are called 3-centimeter or X-band radars; those at 3070 mc are 10-centimeter or S-band radars.

The pulses of high-power high-frequency RF are transferred from the magnetron via a length of waveguide to the radar antenna. The antenna in marine radar systems is called a *scanner,* due to the fact that it rotates continuously, scanning the surface surrounding the ship. The scanner consists essentially of a horn for terminating the waveguide; a section of a parabola which is used as a highly directional reflector, concentrating RF energy from the horn into a narrow beam; a motor for rotating the assembly; and a synchro generator for transmitting directional information to the display unit, or indicator.

During the time (between pulses) when the radar transmitter is not operating, the *duplexer* permits energy to proceed to the receiver. During pulse time, however, the duplexer keeps the receiver input shorted out, so high-power pulses of transmitter RF will not harm the delicate receiver-input crystals. Tubes used as switches in duplexers are

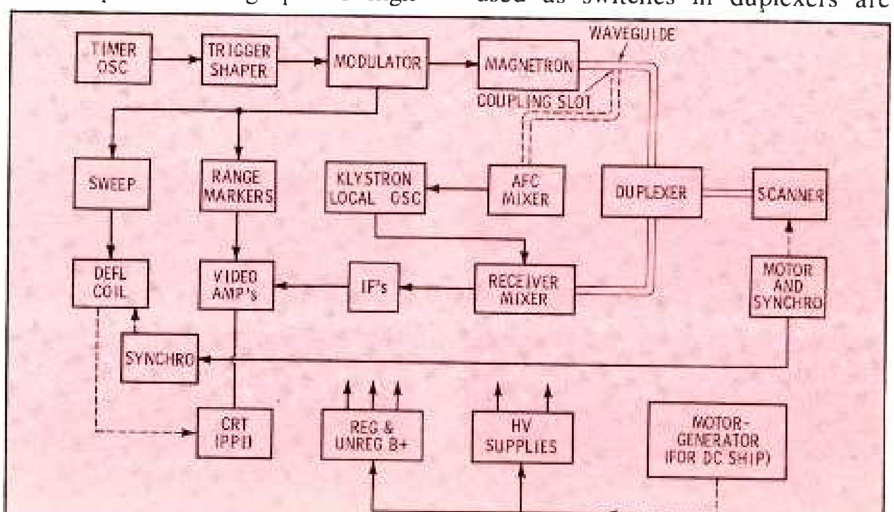


Fig. 1. Rather comprehensive radar system such as used on ships and large yachts.

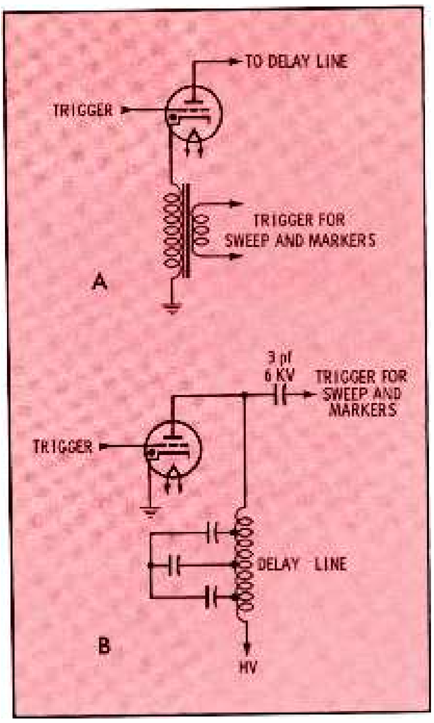


Fig. 2. Taking trigger from modulator.

the 1B24A in X-band equipment, and the 721B (BL696) in S-band sets. These tubes are called TR (transmit-receive) tubes or switches. Duplexers of X-band radars sometimes use a second tube for increasing waveguide efficiency during the time the pulse is off, while the receiver is operating. A 1B35 is used for this purpose, and is called an ATR (anti-TR) tube.

The energy which is picked up by the highly directional antenna and fed to the receiver is echo information caused by reflection of the pulsed RF energy from whatever targets exist in the direction of the beam. This minute energy is picked up by the antenna, carried down the waveguide and mixed in a signal-crystal (usually a 1N23-type) mixer with a local oscillator (LO) signal. The local oscillator is a klystron tuned to a frequency that differs from the magnetron frequency by exactly the IF of the radar system. The 2K25 (723A) is a typical LO in X-band sets, and the RK6043 is common in S-band receivers.

Following the mixer, a system of IF amplifiers amplifies the slight bits of echo or target energy. The IF amplifiers are usually fixed-tuned, wideband amplifiers designed to pass the full range (sometimes up to 10 mc) of video (target) information carried on the IF frequency.

Tubes used for IF amplifiers are usually high-gain, low-noise types similar to those used in television. A cascode preamplifier is commonly found; this may be a 6AK5-6J6 combination or the popular 6BQ7 cascode stage. For IF amplification, 6AK5's and 6CB6's were customary, but modern high-gain types are becoming common.

A 6AL5 video detector is followed by a wideband video amplifier section, sometimes using 6AU6-6AG7 combinations, sometimes 6AU5's. The most important considerations in this section are bandwidth and gain, and modern tube types make circuitry simpler.

The amplified video still represents the echo or target information reflected back into the radar from some target. This video information is applied to the grid of a cathode-ray tube in a manner to cause the beam to be intensified for the duration of the target information.

The CRT used in marine radar systems is round, and is similar to those used in television, except the phosphor (P4 or P7) is different; the persistence is much longer. Some radar sets use scanner speeds as slow as 11 rpm. This means any video (target) information must remain on the screen at least 5½ seconds while the scanner makes another revolution and the beam is brightened again. In actual use, the persistence is even longer than this, causing a rather full "map" of the surrounding area to be painted on the face of the CRT.

But, before this picture can be painted, the beam must be swept across the face of the CRT; so far, echo reception caused only an increase in CRT beam current, which of course brightens the phosphor where the beam is striking.

The sweep that moves the beam must start just after each pulse from the transmitter, so a place to obtain sweep-timing (trigger) voltage is at the modulator. A small sample of the modulator pulse is taken from the modulator stage and sent to the display unit for timing the sweep circuits. Fig. 2 shows in simplified form the two general methods of obtaining this trigger from the modulator.

The sweep generator is a triggered oscillator—usually a one-shot multivibrator, often a blocking oscillator—activated by trigger from the modulator. The output from the oscillator is amplified, shaped, and applied to a deflection coil which is concentric with the neck of the CRT, similar to the yoke mounting in a TV set.

The CRT is designed so that, when the focus and positioning devices are properly adjusted, the beam rests at the center of the CRT face. The radar deflection coil is made to sweep the beam in a straight line from center to outside edge. All that remains in order to paint the video or target picture, is to get this straight line rotating around the tube center, like the spoke of a wagon wheel around its hub.

Remember the synchro in the scanner? It is a 3-phase synchro transmitter that turns as the scanner turns, and its output feeds a

• *Please turn to page 76*

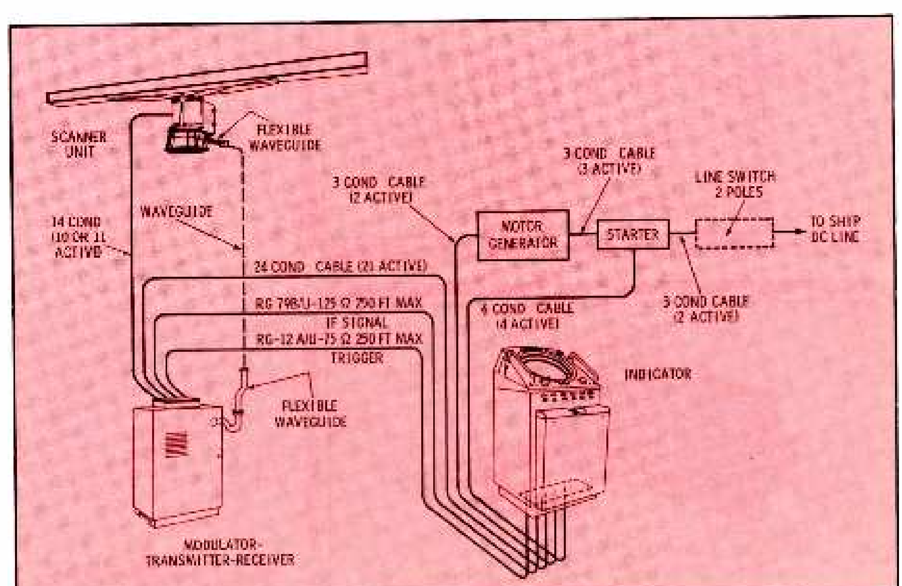


Fig. 3. Intercabling diagram showing how various radar sections are housed.

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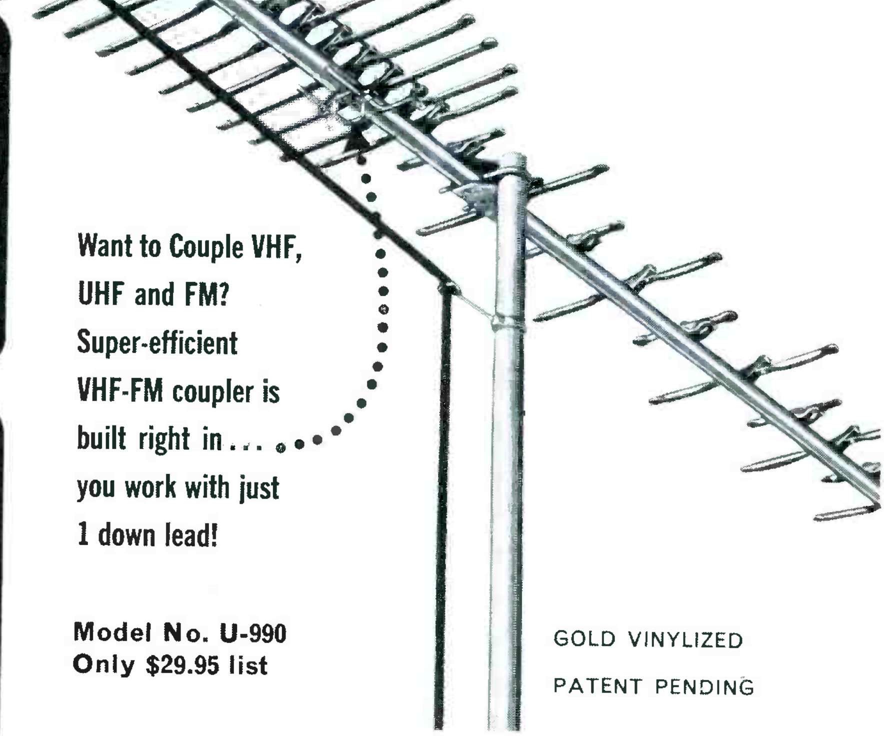

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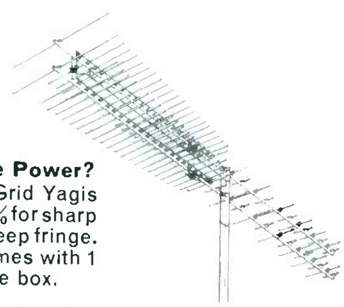

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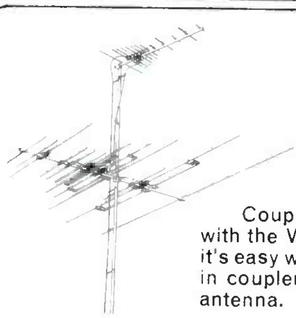

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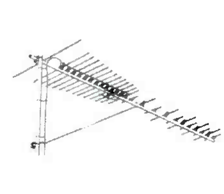

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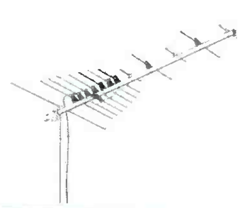

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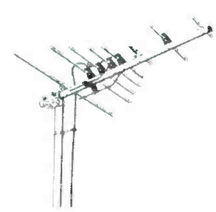

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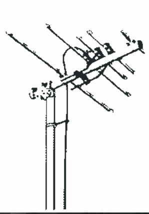

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THE 4-BAY BOW-TIE — and Collinear antennas lack bandwidth. They require at least two separate antennas tuned to opposite ends of the band to give good gain across the entire UHF band. Increasing the gain by stacking of a 4-Bay Bow-Tie is equally impractical because it further reduces bandwidth which is already inadequate. With Winegard's new Planar-Grid Yagis, you get the *highest gain* UHF antenna on the market *PLUS* complete bandwidth.

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PARABOLIC ANTENNAS, by increasing size, can theoretically increase gain, but a parabolic type comparable to the U-990 Planar-Grid Yagi would require an antenna of at least 10 ft. in dia. Parabolics are inefficient and impractical because of size, cost, high wind resistance.

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LOG PERIODIC AND "V" TYPE ANTENNAS, regardless of large size and total number of connected elements, have no more than two or three of their elements working on any one channel. This puts a low ceiling on the available gain for these types of antennas although they do have adequate bandwidth. Another disadvantage is the multiple lobe patterns, especially those antennas employing "V'd" elements working on the third and fifth harmonic mode. This type antenna is unable to reject interfering signals from the side because of these side lobes and can easily degrade picture quality—especially in color.

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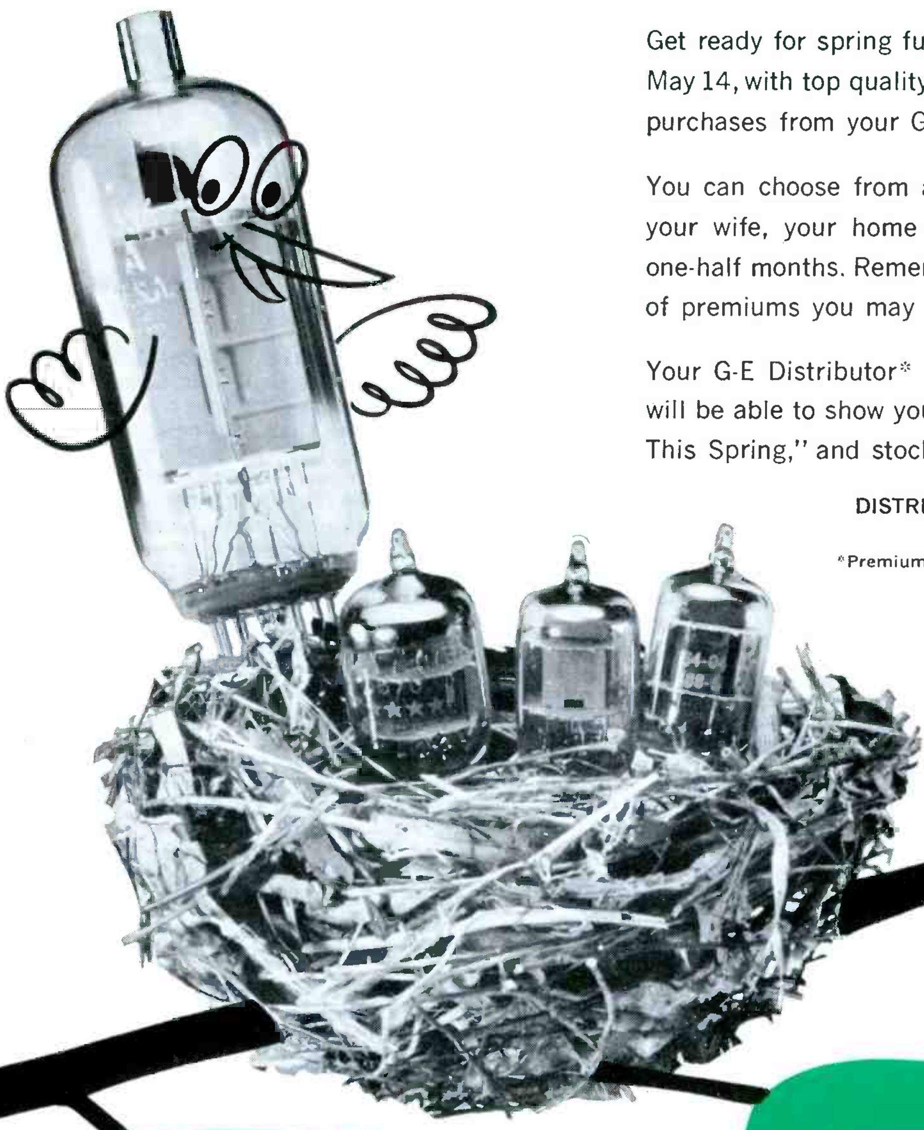

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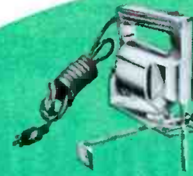

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Repairing Amplified Antennas

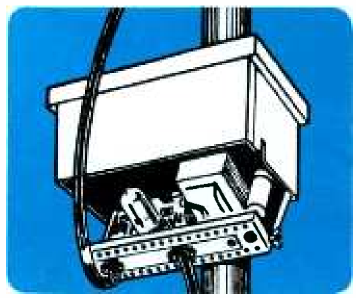
by Lon Cantor

Antenna preamplifiers first came into popular use three or four years ago. Since then, they have proven a boon to the fringe-area viewer and promise to become an additional source of income to the service technician who has not previously included them in his servicing activities.

Because most antenna preamplifiers use transistors, they are quite reliable; for this reason, and because they are relatively inexpensive, few technicians attempt to repair them. Yet, preamplifiers—or *boosters* as they are commonly called—do cost more than most transistor radios. Further, they are considerably less complex and far easier to repair. Whereas a radio consists of at least five different stages, a booster has only one or more RF-amplifier stages, with passive circuits for matching impedances and filtering.

Simplest of the boosters are the single-stage indoor preamps, which have power supply and amplifier in a single unit. The indoor preamplifier provides little improvement in signal-to-noise ratio. It is used either to distribute a signal among several TV sets or to improve pictures on an older set that has poor sensitivity or poor gain.

Fig. 1, the block diagram of one of the most complex preamplifiers on the market, proves they aren't really complicated at all. The preamplifier shown consists of two units: a two-transistor mast-mounted preamplifier; and, a three-transistor combination power supply and post amplifier.



While their appearances may differ considerably, all transistor boosters are essentially alike when it comes to servicing. Perhaps the biggest difference is in physical layout. Some units have components so crowded together that troubleshooting and repair are difficult—the unit shown in Fig. 2 is by no means the worst example of crowding you'll encounter. Fig. 3 shows a comparable unit, constructed on a printed board for easy accessibility.

Because antenna preamps work at very-high RF frequencies, lead length and parts placement are critical. Change the length of a resistor lead, and you've added inductance; route it too close to the chassis, and you've added capacitance. At these frequencies, it's very easy to cause oscillation or to alter frequency response simply by moving a lead.

Antenna Amplifier Circuits

Let's dig into a typical antenna preamplifier and discuss servicing techniques that will apply to any on the market. (Fig. 4 is the schematic of a popular two-transistor amplifier unit.) Since strong input signals will often cause cross modulation (Fig. 5), especially if a single transistor is used for all channels, single-transistor units generally are used only in fringe areas — those with no strong local channel. Two-transistor boosters supply little-or-no-more gain than single-transistor units, but can handle much stronger input signals without overloading. So, in preamps similar to that shown in Fig. 4, transistor X2 amplifies the low VHF band (channels 2 through 6), while X1 handles the high VHF band (channels 7 through 13).

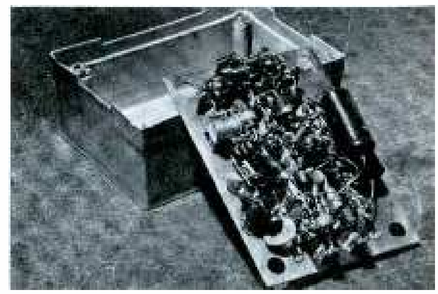


Fig. 2. Some units are crowded inside.

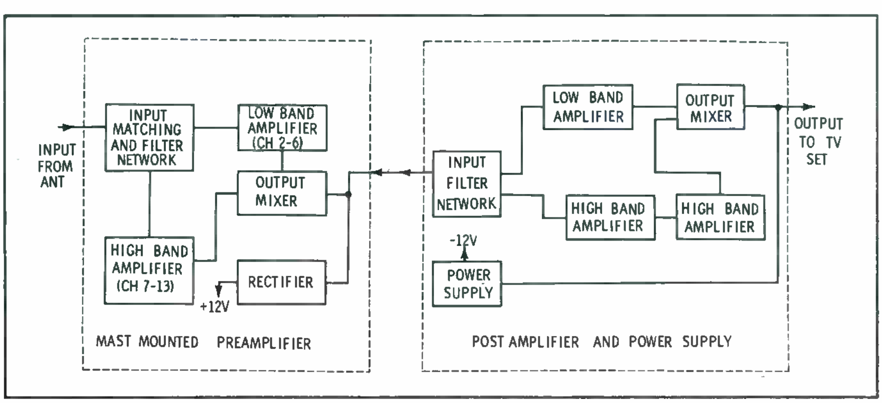


Fig. 1. Block diagram of a typical antenna preamp and associated power supply.

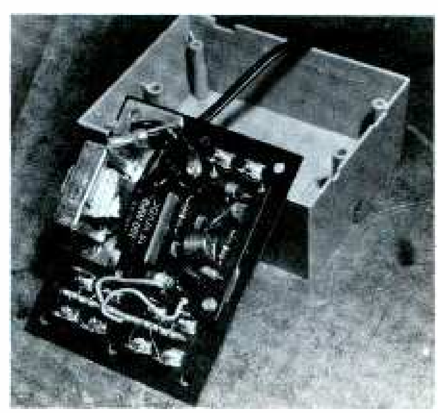


Fig. 3. Others are more neatly laid out.

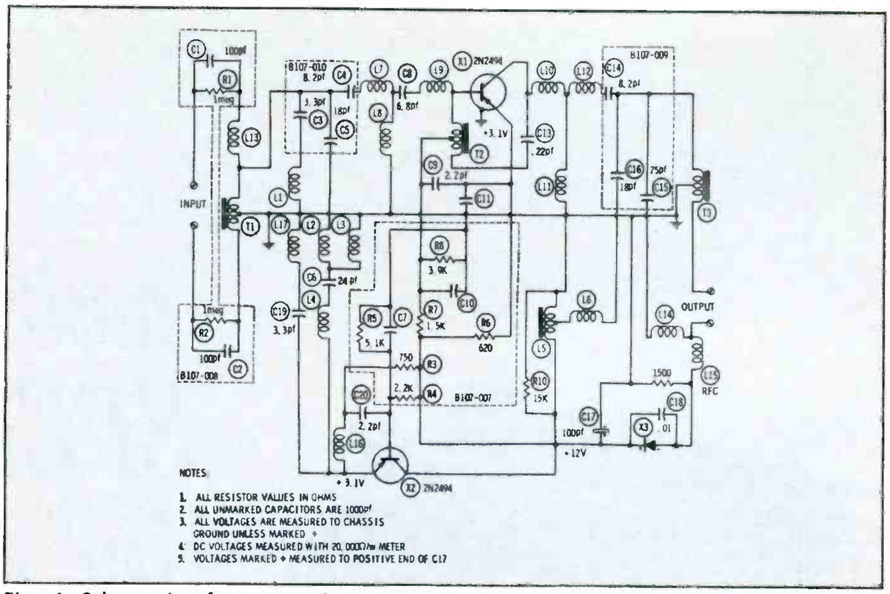


Fig. 4. Schematic of two-transistor antenna preamp found in rather common sets.

Except in rare instances, symptoms in a defective antenna preamplifier are limited to the following: (1) snowy pictures on all channels, (2) snowy pictures on certain channels, (3) poor contrast on all or some channels, (4) poor color response, (5) cross modulation (Fig. 5), and (6) top or bottom half of picture goes blank.

Preliminary Checks

Be sure trouble is actually caused by the booster. Obviously, it's a waste of time to troubleshoot a unit that is operating normally. First, check the lead-in wire—old twinlead can cause all kinds of trouble. A quick continuity check across the two wires with your ohmmeter will reveal any breaks in the line; the reading in a unit such as that shown in Fig. 4 would be approximately 1500 ohms. Remember, however, that frayed twinlead can cause considerable signal loss, especially in wet weather. Also, if the twinlead lies too close to metal or is encircled by metal standoffs, it can develop standing waves, which results in ghosts (often very faint). In color sets, the effects of standing waves are often more obvious—yellows may get greenish, and reds turn toward orange. If you have any reason to suspect the twinlead, it's a good idea to replace it.

Don't overlook the fact that the antenna or the TV tuner can also cause picture defects that may sug-

Fig. 5. Overload with single transistor.

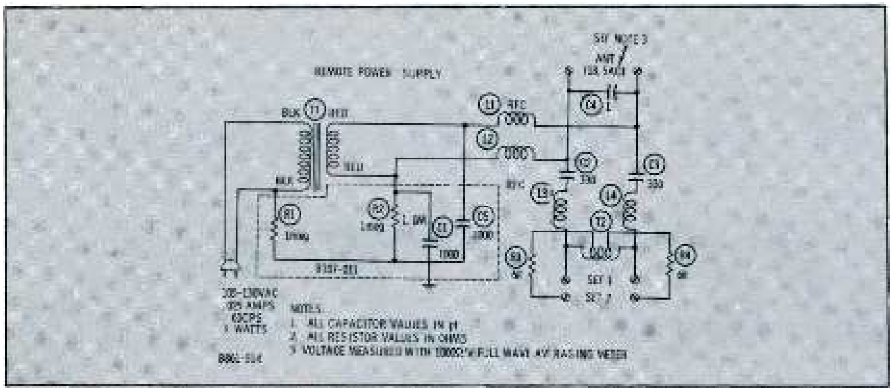


Fig. 6. Schematic of the power supply for the preamplifier shown in Fig. 4.

gest trouble in the booster. A visual inspection will usually indicate the condition of the antenna. Make sure all elements are solidly in place and all contacts — including twinlead connections — are secure.

The best way to determine whether trouble lies in the TV set or the preamplifier is to substitute another set, temporarily. If this is not possible, connect the antenna directly to the set, bypassing the preamplifier and note any change. If, for example you have "windshield wiper effect" with the booster and none without it, the booster is obviously at fault. In this case, you must trap out the local signal that causes the overload or use a booster designed to handle stronger input signals.

Let's suppose, however, that the complaint is of weak or snowy pictures. If bypassing the booster caused little difference, or if there is an improvement in picture quality, the booster is indicated as a source of trouble.

In the Preamp

Suppose we're sure the trouble is caused by the booster. How do we track it down? The power supply is a good place to start. Mast-mounted units use remote power supplies (Fig. 6). Power is sent up to the preamplifier on the same twinlead that carries the signal down.

On the bench, remove both the power supply and the preamplifier from their cases. Then, connect a short piece of twinlead between the two units, to supply power to the preamp. Now, measure the voltage at the power-supply terminals marked "ANT." This should be about 18.5 volts AC. Actually, this voltage reading may vary a bit, depending on the type of meter you use and the polarity of the probes. If you don't measure any voltage output, check the line cord and the transformer. There's very little else to go wrong with a remote power supply of this type.

The 18.5 volts AC is fed into the preamplifier (Fig. 4, again) through the terminals marked "output." It is then rectified by X3 and filtered. As in any rectifier circuit, filters can cause trouble. If the trouble symptom is a blank half-screen—top or bottom—the filter capacitor is probably the culprit, for hum is modu-

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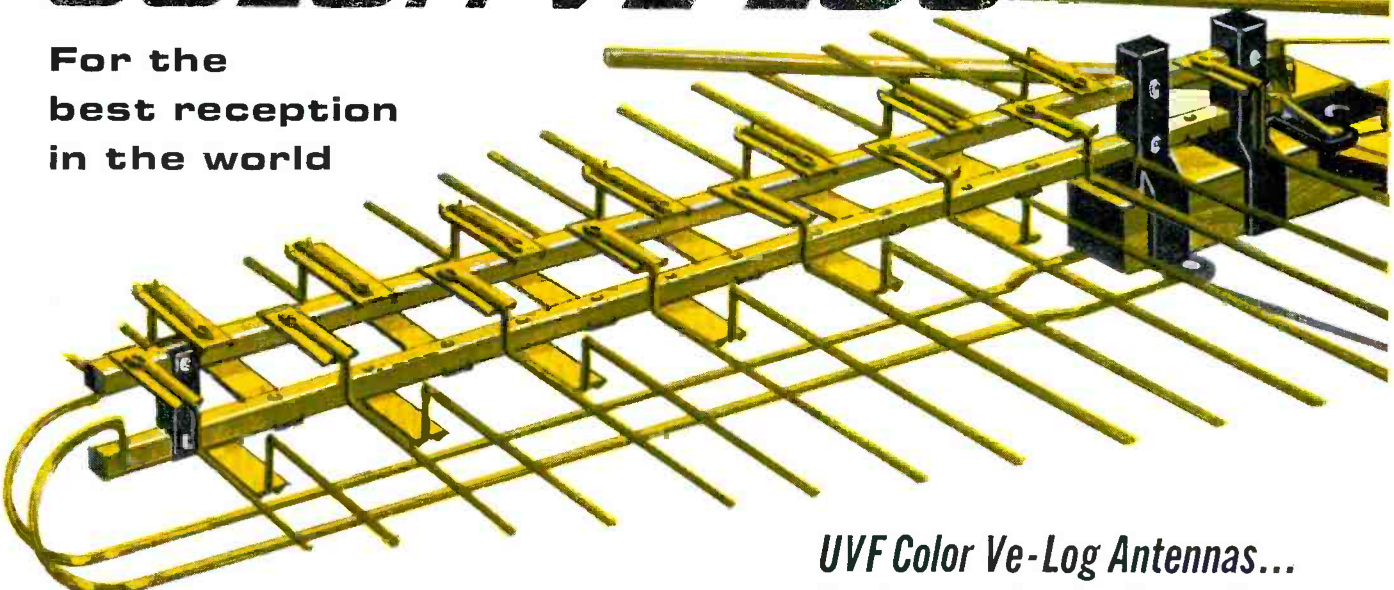

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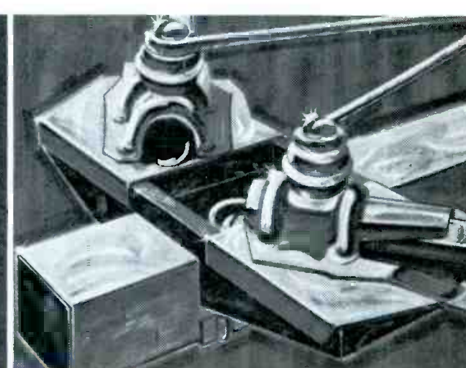

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Notes on Test Equipment

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

by Allen B. Smith

Sweep Waveforms and Marker Pips

Back in the good old days of yore when radio was king, things were certainly easier for the service technician. But things just don't stand still, and the "good old days" weren't really so hot by today's standards. Equipment performance improves, circuits become more complex, and new entertainment devices (TV and FM) increase the numbers of our potentially happy customers. The problem is that some technicians prefer to keep on thumping and rattling rather than progress with the industry. One instrument which illustrates the point perhaps as well as any other is the sweep generator/marker adder used for alignment of the RF and IF sections, and filters and other tuned circuits, in TV and FM receivers.

Fig. 1. Sweep generator has 4.5-mc xtal markers and variable markers.

Typical of these units is the EICO Model 369 TV-FM Sweep and Marker Generator shown in Fig. 1. The Model 369 provides an RF-output signal variable from 3 mc to 220 mc (center frequency) with a sweep width which is variable as much as 20 mc at the higher end of its coverage. A sweep width of at least 10 mc is available at the frequencies required for all TV-channel and

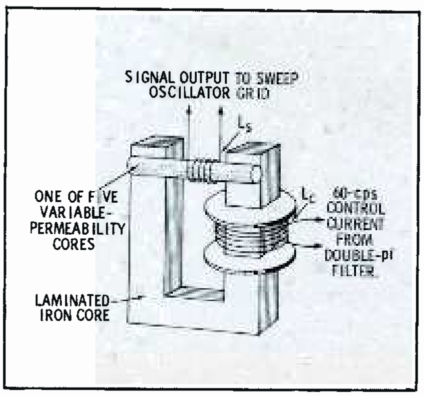

Fig. 2. Controllable inductor generates a variable-frequency signal.

IF-stage alignment. Additionally, marker pips are available from two sources: a variable-frequency generator covering 2 mc to 225 mc, and a fixed-frequency, crystal-controlled auxiliary marker generator at 4.5 mc to speed alignment of intercarrier sound IF's and discriminator adjustments.

The sweep oscillator is of a controllable-inductor type, using a specially constructed multiple-winding transformer. The transformer has cores of both laminated iron and pressed powdered iron. Fig. 2 shows a simplified representation of the special transformer. The 60-cps control winding Lc (only one half is shown; each leg of the laminated "U" core holds one-half of the total winding) receives current from the SWEEP WIDTH control which is fed via a double-pi filter from the line source. The induced current controls the magnetic flux density of the "U" core, thus reducing and increasing (at a 60 cps rate) the permeability of the powdered-iron core of signal coil Ls which is bonded to the legs of the "U" core across its open end. When the

EICO Model 369 Specifications

RF Sweep-Frequency Ranges:

Band A	75 to 220 mc
Band B	36 to 95 mc
Band C	16 to 42 mc
Band D	6 to 16 mc
Band E	3 to 7.5 mc

RF Output Level:

Band A	.1 volt ±1 db
Band B	.2 volt ±½ db
Band C	.3 volt ±½ db
Band D	.3 volt ±½ db
Band E	.3 volt ±½ db

RF Output Impedance:
50 ohms nominal

Sweep Width:
Variable as much as 20 mc, depending on range.

Marker-Frequency Ranges (variable):

Band A	2 to 6 mc
Band B	6 to 20 mc
Band C	20 to 75 mc
Band D	60 to 225 mc

Fixed Marker Frequency:
4.5 mc—crystal included with generator. Other crystals may be used for other frequencies.

Marker Injection:
Markers are added to sweep signal which has been demodulated by receiver under test and returned to the Model 369 via separate cable.

Size (HWD):
8½" x 12½" x 7"

Weight:
16 lbs

Power Requirement:
105 to 125 volts AC, 60 cps, 50 watts.

Price:
$89.95 kit, $139.95 wired.

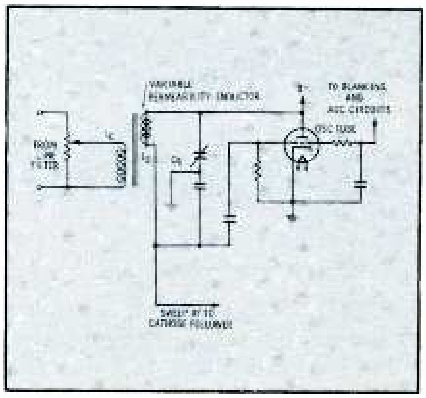

Fig. 3. Static values of L_s and C_g determine the sweep center frequency.

core's permeability drops, so does the effective inductance of the signal coil (Ls) wound around it. Since the total inductance of the signal coil determines the center frequency of the sweep signal in conjunction with Cg (see Fig. 3), the frequency of the sweep-oscillator tube (V2B) varies at the control-signal rate (60 cps). Magnitude of the frequency excursion depends upon the inductance change of Ls, which in turn is controlled by the amplitude of the control signal. The partial schematic shown is a simplified circuit used for clarity in illustrating the operation of the frequency-determining function of the oscillator section. Oscillator operation is actually controlled in part by the AGC and blanking circuits to avoid appearance of a retrace during the negative excursion of the 60-cps sine sweep. Overall operation of the Model 369 can be determined from the block diagram shown in Fig. 4.

In use, this instrument proved to be stable and accurate and demonstrated several useful control functions. Front-panel controls are provided for adjusting all signal characteristics for a quick and simple analysis of the sweep waveform. The use of the post-injection marker system assures a stable marker presentation, and the AGC circuits provide a satisfactorily constant output level across the entire frequency range of the instrument. Action of the attenuator in the Model 369 in our lab was faulty, with little change in level noticed when switching from X100 to X10 and from X10 to X1. A call to the factorv assured us that normal operation shows a well-controlled step-down progression. A definite

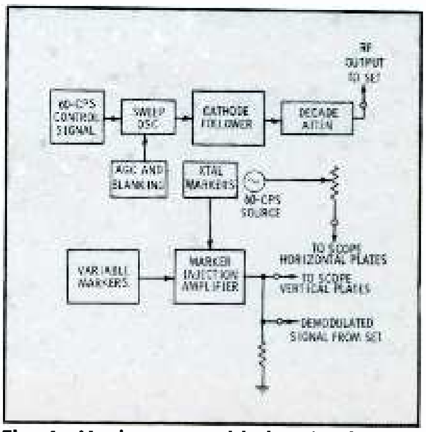

Fig. 4. Markers are added to the demodulated sweep waveform from receiver.

plus factor is the inclusion of the crystal-controlled marker circuit which speeds sound IF and discriminator alignments and adjustments.

Total Tube Analysis

As suggested in the article on tube and CRT checkers in PF REPORTER March 1965, technicians are increasingly dependent on accurate and rapid evaluation of tubes and other active-signal devices. Last month in "Notes on Test Equipment" we covered an analyzer which, though expensive, leaves very few questions unanswered where semiconductor devices are concerned. This month we have evaluated a similarly versatile tube tester/analyzer, the Hickok Model 580 shown in Fig. 5.

As in the case of the transistor analyzer, the Model 580 is expensive. Actual test-equipment cost, however, often becomes a less important factor than how well the instrument performs its evaluation, and how quickly.

One of the most difficult problems in evaluating a complex instrument is to become familiar enough with it to know what it can and cannot do. Surprisingly enough, the operation manual doesn't always prove adequate. The instructions and circuit descriptions in the manual for the Model 580, however, are excellent. A couple of hours spent with it should give anyone an understanding, not only of the instrument's operational capabilities, but also of its circuit functions.

Operation of the Model 580 follows one of two methods, either of which will insure a complete evaluation of the tube being tested. The more familiar method, using the roll-chart information supplied, will undoubtedly be used more often. For tubes not listed on the roll chart, however, the tube-data handbook method, using information found in standard tube manuals, may be used.

Roll-chart operation is straightforward and requires only a brief review of the procedure described in the manual. Control knobs, corresponding to the index references on the bezel of the roll chart, are set to the figure indicated on the chart. A NOTES heading gives information for plate- or grip-cap connections. Before evaluating any dynamic tube condition, two preliminary tests are made: the line voltage is adjusted using the LINE TEST pushbutton switch and LINE ADJUST control; and, the filament is checked for continuity with the FILAMENT VOLTS switch in its OFF position. All other controls are then set as indicated on the roll chart, and the series of dynamic tests is completed. Tests for leakage, Gm, gas, reserve life, rectifier efficiency, and others for special tube types are described in detail in the operating instructions.

Using the second testing method, data is taken from tube manufacturers' specification sheets or data handbooks and correlated into control-switch positions, using the instruction manual for reference. Charts which give the exact voltages available at each switch position are used to determine individual control settings. Several examples, using familiar tube types, illustrate this method in detail. Understandably, this method is more complicated and takes more time, but it provides an excellent means for testing new and unusual tubes (don't forget obsolete types which have been removed from roll charts, too). Using one method or the other, very few tube types will present a problem.

Power rectifiers, using the tube-data method, require a rather involved procedure, but, once again, the indispensable manual comes to the rescue with an emission nomograph, complete with instructions for use. This chart makes possible an evaluation only slightly less accurate than that obtained using roll-chart information.

Construction of the Model 580 is very sturdy, with heavy-duty components providing a good reserve capability. Fig. 6 shows the underchassis arrangement, with the three power transformers dominating. One transformer provides only filament voltages, and separate units are used for the plate supply and for the combination screen, bias, and grid-signal supplies.

Circuitry is basically straightforward. The gas-test circuit is interesting, however, and uses a full-wave bridge (Fig. 7) to establish a reference point which is set using the GAS ZERO ADJ control. A transistor in one leg of the bridge is used as a variable resistance to unbalance the bridge when the tube under test draws grid current.

A very handy dual-tube test circuit is shown in Fig. 8. The use of the DUAL TEST switch eliminates the necessity for changing several control-switch positions when checking dual-section tubes.

In our lab, the Model 580 was used to check a variety of tubes, using both test methods; some were known-to-be-good types and some known-to-be-bad types. In all cases, the Model 580 confirmed the known evaluation. The Model 580 appears to be a competent though expensive, answer to the problem of evaluating thoroughly the wide variety of tubes used

Hickok Model 580 Specifications

Tube-Socket Complement:
9-pin novar, 12-pin compactron, 9- and 10-pin miniature, 7-pin miniature, 8-pin loctal, 5- and 7-pin nuvistor, 8-pin octal, 8-pin round subminiature, 7-pin in-line and subminiature, 5- and 7-pin acorn, 7-pin combination, 4-, 5-, and 6-pin combination.

Tests Performed
Interelement leakage, shorts, gas, mutual conductance (Gm), life test, DIODE CHECKS 1 (signal types), DIODE CHECKS 2 (power-rectifier types), and VR (voltage-regulator) tubes.

Mutual-Conductance (Gm) Ranges:
0-3000, 0-10,000, 0-30,000, and 0-60,000 micromhos—plus two diode ranges and one voltage-regulator range.

Test Voltages:
Filament—0-117 volts AC in 19 steps; Signal (60 cps)—.28 volt rms; Plate—6.3-300 volts DC in 12 steps; Screen—same as for plate, available separately; Fixed Bias—0-50 volts DC, continuously variable in two ranges; Self Bias—by means of jack-mounted resistor.

Interelectrode Leakage Test:
Direct-reading on meter—sensitivity to 50 megohms.

Grid-Current (Gas) Test:
Reads grid current as low as .05 μa.

Size (HWD):
7" x 19" x 15½"

Weight:
30 lbs

Power Requirement:
105-125 volts AC, 50-60 cps, 60 watts.

Price:
$585.

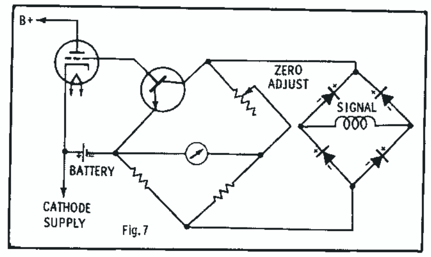

Fig. 7. Transistor is utilized as a variable resistor to indicate gas.

Fig. 5. This tester checks tubes using roll-chart or tube-handbook data.

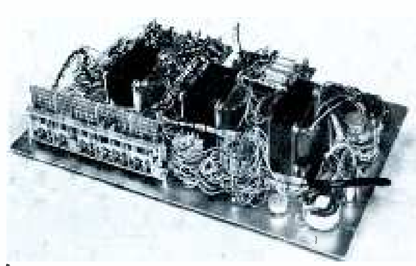

Fig. 6. Under-chassis view shows rugged construction and transformers.

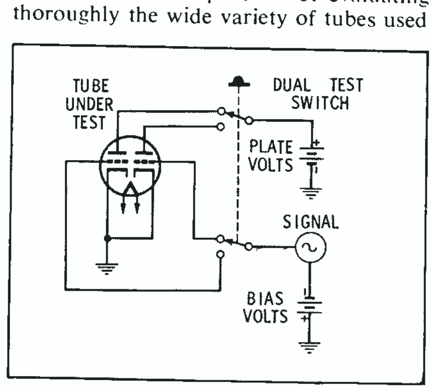

Fig. 8. Dual-Test circuit makes testing dual-section tubes simple.

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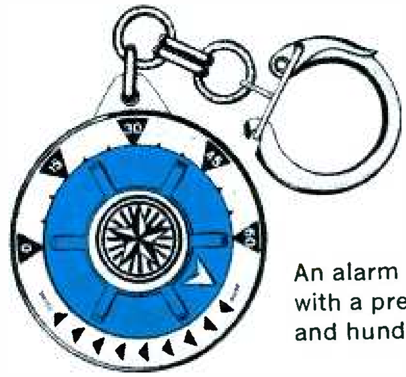

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.001	MFD	±10%	1KV	DD-102	20 pcs
.002	MFD	±10%	1KV	DD-202	10 pcs
.005	MFD	GMV	1KV	DD-502	10 pcs
.010	MFD	GMV	1KV	DD-103	20 pcs
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Visual Vectors and Color Bars

The single most difficult concept in understanding the operation of a color receiver is probably that of the phase relationships in the color-demodulator and matrix circuits. The difficulty stems from the perplexingly abstract nature of phase relationships—it is hard to demonstrate what actually occurs in each stage of the demodulator and matrix circuits at any specific instant. The instrument shown in Fig. 9, the Lectrotech Model V-7 Color Generator and Vectorscope, may assist many technicians to a better understanding of color-phase relationships and thus speed their troubleshooting procedures.

This interesting test set is a combined crystal-controlled, multiple-pattern color-bar generator and simple oscilloscope, used to give a visual display of vector phase relationships in conjunction with the keyed-rainbow pattern supplied by the generator. The usual complement of patterns for convergence and linearity checks and chroma alignment are available, and there are, in addition, several features not found in many other color generators. These include panel-mounted gun-killer switches, an adjustment to control the thickness of the horizontal lines, adjustable brightness of the vertical lines, a video-polarity switch, and provision for calibrating the various timing circuits using the vectorscope to provide waveforms. Recessed, slotted-shaft controls along the left side of the instrument provide for the adjustment of each divider multivibrator.

Basic circuit function, outlined in the block diagram shown in Fig. 10, is very similar to most keyed-rainbow generators seen previously in these pages. A 189-kc crystal oscillator provides the basic signal (chosen because of its harmonic-frequency relationship to the standard 15,750-cps horizontal-sweep and 60-cps vertical-sweep rates of television receivers). This stable frequency is divided through two separate paths to provide horizontal- and vertical-synchronizing pulses.

In the horizontal path, the 189-kc signal is divided 12 times by a pulse-counting multivibrator to attain a 15,750-cps signal. This signal passes through the

Fig. 9. Simple scope provides a way to view the vector relationships.

sync mixer to the modulator. The resulting signal is used to synchronize the set under test to the generator's time base.

The vertical-sync path is less direct but really no more complex; the 189-kc signal is simply divided in three separate

Lectrotech Model V-7 Color Generator Specifications

RF Output Frequency:
Factory aligned to channel 4. Can be set to either channel 3 or channel 5 by returning the RF oscillator.

RF Output Level:
Approximately 100,000 μv (.1 volt).

Video Output Level:
Approximately 2 volts peak-to-peak.

Special Features:
CRT for visual presentation of vector relationships, panel-mounted gun-killer switches; horizontal-lines thickness adjustment; vertical-lines brightness adjustment; calibrate switch for divider adjustments using CRT patterns.

Patterns Available:
Crosshatch; dots; vertical lines; horizontal lines; keyed-rainbow color bars; vector relationships of color bars presented visually on internal CRT.

Size (HWD):
7½" x 8¼" x 12⅞"

Weight:
13 lbs

Power Requirement:
105-125 volts AC, 60 cps, 30 watts.

Price:
$189.50

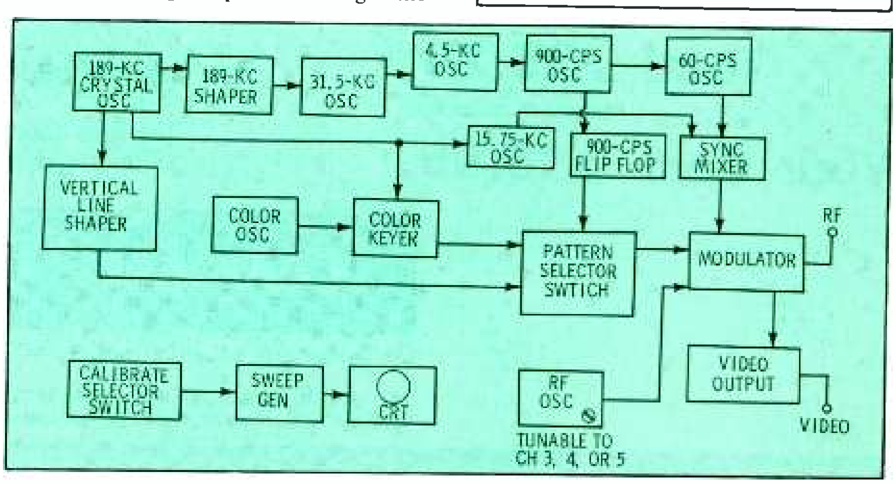

Fig. 10. 189-kc oscillator initiates all pattern and color-bar signals.

stages to attain division by a total factor of 3150. The resulting 60-cps signal also passes through the sync mixer. It provides vertical-synchronization pulses for the set under test.

Generation of the vertical and horizontal lines also begins with the basic 189-kc signal. For vertical lines, the basic signal passes through a shaper circuit, the output of which is a series of narrow pulses fed through the PATTERN SELECTOR switch to the modulator. The pulses are impressed upon the RF carrier and fed to the receiver where they brighten each horizontal-scanning line at 12 equally spaced points (only 10 appear on each trace; the other two are lost because they occur during retrace and blanking periods). The cumulative effect on the raster is a series of ten vertical lines.

Horizontal lines are derived from the basic 189-kc signal by way of the 900-cps divider and the 900-cps flip-flop multivibrator. During each vertical-scanning period (60 cps). 15 pulses from the flip-flop are fed through the selector switch to the modulator and then to the set where, during the 60-cps sweep time, 15 equally spaced lines are formed on the raster. For the crosshatch pattern, both sets of pulses (vertical and horizontal) are applied to the modulator. For dots, a diode clips the lines except at their points of intersection.

The keyed-rainbow color bars are generated by the offset-carrier method using a signal from the crystal-controlled 3.-563795-mc oscillator in the generator. This signal is fed to the receiver where the phase detector synchronizes it with the receiver's color-reference oscillator at the start of each horizontal-scanning line; the set then regards it as a color signal. Since the frequency difference between the two signals is identical to the horizontal-sweep frequency, their relative phase will vary from 0° to 360° during the time of one scanning line. The result is a color pattern on the color CRT which varies continuously from yellow, red, magenta, blue, cyan, and green. To provide bars, the color signal is keyed at a 189-kc rate, thus providing 12 bars at 30° intervals. One bar is used as color-reference burst, one is lost during retrace and blanking, and the other ten appear on the screen as the common color bar pattern.

The vectorscope is a simple cathode-ray oscilloscope, used to give a visual analysis of the phase relationship of the color-bar signals after they pass through the receiver's color-demodulator and matrixing circuits. Since the phase-relation accuracy of the input signal (generated by the instrument itself) is determined beforehand, any phase shift can be attributed to the receiver's circuits. All controls required for correct operation of the CRT display are mounted on the front panel.

A full description of the uses to which the vectorscope can be applied would require a comprehensive article in itself. However, once an understanding of the operation of the color circuits and their effect on vector position is achieved by the technician, he should be able to make rapid color-trouble analyses. ▲

HYBRIDS ON THE AUTO BENCH

by Homer L. Davidson

Logical procedures for shop repair of radios with tubes and transistors.

Repairing the hybrid auto radio (one which uses transistors in the output stage and tubes in the rest of the radio) is not really difficult. With a little knowledge of transistors, a noise generator, a DC power supply, and a few tools, you can add several dollars each week to your net profit. Pulling the auto radio is often the most difficult part of auto-radio repair, but, with a little experience, this, too, will be just another small job in a good day's work.

Let's take a look at a typical case involving the hybrid auto radio. Your customer has just pulled into your driveway with a dead radio. The darn thing is stone dead—when you turn on the radio, there is no audible "thump." (If the transistor output stage of a radio is working, you will hear a "thump.") You then determine that the dial light is fed from the same line as the radio and is on. This proves the fuse is okay.

Check the antenna for an open connection or a short to ground. Disconnect it from the radio and place one lead of your ohmmeter on the antenna rod and the other on the body of the car (be sure to make metal contact). An open reading should be obtained. Water, grease, or an intermittent lead-in connector can cause a short or low-resistance leakage path to ground. Next, touch one ohmmeter lead to antenna and the other to the center pin of the antenna plug; there should be a direct short. Move the lead-in around and notice the ohmmeter reading; an erratic indication suggests a bad connector or lead-in cable. If the lead-in is open, the broken wire is generally at either the plug end or at the base of the antenna. Cut off the plug at the male lead. See if you now have continuity. If not, pull gently on the small coaxial wire. If it comes out, replace the entire lead-in or, better yet, install a new antenna.

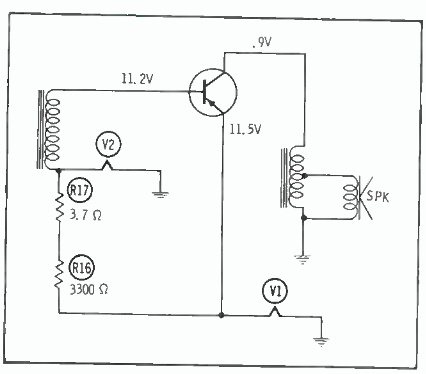

Fig. 1. Transistor-output circuit schematic shows a parallel path to ground.

If you are unfamiliar with the installation, especially if you haven't pulled a hybrid radio before, take a few minutes to discover the easiest way out. If a direct way is not readily apparent, consult your manufacturer's service file or other reference for suggestions. Be sure to disconnect the "A" lead, antenna cable,

Fig. 2. Lift one end of the base resistor (this is 5.6 ohms) for test.

dial-light cable (some are fed from the panel-light circuit of the car), and speaker plug. With the main chassis out of the way, check the speaker. Some servicemen pull the speaker and move it with the chassis to the bench, and some do not. You should at least make an ohmmeter continuity check of the speaker's voice coil.

If replacement is necessary, since the impedance of hybrid-fed speakers will vary, be sure that the replacement speaker is of the same impedance as the defective one. If not, the output transistor can be quickly ruined. There are several universal-replacement speakers for hybrids, but you should replace with a factory part or reliable exact replacement, if possible.

With the antenna and speaker both checked, place the radio on the test bench. Remove the top and bottom covers, connect the "A" lead to your DC power supply, and plug in your test-setup antenna and speaker.

Since there was no "thump" when the set was turned on, we can suspect that the trouble lies in the transistor audio-output stage. A quick look at a set with similar trouble revealed a burned base resistor, but an ohmmeter check was inconclusive because of the parallel path through the transistor to ground (see Fig. 1). Generally, when the output power transistor is shorted, the base resistor gets hot and often burns open. To insure a correct check of the base resistor, remove one leg of the resistor from the PC board or chassis tie point and measure the resistance. The resistor shown in Fig. 1 should have measured 3.7 ohms, but it was open. (In many car radios the emitter or base resistor may be listed as a fuse.) Check this resistor for continuity using the method just described (see Fig. 2).

In this radio, the "A" lead current was excessive after replacing the base resistor, strongly suggesting a shorted output transistor. It was replaced, and the trouble was cured. If an original replacement isn't available, consult a transistor substitution guide for a usable replacement. Be sure to place a small amount of silicon grease between the mica insulation and the metal plate of the transistor. Also be sure the transistor is not mounted directly to ground. Use the two block insulators which are placed around the metal screws before the unit is inserted onto the chassis. Before turning the radio on, check with an ohmmeter from the outside shell of the power transistor to ground; the resistance should be 2 ohms, the forward resistance of the output transistor, if the ohmmeter leads are connected properly. Be sure to set the bias current according to the manufacturer's recommendation.

In another actual transistor-output trouble, a truck driver brought in a Ford F600 truck radio, which he had removed from the dash panel. The base resistor and power-output transistor were found to be defective and replaced. The set was bench tested and given an okay. In about 15 minutes, the customer

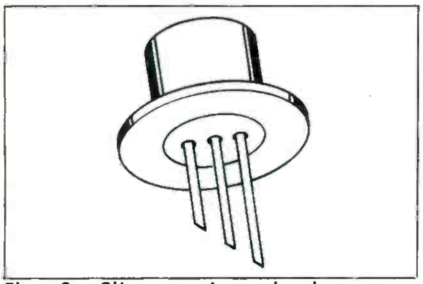

Fig. 3. Clip transistor leads to uneven lengths for easy replacement.

called to say the radio still didn't work. We told him to bring the truck on down to the shop, so we could check it out.

We pulled the chassis, and it worked perfectly on the bench. We asked the customer if the battery in his truck had been replaced or charged recently. He said it had, so we took a quick look under the hood; the cables were hooked up to the proper terminals. We clipped a voltmeter across the 12-volt battery and, as we suspected, the battery indicated a reverse polarity. If care is not taken to observe correct polarities, this reverse-charge condition can occur, with some noninterlocked chargers, whenever the battery's residual voltage has fallen to near zero.

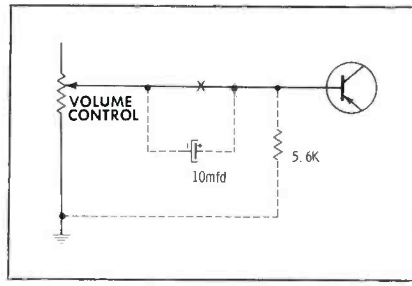

Fig. 4. Factory field changes will improve operation of some auto radios.

The next radio was from another Ford, a Model 04MD. This unit had a transistor audio driver as well as a transistor output stage. The set was dead, but the cause was not apparent so we used the following method to isolate the trouble: We fed a signal from the noise generator to the high end of the volume control. There was no audio output. (A loud audio signal will be heard if the entire audio section is good.) We moved the noise generator output lead to the base of the output transistor and got a good signal, so we knew the trouble must lie between the volume control and base connection on the final output transistor. From the base of the first audio driver, there was no signal in the speaker; but from the collector terminal of the same stage there was good audio response. It looked like a bad transistor, so we took voltage readings with a VTVM using the manufacturer's service data for reference. The base and collector readings were almost identical (indicating a collector-base short), so the transistor was pulled and a new one inserted in its place.

To replace a transistor mounted on a printed-circuit board, first remove the old one using a 25-watt soldering iron and desoldering tools, then clean out the mounting holes with a round toothpick or other pointed tool. Leave the leads on the transistor uncut and carefully work the leads through the board. Resolder using light resin-core solder and the 25-watt iron; then cut the leads close to the underside of the board, using a small pair of side cutters. If you find it difficult to insert all three transistor leads through the board at once, cut the leads to different lengths (see Fig. 3), and the job will be simple. Remember to check a reliable substitution guide, if you don't have an exact-replacement transistor.

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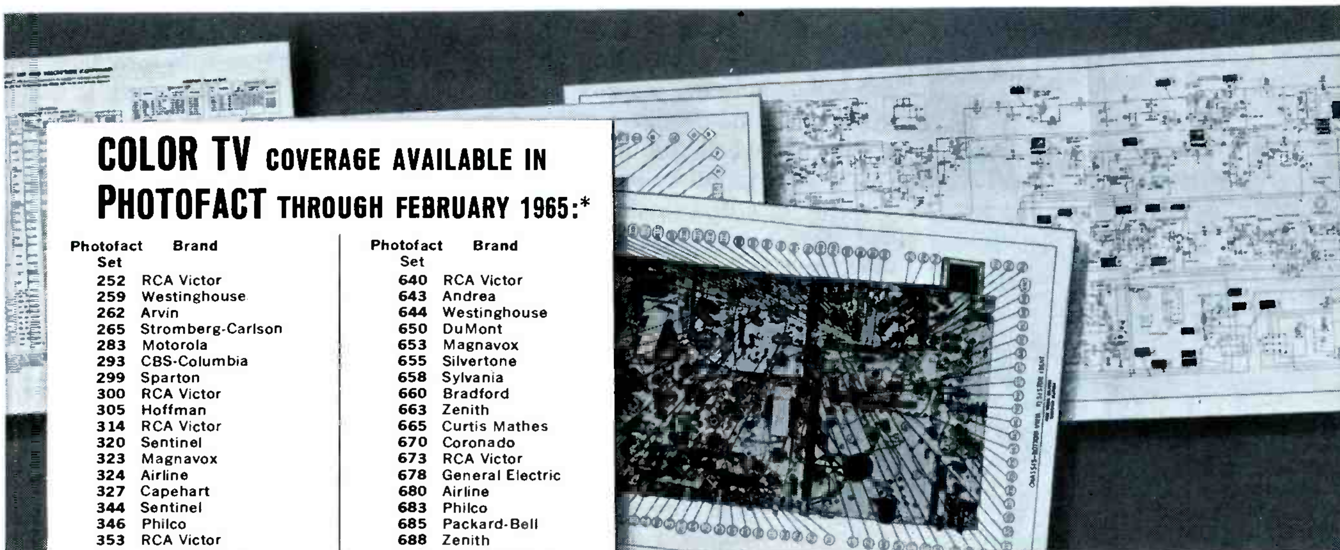

COLOR TV COVERAGE AVAILABLE IN PHOTOFACT THROUGH FEBRUARY 1965:*

Photofact Set	Brand	Photofact Set	Brand
252	RCA Victor	640	RCA Victor
259	Westinghouse	643	Andrea
262	Arvin	644	Westinghouse
265	Stromberg-Carlson	650	DuMont
283	Motorola	653	Magnavox
293	CBS-Columbia	655	Silvertone
299	Sparton	658	Sylvania
300	RCA Victor	660	Bradford
305	Hoffman	663	Zenith
314	RCA Victor	665	Curtis Mathes
320	Sentinel	670	Coronado
323	Magnavox	673	RCA Victor
324	Airline	678	General Electric
327	Capehart	680	Airline
344	Sentinel	683	Philco
346	Philco	685	Packard-Bell
353	RCA Victor	688	Zenith
357	Westinghouse	690	Westinghouse
358	RCA Victor	693	Sylvania
371	Motorola	695	Motorola
378	Raytheon	698	Philco
382	Truetone	700	Airline
383	Admiral	703	Admiral
385	Hoffman	705	Zenith
386	Packard-Bell	708	Magnavox
388	Silvertone	710	Magnavox
399	RCA Victor	713	Silvertone
412	Emerson	715	Setchell-Carlson
433	RCA Victor	716	Truetone
437	Westinghouse	717	Penncrest
459	RCA Victor	719	Emerson
495	Admiral	721	Motorola
517	RCA Victor	722	Zenith
540	Admiral	724	DuMont
546	Packard-Bell	726	Coronado
565	General Electric	727	Muntz
576	DuMont	729	General Electric
584	Silvertone	731	Olympic
588	Magnavox	732	Electrohome
592	Emerson	734	Andrea
596	Olympic	736	RCA Victor
599	Zenith	737	Catalina
614	Packard-Bell	739	Motorola
626	Sylvania	741	AMC
627	Delmonico		

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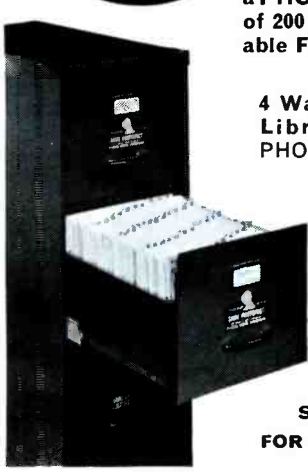

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While we are discussing the audio section, we can't ignore the volume control itself. We once had a Delco Model 98542 car radio in the shop for repair of a noisy volume control. We tried a shot of cleaner-lubricant, but the potentiometer still was noisy at the low-volume end. Replacing the control itself was simple, but a field change is factory-recommended to provide quieter operation and longer life. The modification consists of a coupling capacitor inserted between the base pin of the first audio transistor and the center tap of the volume control. A base-bias resistor is added from the base of the transistor to ground as shown in Fig. 4. All parts for the change are furnished with the factory replacement.

It is always a good policy to replace any auto volume control with exact replacement part, if possible. These can come from manufacturer of the set, of course, but there are also other manufacturers who make exact replacements which will generally do the job as well.

Checking The Front End

We once pulled an intermittent set and hooked it up to the test bench. By pressing firmly on the etched board, we could make the intermittent appear and disappear. Pushing around gently among the set's components with the eraser end of a pencil, we found that one of the IF transformers seemed to be close to the intermittent trouble. To pinpoint the troublesome section, we disconnected the antenna lead and connected our noise generator to the high end of the volume control. The audio section checked okay. We then applied the noise signal to the base of the second IF stage—here, we could induce the intermittent.

Because a transistor seldom behaves as an intermittent element (it either works, or it doesn't) we suspected the IF transformer. The transformer was replaced, and the set was restored to normal operation. Replace IF transformers with a factory part or an exact replacement.

Oscillator Bothers

To illustrate what a pain oscillators can be, let me tell you about a car radio that faded out on the high end of the band. We checked the radio in the car; after a few minutes, the high end was dead. A few local stations at the low end played perfectly.

We pulled the radio and tied it into the test bench; in a few minutes, as it had in the car, the high end went out. The symptom is common to oscillator-tube problems in older sets, and to transistor problems in newer sets. This set used a transistor, so we replaced it, and the set played just fine on the high end of the band. To give it a severe test with the new oscillator transistor, we lowered the "A" lead DC voltage to 9 volts from the normal 12 volts, and it still played okay. *(The use of a variable transformer as a trouble-shooting aid is described in a February 1964 article in* PF REPORTER. *—Ed.)*

Don't overlook the obvious repair. For example, another customer came in with trouble in his car's radio. There was a loud RF rushing sound, but the set would pick up no stations. The antenna checked out okay, so we pulled the set and placed it on the bench. Our preliminary examination revealed a broken lead from the oscillator tuning section. We replaced it, and the set worked like new. Total time on the bench—three minutes; and we had a satisfied customer.

A Few Do's and Don'ts

When you have completed a repair, make a few last-minute checks. Be sure the pointer runs smoothly across the dial; test for slippage at both extremes. Be sure the dial calibration is correct. Don't forget that some trucks and foreign cars use a positive ground. Check the push buttons after the radio has been installed in the car. Don't forget to adjust the antenna trimmer with the radio installed.

Last but not least, as a good customer-relations project, brush off the car seat, wipe off the dash panel, and sweep the floor mats.

Remember that most of the problems you'll find in servicing hybrid auto radios have their direct counterpart in normal tube types. Use common sense, your experience in troubleshooting tube types, and a logical signal-tracing procedure, and you'll make quick work of auto radios—hybrid types or standard models. ▲

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IN-CIRCUIT TESTS

Evaluate Tubes

by Larry Allen

Ever get caught with your tube tester out of whack? Or find yourself looking at the bottomside of a huge TV chassis, wondering if a tube is good or bad, and dreading the thought of grappling with its jagged corners so you could turn it over to recheck a tube? Or push a tube into your tester, beat it, bang it, thump it and bump it, see the meter needle settle at GOOD, but feel sure that same darn tube won't do the job back in its socket?

The solution to these problems is: *Test the tube right there in its socket!* You can, you know; in fact, you can test several important characteristics without pulling the tube at all. The in-circuit tests in this article run the gamut from simple quality tests to a sophisticated (yet uncomplicated) gas test.

Tube Parameters

Tube parameters is an engineering term that describes those characteristics of a tube that can be measured (or metered). Parameters of *normal* operation include: element (pin) voltages; plate, screen, cathode, grid, or filament currents; power or voltage gain (mu); transconductance or mutual conductance (Gm); etc. Tests of tubes are frequently concerned also with parameters of *abnormal* operation. Most important of these are: grid leakage or grid current; gas among the elements; and interelectrode shorts or leakage. Which of these parameters can be checked in the circuit? The answer is: All of them!

How? Consider, first, that a tube tester measures certain parameters and compares them to an average value predetermined by the tester designer. Consider, second, that the designer determines what values are average by testing production-run tube samples. He then devises tester settings that produce a normal reading on the GOOD-BAD meter. Sometimes he studies tube specifications to arrive at settings that provide "normal operating conditions."

Now, apply these considerations to testing a tube in the circuit. If you can simulate normal operating conditions as you'd find them in the tester. . . . But, what are we talking about? In the circuit, the tube *is* operating under normal conditions. Therefore, many parameters can be evaluated without doing anything more complicated than measuring a few voltages—plus maybe some resistances—and applying a bit of Ohm's law. Other operating characteristics can be measured by introducing carefully controlled (by you) test parameters and noting their effect on other parameters.

Ohm's law and a knowledge of tests will enable you to evaluate most tubes quite adequately. Until you've built a backlog knowledge of what to expect from tests like these, you'll need a list of specifications and normal operating conditions for comparison with your test results. Receiving-tube manuals from General Electric, RCA, Sylvania, and Tung-Sol cover most receiving-type tubes you'll encounter.

Measurement Techniques

We'll tell in this section how to measure each parameter of significance to the service technician. For the sake of study, we can group the parameters into three major categories—AC power, DC distribution, and signal parameters.

AC Power Tests

The only AC power tests of any real significance are heater (filament) voltages and currents. The important fact to remember, especially with series-string filaments, is that the correct voltage must be applied to each tube heater if the other tests you make are to be dependable. If the cathode is cool, emission will be weak; if it is too hot, erratic operation may result from overemission; or, a weak tube may seem temporarily okay.

Checking heater current is more of a task than measuring heater voltage, unless you have an AC milliammeter. However, if you need to know heater current, connect an accurate 1-ohm resistor in series with the heater and measure the AC voltage across the resistor. As shown in Fig. 1, each .1 volt measured is equal to 100 ma of heater current; typical values are listed on the schematic.

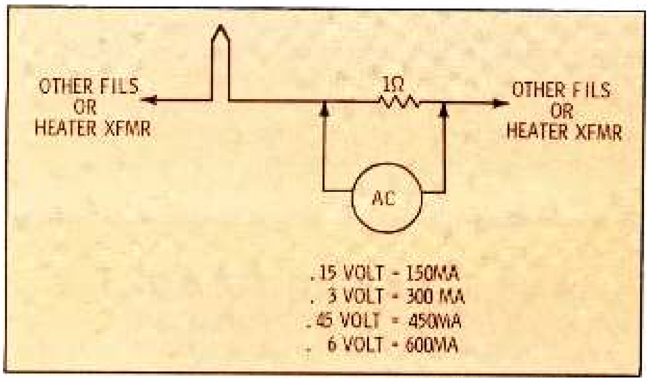

Fig. 1. Method used for measuring AC filament current.

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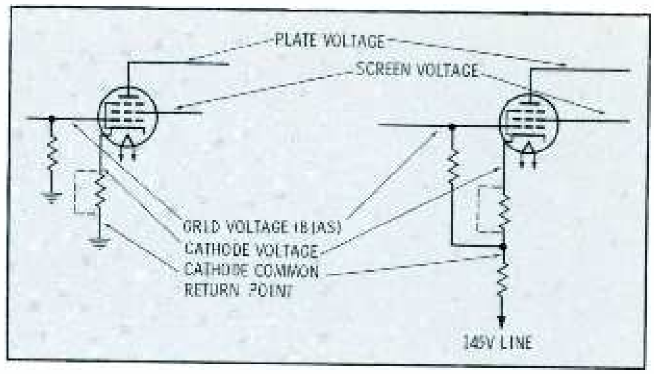


Fig. 2. Reference points for measurement of tube voltages.

DC Parameters

Measurement of DC operating voltages and currents becomes slightly involved, because some interact with others. In a pentode, for example, lower-than-normal screen voltage will not only reduce screen current but will also lower plate current; in fact, a 10-volt shift in screen voltage will have more effect on plate current than will a 10-volt change in plate voltage. A small shift in grid bias will have a greatly exaggerated effect on plate current and a considerable effect on plate voltage because of the greater or lesser voltage drop across the supply resistor as current rises or falls.

The tube-operating parameter measured more often than any other is *plate voltage*. However, this parameter is so dependent on the others, and on conditions in the associated circuit, that it assumes relative unimportance except as a clue to improper operation. Thus, if plate voltage is too high or too low, the next step is to measure other parameters—to find which is causing the plate-voltage upset. Actual plate voltage is measured with a DC voltmeter, with the negative lead connected to the cathode return point (maybe it's ground, and maybe not—see Fig. 2).

Other tube potentials are measured in the same way —with a DC voltmeter connected between the element pin and the cathode return point. *Cathode, screen,* and *grid* voltages are secondary clues in troubleshooting logic; they can often explain exactly why the plate voltage is incorrect, or at least direct you to the fault. Also, they are important for our in-circuit evaluations.

After plate voltage, *plate current* is probably the next most important DC parameter. There are several ways to measure plate current; some are direct and some indirect. Which you use depends on whether the circuit is printed or hand-wired, how easy it is to unsolder the circuit, what kind of plate load is used, etc. Fig. 3 shows several methods.

Inserting a milliammeter in the plate lead is the most direct way, but this requires either unsoldering the plate-pin connection or temporarily slitting the PC-board foil near the tube socket. A more convenient method is to measure voltage across the plate supply resistor (plate load, usually) and calculate the current by Ohm's law. If there is no resistor in the plate circuit, either the direct milliammeter test or an indirect method will have to be used.

One indirect, but often convenient, way to find plate current is to measure *cathode current*. This can be done (Fig. 3) by opening the cathode ground-return lead

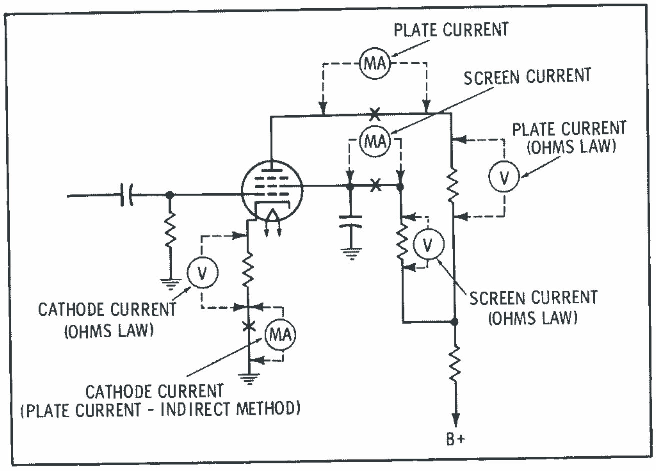


Fig. 3. Metering locations for testing a tube in its circuit.

and inserting a milliammeter, or by measuring voltage across the cathode resistor (if one is used) and calculating current by Ohm's law. However, remember that, in a pentode, cathode current isn't exactly plate current, because a small part is picked up by the screen.

The *screen current* in most pentodes is small in comparison with plate current, and can be determined by one of the means shown in Fig. 3. The voltmeter-Ohm's-law method depends on there being a screen-supply resistor; if there isn't, the milliammeter will be necessary. Keep in mind, then, that cathode current is the combined value of plate and screen currents. Just as you can calculate plate current by subtracting screen current from cathode current, you can also find screen current by subtracting plate current from cathode current.

Important to tube operation is *plate dissipation,* found by multiplying plate voltage and plate current. If the wattage given in the specifications is exceeded, tube life will be reduced seriously.

Screen dissipation can be calculated easily from screen voltage and current values by using the formula P=EI. This parameter is not of prime importance to evaluation, but excessive screen dissipation will destroy or reduce the life of a tube more quickly than will excessive plate dissipation. The screen is a delicate element compared to the plate.

Emission is one key to tube quality (the other is gain) because, if the cathode can't provide enough electrons, tube current won't be sufficient to support amplification. Cathode current is the handiest criterion for judging emission capability, provided operating voltages are "normal" values. In the section on Testing, we'll show how to set up tubes for evaluating emission.

Signal Parameters

Most important of all parameters in the operation of a vacuum tube is that of *gain.* Tube operation usually depends heavily on amplifying ability. Amplification can also be viewed as the ability of various tube elements —particularly the grid—to control the plate current. In engineering and design parlance, the terms *transconductance, mutual conductance,* and *voltage gain* (mu) or *power gain* all refer to the amplification factor of the tube. We'll show you presently how to calculate *transconductance*—the characteristic usually listed in tube manuals; thus you can compare your results easily

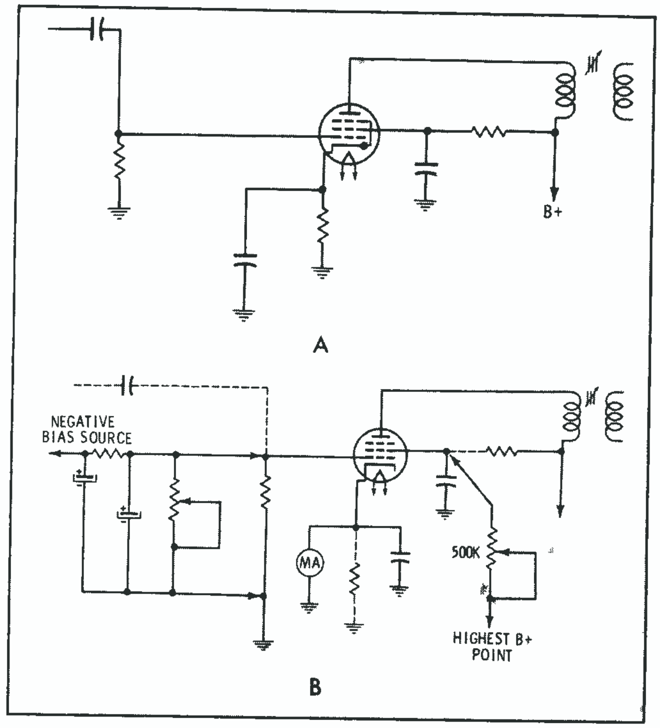


Fig. 4. To set "normal" operating values of current, voltage.

with published specifications.

The effect of the grid on plate current can be measured by feeding a signal voltage to the grid and measuring how much greater the signal is at the plate. You can do this right in the circuit, using an external signal (one you provide from a generator) or a signal source from inside the set. The external source is best, because its output level can be more easily set at any desired value.

Testing and Evaluating

Now that you understand the terminology, we can discuss evaluation tests in terms of what to expect and how to analyze your results. We'll show emission, transconductance, leakage, noise, and gas (grid emission) tests.

General Setting Up

All DC operating voltages should be the same every time you test tubes of a particular type, so the results can be evaluated on an equal basis. You must also consider the circuit in which the tube is used, but, within limits, you can set DC conditions to suit "normal operation" as specified in the tube manual.

Take a look at the typical IF amplifier in Fig. 4A. It contains a transformer-type plate load, so plate current must be measured directly or via a cathode reading. There is a screen resistor, so the Ohm's-law method will work for screen current.

Since a cathode resistor is provided, the Ohm's law method *seems* okay for measuring cathode current, too. But look again. The cathode resistor is used for bias; to set the bias at what we want it to be, we'll have to eliminate the cathode resistor temporarily and furnish bias of our own (see Fig. 4B). This in turn makes a milliammeter test more suitable for cathode current. The little device shown in Fig. 5A can apply whatever bias the tube manual suggests for the tube. The nega-

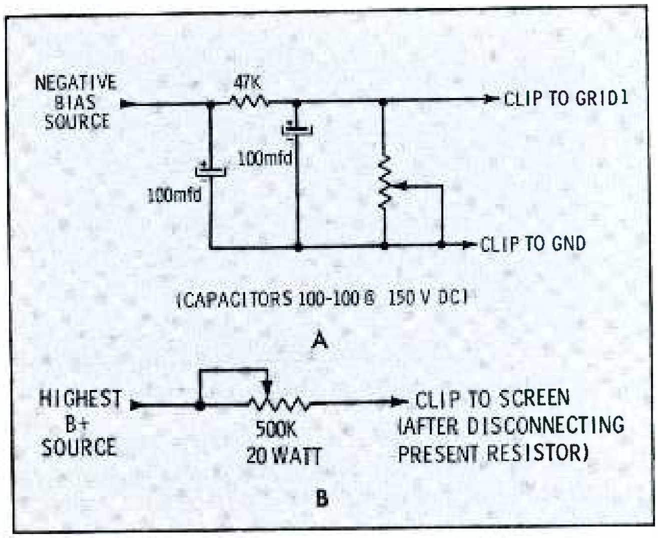


Fig. 5. Some simple devices for making in-circuit tube tests.

tive voltage source can be a bias box or any highly negative DC point in the set (the horizontal-output grid is a good place, usually).

Once bias is set at the indicated value, make sure the screen voltage is also at the specified voltage. If it isn't, use the simple device shown in Fig. 5B to set it. The circuit of Fig. 4A, after connections are made for meaningful comparison with normal ratings, looks like Fig. 4B.

Emission

Many low-cost testers evaluate only the *emission* of tubes, because no tube can function correctly unless sufficient electrons are emitted by the cathode. Since cathode current is the best measure of cathode emission, set up the tube for normal operation according to the manual and read the cathode current on a milliammeter.

Note that if bias using the cathode resistor is the same as that specified in the tube manual, there is no need to attach an external biasing device. Furthermore, there is no need to use a milliammeter; the Ohm's-law method can be used with a simple voltmeter reading across the cathode resistor.

If the tube is up to par, cathode current will be within 20% of the value indicated in the tube manual for plate and screen currents (add them). If cathode current is 30% below normal, the tube is questionable; 40% is pretty poor.

Transconductance

Cathode emission only partly determines whether a tube will actually do its job properly. Even though sufficient electrons are available in the plate-current stream, the tube won't amplify unless the grid can control them properly. Consequently, we should—to evaluate a tube adequately—have some easy way to check grid action. This controllability is revealed in the evaluation of *transconductance.*

Transconductance (Gm) is a measure of the grid-*voltage* swing required to cause a particular plate-*current* (not voltage) change. The term thus takes into consideration the plate resistance besides the amplification factor (mu). Simplified, the formula for transconductance is plate-current change divided by grid-voltage change (GM=Ip/Eg). The term *mho* (pronounced

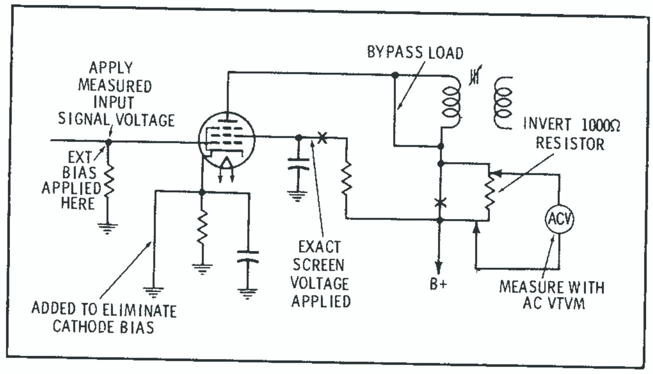


Fig. 6. Evaluating amplifying ability of a tube in circuit.

"moe"), which obviously is *ohm* spelled backward, is used to state the result. Since Gm generally is only a small fraction of a mho, the term micromho (millionth of a mho) is used.

To measure transconductance, you first apply a known signal to the grid. Then the plate-signal voltage must be measured and converted by Ohm's law to current. The test setup in Fig. 6 shows the details of this test. Note that bias and screen voltages have been set for normal operation as outlined earlier.

A sine wave is best for evaluation; so, you can feed in a 1000-cps signal from an audio generator, a 60-cps signal taken from the set's own power supply, or a signal of whatever frequency is normally used with the tube. Don't use RF or IF signals, however, unless you have a voltmeter that reads accurately at RF frequencies. Coupling from the preceding stage must be disabled to avoid having any signal other than the test signal applied to the tube.

Apply the test-signal voltage to the grid—be sure the tube doesn't overload—by raising the signal level until the plate reading ceases to rise, then backing off slightly. For our example, let's say we feed in a signal of 5 volts rms. Measure and record the applied voltage.

Next, measure the output voltage across the 1000-ohm resistor; that value of resistor was chosen so each volt rms would represent exactly 1 ma rms of plate current. We measure 100 volts rms in our example, which means that there is a signal plate current of 100 ma rms. Using the formula stated earlier, we can now calculate transconductance: $Gm = .1/5 = .02$ mho or 20,000 micromhos.

Compare the transconductance calculated from your measurements with the value listed in the tube manual. Gm should be at least 75% of rated value, or the tube is questionable. Below half, the tube ought to be replaced. Remember, too, that the test-signal frequency will affect your evaluation. That is to say, at a test frequency of 1000 cps a tube might check within 10% of its rated transconductance, but still not perform in a stage meant to operate at megacycle frequencies.

A triode has characteristics different from a pentode, since its transconductance is determined largely by the plate-load value. Consequently, the plate-load resistor should be left in the circuit instead of being jumped for the insertion of a 1000-ohm resistor. To determine signal plate current in a triode, then, just measure signal voltage across the plate load and use Ohm's law. Thus, a low-signal triode might test as follows: 500 mv of signal at the grid develops 67.5 volts of signal across

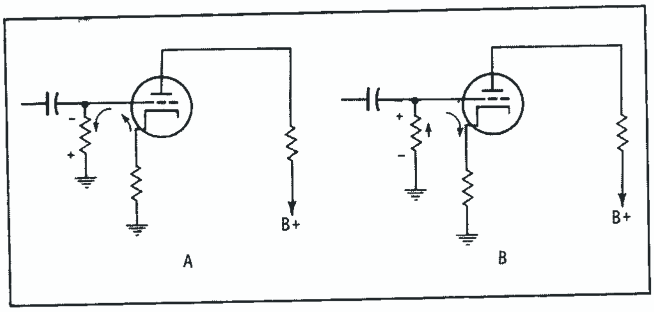


Fig. 7. Gas or grid-emission current causes positive voltage.

the plate load, which is 27K ohms. Ohm's law indicates signal current is 2.5 ma. Our Gm formula gives us .0025/5=.005 or 5000 micromhos as the transconductance of this triode under these operating conditions.

Gas

Gas in a vacuum tube can cause a variety of problems, but most noticeable is grid emission. The grid is bombarded by electrons rushing toward the plate. If it is "softened" by gas, or is otherwise contaminated, the grid releases electrons of its own—thus becoming more positive than normal.

Fig. 7A shows the direction grid current (normal in certain types of operation, such as class C) would ordinarily take, and Fig. 7B shows the direction of abnormal current caused by gas or grid emission. Grid emission is causing the grid voltage in 7B to become more positive, as current flows through the grid resistor in the "wrong" direction.

This last action suggests an easy test for gas: Disconnect the grid and leave it floating, while the tube is otherwise set up for regular operation. Connect your VTVM to the grid, positive lead as probe. The 10-meg input resistance of the VTVM will act as a temporary grid resistor of high value and will show a positive voltage reading if there is any grid emission, whatever the cause. (Be sure the preceding coupling capacitor is disconnected, because even slight leakage from it will place a positive reading on the grid.)

More than 1 volt measured by a 10-meg-input VTVM would mean that gas current exceeds 1 μa—too much for a high-gain tube in a senstive circuit. Take a controlled IF, for example. If 1.5 μa of gas current develops, voltage across a 2-meg AGC-line resistor would amount to 3 volts positive—enough to offset much of the AGC, usually. More than 5 μa of gas current would be unacceptable in most applications.

Noise

There are two very good ways to test for *noise* in almost any tube. We'll describe the easiest first:

Just let the tube operate in its usual maner, hold the top steady (to prevent sockets from generating noise), and thump the tube while you watch (or listen for) the effect of your thumping. A noisy tube that won't reveal itself this way isn't likely to be caught by a tube tester, either.

Another, less simple method requires a set of sensitive headphones (a 2000-ohm set will do) and a .001-mfd, 1000-volt capacitor. Clip one lead of the phones to ground and the other to one end of the capacitor. Jumper the tube grid pin temporarily to cathode (not to ground) and connect the free end of the test capacitor to the plate. Thump the tube and listen in the headset for noise and microphonics. Don't leave the grid-cathode jumper in place for more than a few seconds at a time, for it can damage some tubes.

Testing for intermittent *shorts* is handled the same as for noise. Tubes that are shorted directly should be so obvious they won't require testing.

Leakage

Leakage of any serious consequence will cause abnormal indications during tests already described, with the possible exception of heater-cathode (H-K) leakage.

In-circuit tests for H-K leakage needn't be complicated. If the tube has a cathode resistor, just jumper the grid to ground (not to cathode), and listen for hum at the plate with the headset and a .1-mfd capacitor. A scope at the plate will also reveal any 60-cps hum arising from H-K leakage. If hum is evident, ground the cathode for a moment; the hum at the plate will be nearly eliminated if H-K leakage is causing it.

If the tube cathode is normally grounded, open it temporarily and insert a 1000-ohm resistor. Then make the test as described.

Other Tests

The tests described apply mostly to triodes and pentodes. Rectifiers and multigrid vacuum tubes require slightly different treatment, although the basic intent is the same: Test the tube without removing it from the circuit or making a lot of extra connections.

Rectifiers

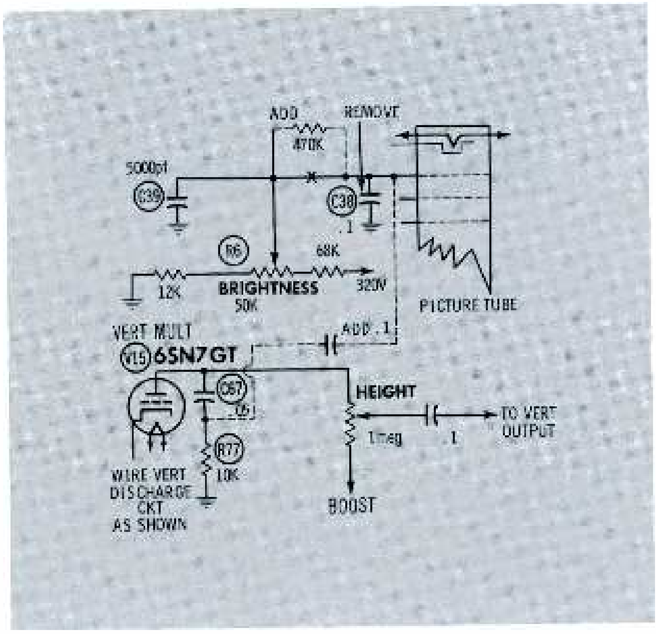
One easy way to test a rectifier is to measure the AC voltage applied to the plates and then measure DC voltage at the output (cathode). With a capacitor-input filter, a vacuum-tube rectifier should produce DC voltage about 10% above the AC rms voltage measured at the rectifier plate(s). With a choke-input filter, the DC output voltage should be about 90% of the applied AC rms voltage.

A better test, which applies to gas-type rectifiers as well as vacuum-tube types, is measurement of the internal resistance of the tube. Unload the B+ circuit following the second filter capacitor and connect a 10K, 50-watt (good for up to 1000 volts) resistor from the rectifier cathode to ground. Current drawn through the rectifier by this resistor will be 1 ma for every 10 volts of DC output. Thus, from a 500-volt power supply, current will amount to 50 ma; from a 270-volt supply, 27 ma.

With output current thus fixed, a voltage check across the rectifier is all that is needed to enable you to calculate the internal resistance of the tube. We'll use a 5U4 as an example. With your VTVM on AC (if you use a VOM, you may have to reverse the leads to get a true reading), clip the negative lead to pin 8 and touch the positive lead first to pin 4 and then to pin 6 (if the two readings aren't nearly equal, shift the negative lead to pin 2).

Record the AC-voltage readings. Switch the VTVM to DC and measure the voltage across the 10K resistor; divide it by 10 to determine milliamps of current being drawn through the tube. Now, divide volts by amps (Ohm's law), to find the approximate internal resist-

Add Retrace Blanking



Quite a few of the older TV models have gone without vertical retrace blanking for many years, because there seemed to be no convenient way to add a blanking circuit. A case in point is the Westinghouse Chassis V-2172 (PHOTOFACT Folder 116-13). There's a slight trick to installing a blanking network in this set; once you catch on to this, you can easily add retrace blanking to satisfy the considerable number of customers who are still using these venerable receivers.

It's advisable to apply the blanking-pulse signal to the grid, and avoid mixing it with the video signal at the cathode. Therefore, you'll need negative pulses. The customary source—the "high end" of the vertical output-transformer secondary—is not usable in this chassis because the waveform at this point contains positive pulses. However, negative pulses can be obtained from the coupling circuit between the vertical multivibrator and output stages, if you make one wiring change: Transpose the position of C67 and R77 so the resistor is connected between the capacitor and ground, as shown in the schematic. Negative spikes are developed across R77 in normal operation; if you arrange to tap in directly across this resistor for a blanking signal, you'll obtain a nearly pure pulse waveform without picking up the sawtooth signal developed across C67.

The coupling circuit is installed simply by connecting a .1-mfd capacitor from the top of R77 to the CRT grid, and adding a 470K isolating resistor between this grid and the arm of the brightness control. Also remove C38 (.1 mfd) from the CRT grid circuit. Resist the temptation to utilize this old part as a pulse-coupling capacitor, since it might break down under the constant stress of the pulses. ▲

ance of the rectifier. A good 5U4, typical of many modern vacuum-tube rectifiers, has internal resistance of about 150-170 ohms. Thus, in our test, at a DC supply voltage of 300, a good 5U4 would have about 5 volts AC across it. If you calculate more than 200 ohms, the 5U4 is getting weak.

Oscillators

Evaluating tubes in oscillator circuits presents no problem. Just disable the feedback loop, whatever it may be, and treat the tube as any other amplifier. Multivibrators can be tested one section at a time by disconnecting one coupling capacitor.

Multigrid Types

Take your cue for testing multigrid tubes from the circuits in which they are used. Special-purpose types, which have become more common as set designs advance, can often be evaluated with the signals that are applied to them in normal operation. Check the effect of signal voltages at each grid, one at a time, by jumping out the signal at all others during each test. Thus, each grid can be evaluated separately for proper control.

Conclusion

Most tube types can be checked with the easily applied tests we've outlined here. Don't use these tests to eliminate your tube tester, but use them to save time and effort whenever you can avoid running to a tester. Besides, the principles you learn from such tests will help you in all your troubleshooting. ▲

Continued from page 47

Fig. 7. Bench setup for signal tracing.

lating the RF signal and riding through to the CRT. Your scope would show you unfiltered half-wave rectification at the junction of R3, R4, and R7.

The next check should be for the 12-volt DC output of the X3. The only other tests you can make with your VTVM are of the transistor's emitter and bias voltages. Emitter voltage is easiest. If it's significantly low, the transistor is probably not conducting. These are PNP transistors, therefore the base must be negative with respect to the emitter. Forward bias should be about .2 volt. Remember, a vacuum tube with zero bias conducts heavily, but a transistor with no bias is virtually cut off.

If voltages checks have no revealed the trouble, you might try checking components with your ohmmeter — but be aware of the transistors. While non-conducting vacuum tubes offer infinite impedance, transistors affect resistance readings by offering a parallel path. Also, transistors can be damaged by some ohmmeters, especially on the low-ohm scales. All things considered, it's a good practice to disconnect two transistor terminals when you're making resistance checks.

Of course, signal tracing is one efficient way of tracking down booster troubles. Fig. 7 shows a bench setup for signal tracing. The signal generator puts out RF signals modulated a 600 cps. The photo shows a homemade detector, but a standard scope-type detector probe will do the job just as well. First, send a 74-mc signal straight through the preamp. The resulting scope trace—a nice, clean sine wave—is shown in Fig. 8.

To obtain a rough idea of the gain of the unit, we simply compare the amplitude of this scope trace with the amplitude of the trace produced by connecting the output of the signal generator directly to the detector input.

The 74-mc signal checks out the low-band portion of the preamp. To check the high-band section, we

• *Please turn to page 82*

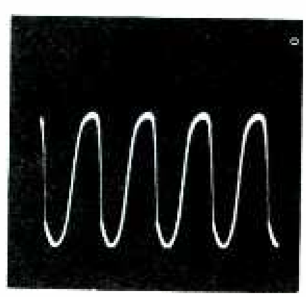


Fig. 8. Normal sine wave.

Fig. 9. A homemade probe.

The Troubleshooter

answers your servicing problems

Questions On Test Jigs

I would like to know if an RCA color test jig can be used to repair Zenith color receivers? Also, is a Zenith test jig suitable for servicing receivers of other makes? The third and final question is: Are most color test jigs interchangeable for servicing any brand of color receiver?

LEW'S RADIO-TELEVISION SERVICE

Ossining, New York

As a standard rule, you'll find that color jigs utilize only one common component—the color picture tube. Most of the receivers presently on the market use the same or a similar type of picture tube. Therefore, it is necessary only to have deflection and convergence yoke assemblies for the basic color receivers patterned after RCA chassis.

You'll find that one deflection yoke is suitable for servicing Zenith color receivers manufactured today. RCA receivers from Chassis CTC7 through CTC16 can be operated using the same deflection yoke and convergence yoke. If you plan to servicing an RCA CTC4 or CTC5 chassis, you'll need the yokes for those individual sets.

Any of the 90° 25" color receivers will require a completely different test jig—both yoke and CRT.

Needs More Channels

I would like to know if it would be possible to arrange two VHF tuners back to back, coupled IF to IF, and convert the two channels I now receive to different channels for testing purposes. We have two translators that broadcast on channels 11 and 13, a cable system that uses channels 2 and 6, and some locations near here receive direct signals on channels 3 and 8.

My shop is in the area that receives the translator signals only; however. I repair sets which receive all of the above named channels. Proper repair is sometimes difficult because I can't air check the receiver on all channels. I noticed in the June '64 PF REPORTER that Blonder Tongue uses two tuners like this to convert UHF to VHF.

CARL LINQUIST

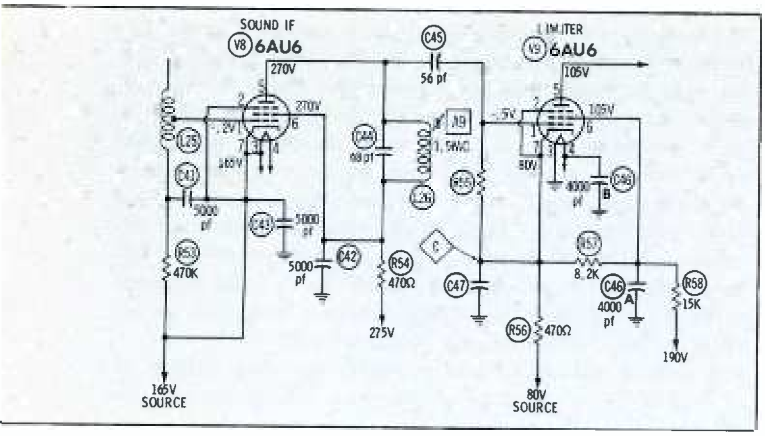
Jackson, Wyo.

Arranging two tuners back-to-back wouldn't work. The Blonder Tongue arrangement you mentioned does work, but only because there are no amplifier tubes in the converter; all stages are passive. The tuned circuits will provide conversion. Using TV tuners, however, the signal simply would have no path through the combinations.

Perhaps additional height on your shop antenna system would enable you to bring in the channels you don't receive now. One alternative, if you feel you must have off-the-air signals for all channels, would be to build a simple mixer circuit. I have the feeling, however, that such an attempt would create as many problems as it would cure.

A second possibility, and probably the most logical of all, would be to purchase a generator which has an output for all VHF channels. One such instrument is the Hickok Model 650C.

Circle 56 on literature card



Befuddled By Source Voltage

I have a Magnavox Chassis CT372 which has a complete loss of sync. I have replaced most of the capacitors and checked resistors throughout the sync circuit with no results. Sound is weak and there is a 60-cps hum that can be heard in the speaker and that is triggering both the vertical and horizontal oscillators.

I do not understand the 80- and 165-volt sources, as these do not come from the power supply. Also, the 80-volt line reads 160 volts, and the filaments on V8, V4, and V7 read 160 volts to chassis. I have checked voltages in the sync separator circuit and they are far from normal. I would certainly appreciate any suggestion you could give me.

J. L. Manak

Cleveland, Ohio

Your description of the symptoms in your Model CT 372 seems to indicate trouble in the 80-volt supply section. The increase in voltage (in your Magnavox television receiver covered in PHOTOFACT *Folder 205-6) from 80 volts to 160 volts will have to be remedied before you proceed to other troubles you may have in the receiver. The sound IF amplifier and limiter are used as voltage dividers for the 160-volt and 80-volt sources respectively. Be sure to check R57, R58, and C46. This may be done quickly by disconnecting the 80-volt line at the source, the junction of R56 and R57. With this disconnected, the voltage at the open end of R57 should read approximately 80 volts. If it still reads 160 volts, check R57, R58, and C46 carefully. If the reading at the open end of R57 does drop to 80 volts when the load is removed, you will have to check along the 80-volt line to find the trouble. I don't see any possibility of the defect occurring anywhere but at the source (barring mechanical shorting of adjacent wiring in the circuit).*

The filaments reading of 160 volts on tubes V4, V7, and V8 is correct, as these filaments are connected to the 160-volt line at V8 as shown on the schematic. The voltage readings on the sync separator and sync amplifier tubes won't mean a thing until the source voltage is returned to normal.

Jittery Top

I am having considerable trouble with an RCA Model 21S353. The trouble is horizontal jitter in the top half of the picture; bottom half is normal. All tubes have been substituted, but to no avail. Adjusting the horizontal-hold control to the extreme left tends to reduce the jittering, but sync is lost before the picture is completely steady. Adjusting the AGC, horizontal lock, and horizontal frequency may steady the picture but only for a short period of time. I have tried almost everything and am about ready to give up. Sure hope you can help me.

Harless Radio and TV

Bluefield, W. Va.

Your scope should isolate the defective circuit, providing a step by step procedure is followed when circuit tracing. One method is as follows:

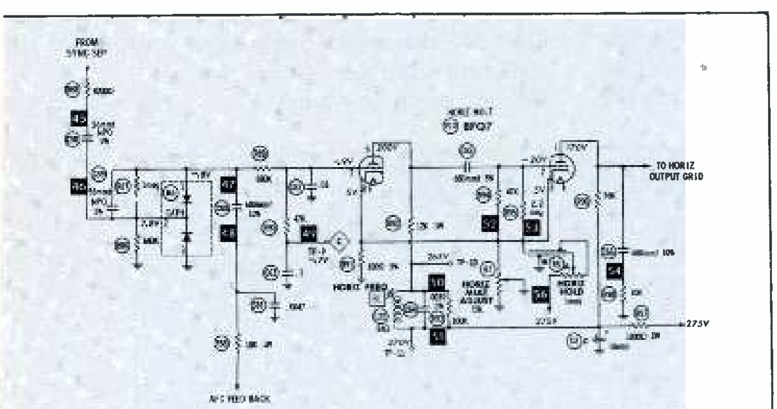
1. *Put chassis in operating condition, with the top and bottom accessible; allow it to play until the conditions you describe are apparent.*
2. *Check waveform (W1) for distortion and amplitude; compare to the one shown on the schematic in* PHOTOFACT *Folder 242-8. If this waveform is correct, the tuner and IF's are eliminated as a potential trouble source. Should this waveform be distorted or decreased in amplitude, the video-IF tubes and associated components must be checked.*
3. *Check waveform (W2) in the same manner; this will determine the merits of the video amplifier.*
4. *Observe waveform (W6); this will check the coupling circuit between the video amplifier and horizontal sync separator.*
5. *Scoping at the grid of the sync amplifier will determine if the horizontal sync signal is arriving at this point.*
6. *Check waveform (W14); the shape and amplitude of this signal is very important. Should it be distorted, an ohmmeter check of all coupling and grid circuit components must be made.*
7. *Check waveform (W15); if any adjustment of the horizontal frequency (B1), or horizontal waveform (B2) coils have been attempted without the use of a scope, W15 will be distorted. Adjust both these coils as outlined under "Sweep Circuit Adjustments," page 13 of* PHOTOFACT.

Voltage Puzzler

I have a Westinghouse TV Model H-K3821 (covered in PHOTOFACT Folder 669-3) with good sound but no high voltage. All tubes, coils, and capacitors in the high-voltage section check normal. The only abnormal voltage readings are on pins 1 and 6 of V10 (8FQ7)—both of these plates measure only 25 volts. The voltage on the B+ side of both R92 and R96 is 270 volts. What would most likely cause a puzzling voltage like this?

ROBERT RICHARDSON

Dallas, Texas



You will probably find the trouble originates in the AFC stage. For instance, if C58 is leaky, it may be placing a positive voltage on the grid (Pin 7) of V10, causing the tube to conduct excessively, in turn lowering the plate voltage. This could pull the horizontal oscillator so far off frequency it becomes inoperative, causing a loss of negative bias on the grid of the second section of V10, lowering its plate voltage, too. M5 could be defective, causing a similar reaction throughout the oscillator stage.

Radar Maintenance

(Continued from page 39)

synchro receiver that is geared to the deflection coil in the indicator. The synchro receiver acts as a motor to turn the deflection coil around the neck of the CRT. Each time the scanner makes one revolution, the deflection coil, and thus the "wagon wheel," also makes one revolution. A system of synchronization is provided to be sure the sweep line points to zero degrees on the CRT face when the scanner points the RF beam over the bow of the ship.

Range markers are used to measure accurately, the distance of a target from the ship. By marking time along the sweep line, the markers also measure the time required for an echo to come back from the target, because the instant its gets back it causes a brightening on the sweep.

The trigger pulse that initiates the sweep also starts the marker. The first marker stage is a blocking oscillator that produces a chain of oscillations. This wave train is shaped and applied to the video amplifiers so that it brightens the sweep at predetermined points, accurately marking time or distance along the sweep line. As the sweep rotates, the marker pips form circles on the face of the CRT, thus the term *marker rings,* as markers are sometimes called. The timing of the marker rings, then, marks off concentric segments of the CRT face, representing miles.

Necessary to the operation of all these circuits are several power supplies. Most radar systems have two high-voltage supplies—one for the modulator, located in the transmitter, and one for the CRT, located in the display unit. All radar systems have one or more unregulated B+ voltages, and one or more regulated. Sometimes negative voltages are supplied, both regulated and unregulated.

The regulated supplies are sometimes adjustable, in which case they are some form of series regulator, often using several tubes in parallel to meet the current requirements. Typical tube complements are: 6SJ7 used as control tube, 6Y6G or 6AS7 used for regulators, and 6L6G tubes sometimes used to regulate lower voltages at lower current. For nonadjustable regulated supplies, ordinary VR tubes are used.

Housings

A large radar system usually groups its components as shown in Fig. 3. The transmitter and receiver are housed in one cabinet, while the video amplifiers, sweep components, and marker circuits are housed in the display unit with the CRT. On ships whose power is 110 or 220 volts DC instead of 117 volts AC, a rotary inverter is used. Some systems use special power converters that supply the radar system with a 400-cps voltage, rather than the standard 60-cps power.

In Fig. 4 is shown a block diagram of a different type of system housing. This system represents several of the smaller, less expensive radar sets. The major difference is the fact that the transmitter-receiver sections are in the scanner.

These radar systems are lower-powered than their larger, more expensive counterparts. Since the modulator pulse isn't so high in power, it is practical to feed it over a transmission line. It is less expensive to carry the modulator pulse to the magnetron than it is to pipe the RF output of the transmitter to the scanner through costly waveguide. So that's what is done. A special, well-insulated coaxial cable carries the modulator pulse to the scanner where the transmitter is housed, and there applies it to the magnetron in the usual manner.

The receiver is handled similarly. The klystron and mixer crystal are in the scanner housing. The duplexer operates as in any other system. The IF output of the mixer is fed into an ordinary low-loss coaxial cable and down to the IF strip which is mounted in the display unit. There is no AFC, so the klystron repeller is tuned manually at the indicator.

Power supplies in most radar systems are housed in the unit where they are used. For example, in the radar system in Fig. 1, the CRT high-voltage supply is in the display unit, the modulator high-voltage supply is in the transmitter housing. In the system in Fig. 4, the CRT and modulator supplies are both housed in the display unit, since that is where they are used. The low-voltage supplies are usually grouped together and then connected via intercabling to the points where they are used; sometimes they are housed in the transmitter housing, sometimes in the display unit.

Servicing

We have discussed radar-system operation without getting involved in circuit detail. For the technician who plans radar servicing, books are available that explain circuits. In fact, many maintenance manuals now include a penetrating circuit analysis of their systems.

In the next and final article, you can go along on a typical radar service call. The radar system we shall service is in poor condition, having laid out the winter abroad ship; on firing it up, we'll likely find multiple troubles. We'll go through a complete check of the equipment, showing a good troubleshooting procedure for the entire equipment, and repairing troubles along the way. Be sure to come along! ▲

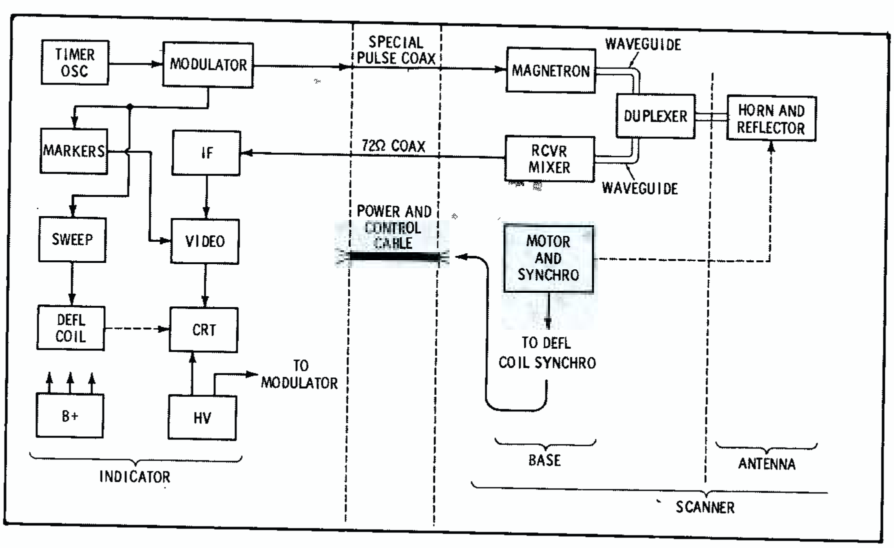


Fig. 4. Small radar has RF plumbing, maggie, and mixer housed in base of scanner.

COLOR COUNTERMEASURERS

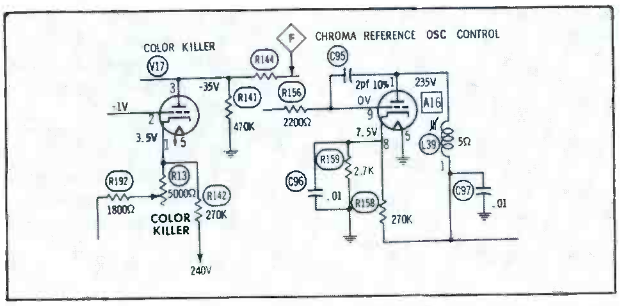
Symptoms and service tips from actual shop experience

Chassis: Zenith 29JC20, 27KC20, 26KC20, 25LC20, 25LC30, 25MC30, 25MC33

Symptom: When channels are changed, the black and white picture precedes the color information by several seconds.

Tip: Align color sync:

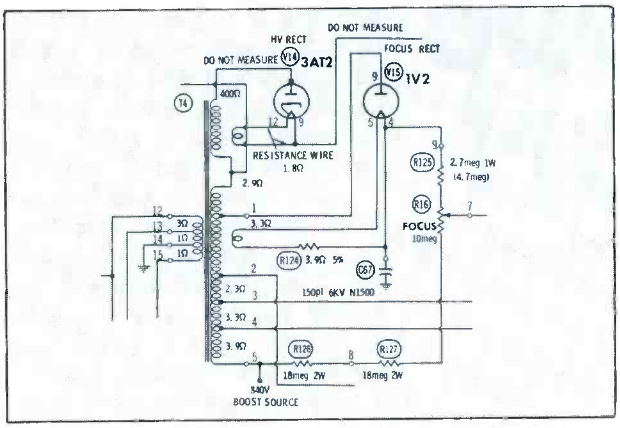
1. Place color switch in "on" position. Connect color-bar generator (color-bar pattern) to antenna terminals. (Alignment can be made by using a transmitted TV-station signal.)
2. Ground test point F (Killer Voltage).
3. Connect a .01-mfd capacitor from the center tap of the burst transformer to ground.
4. Adjust color-oscillator frequency coil (A16) for zero beat as viewed on the picture-tube screen (minimum number of slanting color bars or minimum movement of color bars through the picture).



Chassis: Zenith 29JC20, 27KC20, 26KC20, 25LC20, 25LC30, 25MC30, 25MC33

Symptoms: No raster; weak high voltage; 1V2 focus rectifier burned out.

Tip: Check for shorted focus filter capacitor (150 pf, 6KV). Replace with Zenith part number 22-3578. Check for overheated resistors in focus circuit.



Sorry I had to call you from work, but its, the only way to get you to fix our set.

(Continued from page 33)

AGC Magic

TABLE 1
AGC VOLTAGES FOR TROUBLE ANALYSIS

	Visual symptoms	Detector Voltage	IF AGC	Turner AGC	Receiver condition or general location of trouble
1.	Stable picture, normal contrast and snow (see Fig. 3)	–1.5	–6	–2	Normal for moderate signal
2.	Stable picture, normal contrast with slight snow	–1.5	–6	0	Normal for weak signal
3.	Grainy picture with RF interference (windshield wiper) (Fig. 4)	–1.7	–6.5	–8	Normal set with very strong signal
4.	Overload, little sync (windshield wiper) (Fig. 5)	–1.7	–9	0	Turner AGC too low, C1 leaky, R2 raised in value, or RF tube gassy.
5.	Snow on medium strength signal, normal on distance	–1.5	–2	–10	Turner AGC too high, or IF AGC too low. C2 leaky, IF tube gassy, or R1 raised in value.
6.	Blank raster on-channel, normal snow off-channel	–12	–4	0	Video or AGC keyer dead, C3 shorted, C4 leaky or open, R5 open, B+ 140 too low, or keyer grid voltage too low.
7.	Blank raster	0	–12	–20	G to K short in keyer, open AGC control, or plus 140V B low. Video tube open.
8.	Weak contrast, no snow	–1	–3	0	IF stage weak or dead.
9.	Weak contrast, some snow	–1	–3	0	Mixer stage weak or dead.
10.	Heavy snow, normal contrast (Fig. 6)	–1.2	–4	0	RF stage dead.
11.	Weak contrast, little sync	0	–4	0	Detector diode bad.
12.	Overload, no sync (Fig. 7)	+2	–4	0	Detector diode reversed.

age shorted out, making mixer B+ low.

You might ask if the chart works for some of the new sets where the IF AGC measures up to +30 volts off-channel and down to zero when on-channel. The answer is "Yes, if you measure the IF AGC from the cathode of the first IF tube to the IF AGC terminal." And, what about those sets where the AGC lead on the tuner measures a positive voltage? This positive voltage is bled to ground by the RF grid, therefore ignore any positive voltage here by regarding it as "zero reference." Any negative voltage can be used on the chart without modification.

Suggestion: When you service any set and have the schematic handy measure these three voltages (detector, IF AGC, and RF AGC) and write them on the edge of the diagram. Then, when another of the same model has an AGC trouble, you will be all ready to use the chart without wondering if allowances must be made. The next time you have an AGC or overload problem (or wonder if the AGC is really at fault) just compare the symptoms against the chart and see if the "magic" will work for you. ▲

(Continued from page 37)

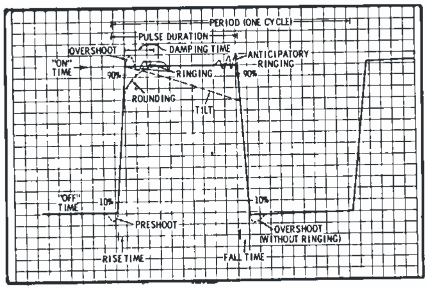


Fig. 3. Terminology of the square wave.

much capacitance. A circuit shunted by too much stray capacitance simply can't pass all the higher-order harmonics in the true square wave. A rounded corner at the top of the rise is indicative that these higher frequencies are missing in the waveform.

Tilt, a falling off in amplitude over the duration of the flat top, suggests poor low-frequency characteristics. The amplitude recedes because the circuit simply can't handle a sustained voltage at any level. If any tilt appears in a square wave, it will be worse at a lower fundamental frequency, because the duration of the flat portion of the waveform is greater (remember the $T = \frac{1}{2}f$ relationship).

Remember these characteristics of a square wave, because they'll be mentioned frequently in all discussions of square-wave analysis.

Square Wave Generators

Square waves can be formed by clipping the peaks from ordinary sine waveforms, but the sloping sides are rather poor in rise-time characteristics. The square wave in Fig. 4 was developed in this way and has a rise time of several msec—much too long. A multi-vibrator produces an output waveform that lends itself readily to being formed into a square wave, and this is the circuit commonly used in most well-equipped square-wave generators.

High-quality instruments (the only practical kind for accurate square-

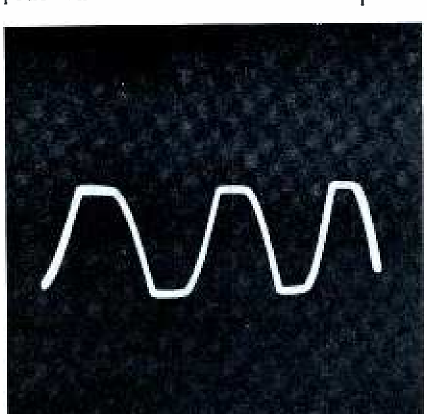
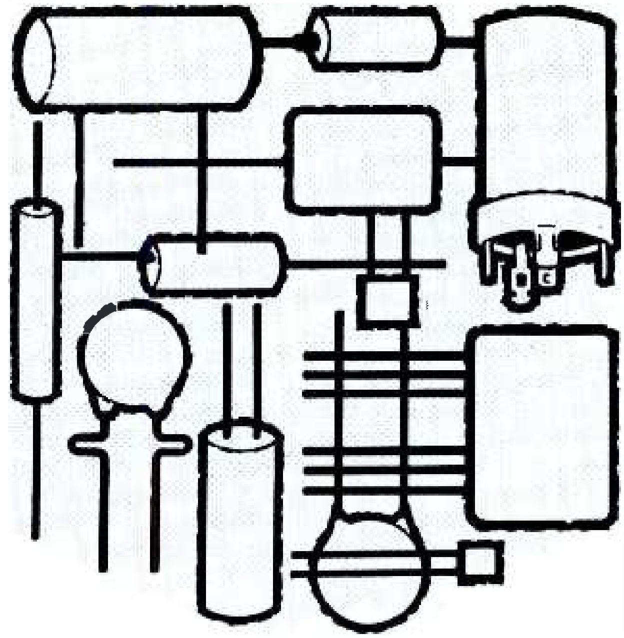


Fig. 4. Sine wave clipped for "square."



wave analysis) develop square waves having a rise time of approximately 25 nsec. (.025 usec) or faster. Preshoot, overshoot, ringing, rounding, and tilt must be absolutely unnoticeable when viewed on a scope with a rise time at least twice as fast (12 nsec). Generators of lesser quality are generally usable for square-wave analysis, but their slight abnormalities have to be discounted in analyses—sometimes a confusing task.

The output level of square-wave generators is seldom great, because high-amplitude (energy) signals aren't needed—they're not even desirable for most tests. One high-grade unit provides a low-impedance output at around 5 volts peak and a high-impedance level of nearly 50 volts peak.

You may have noticed the reference to square-wave voltage as a *peak* level instead of peak-to-peak. Exact terminology depends on whether you are using AC reference or DC reference. Accurate square-wave analysis generally requires response down to DC, therefore a DC-type triggered scope is most appropriate. Fig. 5 shows the difference between considering the square wave as referenced to AC and as referenced to DC. The latter is more common in high-grade instruments, and is easier to work with.

The colored markings indicate AC reference terms, which you're probably familiar with already. The square wave centers itself symmetrically around the zero level; excursion is in a positive direction for one half-cycle and negative for the other.

With DC reference, used in most serious square-wave generators the output is clamped to ground; the pulse is considered "on" for one half-cycle and "off" the other. The labeled active pulse in Fig. 5A is shown positive-going for convenience of presentation. In actual generators, it is common to clamp zero volts to the chassis and let the negative excursion be the output (see Fig. 5B). The only difference in 5A and 5B is in where the trace will situate itself on the screen of a DC scope (A would go upward and downward from zero reference; B will extend downward only).

Square Waves in Analysis

Now that you understand the characteristics of a square wave and know how the signal is presented by a good generator, you can use a triggered scope to view the waveshape both before and after it is applied to the circuit or network to be analyzed. Your analysis will be based on how the square-wave signal is modified by the circuit to which it is applied. Your knowledge of the effects of frequency, duration, rise time, etc., will enable you to analyze changes intelligently.

Assuming the use of a good generator, you know that the waveform you feed in is perfectly square; so, any changes you observe will be caused by the circuit under test. However, it isn't always easy to recognize vague differences, so a means of comparison is handy. There are two ways—one mechanical and inexpensive, the other electronic and costly but more effective and accurate.

The mechanical method consists of making up a transparent square-wave overlay for your scope graticule. Using the generator and scope you'll use for this type of servicing, feed a square wave to the scope and adjust the controls for a pattern (two cycles is probably best) that is convenient to view on the CRT face. Trace this pattern carefully and transfer it in black ink to a stiff piece of transparent plastic film. Whenever you are analyzing with square waves, put the overlay in place, adjust the scope controls to subimpose the test display under the overlay pattern, and compare. Remember, if you change any part of your equipment or setup, you'll have to trace a new reference waveform.

The electronic method is by use of a dual-beam scope—a scope with an

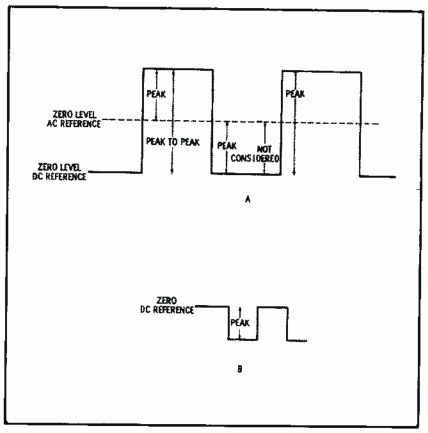


Fig. 5. Ways of considering waves.

electronic switch that presents first one input image and then the other, but does it quickly enough that they appear as two steady displays. Whenever you're analyzing by this system, just connect the generator output to one channel of the scope as well as to the circuit being tested and connect the circuit output to the other scope channel. Both will be displayed on the scope CRT, and they can even be superimposed for more critical examination.

Shape of Things to Come

Subsequent articles, beginning next month, will show you step by step how square waves are affected by various circuit elements and parameters. Starting with the simple effects of resistance, inductance, and capacitance, we'll take you all the way through testing of multiple-terminal devices that are completely unidentifiable except by this method. You'll learn how faults affect the square waves passed by these same components and networks.

Once you understand the basics of sophisticated square-wave analysis, you'll also learn to use square-wave test procedures to analyze audio, video, and chroma circuits, as well as for performing dozens of other practical circuit and servicing tests.

In the process of learning these advanced techniques, you'll learn practical facts about basic electronics that may surprise you. You'll see many functions you've only vaguely comprehended before now presented in a new light. This new understanding will better equip you to survive the onslaught of technology that sometimes threatens to engulf the service technician who tries desperately to keep up with a rapidly advancing field. These articles may prove to be the most informative and ultimately practical series we've ever presented to our readers. We certainly hope they will. ▲

Coils

(Continued from page 35)

the surface (skin) of the wire, causing an in-phase resistance component. To minimize this skin effect, good-conductivity solid wire (sometimes silver- or gold-plated), or Litz wire is used in certain critical coils.

Dielectric Effects—Dielectric losses are introduced by the insulation of the wire with which the coil is wound, by the insulating form on which the coil is wound, and by any insulant within the field of the coil. These losses are minimized by using a self-supporting (airwound) coil of bare wire where possible, or by employing a high-grade, moisture-resistant dielectric (polystyrene, nonhygroscopic ceramic, and the like) in the form and supports. Unessential dielectric bodies must be kept out of the coil field in any circuit at frequencies above 100 kc.

Installation Hints

The following rules will be helpful for obtaining best results.

1. Use only exact replacements.
2. Check inductance carefully with an inductance bridge or inductance meter (100 cps) or Q meter (1 mc). Change the test frequency if another is specifically recommended by the coil manufacturer.
3. In general if a coil is supplied with a shield, do not remove it. Removing the shield not only promotes interference in the circuit, but also changes the inductance of the coil.
4. If you add a shield to a coil, keep the ends of the shield at least one-half the length of the coil away from the top and bottom of the coil, and the sides of the shield at least one diameter from the sides of the coil.
5. In an RF tuned circuit, use only the highest Q (lowest-loss) coil obtainable.
6. Avoid mounting a coil close enough to a variable capacitor, chassis, or other metal object that the field of the coil will cut the chassis or object. (See dimensions in item 4 for proper separation.)
7. Mount coils rigidly.
8. Use *long,* insulated screwdriver or alignment tool when adjusting a variable inductor. ▲

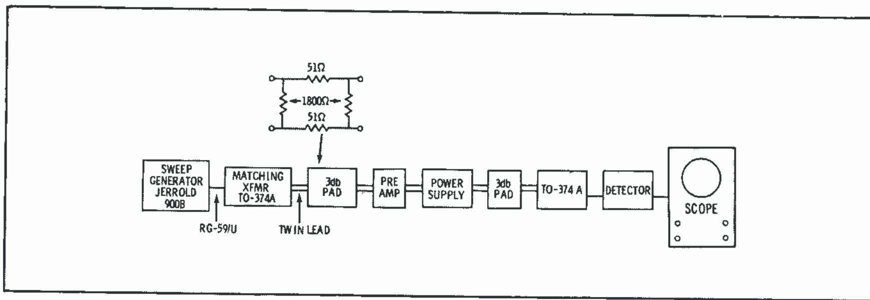


Fig. 10. Diagram of equipment set up for sweep testing described in text.

a 200-mc signal. If the unit is operating properly, the scope trace should look just like Fig. 8. Gain, however, would be about half.

To trace signals within the amplifier, you'll have to build a little probe, like the one shown in Fig. 9.

Suppose, for example, that capacitor C6 were open. We'd get little low-band response with the signal going straight through the unit, but the low-band response would look approximately normal if we connected our probe directly to the emitter of X2. A point-by-point check of all the signal-carrying components between the amplifier input and X2 would quickly reveal the culprit.

The output circuits can be checked in exactly the same way. We simply inject the output of the signal generator directly into the amplifier and connect the scope probe to the detector end. Now, the scope probe can be used anywhere between the transistor collectors and the output terminals of the amplifier. The scope traces should look like those in Fig. 8 at all points where the amplifier is operating properly.

The Sweep Method

The most sophisticated method of servicing an antenna preamplifier is by using an RF sweep generator. The setup (Fig. 10) shows you the entire response of the amplifier at a glance. For gain evaluation, you can make a comparison between the di-

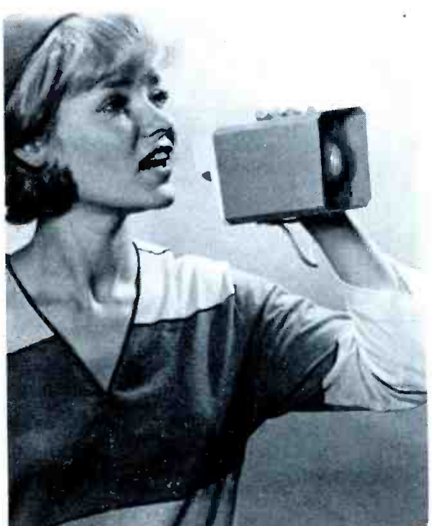
• *Please turn to page 86*

Product Report

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

Low-Cost Tweeters (120)

Two new cone-type tweeters have been added to the line of high-fidelity speakers manufactured under the "Tempo" label by **Oxford Transducer Corp.** Both tweeters feature curvilinear cones designed for good low-end cutoff and high sensitivity in the higher-frequency range. Closed-back baskets prevent interaction with mid-range and woofer speakers in the same system. Model T 3C208 is 3" square and has a specified frequency response of 1800 to 17,000 cps. Model T 5C208 is 5" square, with a specified response of 1000 to 17.000 cps. Both units have a rated power-handling capacity of 6 watts.



Low-Cost Electronic Megaphone (121)

A transistorized megaphone, the Model MV-2 by **Fanon-Masco,** develops one full watt of audio output and is said to increase the vocal range by as much as 150 yards. The compact, hand-held unit would be useful to Boy Scouts, boaters, campers, coaches, and others who are active outdoors. The Model MV-2 operates on eight standard penlight batteries and is made of high-impact plastic. A wrist cord is attached for carrying. A talk-lock switch is provided for easy continuous talking, and a volume control permits adjustment of the output level according to the coverage required. The unit, which weighs 1½ lbs and measures 7" x 4" x 2½", is priced at $19.95.

BOOK REVIEW

How To Make More Money In Your TV Service Business: John Markus: McGraw-Hill Book Co., Inc., New York, New York: 346 pages, hardbound: $7.95. Making money is one goal men choose when they begin a business for themselves. In most cases, it's not the only objective, but it certainly holds a firm position near the top of the list. The unfortunate reality is that many would-be practitioners of the art of private enterprise have only a very fogey notion of even the basic requirements necessary for success. Mr. Markus is convinced there is no reason for technicians contemplating their own service business to make the same mistakes which have caused so many of ther predecessors to fail in similar ventures. For those who will take the time to read, study, and apply the precepts found in his book, success should be a far more easily attained goal.

A complete listing of the topics covered by Mr. Markus would require several lengthy paragraphs, but just a few will demonstrate the breadth of his coverage. In planning a business, Mr. Markus suggests when to begin a part-time business, how to choose a business name, when to move to full-time effort, how to rent a shop and where, how to advertise effectively, how much to charge for your work, how to attract new customers, and how to handle callbacks. He has many other useful suggestions for dealing with customers. He tells how to write ads, discourage credit, make out a bill, collect overdue accounts, set up your records, and answer common customer gripes. His advice will help to hire efficient workers, avoid legal problems, handle installment sales, and save money on your income tax. In short, this book is a well-planned and concisely written business course for those who will take the time to learn from it. Business neophytes and established shop owners alike will find much of value to build their operations and increase their incomes.

While this book has been available for nearly three years its value is such that it warrants new attention and frequent reference by all who own or operate a servicing business and by any who plan to do so.

Goof-Proof Multimeter (122)

An up-to-date version of the well-known line of **Simpson Electric Co.** Model 260 multimeters, known as the Model 260-5P, offers protective circuits to prevent nearly all meter damage. The new meter has the same voltage, current, and resistance ranges as the Model 260-4, which is still in production as a lower-priced instrument without the built-in protection. When an overload occurs, an indicator button on the panel pops out. When the overload has been removed, the meter is reset by pressing the same button. It will not reset while the circuit is still overloaded. The Model 260-5P is priced at $78.95 in standard configuration and at $84.95 with a roll-top case.

Convert Tape Recorders to VOX

(123)

Conversion of any tape recorder to voice-actuated operation is now possible with the new "Voice-matic" from **Kinematix, Inc.** The "Voice-matic" permits operation of tape recorders from a distance, at leisure, or while hands are busy writing, turning pages, etc. Installation takes only a few seconds, and no tools are required for most conversions. An adjustable delay varies the hold-on time to prevent too frequent shutoff of the recorder during pauses in dictation or other continuous recording. The Model KX-5000 "Voice-matic" can be used for dictation, as a film sync device for narrated slide films, as a baby-sitter alarm or burglar alarm, or to control amateur or CB transmitters. The unit is priced at $34.95, complete with case.

Tiny Transistor

(124)

A transistor radio, said to be the world's smallest, is being marketed by **Ross Electronics Corp.** Featuring black-and-chrome styling and measuring 2" square by 1⅞" thick, the 7-transistor radio is about half the size of a standard cigarette package and fits comfortably within the tiniest evening purse. Suggested retail price for Model RDM-7 is $17.95. ▲

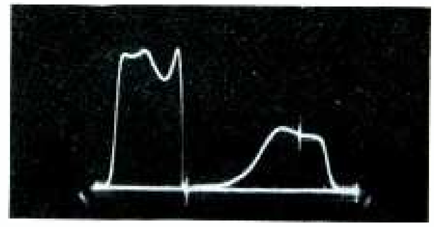


Fig. 11. Note markers 100 and 200 mc.

rect output of the sweep generator and the output of the amplifier.

Fig. 11 shows the sweep response of the unit of Fig. 4 as seen on the oscilloscope. Notice the markers at 100 mc and 200 mc. These facilitate alignment, which is virtually impossible without a sweep generator.

We can use the same type of demodulator probe with this setup as

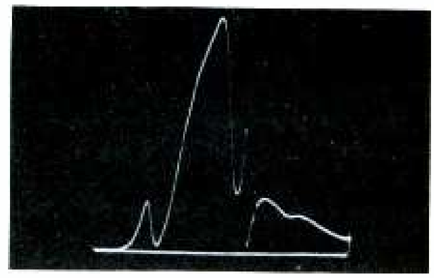


Fig. 12. Low-band curve if C6 is open.

we used for tracing with the signal generator. But scope displays are much more definitive using the sweep method. For example, with C6 open and the probe connected directly to the emitter of X2, the scope display obtained by the tracing method looked quite normal . . . remember? Fig. 12 shows how distorted the response obtained by the comparative sweep method really is.

You can also look at either the high-band or low-band response, separately. Fig. 13 shows the normal high-band response, with the signal injected at the base of X1.

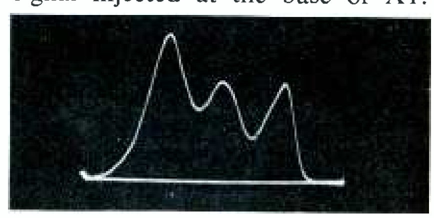


Fig. 13. Normal high-band curve. The marker in second valley is at 200 mc.

Using this method, in fact, you can take a close look at any portion of the band, sweeping as narrow a range as 10 kc.

Conclusion

If you have a reasonably-well-equipped TV shop, plus basic servicing skills, you'll probably have little difficulty in repairing antenna boosters—at a profit. ▲

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NEW TUBE TYPES INTRODUCED IN '65 TV

1DK1	Sony
2HQ5	Airline Bradford Catalina Coronado
2VD4	Airline
3HQ5	Airline
4AF4A*	GE
4ES8	Clairtone
4HA7	Emerson
4XG7	Catalina Coronado
5AN8	Airline
5GX7	Airline
5HA7	Emerson
5HB7	Airline Bradford
5LJ8	Admiral
6C9*	Airline Ambassador
6CA4	Airline Ambassador
6CM8	Packard-Bell
6EU7	Airline
6GH5	RCA
6HB7*	Airline Magnavox
6HM5	Zenith
6HQ5*	Airline Andrea
6HD6	RCA
6JM6*	Motorola GE Zenith
6JN6*	Zenith
6JX8	Clairtone
6KE8	RCA
6KL8*	Airline Ambassador
6KZ8	RCA
6LC8	RCA
7GS7	Arvin
8A8	Arvin
8GM6*	RCA
8LC8	RCA
9JW8	Clairtone
10GN8	Airline Zenith
10JT8	Sylvania
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12BT3	GE
12FS5	Bradford
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18GV8	Arvin, Clairtone
19EA8	Admiral
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21HB5A	GE
21HJ7	Airline
22BW3	Zenith
23Z9	GE
25E5	Arvin Delmonico
27GB5	Clairtone
30AE3	Clairtone
38HE7	Admiral
45BW5	Admiral
5642	Channel Master

FREE Catalog and Literature Service

**Check "Index to Advertisers" for further information from these companies.*

Please allow 60 to 90 days for delivery.

ANTENNAS & ACCESSORIES

57. *ALLIANCE*—Flyer describing Model 300 broad-band VHF booster; suitable for black-and-white or color.
58. *ANTENNACRAFT*—Latest literature on *Channel-Spanner*, a new broad-band high-gain VHF-UHF TV antenna
59. *CORNELL - DUBILIER* — Replacement component selector, TV - FM reception booklet, 4 - page rotor brochure, and vibrator replacement guide.
60. *FINNEY* — Catalog UVF describes new swept-element log-periodic type VHF-FM antennas.*
61. *IEH*—Catalog sheets on Model AP-25 UHF-VHF coupler and Model AP-26 TV-FM splitter-coupler.
62. *JFD*—Literature on complete line of log-periodic antennas for VHF, UHF, FM, and FM stereo. Brochure showing converters, amplifiers, and accessories; also complete '64-65 dealer catalog plus dealer wall chart of antenna selection by area.*
63. *MOSLEY ELECTRONICS* — Illustrated catalog giving specifications and features on large line of antennas for Citizens band, amateur, and TV applications*.
64. *MULTITRON* — Illustrated literature on FM-stereo antenna No. MA-44, Multituner Model M-11, and Minitenna No. MINI-4T.
65. *STANDARD KOLLSMAN* — Catalog sheet on UTC-051 transistor UHF converter kit with IF amplifier.
66. *TRIO*—Brochure on installation and materials for improving UHF translator reception.
67. *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

68. *ADMIRAL* — Folders describing line of '65 equipment; includes black-and-white TV, color TV, radio, and stereo hi-fi.
69. *ATLAS SOUND*—Catalog No. 564 contains illustrations and specifications on PA speakers, microphone stands for commercial and industrial installations, and other new products *
70. *GIBBS SPECIAL PRODUCTS*—Folders describing C-46 and C-66 sound columns, two-way wall speaker system, and bidirectional baffle-speaker combinations.
71. *JENSEN* — 24-page catalog, No. 165-K, illustrates and describes speakers and speaker system kits.
72. *NUTONE*—Two full-color booklets illustrating built-in stereo music systems and intercom-radio systems. Includes specifications, installation ideas, and prices.
73. *OAKTRON* — "The Blueprint to Better Sound," an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.
74. *OXFORD TRANSDUCER*—Product information bulletin describing complete line of loudspeakers for all types of sound applications, including replacements for public address and intercom systems.
75. *PERMA-POWER* — New catalog sheet describing Ampli-Vox Model S-300 and Sound Cruiser sound system Model S-310.*
76. *QUAM-NICHOLS*—General catalog listing replacement speakers for public address, hi-fi, and radio-TV applications.
77. *SAMPSON* — Full-color catalog pages showing new line of Waltham transistor radios, tape recorders, and portable television sets.
78. *SHURE BROTHERS*—Folder on newly introduced hi-fi magnetic cartridge.
79. *TURNER*—New four-page, full-color catalog No. 1040 describing microphones designed for church applications.

COMMUNICATIONS

80. *PEARCE-SIMPSON* — Specification brochure on IBC 301 business-band two-way radio, *Companion 11, Escort*, and *Guardian 23* Citizens-band transceivers.
81. *SONAR RADIO* — Specification sheet on Model FM-40 business radio.

COMPONENTS

82. *BUSSMANN*—Bulletin SFH-10 on new compact fuseholders only 1⅝" long, extending just 29/32" behind front of panel, and requiring only ½" mounting hole. Holders take ¼" x 1¼" fuse and are available with either screw-type knob that is easily removed by hand or with screwdriver slot.*
83. *GC ELECTRONICS* — 80-page industrial catalog FR-66-1 showing newly introduced products.
84. *INTERNATIONAL ELECTRONICS* — New expanded listing covers popular IEC and Mullard tube types for TV, AM and FM radio, and high-fidelity.
85. *J-B-T-INSTRUMENTS*—General catalog 563A has information on frequency meters, elapsed-time meters, and numerous relays and switches.
86. *RAWN*—New professional ideas for knob and plastic repair.
87. *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.*
88. *SWITCHCRAFT*—New product bulletin No. 150 describes a complete line of low-capacity lever switches.*
89. *WORKMAN*—Coil catalog No. 109 and cross reference for replacement of antenna coils. IF transformers, RF chokes, linearity coils, and others for FM radios, tape recorders, and color TV receivers.

SERVICE AIDS

90. *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.
91. *ELECTRONIC CHEMICAL* — Catalog sheet on contact cleaner; brochure on tape recorder head cleaner.
92. *PRECISION TUNER*—Literature supplying information on complete, low-cost repair and alignment services for any TV tuner.*
93. *YEATS* — The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing feather-weight-aluminum construction.

SPECIAL EQUIPMENT

94. *ATR* — Descriptive literature on selling new, all-transistor *Karadio* Model 707, having retail price of $29.95. Other literature on complete line of DC-AC inverters for operating 117-volt PA systems and other electronics gear.*
95. *GREYHOUND* — The complete story of the speed, convenience, and special service provided by the Greyhound Package Express method of shipping, with rates and routes.
96. *ELECTRO PRODUCTS*—Information on transistorized inverter Model TI-100; converts DC to AC and has 125-watt output.
97. *SETCHELL-CARLSON* — Full-line catalog for both color and b-w receivers, plus educational receivers.
98. *STACO*—Short form catalog 2176 on line of variable transformers; complete with latest prices.
99. *TERADO*—Latest information on *Taper Rite* battery charger.
100. *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.
101. *WALLIN-KNIGHT*—Folder on Reflect-O-Scope, an effective tool for static convergence of color TV receivers.

TECHNICAL PUBLICATIONS

102. *CLEVELAND INSTITUTE OF ELECTRONICS*—Free illustrated brochure describes electronic slide rule with four lesson Instruction Course and grading service.*
103. *OELRICH PUBLICATIONS*—Catalog of business forms for TV, radio, and 2-way service; also sample of new NCR service forms.
104. *RCA INSTITUTES* — 64-page book. "Your Career in Electronics," detailing home study courses in TV servicing, communications, automations, drafting, and computer programming; for beginners and experienced technicians.*
105. *HOWARD W. SAMS* — Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

106. *B & K*—Bulletin 108-R on Model 801 Capacitor Analyst. Bulletin No 124-R on 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, and other test instruments *
107. *EICO*—New 1965 catalog listing over 200 products including color-bar generator, oscilloscopes, and others; all available in kit form.
108. *HICKOK*—Specification sheets on Model 662 installer's color generator, Model 677 wideband scope, Model 470A uni-scale VTVM, and Model 799 *Mustang* tube tester.
109. *JACKSON*—Complete catalog describing all types of electronic test equipment for servicing and other applications.
110. *LECTROTECH*—Bulletins on new color TV test instruments, horizontal deflection circuit meter, meter protective devices, and substitute for VTVM battery.*
111. *MERCURY*—Literature covering Model 1100A, 1101, and 202E tube testers; Model 1500 signal generator; and entire line of test equipment.
112. *SECO*—Data sheets on self-service tube testers and caddy-pack tube testers that carry over 200 tubes.
113. *SENCORE*—New 8-page catalogue No. 257 on complete line of company products: oscilloscopes, generators, testers, and many others.*
114. *SIMPSON*—Complete 16-page brochure on entire line of electronic test equipment; also, catalog on line of panel meters.*
115. *TRIPLETT*—All new test-equipment catalog No. 46-T showing complete line of VOM's, tube testers, transistor analyzers, and signal generators.
116. *WATERMAN* — Technical data and photos on pocket-size OCA-11A industrial oscilloscope.

TOOLS

117. *ENTERPRISE DEVELOPMENT*—Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering techniques for speeding up and simplifying operations on PC boards.*
118. *LUXO LAMP*—New catalog No. 114-2 showing illuminated magnifiers and low-voltage lights.
119. *UNGAR*—Catalog No. 763 giving information on series of soldering irons and accessories.

LET'S GET DOWN TO BUSINESS

...in Color-TV Service

Make your shop look like it means business. You can with business-like technical, promotional, business and service aids from RCA . . . with the emphasis on color TV service. Remember, more and more of your service jobs will be color TV jobs.

TECHNICAL AIDS . . . to help you further develop your professional skills.

The famous RCA Color TV Troubleshooting Pict-O-Guide. Completely revised and updated, it's the quick and easy, all in one, profusely illustrated guide to proper troubleshooting and alignment of color TV sets. A **MUST** reference book, if you want to make money in color TV service. Form #1A1389.

Also available (not shown): **RCA Institutes Color TV Home Study Course,** the basic definitive course in color servicing; 8 graded lessons, counselling and examination service. Form #1A1325.

PROMOTIONAL AIDS . . . to help you attract more customers.

Illuminated Flashing Window Display (at left on counter). A real attention grabber for your window or counter. Alternates between full color and black and white to dramatize both services. Form #1A1491.

Color TV Service Banner (on wall). In rich red satin, for door, wall or window display. Form #1A1492.

Also available, (not shown) are a transparent window streamer, ad mats for local newspapers, post cards and envelope stuffers all promoting your color TV service capabilities.

BUSINESS AND SERVICE AIDS . . . to help make your job easier.

RCA Receiving Tube Floor Merchandiser (left) Spacious, 6 foot gravity feed metal shelving unit in bright red baked enamel finish. Seven shelves with adjustable dividers for each shelf. Helps you keep a really good supply of tubes in one well organized area. Form #1A1504.

RCA Receiving Tube Wall Merchandiser (rear) Three feet high and three feet wide, a metal gravity feed shelving unit finished in red baked enamel to hang on wall or rest on counter. Form #1A1503.

RCA TV Tool Kit (on counter) Contains 12 most needed TV tools: 3 aligners, aligning wrench, tuning wand, 3 trimming tools, standard and recessed screwdriver, solder aid, heat sink and clamping type tweezers . . . just about everything you need on a service call in one container; also handy in the shop. Form #1A1509.

RCA Superweld Tube Caddies. Large "Treasure Chest" caddy (1A1001A) shown on counter at right holds up to 362 receiving tubes. Junior version (1A1002A) (not shown) holds up to 234. Both feature a Superweld vinyl covering that protects like armor.

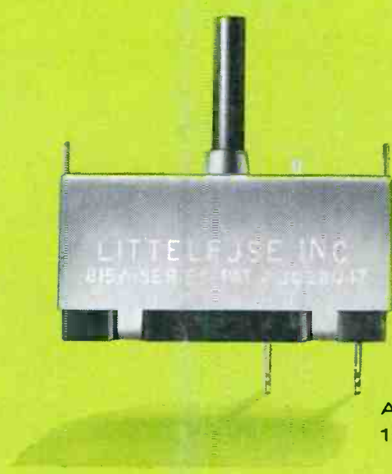
You'll also want to ask your RCA distributor about store hours signs, door knob hangers, and weekly work schedule pads from RCA.

These are the aids you really need in your business.

AVAILABLE THROUGH YOUR LOCAL AUTHORIZED RCA TUBE DISTRIBUTOR.

RCA® **The Most Trusted Name in Electronics**

Introducing a Complete Line of Littelfuse Quality Circuit Breakers



Actual Size
$1\frac{3}{4}'' \times 1\frac{3}{16}'' \times \frac{1}{2}''$

Exact replacement from factory to you

Designed for the protection of television receiver circuits, the Littelfuse Manual Reset Circuit Breaker is also ideally suited as a current overload protector for model railroads and power operated toy transformers, hair dryers, small household appliances, home workshop power tools, office machines, small fractional horsepower motors and all types of electronic or electrical control wiring.

LITTELFUSE DES PLAINES, ILLINOIS

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