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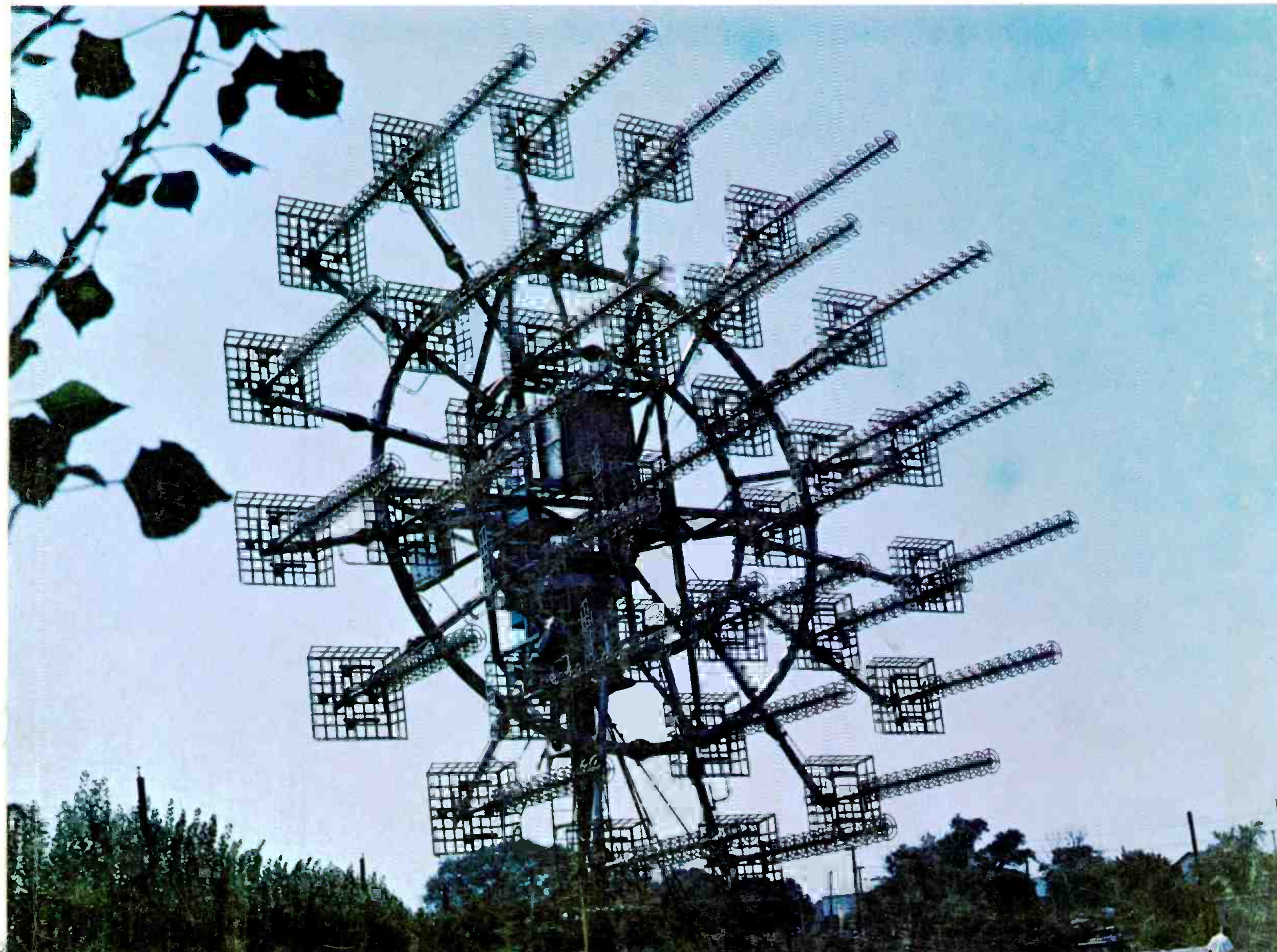
JULY 1965/50¢

PF Reporter™

PHOTOFACT

the magazine of electronic servicing



Special Antenna Section

- Overcoming Wind-Load Effects
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- Phasing Multiple-Antenna Systems
- Plus other servicing features

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THE BIG PRODUCTS . . . THE BIG PROGRAM . . . THE BIG BACK-UP . . . FOR BIG SUMMER PROFITS

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In the new world of color TV, the Jerrold Coloraxial Reception Specialist will be a big man in his community. You can qualify now, and get shirt emblems and truck decals that proclaim you the Coloraxial TV expert in your area. Talk it over with your Jerrold distributor today, and start reaping the profits on our BIG SUMMERTIME SPECIALS.

BIG SUMMERTIME SPECIALS ON Coloraxial* · Powermate Paralog · Paracyl · Colorguard

1 August 15 is the deadline! See your Jerrold distributor today and take advantage of the great specials available on the popular Jerrold line . . . antennas, preamplifiers, amplified couplers, unamplified couplers, and Coloraxial conversion kits.

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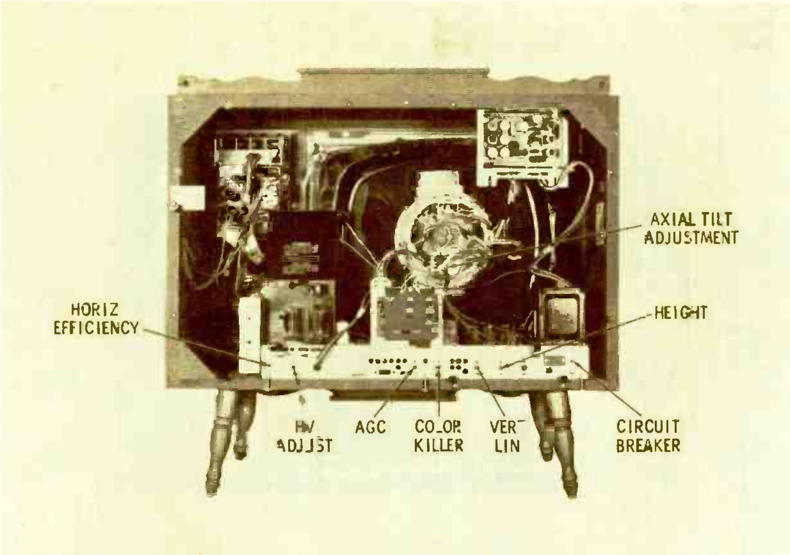
Circle 1 on literature card



Admiral
Model LG5315
Chassis G-1263-1

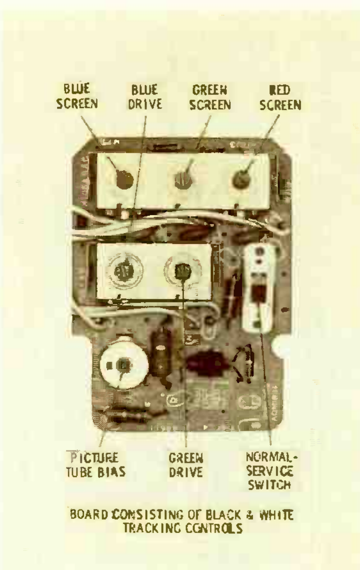
"Giant-size color" might be the best way to describe the above-pictured 25″ Admiral color receiver. In most respects, this set is the same as the company's 21″ models. However, the larger rectangular picture tube, a 25AP22, has necessitated a few circuit modifications along with an additional circuit that corrects for pincushioning at the top, bottom, and edges of the raster. Another new feature, automatic degaussing, is also found in this set.

An axial tilt adjustment is located beneath the yoke and provides a minor adjustment for the blue at the edges of the screen. If necessary, this tilt adjustment should be made after receiver convergence. Loosen the yoke-positioning clamps and turn the ¼″ screw until the blue vertical lines coincide with the red and green vertical lines near the edges of the raster.

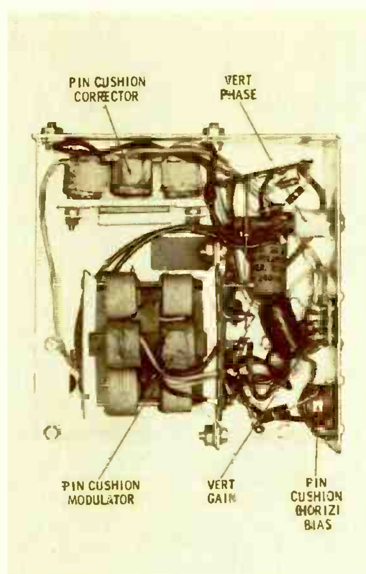
The adjustments for correcting vertical or horizontal pincushioning are in an individual subchassis mounted on the left side of the main chassis (when viewed from the rear). These adjustments should be performed using a crosshatch pattern on the screen. The adjustment procedure for vertical correction is as follows: Turn the vertical gain control fully clockwise; adjust the vertical-phase transformer until the horizontal lines at the top and bottom of the screen are symmetrically rounded or bowed; adjust the vertical-gain control until these lines are straight. For horizontal correction, connect a VTVM from the center lug of the horizontal-bias control to ground, and adjust the control for a 4-volt DC reading on the meter.

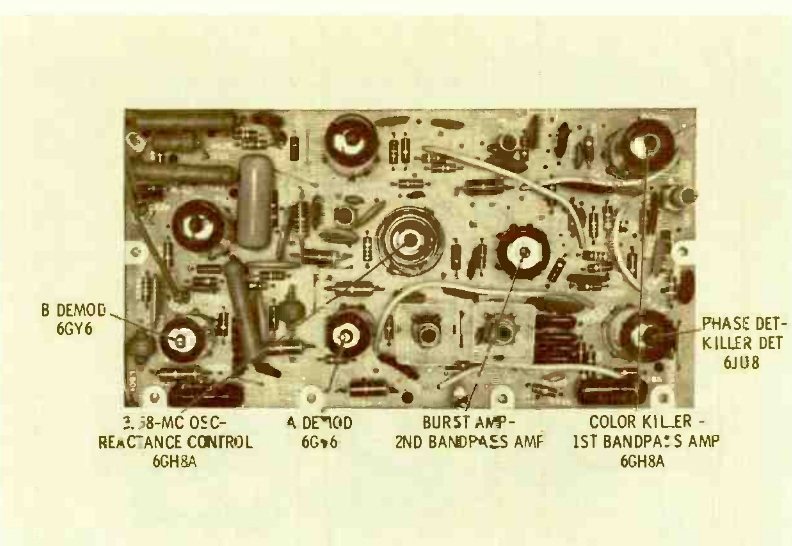
The low-voltage power supply in this transformer-powered set is a little uncommon. It uses four silicon rectifiers wired in a bridge rectifier network.

If you have difficulty in obtaining the correct purity, check the filter choke in the power supply. If this choke has two yellow wires, try reversing the connections. Early production runs used a choke with two yellow leads, and if these are connected improperly, polarization of the choke is incorrect. In later production, a choke with one black and one yellow lead is used to alleviate this problem.



BOARD CONSISTING OF BLACK & WHITE TRACKING CONTROLS





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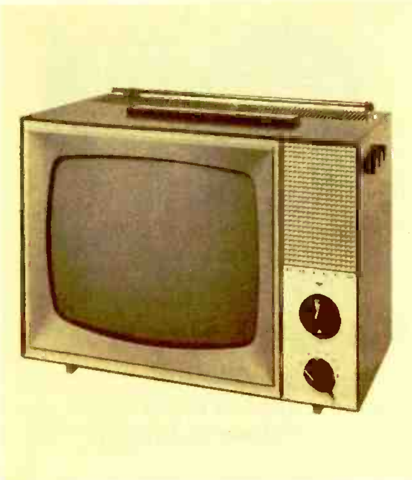
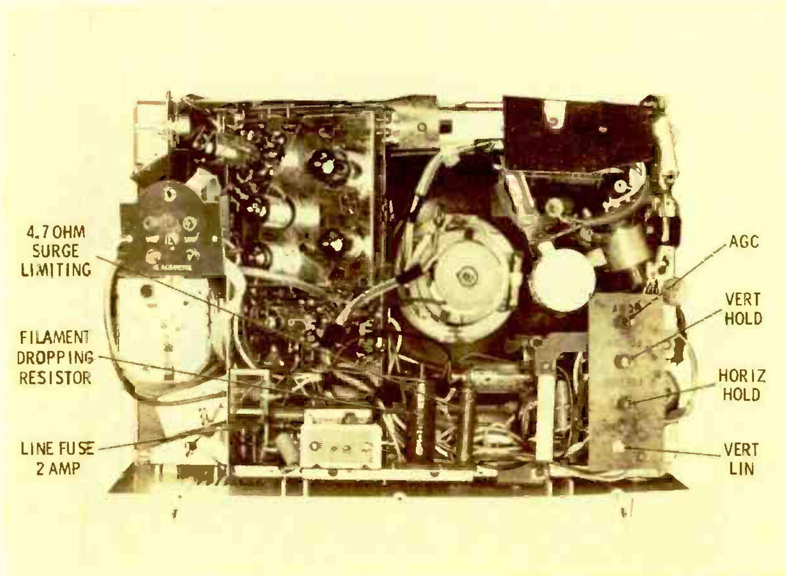


Philco
Model N1200BR



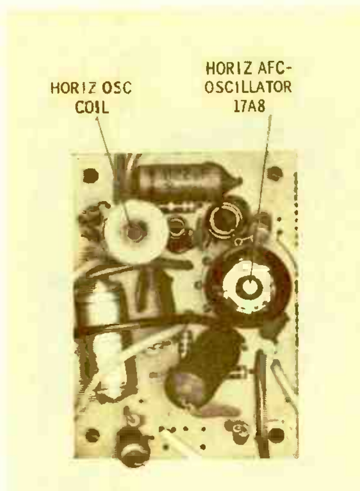
Here's Philco's latest small-screen portable—a 12" set equipped with a built-in monopole antenna, earphone jack, and carrying handle. The chassis in this Japanese import has a different physical appearance along with several unfamiliar tube types.

A total of 14 tubes is used, including the CRT—type A31-12W—and those in the VHF tuner. The chassis consists of three individual printed circuit boards. There are two small boards; one contains the vertical-sweep circuits, the other the horizontal AFC/oscillator. The remainder of the circuitry, with the exception of the low- and high-voltage power supplies and horizontal-output stage, is on the large printed board.

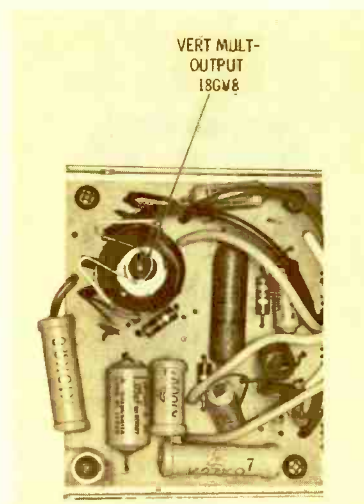
The two-stage video IF strip uses a 6EH7 and 6EJ7 as first and second IF amplifiers, respectively, followed by a 15CW5 as the video output. An 8A8 is used as sound IF amplifier/sync separator; a 16A8 serves as audio output/sync amplifier. The audio detector uses the familiar 6DT6. The vertical section has an 18GV8 operating as multivibrator/output. The horizontal section consists of a 17A8 horizontal AFC/oscillator and a 50JY6 in the output stage. The high-voltage rectifier is a 1X2B, and the damper is a 34R3.

The low-voltage power supply contains one silicon rectifier, which is protected by both a 4.7-ohm surge-limiting resistor and a 2-amp line fuse. The series-parallel filament string has a tapped dropping resistor. AC voltage to the filaments of the horizontal-oscillator, output, and damper tubes is reduced by the 43-ohm section of this resistor, while the filament voltage to the other tubes is reduced by both the 43-ohm section and a 22-ohm section.

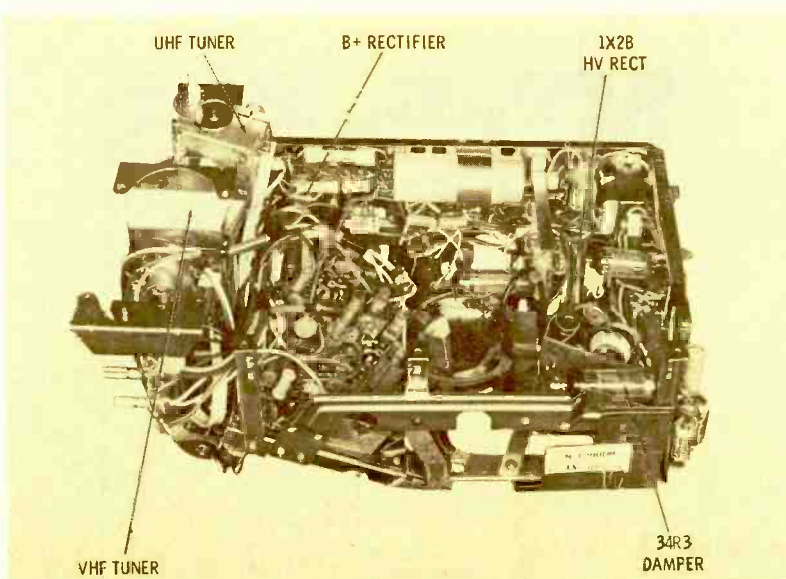
AGC voltage is derived from the output of the video detector, and an RF AGC switch is employed in the tuner AGC circuit. The switch connects either 10 or 27 megohms from the RF AGC line to B+. Width is adjustable by means of a width coil, and the focus may be varied by connecting pin 4 of the picture tube to either B+, boost, or ground.

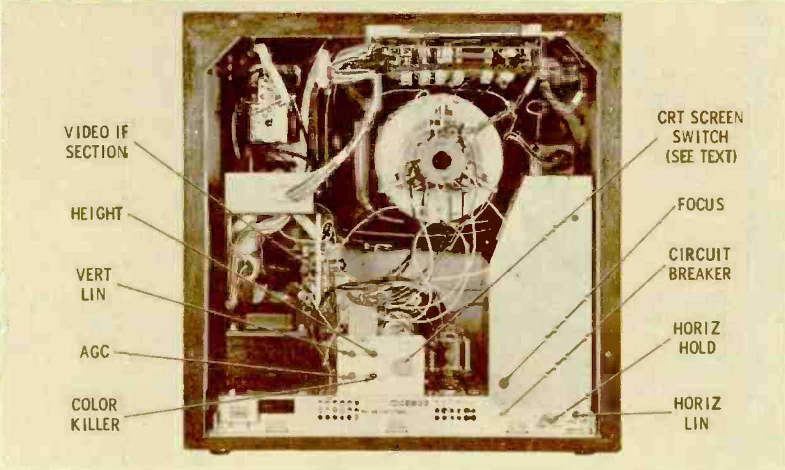


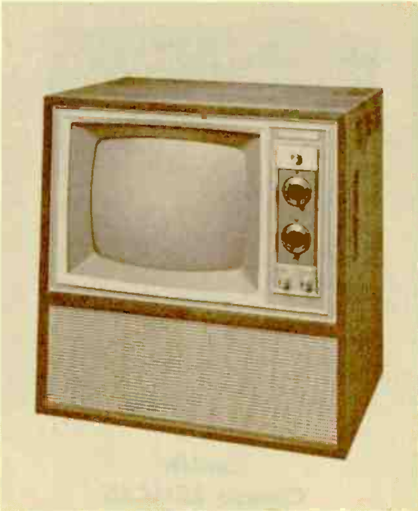
HORIZONTAL
OSCILLATOR BOARD

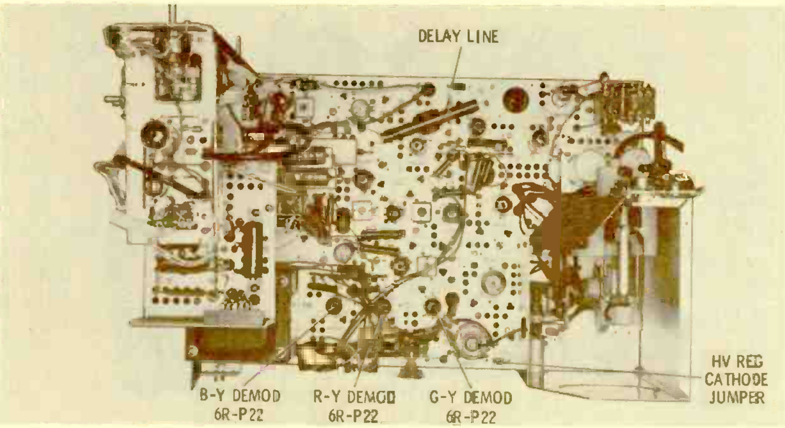


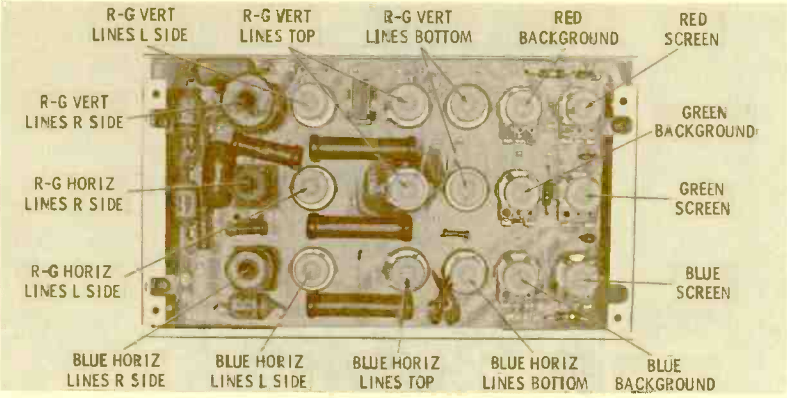
VERTICAL MULTIVIBRATOR-
OUTPUT BOARD

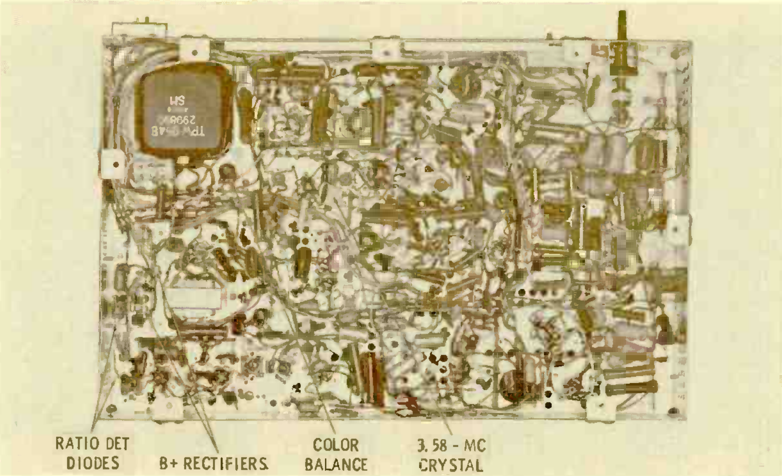












Sears
Chassis 562.10102
Model 5170

This is Sears' small-screen (16") color receiver, housed in a wood cabinet and using a 400KB22 picture tube. The set is manufactured in Japan by Toshiba and imported and sold in this country by Sears Roebuck and Company. Basically, the circuitry is quite similar to that used in color receivers made in the United States. However, there are some differences worth noting.

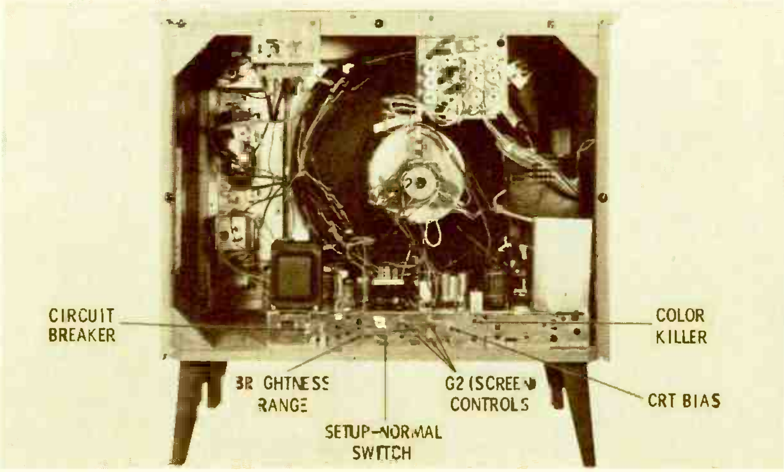
In the color circuits, there are a two-stage chroma bandpass amplifier and three independent demodulators; 6R-P22 tubes are used to demodulate R-Y, B-Y, and G-Y separately. All the other tubes are common types, with the exception of the 5642 focus rectifier.

The convergence coils and controls, along with the screen and background controls, are located on an individual board. (This controls are labeled in one of the photos.) A five-position switch is provided to make purity and convergence adjustments easier. Three 100K resistors connected to the screen grids of the CRT may be connected separately or jointly to ground to obtain the following raster colors on the screen: white, red and green, blue, green, or red. This receiver doesn't have a normal-service switch; therefore, gray-scale tracking is accomplished by using both the screen and background controls—one is provided for each gun.

This hand-wired. transformer-powered chassis has a conventional low-voltage power supply—two silicon rectifiers operating in a full-wave voltage-doubler circuit.

A plug and jumper arrangement is provided on top of the chassis for monitoring high-voltage-regulator cathode current during horizontal-sweep adjustment. Merely remove the jumper and insert a milliammeter in the socket.

The sound-reject and color-balance controls are located beneath the chassis. The color-balance control is pointed out in the photo, and the sound-reject control is beneath the video-IF section.



Zenith Chassis 25MC33

Pictured above is Zenith's latest 21" color receiver. This one isn't changed drastically from earlier-model color sets, but it does have an additional circuit—automatic degaussing—along with some other interesting changes.

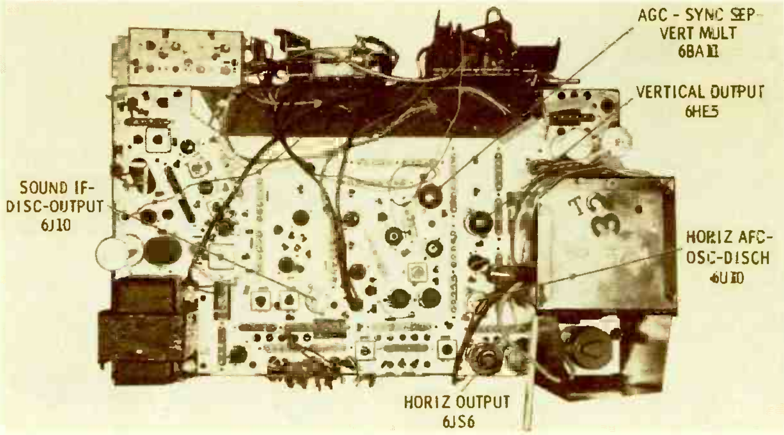
As in the past, the transformer-powered chassis is completely hand-wired, including the convergence board. For speed and ease when converging the receiver, the coils and controls are labeled red and green (R+G) horizontal lines top, bottom, left side, and right side; the same labeling applies to the red and green vertical lines and the blue horizontal lines. Thus, from the labeling you can determine what portion of the screen will be affected by adjusting a specific control or coil.

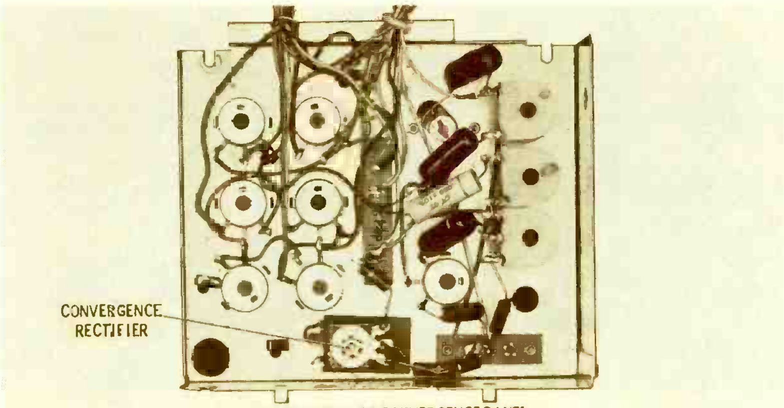
A number of compactrons are used in this set, and as a result fewer tubes are required. Among these multi-purpose compactrons are the 6J10 sound IF amplifier/discriminator/output, 6BA11 sync separator/AGC keyer/vertical multivibrator, and 6U10 horizontal AFC/oscillator/discharge. Although not a compactron, a 6KT8 is now used in the color-sync stages (replacing a 6GH8 used last year) as the 3.58-mc oscillator and reactance control.

Low-voltage B+ is developed from a pair of silicon rectifiers connected in a full-wave, voltage-doubler circuit. The rectifiers are protected by a circuit breaker in series with the secondary winding of the power transformer.

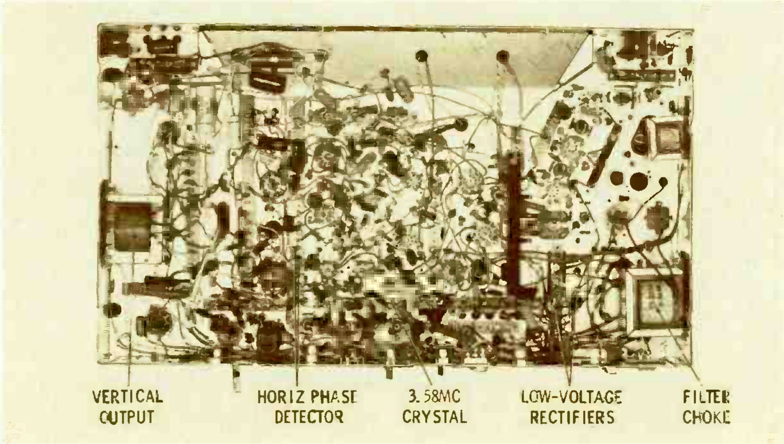
Other semiconductors include the signal diodes functioning as horizontal-phase detector, video detector, sound-sync detector, and convergence rectifier.

The customer operating controls are accessible by opening a door at the front right-hand corner of the set. Normal-service and setup controls are on the rear apron of the chassis and are adjustable from the back of the receiver. Purity, convergence, and black-and-white tracking adjustments are performed in the same manner as on previous sets from this manufacturer. Should any additional adjustments or alignment be required, follow the procedure in the service manual, or consult the appropriate PHOTOFACT folder.

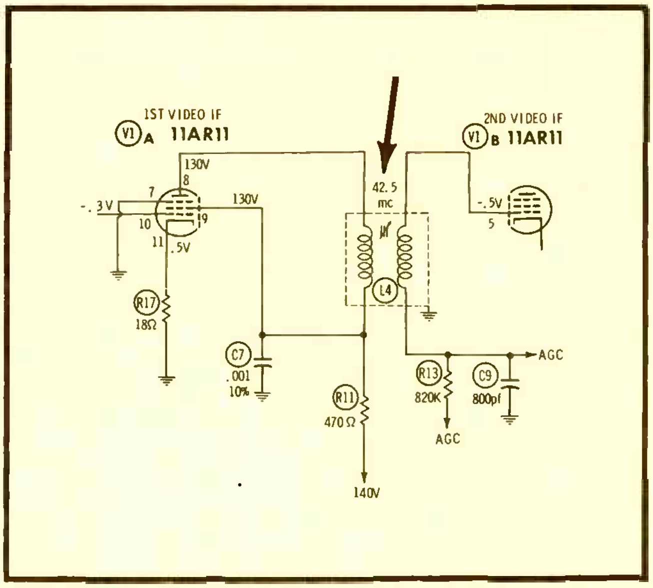




BOTTOM VIEW OF CONVERGENCE PANEL



See PHOTOFACT Set 710, Folder 2



Mfr: General Electric **Chassis No.** QY

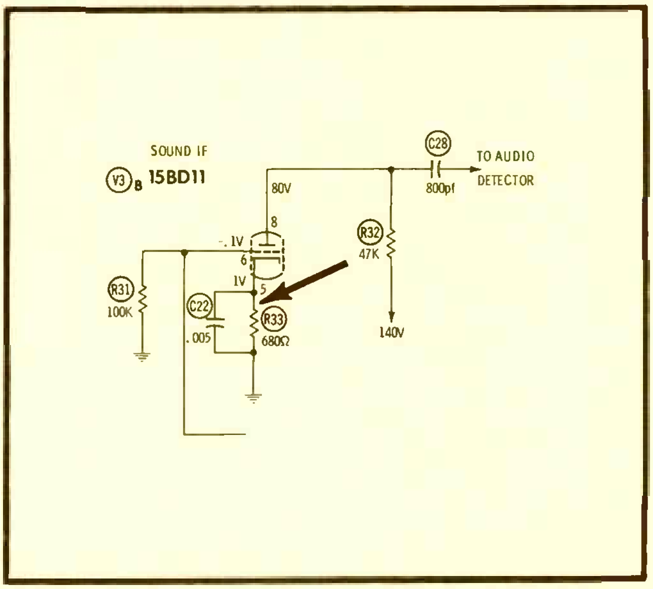
Card No. GE QY-1

Section Affected: Pix and sound.

Symptoms: Video overload and buzz in sound; voltage at pin 5 of V1B (2nd VIF grid) is positive.

Cause: Primary-to-secondary short in video IF transformer.

What To Do: Replace L4.



Mfr: General Electric **Chassis No.** QY

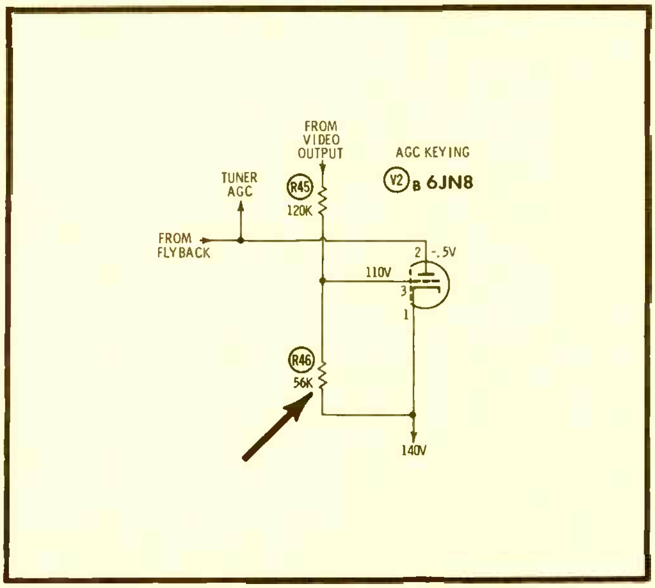
Card No. GE QY-2

Section Affected: Sound.

Symptoms: Volume decreases after set is on for a period of time.

Cause: Increased value of sound-IF cathode resistor.

What To Do: Replace R33 (680 ohms).



Mfr: General Electric **Chassis No.** QY

Card No. GE QY-3

Section Affected: Pix.

Symptoms: Video overload; incorrect voltage on pin 1 of V2B (6JN8).

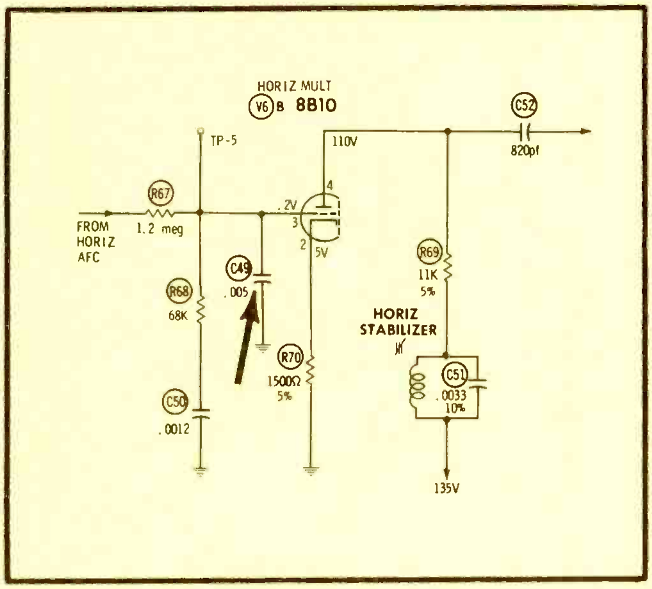
Cause: Grid-to-cathode resistor overheats and reduces in value.

What To Do: Replace R46 (56K).

See PHOTOFACT Set 710, Folder 2

See PHOTOFACT Set 710, Folder 2

See PHOTOFACT Set 710, Folder 2



Mfr: General Electric **Chassis No.** QY

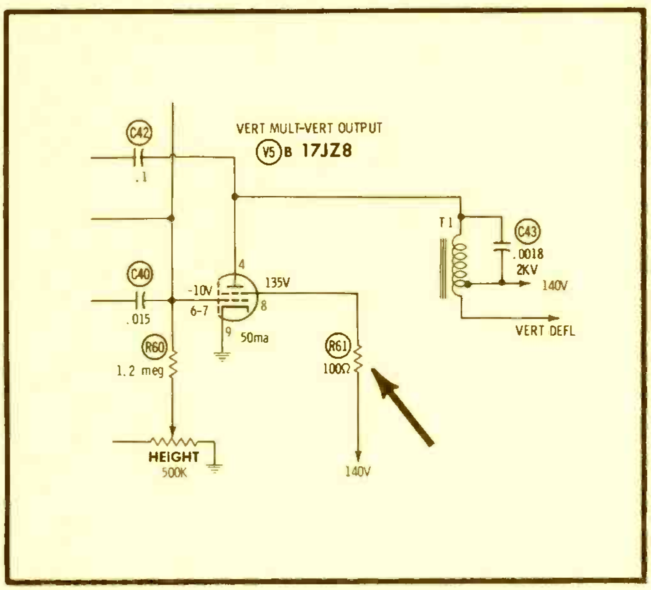
Card No. GE QY-4

Section Affected: Horizontal sync.

Symptoms: Unstable horizontal hold.

Cause: Horizontal-multivibrator grid capacitor opens intermittently.

What To Do: Replace C49 (.005 mfd).



Mfr: General Electric **Chassis No.** QY

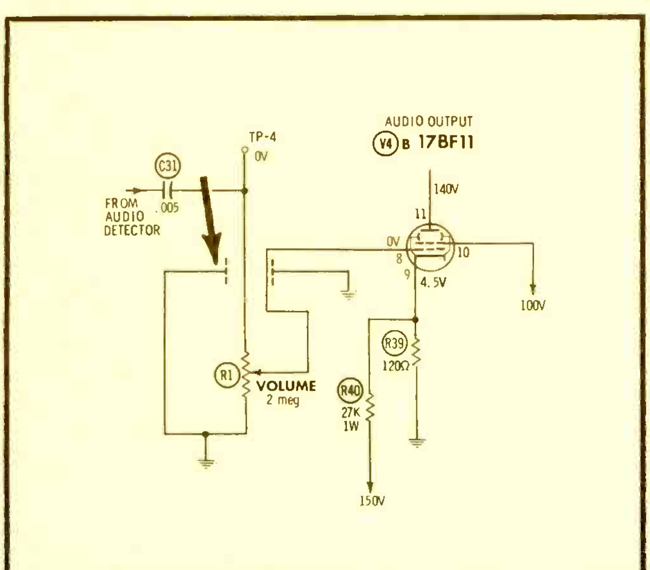
Card No. GE QY-5

Section Affected: Raster.

Symptoms: No vertical sweep. Low voltage on screen (pin 8) of V5B.

Cause: Open screen-supply resistor.

What To Do: Replace R61 (100 ohms).



Mfr: General Electric **Chassis No.** QY

Card No. GE QY-6

Section Affected: Audio.

Symptoms: Intermittent sound.

Cause: Short between conductors in shielded lead from volume control to grid of output tube.

What To Do: Replace shielded wire.

See PHOTOFACT Set 682, Folder 2

See PHOTOFACT Set 682, Folder 2

Mfr: Olympic **Model No.** 6P25

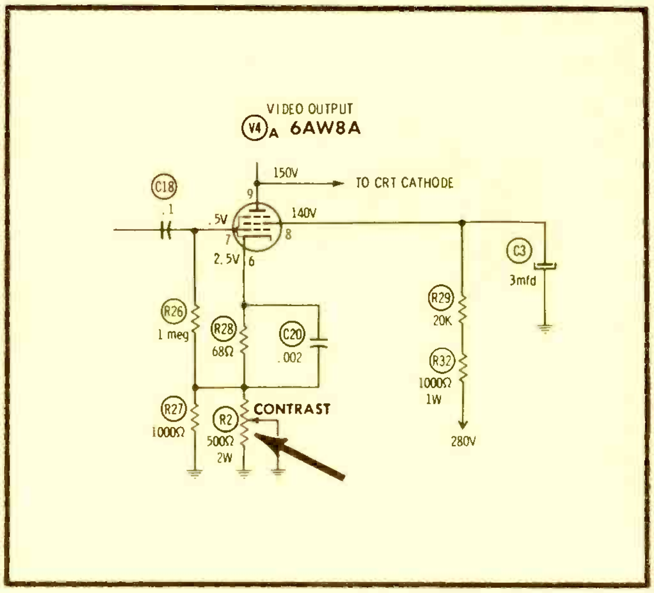
Card No. OL6P25-1

Section Affected: Pix and sound.

Symptoms: Pix and sound disappear intermittently. Cathode voltage on video output (pin 6 of V4A) increases.

Cause: Contrast control opens intermittently. tently.

What To Do: Replace R2 (500 ohms, 2 W).



Mfr: Olympic **Model No.** 6P25

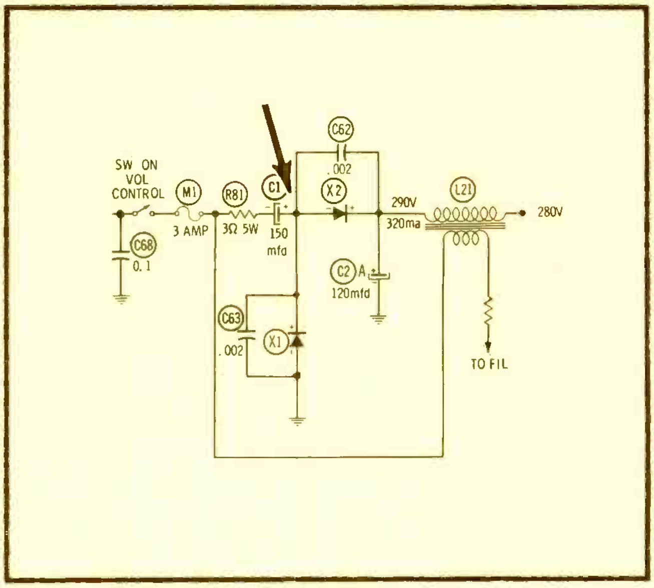
Card No. OL6P25-2

Section Affected: Raster.

Symptoms: Raster takes excessive amount of time to fill screen.

Cause: Defective input electrolytic in power supply.

What To Do: Replace C1 (150 mfd).



Mfr: Olympic **Model No.** 6P25

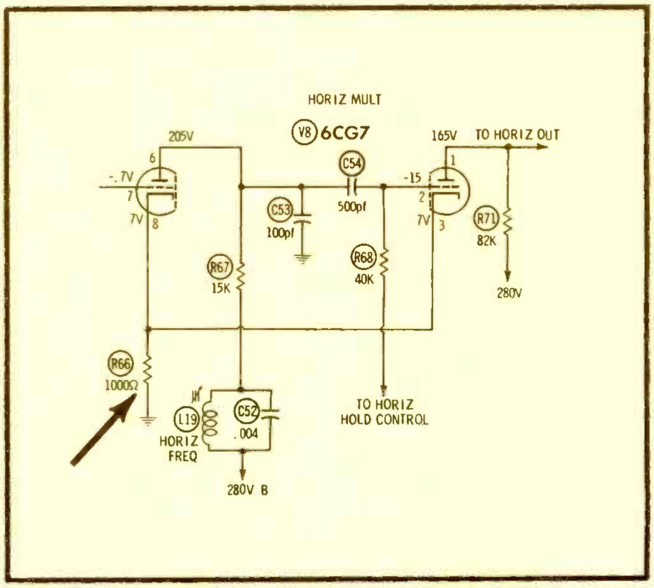
Card No. OL6P25-3

Section Affected: Horizontal sync.

Symptoms: Horizontal-hold control requires constant readjustment.

Cause: Horizontal-multivibrator cathode resistor increase in value.

What To Do: Replace R66 (1000 ohms).



See PHOTOFACT Set 682, Folder 2

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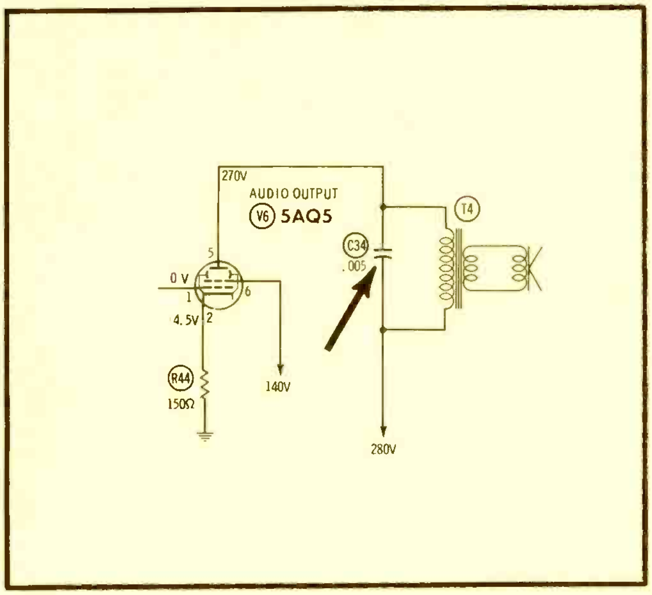


Mfr: Olympic **Model No.** 6P25

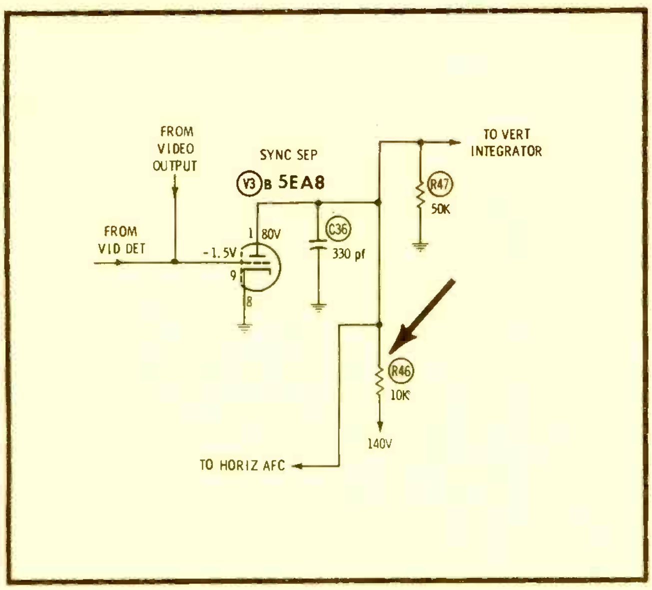
Card No. OL6P25-4

Section Affected: Sound.

Symptoms: Intermittent sound.

Cause: Capacitor across audio-output transformer shorts intermittently.

What To Do: Replace C34 (.005 mfd).



Mfr: Olympic **Model No.** 6P25

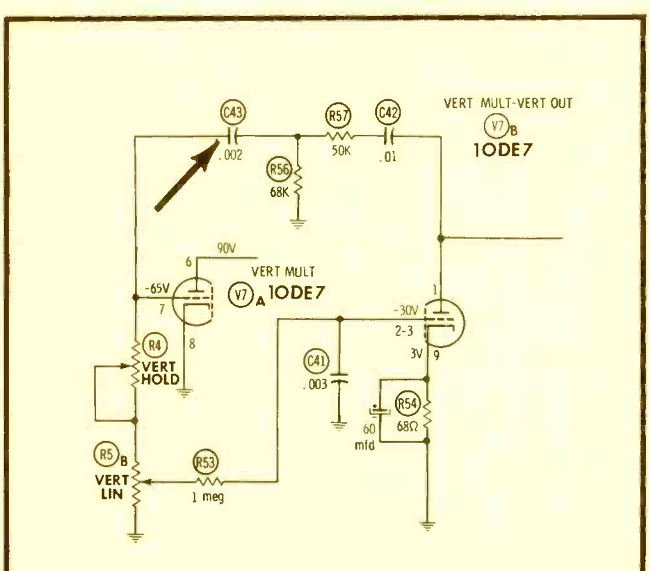
Card No. OL6P25-5

Section Affected: Sync.

Symptoms: Horizontal jitter and vertical roll. Increased voltage at pin 1 of V3B.

Cause: Sync-separator plate resistor overheats and reduces in value (normally caused by defective V3).

What To Do: Replace R46 (10K) and check V3 (5EA8).



Mfr: Olympic **Model No.** 6P25

Card No. OL6P25-6

Section Affected: Vertical sync.

Symptoms: Vertical roll; hold control has to be readjusted continually.

Cause: Vertical-multivibrator feedback capacitor leaky.

What To Do: Replace C43 (.002 mfd).

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the magazine of electronic servicing

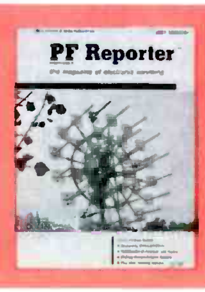
VOLUME 15, No. 7 — JULY, 1965

CONTENTS

SPECIAL ANTENNA SECTION

ABOUT THE COVER

Our cover this month depicts the latest in UHF antenna development. The disc-rod assembly shown here exemplifies the antenna articles you'll find in this, our Special Antenna Section. It's chock full of information on AM, FM, and TV antennas; starting on page 24.



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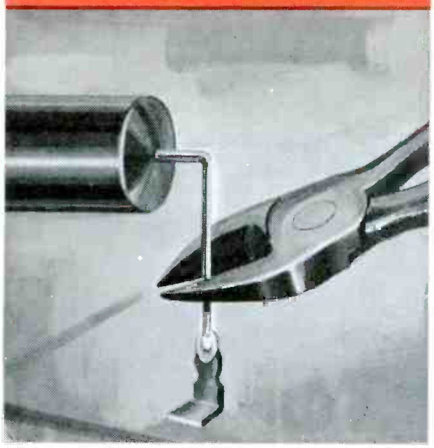
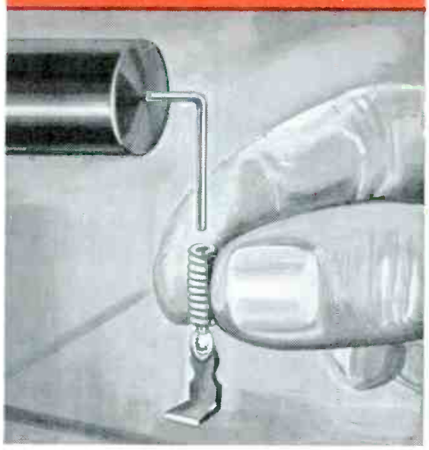
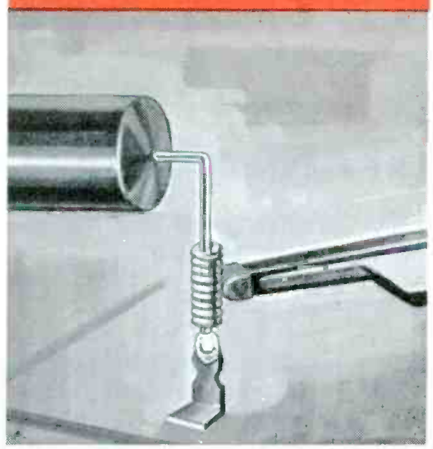
A Snip Lead



B Slip on QUIG



C Heat QUIG, Connection Made!



NOBODY ELSE HAS QUIG CONNECTORS... YOU GET 'EM ONLY FROM SPRAGUE PRODUCTS!

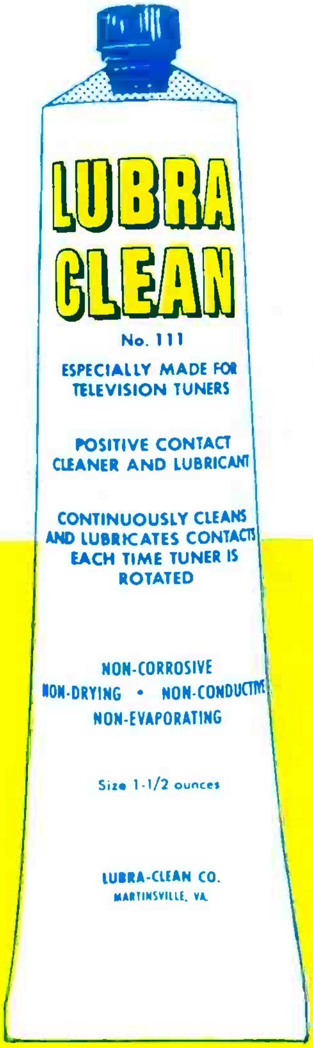
QUIGS are now being packed with Sprague Atom® Capacitors *at no extra cost to you!* Whenever you need tubular electrolytics, insist on pre-packaged Sprague Atoms from your parts distributor and you'll automatically get your QUIG component connectors . . . the biggest boon to the service technician since the soldering gun!

SPRAGUE®
THE MARK OF RELIABILITY

WORLD'S LARGEST MANUFACTURER OF CAPACITORS

6S-4104

Circle 3 on literature card



LUBRA CLEAN

...A T.V. TUNER CLEANER THAT REALLY WORKS!

MADE ESPECIALLY FOR TELEVISION TUNERS

Finally, a tuner cleaner that really works. Apply LUBRA CLEAN and let it do the work for you. Physical cleaning and polishing contacts is no longer necessary. Simply apply—and LUBRA CLEAN continues to polish and lubricate tuner contacts for months after all other cleaners and lubricants have failed.

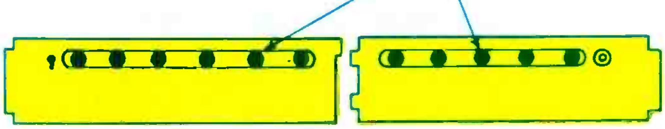
LET LUBRA-CLEAN DO THE WORK!

APPLICATION TO STANDARD COIL TUNER:

A—Do not remove tuner drum from standard coil tuners, Lubra Clean will transfer from strip contacts to brass spring contacts, cleaning and lubricating them.

B—Apply a *small quantity* of Lubra Clean to one row of contacts on channel strip, rotate tuner 180 degrees, apply again and rotate in opposite direction. This will deposit cleaner and lubricant on both sides of spring contacts where it will come in contact with each channel strip as the tuner is rotated, continuously polishing and lubricating contacts.

C—Now rotate the tuner vigorously several times in both directions and replace tuner cover.

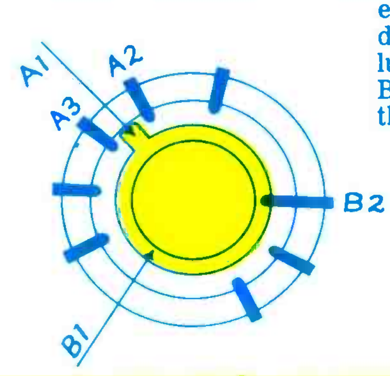


APPLICATION TO WAFER TUNER:

A—Apply Lubra Clean in a *very small quantity* at the points indicated by arrows.

B—By rotating the channel selector you may bring contact A1 inbetween A2 and A3, apply a *small quantity* of Lubra Clean with a slim screwdriver, rotate channel selector back and forth, depositing Lubra Clean on contacts A2 and A3.

C—Apply Lubra Clean at point B1, (both sides of wafer if necessary) rotate channel selector several times vigorously depositing cleaner and lubricant on contact B2 and the balance of the channel contacts.



LUBRA CLEAN COMPANY
P. O. BOX 926 - MARTINSVILLE, VIRGINIA - PHONE (703) 638-1211

Letters to the Editor

Dear Editor:

In the April 1965 edition of Video Speed Servicing, on page 5 (Card No. DM642-2), the card says to replace R27, while the schematic has an arrow pointing to R97. Which is correct?

GIL'S RADIO & TV
Madawasha, Me.

The schematic is correct, Gil. A typesetter's error made the 97 in the text into a 27. The replacement value to use is 2.2 meg, 2 watt, as stated in the parentheses, and the resistor that causes the trouble is R97.—Ed.

Dear Editor:

I believe credit should be given to the person (or persons) who analyzes the waveforms in SYMFACT. These are most revealing of the scope approach to servicing.

J. V. NEILL
Livingston, N.J.

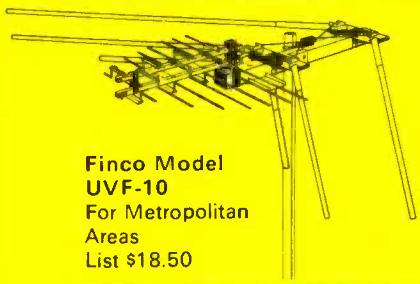
Thanks from the entire staff, J.V. SYMFACT is a group project, utilizing the experience and knowhow of our entire staff. Although SYMFACT is now many months old, having been introduced in September 1962, your letter is one of many we still receive every month telling us how useful and helpful this department is to the practical serviceman. We're proud of the contribution SYMFACT has made to upgrading service technicians everywhere, especially in teaching them to use their scopes—which is, after all, the only real answer to tough-dog television servicing.—Ed.

Dear Editor:

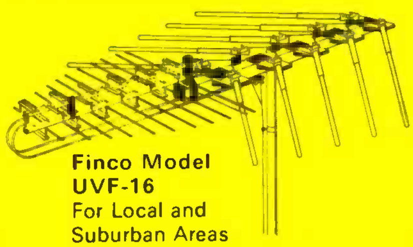
Someone goofed in your Troubleshooter column of April 1965. The Troubleshooter told Lew's Radio that "any of the 90° 25" color receivers will require a completely different test jig—both yoke and CRT"; this is in error. Extension cables for yoke and CRT are all that is necessary to use the RCA test jig on a CTC17 RCA 25" set. This will cause a certain amount of vertical foldover and horizontal ringing, but this won't interfere with general troubleshooting.

IVAN C. HOLST
Lakewood, Calif.

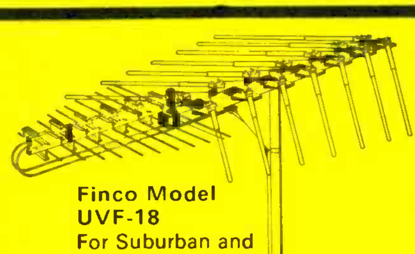
That's true, Ivan, but no one goofed. The Troubleshooter was looking at a few other considerations when he chose not to mention the use you describe: (1) Since horizontal and vertical sweep are affected rather drastically, the jig is not very useful to the technician servicing a sweep complaint; (2) a proper jig shouldn't necessitate a lot of "getting used to" or special considerations on the part of the user; (3) prolonged operation of the set under these conditions has been known to result in damage to sweep components. We therefore feel it unwise to recommend this usage; someone with little experience might wind up with a costly repair besides the one the set was brought to him for. No profit in that!—Ed.



Finco Model
UVF-10
For Metropolitan Areas
List $18.50



Finco Model
UVF-16
For Local and Suburban Areas
List $30.50



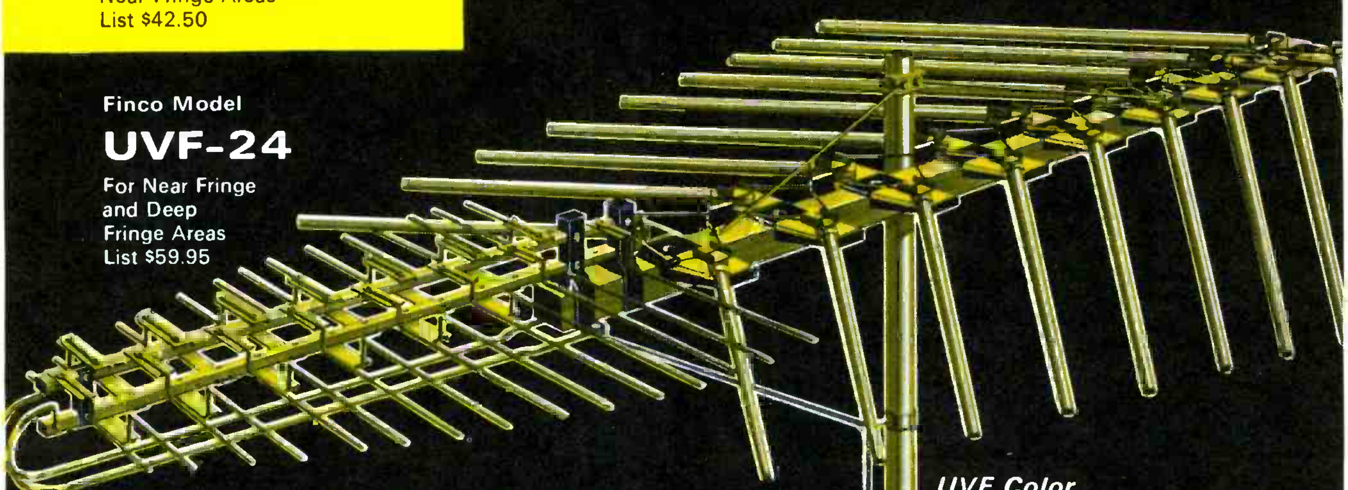
Finco Model
UVF-18
For Suburban and Near Fringe Areas
List $42.50

A major breakthrough in Antenna design!

FINCO

ALL BAND
UHF•VHF•FM
"COLOR VE-LOG"

Featuring Finco's Exclusive Gold Corodizing



Finco Model
UVF-24
For Near Fringe and Deep Fringe Areas
List $59.95

Finco's new All-Band Color Ve-Log Antenna does the work of three — gives startlingly clear black and white pictures and beautiful color on *both* UHF and VHF television channels. Its superlative design also assures the finest in stereophonic and monophonic FM sound reproduction. Comparison tests have proved the superiority of the All-Band UVF Series — superiority backed by Finco's guarantee of supremacy and unquestioned warranty.

UVF Color Ve-Log Antennas . . . Engineered for the future!

- Revolutionary new UHF Section
- Heavy Aluminum reinforced insulator insert cup and heavy duty rivet
- Back-up bracket and square boom
- Finco's exclusive triple thick sleeved elements
- Lock-tite no-tilt saddle bracket
- Finco's exclusive double contact to drive line
- Continuous one-piece drive line and exclusive air insulated polystyrene cross-over spacer

Prices and specifications subject to change without notice.

THE FINNEY COMPANY • 34 W. Interstate Street • Bedford, Ohio

Write for beautiful color brochure Number 20-322, Dept. 310

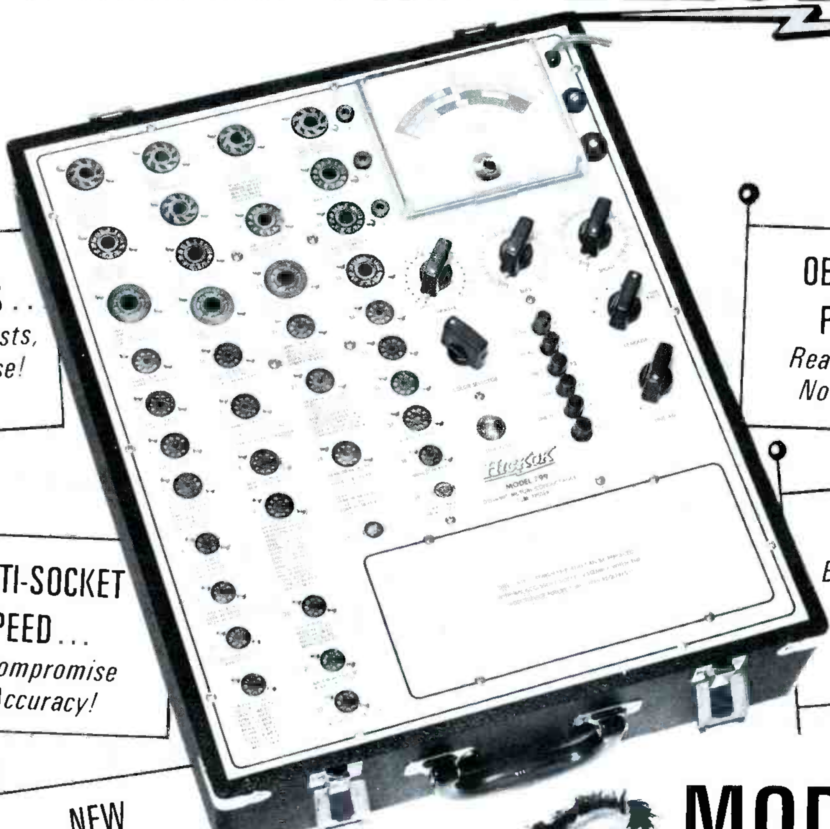
Circle 7 on literature card

ALL NEW FROM HICKOK

100% Gm TESTS . . .
No Emission Tests, No Compromise!

MULTI-SOCKET SPEED . . .
No Compromise In Accuracy!

NEW HIGH-SENSITIVITY LEAKAGE AND GAS TESTS!



OBSOLESCENCE PROTECTION
Realistic, Practical No Compromise!

MORE PROFIT
Because You'll Sell More Tubes . . . Sell Them Honestly!

MODEL 799

Mustang

$199.95

From the laboratories of the world's leading tube tester manufacturer comes the model 799 "Mustang"—a completely new tube tester.

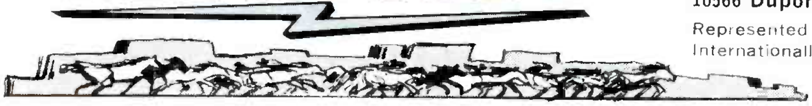
Multi-socket tube testers used to have two serious drawbacks: circuit limitations made them obsolete overnight and, at best, no more than 10% of their tests were actually mutual conductance. But the Hickok "Mustang" doesn't compromise; it delivers *honest* mutual conductance tests. And a unique circuit approach, together with an easily replaceable accessory socket panel, makes it "circuit ready" for any possible new tube types.

A solid-state power supply gives increased accuracy and dependability. An all-transistorized gas and leakage test circuit sets a new standard of reliability for spotting "tricky" tube defects that can "chew up" your profit. You can actually read interelement leakage to 50 megohms; gas grid leakage effects to 0.1 μa!

We call it the "Mustang" because it uses fresh, new engineering ideas and because it gives you a real opportunity to break into new profits.

See it at your Hickok distributor or write for circular TT799.

HICKOK



THE HICKOK ELECTRICAL INSTRUMENT CO.
10566 Dupont Avenue, Cleveland, Ohio 44108
Represented in Canada by Stark Electronics, Ajax, Ontario
Internationally by Hughes International, Culver City, California

Circle 8 on literature card

WHY...
SERVICE COLOR TV?

WHY WAIT? YOU CAN MAKE MONEY NOW!

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

☆ 1,300,000 SETS SOLD IN '64

☆ 70% OF NBC PROGRAMMING* NOW IN COLOR

☆ OVER 3,000,000 NOW IN USE

*PRIME TIME

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

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

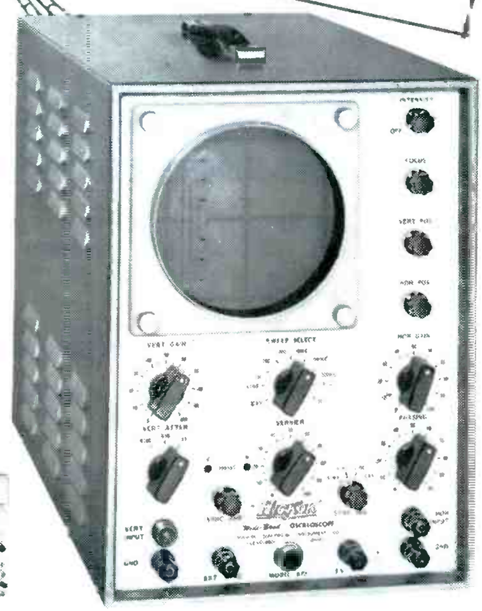
and, of course, it's . . .

HICKOK

COLOR APPROVED

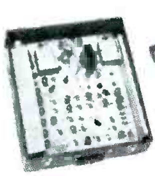
Only $199^{50}

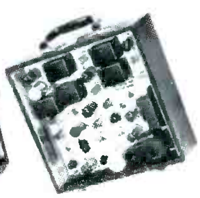
MODEL 677

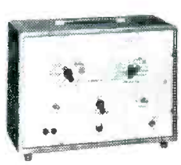


THE COMPLETE COLOR LINE


MODEL 615


MODEL 656XC


MODEL 660


MODEL 661


MODEL 675A

THE HICKOK ELECTRICAL INSTRUMENT CO.
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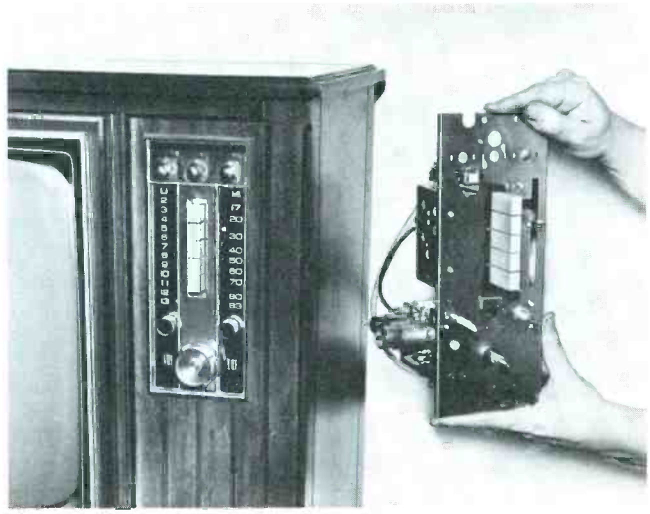
Circle 10 on literature card

The Electronic Scanner

news of the servicing industry

Push-Button UHF With AFC



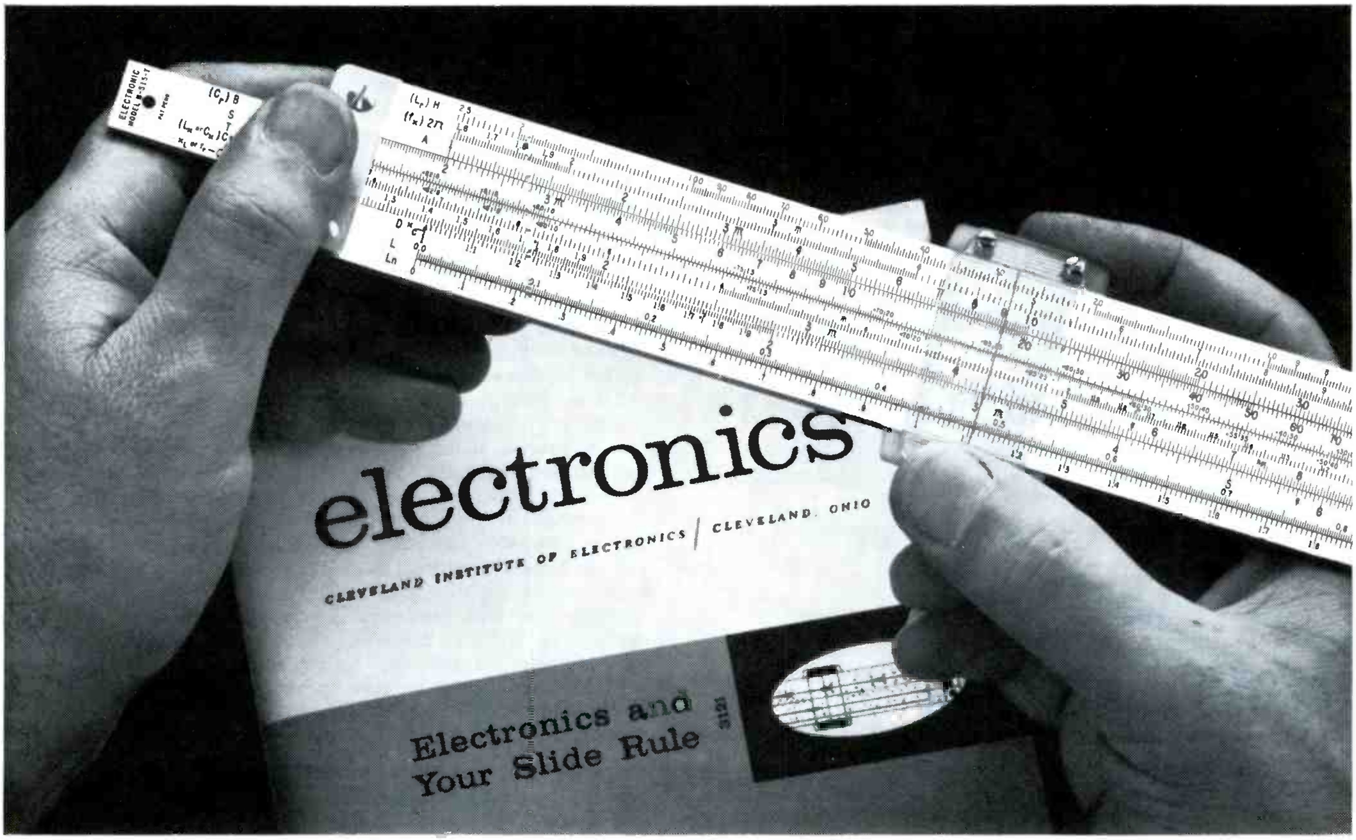
A new 82-channel UHF/VHF tuner system, ready for mounting in the TV cabinet, that provides preset fine tuning VHF and push-button setting for UHF, is being introduced by the Tuner Division of **Standard Kollsman Industries, Inc.** This is the first tuner with push-button UHF, to our knowledge. No detented tuning device is used for UHF reception; five different stations can be preset and chosen positively by a push button. VHF tuning, however, is done in the conventional detent manner. Of the three tuner types available, one includes AFC in the 82 channels.

TV From Phono Record

An electronic system that plays television pictures from a phonograph record was unveiled by **Westinghouse Electric Corporation.** Westinghouse calls the new sight-and-sound system "Phonovid." Along with a series of still pictures, voice and music come from the same long-play disc. The record is not an audio recording that triggers pictures from a slide projector; both the audio and the video signals are present in the grooves and both are picked up by the phonograph needle. Up to 400 pictures and 40 minutes of voice and music are present on the two sides of a 12". 33⅓ rpm recording, called a "Videodisc." The pictures can be line drawings, charts, printed text, or photographs. Westinghouse considers the system an important advance in the art of electronic communications. It appears to hold unusual promise as a flexible, easy-to-operate, inexpensive audio-visual system for educational instruction.

Existing audio and TV equipment is compatible with the "Phonovid" system. Without modification, Phonovid can be integrated into existing closed-circuit and standard broadcast TV systems. With existing telephone equipment, it can transmit pictures over ordinary telephone lines. The record player and the TV set to display the pictures also are entirely conventional. The television display, however, is possible only through specially developed electronic circuits that make up a scan converter. Information from the phonograph cartridge is stored in the scan converter's special electronic storage tubes, which build up and display a complete TV picture every six seconds. One picture is read out repeatedly at high speed and thus displayed continuously on the TV screen during the period the next picture is being formed.

A New Electronic Slide Rule with Instruction Course



Why didn't someone think of this before?

Here's a great *new* way to solve electronic problems accurately . . . easily. The Cleveland Institute Electronics Slide Rule is the only rule designed specifically for the exacting requirements of electronics computation. It comes complete with an illustrated Instruction Course consisting of four AUTO-PROGRAMMED lessons . . . each with a short quiz you can send in for grading and consultation by CIE's expert instructors. With this personal guidance, you'll soon be solving complex electronics problems in seconds while others still struggle along with pad and pencil.

Here's what Mr. Joseph J. DeFrance, Head of the Electrical Technology Dept., New York City Community College, has to say about it:

"I was very intrigued by the 'quickie' electronics problem solutions. It is an ingenious technique. The special scales should be of decided value to any technician, engineer, or student. The CIE slide rule is a natural."

See for yourself. Learn how to whip through all kinds of reactance, resonance, inductance, AC and DC circuitry problems in seconds . . . become a whiz at conventional computations too!

This all-metal 10″ rule is made to our tough specs by Pickett, Inc. . . . comes complete with top grain leather carrying case *and* Instruction Course. A $50 value for less than $20. Send coupon for FREE illustrated booklet *and* FREE heavy vinyl Pocket Electronics Data Guide. Cleveland Institute of Electronics, 1776 E. 17th St., Dept. PF-103, Cleveland, O. 44114.

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SPECIAL BONUS: Mail coupon promptly . . . get FREE Pocket Electronics Data Guide too!

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A leader in Electronics Training . . . since 1934

Circle 12 on literature card

The Future is for . . .

An aggressive sales approach, development of key personnel and strong financial management is the foundation on which you must build your future, William T. Buschmann of **Sylvania Electric Products, Inc.** told electronic parts distributors recently. His words can be echoed to service technicians. Mr. Buschmann pointed out that changing technologies and new products necessitate better business management and extensive sales training programs for the distributor (or technician) who intends to grow and prosper in today's rapidly expanding parts business.

In order to meet the challenges in the years ahead, the wise distributor (technician) will begin immediately a series of training and development programs that will provide him with a well trained, enthusiastic staff that will be able to cope with the greatly expanding electronics business and changing technologies. Sylvania has an educational series that was developed from extensive studies of distributors' problems. Six subjects are covered: Take another look at your job; Build a good order; Sell from the dealer's view-point; Maintain good credit relations; Is the customer always right? and, Help them sell.

At the same time, Gene K. Beare, president of Sylvania, was saying that the electronic parts business is on the brink of another revolution due to the impact of color television. Mr. Beare said "there is no question that color TV will create as much turbulence, as much change, and as much excitement in parts distribution, as black-and-white TV did 15 years ago."

Manufacturers will produce about 2.2 million color sets this year and, with significant increases expected each year, the production of color sets will reach 4.7 million annually by 1970. By that time there will be approximately 70 million black-and-white sets in operation in the country, and the parts business will mushroom into a $2 billion industry. To meet the additional challenge that color TV and other new items such as closed circuit television pose, distributors (and technicians) must closely analyze their investments, practice sound business management, and institute plans for sales and management training.

"Beware of easy credit," Mr. Beare cautioned. "It's too much like buying stocks on margin—it looks good, but suddenly you can be in trouble. It's almost an adage that suppliers who grant easy credit are the ones that lower the boom with the least warning. Prepare in a big way for the entertainment business, with particular emphasis on color TV; help build up the strength of independent service organizations." Aggressiveness at the sales level and technical training in new techniques, such as solid-state components, are high priority items that the Sylvania president considered a must for tomorrow's successful distributor (and technician).

An official of **RCA Electronic Components and Devices,** Harold F. Bersche, division vice president, said that "excellent" is the only word which can describe the outlook for business in general and the electronics industry in particular. "Electronics distribution is today insuring quick availability of countless electronic components, devices, and associated products to industry, commerce, government, institutions, and the home. It is unlikely that this broad function will change very much between now and 1975."

The RCA executive related that expansion of electronics in medicine, education, photography, air-traffic-control, food processing and cooking, is expected to accelerate rapidly. Each of these areas, he stated, will provide new business opportunities for the electronics distributor (and technician) of tomorrow.

Viewers may some day be able to speak to their television set and have it obey their commands, another **Radio Corporation of America** executive predicts. W. Walter Watts, group executive vice president, says such a device is possible with experimental circuits able to respond to human voice and translate the command into electronic signals which would operate the TV set's controls. The wireless remote control for today's television set may be replaced in the future by the human voice. "Imagine just speaking to your TV set with such commands as 'Turn to channel 4,' or a set that shuts off when you say 'good night' to Johnny Carson."

HELP!

Representing the American automobile industry, the **Automobile Manufacturers Association,** has developed a cooperative nationwide program by which motorists in distress can use two-way radio to obtain assistance in the event of an accident, mechanical problem, or other occurrence which incapacitates a vehicle or its driver on the highway. Called H.E.L.P. (for Highway Emergency Locating Plan), the plan is based on use of Citizens-band equipment.

Channel 9 is widely accepted throughout the country and monitored as the frequency for emergency aid to travelers. Accordingly, channel 9 has been recommended as the channel to be used in the H.E.L.P. program whenever highway service or emergency requirements arise. Industry groups hope that later the FCC will assign exclusive radio channels to the H.E.L.P. program, to assure interference-free communications.

Motorists with H.E.L.P. equipment who need assistance, or who sight others who need help, will broadcast a plea on channel 9. This request for help will be answered by individuals and agencies who monitor this channel on a twenty-four-hour basis. Those monitoring include Citizens-band radio emergency volunteer teams, police agencies, road service stations, and hospital emergency services. Need for medical help can also be relayed by telephone from police or others who are monitoring the channel.

Company Renamed

The name of the distribution subsidiary of Texas Instruments Incorporated has been changed from Engineering Supply Company (ESCO) to **Texas Instruments Supply Company.** Headquarters will continue to be in Dallas, with other offices and warehouses in Houston; Tulsa; Kansas City, Mo.; Canton, Mass.; and Union City, N. J. In recent months, international outlets have been established in Stuttgart, Germany; and London, England. Additional offices will be opened this year in Milan, Italy; and Paris, France.

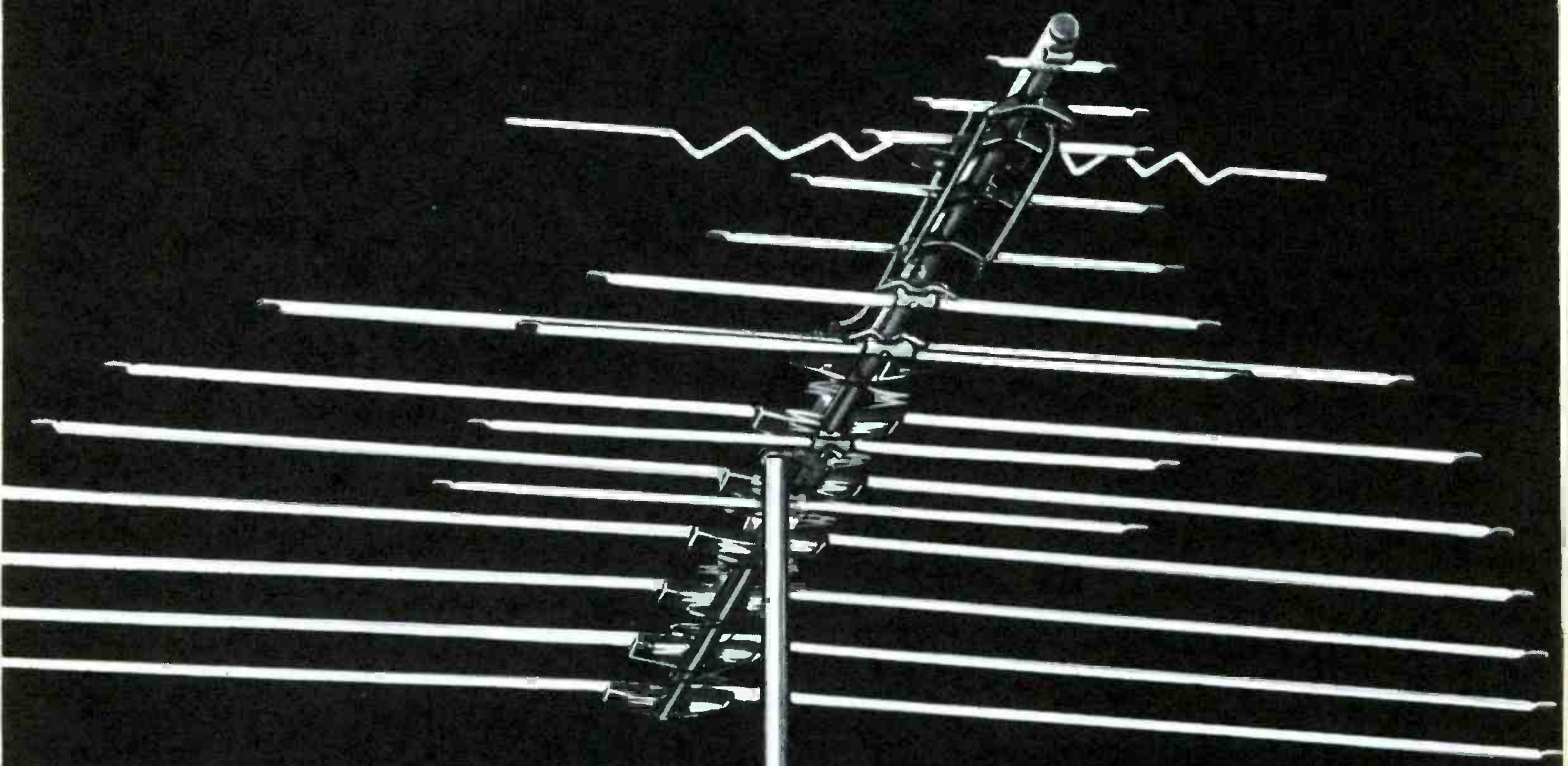
Scientists at RCA's Princeton laboratories have obtained a patent for a syllable analyzer that takes spoken words apart and compresses them into electronic code. In its present form the analyzer can recognize about 200 syllables as spoken by several persons. It already is being used in an experimental phonetic typewriter that takes direct dictation.

Mr. Watts also predicted that color television sets of 10 to 20 years from now would be both larger and smaller than today's models. The bulb-like picture tube of today's television set should give way to a thin screen, 1" or 2" thick, operated possibly by integrated circuits. These screens could be large enough to cover a living room wall or small enough to fit in a pocket.

With predictions and advice like these also coming from others of the industry's top executives, technicians and distributors everywhere should recognize that "the future is for" him who is prepared for the future. The future isn't for him who sits and waits.

New Phonos for Old

Even though that old phonograph gathering dust in basement, attic or garage hasn't issued a note in years, there's still a chance for it to provide musical pleasure. **Benjamin Electronic Sound Corporation,** Westbury, New York, has announced its beginning of a collection of old phonographs. The collection will eventually be made available to banks, schools, and libraries as an educational service. G. Thalberg, national sales manager, said the company will give one of its Miracord record players in exchange for every ancient phonograph that is accepted. The company has not developed any "name list" of wanted phonographs, but a spokesman said that all interesting and unusual record players of ancient vintage will receive consideration. No one should send an actual phonograph to the company. The first step should be the mailing of a snapshot or rough sketch of the phonograph, along with its description.



HOW DID WINEGARD PUT FULL SIZE POWER IN A ½ SIZE ALL-BAND (UHF-VHF-FM) COLOR ANTENNA?

WITH

WINEGARD CHROMA-TEL

the new super-compact high gain antenna designed specifically for all-band UHF-VHF Color Reception and FM

A big disadvantage of most all-band (UHF, VHF, FM) antennas is that they are larger and heavier than necessary. This is because they are really VHF antennas with UHF antennas tacked on the front end. *Chroma-Tel isn't*. It's super-compact and the *first integrated* antenna designed specifically for all-band UHF-VHF color operation.

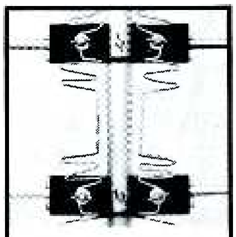
How did we reduce the size so drastically without sacrificing performance?

Two ways. First with our new *Chroma-Lens*

Director System. With this unique system, we are, for the first time, able to intermix *both* VHF and UHF directors on the same linear plane without any sacrifice of performance.

Second, with *Impedance Correlators.* These are the special phasing wires that automatically step up the impedance of Chroma-Tel's 72 ohm driven elements to 300 ohms. The correlators make sure each element has an accurate 300 ohm impedance at its given frequency. No other antennas with multiple driven elements have this! They also allow us to place the elements *only* 5¾" apart instead of 10" to 14" apart as on other all-band antennas, reducing antenna length by one-half.

With the new Winegard Chroma-Tel antenna, we have eliminated *half* the bulk, *half* the wind loading, *half* the storage space, *half* the truck space, and *half* the weight . . . yet still have the best working, easiest installing UHF-VHF-FM antenna ever developed!



Exclusive Winegard Impedance Correlators insure 300 ohm impedance on each element

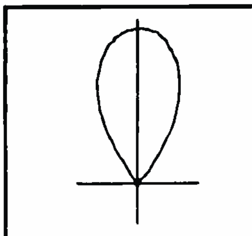
You give your customers a neater installation that performs as well or better than any other all-band antenna on the market . . . and at a much lower price.

Compare Performance. You can't find an all-channel UHF-VHF-FM antenna that will give you better results than Chroma-Tel. Look at the polar patterns. There are no side lobes with Chroma-Tel because the elements are straight . . . unlike V'd elements that offer an element surface sideways to the signal, Chroma-Tel's straight elements will not pick up ghosts from sides or back. Chroma-Tel's front-to-side ratio is practically infinite—Chroma-Tel's exceptional front-to-back ratio is up to 30 db.

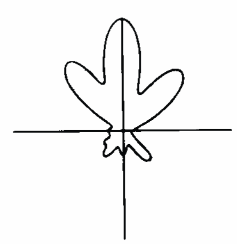
Compare Construction. The Chroma-Tel is Winegard quality throughout . . . from its sales-making compact 4-color box, to its weather resistant Gold Vinylized Finish, to its first quality snap-lock hardware.

For complete information on the exciting new Winegard Chroma-Tel All-Band Antenna, ask your distributor or write for Fact-Finder #242 today.

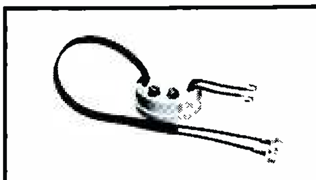
So compact it fits in the back seat of a car



Typical Chroma-Tel Polar Pattern

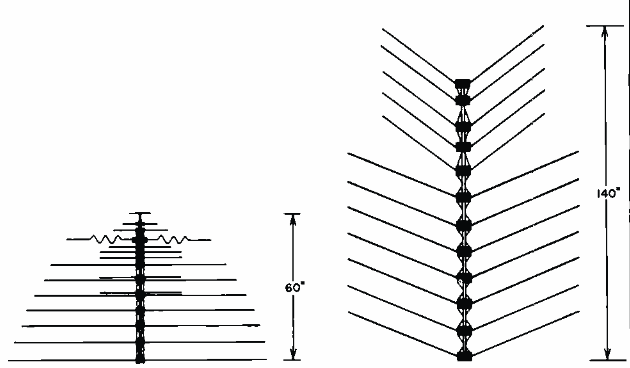


Typical V Type Antenna Polar Pattern

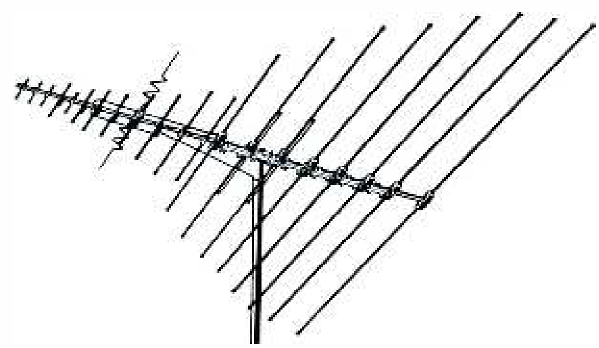


All Chroma-Tels include Winegard's model CS-283 UHF-VHF signal splitter. Splitter hangs conveniently behind TV set. Separates UHF and VHF signals coming from antenna to the two sets of terminals on your set. It's yours FREE when you buy Chroma-Tel.

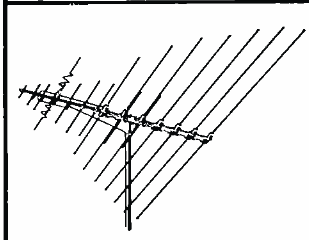
Compare Size and Price. We've illustrated the super-compact Chroma-Tel CT-80 and a comparable V type antenna. Note the difference in size, price and weight for equal or better performance. Because it's even much smaller than ordinary VHF antennas of comparable performance, it is perfect for attic installations, too!



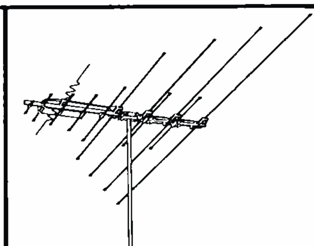
	Winegard Chroma-Tel	V type (Approximate Figures)
Boom Length:	60"	140"
Total Weight:	5 lb., 1 oz.	10 lb., 3 oz.
Carton Size:	.97 cu. ft. (less than 1)	5.8 cu. ft.
Number of Elements:	17	12
List Price:	$27.50	$50.00



Model CT-90 $37.50



Model CT-80 $27.50



Model CT-40 $17.50

Winegard Co.
Antenna Systems
3009H Kirkwood • Burlington, Iowa

Circle 14 on literature card

PHASING Multiple-Antenna SYSTEMS

Improved gain isn't the only consideration.

by Jack Beever

Most technicians think of stacking antennas only in terms of increasing signal strength. Actually, there are many other excellent reasons for combining two or more antennas, and there are more ways of doing it than just putting them in a vertical row on a mast. By stacking antennas, you can:

1. Increase signal strengths, thus improving signal-to-noise ratios
2. Reject ghosts
3. Reject man-made interference
4. Reduce fading from distant stations
5. Reduce airplane flutter
6. Reduce adjacent-channel interference
7. Reduce co-channel interference

These benefits can be achieved because of one basic principle: The radiation pattern of an array of stacked antennas is different from the pattern of a single antenna. In order to use this principle, you must understand it fully.

Single-Antenna Patterns

In order to get an insight into what an antenna pattern really is, it's easiest to start with the dipole pattern shown in Fig. 1. You can

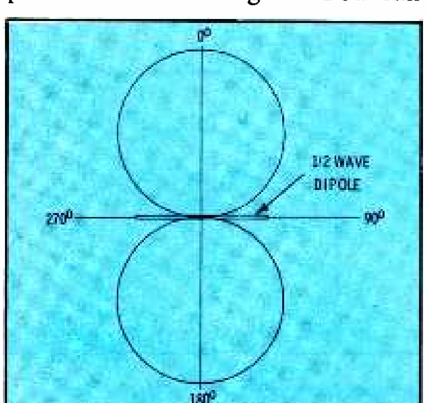


Fig. 1. Sensitivity of simple ½-wave dipole plotted for horizontal plane.

think of this pattern best in terms of signal reception. If you were to take a transmitter of fixed power and move it in a circular path around the antenna, the received signal amplitude would vary with the position of the transmitter. The dipole would pick up maximum signal when the transmitter was at 0° and 180°. It would pick up almost no signal when the transmitter was at 90° and 270°. The curve indicates relative pickup at al lother angles.

So far, it has been assumed that the transmitter was moving around the antenna on a horizontal plane. However, the antenna can also receive signals from directly above and below it, or any angle in between.

The diagram shown in Fig. 1, therefore, is actually just a cross-section of the complete pattern. The total pattern is doughnut-shaped—technically, it's a toroid with the dipole as its axis.

Most commercial antennas are designed in an attempt to elongate the forward lobe of the pattern (in the 0° direction) and attenuate, or reduce, the rear lobe (in the 180° direction). Fig. 2 shows a typical yagi pattern as plotted on a special instrument for testing antennas.

The patterns shown so far were developed in a plane parallel to the earth's surface. Since television antennas are horizontally polarized, this is the *E plane* — the electrical field pattern. At right angles to the E plane is the *H plane*, which contains the magnetic field component of the electromagnetic wave. The signal power received by an antenna or antenna array is dependent on both the magnetic and the electrical fields.

Stacked-Antenna Patterns

Fig. 3 compares the E-plane and H-plane reception patterns of a typical yagi with those of various stacked arrangements of antennas of the same type. Notice that vertical stacking produces narrowing of the forward lobe *only in the magnetic field.* The E-plane pattern remains the same. Conversely, horizontal stacking provides gain only in the electric field. If you do both (stack two antennas high and two antennas wide), you get gain in both fields. This is called a *quad stack* or a "2 x 2 array."

Useing Nulls

Stacking antennas can produce increased gain in the forward direction, but look closely at Fig. 3 and you'll see that some very sharp nulls are also created. It is by judicious use of these nulls that items 2 through 7 on the list of effects of stacking can be produced.

Fig. 4 illustrates two dipoles stacked side by side, with a space of one wavelength between centers. In Fig. 4A, the transmitter is in the 0° direction. In other words, the signals are arriving broadside to the two antennas. Since both dipoles "see" the same wavefront at the same time, the currents developed by the two antennas are in phase. Provided the phasing harness does not change this situation, the two signals will add at the mixing point and deliver twice the power received by either dipole—a 3-db signal gain. Fig. 4B shows the same two phased antennas receiving signals from a transmitter located 30° from center. Notice that while dipole D1 is energized by wavefront W1, dipole D2 is energized by the wavefront immediately behind it (W2), which is ½ wavelength, or 180°, out of phase with W1. Each alternate wavefront induces currents of opposite polarity; the currents induced in D1 and D2 are therefore equal and opposite. Instead of adding, *they cancel each other at the mixing point.*

Fig. 4C illustrates the reception pattern of this pair of horizontally stacked dipoles. In addition to the null at 30°, others are produced at 150°, 210°, and 330°. As can be seen in Fig. 4C, the reception pattern is similar to that of a single dipole except for the deep "dimples"

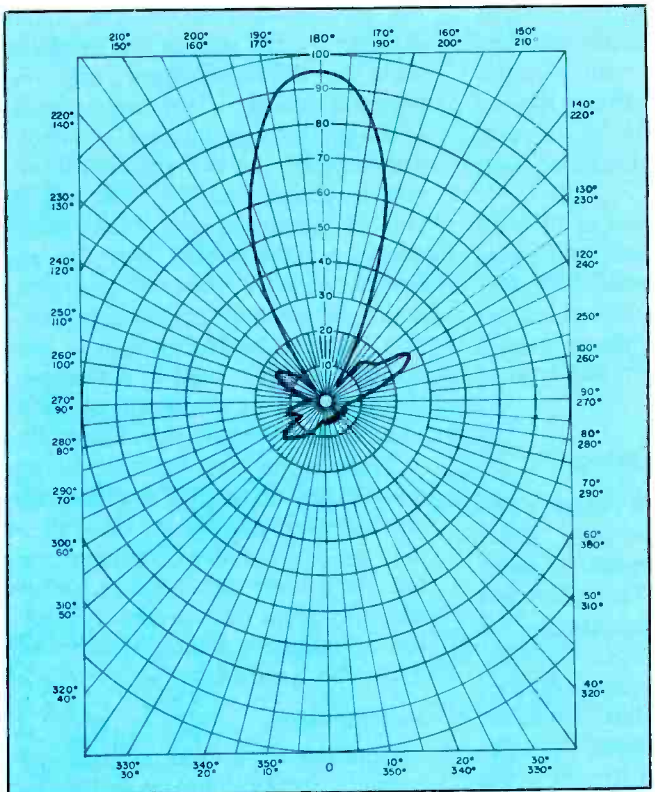


Fig. 2. Yagi antenna pattern plotted in horizontal plane.

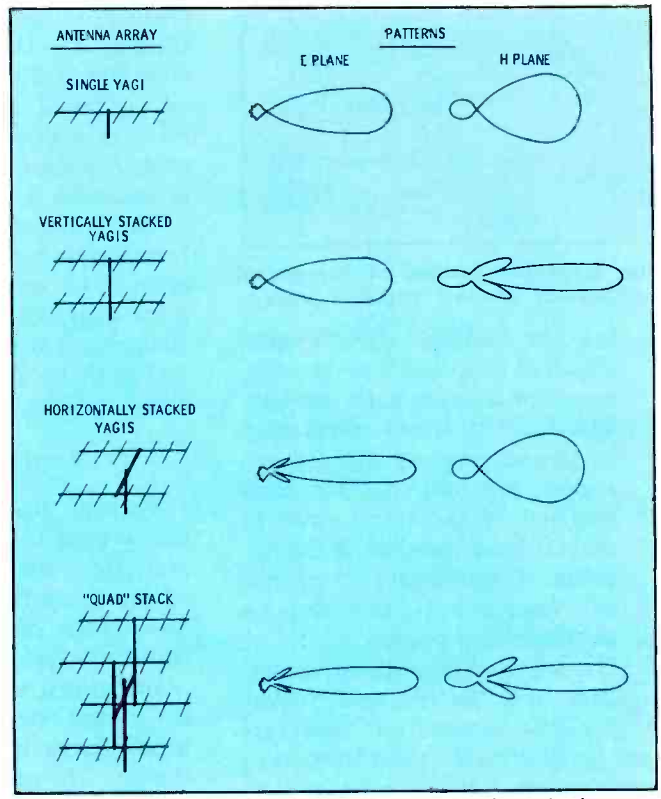


Fig. 3. E- and H-plane patterns of single and stacked yagis.

caused by the cancelling effect due to horizontal spacing.

Do the nulls always appear at 30°? Only if the horizontal spacing between the dipoles is precisely one wavelength at the frequency being received. You can change the angle of the nulls simply by changing the spacing.

When to Use Horizontal Stacks

There's not much point in using horizontal stacks just to increase signal levels; the same gain can be obtained from a vertical stack with considerably less mechanical trouble and expense. But those lovely nulls resulting from horizontal stacking can help to eliminate ghosts, adjacent-channel interference, cochannel interference, and sometimes even interference from man-made noise.

The most common use for horizontal stacking is to solve difficult ghost problems. A ghost is a signal bounced from some obstruction, but it also can be considered as a signal originating from another transmitter sending out the same programs on the same frequency. The only differences between the original signal and the ghost are that they arrive from different directions and the ghost arrives a little later than the direct signal.

To eliminate the ghost, you must, in some way, eliminate the signal from the ghost transmitter. The usual method, which should be tried first, is to use a high-gain antenna. Try to orient a null of the antenna pattern toward the ghost source while still receiving enough usable signal from the prime source. If this approach fails, the horizontal stack must then be used.

The exact angle of the ghost signal in relation to the prime signal source rarely is known. Therefore, a practical cut-and-try approach to finding the correct antenna spacing must be made.

Connecting the Antennas

Another point to be kept in mind is that 300-ohm twin-lead, especially when run horizontally, tends to act as an antenna itself. Therefore, coaxial cable should be used to connect the two antennas.

Fig. 5 shows how a pair of antennas should be stacked horizontally. Matching transformers, mounted close to the antenna terminals, are used to match the 300-ohm antennas to 75-ohm coaxial cable. The antennas *must* have identical characteristics; this usually means they should be the same make and model. A convenient length of coaxial cable is then taken from each matching transformer to a hybrid-type splitter-mixer. There are three very critical points in preparing this harness:

1. Lead lengths between each antenna and the splitter-mixer

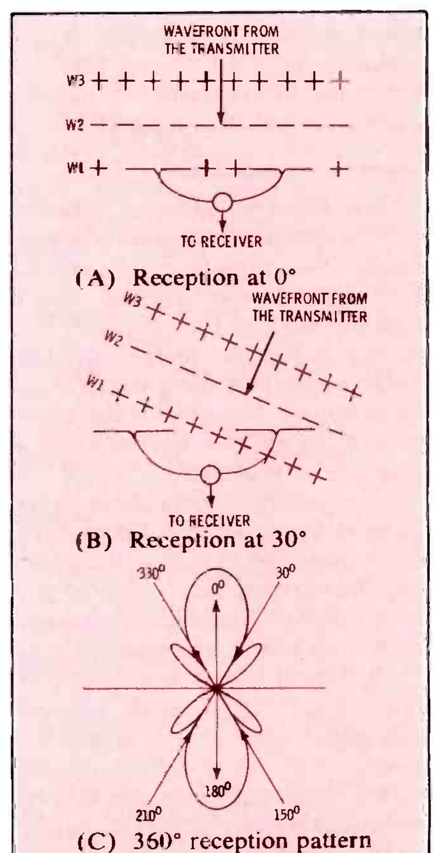


Fig. 4. Reception patterns of ½-wave dipoles spaced one wavelength apart.

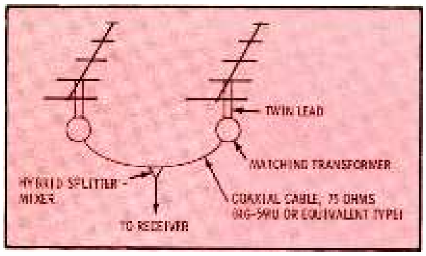


Fig. 5. Proper method of connecting horizontally stacked yagis is shown.

must be identical. Use the same length of twin-lead and the same length of coax for each antenna.

2. The matching transformers must be phased properly with the antennas. Connect the left-hand terminal of the transformer to the left-hand terminal of the antenna. If this is not done, you will have out-of-phase currents at the mixing point.
3. Use a hybrid-type splitter-mixer.

Aside from the fact that it must be perfectly symmetrical, this harness is not critical. It can be used to combine any VHF antennas and to receive any VHF frequency. It can also be used for UHF, provided equivalent UHF antennas, matching transformers, and hybrid splitter-mixers are used.

Once the harness is set up, the output of the splitter-mixer is connected through a matching transformer to the TV receiver. You are now ready to determine the correct spacing for the two antennas.

Adjusting the Antennas

Keep the two antennas parallel and pointed in the same direction—toward the prime signal source. Slowly move one antenna away from the other. At some point, you will see a sudden, sharp reduction in the intensity of the ghost. Mount the antenna at this point; then move the antenna up and down for maximum ghost reduction.

What you have done is to move the antennas apart until the null fell on the angle from which the ghost was being received. Then, you moved one of the antennas up and down until each antenna was receiving equal ghost signal power. The second action helps because only *equal* and *opposite* voltages cancel.

This useful technique can also be used to eliminate adjacent-channel interference (for example, channel 3 interferes with channel 4) and co-channel interference (an unwanted channel 3 interferes with a desired channel 3). If man-made interference comes from a specific location (as opposed to a diffuse source such as a power line), a properly spaced horizontal stack can be used to minimize it.

The horizontal array can be used broadband, but the nulls will differ in angle for each channel. Still, forward gain will be achieved on all channels; it is impossible to make a null at 0° or 180° with this type of array.

Vertical Stacking

Vertical stacks are most commonly used to increase gain. However, they are also useful in minimizing signal fading. To understand how, you must understand the causes of fading.

In the first place, fringe locations are always "over the hill." In other words, there is no line-of-sight reception. The source of trouble is the fact that signals arrive over the horizon by more than one path. For example, they may arrive by diffraction (bending) over an obstruction or because of refraction or reflection by atmospheric layers. Notice that only one of these sources of signal bending—diffraction by an obstruction—is stable. The others vary as the layers themselves move. Because of this behavior, the different signals which arrive at the receiving antenna will have different path lengths.

In Fig. 6, two reception paths are shown; one is diffracted over a mountain top, and the other is reflected from an atmospheric inversion. The second path is the longer one. If it is longer by any odd number of half-wavelengths, the signal arriving by this path is out of phase with the diffracted wave, and the two will cancel. If the second path is longer by any number of whole wavelengths, the two signals will arrive in phase, and they will add to give a greater signal than either could provide alone. But the reflected wave is from an inversion, which is constantly changing position. Hence, the path length is constantly changing; and, as it changes, the two signals go in or out of phase to produce a varying signal intensity.

These signal variations are short-term fades. In actual practice, the effect is highly complex, since there may be four or more different signal paths over the horizon. While this may seem like an almost hopeless situation, it is not. Here's how it can be handled.

Signal Diversity

Consider a tall mast, with one antenna on top of the mast and another about halfway down. Imagine a line drawn from each antenna to the horizon; the lines represent the path of the diffracted signal. Both paths ("A" and "B" in Fig. 6) have practically the same length. Now consider paths "E" and "F" (from the atmospheric inversion). "E" is longer than "F" by the amount "D." Assuming that signal "F" arrives at the top antenna in phase with signal "A," then signal "E" must arrive with some different phase relationship with signal "B." Thus, the top antenna can be producing strong signals while the lower is producing almost none. The situation can readily reverse itself as the atmospheric

• *Please turn to page 50*

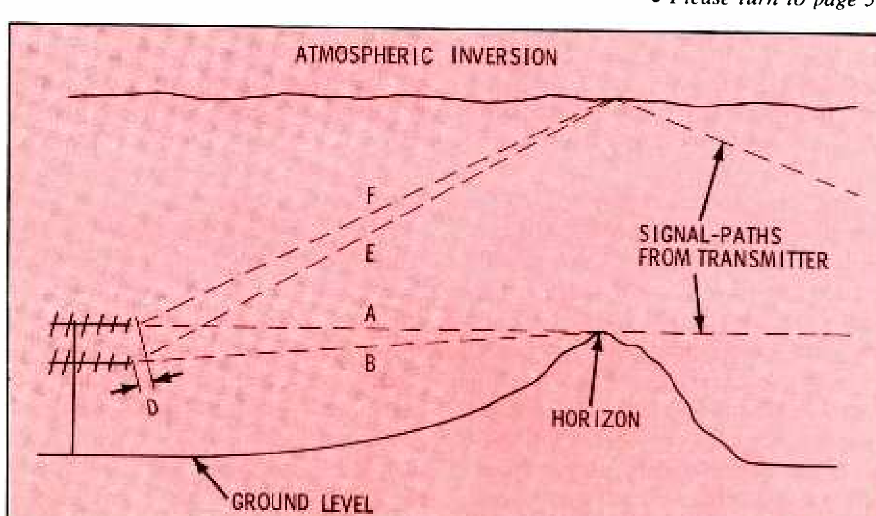


Fig. 6. Multiple signal paths are involved in reception over the horizon.

overcoming WIND LOAD EFFECTS

Techniques for avoiding blowdown.

by Allen B. Smith

In the middle of a long, hot summer, the effects of winter and spring winds on TV, CB, and amateur antennas probably seem a long way off. The fact is, however, that right now is the best possible time to give serious consideration to these problems so that allowance can be made for them during the erection of antennas and antenna systems. Each part of every installation is affected by wind presence and ice loading, but many technicians are unaware of these effects; some know about them but choose to ignore what they know. Either situation can cause serious difficulty, particularly in the case of property damage or personal injury resulting from an improperly installed system. The number of fallen antennas in most areas, following wind storms of even moderate intensity, bears testimony to the lack of planning in many installations.

Three Factors to Consider

Before you can understand what contributes to the strength or weakness of an antenna system, you must have some basic data with which to work. First of all, you should know how much wind pressure can be expected to work toward defeating your best-laid plans. Secondly, the resistance to the wind presented by the antenna, mast, tower, and guys must be determined so that the total force exerted on the system may be calculated. Thirdly, you must determine whether or not the equipment used in the system reasonably can be expected to carry the load.

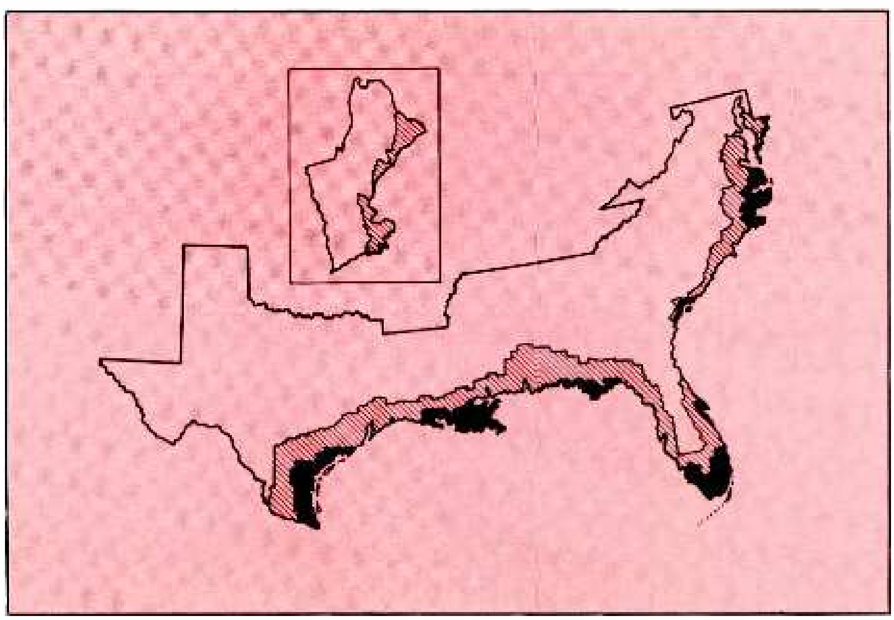


Fig. 1. Coastal areas receive average winds of higher velocity than rest of U.S.

Determining Wind Pressure

To provide standard references for the effects of wind on antennas, the Electronic Industry Association (EIA) has compiled data on maximum wind velocities recorded by the U. S. Weather Bureau since 1932. These figures have been evaluated and averaged out so that one can determine approximately what maximum wind loads will appear on systems installed in various parts of the country.

Wind pressure can be calculated from the formula $P=K(Va)^2$, where P is the pressure in lbs/sq ft, K is a constant coefficient which depends on the shape of the elements used in constructing the antenna (.0025 for cylindrical elements and .0042 for flat-faced elements), and Va is the absolute velocity of the wind recorded in a given area.

Weather Bureau records indicate that maximum velocities during nonhurricane conditions range from 62 mph in Washington, D.C. to 92 mph in Minneapolis, Minnesota. All other areas in the United States, except for the coastal areas subject to hurricane windstorms, fall within this range. Since gusting occurs at levels which exceed the measurable peak velocities by approximately 30%, the EIA has adopted the figure of 110 mph as the maximum velocity expected over most of the U.S. Applying the estimated maximum Va to the formula for determining wind pressure on antennas employing cylindrical elements, the EIA standard figure is determined:

$$P = .0025 \times 110^2$$
$$= .0025 \times 12100$$
$$= 30.25 \text{ lbs/sq ft}$$

Rounded off for convenience, the figure of 30 lbs/sq ft can be relied upon for West Coast and inland areas.

Along the Gulf and East Coasts, there are rather extensive areas which are subjected to frequent buffeting by winds of hurricane velocity. Fig. 1 shows these areas in general terms. The cross-hatched areas represent those in which winds of 100 mph have been recorded with some regularity. Once again applying the formula for wind pressure, we derive a figure for this wind belt of 42.25 lbs/sq ft (with allowance for 30% increase in velocity for gusting, Va = 130 mph). The areas shown in black denote those in which winds in excess of 115 mph are regularly recorded. Using a figure of 150 mph to allow for gusting, we find that expected wind pressures have risen to 56.25 lbs/sq ft. Since the total wind pressure increases in proportion to the square of the wind velocity, it can be seen clearly that relatively small increases in wind speed greatly increase the total pressure.

Isolated locations across the country have recorded extremely high winds during some storms, and this unpredictability can give a technician real headaches. As an example of the way wind pressures can build up alarmingly, wind velocities of 188 mph were recorded on Mt. Washington, New Hampshire. With the gusting factor added, Va becomes 244.4 mph, and the wind-pressure figure reaches a disastrous 149 lbs/sq ft. Working with the average recorded winds, however, will provide a good starting point.

The information provided by the map showing the high-wind belts is probably a little too general for reliable use in many localities where geographical and atmospheric conditions combine to create a non-average wind pattern. Therefore, it always would be a good idea to obtain local wind information directly from the nearest Weather Bureau and use those figures for calculating wind pressures which will apply to a specific area. Remember that most figures received from the Bureau will be absolute velocities which do not include the 30% factor for gusting. Don't forget to add that into your calculation.

System Wind Resistance

Now that you can determine a specific figure which represents the wind pressure applied to an antenna system in most any locale, you must come up with a second figure—the projection area of the antenna and its major structural components.

Fig. 2 illustrates the method used to calculate the actual projected area of a multielement yagi antenna typical of many fringe-area installations. The projected area is determined by measuring the length and diameter of each structural component of the antenna, multiplying the two dimensions to obtain the projected area of each element (usually solved for sq in.), adding the areas of all antenna elements together, and then dividing by 144 to determine the final projected area in sq ft.

As an example, some multielement low-band yagis have booms of 1.5″ diameter which are more than 10′ long. Such a boom would have a projected area of 180 sq in. (120″ x 1.5″), and if the boom carries 12 elements .75″ in diameter which average 40″ in length, then each element has a projected area of 30 sq in. (40″ x .75″). The total projected area for this hypothetical low-band antenna is 180 + (12 x 30) = 180 + 360 = 540 sq in. To get the equivalent figure in sq ft, divide 540 by 144; the result is 3.75 sq ft. Admittedly, this is a pretty large and unwieldly antenna, but it is typical of fringe-area low-band yagis. Adding a rotator to the system brings the total projected area up to 4 sq ft.

Recalling now that the average wind-pressure figure for most of the U.S. is 30 lbs/sq ft, a little simple arithmetic reveals that the total force applied to the antenna is 30 x 4, or 120 lbs. Now that you have a couple of firmly established figures, it is a little easier to see what kind of previously unsuspected forces you have to deal with in putting up an antenna. There is still another factor, however, which really throws a monkey wrench into the picture. The new factor is called the "bending moment" and relates to the situation illustrated in Fig. 3.

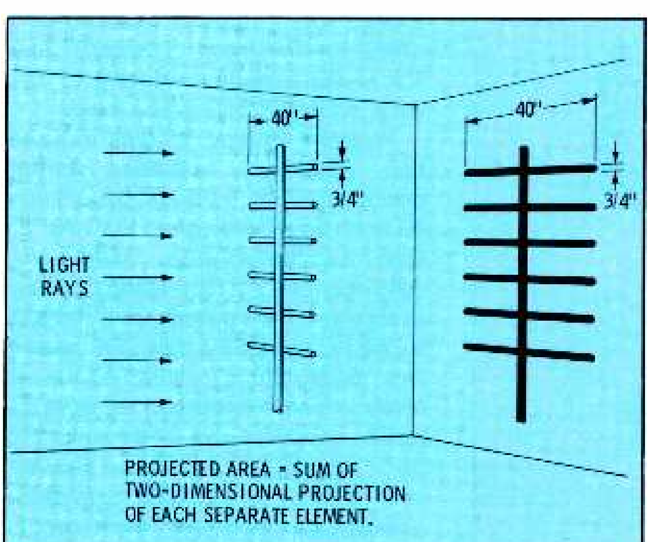


Fig. 2. Projected area of antenna is equivalent to shadow.

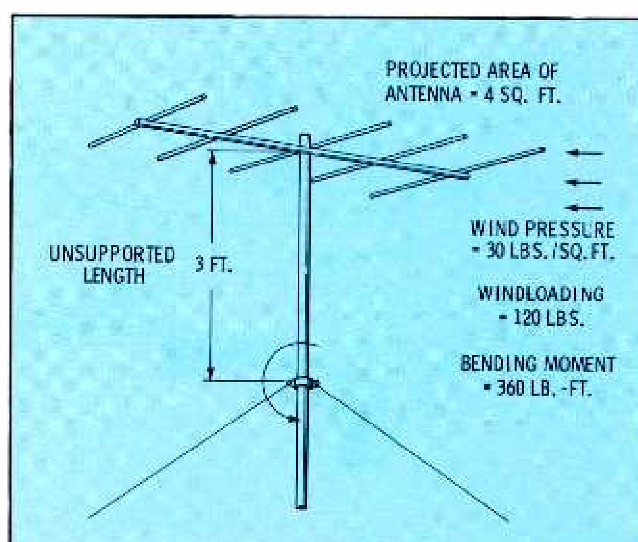


Fig. 3. Bending moment equals windload X free length.

The term is simply another way of referring to the effect of leverage upon the supporting mast.

As shown in the illustration, if the mast is guyed at a point 1′ below the boom, the bending moment is numerically equal to the total force applied to the antenna structure. If the guying point is 2′ below the boom, however, the bending moment is doubled, and if the guying point is 3′ below the boom, the moment is tripled. The bending moment is expressed as a torque in lb-ft.

To provide a vivid example of what you must contend with, assume that you install the hypothetical antenna (which has a projected area of 4 sq ft) on a 1″ mast and guy the mast 3′ from the boom. If the structure is exposed to a 110-mph gust of wind (EIA standard 30 lbs/sq ft wind pressure), you have a situation equivalent to taking that poor little 1″ mast, tying it to the workbench with 3′ sticking out over the edge, and then hooking a 120-lb weight onto the unsupported end (4 sq ft projected area x 30 lbs/sq ft wind pressure = 120 lbs). The bending moment exerted on the mast at the guying point is 360 lb-ft. No imagination is required to see that the whole array will make like a pretzel. If you think you're in deep trouble at this point, wait until the cold winter winds blow and ice builds up ¼″ thick.

Staying with the hypothetical low-band yagi which has a projected area of 4 sq ft with rotor, a few calculations will show that the ¼″ of ice will increase the projected area considerably. The main boom which had a diameter of 1.5″ uncoated, has increased by .5″ so that its projected area reaches a figure of 240 sq in. The .75″ diameter elements have grown to 1.25″ in diameter, and the projected area rises to 50 sq in per element. Instead of the original ice-free total of 540 sq in, we now have a projected area of 840 sq in, or 5.83 sq ft. Adding a rotator increases that figure to 6.08 sq ft, slightly more than a 50% increase in total area.

Under the same mounting conditions described above (a 1″ mast guyed 3′ from the boom), a 110-mph gust that creates a wind pressure of 30 lbs/sq ft will exert a bending moment of 550 lb-ft. Fantastic? You're right, it is; and these factors of wind pressure and bending moment are mighty easy to overlook, too.

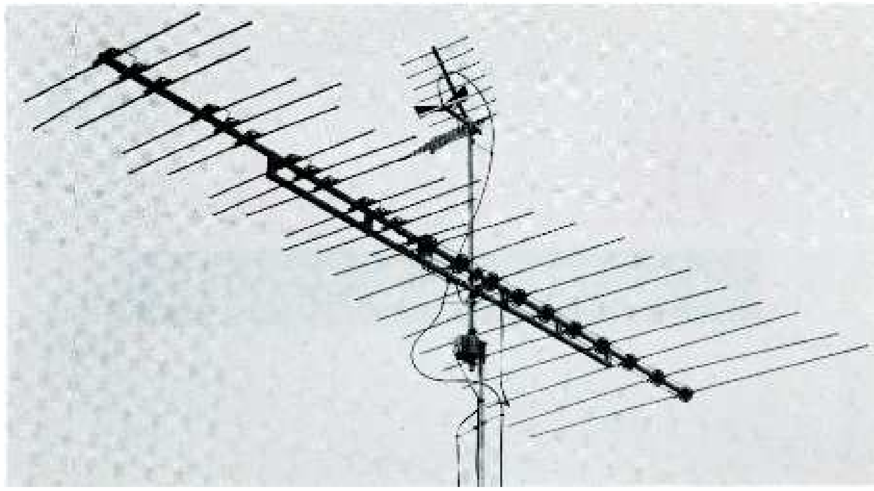


Fig. 4. Amateur multiband antenna has projected area of more than 10 sq. ft.

It may seem that using a large low-band antenna to illustrate the problem exaggerates wind-pressure effects, but a structure of that type actually represents (with its projected area of 4 sq ft) a median surface area. Understandably, most high-band VHF and all UHF and FM antennas will present far less resistance to wind pressure, but virtually all CB and amateur-band antennas will exceed 4 sq ft by a wide margin. An average figure for CB arrays would be on the order of 7.5 sq ft, and a typical amateur installation would range from around 5 sq ft for fairly simple arrays to as much as 16 sq ft in the case of multiband arrays. The antenna shown in Fig. 4, for example, has a projected area very close to 10 sq ft. Whenever faced by an unfamiliar situation or an especially complex installation, you would do well to make a few preliminary calculations such as have been described here—it's good insurance.

Selecting Materials and Equipment

Many manufacturers have helpful information available for the asking and will gladly respond to specific inquiries regarding actual projected area of their antennas, strength of masts, and correct guying methods and insulator selection. Manufacturers of other antenna equipment also can be a very good source of data. Rotator-assembly information of comprehensive depth for evaluating mechanical strength and installation techniques, for example, is available from Alliance Mfg. Co., Cornell-Dubilier, and Channel-Master. Don't overlook EIA recommendations on antenna erection methods, either. If antenna-system design and/or installation is one of your strong fields, you likely will have gathered much of this information already. If it has seemed to fall in the category of "so what?" material until now, perhaps you'll find a little more practical use for it. Select your equipment carefully, and if you have specific questions regarding the suitability of any component, determine what information you need to know to complete a series of calculations and ask the manufacturer. If you don't receive convincing data from that approach, it is a whole lot less expensive to run a few static tests in your shop using sand-filled buckets for simulating loads than it is to face a lawsuit.

Conclusion

While many antennas can be erected with little thought or consideration, that sort of hasty installation can give you considerable time to repent at your leisure. The next time your town is struck by damaging winds or ice storms, don't be among those who have to "make-good" several inadequate antenna jobs. Remember, too, the least possible damage that can result from the loss of an antenna is lost customers, and the worst is frightful to consider. Don't be responsible for personal injury accidents, property damage, and the resulting expensive lawsuits. They might cost you your business. ▲

Maintenance

of ANTENNAS & TOWERS

Timely suggestion: Get these things done before winter!

by Howard S. Pyle

Picture yourself in this situation: The phone rings; a somewhat perturbed housewife announces, "My TV is action strangely; sometimes the voice and picture disappear for a few minutes and then are normal again. At times the ghosting is bad, and it also comes and goes. Can you come out and take a look at it?" Sure you can; that's your business.

As you approach the customer's house, you make a quick visual check of the antenna and lead-in. It seems okay. Inside the house, your routine checks don't reveal the source of trouble, so you decide to take the set to the shop.

On the bench the set works perfectly. You let it play for a half hour, and still there is no sign of a malfunction of any kind. Somewhat reluctantly, you return the set to the customer, realizing that she isn't going to be happy about paying "just for the side." You replace the set in the living room, connect the antenna and power cord, turn it on, warm it up, and w-h-o-o-p-s . . . a terrible picture with snow flurries and ghostly visitations! The speaker crackles, and the voice breaks at frequent intervals. There's one for the book.

You don't panic, but you are puzzled. It works in the shop but goes wacky in the home; what could there be at the house that would so upset the performance? When you made your initial call, you took a casual glance at the antenna, and it looked okay. But is it? The antenna, lead-in, and AC power are the only external items in the installation. Just on a chance, you change the plug to another wall outlet on a different circuit. No go; same troubles persist.

You have a pair of rabbit ears in the truck, so you give them a try, disconnecting the normal antenna, of course. You turn on the set, let it warm up, and then let it play awhile. Ten minutes later the voice and music are still perfect, and the gleaming eye shows *no* ghosts, *no* snow, just a very acceptable picture.

This has pretty much pinpointed the antenna or the lead-in as being defective. From the ground, a visual inspection of the lead-in shows it to be in good condition, at least from

BENTON CITY
RADIO/TV CENTER
Benton City, Wis.

ANTENNA SYSTEM INSPECTION REPORT

for ____________

Date ____________

Technician ____________

Items	Satisfactory	Hazardous	Loose	Corroded	Broken	Rust
ANTENNA						
Elements	✓					
Electrical connections			✓	✓		
LEAD-IN CABLE						
Insulation	✓					
Strain relief at terminals			✓			
SUPPORT MAST						
Section joints	✓					
Mounting base						✓
Bolts and nuts						✓
Guy wires					✓	
Guy wire insulators						
TOWER STRUCTURE						
Section joints			✓			
Bolts and nuts			✓			
Crank-down mechanism	✓					
Tilt-over hinging						
Hoist cable		✓				
Safety catch		✓				
Guy wires	✓					
Guy wire insulators					✓	

Fig. 1. Detailed report is essential to both the inspector and the customer.

the set to the rain gutter over which the twin-lead disappears. The trouble must be either the lead-in connection at the antenna, a chafed spot in the twin-lead not visible from the ground, or the antenna itself.

You remove the ladder from the truck, and up on the roof you go. Your inspection discloses that the wind has broken one of the lead-in conductors. Furthermore, the porcelain eye of one of the stand-off insulators on the roof has cracked and fallen from the screw-eye, and the lashing of the recent wind has completed abrasion of the twin-lead against the rusted iron screw-eye to the point where both conductors are bare and scraping against the eye. Beyond a doubt this accounts for the trouble in the receiver.

Time and Money Savers

Trouble calls such as the one described here are not uncommon; however, locating and clearing such faulty performance is often frustrating. In the average TV installation with a roof-top antenna, the customer promptly forgets, after the initial installation, what's on the roof, never giving it a thought when trouble develops. Immediately he jumps to conclusions; "There is something wrong with the TV—call the service shop." And unfortunately, many shop owners and technicians have fallen into a similar habit. If a quick visual inspection from the ground shows the antenna and its mast or tower in a reasonably upright position, it is assumed that there is nothing wrong there; again, "it must be the set," and off to the shop it goes. This costs the customer an unnecessary service charge and costs you time which might have been devoted to more profitable sales or service calls. A little forethought and planning will reduce both of these elements substantially.

You've done enough TV service to be able to recognize the more common causes of faulty performance when you see the symptoms. Most of these indicates a check of tubes and a visual inspection in the home without chassis removal. Many times, this is sufficient; replacement of one or two defective tubes and perhaps tightening a terminal here and there will clear the trouble, save considerable time, and make the customer relatively happy with a nominal charge. However, if you *don't* locate the trouble spot quickly through your routine checks, give more than a passing thought to the antenna system before you jerk the chassis or lug the set to the shop. Make it a point to carry a pair of rabbit ears with you in the truck; they will give you a quick check on possible antenna faults. A hundred feet or so of twin-lead also takes little space and may save you an extra trip to the shop if you find a lead-in so deteriorated that it requires replacement. Carry a few extra screw-eye standoff insulators as well, to replace any broken ones you may find.

Spotting Antenna and Tower Failures

As for the antenna itself, don't be satisfied just to look for a broken lead-in connection or chafing of the twin-lead insulation. Unlike the TV set, which is protected in the home to the same extent as a piano or organ, the antenna takes an unmerciful beating, particularly in areas which are subject to long, cold,hard winters. It is exposed to the ravages of nature the year 'round, day and night. Wind-whip causes vibration of the elements; vibration eventually causes breakage, particularly at joints of antennas whose active elements are crimped or brazed together in sections. Such cracks, not at all discernible from ground level, can wreak havoc with picture reproduction and cause audio scratchiness. Once you're on a roof or up a tower, make your antenna inspection *thorough*. The inspection report shown in Fig. 1 lists many of the things to look for. The arrows in Fig. 2 shows the points that should be inspected carefully for different types of installations. Some antennas may be repairable if the problem is a simple matter of bent or

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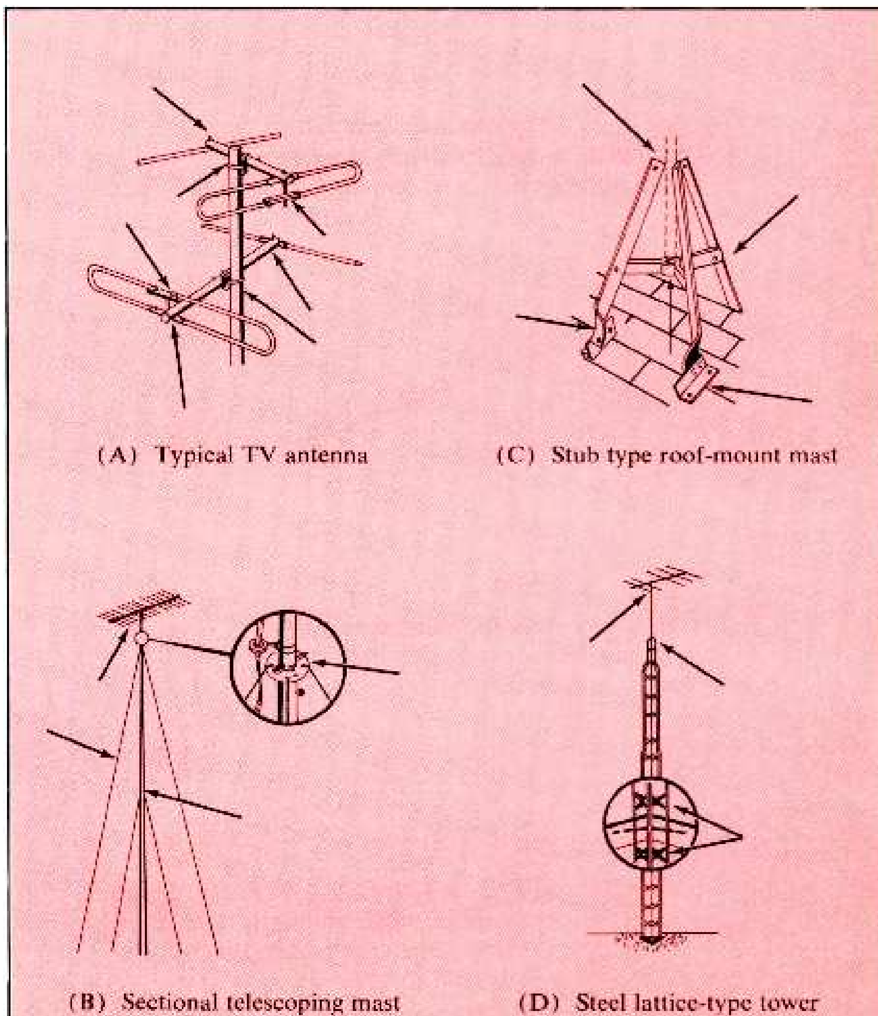
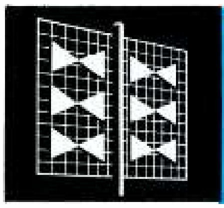
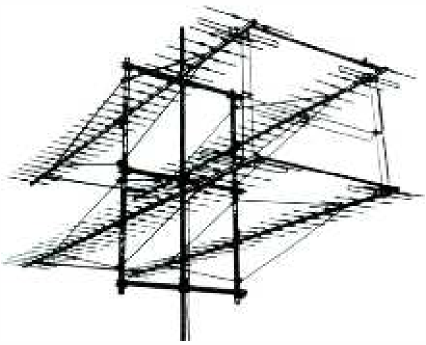


Fig. 2. Beware of these potential antenna trouble spots when making inspection.

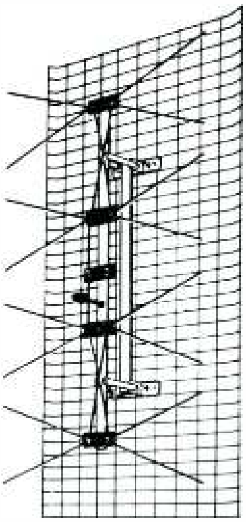


UHF Antennas for 1965

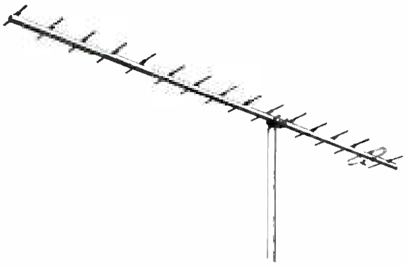
The accompanying chart of manufacturers and types is provided as a guide in antenna shopping. As a further aid, a brief description of each type is given also. Many different models are available from each manufacturer; you can obtain specific details from your distributor.



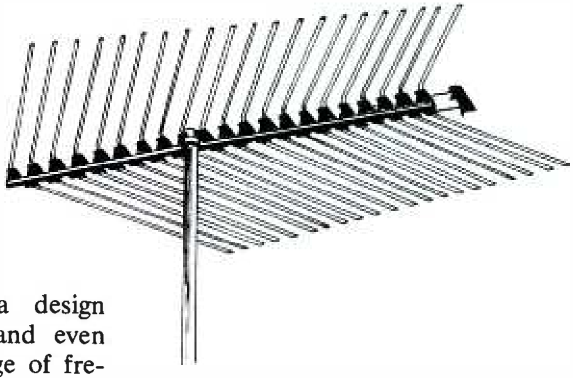
For very long-distance reception, the *collinear array* delivers a snow-reducing signal.



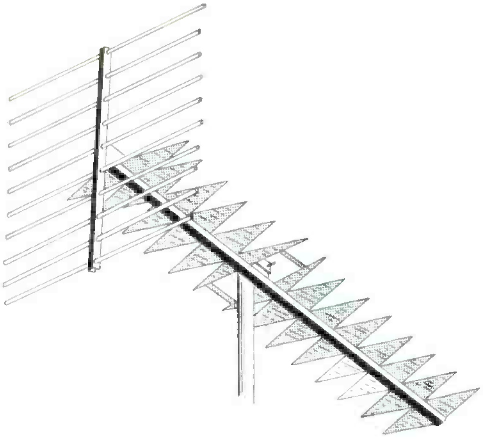
The *bow-tie* antenna provides high gain and broad response in a light-weight and compact unit.



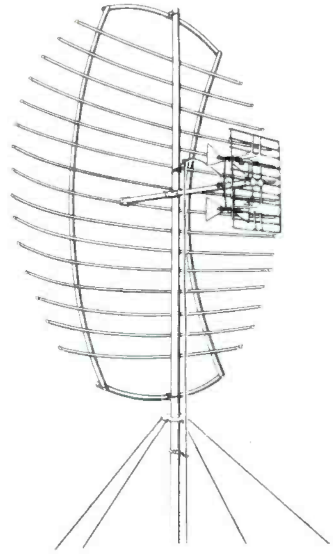
The many parasitic elements of the *yagi* antenna provide for high gain and sharp directivity.



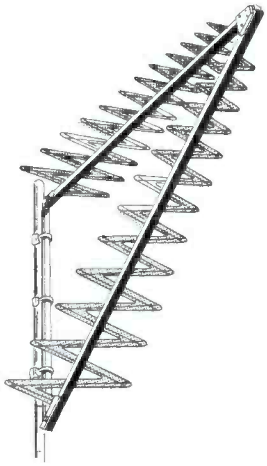
The *log-periodic* antenna design provides high efficiency and even response over a wide range of frequencies.

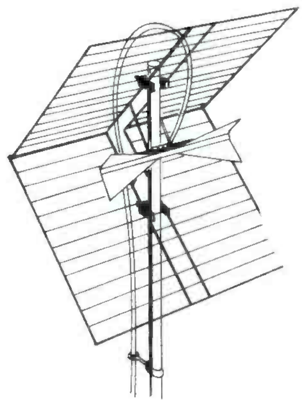


The *parabolic* antenna provides very high gain with a high front-to-back ratio. The screen behind the driven elements is designed to reflect and focus the signal upon the driven element.



A lightweight, high-gain, and highly directive type is the *planar-helical* antenna (two types are shown).



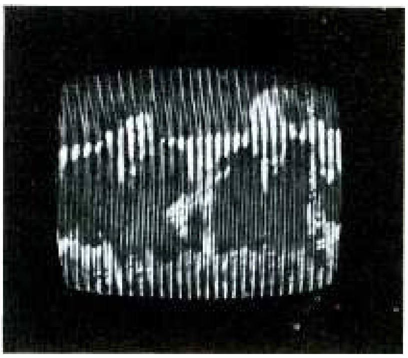


Two screens meet to make a corner and reflect the signal toward a wideband driven element to form the *corner-reflector* antenna.

Antenna Types / Manufacturer	Parabolic	Bow-Tie	Yagi	Corner-Reflector	Log-Periodic	Planar-Helical	Collinear	Planar-Grid
Admiral	X	X		X				
ANDI		X	X					
Antennacraft			X					X
Blonder-Tongue					X			
Channel Master	X	X	X	X		X		
Finney	X	X	X	X			X	
Gavin		X	X					
GC		X	X	X				
Hi-Lo		X	X	X				
IE		X	X					
Jerrold-Taco	X	X	X					
JFD		X	X	X	X	X		
RMS		X	X					
S & A		X		X				
Trio		X						
Winegard	X		X				X	X
Zenith					X	X		

finding and curing
RF Interference

New ideas for an old problem.



by Thomas R. Haskett

Handling RF interference problems can be quite simple if you use the system concept. Although the receiver is theoretically a closed unit or box which admits only the desired signal, it actually is part of a reception *system* which includes the building, surroundings, antenna, ground connection, and (unless it's a battery set) the power line. Should you take the receiver back to the shop, you may "cure" the trouble only to find it still exists at the customer's home when you return.

Receiver Substitution

Assume you are called to a customer's home on an interference complaint. First, eliminate the receiver as the source. If possible when making such a call, take along an AC-powered set and a line filter, such as Cornell-Dubilier's *Quietone* or Sprague's *Filterol*. If the trouble disappears when your set (without the filter) is plugged into the AC receptacle, the customer's set may be generating its own interference. In TV, this often shows up as wiggly vertical lines along the left side of the raster; these are called Barkhausen oscillations, or snivets. The condition is a result of radiation from the horizontal-output tube being picked up by the tuner. It usually can be cured by attaching a small permanent magnet to the envelope of the horizontal-output tube.

If the preceding test fails, try your receiver with a line filter in the AC feed. You will probably have to find a good ground for the filter to be effective, so be sure to take a few clip leads along.

If the power line cannot be blamed for the interference, it's probably coming through the antenna. You could try shorting the antenna leads to see if the interference disappears, although this isn't conclusive. The undesired signal could be beating with the desired signal to cause a disturbance, and shorting the antenna terminals would kill the desired signal and, consequently, the beat. Furthermore, don't forget that sometimes a poorly shielded receiver will pick up strong RF interference directly via chassis wiring, not from the antenna or power-line leads.

Fig. 1. Shot interference in television.

Types of Interference

There are two basic types of interference: random or transient interference that is usually caused by electrical devices and covers a broad band of frequencies, and fixed interference which is produced by electronic devices and occurs at a specific frequency. Transients, rich in harmonics, are created by current impulses in motors, auto ignitions, and neon and fluorescent lights. These transients are often carried by the power line to produce video interference called "shots," "hits," or "birdies" (Fig. 1). A battery portable often can be used to follow such interference to its source.

Fig. 2 shows one such source—a furnace containing a blower motor with dirty, misadjusted brushes. After the commutator was cleaned and the brushes readjusted, the interference disappeared. When you find something like this, also check the motor ground.

In radio, electrical noise usually sounds like clicks, pops, and buzzes. Fluorescent lights are the usual cause of buzz. Turn them off to see if the noise disappears. If so, try a .01-mfd, 600-volt capacitor across the AC line inside the lamp housing. Make sure the metal lamp frame is grounded; if the capacitor doesn't work, try a line filter. In severe cases, check the ballast; if it's a 15% low-power-factor type, replace it with a 90% high-power-factor type.

Fixed interference is generated by transmitters in all services—broadcast, amateur, CB, police, taxi, etc. —and by receiver local and deflection oscillators. In each case the interference is amplified and radiated in such a way as to mix with the desired signal. Fixed interference can be transmitted by way of the power line; the effectiveness of a good line filter and a good ground with the shortest, largest wire connected directly to earth cannot be overstressed. A filter at the receiver doesn't work as well as a filter at the source of interference, but it's sometimes the best that you can do.

Unfortunately, much interference arrives by way of the antenna. For TV or FM, a high-pass filter at the antenna terminals—such as the Regency HP-45 or the Drake TV-300-HP—is the first remedy. For AM

Fig. 2. Furnace often has noisy motor.

Fig. 3. Picture has weak interference.

receivers, use an antenna trap. The purpose here is to admit only signals in the desired band of frequencies and to trap out all the rest.

Identify Symptoms

Fig. 3 indicates a small amount of RF interference, with the interfering signal probably more than 1 mc from the TV picture carrier. Don't confuse this pattern with sound bars; the latter vary in intensity with the audio. The picture in the heading of this article illustrates strong RF interference, and since there are fewer bars, the interfering signal is very close in frequency to the picture carrier. In Fig. 4, RF interference is very strong and has resulted in a negative picture. This only happens with extremely strong overload; in such a case you will undoubtedly find a transmitter in close proximity to the receiver.

Don't forget that interference depends not only on the strength of the interfering signal but also on the strength of the desired signal. In fringe-area TV, the slightest interference will tear up the picture, and radio listeners who listen to out-of-town stations will have trouble from TV horizontal-oscillator radiation, power-line arcing and buzzing, and many other forms of interference that wouldn't bother a local-station listener. This brings up another important point: Be sure the receiver is getting enough signal—the most you can get. Try repositioning the antenna, and check the TV lead-in for breaks or runs parallel with metallic objects. A mast-mounted preamp connected to the receiver with coaxial line will raise the signal-to-noise ratio tremendously in FM and TV weak-signal areas. To cure ignition noise for AM, a better antenna location is just about the *only* solution.

Tracing Sources

If you cannot get rid of the RF interference at the receiver, you must find out what frequency is involved and locate the source of the unwanted radiation. Sometimes a shop RF generator is useful as a dummy source; tune it until it causes the same interference, then note the frequency. You may then be able to employ a trap tuned to this specific frequency.

Another tool that's handy is the portable battery-powered receiver. AM types have bidirectional loops; FM and TV types either have or can be equipped with simple dipoles. You can even use rabbit ears. The technique is to make use of the signal nulls (which give sharper directional information than the maximum lobes) to find where the interference lies. You can then find your way to the offending transmitter (or receiver oscillator). Most transmitters can be filtered to prevent spurious radiations—FCC regulations require this. Receiver local and sweep oscillators present a more difficult problem, especially in fringe-area or long-distance reception, where the desired signal is weak. An offending TV set should be equipped with a low-pass antenna filter. This will usually keep radiation from the horizontal-output tube within acceptable limits—provided the filters are grounded.

Special Techniques

Receivers located in strong RF fields often do strange things. For example, if the customer lives within a couple of blocks of a broadcast transmitter, his receiver will often block or overload at all or many points on the dial; or there may be a continuing series of whines or squeals. You may have to use a series trap with the antenna, and it

Fig. 4. RF overload, negative picture.

may be necessary to shield the set from direct-wiring pickup. If this doesn't remove the interference, try bypassing the grids of the audio stages with 500-pf disc-ceramic capacitors. Keep the leads as short as possible. If trouble persists, check the house wiring for loose or corroded joints, which may rectify and reradiate the strong RF.

While you're at it, why not check the house wiring as a possible source of noise signals? (This applies to other locations besides adjacent-transmitter sites.) Unplug everything in the house and plug in a single brand-new light blub, to draw current. Then listen on a sensitive receiver. Any noise you hear probably comes from faulty wiring joints or fixtures. When tracing a power circuit, be prepared to find an abandoned thermostat or electric-blanket control. If they are left plugged in, they will often put a strange bar in the middle of a weak TV channel, or a slight buzz on AM.

Some receivers work better ungrounded than grounded, and it's best to try them both ways. An AC-DC chassis requires a .01-mfd 600-volt capacitor in series with the ground lead, since one side of the AC line is connected to the chassis.

Two somewhat rare forms of RF interference are produced by cross-

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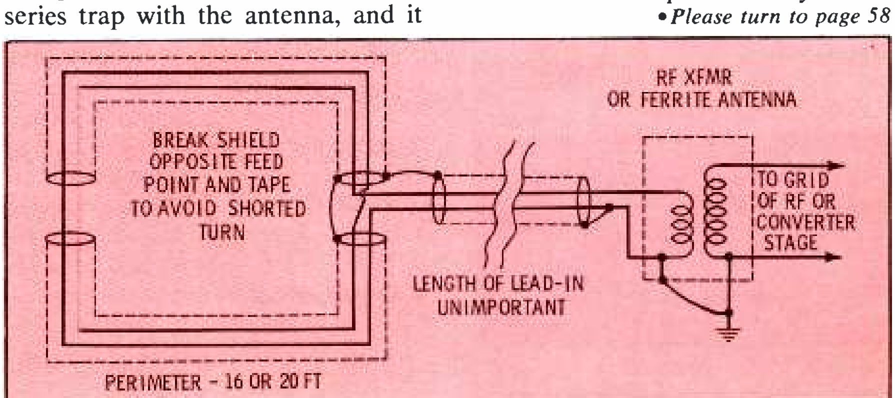


Fig. 5. Low-impedance, shielded loop antenna made of cable.

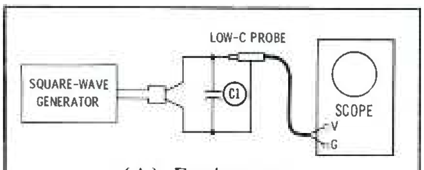
SQUARE-WAVE TESTING of Capacitors

by Robert G. Middleton

Third in a series of square-wave-testing articles, this installment in our "Advanced Service Techniques" department takes up the analysis of capacitance by square-wave testing procedures. Following an introductory article on the square wave itself (April 1965 PF REPORTER—"Advanced Techniques for Future Servicing"), the first two testing articles covered resistance and inductance. In articles that follow, you will learn how to use the knowledge gained from these first articles to analyze three-terminal networks that contain combinations of all three—resistance, inductance, and capacitance. When the only visible portion of a component pack is a set of three leads, these special tests are one of the few ways you can identify what's inside or what may be defective inside.

The techniques outlined can be carried out properly only with a triggered scope of the variety described in the March 1965 PF REPORTER article "Learning About Triggered-Sweep Scopes." Few service shops have such an instrument available; they are found mostly in television broadcast stations, electronic and research labs, and of course a few truly forward-thinking shops. If you can find any way to gain the use of such a scope, for even a few hours each month, take advantage of the opportunity to familiarize yourself with its operation and to practice the testing techniques we're outlining in this series. The time will come when much of your servicing work will require a scope like this; a lot of your present troubleshooting could be greatly simplified by a high-quality triggered scope on a rollabout cart in your shop. Future articles, in addition to showing you how to test component combinations of the ordinary and microcircuit variety, will teach you to use a triggered-sweep scope for regular troubleshooting in television and stereo receivers, where the ability of a fast-rise triggered scope to reproduce faithfully every "squiggle" in a waveform can speed your circuit analysis tremendously.—*The Editor.*

Any capacitor has inductance and resistance as well as capacitance. The resistance of most capacitors is very low and can be neglected, so let's discuss the inductance. The inductance of a capacitor depends on its physical size and the details of its construction.



(A) Equipment

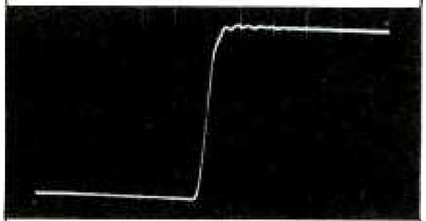

(B) Response

Fig. 1. The capacitor inductance test.

To check a capacitor for internal inductance, connect it across a square-wave source, as depicted in Fig. 1A. If the capacitor has negligible inductance, it will merely slow down the rise of the square wave. On the other hand, if the capacitor has appreciable inductance, the square wave will ring to some degree as illustrated in Fig. 1B.

The capacitor used at C1 in Fig. 1A was a lab-type variable unit, comparatively large physically, not intended for high-frequency work. The rise time of the square wave applied to the capacitor was .02 usec. Obviously, this capacitor would be unsuitable for use with waveforms that have rise times in the order of .02 usec or less. For waveforms with a slower rise, however, this capacitor should be entirely satisfactory.

Most fixed capacitors have pigtail leads which exhibit inductance, capacitance, and resistance. We can neglect the resistance, and the lead capacitance can be lumped with the fixed capacitance. However, lead inductance cannot be neglected in high-frequency or fast-rise operation. Note that a VOM can be used with very long test leads, because the highest frequency of operation will be about 10 kc. The test leads in Fig. 1A, however, must be kept as short as possible; otherwise, you will falsely conclude that capacitor C1 has excessive inductance.

For example, a 250-pf fixed capacitor with very short test leads produced no ringing in this test—it merely slowed down the rise of the square wave. On the other hand, when a pair of VOM test leads was used to connect the 250-pf capacitor into the test circuit, severe ringing occurred, as seen in Fig. 2. In other words, test leads which are quite satisfactory for low-audio-frequency work are completely unsuitable for fast-rise square-wave work.

How Much Capacitance?

Suppose you are checking capacitors, using the test setup shown in Fig. 1A. The rise time of the reproduced square wave is a rough measure of the capacitance value. If the capacitor is open, the rise time is unchanged. A high value slows down the rise more than a low one. For instance, the rise time of a 1-mc square wave with zero shunt capacitance was .02 usec. When 150 pf was connected in parallel—C1 in Fig. 1A—the rise time was slowed down to .06 usec. With 300 pf, the rise time was .10 usec; with 450 pf, .12 usec.

Electrolytic Capacitors

Most electrolytic capacitors have appreciable inductance. Accordingly, if you place an electrolytic capacitor in the test circuit of Fig. 1A, you will see a series of pips followed by ringing, as in Fig. 3. What is happening here? The square wave itself is wiped completely out, be-

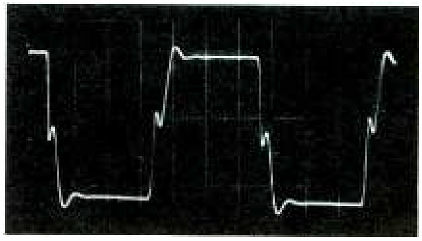


Fig. 2. Ringing caused by test leads.

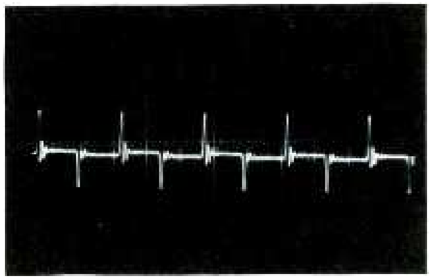


Fig. 3. Ringing across an electrolytic.

cause of the heavy capacitive bypassing across the square-wave source. On the other hand, the inductance of the electrolytic capacitor causes the waveform to ring on leading and trailing edges of the square-wave voltage that is applied. Obviously, this electrolytic capacitor is unsuitable for use as a bypass for waveforms with fast rise.

It is sometimes supposed that an electrolytic capacitor can be "cooled" by shunting it with a mica or ceramic capacitor, and, in theory, this has a certain plausibility. But, in fact, the equivalent circuit of an electrolytic capacitor is quite complex. Most electrolytic capacitors will ring longer than normally when shunted by a mica or ceramic capacitor. The waveform in Fig. 4 shows what happens when the 80-mfd electrolytic capacitor is shunted by a 500-pf mica capacitor: the peak-to-peak ringing voltage is not decreased by the 500-pf capacitor. Moreover, the ringing interval is *increased*.

When the mica capacitor is tested by itself, it produces no overshoot or ringing—it merely slows down the rise of the square wave. In other words, the *inductance* which produces the resonant ringing in Fig. 4 is provided by the *electrolytic capacitor*. We can summarize these facts by stating that heavy bypassing in fast-rise circuits cannot be accomplished completely by electrolytic capacitors, nor by electrolytic capacitors shunted with mica capacitors. On the other hand, it is quite possible to obtain practically complete bypassing with suitable *circuitry* comprising electrolytic capacitance, mica capacitance, and resistance.

Paper Capacitors

In general, paper capacitors have considerably less inductance than electrolytic capacitors. However, their inductance is greater than that of mica or ceramic capacitors. Inductance in paper units is related to physical size. A .5-mfd paper capacitor has more inductance than a .001-mfd paper capacitor. Fig. 5 shows the ringing waveform produced by a .5-mfd paper capacitor at a rise time of .02 usec. On the other hand, a .001-mfd unit only slows down the rise of the square wave, without visible overshoot or ringing.

Calibration of Sweep Speed

Whenever you measure the rise time of a waveform, you must know the sweep speed. The more elaborate types of triggered-sweep scopes have sweep speeds indicated to 3% accuracy. However, when you wish to make measurements with extreme accuracy, you can easily check the sweep speeds.

The simplest test is made with an accurate signal generator. If you tune the signal generator to 1 mc, one cycle of the sine wave displayed on the scope screen will occupy a time of 1 usec. If the scope is set on its 1 usec/cm sweep position, one cycle of the sine wave should occupy 1 centimeter along the horizontal axis. If it does not, simply touch up the sweep-speed trimmer on the 1 usec/cm range. The other sweep speeds can be checked similarly, but be very sure the signal-generator frequency is precisely accurate.

Another way to check sweep-speed calibration is to use a time-mark generator. A time-mark generator has crystal oscillators, followed by waveshaping circuits to develop a sharp output pulse. A few triggered-sweep scopes have built-in time-mark generators. When a time-mark generator is connected to the intensity-modulation terminal of a scope, a broken trace is displayed as shown in Fig. 6. With the generator set for 1-usec time markers, the blanked intervals occur 1 usec apart. Hence, if the scope is set for a sweep speed of 1 usec/cm, the blanked intervals should appear lined up with each horizontal cm division, as they are in Fig. 6.

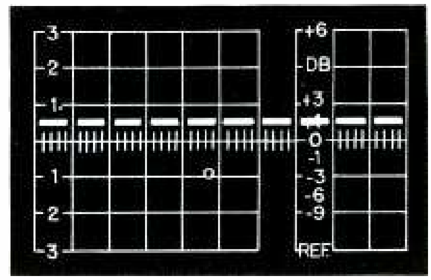


Fig. 6. Time markers blank the trace.

For Transistorized Circuitry

Electrolytic capacitors for transistorized circuitry are very compact, and operate at comparatively low voltage. In spite of their compact construction, this type of capacitor has considerable inductance. Hence, a square-wave test made as shown in Fig. 1A displays the waveform illustrated in Fig. 7. It is evident that you cannot estimate the internal inductance of an electrolytic capacitor by its physical size; only a square-wave test will give the answer.

Unusually large values of capacitance are sometimes used in transistorized circuits. For example, an electrolytic capacitor might have 1000 mfd of capacitance, with a rating of 6 volts. Such a capacitor is fairly large physically. It also has considerable inherent inductance, as a square-wave test will show. When

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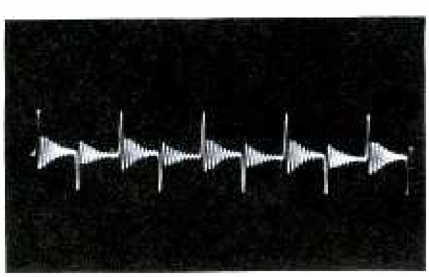


Fig. 4. Mica across the electrolytic.

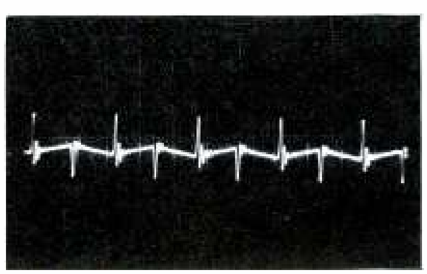


Fig. 5. Ringing produced by a .5 mfd.

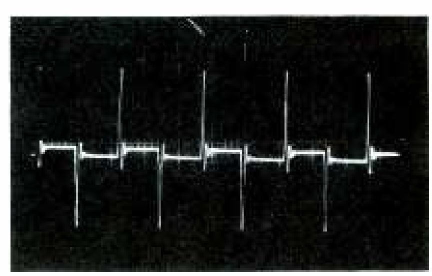


Fig. 7. Testing low-voltage filter cap.

Notes on Test Equipment

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

by James E. Richardson and Allen B. Smith

Kit-Style Stereo Generator

Manufacturers of FM tuners and receivers for use in high-fidelity audio systems are at long last achieving success in communicating the advantages of FM stereo listening to a fast-growing segment of dedicated audiophiles and, more importantly for the service technician, to the mass-market consumer as well. The natural result of this heightened interest in stereo is more equipment in the hands of the public, and this creates an obvious and expanding source of income for the alert shop owner who has the test

Fig. 1. Crystal-controlled oscillators generate a composite stereo signal.

equipment and knowledge to service and repair FM stereo equipment.

In many shops, the Heath Model IG-112 FM Stereo Generator shown in Fig. 1 will provide the primarily important test instrument for servicing multiplex stereo tuners and receivers. This generator, assembled from kit form, provides a low-power signal equivalent to that received off-the-air from the FM stereo station. The composite signal (or one of its individual components, each of which is available separately at a panel-mounted jack) is used in performing the required analysis, alignment, and repair operations.

A second aspect of stereo servicing (understanding the operation of the multiplex system of transmission and reception) also receives some assistance from the Heath Co. The instruction manual contains a concise and informative description of how the multiplex signal is generated, transmitted, and received. A capsule summary of this type certainly doesn't make experts of technicians entirely unfamiliar with FM, sideband, and subcarrier techniques, but it can aid measurably in providing a starting point from which to acquire a sound and workable servicing technique.

A block diagram of the Model IG-112 is shown in Fig. 2. Since many components of the composite signal include or are derived from a 19-kc basic signal, the 19-kc oscillator is the section of primary importance. The oscillator is a Pierce circuit, crystal controlled to provide a high degree of stability. The 19-kc pilot signal is fed first to a buffer stage and then to switched RC circuits where it is shifted in phase +45° or −45° relative to zero phase. Then the 19-kc signal is amplified and fed to the composite-audio amplifier, where it is mixed with the double-sideband suppressed-carrier output of the 38-kc balanced modulator.

The 19-kc signal is also fed to a doubler stage, the 38-kc output of which is applied to the balanced modulator. At this point, a signal (any one of the several audio frequencies listed in the *Specifications* box) from the audio oscillator is fed through a cathode follower to the balanced modulator, where it is used to modulate the 38-kc signal. The function of the balanced modulator is to remove the 38-kc carrier component from the modulated signal, thus generating the 38-kc double-sideband, suppressed-carrier signal which is fed through a low-pass filter (to remove high-frequency harmonic distortion which may have been introduced by the balanced-modulator action) to the composite-audio amplifier.

To return briefly to the audio oscillator section, note that its output also is fed directly to the composite-audio amplifier. This insures that all audio signals may be applied to the reactance-tube modulator to provide monophonic FM signals. The audio oscillator is a Wien bridge type, varied in frequency through a series of switched resistances in the grid circuit.

The manner in which the 19-kc pilot signal and the 38-kc double-sideband signal are combined in the composite-audio amplifier circuit determines the character of the signal fed to the composite-audio jack or to the reactance modulator. When the FUNCTION switch is set to PHASE TEST, the two signals are in phase; the resultant signal is seen by the tuner as two separate channels.

When the FUNCTION switch is indexed to LEFT CHANNEL, the phase-

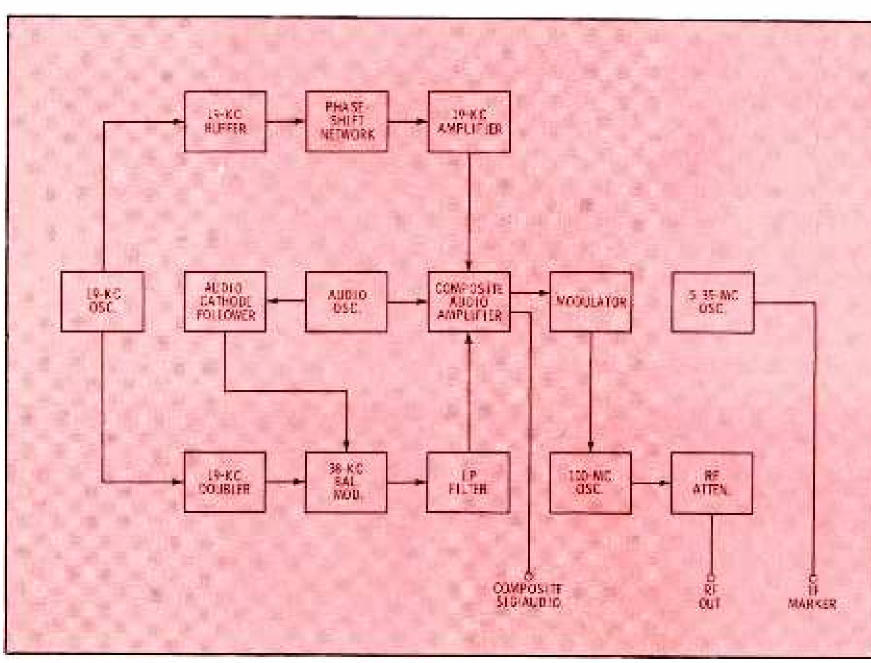


Fig. 2. Simulated stereo signal generation similar to FM station exciter unit.

shift network causes the 19-kc pilot to lag 45° behind the 38-kc balanced-

Heath Model IG-112 Specifications

RF Output:

Center frequency is 100 mc ± 2 mc; pilot signal modulating frequency stable ± 2 cps @ 19 kc; modulation modes — left channel, left + right (in phase)for phase test, and mono FM. Deviation is variable to 75 kc. 60-cps sweep rate adjustable to maximum width of 750 kc.

Crystal Markers:

Marker signals are provided for reference at 10.7 mc, 90.95 mc, 96.30 mc, 101.65 mc, and 107.00 mc.

Composite Signal Output:

Left channel (stereo), right channel (stereo), and phase test.

Audio Outputs:

Audio signals are provided at 400 cps, 1000 cps, 5000 cps, 19 kc ± 2 cps, 38 kc, and 65 or 67 kc (SCA) with maximum distortion of 5%.

Front-Panel Controls:

DEVIATION — SWEEP WIDTH — COMPOSITE LEVEL—AUDIO LEVEL control; FUNCTION switch; 19-KC PILOT LEVEL control; FREQUENCY switch; RF ATTENUATOR.

Rear-Panel Adjustments:

BALANCE ADJUST; 38-KC SYNC; PILOT LEVEL ADJUST; SCA FREQUENCY switch.

Power Requirements:

105-125 volts AC, 50-60 cps, 35 watts.

Size (HWD):

10½" x 13" x 8"

Weight:

8 lbs.

Price:

Kit form, $99.00

modulator signal. Upon reaching the FM receiver matrix circuit, the signal undergoes an additional 45° shift, and the result of the matrix demodulation is a left-channel output.

Similarly, when the FUNCTION switch is indexed to RIGHT CHANNEL, the pilot signal is shifted in phase to lead the 38-kc signal by 45°. This shift is doubled in the receiver's matrix network, and the resultant signal is right-channel output.

All audio and RF information generated by the instrument is mixed in and distributed through the composite-audio amplifier and applied to the reactance modulator which swings the frequency of the 100-mc RF oscillator to a maximum 75 kc deviation, the front-panel control is used to set the swing limits.

Markers, as noted in the *Specifications* box, are also injected in the composite-audio amplifier. The frequency of crystal-controlled Pierce oscillator (5.35 mc) is doubled to provide 10.7 mc for use as an IF marker, and harmonic frequencies provide other marker pips throughout the 88 to 108-mc FM band for alignment use.

The Heath Model IG-112 is a well-conceived instrument which provides the signals required to service FM tuners or receivers designd for stereo FM reception. The consumer's dollar is waiting for the masters of multiplexing. Are you getting your share?

For further information circle 121 on literature card

Quick Capacitor Checks

One of the really time-consuming jobs in most troubleshooting stems from the fact that many components must be disconnected from their associated circuit before a reliable evaluation of their condition can be made. The Mercury Model 1400 In-Circuit Capacitor Tester shown in Fig. 3 can ease the situation by determining the condition of capacitors while they are still connected in the circuit. As noted in the *Specifications* box, several tests can be performed to evaluate capacitors quickly.

The Model 1400 has a coaxial cable with two clip leads used for rapid connection to the leads of the capacitor in question. A plug-in power cord provides the instrument with power from the line.

Operation of the tester is very simple, with few controls to manipulate. Only two are accessible on the panel, and one (the 20K CAL potentiometer) is inside the case. The bar-type indicator also is mounted on the

Fig. 3. Handy capacitor checker can speed preliminary troubleshooting.

front panel. Before any circuit checks are made, the equipment under examination must be disconnected from the power line, and the capacitor being tested must have no residual charge that might damage the tester or cause erroneous indications. When power is applied to the tester and the function switch is indexed to any position other than OFF, the front-panel-mounted POWER lamp lights.

The tests performed by the instrument are easily applied. For example, shorts tests may be made quickly by turning the function switch to SHORTS position, connecting the insulated clips across the in-circuit capacitor in question, and observing the indicator tube; its bars will close if the component is shorted, remain open if the unit is all right. If the capacitor is shunted with a circuit resistance less than 6 ohms, one end will have to be lifted to insure an accurate evaluation; that circumstance, however, is not common.

Testing for open circuits is performed as easily, by setting the function switch to OPENS, connecting the leads to the capacitor, and observing the indicator; a fault (open circuit) will cause the bars to close.

The remaining test performed by the Model 1400 is to determine the value of elctrolytic capacitors in a range of 2 mfd to 450 mfd. While capacitors to be measured occasionally will fall outside that range of values, nearly all electrolytics (99%, or more, according to the manufacturer) will fall within the instrument's capability. Testing is simple, requiring only connection of the test leads to the electrolytic (each section, of course, is tested separately) and turning the value dial until the indicator bars close. While it is perfectly acceptable practice to perform SHORTS and OPENS tests on electrolytics, they are unnecessary if a value measurement can be made. If the bars close, indicating a specific value, the capacitor is good and no further tests need be made. In some cases, capacitors having values less than 10 mfd may have shunt resistances of extremely low values; inconclusive test results will then be obtained. Proper evaluation can be made, however, by lifting one circuit lead from the unit being tested and making an out-of-the-circuit test.

The instruction manual accompanying the instrument provides complete procedures for testing all types of capacitors, and also suggests several steps to be taken if inconclusive results are obtained. Two charts provide hints for troubleshooting television sets and audio equipment. While most of the suggestions are rather elementary, the charts could be used as a

Mercury Model 1400 Specifications

Function:
To test all types of capacitors, from small-capacity ceramics to large-capacity electrolytics, without disconnecting the component from its circuit.

Tests Performed:
Short test — Test capacitors shunted by resistances as low as 6 ohms.
Open test—Effective on all in-circuit capacitors as small as 7 pf.
Electrolytic test — Measures values of electrolytics in circuit, ranging from 2 mfd to 450 mfd.

Indicator:
Uses EM84 bar-indicator tube; instructions printed on panel assist in performing evaluation.

Power Requirements:
105-120 volts AC, 50-60 cps, 15 watts.

Size (HWD):
6¼" x 10¼" x 4⅜"

Weight:
4½ lb

Price:
$29.50

quick, once-over-lightly reference to eliminate or indicate several trouble possibilities.

In all, the Model 1400 provided us with useable information which speeded evaluation of troubles in several radios and TV sets. In some cases, value determinations were difficult to achive, but shorts or opens were immediately apparent. As a time-saving addition to the bench, the low-priced Model 1400 will be useful to many technicians.

For further information, circle 122 on literature card

Colors, Bars, and Crosshatch

In the past few years, sales of color sets have increased due to lower prices, more stable units, ease of purchasing, and increased color programing. If the technician intends to cash in on the potential service market these sales have produced, he must have the proper test instruments.

One of the necessary pieces of color test equipment is a generator capable of producing dots, bars, and crosshatch patterns. The dot pattern is invaluable in making static convergence adjustments. When performing dynamic convergence, a source of separate horizontal and vertical lines is required for fast, accurate adjustments, and a crosshatch pattern is desirable for checking overall convergence and linearity settings. In addition to these adjustments (which are a prerequisite to producing a good black-and-white picture), the operation of the chroma circuits must be checked; this necessitates having a color-bar pattern.

Since malfunctioning of the RF or IF circuits can prevent a set from producing a proper color picture, a signal which can be injected after the video detector, and hence enable a technician to localize trouble either before or after this point, is highly desirable.

Fig. 4. Color-bar generator has gun interrupters and storage compartment.

One of the latest additions to the color test-equipment market, the SENCORE Model CG135 color generator, contains all the above signal sources. The CG135 (shown in Fig. 4) also provides such features as color-gun interrupters, composite video and sync, a 4.5-mc audio carrier to aid in correctly setting the fine-tuning control, and the composite sync output for aid in servicing Zenith receivers.

The fundamental operating principle of this unit is similar to that of other dot-bar generators: A master oscillator and a series of frequency-divider circuits are used to derive the necessary pulse frequencies. The timer or divider circuits in the CG135 employ unijunction transistors. The UJT, as it is more commonly called, is still a little rare in the service field, but its function in the operation of the CG-135 is not complicated.

Physically, the UJT consists of a uniformly doped N-type semiconductor bar with ohmic (nonrectifying) contacts at each end. A PN junction is formed at the approximate center of the slab (see Fig. 5).

SENCORE Model CG135 Specifications

RF Range:
Channels 3, 4, and 5 (factory set to Channel 4), adjustable at front panel

Signals Available:
Modulated
10 standard color bars (crystal controlled), white dots (size adjustable at front panel), crosshatch pattern, vertical and horizontal bars, and 4.5-mc audio carrier
Unmodulated
Composite video and sync

Crystals:
1—189 kc ±.005% for timers
1—3563.795 kc ±.001% for color bars
1—4500 kc ±.02% for sound carrier

Power Requirements:
3½ watts at 117 volts AC, 60 cps

Size (HWD):
9½" x 10¼" x 4"

Weight:
8 lb

Price:
$149.95

The UJT is most often used as a triggering device. Consider the circuit shown in Fig. 6. Battery M1 is a 20-volt source; M2 is a variable DC supply. Suppose M2 is set at 0 volts. Battery M1 causes a uniform voltage drop from base 1 to base 2. Therefore, the voltage present at the PN junction is approximately 10 volts. Assume the resistance from base 1 to base 2 is 10K. The current from base 1 to base 2 is then 2 ma. As M2 is varied to any value between 0 and 10 volts, the PN junction is reverse biased

• *Please turn to page 70*

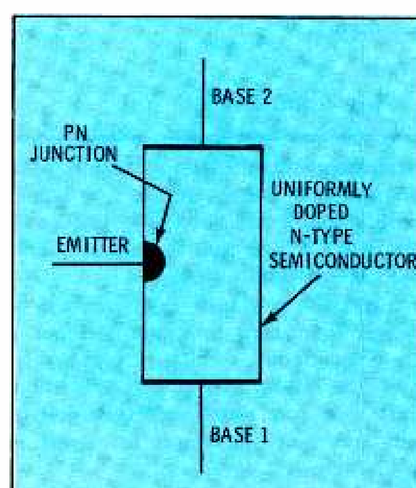


Fig. 5. Symbolic construction of UJT.

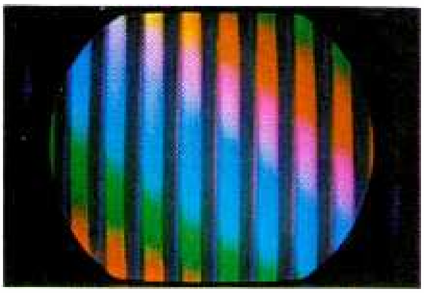
Home Servicing

by

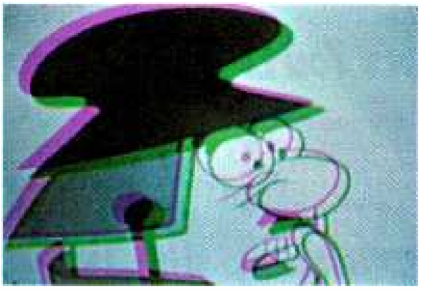
Color Picture Symptoms

A quick and convenient method of servicing color receivers is to take advantage of the presentation on the screen. The symptoms will usually tell you what section or stage is responsible for the trouble. However, this requires that the technician know what each symptom is actually telling him. This pictorial discussion will help in at least two ways: The symptoms and tips will benefit the inexperienced serviceman by pointing out tubes most likely to be responsible for a fault; they will aid the experienced repairman who needs a review or a handy record of these symptoms and tips both for conditions that can be repaired in the home and for those troubles that require the set be repaired in the shop.

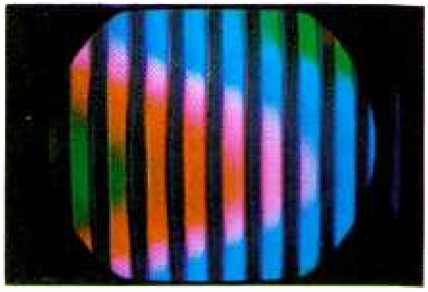
Note: Material for a portion of this article was adapted from the Howard W. Sams "**Color TV Guidebook.**"



Loss of color sync is a quite common trouble. Notice there is color present only where the color bars should be; however, the color is displaced diagonally across the screen. In this photo the oscillator frequency error is only slight—the greater the error, the more diagonal bars are present (smaller error means fewer bars or stripes). This symptom is indicative of trouble in either the 3.58-mc oscillator or reactance-control stages.

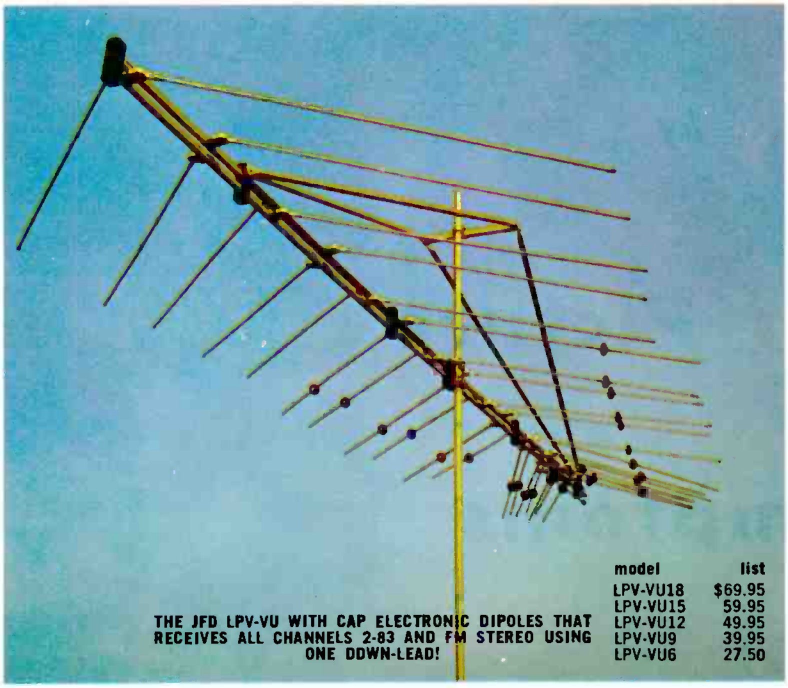


Displaced color is normally caused by the misconvergence of one color—in this case, green. In all cases of misconvergence, first be sure to position the static convergence magnets correctly; also, these should be double checked after the vertical convergence controls have been adjusted but before the horizontal controls are aligned. Without these static checks, you may be working for nothing and have to readjust dynamic convergence.



This distorted color-bar pattern was caused by hum being introduced at the cathode of the chroma reference-oscillator control tube in an RCA CTC16 chassis. (However, the same basic symptom will appear on nearly all recent color receivers.) The hum wasn't visible on a black-white picture. Notice the color bars are bent in the shape of a sine wave. In most receivers, the oscillator and oscillator-control tubes are in the same envelope.

Don't Be 1/2 Set... With JFD LPV Log



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model	list
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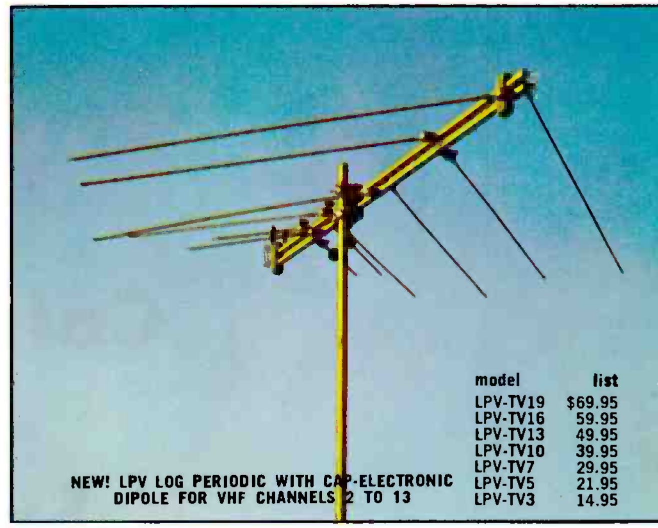
LPV-VU15	59.95
LPV-VU12	49.95
LPV-VU9	39.95
LPV-VU6	27.50



NEW! LPV LOG PERIODIC WITH CAP-ELECTRONIC DIPOLE FOR VHF CHANNELS 2 TO 13

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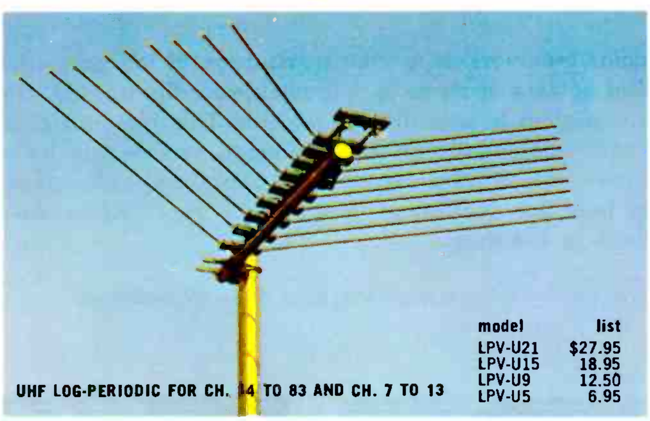
LPV-TV3	14.95



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LPV-U21	$27.95
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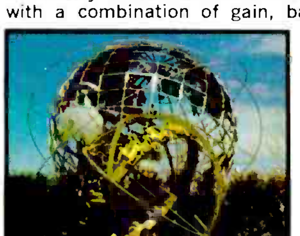
GET THE LION'S SHARE OF ANTENNA BUSINESS (FLATTEN CATV COMPETITION, TOO) BY FEATURING THE JFD LPV-VU LOG PERIODIC! THIS NEW GENERATION OF LOG PERIODIC ANTENNAS DELIVERS WHAT VIEWERS WANT—MANY **MORE** STATIONS...VHF CHANNELS 2 TO 13...UHF CHANNELS 14 TO 83...FM/STEREO. GIVES THE CLEAN, UNIFORM SIGNAL SETS NEED ESPECIALLY FOR VIVID **COLOR** RECEPTION.

Only the LPV follows the patented **frequency independent Log Periodic** antenna formula developed by the Antenna Research Laboratories of the University of Illinois. This new log periodic cellular concept provides you with a combination of gain, bandwidth, directivity and impedance match never before possible with conventional antenna designs.



You can actually **see** the difference in **truer** color purity, in **greater** contrast, in **finer** detail—not on just some of the channels but **all** of the channels! **Small wonder more JFD Log Periodics were installed in the last 12 months than any other brand.**

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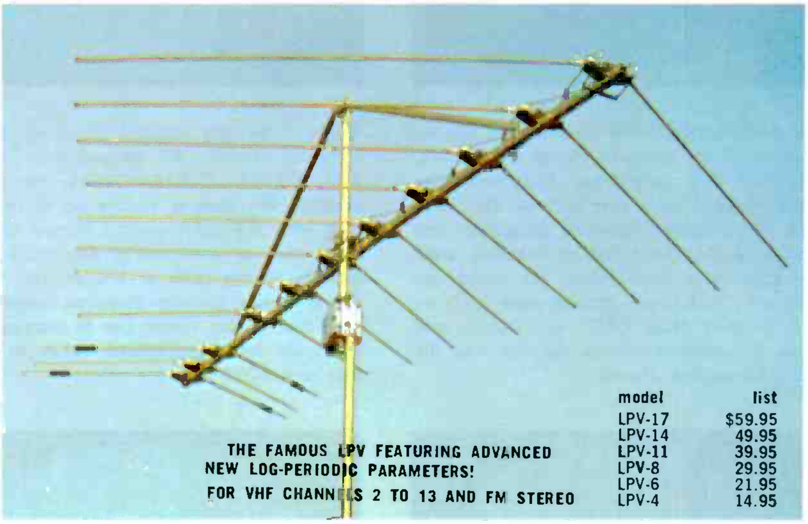

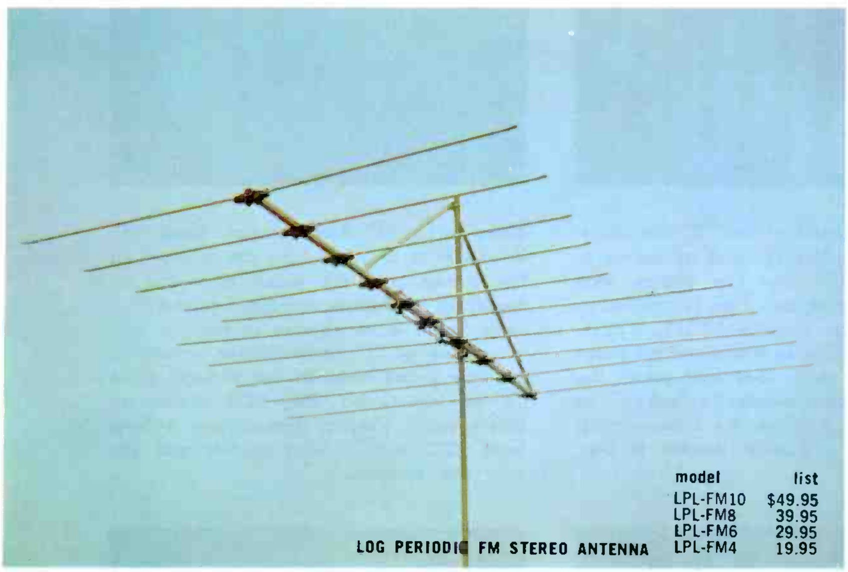

(Ch. 14-83)...FM/Stereo...VHF/UHF/FM-COLOR & Black/White

groups (cells) of overlapping resonances. These harmonically resonant V-dipoles result in a frequency-independent performance. The LPV's inherently high gain, sharp directivity, 300 ohm impedance match and flat response are virtually constant across the entire band.

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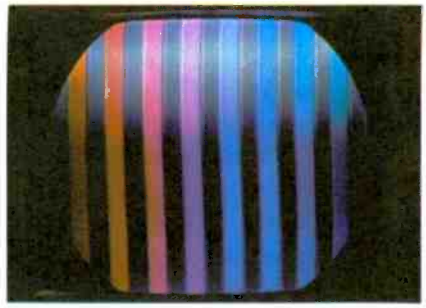
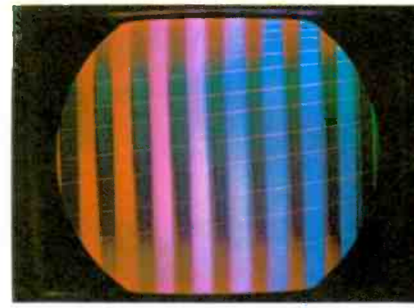
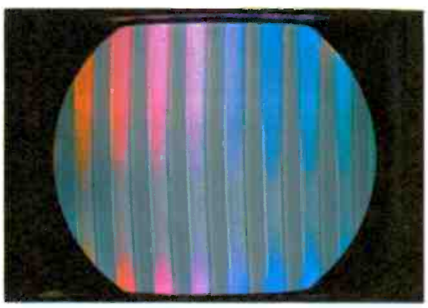
Color is out of lock on this network color broadcast. Use a generator to check whether the trouble is in the receiver or at the station. Remember not to use a strong output signal from the color-bar generator; some sets which exhibit out-of-lock symptoms will display proper sync on a strong signal from the generator. Suspected tubes are the burst amplifier, chroma-sync phase detector, 3.58-mc oscillator, and oscillator control.



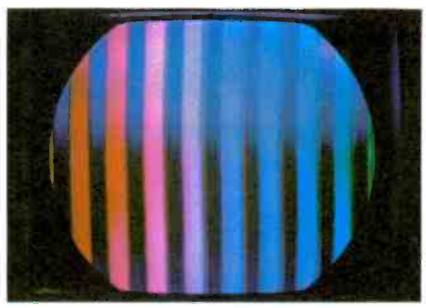
This distorted color-bar pattern was caused by hum in the cathode circuit of the R-Y, B-Y, and G-Y amplifiers. The hum also could be seen on a b-w picture. The cathodes of all three difference amplifiers are connected together, and a common cathode resistor is used; thus, all colors are distorted. Such hum can appear on any RCA chassis from CTC7 up. Zenith and some Motorola receivers do not use difference-amplifier stages.



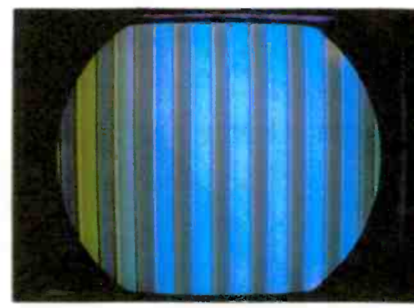
These lines are caused by hum at the cathode of the "X" demodulator on an RCA CTC12, CTC15, CTC16, or CTC17 chassis. No hum is visible on a b-w picture with the color control turned counterclockwise—a good test to determine if the hum is in the color or b-w stages. Notice the color-bar pattern displays correct colors—that is, the fourth bar is magneta, as it should be. Demodulator tubes in these sets are 6GY6's.



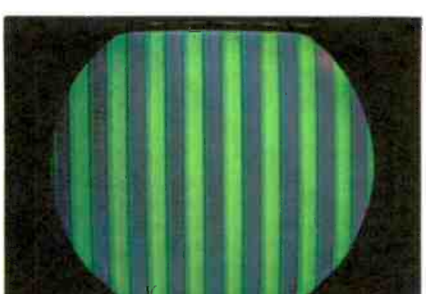
Distortion is due to hum at the cathode of the bandpass amplifier. This distorted color-bar pattern may appear on any color receiver utilizing only one bandpass amplifier stage. In this case the chassis was an RCA CTC16. The distortion isn't visible during monochrome reception, since the bandpass stage is cut off by action of the color killer. In many cases, defects in the bandpass amplifier will result in a complete loss of color.



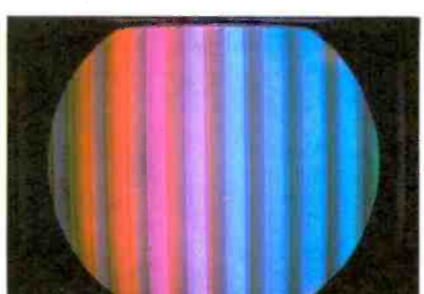
Hum at the cathode of the "Z" demodulator will usually display itself as shown in the above photo. (The b-w picture was free of any symptoms.) This is particularly true of RCA chassis CTC12, CTC15, CTC16, and CTC17. In just about all cases of hum in the video (b-w and color), the trouble is filament-to-cathode leakage in some tube that handles the video signal. First determine if hum is present in b-w, color, or both.



There is no "X" demodulation. Since "X" is closest to R-Y, red bars are missing on the screen, and the green bars are reversed in brightness compared to the blue bars. There is no change in the b-w picture. Loss of "Z" demodulation results in no blue being seen in the picture, since "Z" is close to B-Y. Any RCA chassis (or others using similar demodulator stages) from CTC7 until current models will display this symptom.



No 3.58-mc oscillator carrier; b-w picture is normal. This condition occurs in RCA chassis CTC12, CTC15, CTC16, and CTC17. In RCA CTC7 to CTC11, the bars are purple. The tint control has no effect on the bars; the color control will reduce their intensity. These bars are caused by demodulator overload on color sidebands. Zenith sets show no color bars; the screen is bluish green. Check the 3.58-mc oscillator and reference-control tubes.



Improper color bars can be caused by a number of tubes and components. In this case, the .01-mfd capacitor shunting the 100K resistor in series with the red grid of the picture tube was open; this caused the R-Y amplifier to have poor high-frequency response. Incorrect colors may also be caused by malfunctions in the burst amplifier, the difference amplifier, and in some cases even the bandpass amplifier stages.

Bars are blurred by misalignment. The fine tuning was detuned, and the generator output and color control were advanced to give full color. Similar bars can be caused by poor IF alignment. Almost as bad a symptom can occur because of poor chroma alignment, multiple sets on the same antenna, poor distribution system, etc. A bar generator provides the best proof, but be sure to disconnect the antenna before connecting the generator.

Now you can quickly locate defective capacitors affecting the performance of electronic circuits —and prevent costly call-backs!

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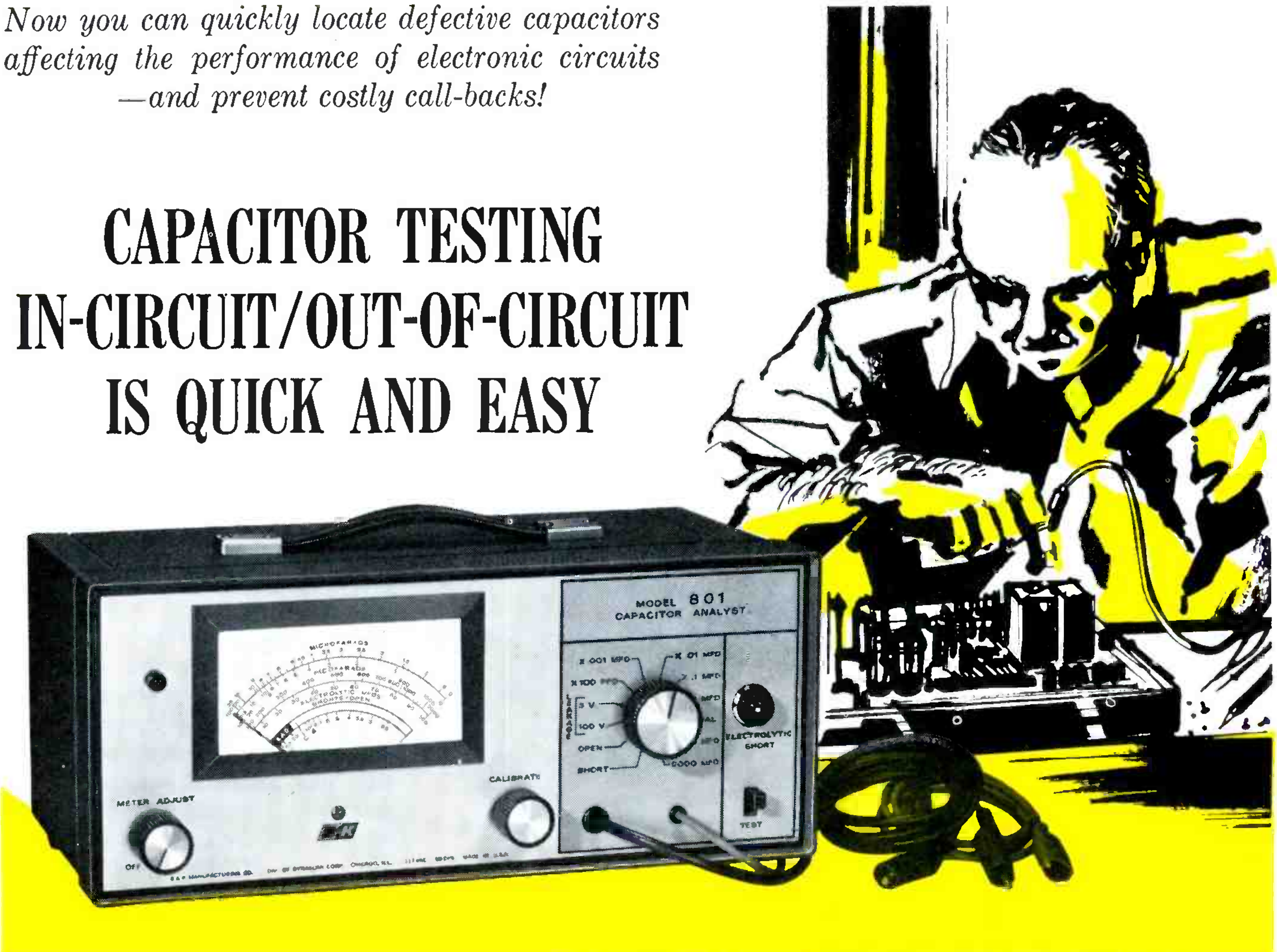

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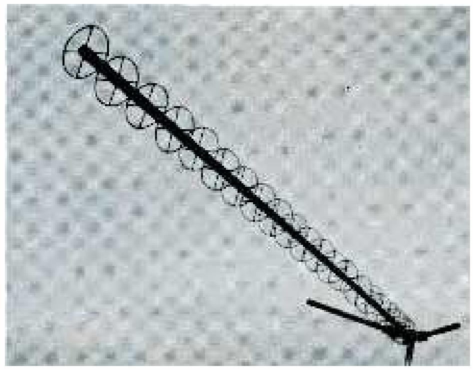

Space research contributes to consumer electronics.

by Ira Kamen

The disc-rod antenna developed for NASA's missile and Apollo program has certain characteristics suitable for UHF TV receiving applications. The gain measurements made for the military and space-agency services show that an all-band UHF antenna can have uniform signal-capture area and a gain characteristic that rises with frequency to compensate for the inherently higher system losses and increased receiver noise prevalent at the higher UHF channels. Fig. 1 shows the gain-versus-frequency curve for a single 8′ disc-rod antenna. The results for this antenna closely match those for a parabolic dish having an area of 12 square feet. The gain increase is from 13 db at channel 14 to approximately 18 db at the high end of the UHF band. Another feature of the antenna is that the 300-ohm impedance is relatively constant over the entire UHF band.

A typical disc-rod antenna design has a high front-to-back ratio (as shown by the chart in Fig. 2) and a very directive narrow beam which provides a favorable signal-to-noise ratio in fringe areas. Such a pattern is an important feature if the antenna is to discriminate against reflections. As all servicemen know, color reception cannot tolerate significant reflections or ghosts. The uniform gain characteristic of this antenna also contributes to its usefulness for color reception, since its uniformity minimizes variations in reception over the channel.

A 50% reduction in beamwidth and a 3-db gain increase can be obtained across the entire UHF band by stacking two disc-rod antennas. A spacing of only 42″ is required for such a stacked array.

From a practical standpoint, the disc-rod antenna provides a relatively maintenance-free antenna installation. In tests, the antenna showed negligible losses under a variety of conditions: full ice coverage, 90° bending of 20% of the disc elements, soot coverage, and the presence of nearby blocking objects such as metal pipes and VHF antennas. This antenna is a lightweight structure (even when heavily iced) and presents minimal wind resistance. It therefore requires a simple support structure and offers reduced callback potential. The disc-rod antenna may be side mounted easily on CATV or fringe-area towers with no significant influence on the performance of nearby VHF antennas.

One of the peculiar characteristics of UHF reception is the fact that the polarization of the incoming wave is affected by weather

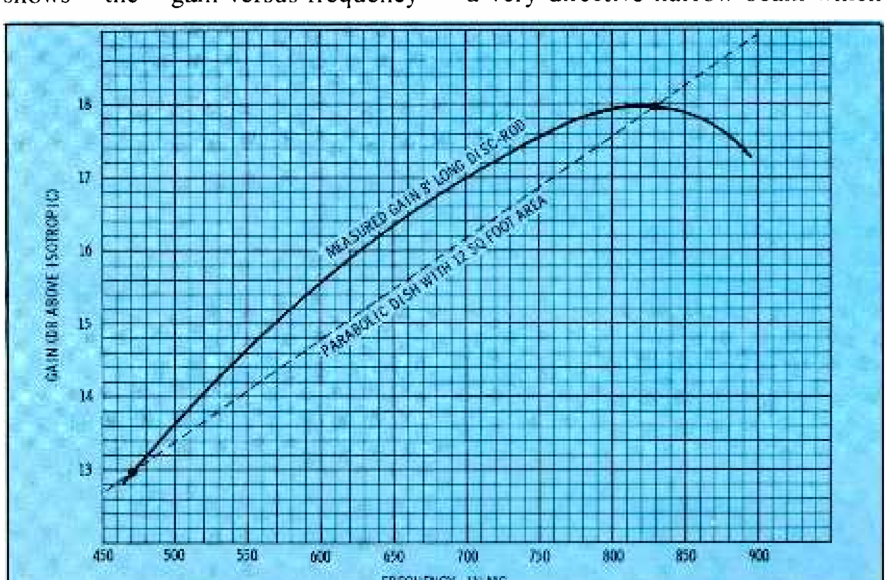

Fig. 1. Gain-frequency characteristics, disc-rod and parabolic type antennas.

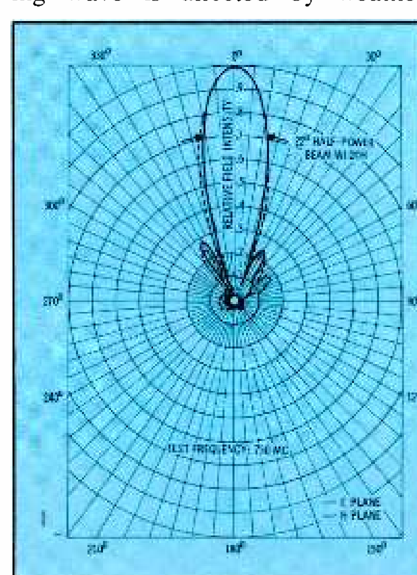

Fig. 2. Directional characteristics of a single-bay disc-rod type antenna.

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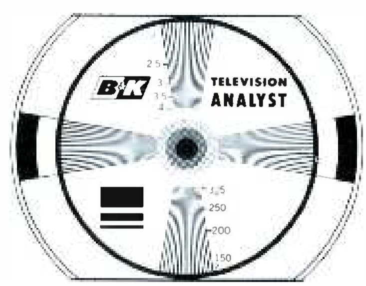

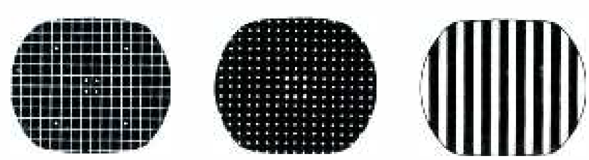

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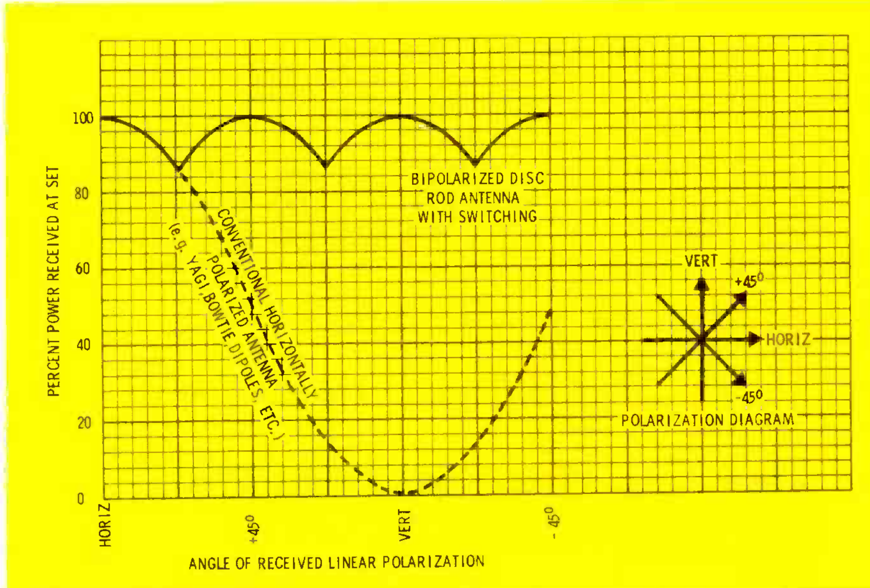

Fig. 3. Performance comparison under various conditions of polarization.

conditions, distance from the source of transmission, the influences of dry or wet vegetation (which may change from day to day), and reflections. Also, the polarization variations are a function of frequency, which means that signals on channel 14 may arrive with horizontal polarization while signals on channel 83 may even become vertically polarized. UHF TV receiver installations will be subject to this condition. Fig. 3 shows the comparison between a conventional horizontally polarized antenna and the disc-rod antenna. With this antenna, the installer can set the optimum polarization at the time of installation. In addition, in fringe or critical UHF reception areas, the TV-set user can be supplied at the TV set with a switch which will allow him to peak the performance of the antenna for the existing environmental conditions or the UHF channel chosen for reception.

Fig. 4 shows a disc-rod antenna array used by Lincoln Laboratories for TV transmission tests for a classified application. A similar antenna could be used for UHF CATV or super-fringe-area installations where a broadband gain of 20 to 24 db is necessary for effective performance.

Commercial versions of the disc-rod antenna will soon be making their appearance. The development of this antenna serves to illustrate how space-age technology often produces developments that have direct applications in our everyday lives. ▲

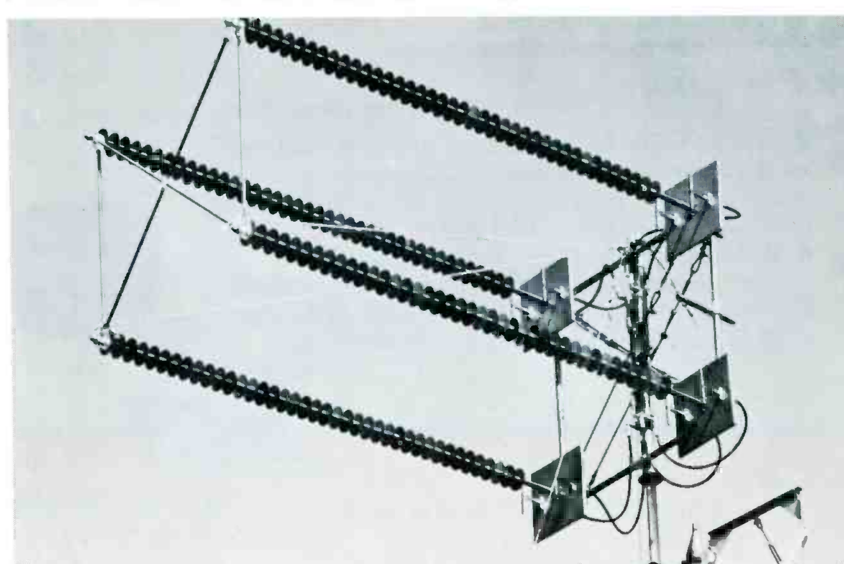

Fig. 4. One of the disc-rod antenna arrays used by Lincoln Laboratories.

Phasing Antennas

(Continued from page 26)

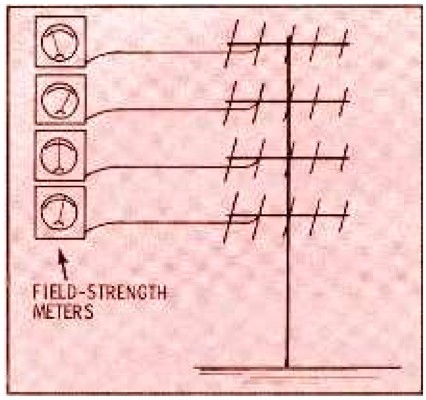

Fig. 7. Signal strength varies from antenna to antenna on vertical stack.

boundary layer moves, changing the lengths of paths "E" and "F." This is the direct mechanism of short-term fades.

If you were to mount a number of antennas up and down a mast in a fringe location and simultaneously watch all the signal levels, you would see the results illustrated in Fig. 7. Each antenna produces varying signals, but the signals do not vary in synchronism. Some will go up as others go down; it is rare when all go down at once.

If a number of antennas are stacked vertically and then phased together, it should be possible to get an *average* signal that doesn't vary a great deal. It is necessary to mix the outputs of the antennas so that those developing signals ocntribute to the output but those with very weak signals do not hurt reception. This *can* be done, but it cannot be done by the commercially available "stacking bars."

Phasing the Antennas

The diagram of Fig. 8. symbolizes four antennas connected in parallel. The output of this hook-up will have four times the power of one antenna, if the antennas are putting out equal powers and are in phase. Should one antenna deliver less power than the others, it will appear to be a load across the network, causing the network to deliver less power. If one of the antennas delivers no power, it will absorb part of the output of the other three; less energy will then be available than if the useless antenna were out of the circuit. This happens when conventional stacking bars are used to phase antennas together in a vertical stack. It is the reason many technicians find that they get no significant improvement by stacking antennas in some locations.

Of course, there's another reason why you can't just connect antennas in parallel. In stacking antennas, you must maintain impedance match. Conventional stacking bars match impedance by using quarter-wave sections of parallel-pair transmission lines. Such bars are compromise arrangements when used broadband all channel). Usually, they are cut to a quarter-wavelength at channel 4; the same bars represent ¾ wavelength near channel 10. Since the impedance exhibited repeats itself at each odd quarter-wavelength, the bars will work reasonably well in the high VHF TV channels, 7 to 13. They do require equal signals from each antenna to produce full gain.

The proper way to stack antennas is to use a symmetrical coaxial are connected into a hybrid mixer, harness with hybrid mixers. If two antennas are connected into a hybrid mixer, no matter how low the signal of one of them goes, that antenna cannot absorb more than 10% of the other's energy.

Fig. 9 is a schematic diagram of a four-bay vertical stack using hybrid mixing techniques. Mechanically, the four antennas are mounted one above the other on the tower or mast. Each antenna should be of the coaxial-feed type or else be matched to coaxial cable with matching transformers. Vertical spacing between antennas should be at least 2/3 wavelength at the lowest channel in use, but a full wavelength is preferable. The harnessing together of these antennas is symmetrical, which means that every antenna sees the same length of line between itself and the final mixing point.

The rig should be capable of

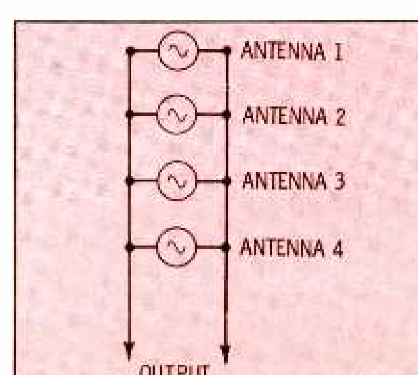

Fig. 8. Analogy comparing four antennas to four parallel wired generators.

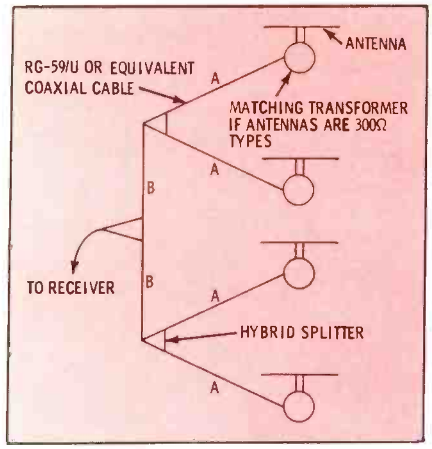

Fig. 9. Four-bay vertical stack antenna with hybrid mixing techniques.

orientation (aiming) as a unit, and antennas should be mounted one directly above the other; do not stagger them.

The array thus made will deliver four times the power of one antenna, *when all antennas are equally illuminated by the signal.* When equal illumination is not delivered, the array will behave as a "diversity" array and will deliver the signals from its best-illuminated bays to the final mixing point.

In this way, the stack provides gain over a single antenna and provides protection against normal fading. This stack also minimizes airplane flutter. (Airplane flutter after all, is the same effect as that seen when a reflection occurs from an inversion. Airplane wings are very effective reflectors, and airplanes are in motion.)

Summary

Returning to our original list, here's how each of the desirable effects of stacking can be accomplished:

1. Increase signal strengths by either vertical or horizontal stacking (vertical preferred), or by "quad stacking."
2. Reject ghosts by horizontal stacking with controlled spacing.
3. Reject man-made interference by horizontal stacking.
4. Reduce fading by vertical stacking.
5. Reduce airplane flutter by vertical stacking.
6. Reduce adjacent-channel interference by horizontal stacking with variable spacing.
7. Reduce cochannel interference by horizontal stacking with variable spacing. ▲

Tower Maintenance

(Continued from page 31)

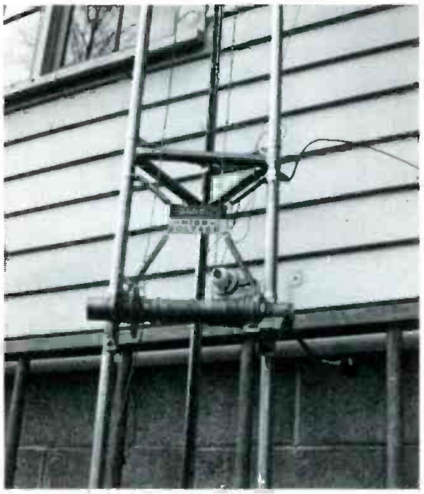

Fig. 3. Example of a crank-down tower.

loose elements. Antennas in which brazing or silver-soldering of the joints is involved can seldom be repaired successfully without welding or brazing equipment or a silver-soldering outfit—neither of which are ordinarily found in the average TV shop. In such cases it's better to sell the customer a new antenna and, if necessary, include a new lead-in cable as well.

Don't overlook the antenna *support* structure either. If it is a metal mast, examine the base mounting at the roof; generally this is a hinged affair in which the mast is secured by a single bolt passed through it and a couple of "L" brackets. A little weaving at such a joint can create a scratchy hash in the speaker even though it isn't electrically connected to the antenna. Rusty and loose hinge bolts can do likewise—inspect and replace these when necessary. If the mast itself is higher than six to ten feet, it is probably either aluminum or galvanized steel and of the telescoping-tube type. The slip joints should be examined for tightness and any appearance of corrosion or rust. Aluminum will oxidize and cause an imperfect contact, particularly when the joint is loose, and this will also contribute to an intermittent crackle in the speaker. Steel masts are more susceptible to rust—even galvanized ones, because the coating may be scratched or abraded due to weaving in the joints.

Relatively high lattice-type tower structures should have an even closer inspection. Most towers are made of galvanized steel or aluminum; either type may be assembled by bolts or welding. The welded type of tower will ordinarily cause little trouble except for rusty, cracked, or broken welds. You can wire-brush and paint the rusty spots, but a broken weld just about dictates lowering the tower and having it professionally rewelded at the bad spots. Bolted towers are subject to rust and corrosion at the bolted joints; sometimes a broken bolt or a stripped thread will appear. Occasionally you'll encounter a tower of the telescoping type with a built-in winch mechanism (similar to the one shown in Fig. 3) to raise and lower the upper section. Check all winch joints and bearings, and pay particular attention to the hoisting cable; if it is frayed, shows broken strands, or indicates other signs of wear, it can be dangerous. If any doubt exists, be sure to replace it. The hinge-over type of tower using a base-hinge arrangment also requires critical inspection of the hinging mechanism; again, if it's not in tip-top shape, fix it.

Fig. 4. Guy wires are of extreme importance on this remote relay station.

Masts and towers of greater than "stubby" height are customarily fitted with guy wires as shown in Fig. 4. These may or may not be broken up with insulators. If they are, check the insulators to be sure that none are cracked or broken; replace any defective ones. Check the guy wires themselves at both ends to make certain they are firmly secured. In a triple-wired guying system, loss of just one guy can cause the tower to fall, causing rather widespread property damage and sometimes even human injury.

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Play it safe with *any* antenna system—particularly so on those supported by masts and towers at rather high levels.

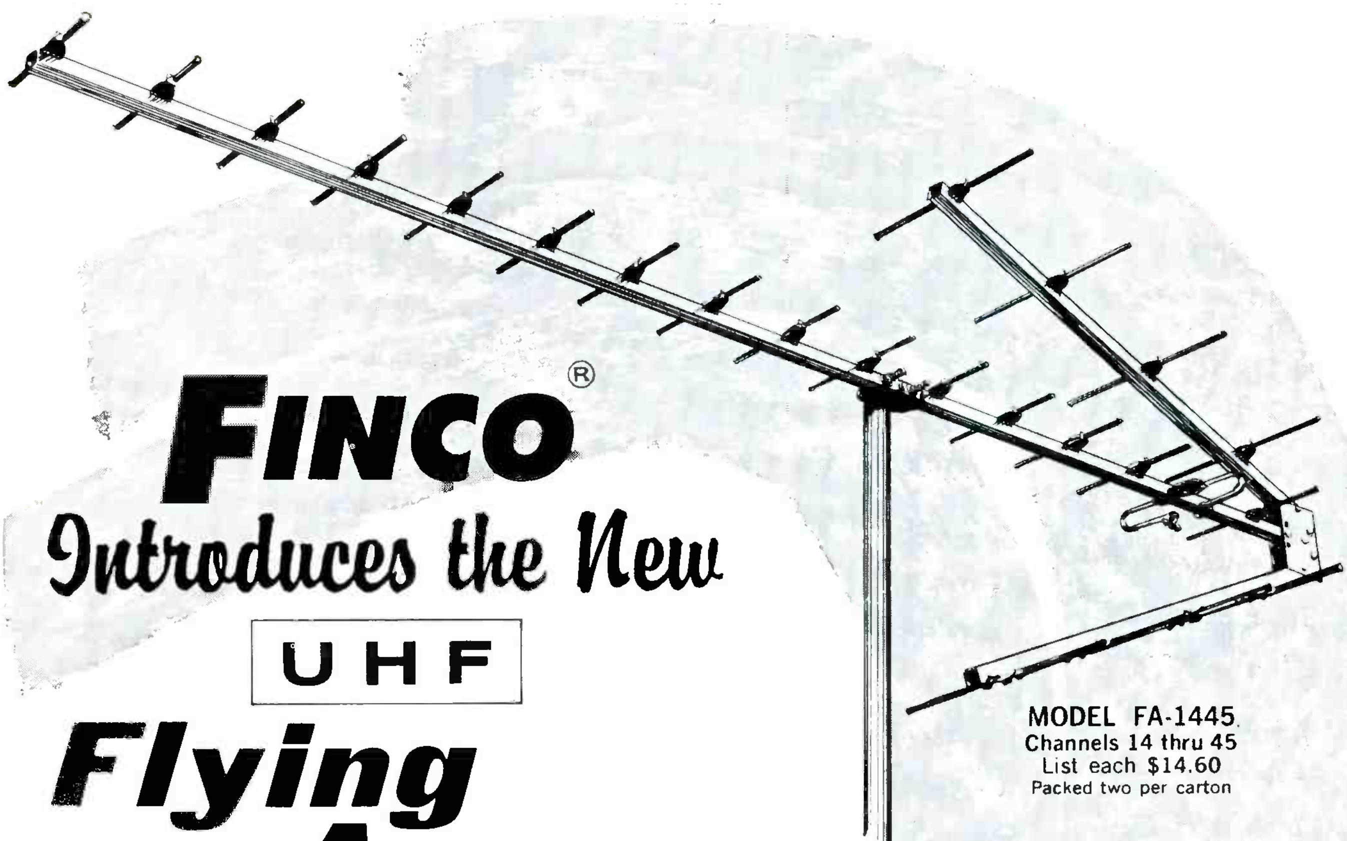
Other Types

TV antenna systems are not the only kind you may encounter. If you also handle Citizens band equipment, the base-station antennas and supporting structures should receive the same treatment you give TV installations. Perhaps you have a service contract with local police or taxicab companies in connection with their two-way radio communication gear; the problem here is the same. Public utilities and governmental agencies practically all use two-way radio. If you have any of these on your customer list (and you *should* have), apply the same principles of antenna, mast, and tower maintenance as have been described for TV antenna systems. In servicing two-way radio equipment, you probably will encounter radio-equipped vehicles as well as base stations. Mobile antennas are easily inspected visually, and in most cases necessary repairs can be made readily and at small cost. An inspection report, such as the one in Fig. 1, is useful in reporting your findings to the customer.

Even amateur radio enthusiasts, particularly those with the heavy rotary-beam type of antennas, can be good prospects for your services from time to time. Many of these hams are in the older age groups and do not wish to or cannot climb tower structures even though their antennas need maintenance attention periodically just as do those in the other radio services. You can fit the picture here also and, at the same time, add a few more names to your customer-prospect list for the sale of a TV, hi-fi, etc.

Conclusion

Just remember: The successful radio-TV serviceman is the one who is known to render *complete* and satisfactory service not only in selling the equipment but also in *maintaining* it once it is sold. And *complete* does not stop at the radio or TV chassis; without a properly functioning and maintained antenna system, customer dissatisfaction will be high. Don't let dissatisfaction put *you* behind the eight ball! ▲



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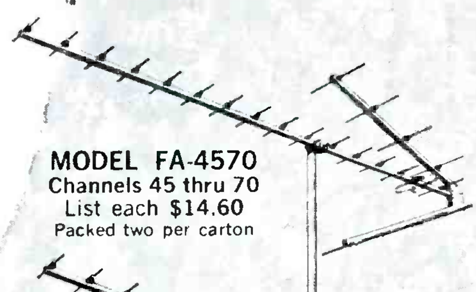

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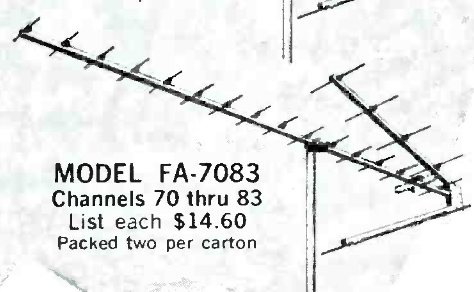

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Aluminum screw and nut at terminals?	Yes	Yes
Positive location of dipole on boom?	Yes (preassembled)	No — loose in carton.
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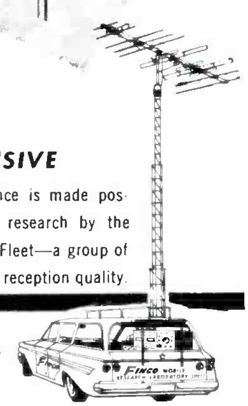

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RF Interference

(Continued from page 35)

beating of two local stations. In one area, there is an FM station at 92.5 mc and a TV station on channel 5, the sound carrier of which is 81.75 mc. The difference frequency is 10.75 mc. FM tuners in the area between the FM and TV transmitters are affected, since most of them have an IF of 10.7 mc. In a second case, two AM stations in the same area operate at 1320 kc and 1050 kc, respectively. The difference frequency is 270 kc. In the vicinity of the two transmitters, portable and car radios with IF's around 265 kc are subject to interference. Under existing regulations, the stations involved in these cases cannot change their frequencies, so there is only one solution to these prize problems—shift IF's slightly away from the cross-beat. Fortunately, interference is experienced only near the transmitters; when the signal level drops, so does the beat.

Shielded two-conductor cord is useful in two ways. First, it must sometimes be used with an AC line filter to prevent high-level noise from leaking around the filter. Naturally, the shield must be grounded. Also, in extremely noisy locations where AM reception is marred by much electrical noise, you can make up a shielded, low-impedance loop by cutting about 16′ or 20′ of the cable; and arranging it as in Fig. 5. Radio waves have both electrostatic and electromagnetic components, but either will do for reception. Most electrical noise is predominantly electrostatic, and the low-impedance shielded loop rejects electrostatic signals and picks up only electromagnetic components. The loop is pretty large, but you can staple it along the back of a bookcase or inside a closet. The length of lead-in (which is the same type of cable) isn't important. The coupling to the AM receiver is a few turns of hookup wire doped in place over an RF coil (or a ferrite loop with the core removed). The RF coil must be enclosed in a shield can.

Conclusion

Interference troubleshooting is no harder than component-defect hunting. The main difference is that the villain is usually where you can't see him right away. You have to track him down and then bottle him up. ▲

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SK-3009	pnp type, Audio Output Stages of Auto Radios
SK-3010	npn type, AF Driver and Output Stages of Broadcast Receivers
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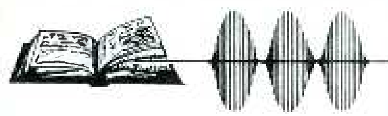
BOOK REVIEW



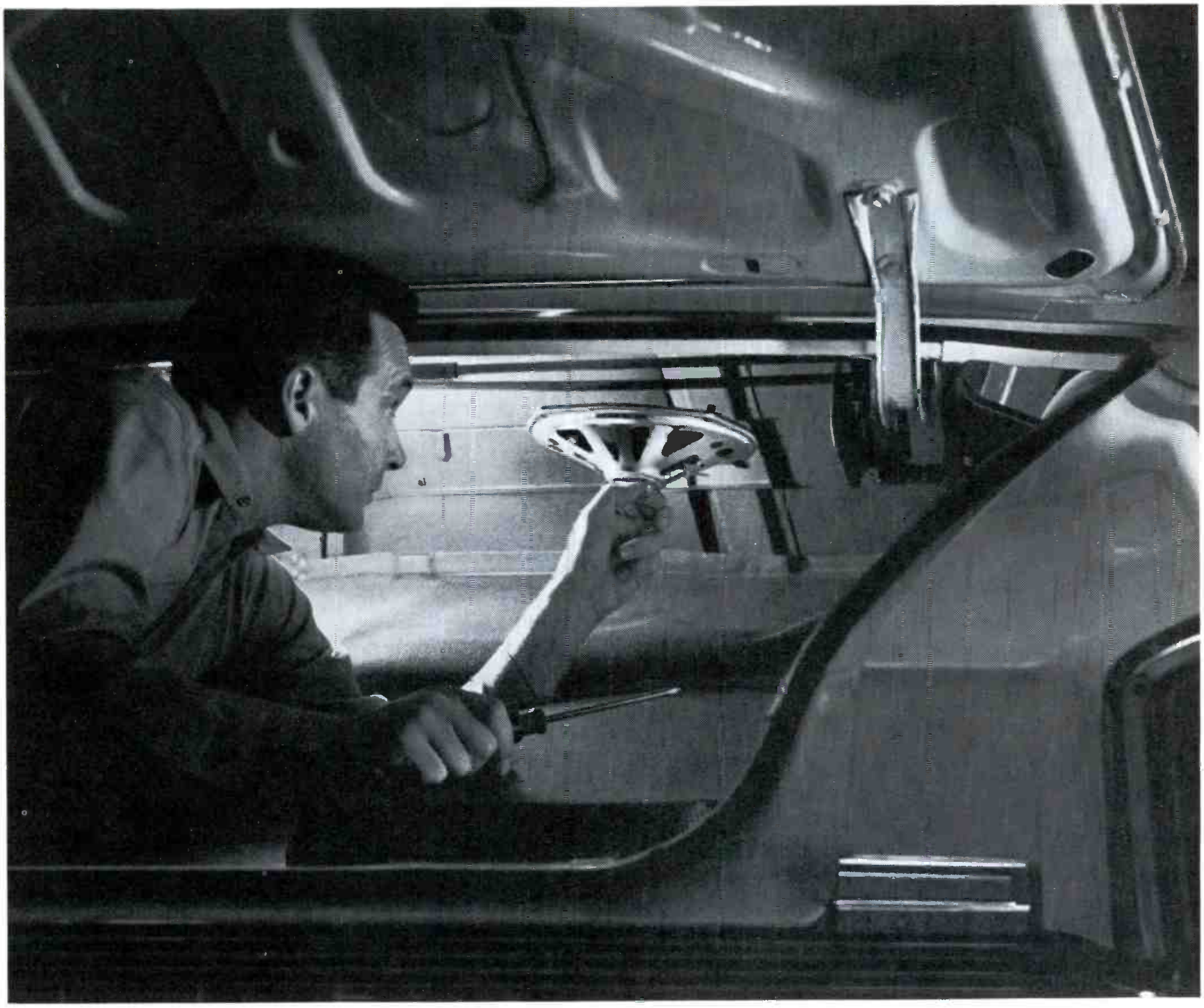
Acoustical Tests and Measurements: Don Davis; Howard W. Sams & Co., Inc., Indianapolis, Indiana; 192 pages, 5½" x 8⅕", softbound; $4.95.

For more years than most sound technicians care to admit, analysis of the acoustical properties of convention halls, auditoriums, theaters, broadcasting studios, and concertoriums has been of an essentially subjective nature. An architect's observations of previously constructed halls that "sounded good" and liberal use of reflectors, absorbtion plates, and baffles served to sound condition a new hall. Undeniably, music listeners and audiophiles suffered as a natural result of the method.

This volume by Mr. Davis serves notice that measurements pertaining to the manner in which various rooms respond to sound waves throughout the audible and superaudible frequency spectrum not only are possible, but are also relatively simple and easily understood. In a straightforward manner, Mr. Davis sets forth four basic parameters for consideration: quietness; reverberation; loudness; and distribution. In each of these areas, the author describes an understandable frame of reference, the use of specific test instruments, gathering the data, and interpreting the results of the tests. Individual and collective results of various tests are correlated to provide a good understanding of acoustics.

The useful technique of using short-duration audio bursts to evaluate the relationship of direct and reflected sound waves and their effect on listeners in various sections of the hall deserves special notice. Another very informative section concerns practical methods used to test sound systems installed in various types of halls and auditoriums. Frequency response, distortion, and distribution patterns are covered with data-recording and analytical aspects receiving primary consideration.

In every respect, this is an excellent book for the engineer or advanced sound technician who, in the normal course of his work, is required to make objective evaluations of various rooms in which sound must be distributed to a sizable audience.



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Circle 30 on literature card

Square Waves

(Continued from page 37)

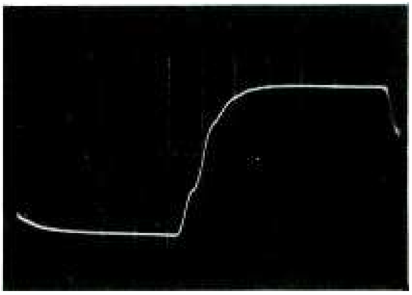

Fig. 8. Long leads in the test setup.

used to bypass fast-rise waveforms, the associated circuitry must be elaborated to provide thorough bypassing if that is required.

High-Voltage Capacitors

At another extreme, we have capacitors which are rated for very-high-voltage operation—20,000 or 30,000 volts. These generally have rather small capacitance values, such as 500 pf, and titanium-dioxide design is usually employed. Such capacitors have very low inherent inductance, and seldom ring a square wave with .02 microsecond rise time—they merely slow down the rise of the waveform.

A valid test requires, of course, that you keep the test leads short. For example, if you use 8″ test leads, significant inductance is added to the test circuit. In turn, you will see a definite "wrinkle" in the rise of the reproduced square wave, as illustrated in Fig. 8. This wrinkle is a ringing interval which develops along the leading (rising) edge of the waveform.

Paralleled Capacitors

A .1-mfd paper capacitor produces very noticeable overshoot and ringing when tested with a square wave having a rise time of .02 microsecond. What do we gain by paralleling two .1-mfd paper capacitors? A test will show that only a little is accomplished insofar as reduction of overshoot and ringing is concerned. The peak-to-peak voltage of the overshoot and ringing is reduced by only a small amount. This might be an unexpected result, because we know that when inductances are paralleled, the inductance value is halved. Keep in mind that this is true only of ideal inductances.

The inductance in a capacitor is distributed; in other words, the inductance is spread out over the entire area of the foil, just as the capacitance is spread out over the entire foil area. We cannot, therefore, consider the inductance as an ideal lumped inductance. Instead, the inductance and capacitance are associated basically as in a delay line with a very short delay time. Various types of paper capacitors have somewhat different characteristics; parallel combinations, however, never provide substantial reduction of overshoot and ringing.

Conclusion

You are now familiar with the basic square-wave response of resistors, capacitors, and inductors. The most important facts set forth in these three articles can be summarized as follows:

1. Pure resistance has no internal inductance nor capacitance. However, all resistors do have some small reactance. The inductance and capacitance of composition-type and similar resistors is usually negligible in TV applications. On the other hand, wirewound resistors have significant inductance, and many potentiometers have considerable capacitance. Square-wave tests show whether inductance or capacitance is excessive for a given application.
2. Pure inductance has no internal resistance or capacitance, but all practical inductors have some of both. Capacitance causes the inductance to ring at some self-resonant frequency. Resistance determines how fast the ringing waveform decays. Just as shunt capacitance slows down the rise of a square wave, shunt inductance speeds up the rise; amplitude of the resultant overshoot is dependent on the inductance value. Iron-core coils have nonlinear inductance; nonlinearity is displayed as dissymmetry in a square-wave test.
3. Tuned transformers have a more complex ringing pattern than simple coils. Energy is transferred back and forth between primary and secondary in a square-wave test. When the primary energy decays to zero,

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the secondary energy builds up to peak value, and vice versa. The rate of pattern decay is a measure of winding Q. The number of cycles in each ringing interval is a measure of looseness or tightness of coupling.

4. Pure capacitance has no internal inductance or resistance, but all practical capacitors have some inductance and resistance. Resistance is negligible in all "good" capacitors. For most TV applications, inductance is negligible in ordinary mica and ceramic capacitors. Large paper capacitors and electrolytic capacitors, on the other hand, have substantial inductance which limits their usefulness in critical applications.

5. Square-wave tests require that the rise time of the square wave be fast enough to give the necessary test data. The rise time can be varied as required in a given test by shunting a suitable capacitance value across the generator output terminals. Square-wave tests also require that a triggered-sweep scope be used which has sufficient sweep speed and adequate vertical-amplifier bandwidth. The most suitable scopes have accurate direct-reading calibration of both sweep speed and vertical sensitivity.

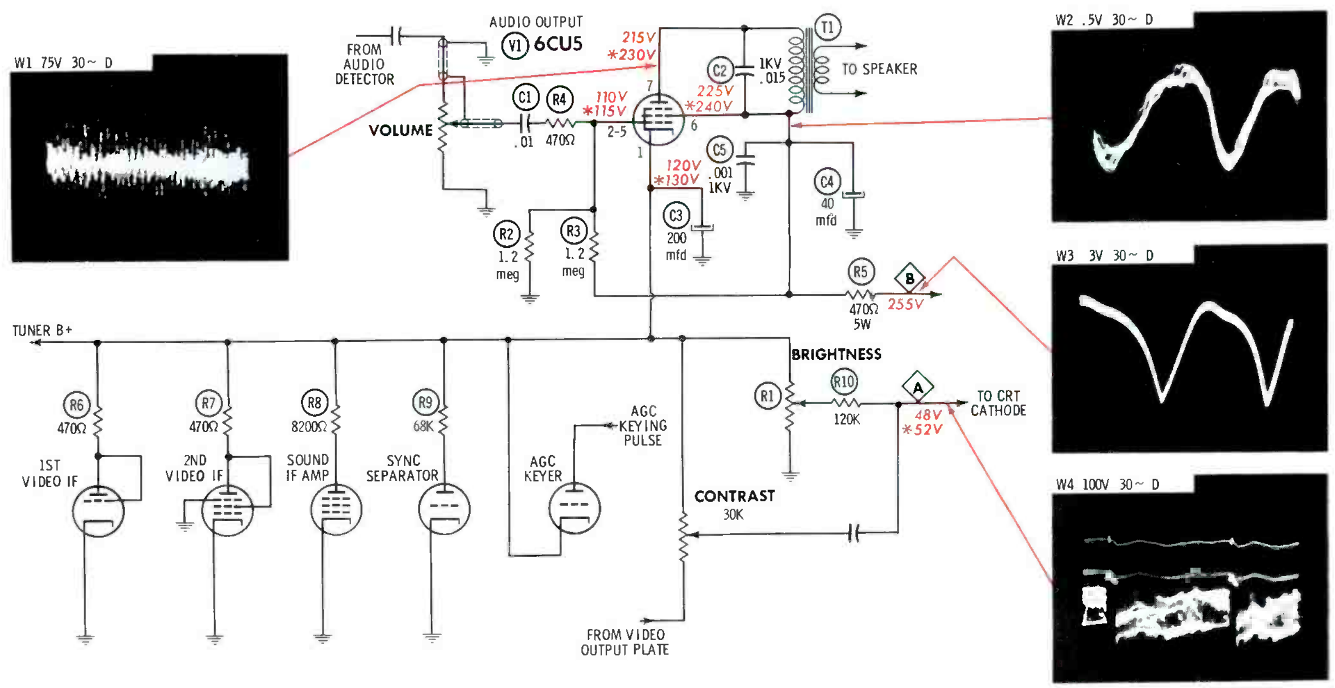
6. Test leads have distributed inductance and capacitance. Unless leads are kept short in basic square-wave tests, you may falsely conclude that a component is out of tolerance.

With these basic facts in mind, you are prepared now to consider square-wave tests of simple three-terminal circuits such as *Couplates* used in modern TV receivers. You'll find square-wave tests helpful in testing a wide variety of printed-component circuitry. The reproduced square waveforms will show whether a defective component is present, often without necessity for disconnecting the component from the PC board. The basic tests will be explained and illustrated in the next "Advanced Service Techniques" article. ▲

PF REPORTER Symfact™

Stacked B+

Audio Output as Voltage Divide



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

WAVEFORMS taken with wideband scope; TV controls set to produce normal picture and sound. Direct probe (DP) is usable throughout the circuit.

Normal Operation

Schematic (from Emerson Chassis 120758-A) consists of audio output stage and partials of circuits that receive B+ voltage from cathode of 6CU5. Cathodes of tubes connected in stacked B+ arrangement are shown tied directly to ground for simplicity—actually cathode resistors are used in most cases. Audio-output tube is heavy-current type; thus, great amount of plate current flows in V1. Other tubes supplied by cathode of V1 are low-current types and total plate current in output tube is divided among all these tubes. Current flows from cathodes to plates of IF and sync stages, through V1 (developing a DC voltage of 120 volts without signal—130 volts with signal—at cathode of output tube), and through T1 and R5 back to low-voltage power supply (255 volts, point B), and returns thus to ground. Grid voltage of V1 is obtained from 255-volt source via voltage-divider resistors R2 and R3; divider current flows from ground through R2, R3, and R5, then returns to power supply. Grid voltage is developed across R2 and in this case is approximately one-half value of screen voltage, as R2 and R3 are same value and thus divide voltage equally. With signal, AGC action decreases current flow through IF stages increasing voltage on audio-output cathode. Increased cathode voltage will increase bias, decreasing plate and screen-grid current thus increasing voltages on screen grid, plate, and control grid. Decoupling filters C3 and C4 eliminate audio fluctuations from 255- or 130-volt source paths.

Operating Variations

PIN 2,5 With-signal voltage determined by setting of volume control, normal position produces reading of 115 volts; increases in volume will slightly increase grid voltage.

A DC voltage on cathode of CRT is determined by setting of brightness and contrast controls. Contrast produces 12-volt swing; at normal brightness, varies from 42 to 54 volts. Rotation of brightness control changes with-signal voltage from low of 35 volts (maximum brightness) to high of 130 volts (with raster extinguished).

PIN 1,6,7 Cathode, plate, and screen voltages of V1 are unaffected by control rotation, unless signal is present. With signal, all elements have increased readings, and voltages vary just slightly with movement of volume control.

WAVE-FORMS Amplitude of W1 is dependent upon signal content and setting of volume; maximum volume gives 400 volt p-p signal, normal is 75. Amplitude of W2 is changed by rotation of contrast control; normal is 100 volts p-p, minimum is 25 volts and maximum is 125 volts. DC ripple of W3 is determined by power-supply filters and filter choke, 2 or 3 volts is typical for most receivers. Only .5-volt ripple is normal at V1 screen because of C4 and R5; also at screen, notice slight amount of audio signal.

Symptom 1

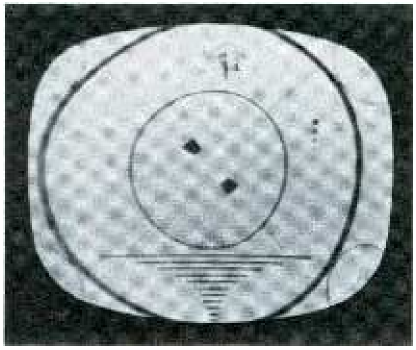
Video Weak

Sync Critical

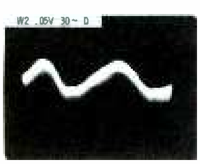
R5 Increased in Value

(B+ Supply Resistor—4700 ohms)

Symptom Analysis



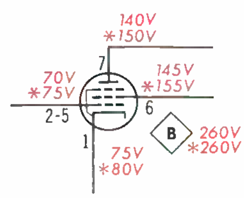
Picture shows video is weak though no snow is present. Sync is occasionally lost, especially when channels are changed. Sound is weak and slightly garbled. Contrast and brightness controls are operative. Loss of gain in IF, video, or output stage is indicated.



Waveform Analysis

Waveform (W4) is only 25 volts p-p (normal is 100 volts p-p). Loss of gain in preceding stages is responsible for weak picture and poor sync. Plate signal of audio output tube (W1) is reduced almost 50% (p-p amplitude is only 40 volts). Scope has given clue (W4) that decreased B+ voltage supplying IF tubes may be responsible. Amplitude of ripple in W2 is greatly reduced suggesting increase in value of R5 could be responsible for trouble.

Voltage and Component Analysis



Voltage at point B (output of low-voltage power supply) has increased slightly—5 volts—although this really isn't any help. There are too many factors that could cause this small change—even under completely normal conditions. Best voltage clue is fact that 135-volt source (pin 1 of V1) is reduced to 80 volts, which accounts for low gain in video- and sound-IF stages. Voltages on plate and screen of V1 are reduced but B+ side of R5 is normal. Leaky C4 or C5 could cause same symptoms; ohmmeter reveals R5 is culprit.

Best Bet: Voltage and resistance checks.

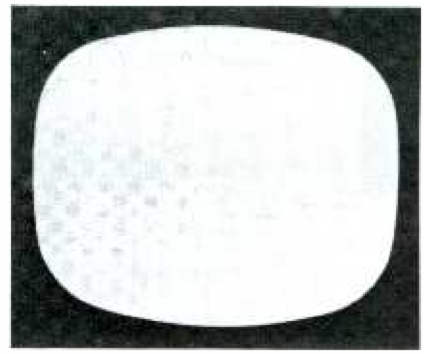
Symptom 2

Picture and Sound Missing

Raster Can't be Extinguished

C4 Leaky

(B+ Filter—40 mfd)

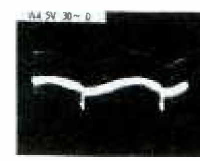


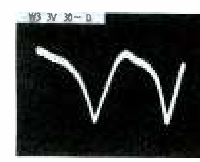
Symptom Analysis

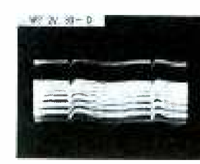
Picture and sound are missing on all channels. Brightness control affects, but can't extinguish, raster. Possibilities include defective CRT; malfunction in brightness circuit; trouble in B+ path which supplies cathode voltage to picture tube.

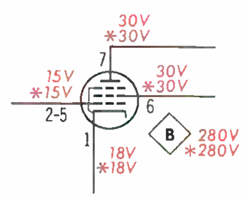
Waveform Analysis

Possibility of defective CRT is ruled out by applying scope to cathode. Content of W4 is only 5-volt, 60-cps pulse; video is entirely missing. W3 is normal in content and amplitude; power supply probably isn't at fault. Abnormality at W2 is quickly noted: 2 volt signal is present but isn't normal ripple. Scope indicates possibility of open or (more likely) leaky C4. Opening C4 increases ripple, ever more than present condition.









Voltage and Component Analysis

B+ line reads 280 volts, indicating power supply is not properly loaded. First definite clue is extremely low voltages on plate, control grid, and screen grid of V1. Cathode voltage is correspondingly low, effectively removing B+ supply from IF stages and CRT cathode. Raster can't be extinguished because brightness control is connected to 130-volt supply. It is good idea to replace associated B+ resistors when replacing leaky electrolytics. Here, leaky C4 caused R5 to overheat and value to increase to approximately 2 megs.

Best Bet: Voltage, then resistance measurements.

Sound Weak

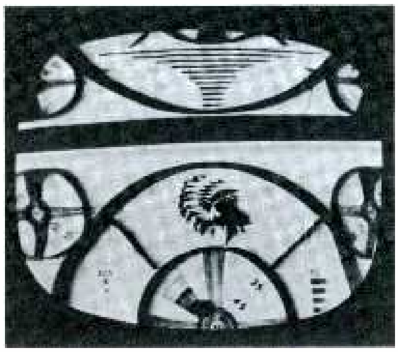
Interference in Picture

SYMPTOM 3

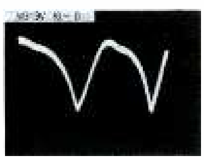
C3 Open

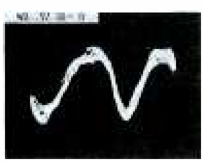
(+130-Volt Filter—200 mfd)

Symptom Analysis



Sound is weak and accompanied by extremely annoying intercarrier buzz. Vertical sync is occasionally lost and sound bars are quite pronounced. Symptoms are indicative of audio trouble accompanied by interaction which is undoubtedly caused by poor B+ filtering.

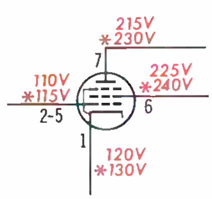




Waveform Analysis

Checking B+ ripple at point B (W3) gives positive indication of condition of power-supply electrolytics; normal waveform at this point clears them. C4 is proven good by presence of normal waveform (W2) at V1 pin 6. At 135 volt source (pin 1 of V1), waveform shows 6-volt p-p signal which contains audio and hash. C3 should normally bypass all signals to ground to prevent V1 from acting as common load and producing symptoms of interaction.

Voltage and Component Analysis



DC voltages give no indication as to cause of trouble. All voltages are normal with or without signal present. Practice of troubleshooting B+ and sound circuits with scope isn't common. Notice, however, in this case, how readily defective stage and faulty component were isolated. Often, filter troubles can be located by bridging with good units, but leakage between sections cannot be located by that method. To search for cause of interaction and filter malfunction, scope is invariably easiest and most sure method.

Best Bet: Scope locates trouble easily.

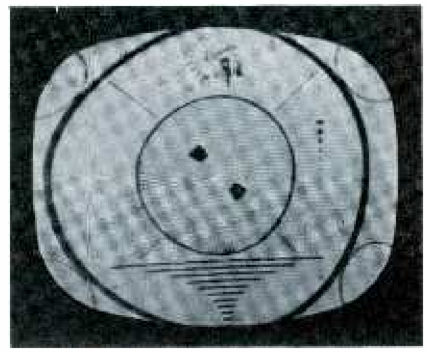
Video Weak

Horizontal and Vertical Sync Critical

SYMPTOM 4

C1 Leaky

(Grid Coupling Capacitor—.01 mfd)

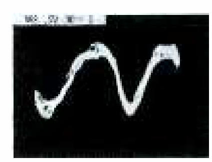


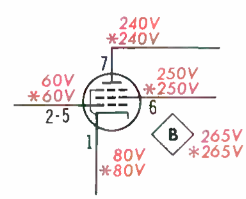
Symptom Analysis

Contrast control must be advanced to near maximum to obtain even washed-out picture. Changes of video in picture cause vertical rolling and horizontal jitter. Absence of snow gives indication that trouble is caused by video output stage or decreased B+ voltage.

Waveform Analysis

Reduced amplitude of both W1 and W4, even with volume and contrast controls advanced, proves defect is common to audio and video. Signal amplitude at video output tube grid is found also reduced, so IF stages are suspect. IF stages are in stacked B+ arrangement; waveforms at V1 may be useful. W2 and W3, however, are normal. Scope has rapidly isolated stage, but voltage checks are now needed for more information.





Voltage and Component Analysis

B+ supply voltage is increased slightly (10 volts) but no significant clue is obtained from increase. Voltages on screen and plate differ slightly from normal if signal is present. Even greater difference is noted without signal—bias is normally 10 volts, but is now 20 volts. Leaky capacitor can be located by disconnecting end tied to volume control and checking with VTVM for positive voltage. Even greater leakage through C1 would cause complete loss of picture and sound, as voltage on pin 1 of V1 would be lowered further.

Best Bet: Scope isolates; VTVM pinpoints.

Symptom 5

Sound Missing

Raster and Video Normal

C2 Shorted

(Transient-Suppression Capacitor—.015 mfd, 1 kv)

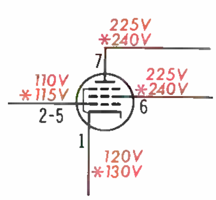
Symptom Analysis

Absolutely no sound can be heard from speaker, even at maximum setting of volume control. Video and sync appear perfectly normal, which clears all circuits which precede sound takeoff. Audio output stage is definitely suspect whenever not even hum or buzz is audible.

Waveform Analysis

At maximum setting of volume control, audio signal (W1) at pin 7 (plate) of V1 is 3 volts p-p; this signal is normally 75 volts p-p. Since audio signal at pin 2 (grid) of V1 is normal and changes amplitude as volume control is varied, grid circuit of V1 and preceding stages must function properly. Because V1 grid-cathode circuit and all preceding stages are shown to be normal, scope has definitely isolated trouble to plate circuit of output stage.

Voltage and Component Analysis



At first glance all voltages may appear normal; closer inspection, however, reveals that plate voltage is high and remains exactly equal to screen voltage. This is excellent indication that T1 is shorted or that C2 is very leaky. To check C2, disconnect one end and use VTVM to check for positive potential to ground. In this instance, C2 was completely shorted. As this example shows, it is possible to have faults in stacked B+ supplies without affecting stages that depend on DC voltage from output tube cathode.

Best Bet: Scope to isolate, follow with VTVM.

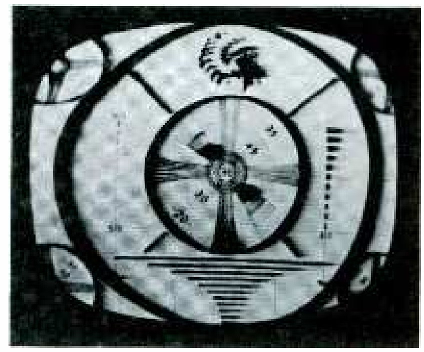
Symptom 6

Video Overloaded

Sound Reduced

R2 Increased Value

(Grid Resistor—1.2 meg)

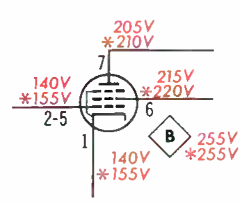


Symptom Analysis

Video is overloaded; sound is reduced and accompanied by buzz. Picture has excessive contrast with horizontal tearing; overload is noticeable even with minimum contrast. Since AGC control operates, though it doesn't restore normal picture, other circuits are suspected.

Waveform Analysis

Output of video detector shows IF stages are amplifying more than normal—video signal is 8 volts p-p, normal is 3 to 5 volts. Fact that AGC control is operative gives clue that AGC circuit isn't at fault. B+ to IF stages comes from audio output cathode. Waveform (W1) at plate of V1 reveals that waveform is distorted and amplitude is only 15 volts p-p (compare to normal W1). Voltage and resistance checks are needed to run down faulty part.



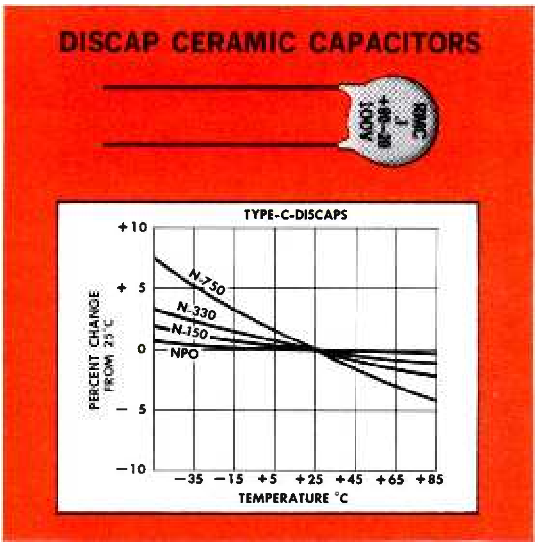
Voltage and Component Analysis

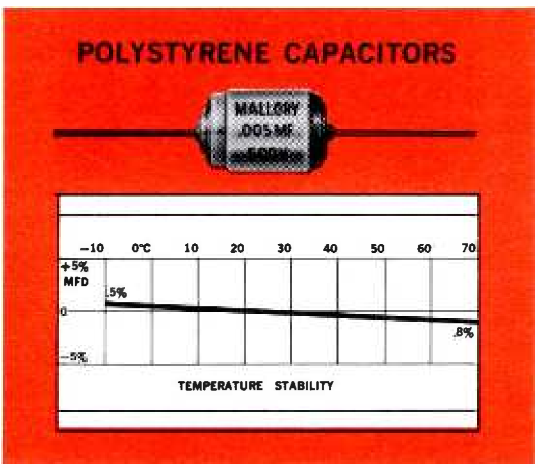
Power-supply voltage is normal, but plate and screen-grid voltages on V1 are low. With signal present, plate and screen-grid voltages are even further from proper values. Really significant symptom is voltage on grid and cathode of V1; normally there is 10-volt (without signal) to 15-volt (with signal) difference between control grid and cathode. High voltage at junction of R2 and R3 suggests one of them has changed value. Either decrease in value of R3 or increase in R2 can produce trouble. In this case, R2 increased to 2.5 meg.

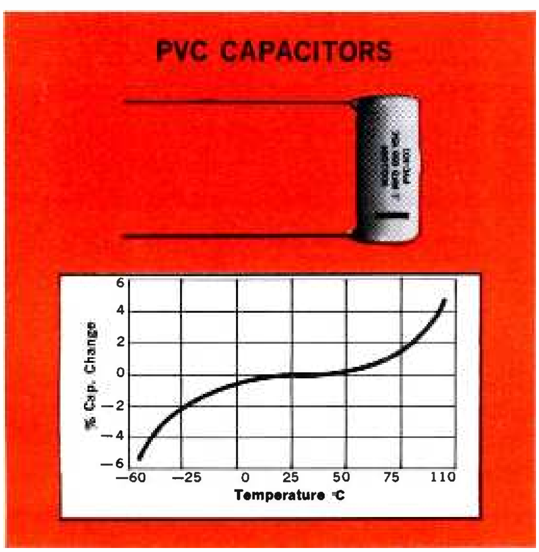
Best Bet: Use scope, follow with VTVM.

MALLORY **Tips for Technicians**

What you should know about capacitor stability







Why worry about capacitor stability? After all, aren't all capacitors pretty much alike? Well, as we all know, capacitors aren't "all alike". Matter of fact, there are many circuits where you wouldn't want capacitance to change with either temperature or time. For example, tuned circuits or RC timing networks. And this is especially true in color TV, because the eye notices even minor shifts that would pass unnoticed in black and white. Therefore, capacitor stability *is* important.

The trouble with most "static" capacitors is that capacitance increases as temperature increases. In other words, they have a *positive* temperature coefficient. And so do most inductance coils. Put these two creatures together and you'll see why frequency and timing can drift as the set warms up.

Now—what can you do about it? For small capacitance values, your best bet is a DISCAP® disc ceramic capacitor (made by Radio Materials Company, a Mallory division). DISCAPS are available in a vast array of temperature coefficients to exactly match circuit requirements. DISCAP temperature coefficients can be chosen so that they exactly offset the positive drift of coils (or other components). Thus, circuit characteristics stay constant regardless of temperature change. There are NPO (zero change) and up to N1500 (very sharp *negative* temperature coefficient) types. You'll find these listed in the 1965 Mallory General Catalog.

A brand new type of ultra-stable capacitor is now available. It's the new Mallory Polystyrene Capacitor that offers both temperature and time stability. The temperature coefficient is comparable to an N150 DISCAP. And capacitance change vs. time is practically zero. They are made from a unique form of stretched and fused polystyrene. They're transparent. You can look right through the clear plastic and actually *see* the aluminum foil! They're available from 5pF to .01 mfd. They're rated 500 WVDC and sizes and prices are right down there with comparable values in ceramics or molded film capacitors.

Mallory Polystyrene Capacitors can be successfully substituted for all sorts of other capacitor types: mica, ceramic, paper, film, or anything else in their capacity and voltage range. But don't think of them as substitutes. They're not. They're new. And they're better . . . especially where stability is downright important.

On the other hand you may really need a Mylar* type capacitor. When you do, take a look at the terrific Mallory PVC. These are available in a whole host of values and they're unbeatable in their class. The blue polyvinylchloride coating is just plain *moistureproof*.

And one more tip. Your Mallory distributor now has the new 1965 Mallory General Catalog. Ask him for your copy today. Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

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Notes *(Continued from page 40)*

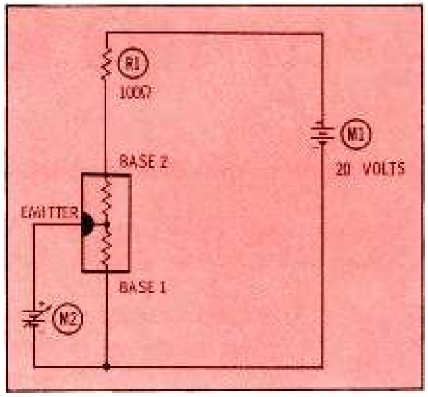

Fig. 6. Operational analysis of UJT.

and has no effect on the current in the base slab.

When M2 becomes greater than 10 volts, the PN junction is forward biased, and electrons flow from base 1 to the emitter. The resistance between the emitter and base 1 drops to a very low value, making the resistance from base 1 to base 2 about one-half its original value, or in the neighborhood of 5K. Hence, there is an increased current flow in the M1 circuit. This can be detected easily by the increased voltage drop across R1. If the voltage of M2 is lowered below 10 volts, the original circuit condition is restored.

When power is applied to the circuit in Fig. 7, capacitor C1 will begin to charge through R1. When the voltage across C1 exceeds 10 volts (in this example), the PN junction is forward-biased, and current will flow through R2 and the PN junction, discharging C1. This current flow will produce across R2 a positive output pulse capable of triggering any circuit requiring such a pulse. With C1 discharged, the PN junction is again reverse-biased, and C1 begins to charge through R1 again, repeating the cycle. The output pulse frequency is determined by the R1-C1 time constant.

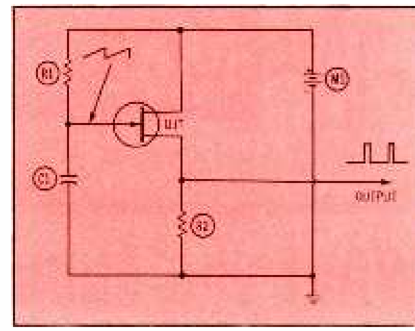

Fig. 7. Simplified UJT timer circuit.

In the CG135, the timer stages consist of six UJT's connected in circuits similar to Fig. 7. All the timers are identical except for the RC combinations used to give the proper operating frequencies.

The master oscillator is a crystal-controlled Pierce oscillator operating at a frequency of 189 kc. Shaping and dividing stages develop the horizontal and vertical bars, dots, color bars, and deflection sync. The color pattern is generated in a Pierce offset-subcarrier-type oscillator and keyed by the 189-kc shaper. The Colpitts RF oscillator is tunable over a range of 60 to 82 mc.

Other features of the instrument include: separate gun killers (these are equipped with insulation-piercing slips), dot-size adjustment on front panel, RF-frequency adjustment on front panel, composite-sync output, composite video output of either polarity, and instant operation. A mirror in the case cover is included to aid in making purity and static-convergence adjustments.

The service manual packed with each instrument contains much useful information on color TV service in addition to a complete description of the CG135 circuitry, troubleshooting hints, and prices for all replacement parts. ▲

For further information circle 123 on literature card

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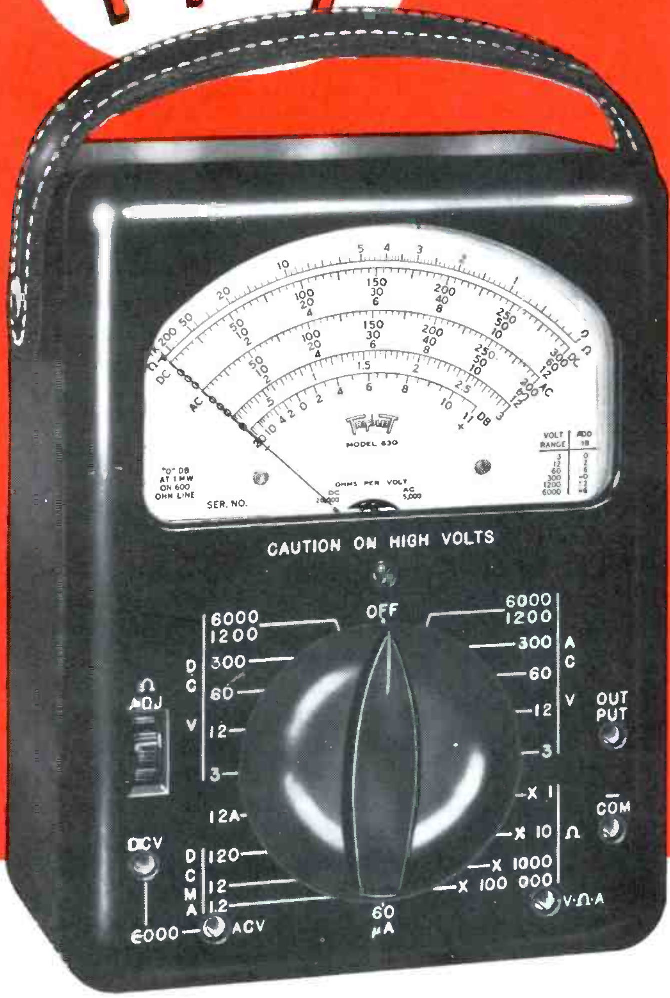

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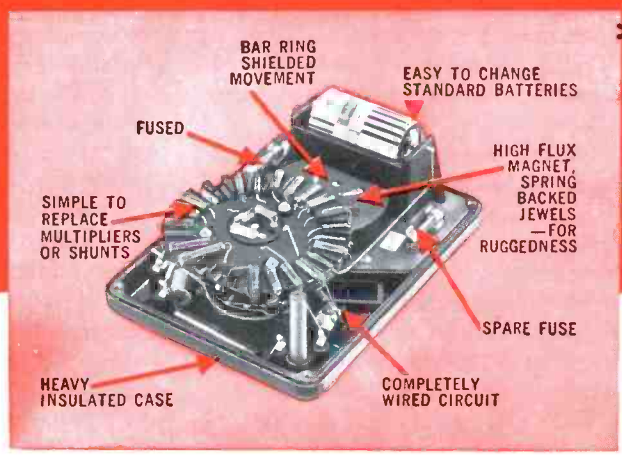

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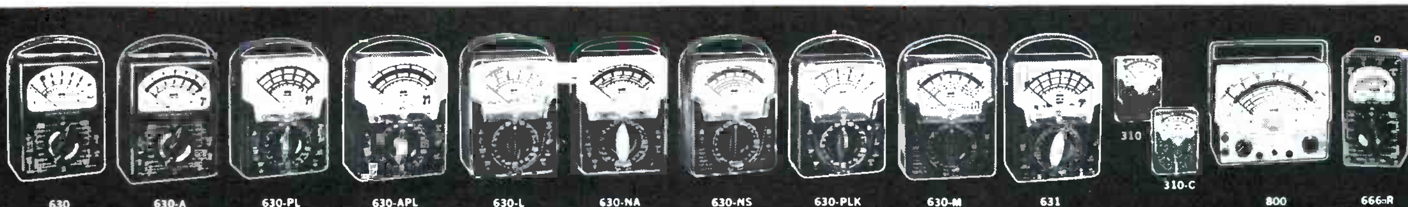

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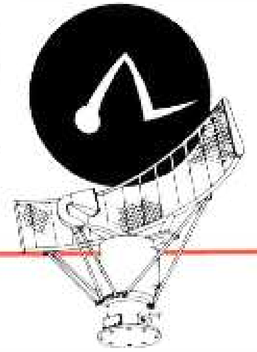

Radar Maintenance is EASY

In this final of three articles (February and April PF REPORTER), a radar technician will take the reader along on a radar service call, demonstrating a troubleshooting technique that can be applied to almost any marine (or other) radar system. Let's let him guide us. . . .

The RADAR QUEEN has been docked during the winter months, and when the crew tried out the radar, they got no results. So we'll be servicing troubles that developed during last year's operation and the ensuing layup.

We arrive at the dock, park the car, and climb aboard the QUEEN, letting the First Mate know we're aboard and the nature of our business. He offers us a cup of coffee, which we gratefully accept. Then we proceed to the wheelhouse to see what problems await us in the radar set.

The radar indicator is pictured in Fig. 1, and the system is shown in block form in Fig. 2. It is an X-band system, operating at a frequency of 9375 mc.

Power Checks

First, we turn the radar set on, leaving the power switch in the STANDBY position. On the built-in meter of the display unit (indicator), we spot an input reading that is varying up and down around 107 volts AC. Trouble already! We ask the Mate where the motor generator (MG) is mounted, and proceed to its location—beneath the wheelhouse.

We squeeze ourselves in, pull the master line-disconnect switch, and wait for the MG set to coast to a stop. This particular MG set converts the ship's 115-volt DC power to 117-volt AC power at 60 cps, for use by the radar system. Its speed is held constant by a three-ring speed regulator (Fig. 3) mounted on the end of the motor shaft. This regulator increases or decreases field current to the motor by means of vibrating reeds, actuated by centrifugal force.

Opening the speed-regulator cover, we examine both the reed contacts and the fixed contacts. Finding these to be badly burned and pitted, we replace them; had they been only slightly pitted we might have just burnished them. The regulator brushes are in good shape and the slip rings are smooth. Now we adjust the vibrating reeds until the motor turns the generator at the correct speed—in this case, 1800 rpm.

Output AC voltage is still a bit low, so we inspect brushes on the DC motor and on the AC generator. Two of the AC brushes are worn badly, so they're replaced, and a slightly rough slip ring is dressed smooth. The output of the MG set now reads 118 volts AC, so this is considered okay. The voltage is also stable now, instead of erratic.

A quick check of the magnetic controller used for starting the motor generator shows the dashpot oil level to be normal, and the pull-in time set for 5 seconds, as recommended in the manufacturer's instructions. This ends our work in the cramped below-deck compartment; with a sigh of relief and a stretch of tired back muscles, we return to the indicator in the wheelhouse.

After the radar goes through a three-minute warmup-timing cycle, the "ready" light comes on, and we can turn the power switch to "on." But wait! A rather annoying buzzing sound is heard coming from inside the indicator, and is found to be a relay chattering slightly. The trouble is in the self-latching contact of one relay; burnishing solves the problem.

Everything seems normal now, as we switch the radar set to OPERATE. But, alas, nothing happens! Well, at least, it seems that way. Let's look

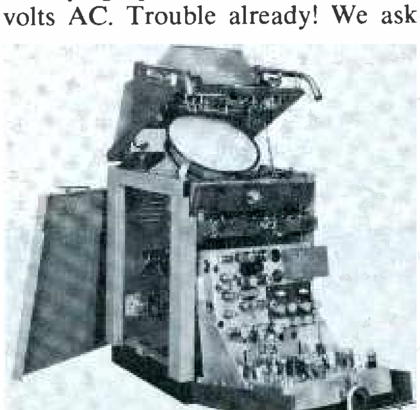

Fig. 1. Typical marine radar indicator showing accessibility for service work.

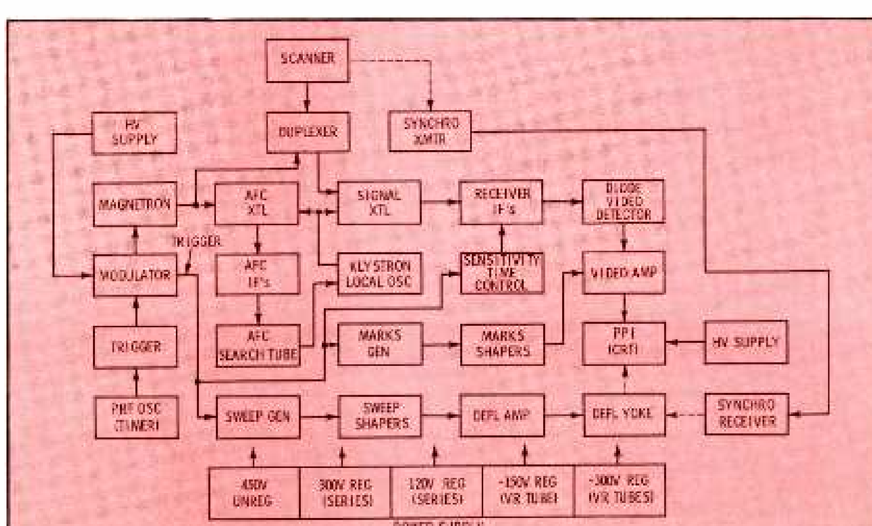

Fig. 2. Knowledge of system interconnection is indispensable for troubleshooting.

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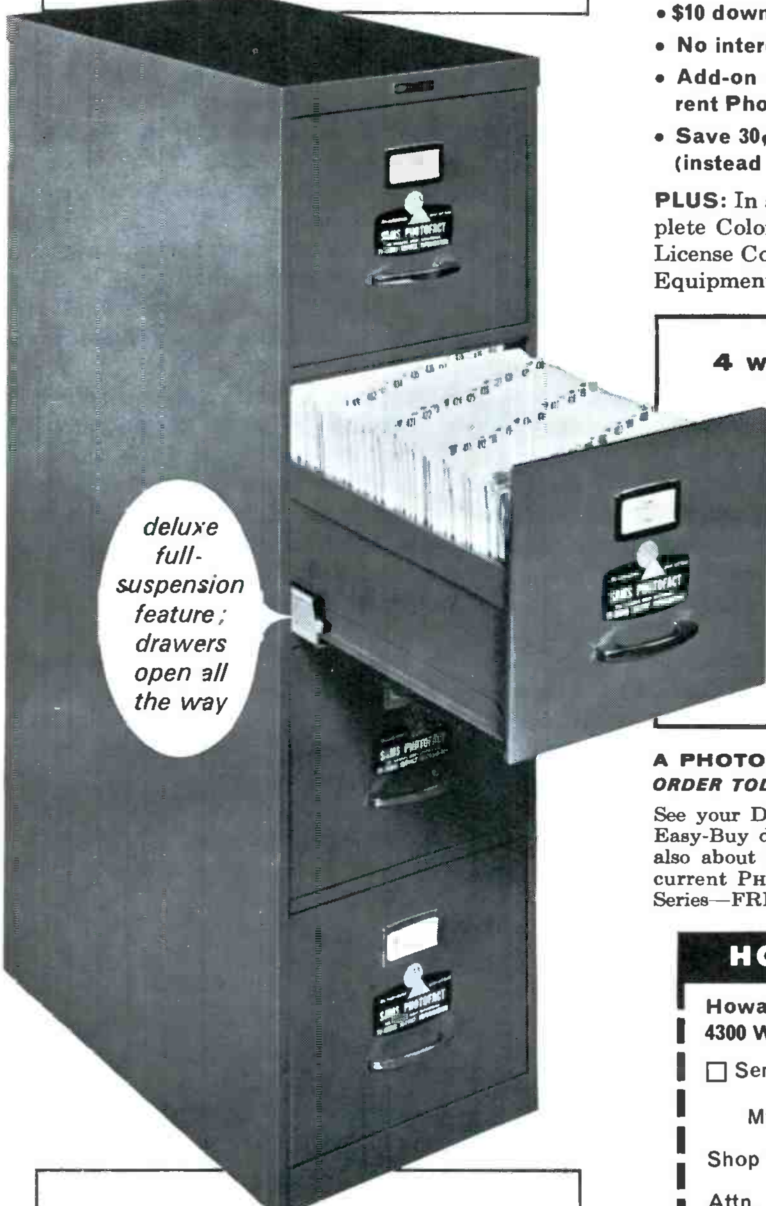

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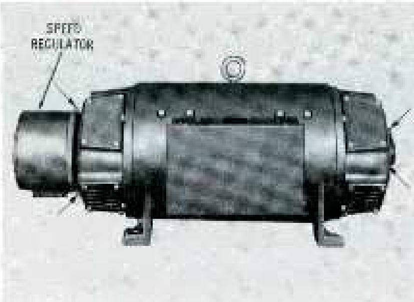


Fig. 3. Cover at left end is removable to expose speed regulator for servicing.

at some of the other power measurements, by switching the radar test meter. A couple of positions check output voltage of the two regulated low-voltage power supplies. We note that both are functioning, but the 120-volt regulated output reads very low. Turning the adjustment screw brings the voltage almost to normal, but only at the very end of the control's rotation.

The schematic diagram in Fig. 4 shows this series-type regulator. We try changing the two tubes—they could be low in emission, causing too much internal drop. Replacing them raises the output voltage well above normal, and readjusting the control brings the voltage to its proper level.

Tapping the power-supply tubes detects an arcing 5Y3GT, which we replace, bringing the low-voltage power supply to a state of dependable operation.

The Sweep System

We note there is a tiny bright spot in the center of the CRT, so the high voltage must be operating normally, but there is still no sweep line on the CRT face. Here our knowledge of the system layout, as depicted in Fig. 2, stands us in good stead. To develop a sweep, the sweep circuits must be triggered by a pulse taken—in this system—from the modulator section. If this trigger is present, we can assume the fault is in the sweep amplifier chain; if it's absent, the trouble must lie back of the modulator section. Another clue here can be had from observing magnetron current indicated by the radar test meter. This time, the reading indicates no magnetron current, so the modulator may not be operating. Measuring across the trigger input cable with the 10-volt AC range of our VOM fails to detect even the slightest indication of trigger voltage, so we must troubleshoot the modulator section.

The modulator section in this system is in the transmitter-receiver housing. Upon opening the modulator protective cage (thousands of LETHAL volts in here!), we momentarily cheat the interlock, taking care that we are well clear of any live voltages, and then release it. We can tell whether modulator high voltage was present by carefully discharging the modulator plate cap to ground with a long screwdriver; the high voltage will have been applied during the brief instant we cheated the interlock, but will not have been discharged through the circuit. The plate resistor will prevent *our* test-discharge process from being too rapid, but don't forget the volts are many, so caution must be used. Discharging this plate cap thoroughly also removes stored voltage from the circuits so we can proceed to the next tests.

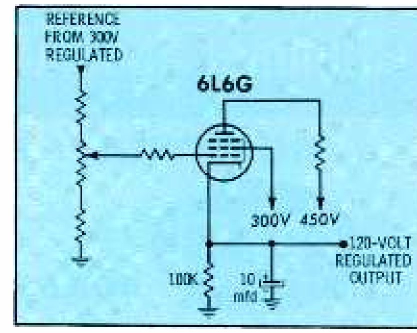


Fig. 4. Simplified schematic. In actual supply, two tubes are used in parallel.

We can troubleshoot the oscillator and shaping circuits that precede the modulator (Fig. 5) by using the VOM on its AC ranges, or by using a scope. In this set, we find no AC voltages at any of the test points. We must therefore conclude that the oscillator is not working. Tube substitution proves futile, so further analysis is in order. A quick visual inspection of the components associated with the oscillator reveals a discolored R155; ohmmeter measurement results in a reading of 170K. Replacement of this resistor solves the apparent problem; but because the tube may have shorted and caused the resistor to overheat, we also replace the tube, taking no chances of this happening again. We hope.

Now when we momentarily cheat the interlock, the modulator "sings" out at the PRF rate, and the thyratron modulator takes on its characteristic blue glow. So we replace the cover and proceed back to the indicator.

At the indicator, we see a full sweep now; the sweep line is stationary on the CRT face, and this is because the antenna-motor switch is off. We check the sweep tubes for noise or microphonics, by tapping.

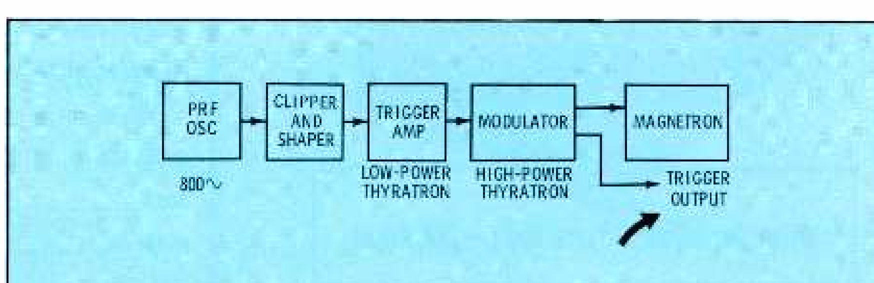


Fig. 5. The pulse-repetition-frequency oscillator sets timing via the trigger.

When we hit the second sweep amplifier, the sweep cuts out momentarily, so we replace the tube. The PRF oscillator exhibits a tendency to self-trigger, as evidenced by a thick double sweep line. To eliminate this tendency, we disconnect the trigger input lead and adjust the multivibrator bias control just beyond cutoff. With the trigger reconnected, the sweep should be stable. And it is.

At this point, we start the scanner turning by flipping the antenna motor switch on. The sweep line rotates until it reaches a point nearly at zero degrees (straight ahead), then stops. In a few seconds, a click is heard and the sweep proceeds in its rotation. This hesitation and click are caused by the deflection-coil drive synchro falling into step with the synchro in the scanner, so that as the scanner points in any particular direction, the sweep line will also be at that position on the face of the CRT. Since the sweep continues to rotate normally, we can assume that correct synchronization has taken place and forget this point for now.

Marker Information

We advance the Marker Rings control and note that small, evenly spaced pips appear along the sweep line. As the sweep rotates, these markers trace concentric circles on the face of the CRT. We notice they are rather weak, and experience reminds us they should be strongly visible even at low settings of the control. Tube substitution in the marker stages is indicated; with two new ones, markers are visible at less than half the control rotation.

After setting the RANGE switch for the 20-mile range, we turn up the variable marker control. The variable marker is a single pip similar to the fixed marker pips, but this one is movable by cranking a knob. The crank is geared to a Veeder-Root counter which is calibrated in miles. The counter is also connected to a 20K helipot which, when varied, changes the timing of the marker pip and puts it at a different location on the sweep.

Using the fixed range rings as a reference (these must never be tampered with in the field, as their accuracy is a matter of life or death to the navigator), we find that the variable marker does not track. That is, when the counter says 10 miles, the variable marker is not at the same point on the sweep as the 10-mile fixed marker.

To calibrate the variable marker, we set the range switch to 1-mile range and set the counter to read .5 mile. We adjust the ZERO-SET control to cause the variable marker to coincide with the 5-mile fixed range ring. Next, we switch to the 20-mile range and crank the counter to read 20 miles. We adjust the SLOPE control until the variable marker is superimposed on the 20-mile fixed range ring. These adjustments are interrelated so we repeat them until tracking is accurate.

Fixed range rings are factory adjusted and usually sealed, or at least covered, to prevent tampering. No adjustment of these should *ever* be attempted by a technician, because only closely calibrated equipment and specific techniques can result in proper calibration. A little imagination can suggest the dire consequences of navigating with improper mileage-marker

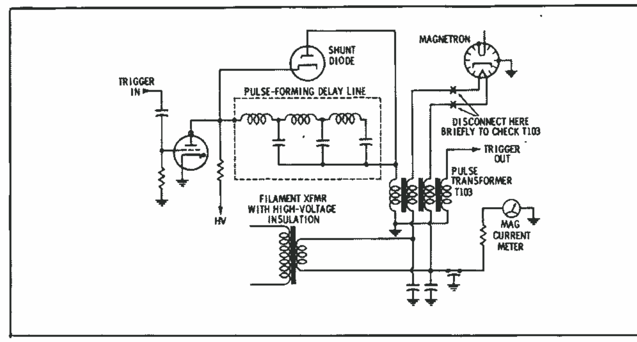


Fig. 6. Mag current is "zero" with maggie disconnected.

calibration.

Just to check operation, we go through the recommended adjustments for the sweep circuits, first setting the 40-mile gate control, then proceeding to adjust the sweep lengths on each range.

Looking for Targets

Examination of our results so far shows we have a stable sweep, with range marks as they should be, but with no targets showing. Advancing the master gain control shows us good IF gain, since we have an effect similar to TV snow, but still no targets. We check to make sure the STC (Sensitivity Time Constant) control is not set so as to affect over-all gain, then proceed to try to locate the trouble which is keeping targets invisible.

We know the modulator is working, since we serviced it earlier. A check of magnetron current shows the meter to be pegged, so we switch the set to STANDBY. Study of the simplified schematic in Fig. 6 shows two likely causes: the magnetron could be drawing excessive current or pulse transformer T103 could be shorting internally. Disconnecting the plug to the magnetron and switching the radar set to OPERATE, we again find the meter pegged: the transformer must be at fault. Luckily, we have one in our car, so we get it and install it.

When we start the set again, the meter is off the peg, but current is lower than normal, and we still have no targets. Reasoning says: weak modulator pulse or poor magnetron. A new modulator tube makes no difference, so we change the high-voltage rectifiers in the modulator cage. Magnetron current is now in the range recommended by the manufacturer, so we replace the modulator cage cover. A glance shows targets on the CRT face in certain pie-shaped sections, but none in other sections. Let's see if we can figure out why.

This radar system uses an AFC circuit to eliminate the need for tuning the set each time it is used. The AFC circuit applies a search voltage to the klystron tuning circuit. If the klystron is not adjusted properly, or the AFC circuit is not functioning correctly, this search voltage swings the klystron tuning back and forth across its operating mode. This hunting accounts for the targets that are shown as the klystron is tuned through a correct point by the AFC search voltage. As the sweep rotates around the CRT, the tuned points appear as pie sections between offtune points.

We try tuning the klystron, but still can't get the AFC to lock. With our 1-ma meter scale, we check

AFC crystal current and find none. Replacing the crystal brings current up to a normal reading around .4 ma, but the AFC is still hunting.

Tuning Up

Now back to the klystron. Metering the signal-crystal current, we tune the klystron (Fig. 7) very carefully. The klystron tuning tool is used to set the tuning screw maximum counterclockwise, which sets the klystron at the high-frequency end of its operating range. Be sure the AFC-MANUAL switch is on AFC, and the repeller-TUNING potentiometer is at the center of rotation. As you turn the klystron tuning screw slowly clockwise, signal-crystal current starts to rise and is pulsing (AFC hunting). As you continue to turn the screw slowly, a point is suddenly reached where hunting stops. The current is very low, but carefully turning the screw further brings a point of maximum crystal current. Stop here for now.

Reach up and switch the AFC switch to MANUAL, this disabling the AFC search voltage. The signal crystal current may drop considerably, so adjust the TUNING potentiometer to again find maximum crystal current. Now, flipping the AFC switch on and off should produce very little change. If it does, readjust the klystron slightly with AFC on, and touch up the potentiometer with AFC off.

The only other tuning adjustment is the TR tube. This is best tuned by looking at the CRT face and turning the TR tuning screw for maximum tarket brightness. In this installation, the CRT face can't be seen from the transmitter-receiver housing, so we can use a different method. This receiver provides an IF test point: using our VOM on its 2.5-volt DC range, we connect the positive lead to the test point and the negative lead to ground. This provides only a very slight indication, but enough to tune the TR tube for maximum.

Miscellaneous Adjustments

Now we have targets galore on the screen but we notice the center is cluttered with echoes from nearby objects, which saturate the receiver. To eliminate this clutter, the radar is equipped with a circuit called the Sensitivity Time Constant (STC) circuit. Operating the STC GAIN control on the front of the indicator clears this clutter so we can see the outlines of the harber quite plainly.

We quickly check operation of the FTC or RAIN-SNOW switch. This Fast Time Constant circuit is a differentiator in the video amplifier which, when activated, causes the leading edges of larger targets to be accentuated, making very small targets less prom-

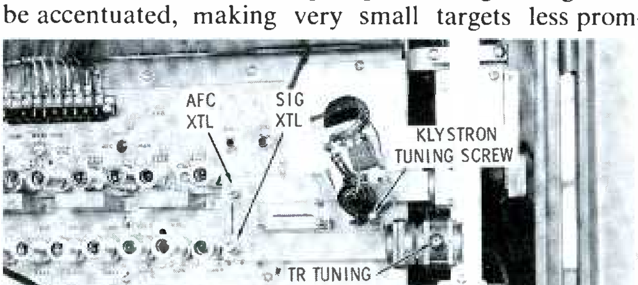


Fig. 7. Receiver "plumbing" shows klystron and TR tuning.

inent. Thus, rain or snow squalls will not be as plain on the screen as targets having better reflectivity. This one is operating normally as indicated by breaking up of nearby targets (which consist of buildings and hills in the vicinity of the harbor).

Topside

Now to inspect the antenna, or scanner. Before ascending to the scanner mount, we look at the heading flasher on the screen of the indicator. The heading flasher is a momentary brightening of the sweep as the scanner passes through zero degrees relative, or straight ahead of the ship. This flasher should be positioned exactly 0° on the bearing ring surrounding the CRT face. In addition, some target of reference, which can be visually verified to be precisely straight ahead, should lie directly under the heading flash.

If the flasher coincides with a visual reference target, the flasher switch in the scanner is properly adjusted. If not, adjustment is needed. If the flasher is correct with respect to target, but does not occur exactly at 0° on the bearing ring, the entire picture is not truly oriented, and must be corrected by turning one of the synchros slightly, preferably the one at the deflection coil in the indicator. Before changing synchro position, be *sure* the flasher line is correct compared with an actual target (scanner switch adjustment).

Some radar systems are very difficult to adjust for proper synchronization. Improper synchronization is indicated by a loud click as the sweep goes through zero degrees, or by the sweep frequently sticking or jumping somewhere near zero. Occasionally the sweep will apparently synchronize, but the entire picture will be rotated several degrees one way or another. This is another sign of incorrect synchronization. In all cases of poor synchronization, follow the manufacturer's instruction booklet very carefully and synchronization can be achieved with a minimum of trouble.

On the RADAR QUEEN, the heading flasher meets both requirments, and the sweep synchronizes normally, so we proceed with our inspection of the scanner. We check the oil level, clean soot off the horn (with the radar off so as not to get a radiation burn), check for loose or worn parts. Adding a little oil as recommended by the manufacturer seems to be all the service this scanner needs, so we add it, button the cover up, and climb back down.

All that remains is to make our entry in the radar maintenance log. This is done by recording the date and the hours on the radar running-time meter, listing parts installed, adjustments made, results of inspection, writing in the license number, date, and name of the technician performing maintenance.

That's All

Other systems require the same approach to service, if a complete job is to be done. Some have fewer gimmicks, and some are arranged differently; but step-by-step analysis of the system, such as we've done here, will show the competent technician what needs to be done. Radar maintenance isn't difficult at all! ▲

The Troubleshooter

answers your servicing problems

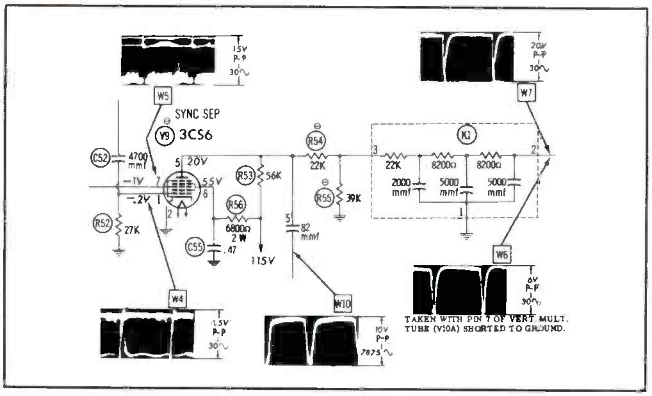
Poor Horizontal Sync

I have a Westinghouse portable Chassis V2311-45 (covered in PHOTOFACT Folder 355-15) that has just enough height with proper linearity. The vertical deflection locks in properly.

Now the problem: At times the last few scanning lines at the bottom of the screen slowly compress and then expand. Adjustments do not affect this condition, and the scanning-line spacing jumps back to normal when scene changes occur.

When the scanning-line compression is present, the horizontal linearity is not good. Also, vertical lines in the picture are wavy. No adjustments, including the contrast control help.

CHARLES E. HEDGES
Bellefontaine, Ohio



Both the vertical and horizontal symptoms seem to be caused by horizontal instability. New sync-separator and horizontal-AFC tubes should be tried. Also check supply voltages for the sync-separator stage. Scope checks in the separator and AFC circuitry should help pinpoint the trouble. In particular, check horizontal-sync pulse W10 and vertical sync pulse W6. A generally run-down boost supply can cause instability troubles; substitute for the horizontal-output and damper tubes. As a final polish for best stability, adjust the horizontal multivibrator according to the instructions on page 13 of PHOTOFACT *Folder 355-15.*

Overheated Transformer

The horizontal-output transformers in some of the early model color sets have a tendency to get rather hot. In fact, in some cases, they get so hot the coating of wax on the transformer actually melts.

I felt that you and your readers might be interested in my approach to this problem. I remove all the wax from the "donut" (it can be chipped off rather easily) and replace it with a heavy application of Dow-Corning silicon bathtub seal. This substance is a high-temperature rubbery material and can be used for many other applications, such as potting, etc. The flyback still gets warm, but the insulation stays in place.

PETER F. HILLE
Columbus, Ohio

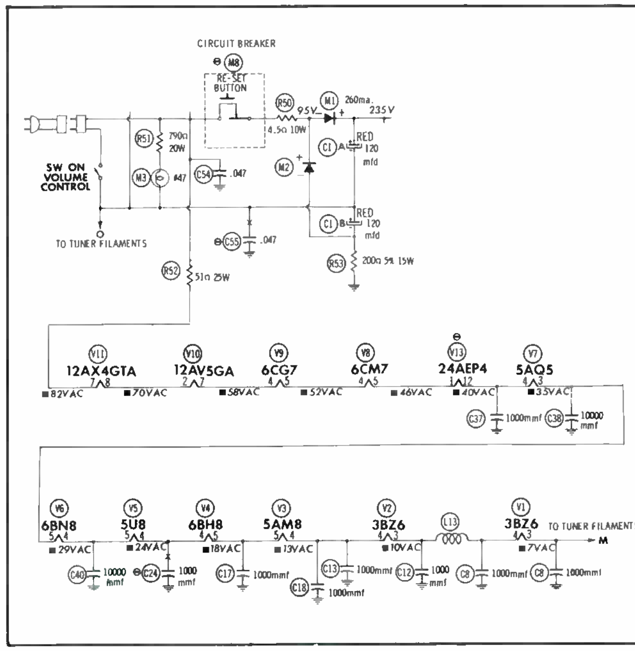
Thanks, Peter, for this timely suggestion. This may save many serviceman lots of time in looking for a nonexistent defect in the receiver.

Instant Tube Burnout

I am having trouble with a Silvertone Chassis 528.51108 (covered in PHOTOFACT Folder 397-3). The horizontal-multivibrator tube (6CG7) will burn out as soon as it is installed. The tube lights up very bright, ahead of the other tubes, when the set is first turned on. I have replaced the filament dropping resistor (R52, 51 ohms, 25 watts) and power-supply filters C1A and C1B but haven't been able to locate the trouble. Any help would certainly be appreciated.

MORRIS BOBO

Union, S. C.



From the symptoms you mention, it seems the reason the 6CG7 (V9) is burning out immediately after installation is that the socket is shorted at pin 5. This would account for the tube lighting brightly when the set is turned on. However, there is a possibility that one of the decoupling capacitors located in the filament string is shorted. Take a resistance measurement from pin 4 to ground and then from pin 5 to ground with the tube removed from the socket. There should be approximately 45 ohms from pin 5 to ground. If the resistance is considerably lower than this, there is evidently a short somewhere in the filament string between pin 5 and ground.

Puzzler Solved

I am submitting this additional information in regard to the "Voltage Puzzler" on a Westinghouse TV Model H-K3821 (The Troubleshooter, April 1965 PF REPORTER, page 75).

I have had several of these sets—and other receivers having a similar type of horizontal-oscillator circuit—with the same trouble symptoms. The common cathode resistor, R91, greatly increases in value and causes the plate voltage to decrease. I have found replacing this resistor with a 1-watt unit prevents future trouble. Also, in some instances, I have found C3 (10-mfd electrolytic) to cause the same trouble. Both of these components are logical suspects as causes of horizontal-oscillator trouble.

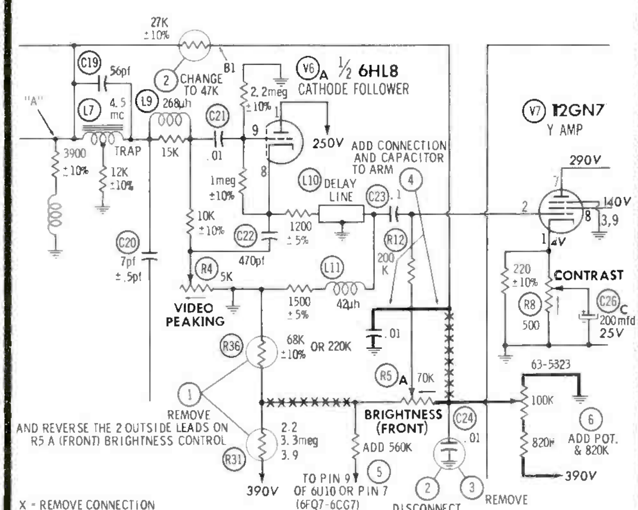
D. W. ALLEESON

Los Angeles, Calif.

Thanks, D. W., for letting our readers share your experiences and the remedies you have found for these troubles.

COLOR COUNTERMEASURES

Symptoms and service tips from actual shop experience



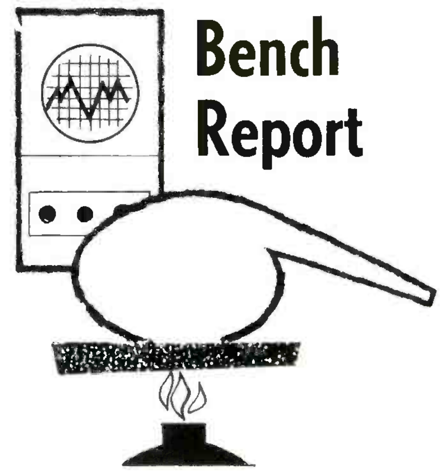
Chassis: Zenith 26KC20, 25LC20, 25LC30

Symptom: Excessive brightness causes blooming and poor focus or low brightness.

Tip: Install brightness range control (Zenith part No. 63-5323) and make following circuit modification, consisting of eight simple steps:

1. Remove R36 (68K) from one side of the brightness control to ground. Reverse the two outside leads on the brightness control (black-white and white). Remove the B+ resistor (R31) connecting the black-and-white lead from the brightness control to the 390 V line.
2. Remove the 27K resistor located between the 4.5-mc trap (terminal A on L7) and the white wire leading to the brightness control. Disconnect the end of C24 (.01 mfd) fastened to this point. Run a length of hook-up wire from terminal A on the 4.5-mc trap to a blank lug on the terminal strip adjacent to the 12GN7 tube socket. Install a 47K resistor between this end of the wire and R12 (220K) at the junction on the terminal strip with the blue wire leading to the center tap of the brightness control.
3. Remove C24 (.01 mfd) loosened in step 2.
4. Replace the .01-mfd capacitor in step 3 from ground to the junction of the terminal strip of the 47K resistor, the 220K resistor (R12), and the blue wire leading to the center tap of the brightness control.
5. Connect a 560K resistor from the black-and-white lead on the brightness control to pin 9 of the 6U10 horizontal-discharge tube. (In 26KC20 chassis—Pin 7 of the 6FQ7 or 6CG7.)
6. Mount a 100K brightness range control (Zenith part No. 63-5323) midway between the circuit breaker and the AC interlock at the rear of the chassis. (On the 26KC20 chassis use the blank cut-out nearest the set-up switch.) Mount the control so the lugs are readily available for soldering. Looking at the back side of the control with the lugs facing down, ground the right-hand lug by soldering it directly to the chassis. Run a piece of hookup wire from the center lug on the range control to the white wire leading to the brightness control. Connect a hookup wire from the remaining lug to a blank lug on the terminal strip nearest the horizontal discharge tube. Install an 820K resistor between this hookup wire and the 390 V B+ line.
7. Rotate the channel selector to a station signal and set the brightness and contrast to maximum.
8. Adjust the brightness range control just below the point at which the raster tends to "bloom." Raster lines should be distinct.

PFR Bench Report



"Magic-Wand" Degausser

Not so very long ago, during a local dealer showing of the new line of Zenith home-entertainment instruments, Jack Clouse, color merchandising manager for the Zenith distributor

in our area, called us over to a color set with a large area of severe impurity. While several of us stood around the set, Jack took a small device from his jacket pocket and passed it once or twice across the face of the CRT. Presto! The impurity disappeared as if by magic.

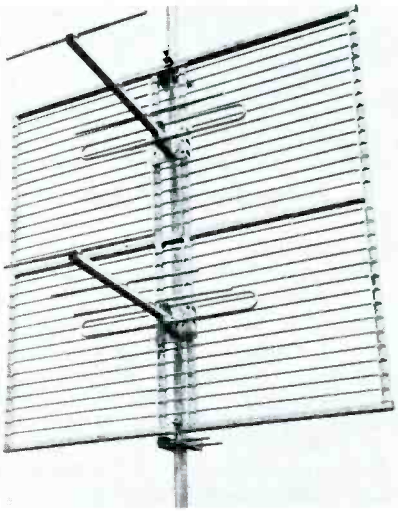
Jack's rather dramatic demonstration was followed by a closer look at the "magic wand," which proved to be a small, magnetically polarized powdered-iron wheel mounted to a short plastic handle by a "U"-shaped bracket which allowed the wheel to spin freely. The wand's degaussing action is initiated by spinning the wheel, thus setting up a rapidly rotating magnetic field which redistributes the field in the vicinity of the CRT into a random pattern. In use, the wand is spun rapidly, passed back and forth in front on the CRT about an inch or two away. When the entire screen has been covered, the wand is withdrawn while the wheel is still spinning.

We subsequently found the wand he gave us useful for restoring purity to several sets which had picked up some contamination while being moved around our lab area. It should come in real handy for house-call problems of impurity resulting from electrical-appliance magnetization or other common household sources.

The Zenith part No. is S67714, and the degausser is available from Zenith distributors and dealers. The price is $2.50.

Product Report

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



Dual-Element Screen Yagi (124)

For TV service requiring high gain at 210 to 216 mc, **TACO** provides a screen-type yagi, Model SY-42-13, having a gain of 13 db. Front-to-back ratio is several times better than that of an ordinary yagi. Direct coaxial input for either 50 or 75 ohms is provided by an internal balun. VSWR is 1.5:1; power rating is 2040 watts. The reflector measures 60" x 60"; the frame is fabricated from 1¼" square aluminum, and the screening is of ⅜" diameter tubing. Yagi elements are ½" diameter with ⅝" reinforcing sleeves. Combining lines provide a single coaxial input.

Bass Compensator (125)

A "bass energizer" designed to compensate for low-frequency deficiencies in small speakers by providing an increase (relative to the rest of the spectrum) in very-low bass level is being manufactured by **Altec Lansing** for distribution through its high-fidelity outlets.

The device, designated as the Altec 100A Bass Energizer, requires no electrical power and connects between the amplifier output and speaker input. It can be attached either to the back of the speaker enclosure or next to the amplifier, whichever is more convenient for the user.

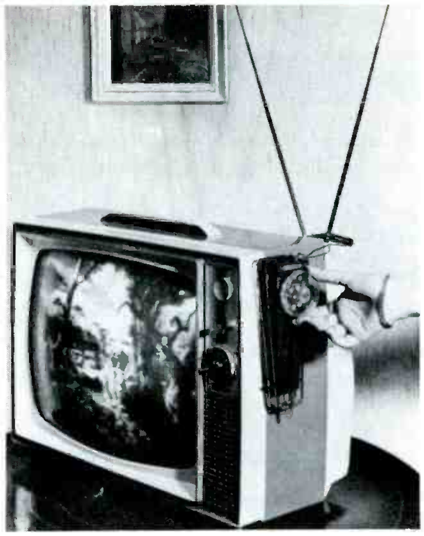
The compensation becomes effective only below 150 cps and builds to full efficiency from 60 cps down to speaker cutoff. Though designed to operate with efficient speakers, the unit can be used with inefficient speakers if the amplifier power is adequate. Consumer net price is $30.

Pocket Voltmeter (126)

A new vest-pocket-sized voltmeter known as the "Mini-Test" is being offered by **IEH Mfg. Co., Inc.** The new device, Model VT-101, can be used to check TV sets, radios, and other electrical appliances. It can also be used to trace open lines, shorts, and blown fuses. Range of the "Mini-Test" is from 65 to 800 volts, AC or DC; the VM is priced at $1.49.

Miniature Soldering Iron (127)

Small size and a four-second heating time are features of the "miniscope" soldering iron. The tip can remain cold until it touches the soldering point, a characteristic designed to help eliminate burning of adjacent wires, terminals, or insulation in cramped spaces. The iron operates from a 2-volt supply to reduce the danger of voltage leakage damaging delicate transistors. It is normally used with a transformer, but can be battery operated when an AC source is not available. The **Parker Trading Co.** tool weighs 1¾ oz.



Antenna Accessory

(128)

The "Tenna-Mate" (Model 3D-M) is a self-adhering TV antenna accessory, designed specifically for receivers with built-in antennas, developed by **Snyder Mfg. Co.** The unit is designed to improve picture reception by portable TV receivers. The accessory is affixed to the side of a set with a pressure adhesive. It needs no electrical outlet and is attached to the antenna elements with small clamps. It is priced to retail at $4.95.

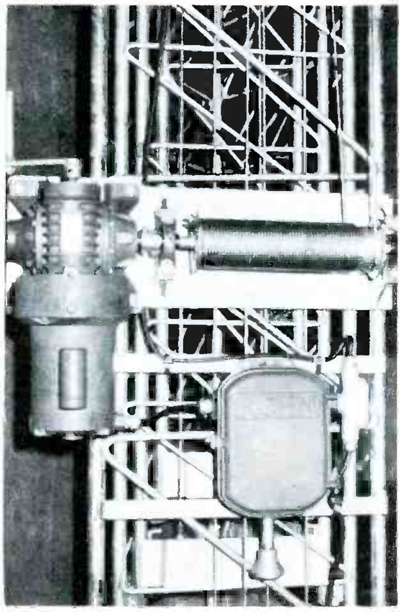
Field-Strength Meter

(129)

Field surveys, antenna checks, and gain measurements can be made with the **Sadelco, Inc.** Model FS-2 field-strength meter. It provides two bands, one for channels 2 to 6 and FM, and the other for channels 7 to 13. UHF coverage is available through the plug-in addition of Sadelco's UA-1 Adaptor.

Gain measurements can be made in terms of microvolts or db. Picture and sound carriers are clearly marked, and provision is made for peak carrier readings. Four db scales provide 1 db resolution from −33 to +60 db. Each scale is read directly, with no calculations required, from a semilogarithmic scale.

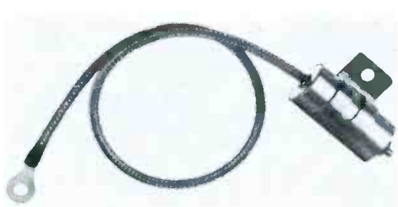
The printed-circuit unit is fully transistorized and battery operated. The instrument measures 8¼" x 4½" x 3" and weighs 3½ lb. The price of $295 includes a carrying case which provides space for phones, matching transformers, adapter cables, etc. The price also includes the two 9-volt batteries necessary for operation.



Motorized Winch for Crank-Up Towers (130)

By means of the winch shown here, an operator can control by push-button operation the up-and-down movement of a **Rohn Manufacturing Co.** HD Series crank-up tower. The complete system consists of the winch, a heavy-duty weather-proof geared motor, and a control unit. Fuses and a reset device are utilized for protection of the motor, while limit switches are employed to prevent damage to the tower when up or down travel limits are reached.

The Rohn Model 200 remote control unit, an optional feature, can be added to enable the operator to control the movement of the tower from a remote point. This unit includes a tower-height indicator.



Cable Shield and Filter (131)

The Electro-Shield Filter and shielded cable by **Estes Engineering Company** provides a waterproof 30-amp 100-VDC filter with optional lengths of shielded cable. The filter provides noise-free power cables for such DC electronic equipment as two-way radios, depth indicators, direction finders, etc. The filter eliminates power-cable noise and thereby provides improved electronic and communications reliability.

Circle 56 on literature card

Circle 51 on literature card

Miniature "Walkie-Talkie" (132)

"Walkie-talkies' so small they fit in the palm of the hand are being added to **Westinghouse Electric Corporation's** 1965 transceiver line. The Citizens band units have a range of three miles, depending upon terrain, making them suitable for person-to-person communications while hunting, camping or boating, in construction work, and around the house. The new units measure 4 5/16" x 2⅛" x 1⅛".

Each transceiver, enclosed in an anodized aluminum case, is powered by a single nine-volt battery and contains eight transistors, one diode, and one thermistor. In addition, the tiny transceivers are equipped with 10-section whip antennas. The units are expected to sell in gift-packed pairs for less than $80, including leather carrying cases.

Two-Way Business Radio (133)

The "Courier 50 FM" is a two-way FM business radio designed to provide small-business and professional men with two-way contact with off-premises personnel. The transceiver is engineered to operate in the 25-to-50 mc range with an output of 50 watts. It is available with either an AC or a 12-volt DC power supply. The unit, made by **E.C.I. Electronics Communications, Inc.,** has been type accepted by the Federal Communications Commission. List price is $279.50.

INDEX TO ADVERTISERS

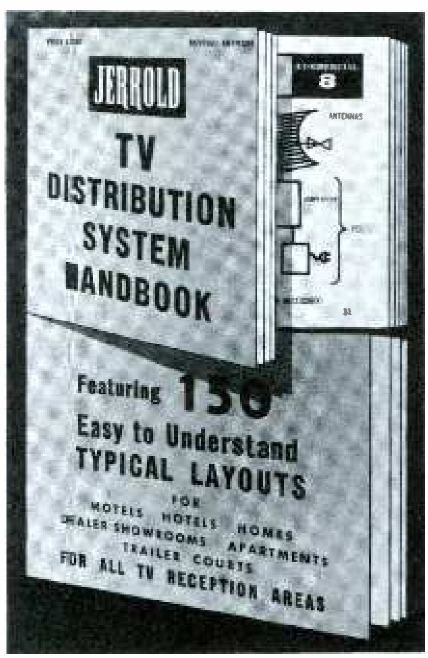
JULY 1965

Replacements for Color-TV ADG Components (134)

A packet consisting of two variable resistance components (one thermistor and one varistor), which are designed to provide replacements for defective units in color-TV sets using automatic degaussing circuits. Packet identification number of this **Workman** product is 50. ▲

New Literature

Technical Booklets You Can Buy



Master TV Systems Handbook (135)

Jerrold Electronics Corp. offers the "TV Distribution Systems Handbook." This new guide to master TV antenna systems covers 150 typical layouts for motels, hotels, homes, dealer showrooms, apartments, and trailer courts. The booklet is primarily for servicemen who are interested in making money in the MATV field. It gives practical installation and servicing hints along with design theory. The handbook is priced at $1.00 from **Jerrold Electronics Corp., 15th and Lehigh Ave., Philadelphia 32, Pa.** ▲

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

58. *ANTENNACRAFT* — Literature on new 75-ohm TV and FM antennas for use with RG-59/U coaxial cable.

59. *FINNEY*—Catalog 20-322 showing newest addition to the All-Band Color-Ve-Log series of UHF-VHF-FM antennas.*

60. *JERROLD* — 16-page booklet describing latest TV-FM reception aids; includes antennas, antenna amplifiers, amplified couplers, UHF converters, and home distribution systems.*

61. *JFD*—Literature on complete line of log-periodic antennas for VHF, UHF, FM, and FM streo. Brochure showing converters, amplifiers, and accessories; also complete '64-'65 dealer catalog plus dealer wall chart of antenna selection by area.*

62. *MOSLEY ELECTRONICS* — Illustrated catalog giving specifications and features on large line of antennas for Citizens band, amateur, and TV applications.*

63. *STANDARD KOLLSMAN* — Catalog sheet on Model TA transistorized UHF converter and transistor converter kit.

64. *TRIO*—Brochure on installation and materials for improving UHF transistor reception.

65. *ZENITH* — Informative bulletins on antennas, rotors, batteries, tubes, loudspeakers, record changers, and wire and cable.*

AUDIO & HI-FI

66. *ADMIRAL* — Folders describing line of '65 equipment; includes black-and-white TV, color TV, radio, and stereo hi-fi.

67. *ELECTRO-VOICE*—New booklet covering sound reinforcement as it applies to the new changes in the Catholic Church liturgy.*

68. *GC ELECTRONICS* — New up-to-date phono wall chart, No. FR-250-W, including new drives and hundreds of newly cross-referenced models.*

69. *JENSEN* — 24-page catalog, No. 165-K, illustrates and describes speakers and speaker system kits.

70. *NUTONE*—Two full-color booklets illustrating built-in stereo music systems and intercom-radio systems. Includes specifications, installation ideas, and prizes.

71. *OAKTRON* — "The Blueprint to Better Sound," an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.

72. *OXFORD TRANSDUCER*—Product information bulletin describing complete line of loudspeakers for all types of sound applications including replacements for public address and intercom systems.

73. *QUAM-NICHOLS* — Automotive speaker guide listing replacement speakers for all automobiles from 1954 through 1965 for both front- and rear-seat applications.

74. *SAMPSON*—Full-line four-color catalog page showing transistor radios and tape recorders.

75. *SONOTONE*—Specification sheet on new *Sonomaster* speaker system, Model RM-2, sheet No. SAH-96.*

76. *EICO*—Data sheet on Model 753 *Tri-Band* transceiver and other ham gear, plus full-line catalog.

COMMUNICATIONS

77. *GENERAL RADIOTELEPHONE* — Literature on Models BB-30 business radio, MC-8 and VS-6 CB transceiver, CG-3 frequency counter, and 615-B CB wattmeter.

78. *PEARCE-SIMPSON* — Specification brochure on IBC 301 business-band two-way radio, *Companion 11*, *Escort*, and *Guardian 23* Citizens-band transceivers.

COMPONENTS

79. *BUSSMANN*—Bulletin SFH-9 on fuse and holder combination designed for use where identification of open circuit must be positive. GBA fuse has a red-tipped indicating pin that extends from end of fuse when fuse opens. HLD holder has transparent knob to permit indicating pin on open fuse to be seen clearly.*

80. *COMPONENT SPECIALTIES* — Brochure on intercoms, speakers, earphones, and other *Speco* products.

81. *EBY SALES*—Literature on new socket adapters and conversion harnesses for 90° color tubes.

82. *E-Z-HOOK*—Catalog sheets showing complete line of test connectors, harness-cable board binding posts, and test leads and clips.

83. *IEH*—Catalog of 12 solid-state circuit modules.

84. *INTERNATIONAL ELECTRONICS* — New listing of IEC electron tubes.

85. *J-B-T-INSTRUMENTS*—General catalog 565; bulletins on reed relays, osscillator controls, toggle switches, and subminiature rotary-lever switches.

86. *LITTELFUSE* — New circuit breaker cross reference brochure.*

87. *RAWN* — Detailed instruction sheets on TV knob and plastic repairs with *Plas-T-Pair*.

88. *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.*

89. *SWITCHCRAFT*—New product bulletin No. 151 describes series 3600 coaxial video jacks and plugs.

90. *TRIAD*—1965 replacement catalog and television guide on transformers for television, hi-fi, home and auto radios.

91. *VACO* — Terminal catalog featuring all new styles and types.

92. *WALDOM*—Latest catalog No. 6F5 covering solderless terminals and connectors, hardware, tube sockets, terminal strips, knobs, dials, and service replacement parts. Includes index and prices.

SERVICE AIDS

93. *CASTLE*—How to get fast overhaul service on all makes and models of television tuners is described in leaflets. Shipping instructions, labels, and tags are also included.*

94. *CHEMICAL ENGINEERING* — Literature on new *Ever-quiet* contact cleaner.

95. *INJECTORALL*—1965 catalog No. 65 on electronic chemicals.

96. *LUBRA CLEAN* — Information on new tuner cleaner.*

97. *PRECISION TUNER*—Literature supplying information on complete, low-cost repair and alignment services for any TV tuner.*

98. *YEATS* — The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing feater-weight aluminum construction.*

SPECIAL EQUIPMENT

99. *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.*

100. *GREYHOUND* — The complete story of the speed, convenience, and special service provided by the Greyhound Package Express method of shipping with rates and routes.

101. *PERMA-POWER*—New Catalog on all-transistor garage-door operator with pulse-tone modulation.

102. *TERADO*—Bulletin on *Trav Electric* Model No. 50-160 transistorized DC-AC power inverter.*

103. *VOLKSWAGEN* — Large, 60-page illustrated booklet, "The Owner's Viewpoint," describes how various VW trucks can be used to save time and money in business enterprises, including complete specifications on line of trucks.

TECHNICAL PUBLICATIONS

104. *CLEVELAND INSTITUTE OF ELECTRONICS*—Free illustrated brochure describes electronic slide rule with four lesson Instruction Course and grading service.*

105. *RCA INSTITUTES* — 64-page book, "Your Career in Electronics" detailing home study courses in telecommunications, Industrial electronics, TV servicing, solid-state electronics, and drafting. Preparation for FCC license, and courses in mobile communications and computer programming also available.*

106. *HOWARD W. SAMS* — Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1965 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

107. *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.*

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 *Metergards, Lectrocells*, Models V-6 and V-7 color-bar generators, and Model T-100 horizontal-deflection circuit meter.*

111. *MERCURY* — Full catalog showing new kits for Models 501, 1101, 1101A, and 1400.

112. *RCA COMPONENTS*—Bulletin on RCA WR-52A stereo FM signal simulator (form 1Q1130).*

113. *SECO*—Eight page tube-tester brochure includes specifications and prices.*

114. *SENCORE*—Information on all solid-state color generator Model CG135 plus full line catalog.*

115. *SIMPSON* — Complete 16-page brochure on entire line of electronic test equipment; also, catalog on line of panel meters.

116. *TRIPLETT*—New test equipment catalog No. 47-T with information on all Triplett VOMs, VTVM's, tube testers, transistor analyzers, signal generators, and related accessories.*

117. *WATERMAN*—Technical data on OCA-11A industrial scope and OCA-12A dual trace scope.

TOOLS

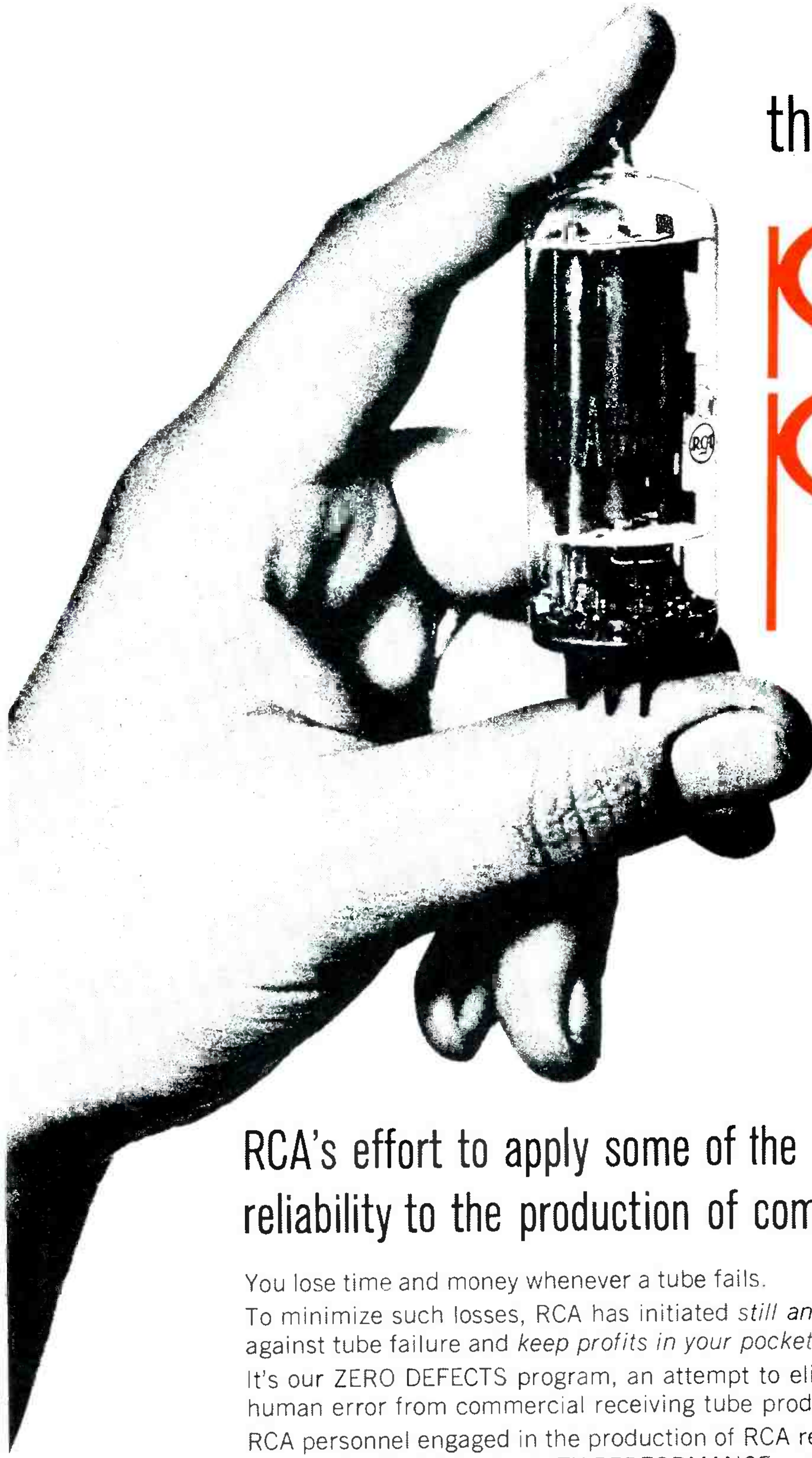
118. *ENTERPRISE DEVELOPMENT*—Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering techniques for speeding up and simplifying operations on PC boards.

119. *LUXO LAMP* — Information on Model LVT-2 low voltage lamp with movable extension arms.

TUBES & TRANSISTORS

120. *SEMITRONICS* — Bulletins describing new No. TV1000 UHF transistor and No. CTV358 color crystal.

RCA announces a zero defects program



through...

Personal **Q**uality **P**erformance

RCA's effort to apply some of the concepts of missile-type reliability to the production of commercial receiving tubes

You lose time and money whenever a tube fails.

To minimize such losses, RCA has initiated *still another quality control measure* to guard against tube failure and *keep profits in your pocket*.

It's our ZERO DEFECTS program, an attempt to eliminate as far as possible the factor of human error from commercial receiving tube production.

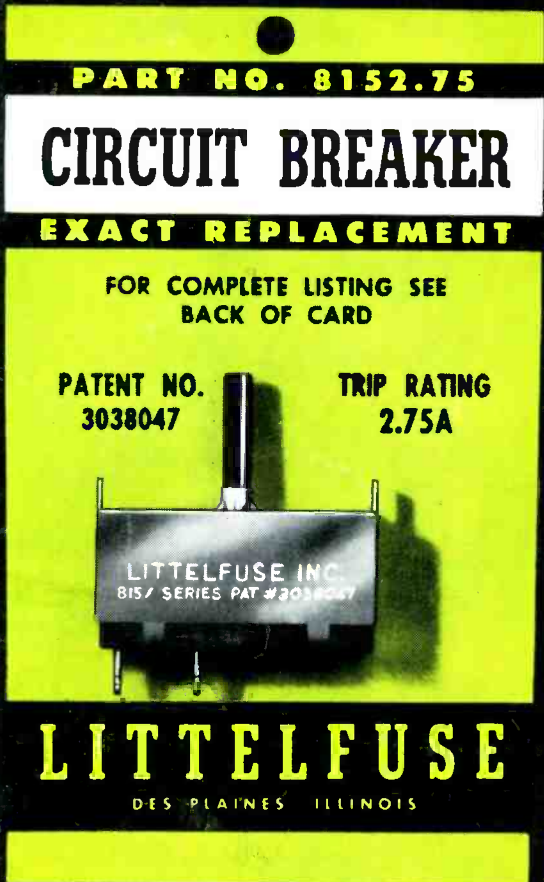
RCA personnel engaged in the production of RCA receiving tubes have voluntarily signed a pledge of PERSONAL QUALITY PERFORMANCE...a pledge to strive for error-free performance in every task they undertake in the making of RCA receiving tubes.

Their pledge is one more assurance to you of tube reliability and greatest possible reduction in callbacks when you sell and install RCA receiving tubes.

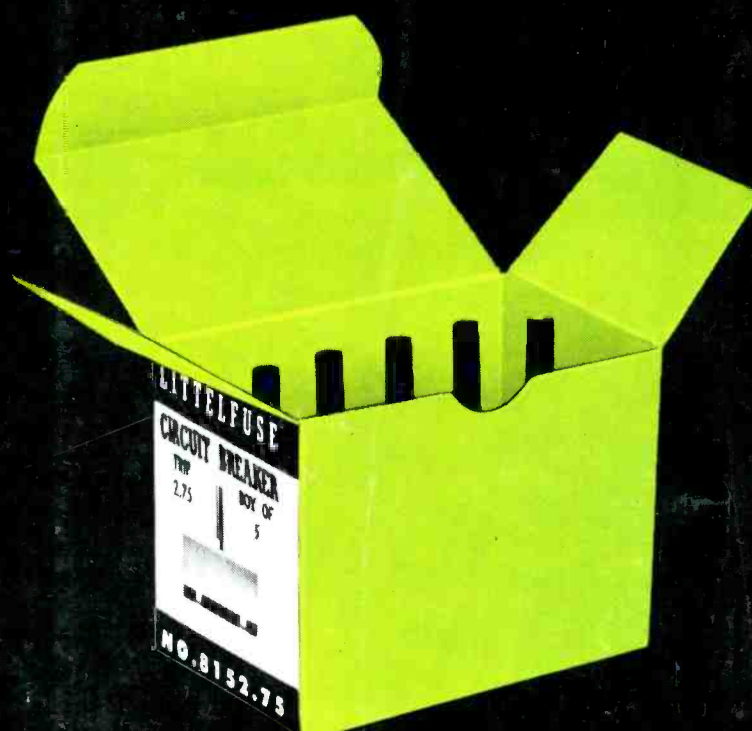
RCA Electronic Components and Devices, Harrison, N.J.

The Most Trusted Name in Electronics

EXACT REPLACEMENT direct from factory to you



packaged for your particular needs



Complete range of high quality circuit breakers to cover every replacement need, packaged for your convenience individually on a display card or 5 per box.

Also available in 10 card assortment (9 separate ratings) or 10 breakers per unit box (9 separate ratings).

LITTELFUSE DES PLAINES, ILLINOIS

Circle 57 on literature card