Page 56

BUILD—High-Gain 48-Element UHF Antenna

60c ■ APR. 1968

Radio-Electronics®

TELEVISION · SERVICING · HIGH FI

A GERNSBACK PUBLICATION

Special Report
TV & FM ANTENNAS and HOME SYSTEMS

MAG TEK

ANT. ROTORS P. 44

Be an Expert Organ Tuner

P 52

Fix Color TV Troubles Fast

SHOP PROJECTS

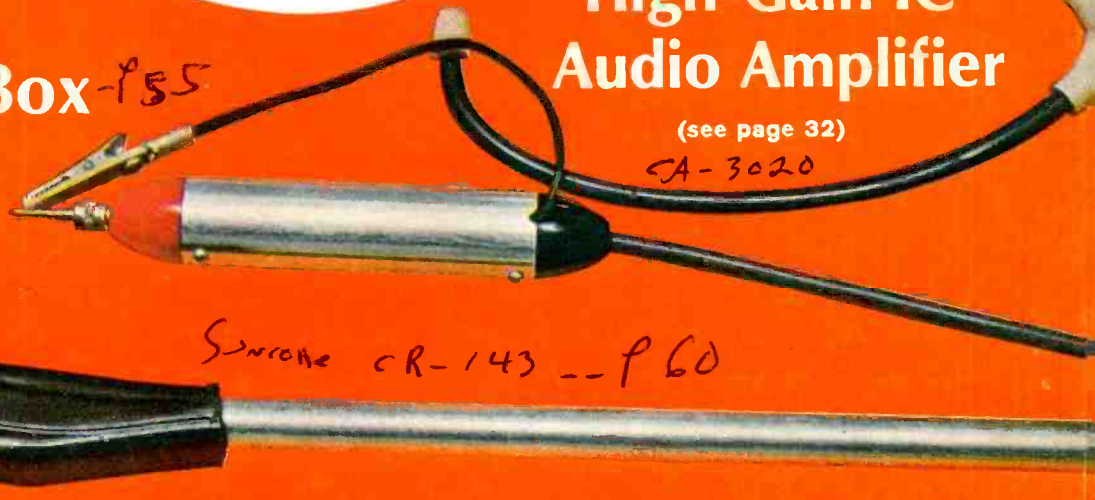
Voltage Step Box - P 55

meter

BUILD High-Gain IC Audio Amplifier

(see page 32)

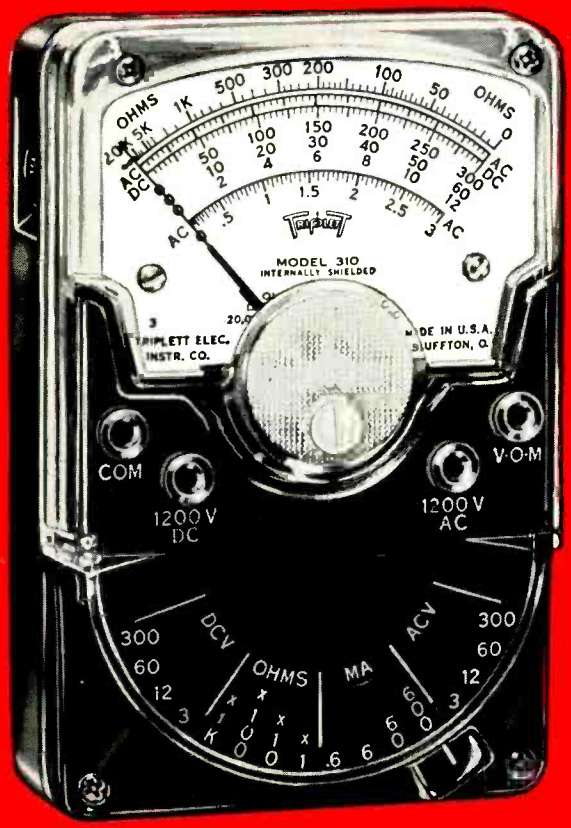
CA-3020



SUNCORE CR-143 -- P 60

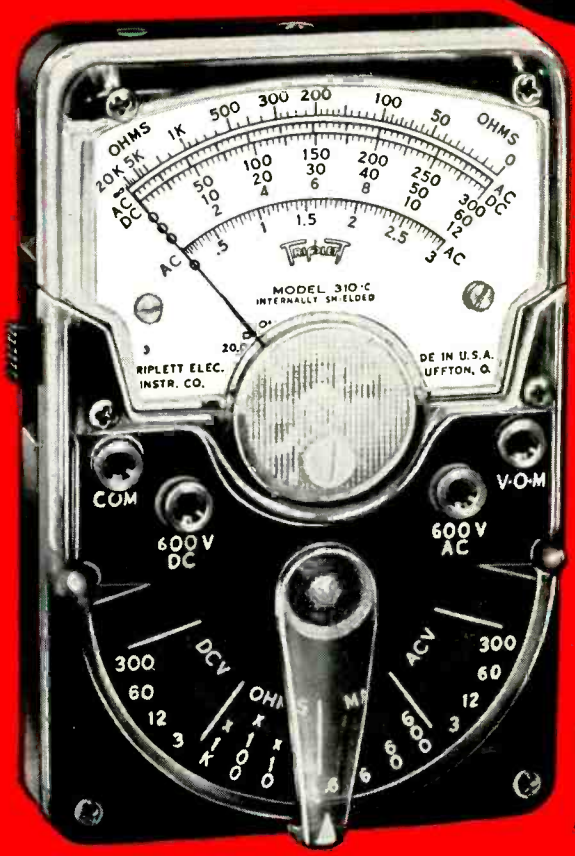
WORLD'S LARGEST SELLING AND WORLD'S NEWEST Hand Size V·O·M's

TRIPLETT



MODEL 310
World's Largest Selling
Volt-Ohm-Milliammeter

MODEL 310-C
World's Newest
Volt-Ohm-Milliammeter



BOTH TESTERS SHOWN ACTUAL SIZE

1 HAND SIZE V-O-M WITH PROVISION FOR ATTACHING AC CLAMP-ON AMMETER.

2 20,000 OHMS PER VOLT DC SENSITIVITY; 5,000 AC.

3 ONE SELECTOR SWITCH MINIMIZES CHANCE OF INCORRECT SETTINGS AND BURNOUTS.

SELF-SHIELDED Bar-Ring instrument; permits checking in strong magnetic fields. FITTING INTERCHANGEABLE test prod tip into top of tester makes it the common probe, thereby freeing one hand. UNBREAKABLE plastic meter window. BANANA-TYPE JACKS—positive connection and long life.

Model 310—$44.00 Model 310-C—$56.00 Model 369 Leather Case—$4.20

ALL PRICES ARE SUGGESTED U.S.A. USER NET, SUBJECT TO CHANGE

THE TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

310-C PLUS FEATURES

1. Hand size V-O-M with provision for attaching AC Clamp-on Ammeter.
2. 15,000 OHMS per volt AC sensitivity; (20,000 DC same as 310).
3. Single fully enclosed Lever Range Switch, plus DC Polarity Reversing.

MODELS 100 AND 100-C

Comprehensive test sets. Model 100 includes: Model 310 V-O-M, Model 10 Clamp-on Ammeter Adapter; Model 101 Line Separator; Model 379 Leather Case; Model 311 leads. ($83.20 Value Separate Unit Purchase Price.)

MODEL 100—U.S.A. User Net.. $78.00

MODEL 100-C—Same as above, but with Model 310-C, Net..... $88.00

USES UNLIMITED: FIELD ENGINEERS • ELECTRICAL, RADIO, TV, AND APPLIANCE SERVICEMEN • ELECTRICAL CONTRACTORS • FACTORY MAINTENANCE MEN • ELECTRONIC TECHNICIANS • HOME OWNERS, HOBBYISTS

THE WORLD'S MOST COMPLETE LINE OF V·O·M's • AVAILABLE FROM YOUR TRIPLETT DISTRIBUTOR'S STOCK

BIGGEST PURCHASE OF RECORDING TAPE EVER!

Why Pay up to **$4.13** for this same type tape?

In Lots of 50 – Up **1.09 EA.**

1800 FEET 7" REEL 1.0 MIL POLYESTER

Save $$$
ON RECORDING TAPE AT RADIO SHACK

★ *Super Strength 1.0 Mil Polyester!* ★ *Broad Response!*
★ *Pre-Tested Uniform Top Quality!* ★ *Extreme Sensitivity!*
★ *Freedom from Flake-Off!* ★ *Lower Print-Through — No Echo!*
★ *Splice Free!* ★ *Lower Noise Level!* ★ *Built-in Lubrication!*

Bought by the truck load direct from America's #1 manufacturer of professional recording tape! It's double-play, super-strength 1.0 polyester . . . the *quality* base material (*not acetate!*), on 7" reels in our own "CONCERT" brand boxes. We believe this to be the largest lot purchase in audio history — and Radio Shack is returning the savings to *you!* This combination of quality and economy makes it a "natural" for schools, studios and tape enthusiasts! Order today and cash in on this value!

Description	PER REEL	LOTS of 3-9	LOTS of 10-49	In Lots of 50 - up
1800' 1.0 Mil 7" Reel **44-1018**	**1.55 EACH**	**1.39 EACH**	**1.25 EACH**	**1.09 EACH**

Now Over 195 Radio Shack Stores Coast to Coast!

ARIZONA — Phoenix
ARKANSAS — Little Rock
CALIFORNIA — Anaheim, Bakersfield, Covina, Downey, Garden Grove, Glendale, La Habra, Long Beach, Los Angeles, Mission Hills, Mountain View, No. Hollywood, Oakland, Pasadena, Pomona, Reseda, Sacramento, San Bruno, San Diego, San Francisco, Santa Ana, Santa Monica, Torrance, West Covina
COLORADO — Denver, Englewood, Thornton
CONNECTICUT — Bridgeport, Hamden, Manchester, New Britain, New Haven, New London, Orange, Stamford, Torrington, West Hartford
FLORIDA — Cocoa Beach, Jacksonville, Orlando, W. Palm Beach
GEORGIA — Atlanta
ILLINOIS — Belleville, Chicago, Elgin, Harvey, Waukegan
INDIANA — Richmond
KANSAS — Overland Park, Wichita
KENTUCKY — Bowling Green, Newport
LOUISIANA — Baton Rouge, Gretna, Monroe, New Orleans, Shreveport
MAINE — Bangor, Portland
MARYLAND — Baltimore, Langley Park, Rockville
MASSACHUSETTS — Boston, Braintree, Brockton, Brookline, Cambridge, Dedham, Dorchester, Framingham, Leominster, Lowell, Medford, Natick, Quincy, Saugus, Springfield, Waltham, West Springfield, Worcester
MICHIGAN — Detroit, Grand Rapids, Lincoln Park
MINNESOTA — Duluth, Minneapolis, St. Paul
MISSISSIPPI — Jackson
MISSOURI — Kansas City, St. Joseph, St. Louis
NEBRASKA — Omaha
NEVADA — Las Vegas
NEW HAMPSHIRE — Manchester
NEW JERSEY — Fords, Pennsauken, Trenton
NEW MEXICO — Albuquerque
NEW YORK — Albany, Binghamton, Buffalo, New York, Rochester, Schenectady, Syracuse
NORTH CAROLINA — Charlotte
OHIO — Cincinnati, Cleveland, Columbus, Lima, Willowick
OKLAHOMA — Oklahoma City, Tulsa
OREGON — Portland
PENNSYLVANIA — Greensburg Philadelphia, Pittsburgh, Plymouth Meeting
RHODE ISLAND — Providence, East Providence, Warwick
TENNESSEE — Memphis, Nashville
TEXAS — Abilene, Amarillo, Arlington, Austin, Brownsville, Corpus Christi, Dallas, El Paso, Fort Worth, Houston, Irving, Lubbock, Midland, San Antonio, Sherman, Tyler, Waco
UTAH — Salt Lake City
VIRGINIA — Arlington, Hampton, Norfolk, Portsmouth, Virginia Beach
WASHINGTON — Seattle
WEST VIRGINIA — Martinsburg

FILL IN AND MAIL TODAY!

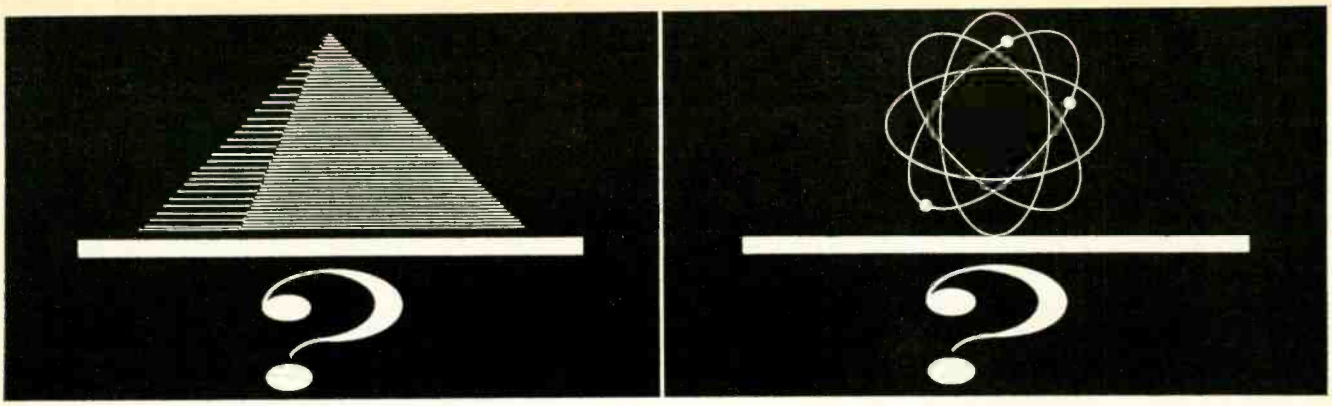
RADIO SHACK { EAST: 730 Commonwealth Ave., Boston, Mass. 02215 / WEST: 2615 West 7th St., Fort Worth, Texas 76107

Rush me _____ reels of polyester tape (44-1018).
I enclose $_____, plus 5¢ per reel to cover handling and postage anywhere in the U.S.A.
☐ Send me a FREE 1968 Radio Shack Catalog

Name_____
Street_____
City_____
State_____ Zip_____
DEPT. XE

Circle 8 on reader's service card

Circle 7 on reader's service card



WHAT IS THE COMMON DENOMINATOR OF AN ANCIENT EGYPTIAN PYRAMID AND A MODERN ELECTRONICS CAREER?

A STRONG FOUNDATION!

The ancient pyramids were built on strong foundations and thus have endured extensive changes in their environment. How about your electronics career? Is it built on a solid foundation of knowledge and understanding? Can the foundation under your electronics career endure the rapid changes now occurring in the electronics industry?

Grantham's strong-foundation educational program in electronics engineering technology leads to non-obsolescent skills — to skills which are based more on reasoning than on merely doing — and leads to the Degree of *Associate in Science* in Electronics Engineering. As many as five of the six semesters in the educational program can be completed by *correspondence*. And technicians who have had at least one full year of practical experience may obtain credit for the resident semester, thus qualifying for the ASEE degree in only five semesters, all by correspondence.

Earn Your FCC License & Associate Degree

You have heard and read, over and over again, about how important an FCC license is to your success in electronics. It is certainly true that an FCC license is important — sometimes essential — but it's not enough! Without further education, you can't make it to the top. Get your FCC license without fail, but don't stop there. To prepare for the best jobs, continue your electronics education and get your degree.

This kind of thinking makes good common sense to those who want to make more money in electronics. It also makes good common sense to prepare for your FCC license with the School that gives degree credit for your license training — and with the School that can then take you from the FCC license level to the DEGREE level. (The first two semesters of the six-semester Grantham degree curriculum prepare you for the first class FCC license and radar endorsement.)

Grantham School of Electronics

1505 N. Western Ave.
Hollywood, Calif. 90027
Telephone:
(213) 469-7878

or

818 18th Street, N.W.
Washington, D.C. 20006
Telephone:
(202) 298-7460

Accreditation, and G.I. Bill Approval

Grantham School of Electronics is *accredited* by the Accrediting Commission of NHSC, and is *approved* under the G.I. Bill. For seventeen years, Grantham has been preparing men for successful electronics careers.

A Four-Step Program to Success

It's your move, and the move you make today can shape your future. Begin now with a step in the right direction — Step #1 — and then follow through with Steps #2, #3, and #4.

Step #1 is a simple request for full information on the Grantham Associate Degree Program in Electronics. You take this step by filling out and mailing the coupon shown below. We'll send full information by return *mail*. No salesman will call.

Step #2 is earning your FCC first class radiotelephone LICENSE and radar endorsement. You complete this step in the first two semesters of the Grantham educational program.

Step #3 is earning your ASEE DEGREE. This degree is conferred when you have earned credit for all six semesters of the Grantham curriculum.

Step #4 is getting a better job, greater prestige, higher pay on the basis of your extensive knowledge of electronics.

It's your move! Why not begin with Step #1.

Grantham School of Electronics RE 4-68
1505 N. Western Ave., Hollywood, Calif. 90027

Please mail me your free catalog, which explains how Grantham training can prepare me for my FCC License and Associate Degree in electronics. I understand no salesman will call.

Name_____ Age_____

Address_____

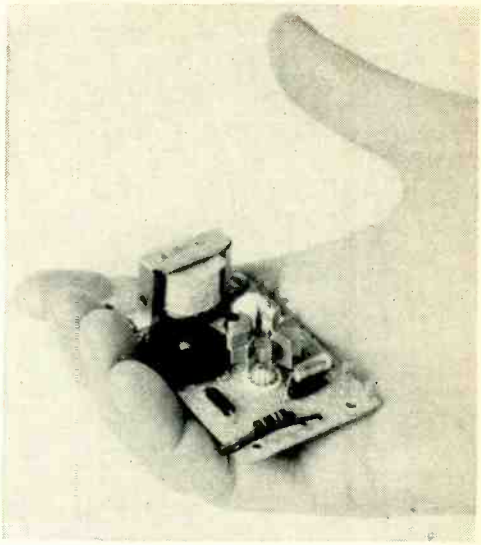
City_____ State_____ Zip_____

Circle 9 on reader's service card

Radio-Electronics

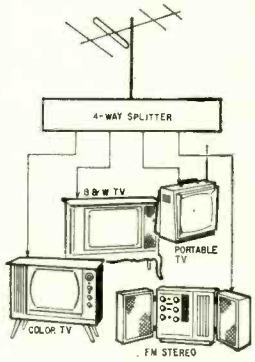
April 1968 • Over 55 Years of Electronics Publishing

CONSTRUCTION PROJECTS



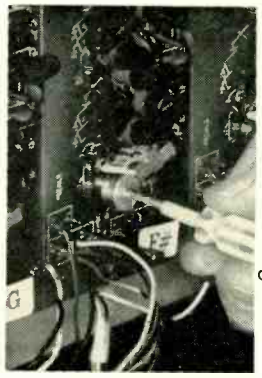
Integrated circuits are now available for almost any electronics application. Among the new crop of IC's is RCA's CA3020, a low-priced, high-gain (58dB) device with enough power output to drive a speaker. With a microscope, you can find 7 transistors, 3 diodes and 11 resistors all on one chip in one TO-5 transistor case. Construction project described on page 32 tells how to assemble and use this high-gain audio amplifier.

ANTENNAS



Liberate your TV set from its fixed location. A home antenna system can make it possible for you to hookup a TV set in any one or every room. From bigger and better antennas on your roof down to the last line splitter, you will find well engineered equipment and suitable installation instructions.
See page 38

SERVICING



A single tuning fork, a stopwatch and knowledge of tonal relationships can make you an expert organ tuner. Even if you don't intend to ever tune an organ, your appreciation for organ music discipline will be much enhanced.
See page 52

DEPARTMENTS

RADIO-ELECTRONICS, APRIL 1968, Volume XXXIX, No. 4.
Published monthly by Gernsback Publications, Inc., at Ferry St., Concord, N. H. 03302.
Editorial, Advertising, and Executive offices: 200 Park Ave. S., New York, N. Y. 10003. Subscription Service: Boulder, Colo. 80302.
Second-class postage paid at Concord, N. H. Printed in U.S.A. One-year subscription rate: U. S. and possessions, Canada, $6. Pan-American countries, $7. Other countries, $7.50. Single copies: 60c.
POSTMASTER: Notices of undelivered copies (Form 3579) to Boulder, Colo. 80302.

Member,
Institute of High Fidelity.
Radio-Electronics is indexed in *Applied Science & Technology Index* (formerly *Industrial Arts Index*)

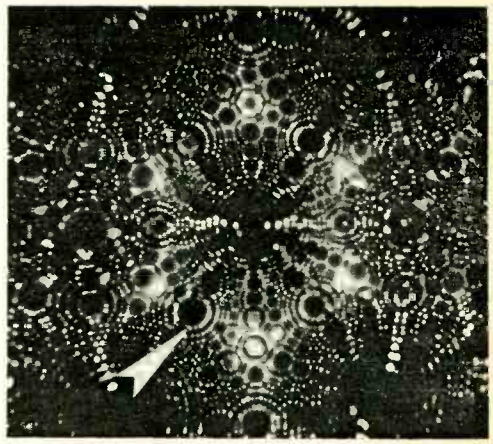
NEWS BRIEFS

WILL TV SHIFT TO WIRE?—A battle is developing over spectrum space. One side consists of land-mobile radio users (taxicab, business radio, etc.) who are drawing a bead on the uhf TV band of 470–890 MHz. Land-mobile spokesmen have charged that many uhf channels are unused and asked that some space be given to overcrowded mobile users. Proponents point out that you can't transmit by wire to a moving vehicle, while you can to a fixed TV receiver. Recently Robert Galvin, Motorola president and EIA chairman, said he thinks it inevitable that all TV broadcasting will eventually convert to cable.

Broadcasters, on the other hand, concede that some reallocation of frequencies may be desirable, but they see no need for shifting nearly 500 MHz of spectrum space from TV to mobile or other use. Public entertainment investment, they claim, is too great to obsolete the present system.

SUNSPOT MAXIMUM DUE—Summit of the present 11-year sunspot cycle is expected sometime in 1968. Although the National Bureau of Standards believes that the peak was reached last fall, most observers think that the peak will not be reached until mid-1968 or later. The present cycle began with a minimum in October 1964. In May the smoothed sunspot number is expected to reach 117 to 120. This compares with a number of 201 at the last peak in March 1958, and with 152 at the previous peak in May 1947. Those two cycles, however, had the highest recorded peaks since accurate sunspot records began to be kept in the late 18th century.

Increased solar activity of the past year has caused a great improvement in short-wave reception, particularly on the higher frequencies. The 21- and 28-MHz amateur bands, the 21- and 26-MHz international broadcast bands and the CB band have been producing very strong long-distance signals. These conditions will probably continue for the next year or so as solar activity begins its slow decline toward the next minimum, which is expected in 1974 or 1975.

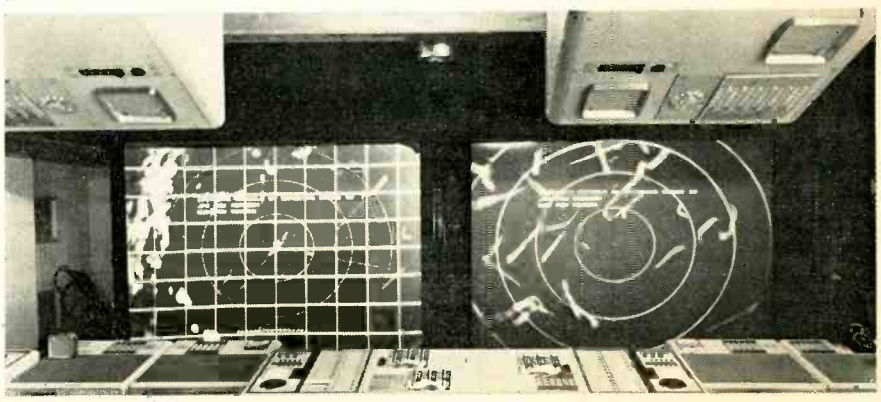


MICROSCOPE IDENTIFIES SINGLE ATOMS—The operator of the atom-probe field ion microscope developed by Prof. Erwin Mueller of Pennsylvania State Unversity can select a single atom for analysis from thousands of surrounding tungsten atoms, seen here at magnification of 2,100,000 times.

ELECTRIC PASSENGER CAR—First electric passenger car on West Coast is driven by violinist Jascha Heifetz, shown examining the power system. Car is powered by 12 normal car batteries and produces absolutely none of the smog that now smothers the entire Los Angeles area.

LARGE-SCREEN AIR-TRAFFIC DISPLAYS—Closed-circuit displays designed and installed by TNT Communications, Inc., for the Federal

(continued on page 70)



GOOF-PROOF VOM

Here's the most foolproof volt-ohm-milliammeter ever made. Protection approaches 100%. It's the VOM you will want to have on hand where inexperienced people are running tests . . . or will reach for yourself on those days when you're all thumbs. The 260-5P will save you all kinds of headaches from burned out meters and resistors, bent pointers, and inaccuracies caused by overheating.

Combined Protection You Won't Find In Any Other VOM

1. Reset button pops out to indicate overload.
2. You cannot reset circuits while overload is present.
3. Protective circuit does *not require* massive overloads which can cause hidden damage to the instrument.
4. All ranges are protected except those not feasible in a portable instrument—1000 and 5000 volts DC and AC; 10 amp DC.

SIMPSON 260-5P

ONLY $94.00

Write for Bulletin 2076

Ranges—The 260-5P has the same ranges and takes the same accessories as Simpson's famous 260-5 volt-ohm-milliammeter.

AGM DIVISION

Simpson
INSTRUMENTS THAT STAY ACCURATE

SIMPSON ELECTRIC COMPANY
5200 W. Kinzie Street, Chicago, Ill. 60644 • Phone: (312) 379-1121
Representatives in Principal Cities . . . . . See Telephone Yellow Pages
Export Dept.: 400 W. Madison St., Chicago, Ill. 60606 Cable, Simelco
In Canada: Bach-Simpson Ltd., London, Ontario
In India: Ruttonsha-Simpson Private Ltd., Vikhroli, Bombay

WORLD'S LARGEST MANUFACTURER OF ELECTRONIC TEST EQUIPMENT

Correspondence

THERE REALLY IS A JOE DOWN THE STREET

Concerning your article, "Be Brave! Take On Transistor Radios!" (September 1967) why *not* let Joe's Radio Repair down the street have the job?

JOE FISHBEIN
Joe's Radio-Phono Repair Service
Southfield, Mich. 48075

Okay, Joe, but if you're the guy down the street you should have plenty of work; the fellows up the street are still turning down the repair jobs on these small transistor radios.

UNDERGROUND RADIO

The article, "Keeping in Touch Underground" by Peter E. Sutheim (January 1968) was well written; however, we feel that the complete story was not told because the author virtually eliminated any mention of our Type 65 Carrier Equipment, a vital part of TA communications. (The only indication of "carrier" was in Fig. 2, and the "10 kHz" is incorrect.)

In particular, we take issue with the statement, beginning at the bottom of page 57, that except for "baluns, cavity resonators, and power splitter, all the equipment was Motorola stock." Here are the facts: In 1964 Motorola provided a pilot installation of six stations on the Lexington Avenue Line. The carrier equipment was our Type 65A (then sold under the Budelman name). In 1965 Motorola contracted to equip 26 stations on the IRT. The carrier equipment was Cardion Type 65B (improved version of 65A).

BYRON H. DRETZMAN
SYSTEM ENGINEER
Cardion Communications Co.

Peter Sutheim informs us that the article was written almost entirely from material supplied by the New York City Transit Authority, which included no mention of the Cardion Type 65

(continued on page 12)

Radio-Electronics

200 PARK AVE. SOUTH
NEW YORK, N. Y. 10003

HUGO GERNSBACK (1884-1967)
founder

M. HARVEY GERNSBACK, *publisher*
ROBERT CORNELL, *editor*
Robert F. Scott, *W2PWG, senior editor*
Thomas R. Haskett, *managing editor*
Jack Darr, *service editor*
Peter E. Sutheim, *audio editor*
I. Queen, *editorial associate*
Matthew Mandl, *contributing editor*
Linda Albers, *assistant to editor*
Wm. Lyon McLaughlin, *technical illustration director*
Bruce Ward, *production manager*
Sandra Esteves, *production assistant*
G. Aliquo, *circulation manager*

Cover by Harry Schlack

RADIO-ELECTRONICS is published by Gernsback Publications, Inc.
President: M. Harvey Gernsback
Vice President-Secretary: G. Aliquo

ADVERTISING REPRESENTATIVES

EAST
John J. Lamson,
RADIO-ELECTRONICS, 200 Park Ave. South
New York, N. Y. 10003, 212-777-6400

MIDWEST/N.&S. Car., Ga., Tenn.
Robert Pattis, the Bill Pattis Co., 4761 West Touhy Ave., Lincolnwood, Ill. 60646, 312-679-1100

W. COAST/Texas/Arkansas/Oklahoma
J. E Publishers Representative Co., 8380 Melrose Ave., Los Angeles, Calif. 90069, 213-653-5841; 420 Market St., San Francisco, Calif. 94111, 415-981-4527

UNITED KINGDOM
Publishing & Distributing Co., Ltd., Mitre House, 177 Regent St., London W.1, England

SUBSCRIPTION SERVICE: Send all subscription correspondence and orders to RADIO-ELECTRONICS, Subscription Department, Boulder, Colo. 80302. For change of address, allow six weeks, furnishing both the old and new addresses and if possible enclosing label from a recent issue.

MOVING? Or writing about subscription? Be sure to fill out form below.

For FASTEST service on address change, missing copies, etc., attach old mailing label in first space below. Otherwise please print clearly your address as we now have it.

OLD ADDRESS (Attach old label if available)

Name .....

Address .....

City ..... State .....

Zip Code .....

NEW ADDRESS

Name .....

Address .....

City ..... State .....

Zip Code .....

Mail to: RADIO-ELECTRONICS
Subscription Dept. Boulder, Colo. 80302

NEW FINCO®

COLOR SPECTRUM T.M. ANTENNAS are "signal customized" for better color reception...

"the ANTENNA that captures the RAINBOW"

FINCO has developed the Color Spectrum Series of antennas — "Signal Customized" — to exactly fit the requirements of any given area.

There is a model scientfically designed and engineered for your area.

Check this chart for the FINCO "Signal Customized" Antenna best suited for your area.

STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION ▼	Strength of VHF Signal at Receiving Antenna Location				
	NO VHF ▼	VHF SIGNAL STRONG ▼	VHF SIGNAL MODERATE ▼	VHF SIGNAL WEAK ▼	VHF SIGNAL VERY WEAK ▼
NO UHF →		CS-V3 $10.95	CS-V5 $17.50 CS-V7 $24.95	CS-V10 $35.95	CS-V15 $48.50 CS-V18 $56.50
UHF SIGNAL STRONG →	CS-U1 $9.95	CS-A1 $16.95	CS-B1 $29.95	CS-C1 $43.95	CS-D1 $43.95
UHF SIGNAL WEAK →	CS-U2 $14.95	CS-A2 $22.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95
UHF SIGNAL VERY WEAK →	CS-U3 $21.95	CS-A3 $30.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95

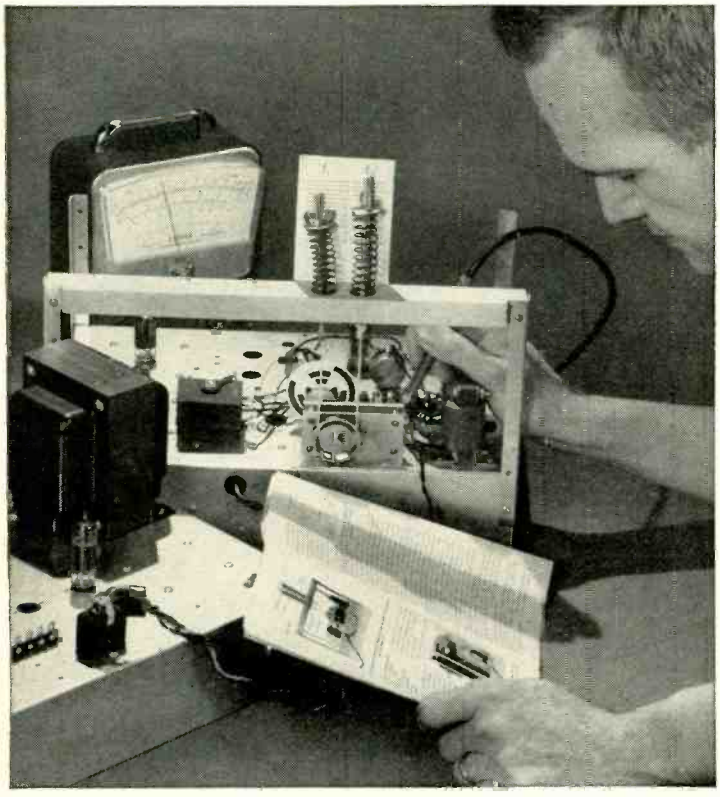
NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable downlead where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

THE FINNEY COMPANY

34 West Interstate Street • Dept. RE • Bedford, Ohio 44146

Circle 12 on reader's service card

EXPERIENCE IS STILL YOUR BEST TEACHER



NRI designed-for-learning training equipment gives you priceless confidence because your hands are trained as well as your head.

Learning Electronics at home the NRI way is fast and fascinating. Read opposite page.

nri

OLDEST AND LARGEST SCHOOL OF ITS KIND

Accredited by the Accrediting Commission of the National Home Study Council

You get more for your money from NRI

—more value, more solid experience so essential to careers in Electronics. NRI's pioneering "discovery" method is the result of more than half a century of simplifying, organizing, dramatizing subject matter. In each of NRI's major courses you learn by doing. You demonstrate theory you read in "bite-size" texts programmed with NRI designed-for-learning professional lab equipment. Electronics comes alive in a unique, fascinating way. You'll take pleasure in evidence you can feel and touch of increasing skills in Electronics, as you introduce defects into circuits you build, perform experiments, discover the "why" of circuitry and equipment operation.

Almost without realizing it, the NRI discovery method gives you the professional's most valuable tool—practical experience. You learn maintenance, installation, construction and trouble-shooting of Electronic circuits of any description. Whether your chosen field is Industrial Electronics, Communications or TV-Radio Servicing, NRI prepares you quickly to be employable in this booming field or to earn extra money in your spare time or have your own full-time business. And you start out with training equivalent to months—even years—of on-the-job training.

NRI Has Trained More Men for Electronics Than Any Other School

— By actual count, the number of individuals who have enrolled for Electronics with NRI could easily populate a city the size of New Orleans or Indianapolis. Over three-quarters of a million have enrolled with NRI since 1914. How well NRI training has proved its value is evident from the thousands of letters we receive from graduates. Letters like those excerpted below. Take the first step to a rewarding new career today. Mail the postage-free card. No obligation. No salesman will call. NATIONAL RADIO INSTITUTE, Electronics Division, Washington, D.C. 20016.

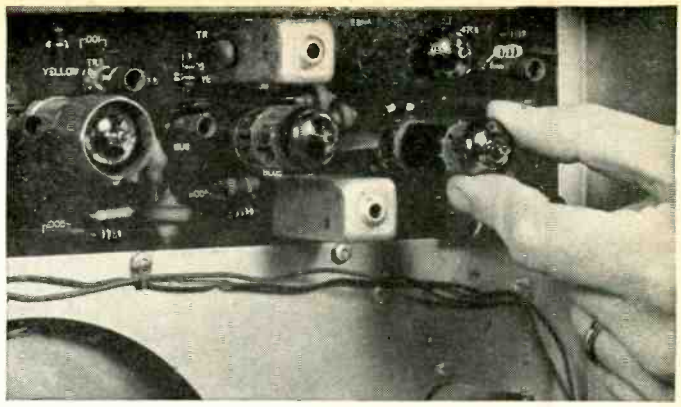
L. V. Lynch, Louisville, Ky., was a factory worker with American Tobacco Co., now he's an Electronics Technician with the same firm. "I don't see how the NRI way of teaching could be improved."

G. L. Roberts, Champaign, Ill., is Senior Technician at the U. of Illinois Coordinated Science Laboratory. In two years he received five pay raises. Says Roberts, "I attribute my present position to NRI training."

Don House, Lubbock, Tex., went into his own Servicing business six months after completing NRI training. This former clothes salesman just bought a new house and reports, "I look forward to making twice as much money as I would have in my former work."

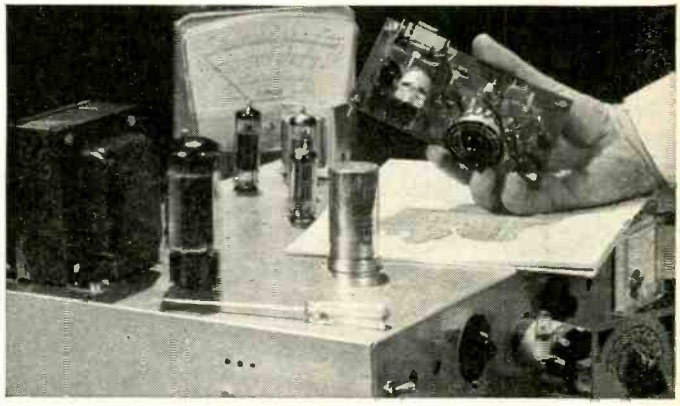
Ronald L. Ritter of Eatontown, N.J., received a promotion before finishing the NRI Communication course, scoring one of the highest grades in Army proficiency tests. He works with the U.S. Army Electronics Lab, Ft. Monmouth, N.J. "Through NRI, I know I can handle a job of responsibility."

APPROVED UNDER NEW GI BILL. If you served since January 31, 1955, or are in service, check GI line on postage-free card.



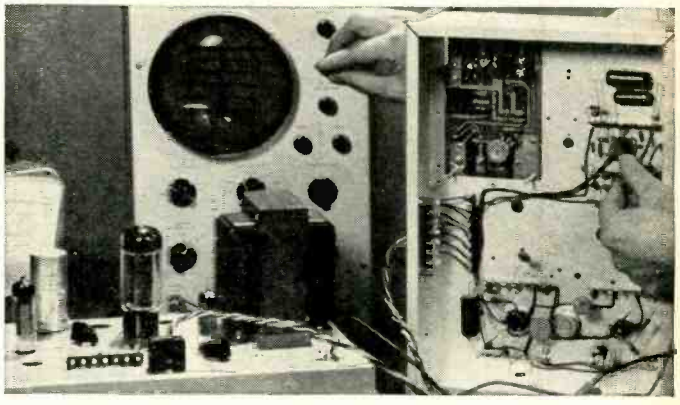
COLOR TV CIRCUITRY COMES ALIVE

as you build, stage-by-stage, the only custom Color-TV engineered for training. You grasp a professional understanding of all color circuits through logical demonstrations never before presented. The TV-Radio Servicing course includes your choice of black and white or color training equipment.



COMMUNICATIONS EXPERIENCE

comparable to many months on the job is yours as you build and use a VTVM with solid-state power supply, perform experiments on transmission line and antenna systems and build and work with an operating, phone-cw, 30-watt transmitter suitable for use on the 80-meter amateur band. Again, no other home-study school offers this equipment. You pass your FCC exams—or get your money back.



COMPETENT TECHNICAL ABILITY

can be instantly demonstrated by you on completing the NRI course in Industrial Electronics. As you learn, you actually build and use your own motor control circuits, telemetering devices and even digital computer circuits which you program to solve simple problems. All major NRI courses include use of transistors, solid-state devices, printed circuits.

CORRESPONDENCE
(continued from page 6)

carrier equipment. The statement in question said only that the equipment was "stock" (not Motorola stock). The intended meaning was that the job was accomplished without recourse to highly unusual custom-built apparatus. The 10 kHz figure, judging from your brochure, should indicate the channel spacing. The channels can be transmitted at frequencies up to 210 kHz.

μL914 HAS A FLAT

As a result of the articles in the December 1967 and January 1968 issues of your magazine, I purchased several Fairchild μL914 integrated circuits, as recommended. When the IC's arrived, they did not have pin 8 marked as shown in the articles.

CHARLES V. THOMAS
Hot Springs, Ark.

Charles, the μL914 is available in several different housings. If you look carefully, you will find a very small but definite flat side on the epoxy case. The flat serves as an identifier of pin 8, just as a painted dot would do. Pin numbering is clockwise when the leads on the unit are pointed toward you.

DATA WANTED

I wonder if you can help me determine the manufacturer of a superhet (circa 1937) I would like to restore. It was marketed by the E. C. Simmons Hardware Co. here in St. Louis under the trade name "Keen-Tone." I feel reasonably sure the Simmons company did not manufacture the receiver but had it manufactured. There is no clue to the manufacturer other than the label on the chassis which indicates that the receiver was manufactured in "Plant A" in Chicago. There are references to RCA and Hazeltine patents on the chassis sticker.

J. R. MCCANN, MANAGER
Loss Prevention Dept.
Ralston Purina Co.
Checkerboard Square
St. Louis, Mo. 63119

FOREIGN SERVICE

I have finally found the address for the "Saxon," not Saxton, tape recorders. It is Martel Electronic Sales, Inc., 2339 S. Cotner, Los Angeles, Calif. 90064. They also handle Uher, AutoSonic, Telmar and Martel. The L.A. telephone directory has a Saxon listed and these fellows are just a little upset about getting phone calls for service information; it seems they're a hardware representative. Fujiya parts can be obtained from ETCO Radio Service, 259 East 134 St., Bronx, N.Y., (212) LU 5-1888. Who handles or imports Honeytone?

PAT KILLMER
Long Beach, Calif.

Thanks for the info, Pat. For Honeytone, try Associated Importers, 1168 Battery St., San Francisco, Calif.

B.A.E.C. NEWSLETTER

I was very pleasantly surprised to hear from one of your readers that you had published a letter from me in January 1968. I have now received my copy, and would like to express to you my sincere appreciation for your continued interest in the British Amateur Electronics Club.

As you know, the Newsletter is designed to serve all those interested in electronics as a hobby, regardless of where they live. Membership fee for the U.S.A. is $2 per year, and if you would be kind enough to publish my address with these details I would be very pleased indeed to send a copy of our Newsletter to anyone interested in joining the club.

I am sure that you would like to know that, thanks to the publication of my letter in RADIO-ELECTRONICS, the B.A.E.C. now has several new members in the US and Canada, and I have made several friends there.

CYRIL BOGOD
B.A.E.C.
"Dickens"
26, Forrest Rd.
Penarth
Glam, Great Britain

Cyril, electronics has no geographic borders, but it does have language and symbol barriers, let alone semantics. If your Newsletter helps shed some light over here on what's going on over there your job will be well done.

HEATHKIT AR-15 REVIEW SQUELCHED

As a Heathkit dealer we were naturally very pleased to read the complimentary review of the AR-15 receiver, by Peter Sutheim (January 1968). We

Getting a hernia and not getting paid for it?

Switch to Elmenco dipped Mylar®-paper capacitors and you won't have to worry about call-backs, lost profits, broken reputations or broken anything else.

The only ordinary thing about them is their price.

You get capacitors that meet the requirements of high-reliability computer and missile systems. You get capacitors that hold their rating at 125°C continuous operation. Yet you get them at TV set prices.

Elmenco dipped Mylar-paper capacitors come in just about any value you need from .001 mfd to 1.0 mfd. And just about any TV rated voltage you need, too, from 100V through 1600V.

Ask your Authorized Elmenco Distributor to put them on your next order. Without fail.

Tell him you're counting on his support.

(While you're at it, ask about other Elmenco types: padders and trimmers; high voltage dipped micas.)

Loral Distributor Products
A Division of Loral Corporation
Pondhill Industrial Park
Great Neck, New York
Torrance, California

® DU PONT TRADEMARK.

Circle 14 on reader's service card

are proud of this unit and, of course, quite gratified when others share our high opinion of it. However, after living with, building, repairing and checking performance of many examples of this model, we feel sure that the example which you tested was not operating properly in one particular respect.

If you check the schematic and circuit description of the AR-15, you will find that the squelch circuit is very elaborate. To eliminate the unsatisfactory type of muting performance you noted in your review, the squelch is keyed to two separate conditions, 100-kHz noise and center of passband of the detector. The combination of these two conditions very effectively eliminates noise bursts such as you describe. We can only conclude that the squelch circuit on the unit you tested was not operating properly and should be repaired.

KENNETH O. FULLMER
Berkeley, Calif.

Apparently the AR-15 receiver checked out by Mr. Sutheim was slightly deficient in its squelch operation. Since its performance was otherwise so completely satisfactory, and since the less-than-perfect muting operation was no worse than what would have been expected from other high-quality receivers, it didn't occur to him that perhaps he had a correctable defect. The particular receiver tested is not available for retest, so we will never know for sure. Thank you for pointing out the possibility.

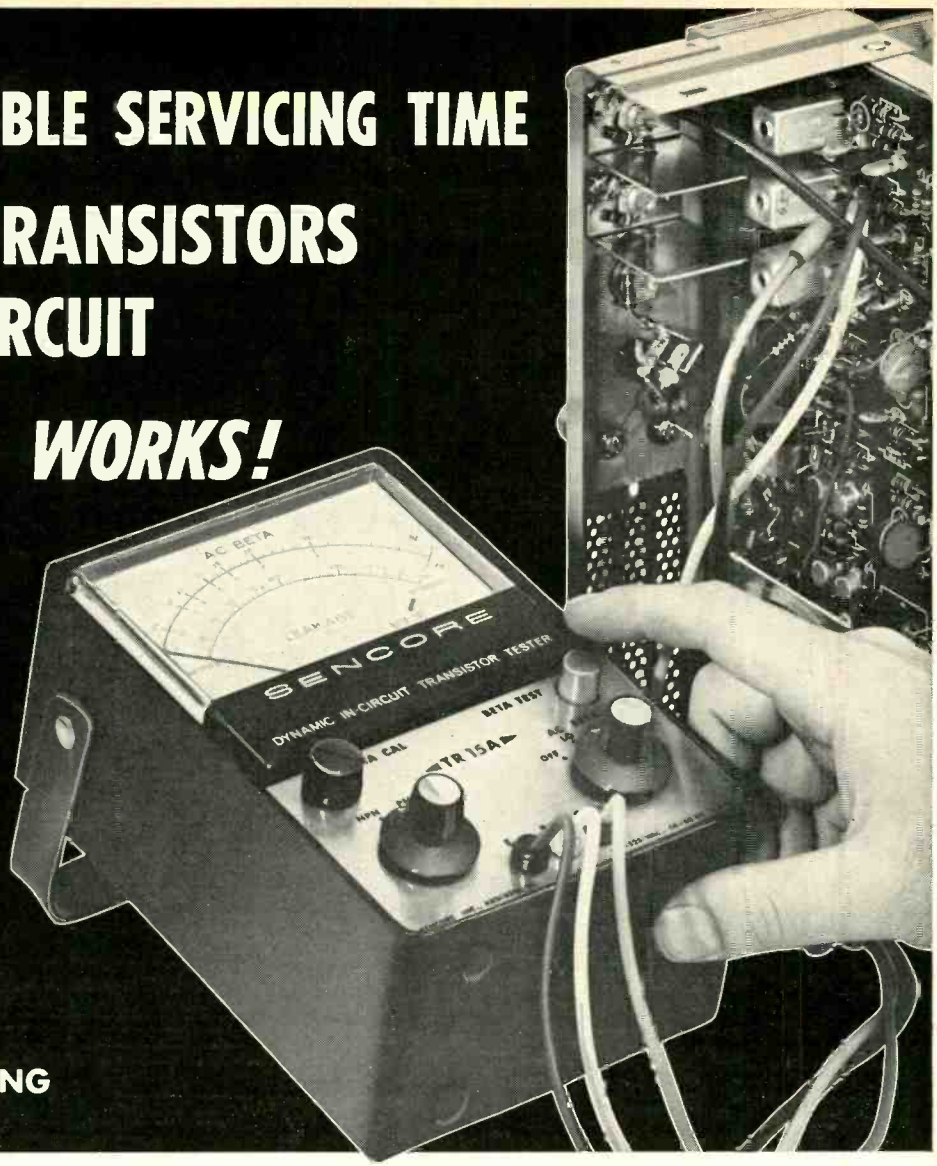
MUCH ADO ABOUT SCR's

I have been thinking about the SCR and I think the name shouldn't be silicon controlled rectifier but rather CSR or VCSR, for controlled silicon rectifier or voltage controlled silicon rectifier. If you think about it, the controlling factor in an SCR is not the silicon, but rather the voltage applied to a gate which turns it on. What do you think?

STUART SJALUND
Haileybury, Ontario, Canada

We think it's a matter of semantics. It's a controlled rectifier and it contains silicon, among other things. Stuart, someone once said, "We are learning more and more about less and less and pretty soon we will know everything about nothing." **R-E**

SAVE VALUABLE SERVICING TIME
TEST ALL TRANSISTORS IN CIRCUIT
IT REALLY WORKS!



AND FOR ONLY
$64.50 –
LOWEST PRICE GOING

You're wasting time using those old-fashioned methods—measuring voltages and tedious unsoldering and soldering transistors back in the circuit. You're way ahead with the new TR15A In-Circuit transistor tester. It takes only seconds . . . and it works every time.

Take it from the technicians who already know—Sencore In-Circuit Transistor Testers are the ones that **really** work. With either the new Compact TR15A or the Deluxe TR139 you can check any transistor, diode or rectifier without disconnecting a single lead. Right in the circuit. In seconds. And get truly accurate readings.

True Beta Measurements. Ratio of signal in to signal out. Just set the CAL knob, press the beta test button, and read the actual AC gain on the meter. Range, 2 to infinity.

Icbo Measurements. Read the exact leakage current (Icbo) right on the meter. Range, 0 to 5000 microamps.

Out-of-Circuit Tests. Same test procedure. Out-of-circuit, transistors may be sorted, selected and matched for specified values of beta and Icbo.

Complete Protection. Can't damage the transistor, circuit or instrument, even if leads are incorrectly connected. Special circuitry protects all parts.

No Set-up Book needed. So simple, even unknown transistors can be checked. PNP and NPN types determined at the flick of a switch.

All Steel Case. Vinyl covered, with brushed chrome panel. Easy-to-read 4½" meter.

DELUXE TR139 *—Same basic circuitry as TR15A. Larger 6" meter. Howard W. Sam's transistor reference manual included $89.50*

Ask your distributor for the ORIGINAL IN-CIRCUIT TRANSISTOR TESTERS

SENCORE

NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT

426 SOUTH WESTGATE DRIVE, ADDISON, ILLINOIS 60101

Circle 16 on reader's service card

In the Shop . . . With Jack

By JACK DARR

AUTOMATIC FINE TUNING

THERE'S ANOTHER NICE NEW CIRcuit that'll be giving us fits in a little while. It is automatic fine tuning, or aft, although some people persist in calling it "afc." This could lead to confusion unless we remember to add the identifiers "horizontal" afc, "color" afc, etc.

All the aft circuit amounts to is this: Manufacturers have replaced some of the normal "tuning capacitance" in the tuner oscillator circuit with a special diode. Motorola calls it an "Epicap"; others call it a "varactor" diode, and so on. It's a specially designed junction diode.

All junction diodes have a certain capacitance. These special jobs have a little more. Fig. 1 shows how this junction diode works. With zero bias, contact potential will cause any free carriers in the depletion zone to flow to one side or the other. This, in effect, creates an empty space between the junctions, and what's an empty space between two surfaces? Right—a dielectric! So, the diode is a capacitor.

If we apply a reverse bias to it,

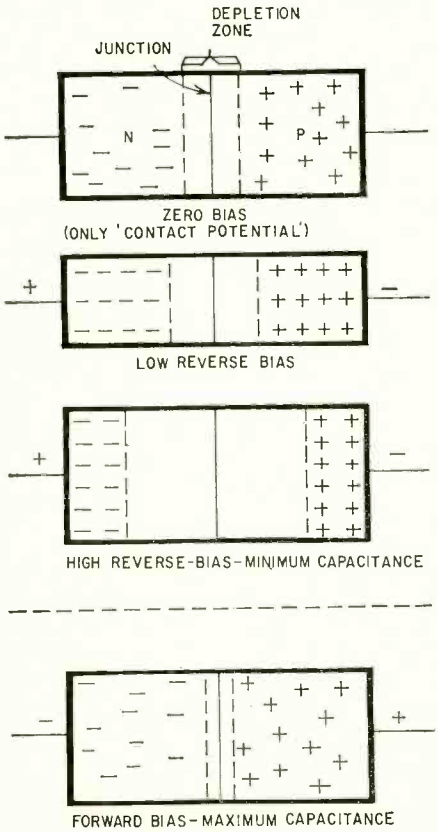


Fig. 1

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. S., New York 10003.

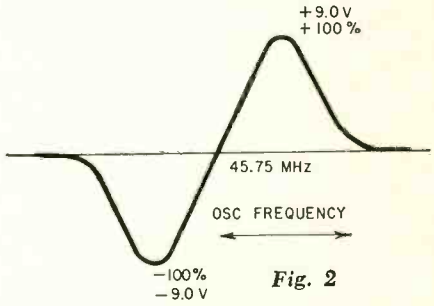


Fig. 2

the junctions will move farther apart, and we have less capacitance. Putting a forward bias on it moves them nearer to each other, and we have more capacitance. That's all there is to it: the actual capacitance of the device at any time depends on the *applied dc voltage*.

To use this for automatic oscillator frequency control, all we have to do is hook the junction diode across the oscillator coil, replacing some of the fixed capacitance normally used there. Now, if we had a source of dc voltage that would vary in *amplitude* and *polarity* as the frequency changed, we'd have a very nice little tuner corrector device.

We have such a source of dc voltage; it's called a discriminator. As you know, the discriminator output is a dc voltage which varies in amplitude and polarity with input-frequency changes. This gives it the familiar S-curve characteristic of Fig. 2.

For aft, the picture i.f. carrier is picked off and fed to an amplifier/limiter stage, then to the discriminator transformer. As long as the i.f. carrier is right on the nose at 45.75 MHz, we have no dc output. If the tuner oscillator drifts in either direction, the *beat-*

(continued on page 22)

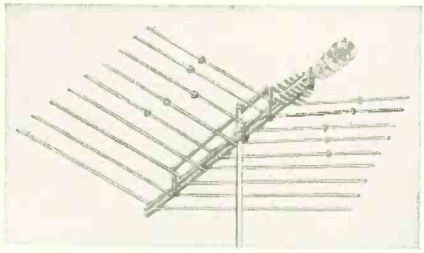
"I like the results . . .

. . . when I install the JFD Color Laser," comments Elmer Whitmore, Hill's Antenna Service, Saginaw, Michigan, who has made over 13,000 antenna installations in the 14 years he has been in business.

" 'That's a real good color picture!' is what I like to hear after I put up a new antenna because to me a pleased customer is like money in the bank. So I don't take chances—I install JFD Color Lasers for top color pictures.

"I like the way the Color Lasers work on all the VHF and UHF stations here. They rig up fast and give us better results in the form of precise color and ghost-free images."

Elmer Whitmore prefers JFD engineered-for-color Color Lasers, like many other professional antenna installers, for best possible performance.



☐ **BRILLIANT COLOR** — flat (frequenoy independent) response across each channel, free from suck-outs or roll-offs. Keeps colors vivid and alive.

☐ **PATENTED W-I-D-E BAND LOG PERIODIC DESIGN** — the most efficient ever developed — provides higher gain, better signal-to-noise ratios, needle-sharp directivity. Eleven patents cover its revolutionary space-age design.

☐ **MORE DRIVEN ELEMENTS.** Harmonically resonant capacitor coupled design makes dual-function elements work on both VHF and UHF frequencies. *Entire* antenna (not just part of it as in other log periodic imitations) responds on every channel.

☐ **LUSTROUS, ELECTRICALLY CONDUCTIVE GOLD ALODIZING** promotes signal transfer, protects against corrosion, enhances appearance.

PROFESSIONAL ANTENNA INSTALLERS KNOW —

The Best Antenna for Color TV is The Color Laser by

JFD®

Now at your JFD distributor!

JFD ELECTRONICS CO.
15th Avenue at 62nd Street, Brooklyn, N.Y. 11219
JFD International, 64-14 Woodside Ave., Woodside, N.Y. 11377 JFD Canada, Ltd., Ontario, Canada
JFD de Venezuela, S.A., Avenida Los Haticos 125-97, Maracaibo, Venezuela

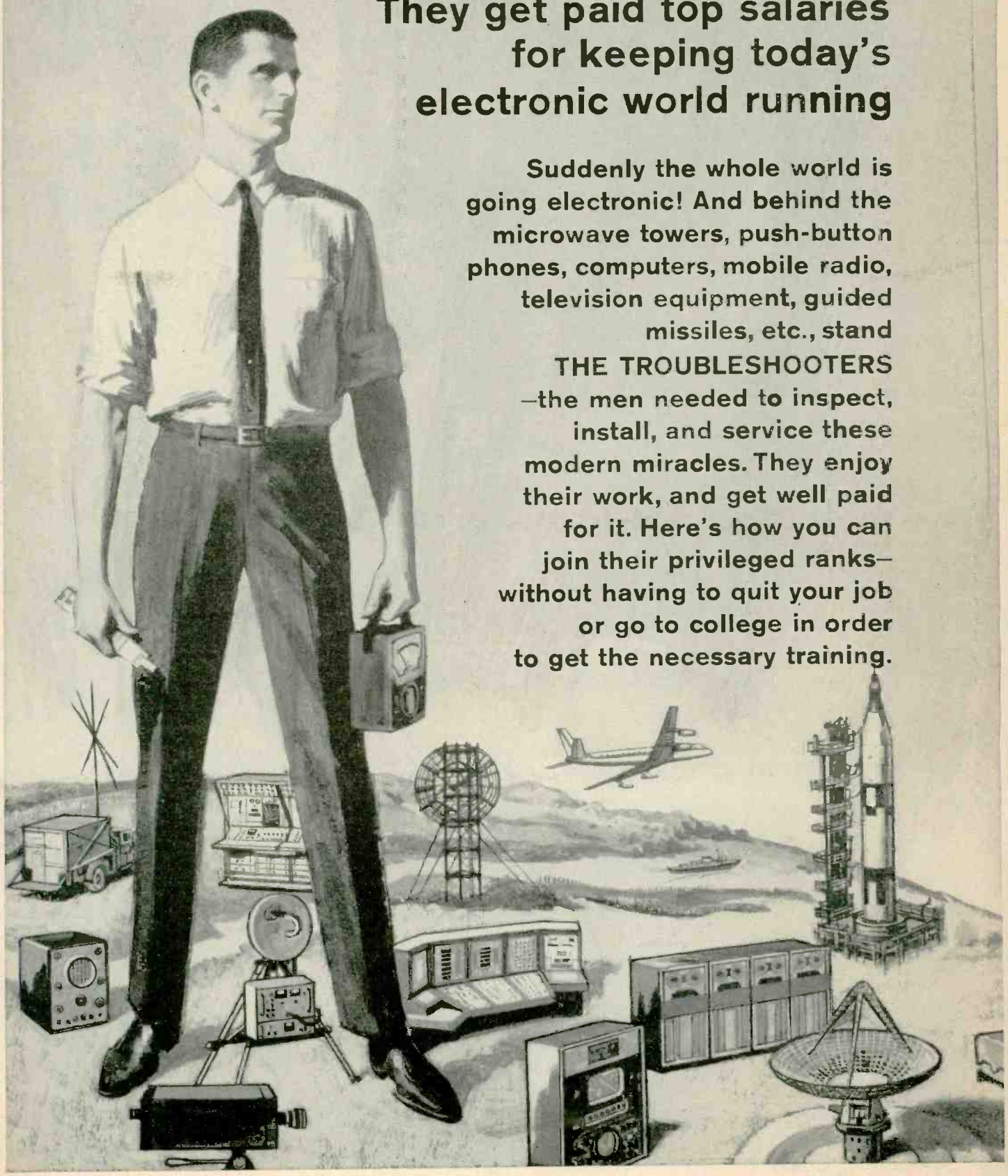
LICENSED UNDER ONE OR MORE OF U.S. PATENTS 2,958,081; 2,985,879; 3,011,168; 3,108,280; 3,150,376; 3,210,767, RE. 25,740 AND ADDITIONAL PATENTS PENDING IN U.S.A. AND CANADA. PRODUCED BY JFD ELECTRONICS CO. UNDER EXCLUSIVE LICENSE FROM THE UNIVERSITY OF ILLINOIS FOUNDATION. LICENSED UNDER ONE OR MORE OF U.S. PATENTS 2,955,287 AND 3,015,821 AND ADDITIONAL PATENTS PENDING.

Circle 18 on reader's service card

Join "THE TROUBLESHOOTERS"

They get paid top salaries for keeping today's electronic world running

Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS —the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well paid for it. Here's how you can join their privileged ranks— without having to quit your job or go to college in order to get the necessary training.



JUST THINK HOW MUCH in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter...keep a whole assembly line moving by fixing automated production controls...prevent a bank, an airline, or your government from making serious mistakes by repairing a computer.

Today, whole industries depend on electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians—The Troubleshooters.

Because they prevent expensive mistakes or delays, they get top pay—and a title to match. At Xerox and Philco, they're called Technical Representatives. At IBM they're Customer Engineers. In radio or TV, they're the Broadcast Engineers.

What do you need to break into the ranks of The Troubleshooters? You might think you need a college diploma, but you don't. What you need is know-how—the kind a good TV service technician has—only lots more.

Think With Your Head, Not Your Hands

The service technician, you see, "thinks with his hands." He learns his trade by taking apart and putting together, and often can only fix things he's already familiar with.

But as one of The Troubleshooters, you may be called upon to service complicated equipment that you've never seen before or *can't* take apart. This means you have to be able to take things apart "in your head." You have to know enough electronics to understand the engineering specs, read the wiring diagrams, and calculate how a circuit should test at any given point.

Now learning all this can be much simpler than you think. In fact, you can master it without setting foot in a classroom and without giving up your job!

AUTO-PROGRAMMED™ Lessons Show You How

For over 30 years, the Cleveland Institute of Electronics has specialized in teaching electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before.

For one thing, our AUTO-PROGRAMMED™ lessons build your knowledge as you'd build a brick wall—one brick at a time. Each piece rests securely on the one that came before it.

In addition, our instruction is personal. When your teacher goes over your assignment, no one else competes for his attention. You are the only person in his class. He not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the day it's received so that you can read his comments and corrections while everything is fresh in your mind.

Always Up-To-Date

To keep up with the latest developments, our courses are constantly being revised. This year CIE students are getting new lessons in Laser Theory and Application, Microminiaturization, Single Sideband Techniques, Pulse Theory and Application, and Boolean Algebra.

In addition, there is complete material on the latest troubleshooting techniques including Tandem System, Localizing through Bracketing, Equal Likelihood and Half-Split Division, and In-circuit Transistor Checking. There are special lessons on servicing two-way mobile equipment, a lucrative field in which many of our students have set up their own businesses.

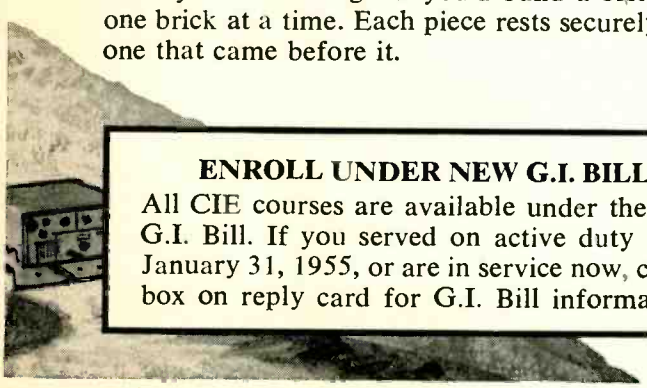
Your FCC License—or Your Money Back!

Two-way mobile work and many other types of troubleshooting call for a Government FCC License, and our training is designed to get it for you. But even if your work doesn't require a license, it's a good idea to get one. Your FCC License will be accepted anywhere as proof of good electronics training.

And no wonder. The licensing exam is so tough that two out of three non-CIE men who take it fail. But CIE training is so effective that 9 out of 10 of our graduates pass. That's why we can offer this warranty with confidence: *If you complete one of our license preparation courses, you'll get your license—or your money back.*

Mail Card for 2 Free Books

Want to know more? Mail the postage-paid reply card bound here. We'll send our 40-page catalog describing our courses and the latest opportunities in Electronics. We'll also send a special book on how to get a Commercial FCC License. Both are free. If the card is missing, just send us your name and address.



ENROLL UNDER NEW G.I. BILL

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

CIE

Cleveland Institute of Electronics

1776 E. 17th St., Dept. RE-47, Cleveland, Ohio 44114

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

Circle 38 on reader's service card

(continued from page 16)

frequency changes, since the incoming picture carrier is fixed. The 45.75-MHz signal moves either up or down the S-curve, the dc voltage output goes to "+" or "—" (depending on how far and in what direction the oscillator drifted), and the oscillator is yanked back to the right frequency.

Fig. 3 shows a typical application, taken from a Magnavox color circuit. Note the 6.8-pF blocking capacitor. We can't have the dc control voltage floating around in the oscillator circuit, so the blocking capacitor must be used. The total capacitance added to the oscillator circuit will be the sum of the blocking capacitor's and the diode's capacitance. The bottom end of the diode is made "rf ground" by the 0.002μF bypass capacitor, which is actually a feed-through type in the tuner.

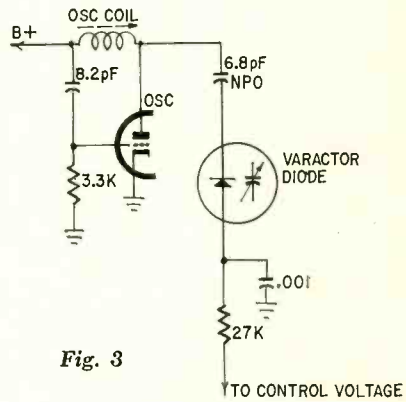


Fig. 3

How to test this circuit? Easy. All sets using it have an AFC DEFEAT switch, on the front panel. Hold this down, and tune in a color program so that the colors are just right. Let go of the switch and see what happens. The normal reaction is—nothing. It should stay exactly in tune.

Push the defeat switch again, and deliberately tune the picture into the "worms," the beats in colored portions. Let go. The aft should pull it back in tune and clear up the color. You can detune to the other side, of course, but this way is easier to see.

In some sets, the aft is automatically defeated when the fine-tuning knob is pushed in to adjust the tuning.

It's easy to check for aft trouble; if the aft is working, you'll get the reaction just mentioned. If it isn't, the tuner won't pull back to the right setting. Possible causes for this—dead amplifier tube, etc.

Alternate: If the aft pulls the

Circle 21 on reader's service card ➔

"King of the hill"

Keep on top of your solid-state replacements...with RCA "Top-Of-The-Line" SK-Series. They make up just a handful of types—23 transistors, 6 rectifiers, and 2 integrated circuits. Together these 31 RCA SK-Series types can keep you ahead of 10,000 solid-state replacements in entertainment-type equipment. Designed especially for this purpose, you'll find these devices useful in line-operated and battery-operated radios, phonographs, tape recorders, TV receivers, AF amplifiers, automobile radios, and stereo.

RCA SK-Series transistors and rectifiers and the 10,000 types they replace are cross-referenced in the RCA Solid-State Replacement Guide. It's a handy booklet listing comparably-rated types including industry standard EIA types, foreign types, and those identified only by device manufacturers' or equipment manufacturers' parts numbers.

Check with your RCA Distributor. He stocks the complete line in either cartons or see-through display packs. Also, pick up your copy of the RCA Replacement Guide SPD-202-E available through your RCA Distributor. RCA Electronic Components, Harrison, N.J. 07029

Page 23

(continued from page 22)

tuner *off* when you let go of the defeat knob, you've got trouble in the aft circuit. (Typical symptom of a bad diode in the discriminator, etc. *Not* necessarily the aft diode in the tuner, although, of course, it could be. Don't jump to conclusions, no matter how much you need the exercise.)

Don't realign the aft transformer, discriminator, etc., at random. *Check* first. Not by smell, either. Feed in a known-accurate 45.75-MHz signal, and monitor the dc voltage output (control voltage) at the terminal on the tuner. In the Magnavox circuit shown, this should be zero when the picture carrier is exactly on-frequency, and vary "+" or "—" as the test signal is varied above and below 45.75 MHz. If you see this kind of reaction, the aft transformer, amplifier and discriminator circuit are okay.

Realignment of this circuit is no more difficult than for the old FM detectors. In some sets, you'll find that the amplifier stage has a specially shaped response curve. To do any alignment work, be sure you have proper test equipment *and* alignment instructions on hand.

Actually, like i.f. circuits, aft circuits very seldom drift. If realignment is really necessary, the cause is most likely to be screwdriver drift, just as it is in the i.f.'s of the TV set.

In emergencies, if an aft diode or other part has gone out and you do not have the exact replacement, just kill the aft by shunting the defeat switch, and let the customer have the set back till you can get the part. Tell him it operates just like an old-fashioned manual tuner. Exact replacements of aft components, especially of the diodes, are necessary.

Tuning eye on FM

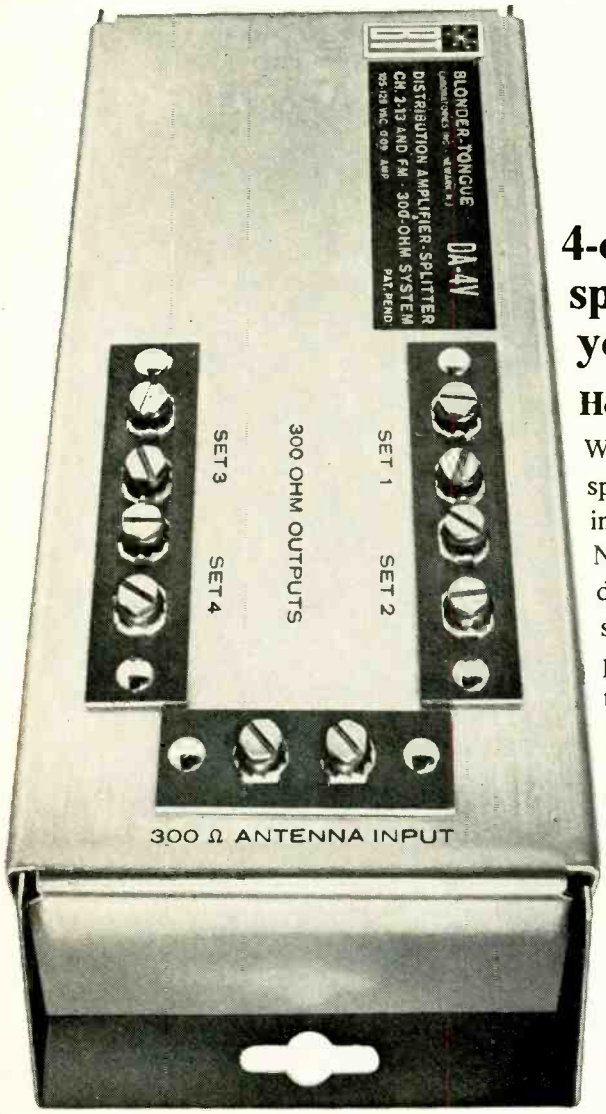
I've got some 6AL7 tubes, and I'd like to use one on my FM set. When I hook it to the ratio detector, I don't get enough reaction. Any ideas?—R.S., Somerset, Pa.

I'll never forget the lady who called me up, a long time ago, and cried, "The radio works fine, but the Magic Eye is all bloodshot!" (It was, too; weak tube, which made the pattern look reddish!) However, that's neither here nor there.

The 6AL7 tube needs a 7-volt change to close the eye; on pins 4 and 6, the top part of the pattern will move.

January 25, 1968:

Blonder-Tongue introduces the DA-4V amplified splitter



4-output 300 ohm VHF amplified splitter obsoletes anything you are now using.

How does the DA-4V fit into today's competitive picture

We have tested the performance of every indoor amplified splitter on the market. We have examined the price of all existing units. None measures up to the performance of the DA-4V. None offers comparable value. Dollar for dollar, the DA-4V delivers better reception than any existing unit. We priced it so you can sell these amplifiers in large volume and at a full profit. Check the low, low price at your Blonder-Tongue distributor today. Find out how Blonder-Tongue can fill all of your amplifier needs better than any line available today.

How Blonder-Tongue makes it easy for you to sell more amplifiers.

In 1968 we're going to make it easier than ever for you to sell Blonder-Tongue products. Ask your distributor about the Blonder-Tongue service technician-oriented support program. Send us your name today for a no-cost, no-obligation subscription to our new publication designed especially for you. *"Problem Solving for TV Servicemen."*

1951	1952	1960	1962	1964	1968
First VHF high-gain, fixed-tuned home amplifier.	First tubed amplified splitter to drive several sets from one antenna.	First transistorized VHF mast-mounted home TV amplifier.	First transistorized amplified splitter to drive several sets from one antenna.	First transistorized all channel TV amplifier for the home.	*The year Blonder-Tongue took over the TV amplifier market.*

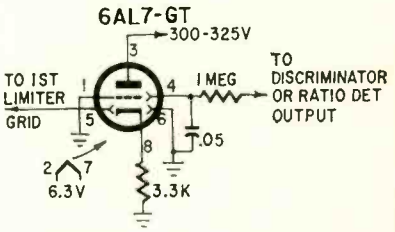
BLONDER-TONGUE
Blonder-Tongue Laboratories, Inc.,
9 Alling Street, Newark, N.J. 07102

Circle 23 on reader's service card

In the Shop . . . With Jack

(continued from page 24)

On 5, the whole bottom half is controlled. The bias resistor on this tube should be 3300 ohms; check it. If the tube isn't biased correctly, you will lose sensitivity.



The diagram shows the hookup. The pin-5 deflector goes to the grid circuit of the limiter or last FM i.f. stage. This controls the bottom half of the pattern, and you tune for minimum height. Pin 4 goes to the FM detector output and you tune for minimum height again. When you reach the "on-channel" position, each shadow should be the same width.

"Undistorted" power output?

I've got an old mail-order radio, and I'm trying to fix it up. I get pretty bad distortion if I run the volume control past about ⅔ open. The instructions say this has a 10-watt undistorted power output, but I don't think I'm getting that much. How can I check it?—E.S., Pratt, W. Va.

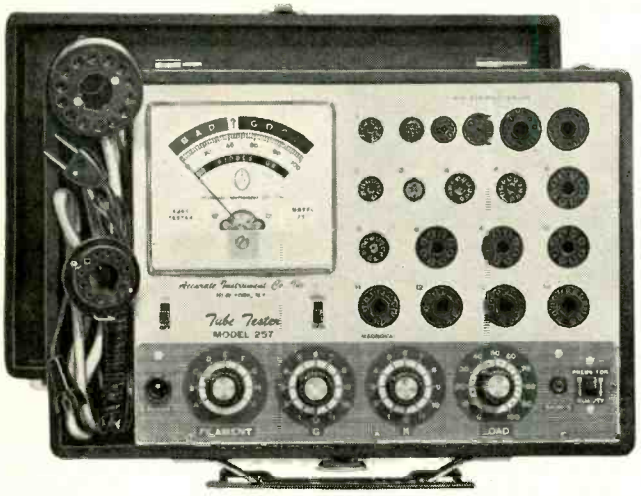
Frankly, when this radio was made, there were some people who stretched the truth a little about "*undistorted* power output"! This set has a pair of 6V6's; rating, 10 watts *maximum* power output, which is a long way from 10 watts undistorted! About 6–7 watts undistorted power output is all you can expect under the best conditions.

Connect an 8-ohm resistor across the output, feed in about a 1-kHz sine-wave signal to the top of the volume control, and then read the ac voltage across the resistor. Ohm's Law will give you the power by $P = \frac{E^2}{R}$. To check the distortion, hook a scope across the load resistor. Watch for signs of clipping or distortion in the sine-wave signal. This is a pretty crude way, but useful. Turn the volume control up until the output shows distortion, then read the voltage and figure the wattage; *this* will be your undistorted power output.

Check *all* coupling capacitors for any sign of leakage, and all resistors for a change in value. This is the most common trouble in old radios. **R-E**

The New 1968 Improved Model 257 **A REVOLUTIONARY NEW**

TUBE TESTING OUTFIT



- **Tests all modern tubes including Novars, Nuvistors, Compactrons and Decals.**
- **All Picture Tubes, Black and White and Color**

ANNOUNCING... for the first time

A complete TV Tube Testing Outfit designed specifically to test **all** TV tubes, color as well as standard. Don't confuse the Model 257 picture tube accessory components with mass produced "picture tube adapters" designed to work in conjunction with all competitive tube testers. The basic Model 257 circuit was modified to work **compatibly** with our picture tube accessories and those components are not sold by us to be used with other competitive tube testers or even tube testers previously produced by us. They were custom designed and produced to work specifically in conjunction with the Model 257.

COMPLETE WITH ALL ADAPTERS AND ACCESSORIES, NO "EXTRAS"

STANDARD TUBES:

- Tests the new Novars, Nuvistors, 10 Pins, Magnovals, Compactrons and Decals.
- More than 2,500 tube listings.
- Tests each section of multi-section tubes individually for shorts, leakage and Cathode emission.
- Ultra sensitive circuit will indicate leakage up to 5 Megohms.
- Employs new improved 4½" dual scale meter with a unique sealed damping chamber to assure accurate, vibration-less readings.
- Complete set of tube straighteners mounted on front panel.

BLACK AND WHITE PICTURE TUBES:

- Single cable used for testing all Black and White Picture Tubes with deflection angles 50 to 114 degrees.
- The Model 257 tests all Black and White Picture Tubes for emission, inter-element shorts and leakage.

COLOR PICTURE TUBES:

- The Red, Green and Blue Color guns are tested individually for cathode emission quality, and each gun is tested separately for shorts or leakage between control grid, cathode and heater. Employment of a newly perfected dual socket cable enables accomplishments of all tests in the shortest possible time.

The Model 257 is housed in a handsome, sturdy, portable case. Comes complete with all adapters and accessories, ready to plug in and use. No "extras" to buy. Only **$47.50**

NOTICE

We have been producing radio, TV and electronic test equipment since 1935, which means we were making Tube Testers at a time when there were relatively few tubes on the market, 'way before the advent of TV. The model 257 employs every design improvement and every technique we have learned over an uninterrupted production period of 32 years.

Accurate Instrument Co., Inc.

SEND NO MONEY WITH ORDER
PAY POSTMAN NOTHING ON DELIVERY

Try it for 10 days before you buy. If completely satisfied then send $10.00 and pay the balance at the rate of $10.00 per month until the total price of $47.50 (plus P.P., handling and budget charge) is paid. If not completely satisfied, return to us, no explanation necessary.

ACCURATE INSTRUMENT CO., INC.
Dept 558 2435 White Plains Road, Bronx, N. Y. 10467

Please rush me one Model 257. If satisfactory I agree to pay $10.00 within 10 days and balance at rate of $10.00 per month until total price of $47.50 (plus P.P., handling and budget charge) is paid. If not satisfactory, I may return for cancellation of account.

Name_____

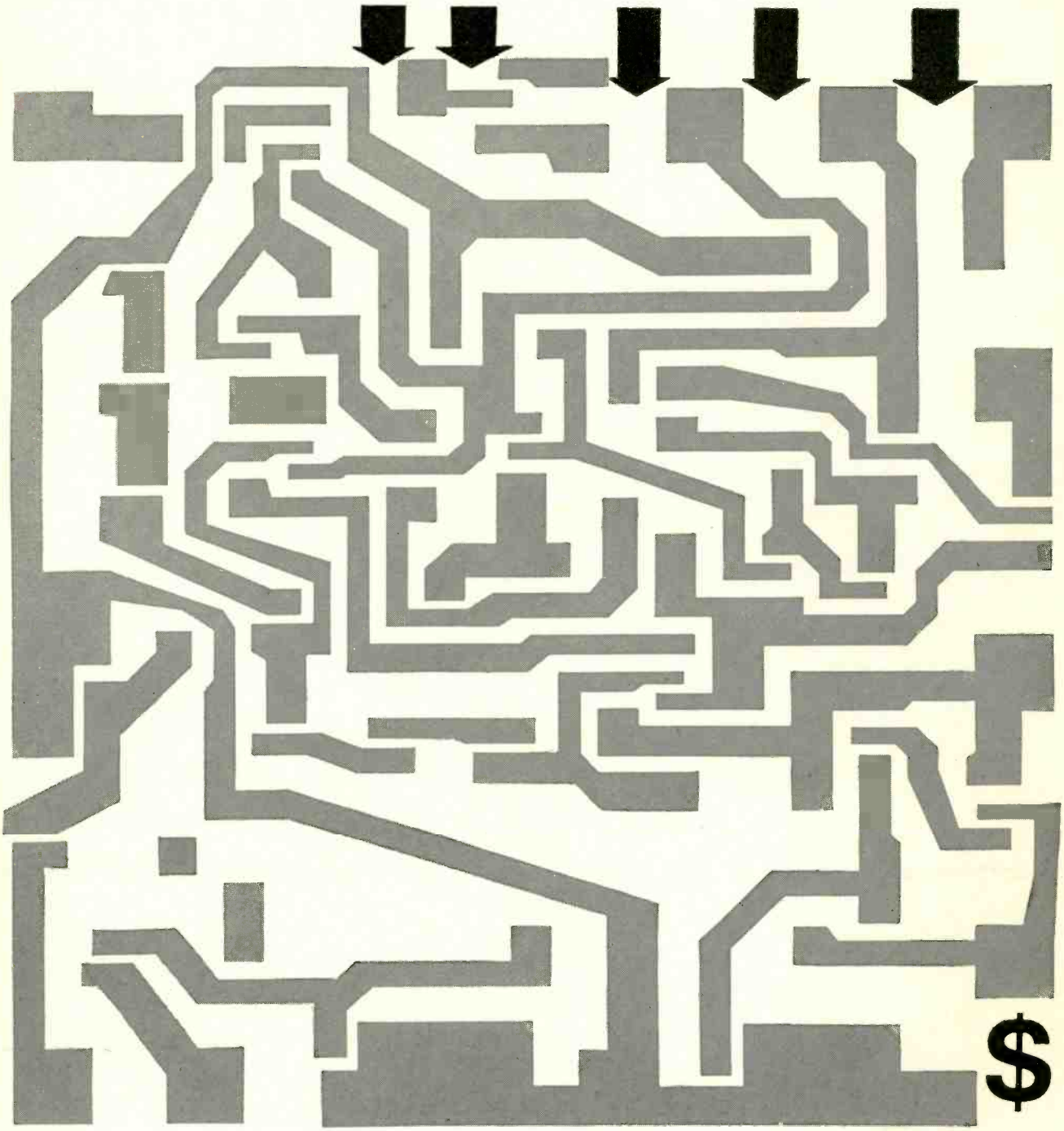
Address_____

City_____ Zone_____ State_____

☐ Save Money! Check here and enclose $47.50 with this coupon and we will pay all shipping charges. You still retain the privilege of returning after 10 day trial for full refund.

Circle 26 on reader's service card

There's more than one road to success.



An integrated circuit enlarged several thousand times

RCA Institutes can help find the one best for you!

Are you trying to find your way through a maze of career possibilities? Find out how RCA Institutes can start you on your way toward a well paying job in electronics. Send the attached card today!

Learn electronics at home faster, easier, almost automatically— with RCA AUTOTEXT

Are you just a beginner with an interest in the exciting field of electronics? Or, are you already earning a living in electronics and want to brush-up or expand your knowledge in a more rewarding field of electronics? In either case, AUTOTEXT, RCA Institutes' own method of Home Training will help you learn electronics more quickly and with less effort, even if you've had trouble with conventional learning methods in the past.

THOUSANDS OF WELL PAID JOBS ARE OPEN NOW TO MEN SKILLED IN ELECTRONICS!

Thousands of well paid jobs in electronics go unfilled every year because not enough men have taken the opportunity to train themselves for these openings. RCA Institutes has done something positive to help men with an aptitude and interest in electronics to qualify for these jobs.

HOME STUDY CAN TRAIN YOU FOR REWARDING CAREER OPPORTUNITIES

To help fill the "manpower gap" in the electronics field, RCA Institutes has developed a broad scope of Home Training courses, all designed to lead to a well paying career in electronics in the least possible time. You also have the opportunity to enroll in an RCA "Career Program" exclusively created to train you quickly for the job you want! Each "Career Program" starts with the amazing AUTOTEXT Programmed Instruction Method. And, all along the way, your program is supervised by RCA Institutes experts who become personally involved in your training and help you over any "rough spots" that may develop.

VARIETY OF KITS ARE YOURS TO KEEP

To give practical application to your studies, a variety of valuable RCA Institutes engineered kits are included in your program. Each kit is complete in itself, and yours to keep at no extra cost. You get the new Programmed Electronics Breadboard for limitless experiments, including building a working signal generator, multimeter, and a fully transistorized superheterodyne AM receiver.

ONLY FROM RCA INSTITUTES— TRANSISTORIZED TV KIT— VALUABLE OSCILLOSCOPE

All students receive a valuable oscilloscope. Those enrolled in the Television program receive the all-new transistorized TV Kit. Both at no extra cost and only from RCA Institutes.

CHOOSE THE "CAREER PROGRAM" THAT APPEALS MOST TO YOU

Start today on the electronics career of your choice. Pick the one that suits you best and mark it off on the attached card.

- Television Servicing
- Telecommunications
- FCC License Preparation
- Automation Electronics
- Automatic Controls
- Digital Techniques
- Industrial Electronics
- Nuclear Instrumentation
- Solid State Electronics
- Electronics Drafting

ADVANCED TRAINING

For those already working in electronics, RCA Institutes offers advanced courses. You can start on a higher level without wasting time on work you already know.

UNIQUE TUITION PLAN

With RCA Institutes Training, you progress at your own pace. You only pay for lessons as you order them. You don't sign a long-term contract. There's no large down-payment to lose if you decide not to continue. You're never badgered for monthly payments. Even if you decide to interrupt your training at any time, you don't pay a single cent more.

CLASSROOM TRAINING ALSO AVAILABLE

If you prefer, you can attend classes at RCA Institutes Resident School, one of the largest of its kind in New York City. Coeducational classroom and laboratory training, day and evening sessions, start four times a year. Simply check "Classroom Training" on the attached card for full information.

JOB PLACEMENT SERVICE, TOO!

Companies like IBM, Bell Telephone Labs, GE, RCA, Xerox, Honeywell, Grumman, Westinghouse, and major Radio and TV Networks have regularly employed graduates through RCA Institutes' own placement service.

SEND ATTACHED POSTAGE PAID CARD TODAY. FREE DESCRIPTIVE BOOK YOURS WITHOUT OBLIGATION. NO SALESMAN WILL CALL.

All RCA Institutes courses and programs are approved for veterans under the New G.I. Bill.

RCA INSTITUTES, DEPT. RE-48
320 West 31st Street,
New York, N.Y. 10001

Accredited Member National Home Study Council

RCA

BUILD HIGH-GAIN IC

A tiny versatile af amplifier with many uses

By LYMAN E. GREENLEE

INTEGRATED CIRCUITS ARE FAST FINDING their way into all types of electronic equipment. What's in hi-fi today will be in table model radios tomorrow. Here's a low-priced, high gain (58 dB) IC with more than enough power to drive a speaker. It can put out about ½ watt of audio power. Inside the package, which is no larger than an ordinary TO-5 transistor case, you will find, with a microscope, 7 transistors, 11 resistors and 3 diodes, all interconnected and terminated with a dozen leads. The pinkie nail-sized component sells for less than $3. It is RCA's CA3020, and is shown schematically in Fig. 1.

You can assemble an IC Mini-Amp circuit on a small piece of Bakelite 1¾" x 2", as shown in the photos. The circuit is shown in Fig. 2, and is one of several recommended by RCA.

How to use it

If the gain of 58 dB is not enough, a single-transistor preamplifier will bring it up. As with any transistor amplifier battery drain is highest at full output. Continued operation at high output calls for larger than an ordinary 9-volt transistor-radio battery. Use mercury cells or a heavy-duty battery to obtain more useful battery life.

Although 9 volts must be used for full power output, output with a 6-volt supply is adequate for many applications.

Output transformer T1 should match 125 ohms center-tapped to the speaker voice coil. Use Argonne AR-174, or similar for a 3.2- or 4-ohm speaker, or Argonne AR-176, or similar for an 8-ohm speaker. Speaker size is not important, but the speaker should be able to handle a watt of audio power. Some small transistor-radio speakers will handle only about 100 mW without distortion. Low-impedance headphones may also be used.

The amplifier (Fig. 2) is useful for restricted-bandwidth speech applications. For a bandwidth of 300 to 3,000 Hz, RCA recommends the following capacitor values:

C1	0.02 μF
C2	1.0 μF
C3	2.0 μF
C4	0.1 μF
C5	0.2 μF

For maximum bandwidth, C5 may be omitted. It is used to roll off high frequencies and its value may vary from 0.001 to 0.2 μF. The value will depend on the amplifier's application and the quality of the speaker.

To use as a preamplifier for CB transceivers with low modulation due to insufficient audio gain, hang a 10-ohm carbon resistor across the output in place of the speaker load (see Fig.

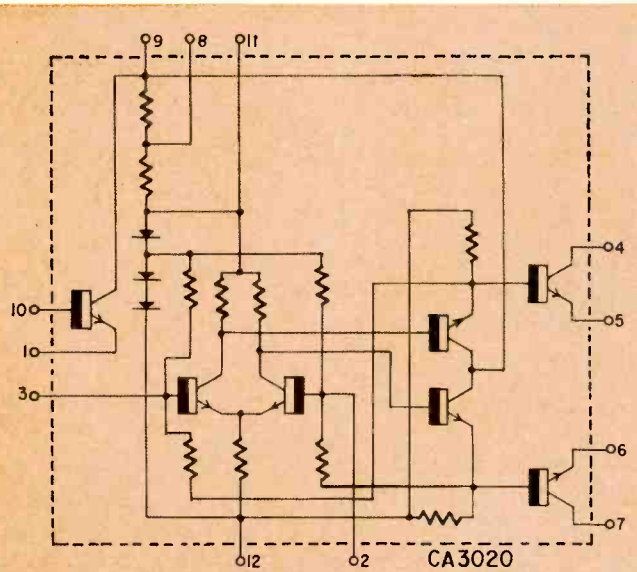


Fig. 1—Schematic of RCA's CA3020 integrated-circuit 550-mW af power amplifier.

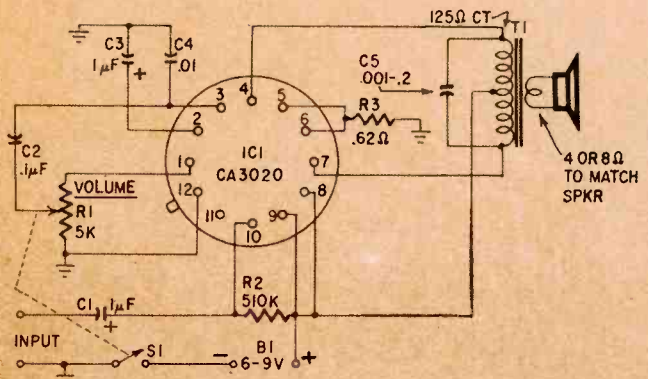


Fig. 2—Circuit of the Mini-Amp audio amplifier designed around the RCA CA3020 integrated circuit.

B1—6 to 9-volt battery

C1, C3—1-μF, capacitor

C2—0.1-μF, capacitor

C4—.01-μF, capacitor

C5—.001- to 0.2-μF capacitor

IC1—RCA CA3020 integrated circuit

R1—5000-ohm miniature potentiometer with (optional) attached switch

R2—510,000-ohm, ½-watt carbon resistor

R3—0.62-ohm, 1-watt resistor

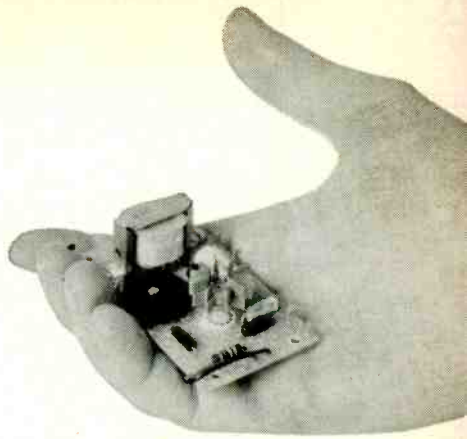
S1—Spst switch (on R1)

T1—Transistor output transformer, primary 125 ohms ct, secondary to match speaker. (Argonne AR-174 or similar for 4-ohm speaker or AR-176 or similar for 8-ohm speaker)

Bakelite or other insulating board, or phenolic perforated board, terminals, battery connector, Augat No. 8058-1G28 IC socket or similar, etc.

AUDIO AMPLIFIER

in home, shop, lab or field



3-a). Use the values for C1 to C5 as for restricted-bandwidth speech applications.

The volume control is a standard 5000-ohm transistor-radio control with switch. It is mounted on the Bakelite board as shown in the photo. The board can then be mounted at right angles to a metal panel with two small angle brackets. The control knob should protrude just far enough for convenient operation.

Use a socket for the CA3020. Too much heat can ruin the IC. There is little danger of ruining the socket. With the socket, different CA3020's can be substituted to provide you with a good test setup for evaluating them.

There are no construction problems except the difficulty of soldering components to the closely spaced socket pins. To prevent solder from flowing where it isn't wanted, slip a sliver of paper or thin cardboard between pins while making a connection.

Do not insert the CA3020 into the socket until all connections have been made and wiring has been checked for errors. Do not cut off the leads on the CA3020. Carefully fan them out with a pencil eraser; be sure all are started in the correct holes. Then push down on the IC firmly but gently and work it back and forth until all pins have entered the proper holes. Apply firm downward pressure to force the 12 leads fully into the socket, without distorting them.

RCA recommends a heat sink be used for high-power outputs. You can snap on one of the TO-5 transistor heat sinks if the amplifier is to be run at power levels greater than 100 mW for long times. Adequate ventilation must be provided for high power outputs. Case temperature must not exceed 150°C.

For certain applications, you may eliminate the output transformer by substituting a couple of ½-watt 62-ohm carbon resistors as shown in Fig. 3-b. This would be an advantage in making a very tiny amplifier for use with headphones. Any medium- or

(continued on page 66)

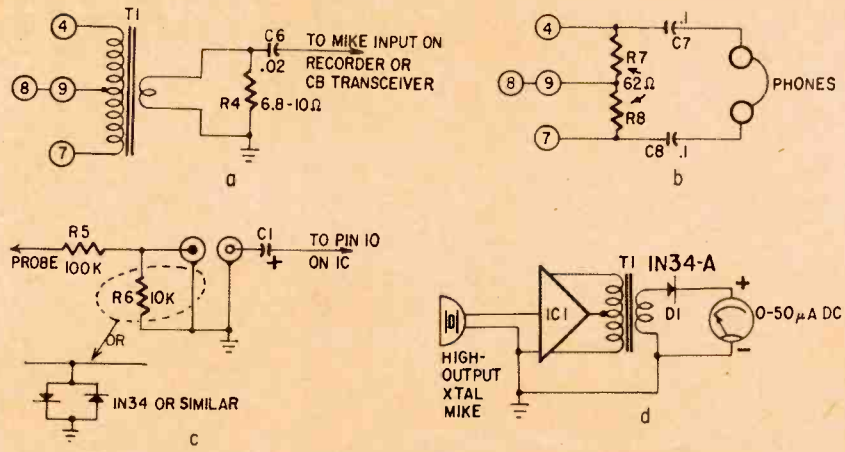


Fig. 3—Accessory circuits of the Mini-Amp. When used as a preamp, T1 (a) feeds signal to mike jack on recorder or transceiver. Connections for medium- to high-impedance phones are shown at b. *Signal-tracer probe is at* c. *Diodes clip at about 550 mV input to prevent damage to IC. A sound-level meter is shown at* d.

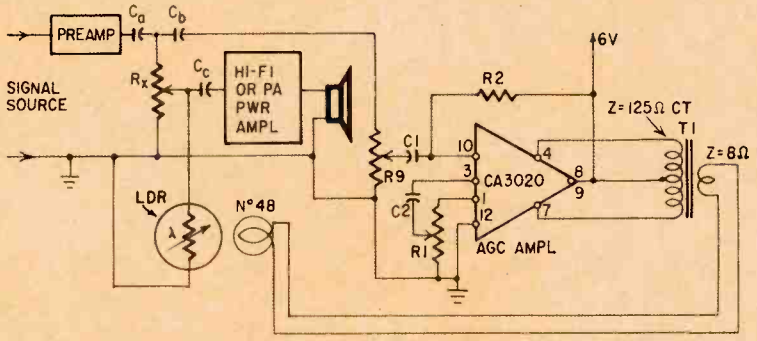


Fig. 4—How the CA3020 provides agc for a power amplifier. Resistance of photocell varies with lamp brilliance to limit signal at input of power amplifier.

Characteristics of the CA3020

Input voltage for full power output	45 mV
Maximum power output	545 mW*
Idling current	22 mA
Maximum current	85 mA
Input resistance	50,000 ohms
Total harmonic distortion at 135 mW output	3.3%
Signal-to-noise ratio at 20 mV input	77 dB
Power gain	58 dB
Size	TO-5 transistor case

*Adequate heatsink must be used

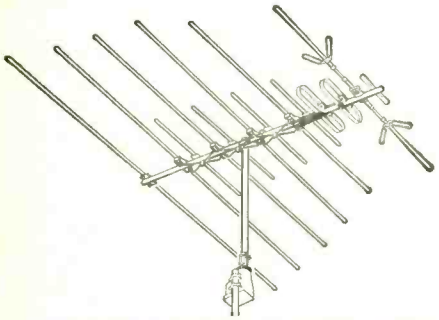
TV/FM Antennas Are

THE RECEIVING ANTENNA IS A VITAL link in any wireless communication system. Acting as a generator, the antenna intercepts waves traveling through the air, converts them to electrical energy, and feeds them to the receiver.

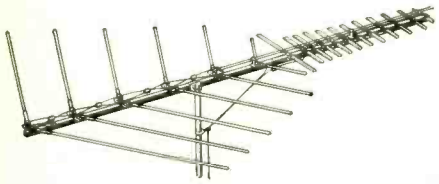
It is primarily the antenna that determines signal quality. Later amplification can increase signal strength, but it cannot improve signal quality.

The radio antenna has evolved from an elaborate outdoor rig, to an indoor wire, to a small ferrite loop inside the receiver cabinet. For a time,

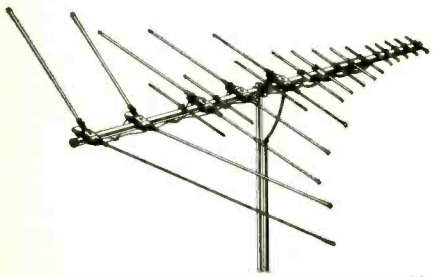
ALL CHANNEL TV/FM ANTENNAS



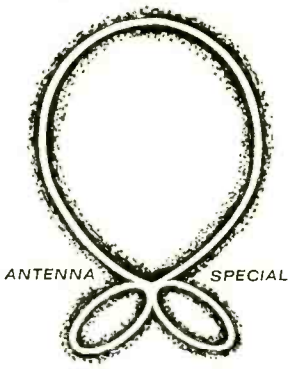
Channel Master Color Crossfire series utilizes Vutronic design with colinear directors serving both uhf and vhf sections. The uhf section uses series-fed dipoles with whiskers, while the vhf section uses the crossfire principle. Mechanical features include blue Kralastic insulators at all crossover points. vhf/uhf band splitter included. Model 3665-G shown has 13 elements.

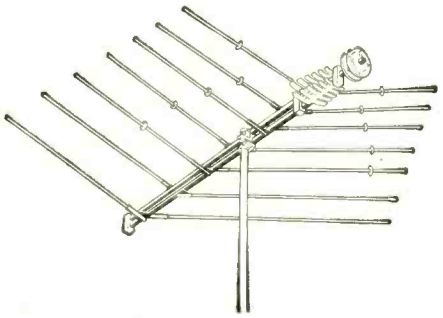


Finney Color Spectrum series is "Frequency Dependent," providing higher gain at higher frequencies. Features square boom, one piece drive line and insulated crossover spacers. Complete with uhf/vhf splitter. The model CS-B2 shown has 6 driven vhf TV and FM elements, 10 driven uhf elements, and 3 parasitic elements.

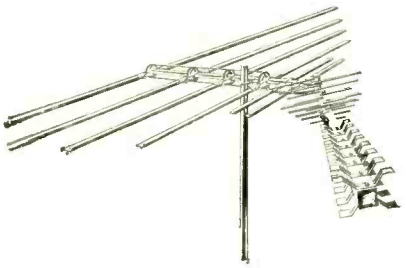


Gavin Gold Crest series designed on V-Yagi principle for increased gain with flatness. Both uhf and vhf elements are combined into one integral antenna. Features total weatherproofing, Cycolac insulators, reinforced, heavy-duty aircraft aluminum elements and corrosion-resistant coating. Complete with uhf/vhf TV/FM signal splitter. Model 1118 has 8 driven and 10 parasitic elements.

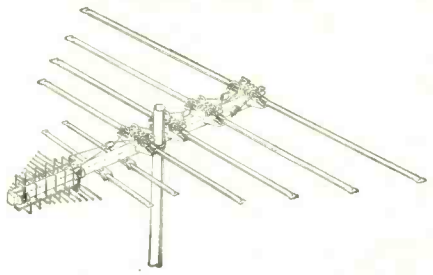




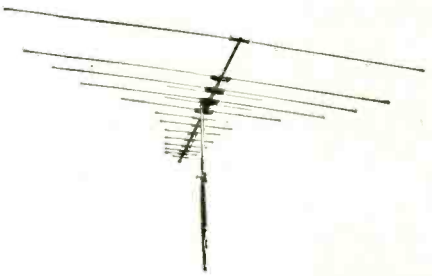
JFD Color Laser series uses frequency-independent log-periodic V design with elements working on both fundamental and harmonic modes. Resistance-loaded vhf dipoles with capacitance-loaded dual-band directors. Disc-on-rod uhf directors. Includes uhf/vhf splitter. Twin boom construction. Model LPV-CL400 shown has 21 elements.



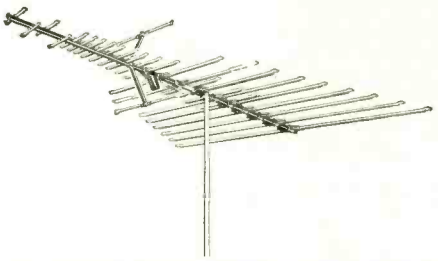
Jerrold Uses log-periodic design with hinged joint, allowing separate uhf and vhf orientation. Square-boom construction, Cycolac insulators and golden armor coating for ruggedness. Includes outputs for both 75 and 300 ohms. Model PXB-50 shown has 4 driven and 2 parasitic vhf elements, plus 11 driven and 16 parasitic uhf elements.



Lance Colormaster series use log-periodic design. Features air-insulated crossover spacers, square-boom construction and automatic locking hardware. Complete with uhf/vhf signal splitter. Model LC41 shown has 11 uhf elements and 6 vhf elements.



RCA Colorscan series uses modified Yagi design for both uhf and vhf. The vhf portion utilizes multiple, exponentially tapered elements of closely spaced end-fire type, coupled by folded transmission lines. Tuning stubs are used on some of the directors to make them operate in both high and low vhf bands simultaneously. The uhf portion utilizes full-wavelength dipoles. Round boom construction and double polymerized vinyl coatings on all elements. Model 10B1120 shown has 14 elements.



Wineguard Super Colortron series features built-in housing for downlead, preamp, trap or filter. Ellipsoidal boom, high tensile aluminum elements, and high-impact polystyrene wrap-around insulation. Complete with uhf/vhf signal splitter. Model SC82 has 27 elements.

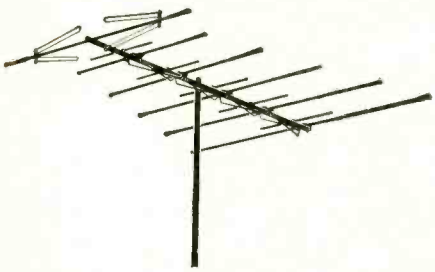
By LON CANTOR

Getting Bigger and Better

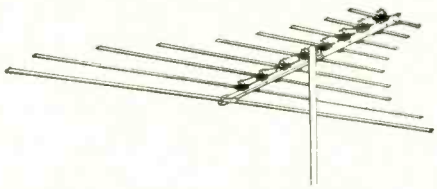
it seemed that the television antenna was headed in the same direction. However, color TV, uhf, FM stereo and CATV have all contributed to a reversal of the trend. The recent introduction of the US Air Force Subminiature Integrated Antenna notwithstanding, the typical 1968 antenna is bigger and more efficient than ever before.

Color TV has been the prime motivating force in the development and use of bigger and better antennas. A recent poll showed that color TV was the "most wanted" item of a majority

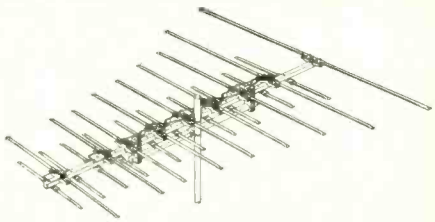
VHF/FM ANTENNAS



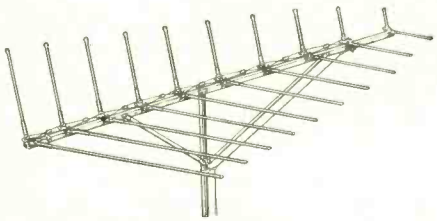
Channel Master Color Crossfire series uses "folded whiskers" to make directors work on all vhf TV channels plus FM. They feature blue Kralastic insulators and golden E-P-C coating. The model 3614 shown has 11 elements.



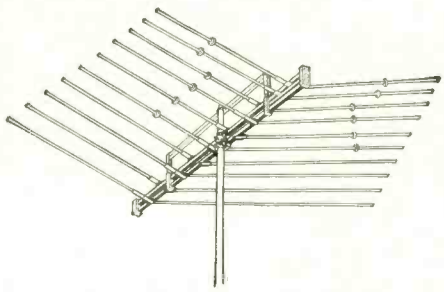
GC Electronics Magic Color series are designed for use in the 60- to 100-mile range, have Gold Guard Finish for all-weather protection and longer service life. Model 32-709 shown has 9 elements and a vhf TV and FM range of 100 miles.



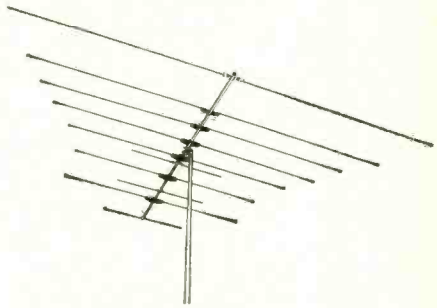
Lance Colormaster series features log periodic design, square boom construction and automatic locking hardware. Model LC23 shown has 19 elements.



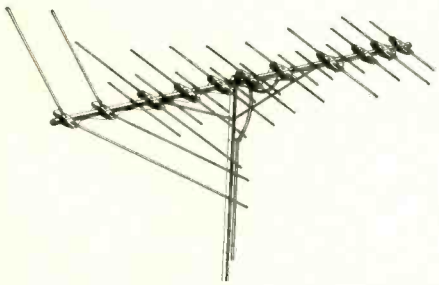
Finney Color Spectrum series features frequency-dependent response (to compensate for unequal propagation of TV frequencies), one-piece drive line, insulated crossover spacers and square boom. Model CS-V10 has nine driven elements and one parasitic element.



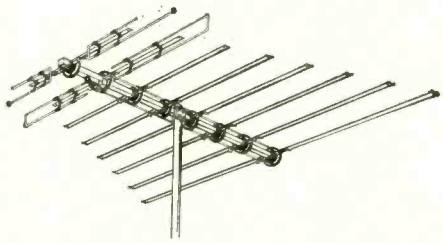
JFD Color Log Periodic series uses reactance-loaded dipoles for narrower beams and dual band directors enabling elements to be active for both high and low bands. Features twin boom construction and improved 300-ohm impedance match. Model LPV-TV 100 shown has 10 elements.



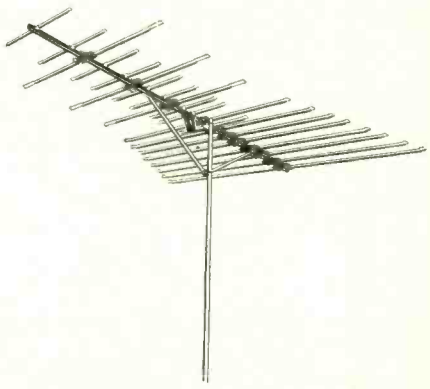
RCA Stratobeam series uses modified Yagi design, with multiple, exponentially tapered driven elements of closely spaced end-fire type, coupled by folded transmission lines. Some of the directors employ tuning stubs to make them operate at both high and low vhf bands simultaneously. Features include round boom construction and double polymerized vinyl coating on all elements. Model 10B1020 has 10 elements.



Gavin Gold Crest series utilizes V-Yagi design for extra gain and flatness. Features round boom, reinforced, heavy duty elements, Cycolac insulators and reinforced rivets. Model 1023 has 7 driven elements and 12 parasitics.



Jerrold Paralog Plus series features log-periodic design plus Bi-Modal directors for extra gain. Square boom construction, Cycolac insulators and golden armor coating provide ruggedness. Outputs for both 300 and 75 ohms included. The model PIX-75 shown has 8 elements plus 2 Bi-Modal directors.



Wineguard Super Colortron series include built-in weatherproof housing for twinlead or plug-in preamplifiers, filters or traps. Features electro-lens director system and impedance correlators. 300- and 75-ohm outputs. Model SC-53 shown has 20 elements.

of American women. Most people know that color is harder to receive than monochrome. They are willing to invest in an antenna that will feed an expensive new color set properly.

With more and more stations coming on the air and more and more people owning all-channel receivers, the demand for uhf and 82-channel antennas has grown tremendously.

The growth of FM stereo has also led to more and bigger rooftop antennas. Good FM stereo reception requires more rf signal at the tuner than does monophonic. This often means more antenna gain. Hence, those interested in FM stereo generally buy either a high-gain FM-only antenna or a good combination TV–FM antenna.

Gain is the factor most often used in comparing antennas. Actually, it is a misleading term, since no antenna amplifies incoming signals. However, some antennas do produce more signal voltage at their output terminals than others; gain is used to compare two antennas.

Common practice in using gain as a figure of merit is to employ a half-wave dipole (Fig. 1) as the reference antenna. (An open dipole has a nominal impedance of 72 ohms at its design center frequency; a folded dipole has nominal impedance of about 300

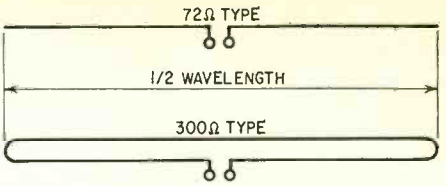
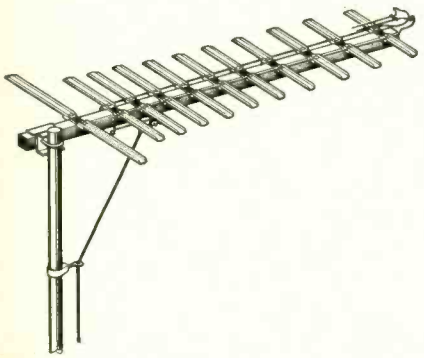
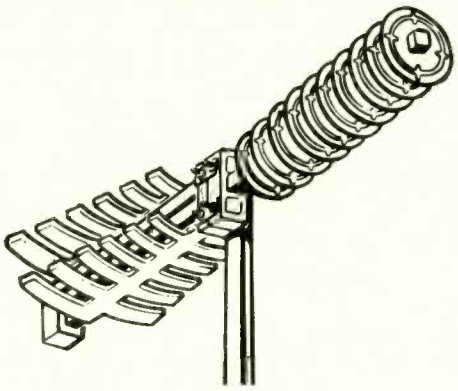


Fig. 1—The half-wave dipole is the usual standard for comparison of various types of antennas for TV and FM.

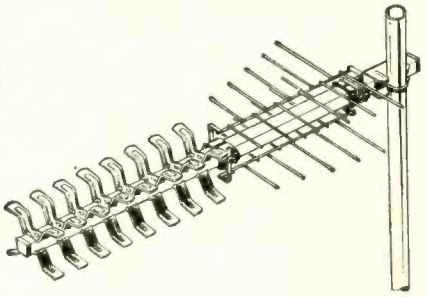
UHF ANTENNAS



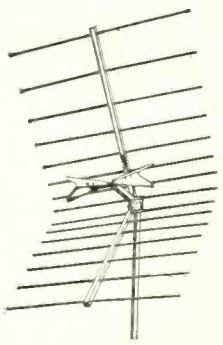
Finney Color Spectrum series utilizes log-periodic design. Feature frequency-dependent response for higher gain on higher channels. Model CSU2 shown has 10 driven elements and one parasitic.



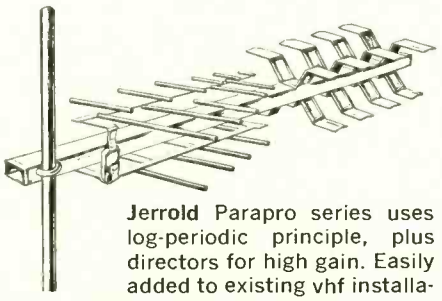
JFD Uhf Color Laser series uses log-periodic design with disc-on-rod directors. Circular directors increase capture area. "Zoned" log-periodic driver increases gain especially at low end of uhf band, where most stations are. Model LPV-UCL22 shown has 6 driven elements and 10 disc-on-rod directors.



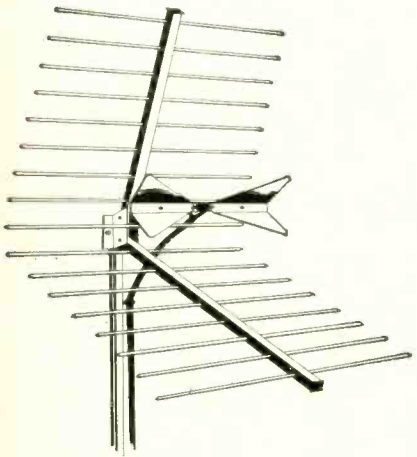
Lance Colormaster series uses log-periodic design. Combines easily with vhf antennas, without uhf/vhf coupler. Model LU820 shown has 11 driven elements and 16 parasitic directors.



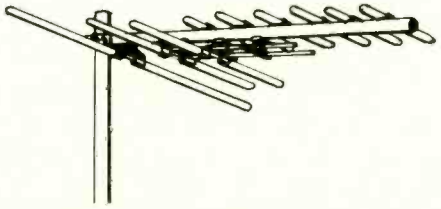
RCA Stratostar series is corner reflector type with bow-tie driver. Large vertical capture area; 100° angle. Reflector rods are permanently locked into support arms without holes or rivets, gold anodized for corrosion resistance. Model 7B141 shown has a broadband 300-ohm dipole and 15 tuned reflector elements.



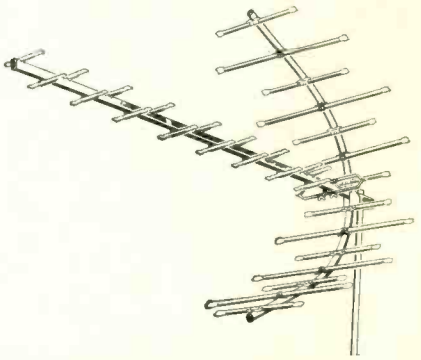
Jerrold Parapro series uses log-periodic principle, plus directors for high gain. Easily added to existing vhf installation, without need for special uhf/vhf coupler. Model PUX-450 shown has 11 driven elements, plus 8 directors.



Gavin Gold Crest series utilizes bow ties with corner reflectors to provide large vertical capture area and high gain. Easily added to existing vhf antenna installation. Model CR-10 shown has one driven element and 16 parasitics.



Kay-Townes Add-A-U series features Yagi design and gold, corrosion-resistant finish. Easily combined with any vhf antenna. Model AAU-9G shown has 9 elements.



Wineguard Color Tracker series combines parabolic reflector with Yagi. Large vertical capture area. Ellipsoidal boom. Model U-630 has 31 elements.

ohms.) This dipole is said to provide unity gain, or 0 dB (Table I). If an antenna produces twice as much signal voltage at its output terminals as a standard half-wave dipole (when both are in the same amount of rf field) the test antenna has 6 dB gain. (6 dB = 2 × voltage, as shown in Table I.)

TABLE I
DB TO VOLTAGE TIMES CONVERSION

DB	VOLTAGE TIMES	DB	VOLTAGE TIMES
1	1.12	8	2.5
2	1.25	9	2.75
3	1.4	10	3.16
4	1.6	20	10
5	1.8	26	20
6	2	30	32
7	2.25	40	100
		60	1000

Unfortunately, it's very hard to know just how much gain a given antenna provides at a given frequency. And some antenna manufacturers have given up specifying gain because it got to be an exaggeration contest.

If you really want to compare two antennas, put one up on a mast and then record sound and picture carrier levels for each channel, as read on a reliable field-strength meter. Then check the second antenna in the same way, installing it on the same mast at the same height and aiming in the same direction.

Sad to say, even this seemingly foolproof method doesn't always work. In some regions—especially weak-signal areas—signals vary from moment to moment. You can actually watch the needle on your field-strength meter swing. Thus you can't be sure that the incoming signal is the same for both antennas under test. But most of the time this method will give you a pretty accurate estimate of which antenna brings in the most signal.

One complicating factor is that antennas don't provide the same gain on every channel. Some antenna manufacturers tilt their receiving antenna response, providing higher gain at higher frequencies.

This brings us to another important factor—flatness. In the days of black-and-white TV, the Yagi was king. It provided better gain than any antenna short of a parabolic reflector. However, Yagis generally have two problems:

1. They operate at high frequencies in the 3/2 wavelength mode, resulting in side lobes. And side lobes (Fig. 2) can pick up ghosts.

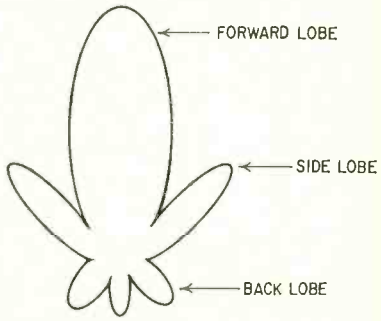
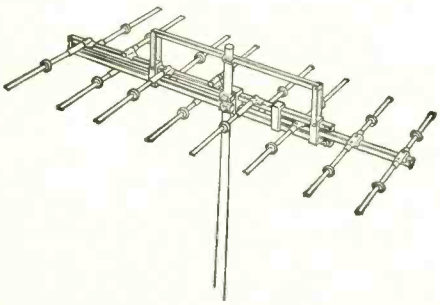


Fig. 2—Older antennas, operating in 3/2 wavelength mode, had large side lobes.

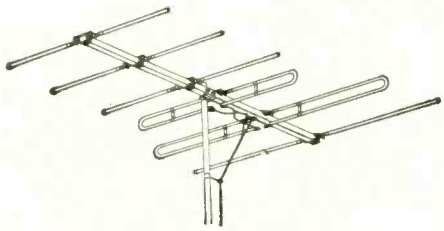
2. They don't have flat response.

(continued on page 90)

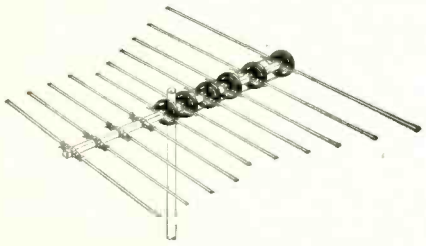
FM ANTENNAS



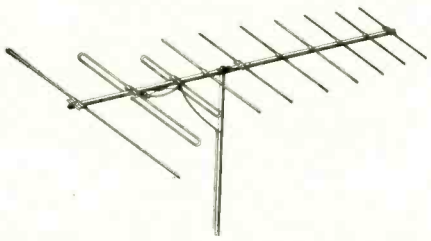
JFD LPL-FM series uses log-periodic design. Features include full wavelength dipoles, controlled capacitance, excellent 300-ohm match and twin-boom construction. Model LPL-FM8A shown has 8 elements.



Finco FM series uses twin drive and impedance-match stubs. Features include extra-wide element spacing, square-boom construction, corodized aluminum elements and lock-tight saddle mounting. Model FM-4G shown has 2 driven and 4 parasitic elements.

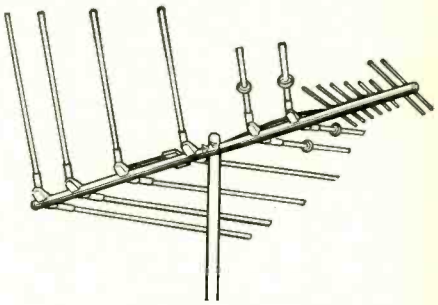


Jerrold Paralog series antennas work on log-periodic principle. Highly directional, with narrow forward lobe to minimize multipath distortion. Model FMP-10 shown has 10 elements.

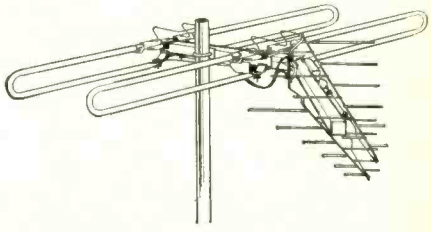


Gavin Color Crest series uses high-gain Yagi design. Construction features include round boom, Cycolac insulators, internally braced aircraft aluminum elements and corrosion-resistant plating on all surfaces. Model FM-10 shown has 2 driven elements and 8 parasitics.

Metropolitan Antennas



JFD 82-channel log periodic model GK-4 is made specifically to minimize ghosts in urban areas. Features "ISO-valve" trap to filter out reflected signals. 6 vhf and 8 uhf elements, include splitter.



Jerrold Metro color series is designed to reject reflected signals and minimize standing waves. Both uhf and vhf sections are hinged, permitting separate orientation. Includes both 300- and 75-ohm outputs. Model MCX-82 shown has two vhf elements and 11 uhf elements.

HOME ANTENNA

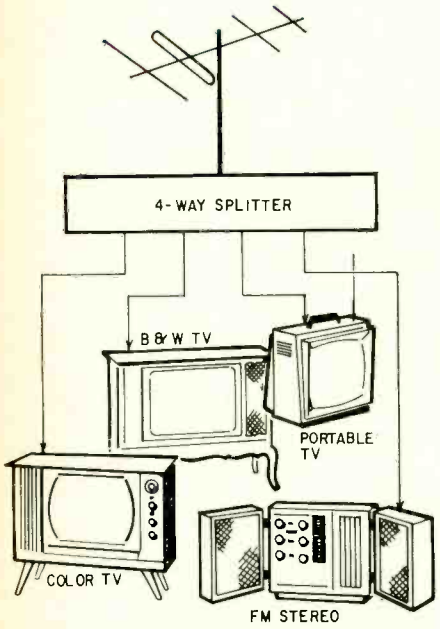
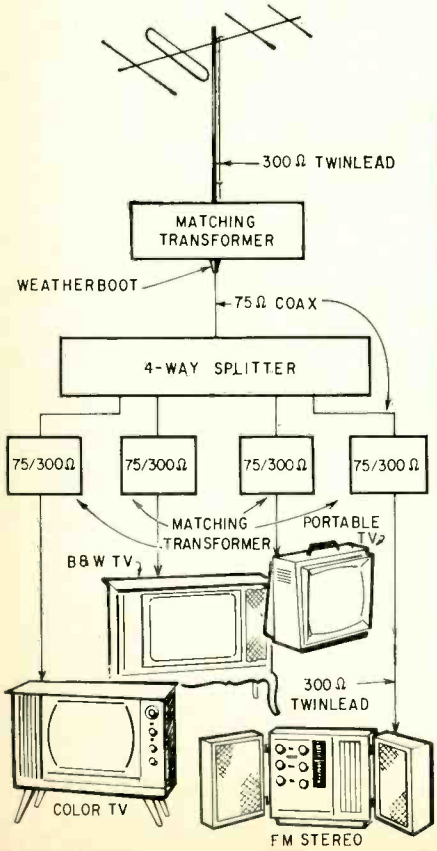


Fig. 1—Passive system for 4 receivers and 1 antenna in a strong signal area. Fig. 2 (below)—Coax distribution system picks up less noise, has greater signal losses and must be matched to the antenna and the receivers by transformers.



IN 1968, MORE AMERICAN FAMILIES own TV receivers than bathtubs. This may be a commentary on American cleanliness (or the lack of it!) but it does indicate that television is a dominant factor in our culture.

It is not uncommon for a family to own a color console, an old black-and-white set that just won't die, an inexpensive portable TV, and an FM stereo radio. This points up the need for a good antenna system in every home. Indeed, the single-outlet home antenna system is almost as obsolete as a home with only one electrical outlet.

While the majority of Americans own two or more TV sets, few, if any, actually have a set for every room. Still, an antenna outlet in every room is a good idea. With a good antenna system, the portable can be enjoyed in the kitchen, in the basement or out on the patio. And it's especially nice to be able to carry a portable TV set into a child's sickroom.

Simple home TV systems

Figure 1 shows the simplest type of home MATV system. It is nothing more than a good-quality broad-band antenna along with a passive, 300-ohm,

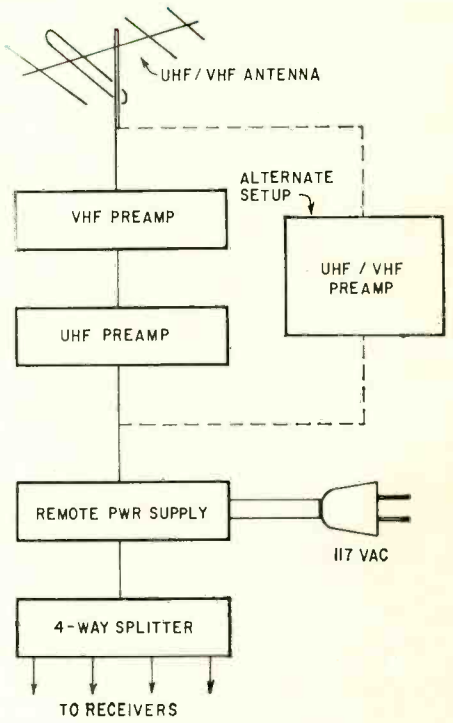


Fig. 3—In weak-signal areas, preamps are required. If uhf and vhf channels are not received from the same direction, use separate uhf and vhf antennas.

MATV Terms

Amplifier: A device using tubes or transistors which raises signal level.

Preamplifier: It usually works ahead of an amplifier. Generally, a preamp has lower noise figure and not so high an output level as an amplifier. Lower noise figure means greater input sensitivity, or ability to handle weaker signals.

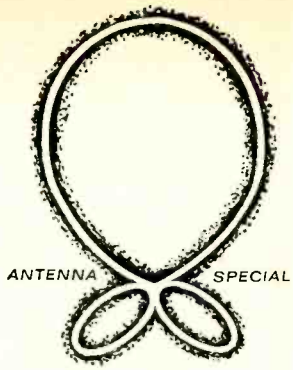
Mast-mounted preamp or booster: Device which is mounted outdoors, on the antenna mast. Usually, such a device uses a remote power supply which is mounted indoors.

Distribution amplifier: An amplifier mounted at the head end or origination point of the distribution system, which it overcomes the losses of the distribution system—cable, splitters and tapoffs. A distribution amplifier may be anything from an amplified two-set coupler to a high-output professional amplifier capable of serving a 400-room building.

Line amplifier or line stretcher: An amplifier used in a trunk line in a distribution system to increase the signal in order to drive further cable

By CAL CORTAN

SYSTEMS



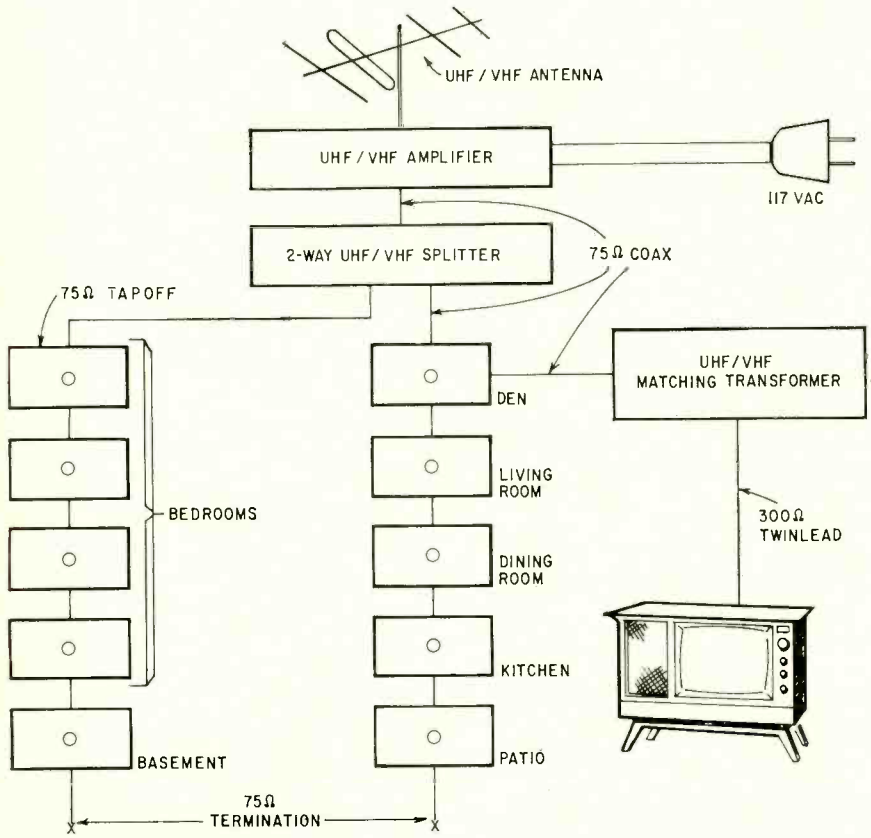


Fig. 4—The full treatment—a professional home TV installation.

MATV Terms

footage. A line amplifier is usually remotely powered.

Coupler: Passive device which splits antenna signal to feed two or more receivers, or combines two or more antenna signals into single downlead. A coupler provides some interest isolation, and maintains nominal 300-ohm impedance between antenna and receivers.

Splitter: Passive device similar to coupler but matched to 75 ohms. Splitters are used in larger, more professional systems.

Amplifier–coupler, amplified splitter: As above, but with amplification included.

Post amplifier: An amplifier working beyond a uhf-to-vhf converter, or another amplifier.

Tapoff: Passive device inserted in a 75-ohm branch distribution line. The tapoff allows the through-line signal to pass with very little attenuation. But it taps off a small portion of the signal voltage (i.e., with much attenuation) and feeds it to the receiver.

four-way splitter. If the system is to serve a color set, the four-way splitter must be top quality. This will assure a minimum of standing waves and provide good isolation between receivers.

If there are uhf stations in your area, it is important that both the antenna and the coupler be designed to handle such signals.

In a weak-signal area, the antenna signal may not be strong enough to feed four sets. In this case, an active, amplifier coupler would be used in place of the passive unit shown.

Many technicians use 75-ohm coaxial cable or shielded 300-ohm twin-lead in preference to ordinary 300-ohm twin-lead. While shielded line costs a little more, its performance is more predictable and it lasts longer. Fig. 2 shows an 82-channel home TV system using coaxial cable and a coaxial splitter. The mast-mounted transformer matches the output of the 300-ohm antenna to the 75-ohm downlead. Notice that a weather boot is used, along with silicone grease, to make the connection solid and weatherproof.

The four-way coaxial splitter is mounted indoors, generally in the attic, or the basement or behind one of the TV sets.

A 300-ohm shielded twin-lead system would be similar, except that no transformers would be needed. These systems are completely passive. They will work well only in good signal areas. To amplify the signals for other reception areas, you simply substitute an amplified four-way splitter.

Fringe-area systems

Thus far, we've discussed only home systems suitable for strong- or medium-signal areas. In fringe areas, you'll generally need a mast-mounted preamplifier. This type is generally solid state, and powered by an indoor remote power supply. Input is almost invariably 300 ohms, and output may be either 300 or 75 ohms.

Figure 3 shows how mast-mounted solid-state preamplifiers would be used in a simple home TV system. An 82-channel system is shown, with a uhf "line stretcher" in an outdoor housing providing the uhf gain. Both the vhf

preamplifier and the uhf "line stretcher" are powered by the same remote power supply.

If the uhf channels are strong (as sometimes happens in vhf fringe areas) the uhf line stretcher may be eliminated.

Professional home systems

Up to this point, we've shown systems that supply only four TV/FM outlets. Ideally, a home should have an outlet in every room, plus one in the basement and another on the patio.

This type of system requires a somewhat different technique. Rather than connecting TV sets to the output of a coupler or splitter, we use tapoffs, such as those used in large master TV systems. As the name implies, a tapoff siphons off a very small portion of the signal on a cable, passing the rest undisturbed.

Figure 4 shows a complete, professional home uhf/vhf TV and FM system which will serve even in most poor-signal areas. In deep fringes, mast-mounted preamplifiers may also be required to dig the signal out of the noise at the antenna.

From the wide variety of home master TV/FM system equipment shown here, it should be easy for you to choose the units you need for the systems you plan to install. **R-E**

Passive Couplers

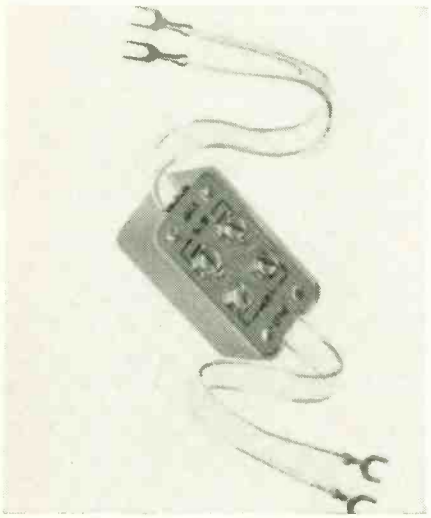
Some models provide only 2 outlets, while others provide 3 or 4. Also, some couplers pass only vhf TV and FM, while others can be used for all channels. Specialized couplers can split high and low vhf, or vhf/uhf.

Mast-Mounted Preamps

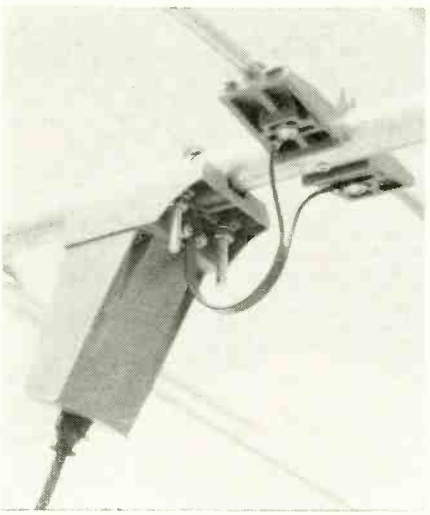
Used to amplify signals before they are deteriorated by downlead, preamps may match 300-ohm twin-lead or 75-ohm coax. They may handle FM, vhf or uhf TV, or all three bands of frequencies. Most models today are solid-state.

Amplified Couplers

Used to provide multiple outlets from single antennas, these units are available in a wide variety of types including uhf only, vhf only, FM only, all-channel, 300-ohm or 75-ohm impedance, and with from 2 to 8 outputs.



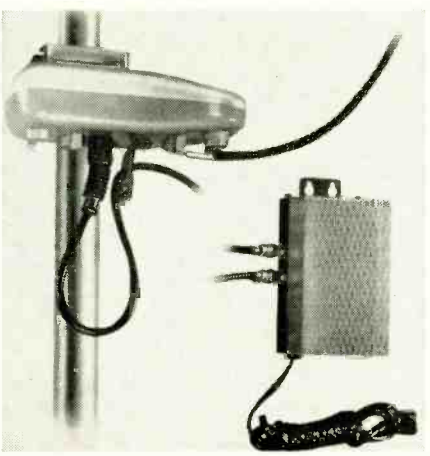
Gavin C205



Winegard

Blonder-Tongue HOMER

Blonder-Tongue A-107



JFD SP-2700

Jerrold TAU-12

Professional Systems

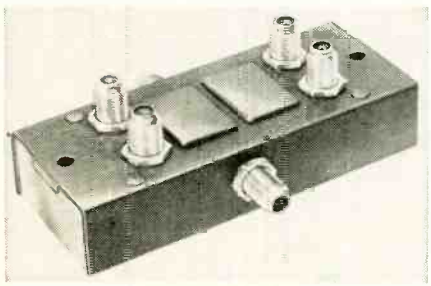
To feed a large number of receivers, a broadband head-end amplifier is used. Models are available for uhf, vhf, and 82-channel systems. Most equipment is solid-state today, but good vacuum-tube gear still remains available on market.

Winegard BC-234

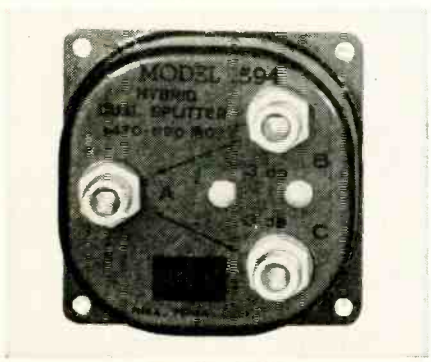
Jerrold 5330

Line Splitters

In 75-ohm systems, these units are used to provide multiple trunk lines from the output of the head-end amplifier. Models with 2 and 4 outputs are most common. 82-channel splitters are musts if system includes uhf TV.



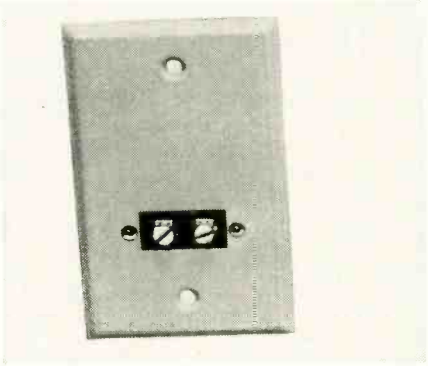
Winegard LDV-4



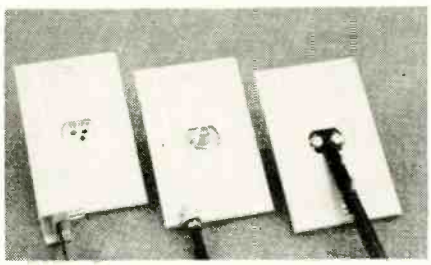
Jerrold 1594

Tapoffs

Usually wall-mounted, tapoffs are available in almost endless variety. Both flush- and surface-mounted types are made, with either 300 or 75 ohms impedance, and isolation from 8 dB up, to minimize set-to-set interference.



Blonder-Tongue TF-731



Winegard

Jerrold MTP-20

Mosley MC-1

Line Stretcher

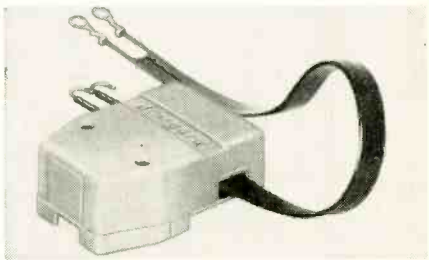
On a long cable run, signal level can drop too much, but the line extending amplifier brings it back up to par. Units are available for uhf or vhf TV service, but also pass all TV and FM frequencies.

JFD SL-6310

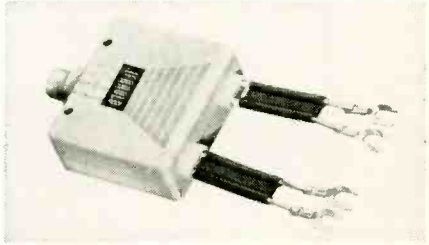
Baluns

Final link from system to receiver is the balun (balanced-to-unbalanced transformer). Some models split uhf and vhf TV signals to feed separate receiver input circuits. Others have a separate FM outlet apart from TV.

Blonder-Tongue Cablematch



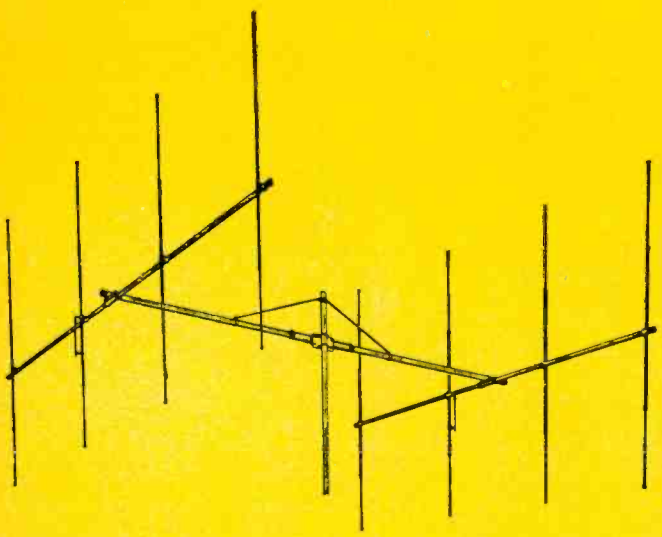
Winegard CS-285



Jerrold T-380

1968 Crop of CB, Ham and

By NOEL PENN



When you think about home TV and FM antennas, you are concerned only with reception. However, in CB, ham or mobile antenna installations the most concern is for transmission.

While transmitter power is limited by the FCC, antenna gain is not. Since an increase in antenna gain is just as effective as an increase in transmitter power, antenna selection is very important.

Antenna efficiency can be improved in three ways:

1. Add elements that increase directivity. Base-station antennas, for example, can be made highly directional and rotated to aim at mobile units.

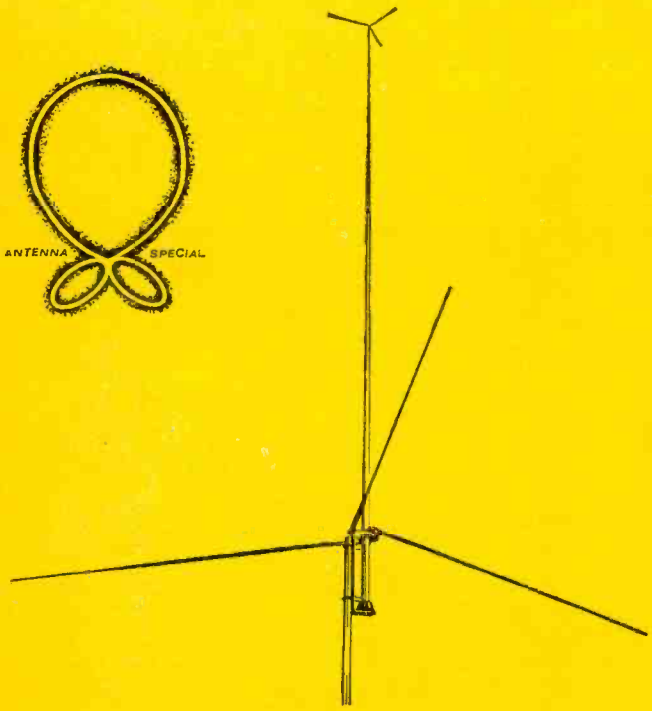
2. Mount the antenna at an optimum height. Follow the antenna manufacturers' instructions. For local contacts, consider line-of-sight obstructions.

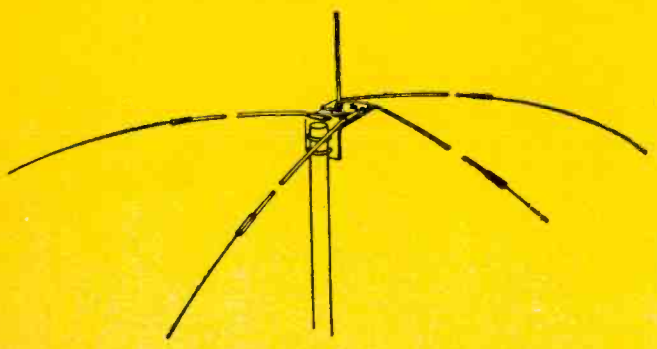
3. All antennas in a communications system should be polarized in the same way; either all horizonal or all vertical. Vertical antennas have vertical polarization. Single-element verticals tend to be omnidirectional and put out signals in a horizontal direction, with little or no signal going straight up or straight down.

4. Improve match. You get maximum transfer of power only when the transmitter, the antenna and the transmission line between them are properly matched. The amount of signal put out by the transmitter but not radiated by the antenna is reflected back and forth in the cable and sets up standing waves. Thus, the degree of match is expressed in terms of VSWR (voltage standing-wave ratio). A perfect match would be a VSWR of 1:1, and 1.5:1 is considered the maximum allowable for a good antenna installation.

The partial selection of antennas shown here can only suggest the vast number of various types available.

Today's CB'ers and hams have a tremendous variety of antennas from which to choose. Some antennas can be used for a number of different applications. Many are easily alterable or tunable to frequency. There are antennas for homes, offices, cars, boats and airplanes, with electrical characteristics and mechanical features to suit each. One manufacturer (Mosley) even offers a line of do-it-yourself antenna kits for CB'ers who want to build their own. **R-E**



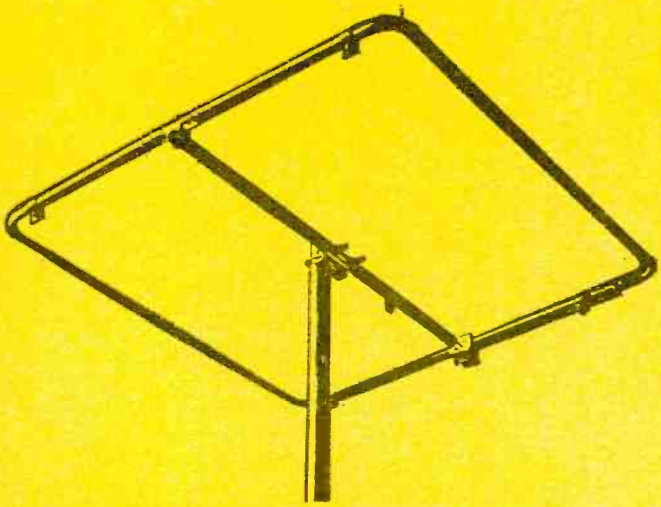


Cushcraft CB-114D (top) 8-element dual-beam base station CB antenna provides 12 dB gain. Front-to-back ratio is 25 dB and VSWR is 1.3 to 1. The dual-beam can be used with any heavy-duty rotator. It has a turning radius of 12 feet.

Hy-Gain CLR2 base station CB antenna has electrically extended 5/8 wavelength radiator. Effective output power is 6.6 watts and VSWR is less than 1.5 to 1. The CLR2 will survive up to 80-mph winds. It provides an omni-directional pattern.

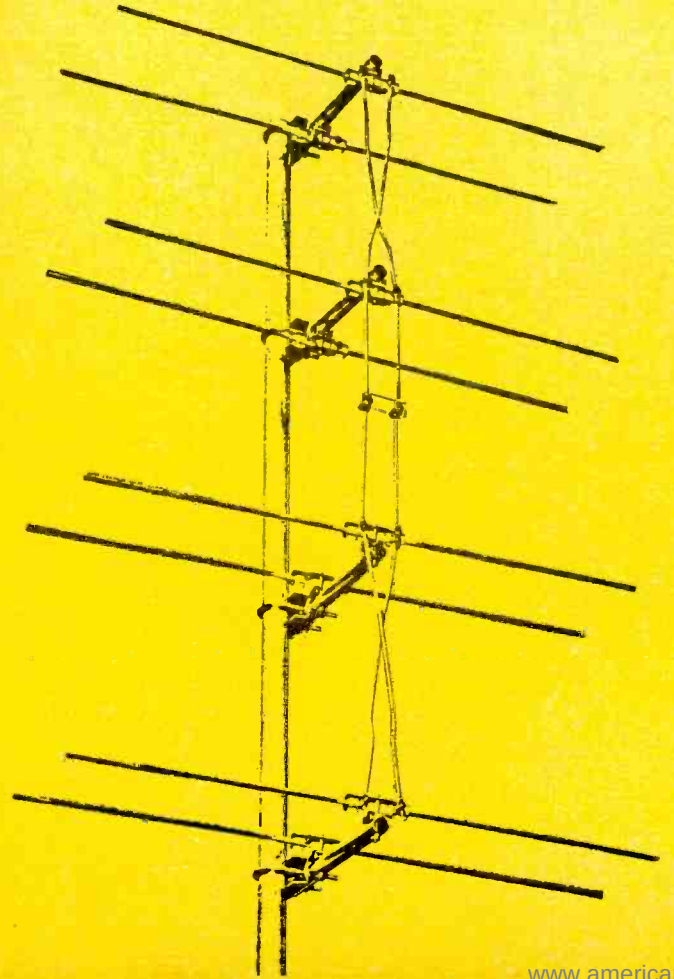
Antenna Specialists MC27 is an omni-directional ground-plane CB base antenna. Features include 108" solid aluminum heat-treated radials, bent at base clamp to proper angle for 50-ohm match. Antenna has omni-directional pattern.

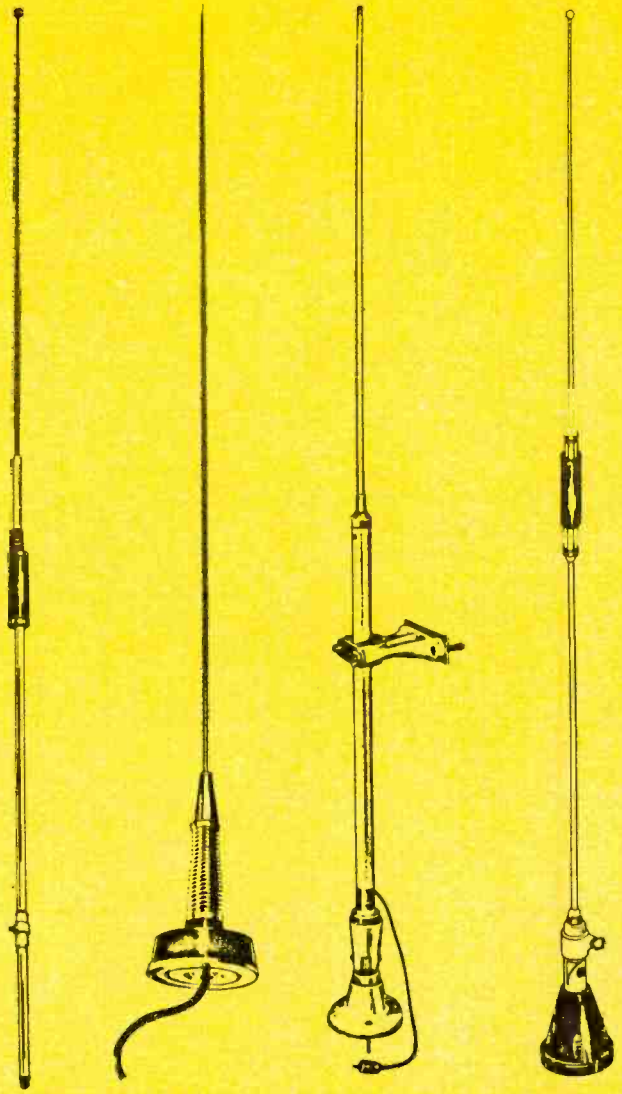
Communications Antennas



Cush Craft Squalo is a full-wave, horizontally-polarized, omni-directional ham antenna. These antennas can easily be stacked vertically to form a complete 5-band "Squalotree" covering the 6-through 40-meter amateur bands. Six-meter Squalos are packaged with suction cup for car mounting, plus a horizontal center support for mast or tower mounting. The Squalo can even be mounted outside a window.

Cush Craft Colinear arrays are well suited to general amateur vhf operation and for amateur TV communications. The 16-element antenna shown below provides a direct match to 300-ohm line, or can be matched to 75-ohm coaxial cable with a balun. Matching stubs are available to match 450-, 200-, 75- or 52-ohm cable directly. Colinear arrays can be stacked for even more gain.





From left to right: **Mosley Lancer 23** is a mobile antenna designed for the CB'er who aspires to be a ham or the ham who works the CB channels. For the CB'er the Lancer 23 is equipped with a 10-meter coil. For the amateur, interchangeable coils for 10 to 75 meters are available. The antennas incorporate a peaking provision for adjustment to any CB channel.

Hy-Gain Hellcat 1 mobile CB antenna has a low-profile look, an etched copper, high-efficiency loading coil in the base, and a spring mounted 17-7 PH stainless steel whip. A new "Claw" mounting device enables antenna to be quickly installed.

Antenna Specialists ASM-1 is a 10-foot CB Marine antenna made of white fiber glass. It has a center-loaded fiber glass whip and chrome-plated brass and stainless-steel fittings. It includes a mounting and lay down kit made of Cycolac, 15' of RG-59/U cable and a connector.

Mosley "Channel Cat" is a CB marine antenna made of stainless steel. Designed to eliminate the need for radials or other difficult to install ground systems, it is effective even on wood and fiberglass boats. The antenna is salt water protected. Loading is through a waterproof coil in the antenna center.

ANTENNA ROTATORS

By RON ROBERTS

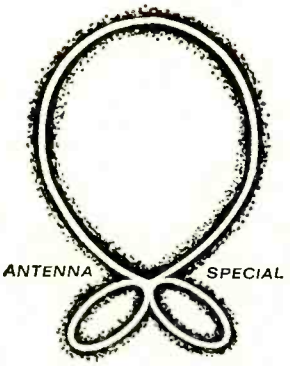
AS ANTENNAS GROW IN SIZE AND INcrease in gain, the need for rotators also grows. Gain is inversely proportional to the width of the antenna's forward lobe. In other words, the greater the gain of a given antenna, the more likely the need for a rotator to pick up channels transmitted from different directions.

The evolution of FM antennas is an excellent case in point. Before FM stereo became a fact, most people used nondirectional "flying S" or "turnstile" antennas. While gain was relatively low, these antennas picked up FM broadcasts from all directions, without the need of a rotator. FM stereo has changed all that. Not only are FM stereo signals weaker than monophonic, they are more susceptible to multipath distortion. Thus, you need a very directional antenna with high gain for good FM stereo reception. But, if a number of stations are coming at you from different directions, you'll also need a rotator to pinpoint the incoming signals.

Color TV is analogous to FM stereo. Ghosting—the TV equivalent of multipath distortion—is far more objectionable in color than in black-and-white. Color also requires stronger signals. In fact, if you mount a good directional antenna on a mast with a rotator, you'll find that color can be received only over a very narrow arc. You can swing the antenna many degrees to either side of the good color arc and still get excellent monochrome pictures. That is why you need a rotator to receive good color pictures.

Antenna rotators can be used anytime you want to receive signals from a number of directions. Rotators, however, are not an unmixed blessing. For one thing, they complicate the antenna installation. For another, rotators present a problem in multiset installations. If Dad wants to watch the baseball game coming from one direction, and the kids want to watch cartoons transmitted from a station in the opposite direction, it's obvious that the rotator can't point the antenna in both directions simultaneously.

One solution is to use two or more separate antennas, mounted on the same mast and combined by a hybrid splitter or coupler. Unfortunately, this can get to be even more expensive, complex and unwieldy than a rotator installation, in many areas.



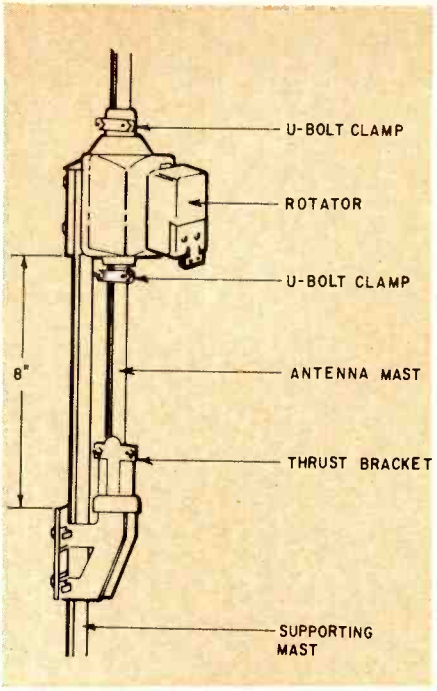


Fig. 1—A thrust bracket is used to take the antenna load off the rotator.

A rotator adds much weight to an antenna installation. Therefore the mast should be braced securely.

For example, installers usually try to keep the mast short to make the installation as solid as possible. In a nonrotator installation, you can often use a 5-foot mast with nothing more than a chimney mount. However, the rotator adds both height and weight. Therefore, guy wires are recommended even for the simplest rotator installations. Use three or even four chimney straps rather than the usual two, and make sure the straps are rustproof stainless steel.

Another good practice is to use a thrust bracket (see Fig. 1) in *every* rotator installation. The thrust bracket takes all the weight of the antenna, prolonging the life of the rotator.

For safety and convenience, do as much as possible of your work on the ground. Chances are you can wire the rotator and mount it, along with the thrust bracket, before you even climb the ladder. You may also be able to attach the antenna to the rotator mast and the lead-in wire to the antenna, all on the ground.

Once you do get up on the roof, be careful not to lose your balance. A big antenna on a high mast with a rotator is very heavy and cumbersome. It's a good idea to have a helper, especially on windy days. Try to keep the mast balanced and under control, with your feet planted firmly on the roof at all times.

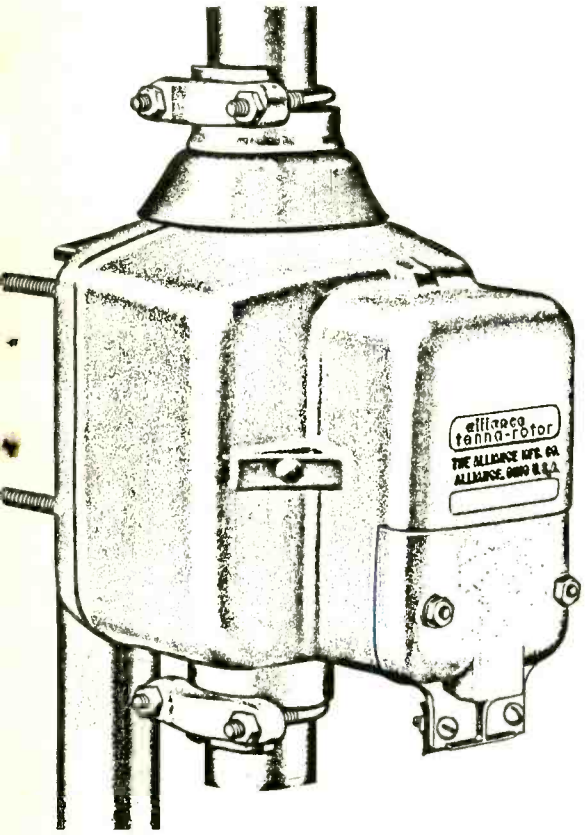
Inexperienced installers often have trouble with the rotator wires. It is easier to twist the leads and tin them *before* attaching them to the rotator terminals. This reduces the likelihood of stray wires shorting between terminals or touching the case.

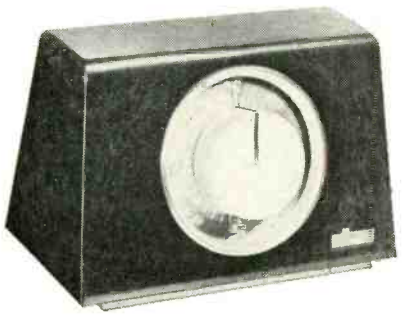
Also, if you use twin-lead, keep it away from the rotator wire. Some standoffs accommodate both rotator wire and twin-lead, but it is definitely bad practice to run these two cables closely in parallel. To avoid interference, tape the rotator wire directly to the mast. Use weatherproof vinyl tape, long standoffs for the twin-lead, and twist the twin-lead. Of course, if you use coaxial cable, interference pickup is no problem and the dual cable standoffs will be convenient.

Rotator types

The most common consists of a top-of-the-set control unit and a mast-mounted motor, connected by four- or five-conductor wires. One major difference between various rotators is the control unit. With manual control units, the user pushes a button or a bar and waits till the picture looks sharp. On automatic types, a knob can be set to a desired direction and the antenna will automatically aim in the direction indicated. **R-E**

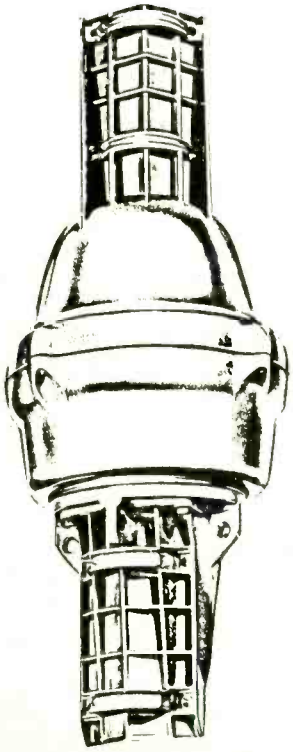
Bigger and better antennas need bigger and better rotators



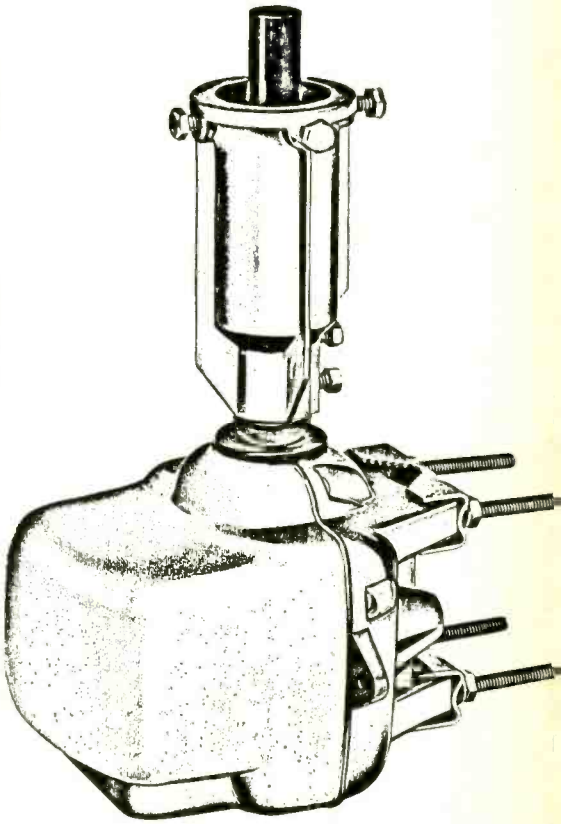


Alliance Tenna-Rotor can be operated with any of three control units. T-45, top left, is a manual control. U-100, top right, is automatic, and the C-225 control unit, is transistorized for automatic, stepless synchronous action.

Cornell-Dubilier's AR-10B (right and above) is an automatic rotator. Antenna turns until its position matches that indicated on compass rose on control box.



Cornell-Dubilier HAM-M. Heavy-duty motor will handle up to 1000 lbs. The calibrated meter control unit indicates antenna position in degrees of rotation.



By WALLACE WANER

How to Get the Most

MOST OF US IN ELECTRONICS REALIZE that color television and stereo FM require a good antenna for peak performance. Even with a good antenna, however, results are often less than expected, and the locality is usually blamed for the poor reception.

In many cases, the fault is actually caused by overlooking some basic requirement for a good antenna installation.

If any antenna system has been up for more than 5 years, it should be suspected of contributing to reception problems. When components are rusted, wires broken and cable insulation chipped, an entirely new installation is in order. Even in new installations, peak reception can be obtained only by following the correct installation procedures.

General characteristics

While you don't have to be an antenna engineer to get the best from an antenna installation, it does help if you understand a few simple basics. Let's review some useful antenna facts. A half-wave dipole antenna with the transmission line connected at the center has a figure-8 pickup pattern, as shown in Fig. 1. Thus, if the overall length of the antenna is approximately

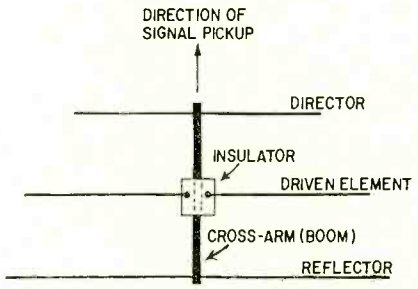


Fig. 2—The basic Yagi antenna contains three elements. Length and spacing of elements determine working frequency.

88 inches, the pattern is a close approximation of the antenna's channel-3 pickup characteristics.

The vertical pattern is the same all around the antenna. That is, the antenna picks up signals from the forward and rear directions as well as from the ground level and sky. For TV, such a simple dipole has several drawbacks: Its impedance is only about 75 ohms and therefore mismatches 300-ohm-input tuners. The antenna has low gain, and signal pickup from two directions can cause ghost troubles and co-channel interference. The pattern changes for higher channels, producing a four-lobe clover-leaf for channel 10.

To increase gain and directivity, manufacturers add reflectors and directors to the basic dipole to form a *Yagi* antenna (named after its inventor). The basic Yagi shown in Fig. 2 has one reflector in back of the driven element (dipole) and one director in front of it. Many multielement antennas (even with a dozen directors) are essentially Yagi types.

The added elements decrease signal pickup from the rear and increase gain in the forward direction, as shown in Fig. 3. If you point the director end north, for instance, the antenna will have maximum signal pickup from that direction, as shown. In this position any station to the northeast will be picked up with decreased gain, while stations due east or west will barely be picked up (unless they are very close and have high power).

Two minor lobes also exist and provide some signal pickup from the southwest and southeast. If adjacent-channel stations are nearby and in these directions, they can still cause some interference, though not to the same degree as the single dipole shown in Fig. 1.

With a long, multielement antenna the forward lobe becomes narrower and the gain increases considerably, as shown in Fig. 4. This makes for superior signal pickup in fringe areas, but

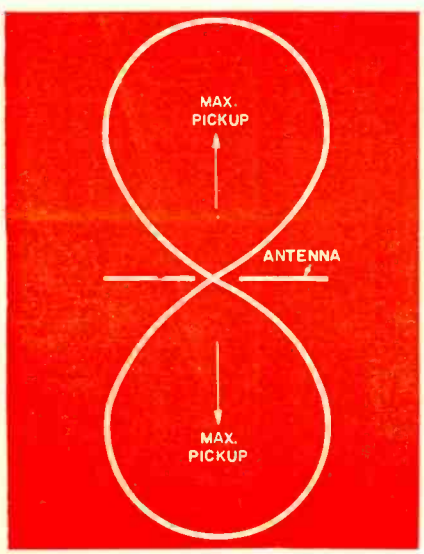


Fig. 1—Simple dipole pickup pattern.

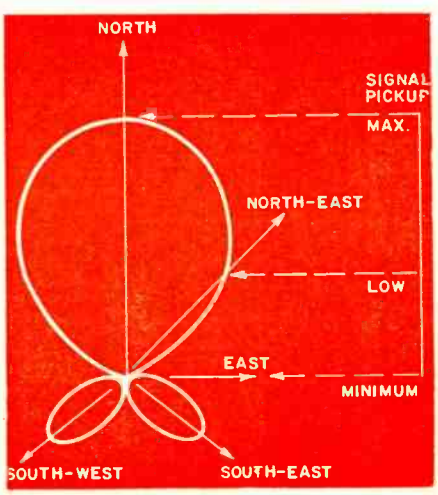


Fig. 3—Yagi pickup pattern shows how to aim antenna for best pickup of desired station, avoiding interference.

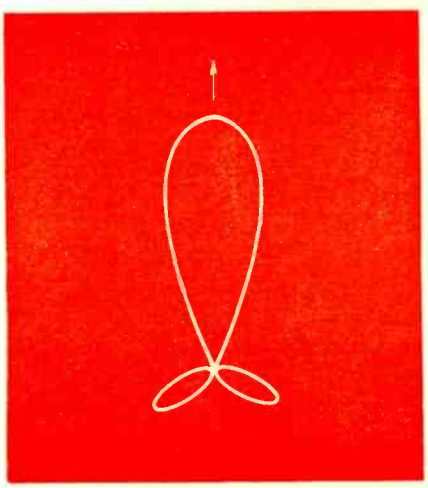


Fig. 4—Highly directional pattern is obtained by increasing the number of director elements in the Yagi.

Helpful hints for improving performance of both new and existing installations

From TV Antennas

the highly directional characteristics makes it necessary to use an antenna rotator for stations not located in the same line of reception.

When an antenna has a sharp forward lobe, and little if any rear-lobe characteristics, it is said to have a good *front-to-back* ratio. Another term to remember is *polarization*, which refers to the plane of the electric component of the transmitted signal. If the transmitting antenna is horizontally positioned (horizontally polarized), the receiving antenna must also be horizontally polarized for maximum signal pickup.

Orientation, on the other hand, refers to (compass) *direction* of pickup. You point the antenna toward the signal source.

Don't confuse *bandwidth* with *directivity*. A Yagi antenna could have excellent directivity (signal pickup along a narrow area) and have either good or poor bandwidth characteristics. If the resonant characteristics of the antenna are too sharp, it may not cover the entire *station bandwidth*, and therefore will cut some sidebands. This fault could have serious effects on color television reception.

Thus a good commercial antenna is preferred over a home-built one—the design engineers take both bandwidth and directivity into consideration. They do this by using proper spacing between elements, various element lengths, and by interconnecting certain sections with proper phasing stubs. Since antenna-resonance effects carry over into the harmonics of the fundamental frequency, it is possible to design antennas with good gain from vhf channel 2 to 13, or from channel 14 to 83.

Don't expect every antenna to have flat response to every channel, but you can orient an antenna to favor some stations with or without a rotator.

Figure 5 is a typical graph of gain vs frequency for an antenna. Here the antenna length has been selected for resonance around channel 3. This is a common practice for antennas to be used in cities such as New York and Los Angeles, where both channels 2 and 4 are used. Since the antenna peak occurs at channel 3, it follows that response will be substantially the same on 2 and 4.

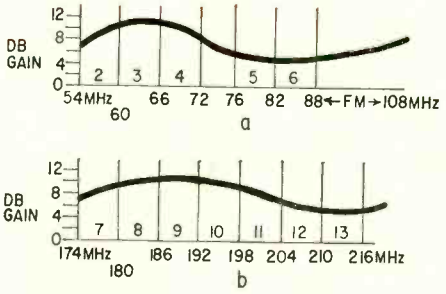


Fig. 5—Frequency response curves for typical TV antenna, for (a) low-vhf TV and FM, and (b) for high-vhf TV.

In the case of the antenna graphed in Fig. 5, gain decreases for channels 4, 5 and 6, but starts to rise at roughly twice the channel-3 frequencies (120 to 132 MHz). A rise occurs again at three times the fundamentals (180 to 198 MHz), then declines again. This harmonic design is on purpose, of course; it equalizes response over the desired frequencies. Sometimes response is deliberately lowered to frequencies between channels 6 and 7. This precaution minimizes interference from FM and other stations.

Charts like Fig. 5 show *bandwidth*, while lobe patterns such as Figs. 1, 3 and 4 show *directivity*.

If you are using standard unshielded twin-lead, remember to keep it away from metal supports, rain pipes, tin roofs, etc. You can drain off a lot of signals by taping the lead to the mast or clamping it to the walls of aluminum siding. However, too many standoff insulators can cause other losses.

All transmission lines introduce some losses, but a good grade of twin-lead usually has less than 1 dB signal loss per 100 feet for the lower television channels. Still, in a weak-signal area, it is best to keep the twin-lead length as short as possible. *Leave only enough slack at the receiver for convenience in moving the set.* If you end up with 5 or 10 feet of lead and coil it up in back of the set, you can sometimes cause complete loss of usable signal.

If ignition and other types of interference are a problem, shielded twin-lead or coaxial cable can be used. If you are in a weak-signal area, however, the higher losses of these types may drop the signal into snow. Shielded lines have the advantages of lower noise pickup and the fact that no standoffs need be used. They may be taped directly to the mast for support. Even on good coaxial lines the losses may range from 1.5 to 5 dB per 100

(continued on page 68)

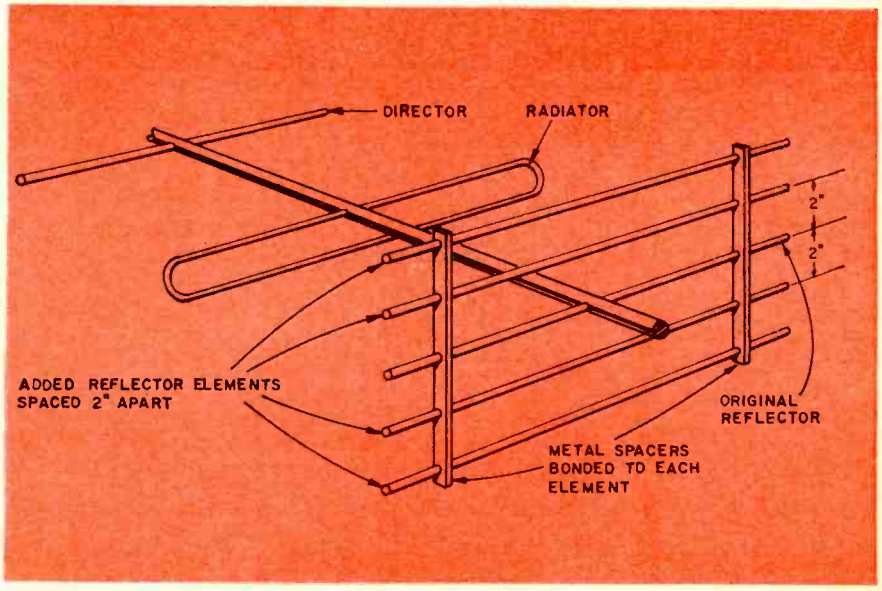


Fig. 6—Where undesired signals are picked up off the rear of the antenna, a more efficient reflector is called for. Here's one way to do the job.

Sophisticated symptoms help pinpoint

FIX COLOR TV

IN MANY CASES AN EXPERIENCED service technician can diagnose faults in a color TV by closely observing the screen. In other instances he may localize a defective stage by a quick check with a single piece of test equipment. The newcomer, on the other hand, may take two or three times longer to pinpoint certain faults and has to use several test instruments in the process.

The experienced man is quicker because his long exposure to practical troubleshooting has provided him with many shortcuts and tricky time-savers. Some of these are particularly useful in color TV servicing because the actual repairs and adjustments are time-consuming enough in themselves without having to spend extra time in diagnosis. There really is no substitute for experience; but one doesn't live long enough to get all the knowhow he would like to have. The next best thing is to learn from other people's experience. Here's a few of them to put in your bonnet.

Misconvergence

After a color set has been in operation for some time the convergence may shift slightly off normal. The process may be so gradual that the viewer remains unaware that his picture quality is not what it was initially. The colors may all appear to be true, and white areas of the scene appear natural. What happens, however, is slight color fringing between abrupt changes in the scene.

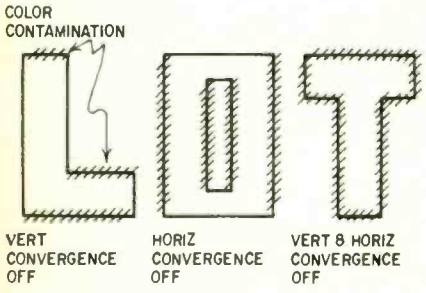


Fig. 1—Examples of color fringing caused by misconvergence. Vertical misconvergence affects horizontal lines, as in the letter L. Horizontal misconvergence upsets vertical lines as in the letter O. Letter T shows vertical and horizontal fringing.

You don't need a dot generator to check this condition, because the clues are evident in almost any scene transmitted. In particular, note if changes from a black area to white (or a dark color to a lighter color) are sharp and clean. If someone in the picture is wearing a dark coat and a white shirt, there should be a clean change from the dark to white, without a band of color appearing along the change area. If a narrow band of green, red or blue runs along the coat lapel bordering the white shirt, convergence is off.

Lettering on the screen will also show if convergence is off. The clues are shown in Fig. 1 for the letters LOT. If vertical convergence is off, all horizontal areas of a letter will show color contamination as indicated for the letter L. If horizontal convergence is off, all vertical borders of a letter will have color tints in them, as shown for the letter O. If both vertical and horizontal convergence are off, both the vertical and horizontal edges of a letter will show evidence of color fringing, as indicated for the letter T.

The types of convergence faults which show up may differ for letters near the sides of the screen, compared to those located near the center. Thus, additional clues are visible and pinpoint whether the convergence should be corrected at the sides only.

Large color-contaminated areas or color blotches indicate a need for degaussing. They could, of course, also indicate severe misconvergence, but if the set was converged properly when installed, it is unlikely that convergence has changed much unless defects had developed in the convergence circuits. Thus, if large miscolored areas appear, try degaussing first, even if the set has an automatic degausser. If this doesn't help, convergence (as well as purity) checks will have to be made.

If good convergence cannot be obtained with the controls, check the convergence board components and try a new shunt regulator tube. Readjust the high voltage to the value specified by the set manufacturer.

(Often the set owner will attempt adjustment of the focus control and the linearity controls; both affect the convergence. Hence, these settings should be checked before converging procedures are begun. Quick-check clues for these are given later.)

Picture pulling

If the picture pulls to one side or weaves slightly, the cause could be a misadjusted age system or horizontal lock circuits. First check the age control on the strongest station. Advance the control to the point where the picture starts to pull or distort and then back it off to the point where pulling stops. If the trouble persists even for weaker local stations, check

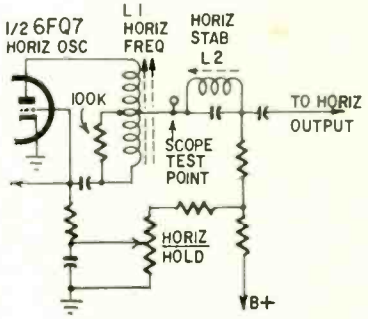


Fig. 2—Oscillator of a typical synchroguide system is identified by two coils connected as shown. Very common in older b-w receivers, the circuit is so stable that the hold control is often omitted.

difficult to find troubles

By MATTHEW MANDL

TROUBLES FAST

the horizontal lock system. You should be able to set the hold control a little bit off its best setting and still get good and rapid picture pull-in when changing stations. If the picture goes out of sync for a second or before locking in after changing stations, try adjustment of the horizontal oscillator coil, preferably following the manufacturer's suggestions for that particular receiver. If this doesn't help, try a new horizontal oscillator tube and readjust the controls. Unless parts in the circuit are defective, you should be able to cure the trouble with the common phase-detector lock systems.

Some newer color receivers are using a modified version of the synchroguide horizontal lock circuit quite popular some years ago. You can identify a synchroguide system by the additional coil connected to the center of the oscillator coil as shown in Fig. 2. Some receivers use a 6FQ7 or 12FQ7 dual triode for the oscillator and control tube. Because adjustment of this circuit is more complex than for the phase-detector type, try a new tube and adjustments of the hold control before realigning the entire system.

If coil adjustments are necessary, the chassis will have to be pulled because the procedures involve shorting out stabilizing coil L2 while adjusting L1 for near sync. The jumper is then removed and L2 adjusted for best lock-in. A quick check to see if L2 is properly adjusted can be made with an oscilloscope connected to the test point shown in Fig. 2.

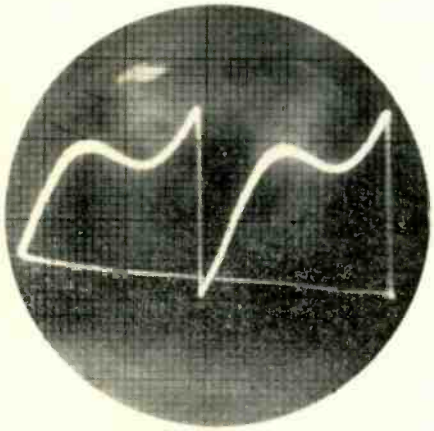


Fig. 3—Waveform at test point of a synchroguide should have equal peaks.

Unshielded scope leads are preferable for this test to minimize probe capacitance which might affect oscillator operation. With the scope's vertical input connected to the test point and a common ground lead between the set and the scope, a pattern such as shown in Fig. 3 is obtained. If, as shown, the curved portion of the trace (the hump) is below the sharp peak of the waveform, coil L2 requires adjustment. Turn the slug of L2 until the hump of the waveform has the same amplitude as the sharp peak. Now the horizontal lock should be stable, though you may have to retouch L1 for best results.

Poor detail

Many color sets are not adjusted to give the sharpest picture. Perhaps this factor is neglected because color pictures themselves are still enough of a novelty that we are apt to overlook possible improvements. As in black-and-white sets, horizontal trace lines should be clearly visible if the set is focused properly. A multicolored scene may tend to obscure the lines, but you can accent them by misadjusting the vertical hold control slightly to the point where the picture almost pulls out of vertical sync. Instead of the two scanning fields interlacing, the lines will pair up and become more visible. You can even have the picture rolling slowly and watch the paired lines for good focus.

Now adjust the focus control until the horizontal trace lines are the sharpest. In most cases several turns of the focus control are required for a noticeable difference in thickness or sharpness of the lines.

Some color receivers have a video peaking switch (or so-called "crispening" control) to provide some high-frequency video-signal attenuation. This, in effect, decreases sharpness of the picture for areas where snow effect or other interference is a problem. Make sure this control is set to give the best picture detail. Too often this control is set for a degraded sharpness even though the set is used in a good signal area. A properly adjusted focus control and the peaking switch set for a crisp picture result in a considerable improvement.

Poor linearity

The quickest way to check vertical linearity is to roll the picture and watch the blanking bar. Experienced service technicians routinely use this procedure.

Throw the picture out of vertical sync and observe the blanking bar at the top of the screen as in position 1 in Fig. 4, then watch it in position 2 at the bottom of the screen. If the bar doesn't retain the same thickness, the

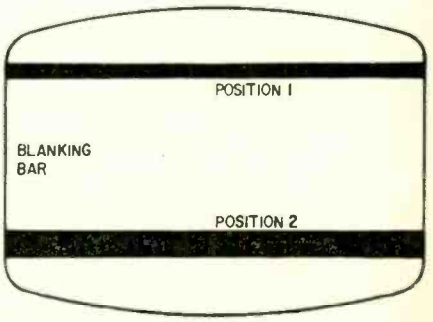


Fig. 4—Vertical nonlinearity is indicated when blanking-bar width varies as it moves vertically across the picture. Adjust both VERT LIN and VERT SIZE controls, which interact, for best linearity, consistent with proper picture size.

vertical linearity is out of adjustment.

After adjusting vertical linearity, recheck the screen and observe objects such as doorways, columns, tables, etc., to see if any bending exists along edges which should be straight, both horizontally and vertically. In color TV, horizontal linearity is related to proper horizontal sweep-circuit operation and high voltage. The drive for the output tube is set by the horizontal oscillator output and not subject to the settings of a drive control as is the case in many black-and-white sets. If horizontal circuitry is operating properly and distortion exists, it may be caused by misadjustments of the pincushion circuitry.

To double-check, use a cross-

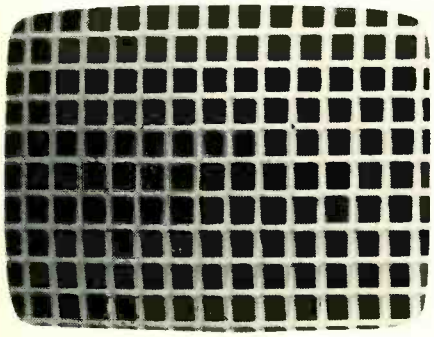


Fig. 5—A crosshatch pattern is desirable for linearity and pincushion checks.

hatch generator set to produce a sufficient number of both vertical and horizontal lines for observing any linearity defects or horizontal line curvature at the top or bottom. Linearity defects show up as variations in spacing between horizontal lines (for vertical linearity) and vertical lines (for horizontal linearity). Pincushion defects show up as a bending of the horizontal lines at either top or bottom, particularly near the edges of the screen.

If defects show up, adjust the pincushion controls for straight horizontal lines, as shown in Fig. 5. Sometimes a pincushion correction circuit uses a tube such as the 6FQ7 for correction amplification. Check this tube if the controls fail to correct the trouble. In some of the small-tube (19-inch) color sets, the 114° deflection tubes have such a wide scanning angle that pincushion correction may be troublesome, particularly if the picture is not centered vertically or the height and linearity controls are not set correctly. In such receivers, make sure you adjust height, linearity and vertical centering carefully. (Many of these sets provide a vertical centering control in addition to the height and linearity.)

Noise streaks

Interference streaks across the screen may be caused by ignition interference or other man-made noise or by high-voltage arcing within the set. For a quick check disconnect the antenna lead-in and see if the streaks still exist. If not, check for loose connections in the antenna system as well as for local noise sources. In a high-noise area it may be necessary to change to a coaxial lead-in.

If the noise streaks persist with the antenna disconnected, check for arcs in the high-voltage supply system and around the high-voltage connections to the picture tube. The back can be removed and a cheater cord used to operate the set. With the room darkened it is often possible to see the arc source. If not, it may be in the high-voltage cage. Any of the commercially available anti-corona fluids (spray-can type) can be applied to eliminate the condition. Some leads may have to be dressed away from the chassis if the anti-corona spray is ineffective.

Audio troubles

The sound from the speaker can also clue you in on the type of trouble. If a loud hum is heard, the likely fault is a filter capacitor in the low-voltage supply. A slight hum which appears only rarely could be transmitted on occasion, but more likely it indicates the initial breakdown of a filter, or cathode-grid leakage in an audio tube.

If the hum is present when the volume control is turned down, it obviously is not part of the incoming signal. Instead, it is due to filter or tube problems. Intermittent noise bursts could be caused by high-voltage arcing picked up by the audio circuits.

Audio distortion calls for a routine tube check in the audio section. If tube replacement fails to correct the trouble, replace the coupling capacitor between the amplifier (or detector) tube and the audio output tube. A slight leak in this capacitor couples enough of the plate voltage from the amplifier stage to the grid of the output tube and upsets bias (Fig. 6).

Many experienced technicians, when confronted with audio distortion,

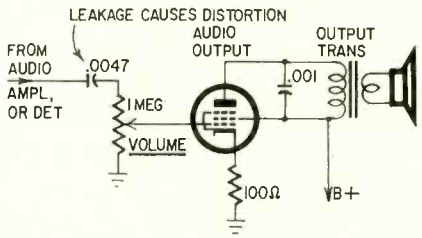
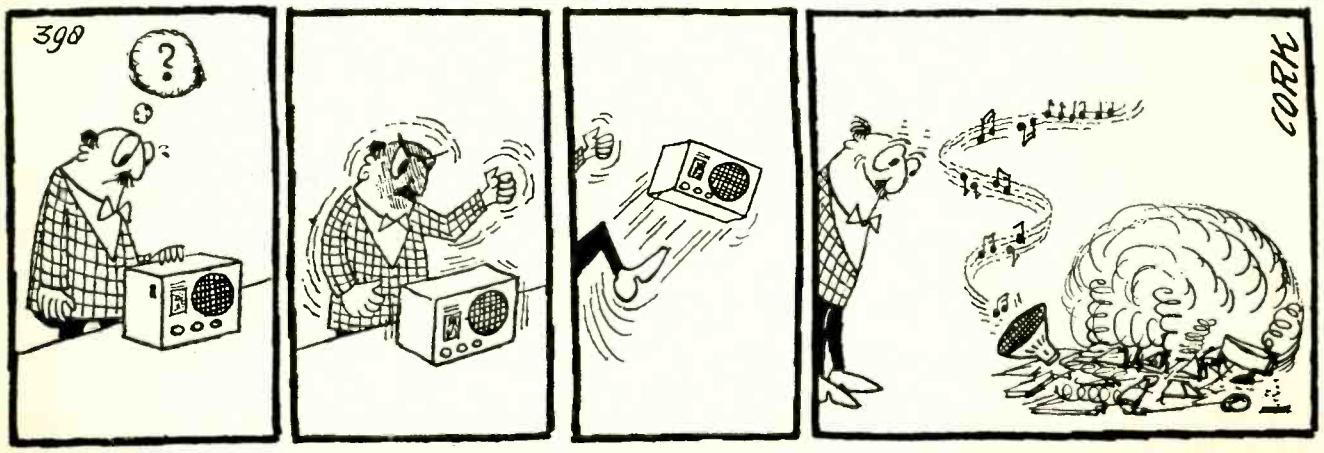


Fig. 6—A leaky coupling capacitor puts a dc voltage on the grid, distorts the sound and makes the volume control noisy.

replace the coupling capacitor routinely, even before checking tubes or replacing other parts. In transistorized audio amplifiers, the same factors apply and the coupling capacitor is often the offender.

Persistent noise is often the fault of dirty contacts in the volume control. Turning the control up and down is a quick check for this condition. Before replacing the pot, try a liquid volume-control cleaner, running it down the shaft and into the casing at the terminal openings. Rotate the knob several times to spread the cleaner over the sliding contact and the resistance strip of the control. In most cases this will cure the trouble and the control is good for another two or three years or more. **R-E**



Build: ESA-meter

Convert a standard meter to read small current variations

By EDWIN N. KAUFMAN

THE EXPANDED-SCALE VOLTMETER has been around for some time. Its dial, instead of being calibrated from zero to 120 volts, might indicate 90 to 130, thereby allowing you to read small changes which you couldn't on the usual meter.

Not so common, however, is a *current*-measuring device with an expanded scale. Such a meter is useful in monitoring small changes in current. For instance, I wanted to measure oscillator supply current when the circuit loading of an experimental hookup was varied. The values ranged from about 32 to 34 mA, difficult to read on a standard 0–50-mA meter.

A circuit was built to convert a conventional milliammeter into an expanded-scale model covering the range of interest. It also appeared desirable to have a circuit that could be inserted in series without regard for polarity.

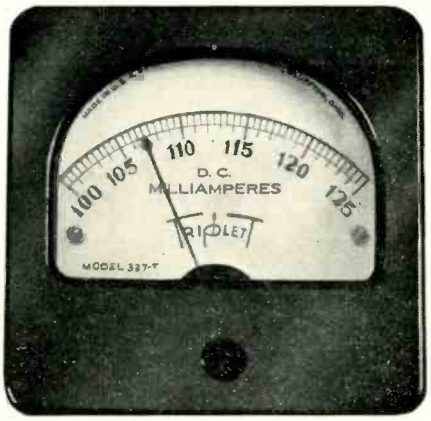
Theory

The basis for this expanded-range voltmeter is simply a bridge circuit which limits meter action to deflection above a certain voltage level (Fig. 1). Depending on the circuit, one or two bridge elements are used to provide a standard or reference voltage across one leg (or two) of the bridge. The ZERO BALANCE control is then adjusted for zero voltage (or null balance) across the bridge while the circuit is drawing its minimum rated current. Any increase in current causes the bridge null meter to read. Maximum sensitivity is obtained when all bridge legs are the same resistance value.

The meter movement should be a milliammeter, not a voltmeter. A typical 0–50-μA movement requires 100 mV for full-scale deflection. Also a 0–1-mA movement will give equally good results.

In Fig. 1, No. 49 pilot bulb is used as the "standard" circuit element, establishing a plateau of 60 mA at 2 volts. The lamp is a simple, inexpensive method of obtaining a standard current, though not as accurate as other ways.

The circuit shown, with either a 0–50-μA or 0–1-mA meter, has a range of 80 mA to 124 mA. Because the resistance of the filament of a tungsten lamp varies greatly with applied voltage, you may have to experiment somewhat to find what current is flowing and what indication the meter shows. Then you can reletter the meter dial accordingly.



The "standard" circuit element must have a reasonable voltage drop across it so that the ZERO BALANCE control can have a relatively high resistance. Then small variations in current through the balance control will cause a voltage drop across the bridge.

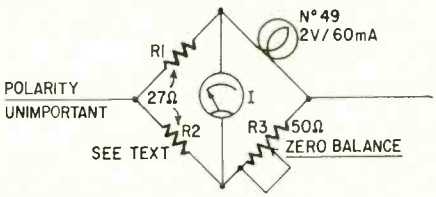


Fig. 1—Easily available and costing little, a pilot bulb can be used as a standard circuit element in the current bridge to limit meter action.

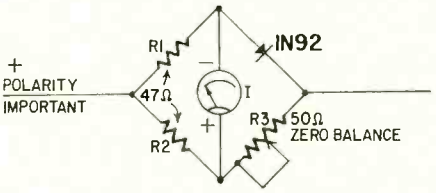


Fig. 2—Greater accuracy is obtained with a diode standard element to establish a current plateau in bridge.

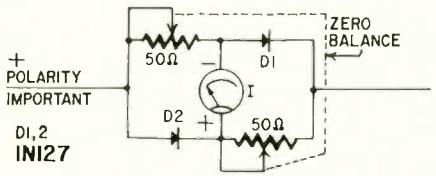


Fig. 3—Variations of the diode bridge uses twin elements. See text for details of the diodes used here.

Bridge voltage drop varies with circuit elements and current, from about 0.6 volt to 10 volts. By increasing (in the circuit of Fig. 1) R1 and R2 to 47 ohms, you obtain a meter range of 100 mA to 145 mA, with bridge drop from 4 volts to 7 volts.

External load current also varies bridge voltage, causing the power supply to act poorly regulated. The effect is more pronounced on low-voltage circuits, and may be minimized by adding a capacitor across the output.

Diode circuit

You can obtain greater accuracy by using a solid-state diode as the "standard" element in the bridge. An inexpensive germanium diode offers low circuit drop voltage, but a Zener will function even better.

The circuit of Fig. 2, using a 0–1-mA movement, has a range of 32 mA to 78 mA. When R1, R2 and R3 are increased to 100 ohms and a 0–50-μA movement is used, range is increased to 100–120 mA.

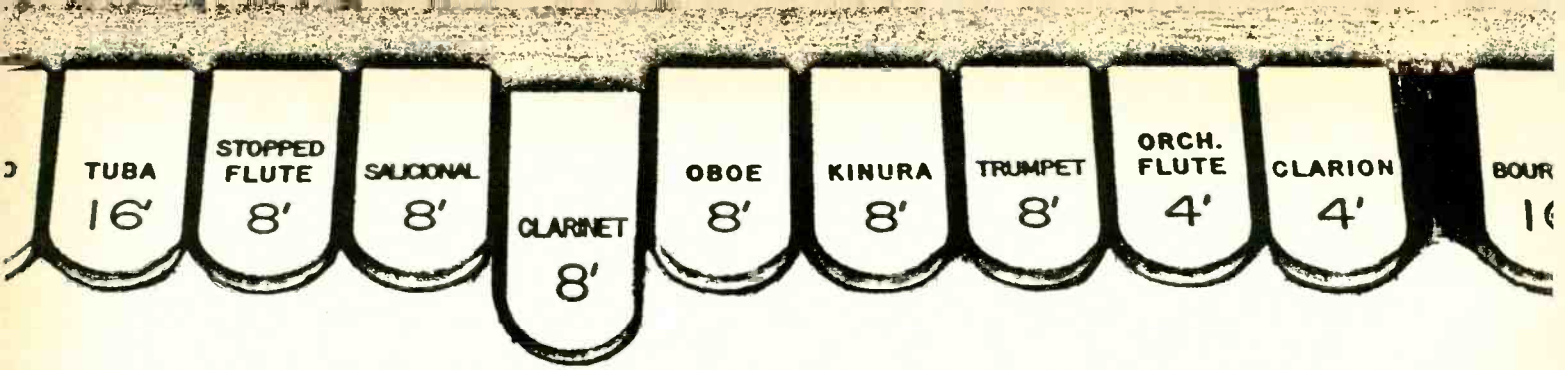
Another circuit (Fig. 3) uses two diodes and two potentiometers (ganged). With the 50-ohm controls adjusted to 47 ohms each and a 0–50-μA movement, range is from 100 mA to 126 mA. When R1 and R2 are 100 ohms, the range is 34–42 mA. Other values: 220 ohms, 8–12 mA; 350 ohms, 3.4–6 mA.

[Author Kaufman built the circuit of Fig. 3, which worked for him. But the 1N127 has a manufacturer's rating of only 30 mA I_{max}; in the circuit of Fig. 3 each diode *could* carry as much as 62 mA. We therefore recommend a diode with a higher I_{max} rating.—*Editor*]

Other tips

Often, by reversing the leads to the meter movement, you will obtain another range of current measurement. It's best to experiment with various hookups and monitor current flow with a vom operating in the milliammeter function.

In the illustrated examples, resistor size depends on resistance and maximum current in the test function. Wattages range from ½ to 2. It's best to calculate dissipation for the worst case in each hookup you make, then choose a somewhat larger-wattage resistor. **R-E**



How to Be An Expert Organ Tuner

Simple procedures and inexpensive equipment add up to profits for you

By RICHARD H. DORF

IT MAY SURPRISE YOU TO HEAR THAT unless your electronic organ has been tuned within the last few months, you may not be enjoying it as much as you might—even though it still seems to sound all right. An organ gets out of tune very gradually and, until the mistuning gets very bad, most people cannot detect the fact that something is sour. Unfortunately, the effects of mistuning are very sneaky: The instrument just somehow doesn't give the pleasure it used to, even though you don't know why. You don't realize how insidious the process has been until you have a good tuning job—and the organ suddenly gives that like-new thrill again!

Every electronic organ using oscillators does get out of tune—regardless of what the salesman may have said—and can be returned *by you*, without prior training, knowledge of music or a special musical "ear." While you can purchase instruments designed for tuning by the unskilled at prices ranging from $35 to $180, the most you actually may *need* to spend to tune your own instrument is about $4—the price of a good A-440 tuning fork (and they can be had for less).

An instrument for tuning is a good idea if you would like to make a few dollars tuning organs for others; it saves time and guarantee accuracy the first time. Instruments are entirely unnecessary if you are willing to spend perhaps 30 minutes to an hour on an organ once every few months. The *beat method* we shall describe requires only an accurate source for the middle-A pitch (440 Hz), a watch or clock with a sweep secondhand, and a little patience.

If you are too chicken to take the risk of beat tuning, there is one tuning system even easier, more nearly infallible and as inexpensive as the beat method. You can use it if you have a phonograph turntable of almost perfectly steady speed (and also preferably almost perfectly accurate) and a special phonograph record. This is a 7-inch, 33-1/3-rpm record* on which 12 perfectly tuned tones have been recorded, representing one complete octave.

With the record as a standard, you simply tune each note for zero beat with the recorded tone. This finishes the job for frequency-divider organs; individual-oscillator instruments such as Conn, Allen and Rodgers require the remaining oscillators to be tuned by zero-beating each with its counterpart in the middle octave first tuned with the record.

There is some risk in tuning by the beat method. Conceivably you could end up with the frequencies scrambled beyond belief. However, if you are sufficiently intellectual to read Mother Goose without moving your lips and you avoid organ tuning while under the influence of alcohol, this danger is negligible—and beat tuning is actually fun.

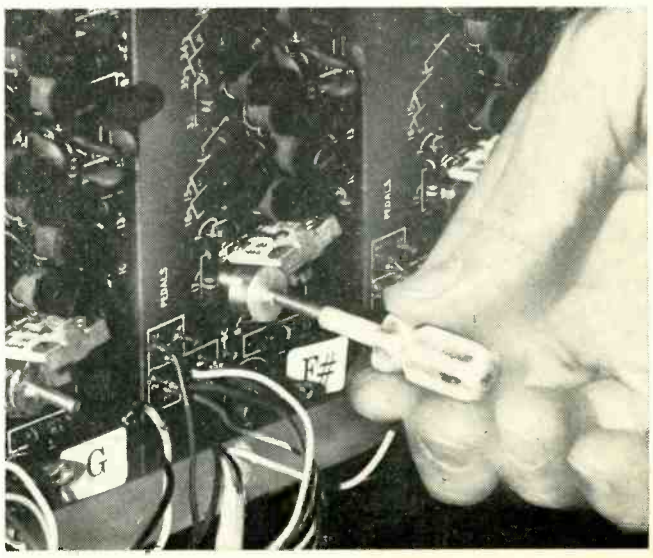
*Available from the Schober Organ Corp., 43 W. 61 St., New York, N. Y., 10023, for $1.

Those crazy frequencies

Table I shows the correct frequencies for all the notes of eight musical octaves. You do not need to know these frequencies to tune by the beat method, but the table shows why musical tuning is so special and cannot be accomplished in any simple way, such as with oscilloscope Lissajous patterns or with a calibrated audio generator. Looking down any vertical column, you will find that in any octave no frequency has any simple relationship to

You will have to recruit an assistant or you can use matchbooks to hold down the necessary keys while you adjust tuning. You will need both hands to do the job right and work smoothly.

Frequency-divider organ has only 12 tuning adjustments. Each is a screw that adjusts the position of an iron slug in an oscillator coil. The F# coil tunes all F#'s simultaneously.



any other. Furthermore, the actual numbers could never be located by eye on the tuning scale of a generator even if the scale were accurate. And while you do not really need all the accuracy given in the table, accuracy to four significant figures is necessary. In fact, to avoid offending the ear even unconsciously, the accuracy requirements of musical tuning are greater than almost any other frequency setting requirement normally encountered.

How all this arises is very simply explained. The normal scale used in the Western world is based on the *octave*, an interval between two frequencies having a ratio of 2 to 1. This decision was not arbitrary; two notes with this relationship sound peculiarly "identical," as experience tells us. The normal person, for instance, knows immediately that middle A (440 Hz) is "the same as" the A an octave lower (220 Hz), even though one is higher in absolute pitch than the other.

Between the two notes an octave apart the scale has been divided into 12 intervals. Since the ear detects intervals between pitches in terms of ratio rather than numerical differences in Hz, the 12 notes of an octave must be obtained by finding a single number by which the frequency of any note can be multiplied to find that of the next. In this way, all intervals sound the same and music can be played in any key on a keyboard instrument. If you are mathematically inclined, you will see that this multiplier must be the 12th root of 2—the number which, multiplied by itself 12 times, will equal the 2 which is the ratio of the octave.

That is exactly how the numbers in Table I were originally arrived at. The 12th root of 2 is actually 1.05946309 . . . The three dots indicate that the number is irrational and you can add as many decimal places as you have long winter nights to figure them, without ever coming to an end. All this, I am sure you will agree, is tremendously logical musically, but because the actual numbers are so outlandishly unrelated, some special way of tuning to them had to be devised.

Theory of beat tuning

Table I not only poses the tuning problem but also points to the answer, assuming you either are brilliant enough to come upon it or have been tipped off in advance, as I was. The key fact is that, beginning with any note, we will find that the note about an octave and a half (in musical terms an octave and a fifth) above it is nearly, but not quite, its third harmonic. For instance, 3 times the frequency of middle C (261.626 Hz) is 784.878 Hz. The frequency of the second G above middle C—the note an octave and a half higher—is 783.991 Hz, which is only 0.887 Hz lower than the C harmonic.

This suggests a method of tuning. Suppose that somehow we have already tuned the C perfectly. Now we tune the G until it is at exactly the third harmonic of the C. This is very easy to do, because we can detect the agreement by ear. When the G fundamental and the C harmonic are reasonably close, say within 15 Hz or so, the difference frequency produces amplitude pulsations known as *beats*. As we tune the G closer to the C harmonic, the beats get slower (farther apart), and when the two agree perfectly, the beats disappear altogether.

This method of getting agreement is highly sensitive and very, very accurate even on your first try. You can even see the beats by putting an ac voltmeter or the vertical input of a scope across the combined signal. The meter needle or scope trace will move in sync with the beats.

Once the G frequency agrees with the third harmonic of the C, we need only move the G 0.887 Hz downward to reach exactly its final frequency. This sounds ridiculous but is actually quite easy. We simply reduce the frequency of the G until we hear the desired frequency difference in terms of beats. Since it would be hard to count 0.887 beat each second (though a professional tuner learns to do it—by "feel," not by actual counting), we count instead 8.87 beats every *10 seconds*. In practice we simply make it 9 beats per 10 seconds, giving an error of .003 Hz, which is completely inconsequential.

The practical process

Table II gives all the information necessary to do the actual tuning, but first some simple preparations and some hints.

You need an accurate source of 440 Hz to set the first note. This is usually a tuning fork, though you can also use the 440-Hz tone on WWV if you can receive it well. WWV also broadcasts 600 Hz, so don't confuse the two signals.

You must use one or more 8-foot organ stops and use keys only in the middle octave—from middle C to the B next above it. This is a matter of convenience and standardization. The notes used need not actually be an octave and a half apart as in our example. If, in addition to the middle C, we had used the G in the same octave (391.995 Hz) rather than that an octave higher, our ears would have been comparing the third harmonic of the C (784.878 Hz) to the second harmonic (783.990 Hz) of the G rather than its

TABLE I—MUSICAL FREQUENCIES

	OCTAVE							
NOTE	1	2	3	4	5	6	7	8
C	32.703	65.406	130.813	261.626	523.251	1046.502	2093.005	4186.009
C#	34.648	69.296	138.591	277.183	554.365	1108.731	2217.461	4434.922
D	36.708	73.416	146.832	293.665	587.330	1174.659	2349.318	4698.636
D#	38.891	77.782	155.563	311.127	622.254	1244.508	2489.016	4978.032
E	41.203	82.407	164.814	329.628	659.255	1318.510	2637.021	5274.042
F	43.654	87.307	174.614	349.228	698.456	1396.913	2793.826	5587.652
F#	46.249	92.499	184.997	369.994	739.989	1479.978	2959.955	5919.910
G	48.999	97.999	195.998	391.995	783.991	1567.982	3135.964	6271.928
G#	51.913	103.83	207.652	415.305	830.609	1661.219	3322.438	6644.876
A	55.000	110.00	220.000	440.000	880.000	1760.000	3520.000	7040.000
A#	58.270	116.54	233.082	466.164	932.328	1864.655	3729.310	7458.620
B	61.735	123.47	246.942	493.883	987.767	1975.533	3951.066	7902.132

fundamental, and this would make no difference. We could even have used the G *below* middle C, in which case the *fourth* harmonic of the G would have been used. The fact is that only these two frequencies are close enough to matter, so whether they are fundamentals or harmonics makes no difference.

Some organ voices are easier to use than others because the beats are easier to hear. Diapasons usually work out well; flutes or tibias do not because there is too little harmonic content in them. Begin by holding down middle C and the G just above it, and trying various 8-foot stops to choose the one which makes the beats most obvious.

Before you do the tuning, locate the tuning adjustments on the organ tone generators. If the organ is a frequency-divider type, there will be just 12 adjustments, almost invariably in the form of screws controlling the positions of the slugs in the master oscillator coils. Be sure you can tell from the markings which screw is for which note. Then test one by turning it slightly one way and the other to find which direction of rotation raises and which lowers the pitch. Generally, turning clockwise raises pitch, but not always.

TABLE II—TUNING BY BEATS

SOUND	TUNE	BEATS IN 10 SECONDS
A–E	E	15
E–B	B	11
B–F#	F#	17
F#–C#	C#	12
C#–G#	G#	10
G#–D#	D#	14
D#–A#	A#	10
A#–F	F	16
F–C	C	12
C–G	G	9
G–D	D	13
D–A	A	10

If the organ has individual oscillators for every note, be sure you have located the adjustments for the notes of the middle octave. Refer to a service manual.

Now you are ready to begin. See that people are not moving around the room (this can create the impression of false beats). Recruit an assistant if you can, to hold down keys at your direction, leaving you free to make the adjustments and watch the sweep secondhand of your timepiece. If you can't find help, you can make keys stay down by wedging a matchbook between pairs of keys. Now here is the process:

Step-by-step process

1. Sound the middle A key alone. Sound your tuning fork by striking one tine against your kneecap and then holding the tines close to your ear or the handle against something which acts as a sounding board. Carefully adjust the A tuning control until the organ and fork tones zero-beat. In making the zero-beat adjustment, always check it by tuning to either side to see that you are actually at the null, and that beats actually do begin as you go to either side of the null.

2. Refer to Table II. In the SOUND column note that A and E are specified. Hold down *both* the A and E keys *in the middle octave only*. This means the E just above middle C and the A above that. Do not be confused by the fact that the two notes seem to be a musical fourth apart and not a fifth. As we have explained, it does not matter.

3. Note the TUNE column of Table II, which specifies E. Tune the E carefully for exact zero beat with the A tone. (This is the organ A tone, not the fork, with which you are now finished.)

4. The BEATS IN 10 SECONDS column of Table II specifies 15. Rotate the E tuning control to *reduce* frequency until you hear a definite beat. Count the beats while looking at your watch. If there are more than 15 in 10 seconds, turn the tuning control for the E to get back up slightly, closer to the zero-beat frequency; you detuned too far. Count again. Make the indicated adjustments and recount as often as necessary. When you finally have 15 beats in 10 seconds you have tuned the E and can go on to the next line of the table.

5. In this same way, go right down the table. Hold the notes shown in the first column; tune the one shown in the second for zero beat; then *lower* the frequency of this note until you get the indicated number of beats in 10 seconds.

6. When you get to the last line of the table, *do not retune the A*. This line is just for checking to see whether you have accumulated too much error. If the result is too different from the 10 beats in 10 seconds shown, go back and start over.

You will never, except as the accident of the century, really end up on the checking line with just 10 beats. If you end up as close as having 5 or 15 beats you will be as close as you could have gotten by using Conn's $180 machine! Remember that the actual frequency error is only 1/10 of the number of beats in 10 seconds. An error of 5, for instance, is a real error of only 0.5 Hz at some frequency between 523 and 987 Hz and is actually only about a hundredth of a semitone. And in all probability the error is shared among several notes, making the error for any one much smaller even than that.

If your organ generators employ frequency dividers, the job is done. If you have an organ with individual oscillators, simply tune the notes in each of the remaining octaves so that they zero-beat with those in the central octave you tuned by beats.

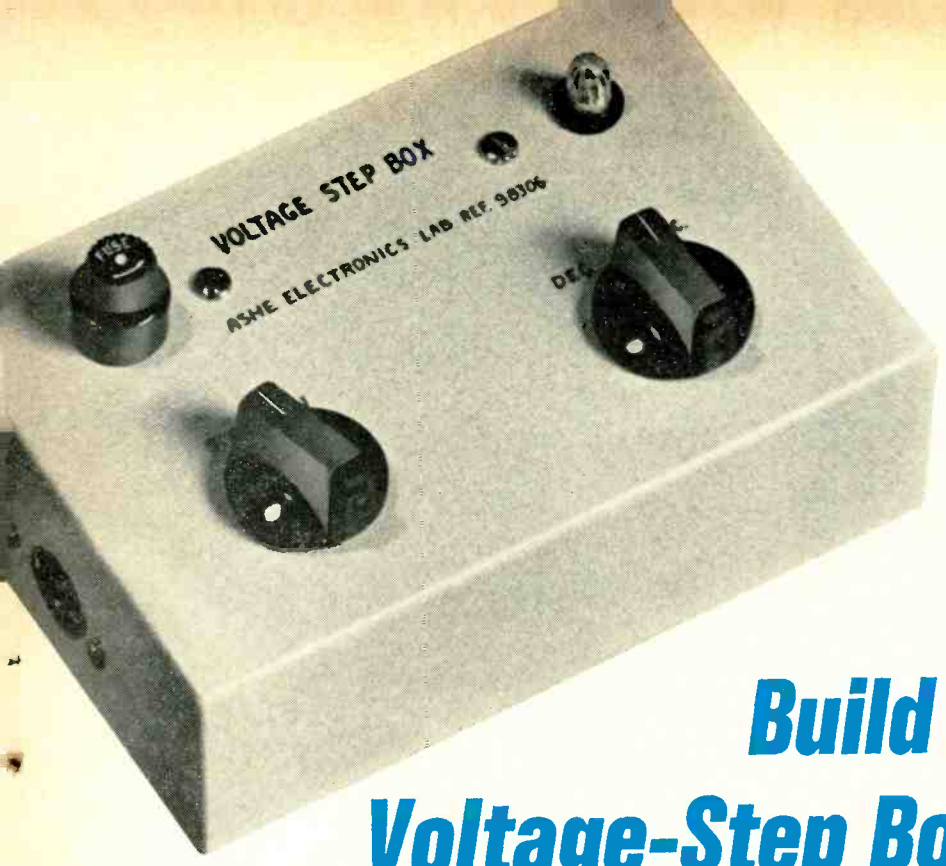
The inevitable temptation

Experience of many years makes me certain that 17.93% of the readers of this article will be tempted to apply this method to piano tuning, the excellent results on the organ having gone to their heads. Please accept my assurances that unless you know quite a bit about piano tuning (in which case you would not have needed to read this article) your most optimistic hope is to avoid breaking strings so that all you will have to pay for to rectify the mess you will make is a professional tuning job.

It is quite true that at least the middle octave of the piano can be correctly tuned by the beat method we have outlined—provided you are willing to learn how to use rubber wedges to kill the sound of all but one of the three strings and are willing to buy a tuning "hammer" (the special pin wrench) and to cope with the unpleasant behavior of steel pins turning in wood.

However, if you tune the other octaves of the piano by zero-beating the notes with those in the middle octave, the result will sound about as inspiring as a bugle made of chewing gum. A piano tuner tunes the upper octaves progressively sharp and the lower ones progressively flat of the middle octave, a process known as *stretching*. This is justified in part, from a physicist's standpoint, by the fact that the harmonics of struck strings are somewhat higher in frequency than true harmonics would be. However, a good tuner stretches a good deal more than that, simply because if he does not the piano sounds dead and uninteresting. Just how much each octave is stretched varies with the instrument and the desires of the owner if he is professional enough to know what he likes. The tuner, however, is *always* a professional, for there is no known way to learn how to stretch a tuning without plenty of experience.

If you try to be your own piano tuner, you will, like the lawyer who tries his own case, have a fool for a client! **R-E**



Build A Voltage-Step Box

Many drift problems are caused by power-line variations. This gadget helps solve them

By JAMES ASHE

ARE YOU HAVING TROUBLE WITH drift or instability in your receiver, test gear or other electronic equipment? Your difficulties may be being caused by poor line-voltage regulation. Here is a simple gadget that enables you to simulate line-voltage changes as you check equipment for drift.

Nearly all line-operated electronic equipment is subject to some form of drift with variations in ac supply voltage. Receivers must be retuned as they warm up, electronic voltmeters must be zeroed before use, signal generators and frequency meters must be recalibrated or zeroed before use for precise measurements. Phonographs and tape recorders may show variations in speed which may be traced to the power source. Some line-voltage variations are gradual while others are sharp dips or rises followed by a return to the original voltage level.

Some engineers call these changes "noise" because they constitute an unwanted signal applied to equipment operated from the power line. The better the grade of electronic gear the more likely it is to be immune to the effects of power-line noise and drift. However, this immunity cannot be taken for granted. The equipment should be checked frequently if you want optimum performance.

A Variac, or similar variable-voltage transformer, and an accurate voltmeter can be used to reproduce gradual changes or drift in power-line voltage but it cannot produce the really sharp changes which are preferable for test purposes. The Voltage-Step Box is simpler, less expensive and far more appropriate for test work. You can build one that handles up to 140 watts for considerably less than $10.

Parts List

F1—2-amp fuse with post-type holder
J1—Chassis-type ac receptacle
P1—TV interlock receptacle (Walsco No. 1650 or similar)
S1—Dpst rotary switch
S2—2-circuit, 3-position nonshorting rotary switch (Mallory 3223-J or similar)
T1—Filament transformer, 6.3 volts, 1.2 amps, see text.
MISC.—Aluminum chassis, 4" x 5" x 2", knobs, cheater cord

How it works

If we connect the primary of a filament transformer across an ac line, we get, at the secondary, a low voltage which can be connected in series with the input voltage. If the two voltages are *in phase*, the connection is *series-aiding* and the output is the *sum* of the two voltages. Reversing the phase of one of the voltages gives us a *series-opposing* connection which yields an output voltage that is the *difference* between the two voltages. Thus, the line voltage fed to the equipment under test can be increased or decreased by the value of the filament-transformer output voltage.

Figure 1 is the schematic of the Voltage-Step Box. When S2 is in the DECREASE position, the primary is across the power line and the secondary is in series in a series-opposing circuit. In the INCREASE position, we

(continued on page 91)

55

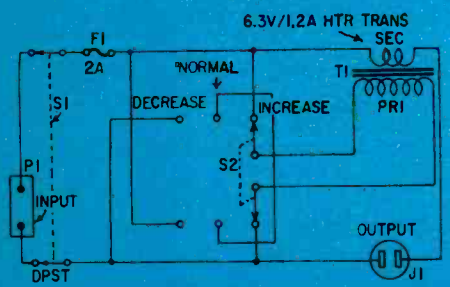


Fig. 1—The Voltage-Step Box lets you raise or lower line voltage when checking for drift. Fuse both sides of ac line when working with ac/dc equipment.

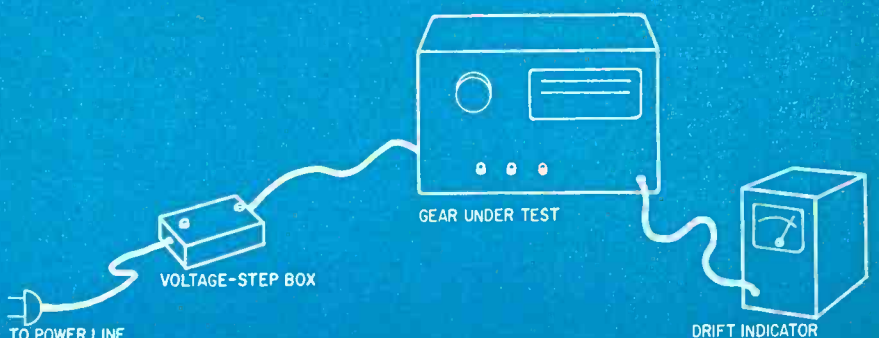
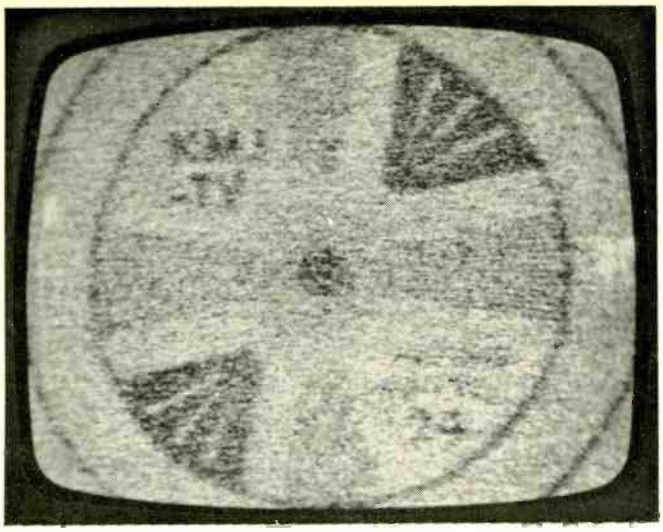
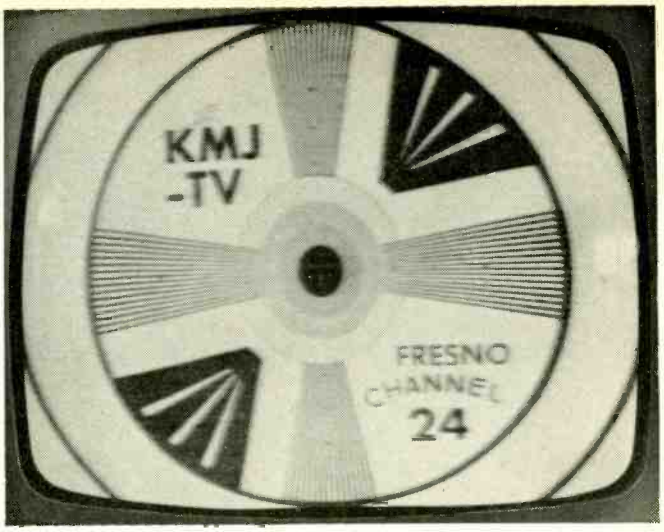
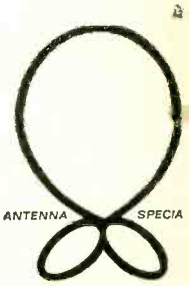


Fig. 2—How box is used to check the stability of your electronic equipment.





Build A High-Gain 48-Element UHF Antenna



Souped-up skyhook has 20 dB gain

By CHARLES L. SMITH

THERE ARE MANY SITUATIONS WHERE it's desirable to obtain clear uhf TV reception beyond the usual range of signals. In the deep-fringe area, far from the big-city station or the small-town translator, private individuals as well as CATV systems often want clean uhf signals. In the Midwest, many schools receive (or would like to receive) educational programs from the airborne transmitters of MPATI (Midwest Program on Airborne Television Instruction). Because of the extreme distance in deep-fringe areas—over 150 miles—it's usually hopeless to try for more than a single channel per antenna.

Uhf front ends have no rf amplifiers, and while a uhf preamp can be used, it must get a usable signal level from the antenna. What's more, every preamp contributes some noise to the signal.

The top left photo shows a test pattern obtained on a single dipole 180 miles from the transmitter. The photo at right shows the same test pattern as received on a 20-dB gain antenna.

You can build a 48-element 20-dB gain antenna; consisting of four 12-element Yagis stacked and phased for maximum pickup.

Designing the array

The number of elements in an individual Yagi is a logical starting point for calculating gain. Interelement spacing dictates the optimum number of elements that can be placed on a boom. For a channel-24 antenna on a 6-foot boom, the optimum number of elements is 12. It will produce approximately 14 dB more gain than a simple dipole.

If two Yagis are stacked, the signal pickup will be increased by 3 dB, for a combined gain of 17 dB. By adding two more Yagis, the gain will be increased 3 dB once again, for a total system gain of 20 dB.

The separation or stacking distance is governed by the gain of the individual Yagis. The spacing must increase as the number of elements increases. An *aperture* or *capture area* surrounds each antenna; the purpose of optimum separation is to prevent overlapping the capture areas. Table 1 shows suitable stacking dimensions for antennas in both the horizontal and vertical planes. Space the Yagis as specified in the table, plus additional distance for phasing line.

Fig. 1 shows how to figure the phasing-line dimensions. Section AX is any number of half-wavelengths. Since a

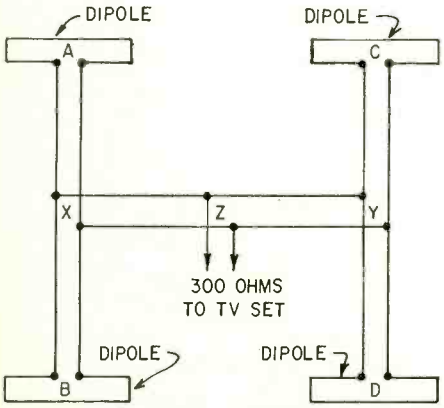


Fig. 1—Phasing-line layout; see text.

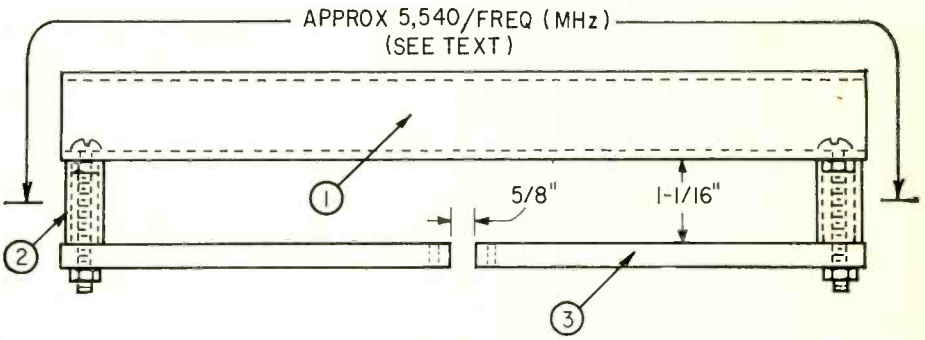
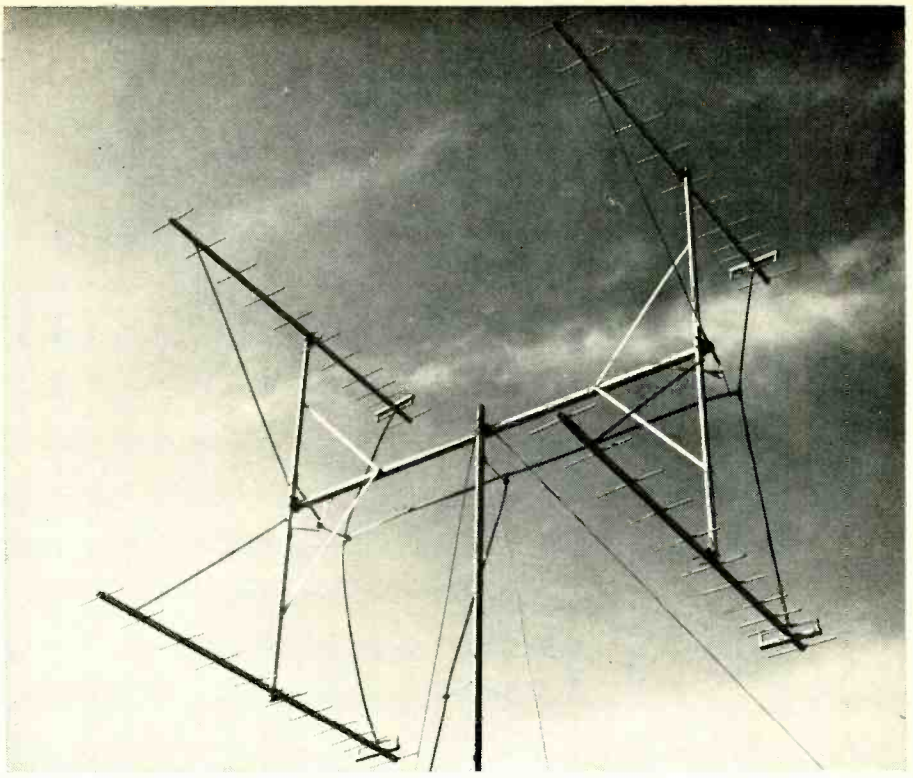


Fig. 2—Construction of the folded dipole. (1) 1" aluminum tubing; (2) 7/16" aluminum spacer; (3) ½" aluminum rod. Compute length from data in Table 2.

half-wavelength line (and multiples thereof) "repeats" an impedance, the total impedance at point X is the same as the folded dipole impedance (assuming for the moment that XZ and XB are not connected). Section BX is the mirror image of AX; therefore, connecting two 300-ohm impedances in parallel at point X results in an impedance of 150 ohms. The same is true at point Y.

The impedance at point Z must be 300 ohms to match the transmission line; hence, the 150-ohm impedances at points X and Y must be transformed to 600 ohms to arrive at the proper value when parallel-connected. A quarter-wavelength line (and odd multiples thereof) inverts impedances by means of its unique transformerlike properties.

To get the proper transformation ratio, it is necessary to select or to construct a quarter-wavelength line that has a characteristic impedance equal to the square root of 150×600. Fortunately, this happens to be 300 ohms. Thus, 300-ohm twin line can be used for the entire phasing line. For best results, use foam-filled tubular twin line. Belden 8275, or equivalent, is satisfactory.



Completed 48-element array ready to pick up a distant uhf channel.

Construction

The folded-dipole driven elements are constructed of 1-inch aluminum tubing and ¼-inch aluminum rod. See Fig. 2 for details. Most hardware stores stock such material; if the material is unavailable in your area, contact the nearest Alcoa, Reynolds or other aluminum distributor. If available, use 6061-T6 alloy; it represents a reasonable compromise between corrosion resistance and strength.

The approximate length of the folded dipole is given by the formula:

$$\text{Length (in inches)} = \frac{5{,}540}{\text{Freq (MHz)}}$$

Note that this formula, as well as those below, includes a *k factor*. Instead of using a full half wavelength, we use only 0.939 of it, to compensate for the length × diameter ratio of the elements.

The video transmitter frequency of the desired uhf channel can be found in Table 2. Select the channel you want to receive, and compute dimensions with the formula and the chart.

Depending on individual construction practices, the resonant frequency may not occur at the desired channel's frequency. The only way to be sure is to check it. The procedure for checking the resonant frequency will be discussed later. Only the first folded dipole need be checked, provided, of course, that the

Table 1 Optimum Antenna Stacking Separation

No. of elements	Separation dimensions (in λ) between Yagis
3	1.15
4	1.25
5	1.50
6	1.60
7	1.75
8	1.90
9	2.10
10	2.30
11	2.50
12	2.80
13	3.10
14	3.40
15	3.50

Table 2 Video Carrier Frequencies (MHz) for Uhf Television Channels

Channel number	Frequency in MHz	Channel number	Frequency in MHz	Channel number	Frequency in MHz
14	471.25	38	615.25	62	759.25
15	477.25	39	621.25	63	765.25
16	483.25	40	627.25	64	771.25
17	489.25	41	633.25	65	777.25
18	495.25	42	639.25	66	783.25
19	501.25	43	645.25	67	789.25
20	507.25	44	651.25	68	795.25
21	513.25	45	657.25	69	801.25
22	519.25	46	663.25	70	807.25
23	525.25	47	669.25	71	813.25
24	531.25	48	675.25	72	819.25
25	537.25	49	681.25	73	825.25
26	543.25	50	687.25	74	831.25
27	549.25	51	693.25	75	837.25
28	555.25	52	699.25	76	843.25
29	561.25	53	705.25	77	849.25
30	567.25	54	711.25	78	855.25
31	573.25	55	717.25	79	861.25
32	579.25	56	723.25	80	867.25
33	585.25	57	729.25	81	873.25
34	591.25	58	735.25	82	879.25
35	597.25	59	741.25	83	885.25
36	603.25	60	747.25		
37	609.25	61	753.25		

Table 3 Director Lengths

Director number	Length in % of full wavelength
1	46.8
2	46.0
3	46.2
4	46.5
5	46.3
6	45.7
7	45.5
8	45.3
9	45.0
10	45.0
11	45.0
12	45.0
13	45.0

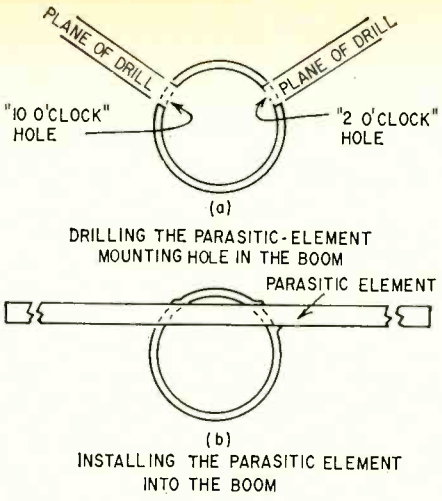


Fig. 3-a—Drill holes in the boom. b—then force-fit the element through the two holes; peen if necessary.

Table 4 Interelement Spacing

Between elements	Spacing (λ)
Reflector-dipole	0.18
Dipole-D_1	0.14
D_1-D_2	0.18
D_2-D_3	0.22
D_3-D_4	0.28
D_4-D_5	0.32
D_5-D_6	0.32
D_6-D_7	0.42
D_7-D_8	0.42
D_8-D_9	0.42
D_9-D_{10}	0.42

others are constructed identically. If the resonant frequency is too high, the element is too short; conversely, if the frequency is too low, the element is too long. Cut and try until the desired frequency is indicated.

The reflector element is constructed of ¼-inch aluminum rod. Its length can be derived from the formula:

$$\text{Length (in inches)} = \frac{5{,}800}{\text{Freq (MHz)}}$$

The director elements are also made from ¼-inch aluminum rod. For best results, each director's length must be cut slightly different from all the others. Table 3 gives the length for each in percentage of a full wavelength. The following formula gives the full wavelength dimensions:

$$\text{Length (in inches)} = \frac{11{,}808}{\text{Freq (MHz)}}$$

As each director is fabricated, file an identifying mark (such as a Roman numeral) on the director. This will permit identification when the directors are assembled onto the boom.

Use 1-inch aluminum tubing for the antenna boom. Several methods of supporting the antenna elements on the boom have been tried; none was easier to construct nor more reliable than the way described here. The parasitic elements are force-fitted through mounting holes that are drilled slightly out of alignment, thus eliminating the need for mounting hardware. Carefully lay out the work before drilling any mounting holes in the tubing.

First, mark a pair of longitudinal lines down the length of each boom; one should appear at the "2 o'clock" position, and the other should be at "10 o'clock." Next, calculate the interelement spacing with the aid of Table 4. Carefully drill a ¼-inch hole at each intersection formed by the longitudinal lines and the interelement spacing lines as shown in Fig. 3.

After all mounting holes have been drilled, drive the parasitic elements into the boom with a hammer. Observe the Roman numerals that were inscribed earlier to insure that the elements are placed in the correct position. If the elements fit too loosely in their mounting holes, strike a sharp blow near the mounting hole with a hole punch to distort the original hole enough to ensure a tight fit. A slight amount of misalignment of the elements can be compensated for by bending the elements after final assembly. Center each element on the boom. The folded dipole is mounted in a V-notch cut at right angles to the plane of the boom. It is held in place by a 2-inch machine screw.

Due to its velocity factor, a wavelength of phasing-line material is shorter than a wavelength in free space. The antennas must be separated a certain number of free-space wavelengths to obtain maximum gain. If the phasing line were cut to the same number of wavelengths, it would be only 70% to 85% as long due to the shortening effect of the velocity factor. To compensate for this, add one wavelength to the optimum separation listed in Table 1 before applying the velocity factor. Then cut the phasing line to precise multiples of quarter- or half-wavelengths. Sections AX, BX, CY and DY must be multiple half-wavelengths; sections XZ and YZ must be an odd number of quarter-wavelengths.

The length of a quarter-wavelength line that is corrected for velocity of propagation or velocity factor can be determined from the formula,

$$\text{Length (in inches)} = \frac{2{,}950 \times \text{VF}}{\text{Freq (MHz)}}$$

The velocity factor (VF) for 300-ohm twin lead varies between 0.7 and 0.85, depending on the type. Check the manufacturer's specifications for the type used. Belden's 8275 Celluline has a velocity factor of 0.80.

The phasing line will be slightly longer than the number of wavelengths chosen. The slack can be taken out of the line by moving the antennas farther apart or by bending the line forward.

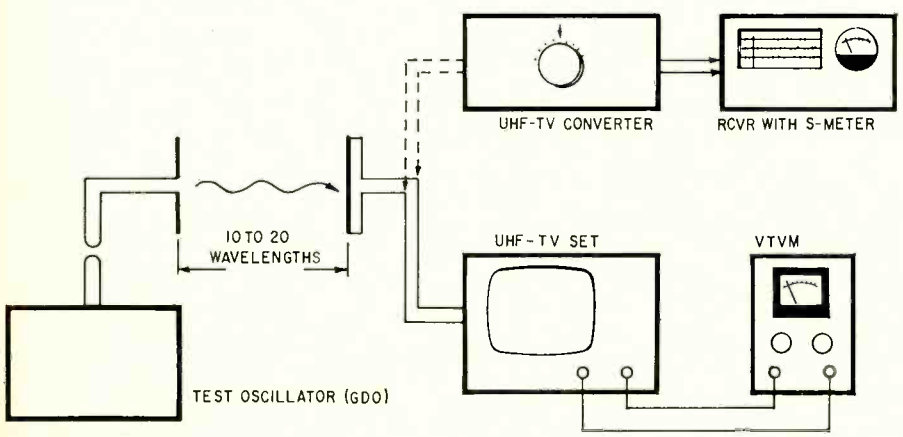


Fig. 4—Equipment setup for making check of the resonant frequency of the antenna.

Checking resonant frequency

Most textbooks mention cut and try as the final step in adjusting Yagi antennas. This is certainly true in the

uhf region. Since the Yagi is a narrow-bandwidth device, it is mandatory that the resonant frequency occur at the desired channel's mid-frequency. Use the test setup shown in Fig. 4 to find the resonant frequency. A test oscillator (grid-dip oscillator or equivalent) radiates a uhf signal that is intercepted by the folded dipole under test. The rf signal travels down a short length of transmission line to a receiver. The receiver can be either a standard uhf television receiver with a vtvm connected across its agc line, or a uhf converter feeding a communications receiver, an FM tuner or any set that has an S-meter and tunes to the uhf converter's output frequency. The vtvm or S-meter indicates the relative output.

Few gdo's have ranges above 300 MHz; however, most of them provide sufficient harmonic output to serve this purpose. By setting the gdo to a frequency that is one-third of the desired frequency, and coupling the harmonic output through a 1-turn loop to a resonant antenna, suitable energy will be radiated at the desired frequency in the uhf television band.

If the gdo doesn't work well at the high end of the band, experiment with the shape and dimensions of a special uhf coil fashioned from flat copper stock until the desired output is achieved.

Use the following procedure for checking and plotting the frequency response:

(a) Set the uhf television set (or converter) channel dial to a channel that is lower than the desired one and adjust the gdo until the vtvm (or S-meter) deflects. Observe and record the value.

(b) Tune the television set (or converter) to the next higher channel. Reset the gdo once again until its frequency coincides with the television set's channel. Again, observe and record the vtvm (or S-meter) indication.

(c) Repeat the above step until the peak output point that indicates resonance is found.

A typical frequency-response curve for a folded dipole is shown in Fig. 5.

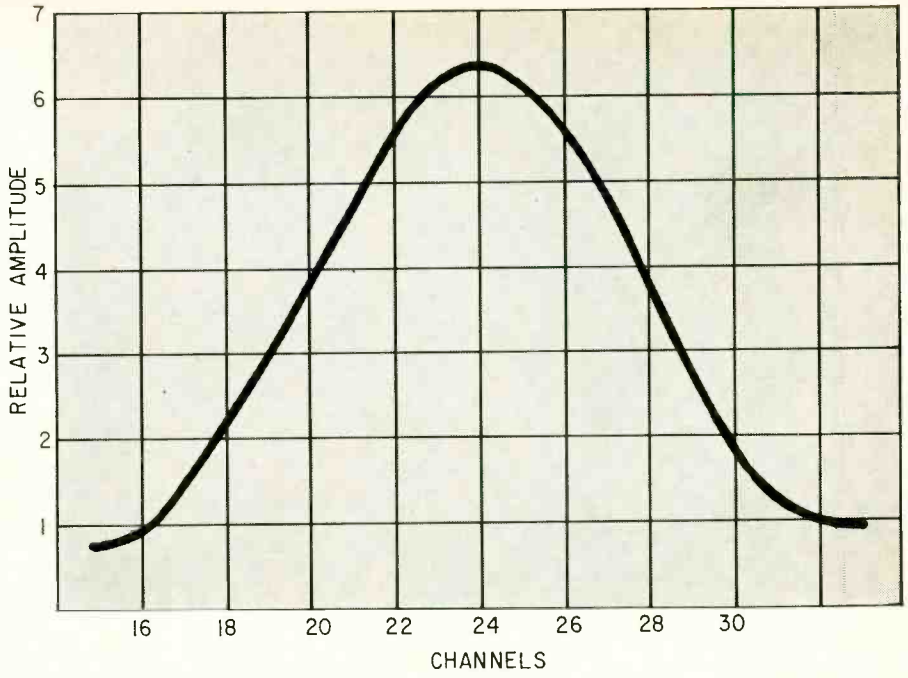


Fig. 5—Response curve for channel-24 dipole obtained with test setup shown in Fig. 4.

Finishing and assembly

Since aluminum corrodes when exposed to the weather, it is good practice to paint it before final assembly and installation. First, scour the aluminum with an abrasive household cleanser until all grease, fingerprints and other foreign matter are removed. Completely rinse the metal. Avoid touching the cleaned surfaces with the hands.

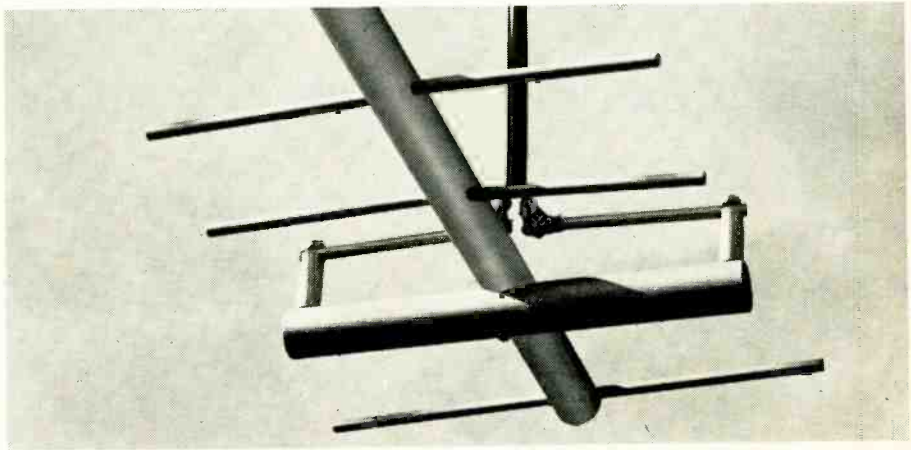
After the material is dry, mask off those points to which electrical contact is to be made, and spray a light coat of zinc chromate primer on all surfaces. Dry the assemblies for 24 hours. Spray the antennas with an aluminum paint. Two coats are desirable for coastal and industrial areas.

Mount the four Yagis on two vertical masts using standard TV U-bolts. Note that the lower Yagis must be mounted upside down (see photo). Connect the phasing line using crimp-type terminal lugs; solder each connection. Attach the horizontal boom to the vertical members with U-bolts. Take out most of the slack in the phasing line; however, do not pull it too taut. Connect the transmission line. Solder all connections. Attach sufficient braces to prevent swaying in the wind. You can use ⅛-inch x ½-inch flat aluminum stock for the braces.

Install the array using conventional TV masts and hardware. Locate the antenna clear of surrounding trees; vegetation is practically opaque to uhf. Since uhf transmission has a "line-of-sight" characteristic it is necessary to consider antenna height, obtructions from terrain and buildings.

For almost two years this antenna has been pulling in excellent TV signals over a mountainous path, thus demonstrating that long-range uhf reception is possible with a good antenna. Perhaps part of the reason for such good results is the fact that uhf reception is less susceptible to airplane flutter, man-made impulse noise, and freak propagation conditions than vhf reception.

Material for the project cost about $25—not an exorbitant amount considering the enjoyment of building the array and the fun of receiving an additional channel of television. **R-E**



Mount the two lower Yagis upside down to accommodate mounting the phasing line.

CRT Color Tracking Tests Simplified

Simulate actual operating conditions to obtain meaningful tests

By ROGER A. ANDERSON*

SOME OF THE TOUGHEST PROBLEMS IN servicing color TV sets center in the color picture tube. It is easy to deal with a circuit that is exposed, to test and to substitute components, in doubtful or marginal condition. But, to remove and replace a color CRT for testing purposes or even to correct for marginal conditions can be a most expensive practice.

If the CRT is not really at fault, an in-warranty tube will not be replaced by the manufacturer.

CRT tester

An obvious answer is to use a good CRT tester. In addition to the usual tests for shorts, opens, leakage and emission, it is necessary in the case of color CRT's to check each gun for tracking . . . the ability to operate in a similar manner within a relatively narrow range.

Purpose of the shorts and leakage test is obvious. It is usually performed with the heater on, using dc voltages across the elements and neon lamps as indicators. In the emission test, normal operating voltage is applied to screen grid G2, and zero bias to control grid G1, as shown in Fig. 2. (Zero G1 bias corresponds to set operation when the brightness control is turned up and the video drive is at a peak of white.) The resulting beam current is measured. A generally accepted minimum for a usable picture is 200 to 300 μA. Tube manufacturers' minimum for new tubes is 1500 to 2500 μA. Actually, this is much more than is required to produce a bright picture, but it is used as a process control in manufacturing to spot cathodes which do not behave in a normal manner.

The test to determine the ability of the control grid (G1) to control the beam is usually performed under the same conditions as for the emission test. However, the G1 voltage is turned down in the negative direction from zero until the beam current is cut off. If G1 controls beam current properly, the current will be reduced gradually and cutoff will occur at some specific value within a specified range of G1 voltage. This value can change during the life of the tube.

Much of a control grid's ability to control the electron stream depends upon its distance from the cathode. This space is very small, and it can change with age because of "creep" or movement of the parts in the electron gun. This movement is normal, and is mainly caused by thermal expansion and contraction. Even a small change in the spacing can make a big difference in the G1 control characteristic.

Up to this point the tests apply to both monochrome and color CRT's. But in a color tube it is necessary for the three guns to track each other. Proper tracking makes it possible to produce correct color combinations and proper gray scale over the full range of drive levels in all picture tones from deep shadow to highlights.

(continued on page 67)

*Sencore, Inc.

Sorry! We've just shot the bottom out of stereo prices!

We think we're about to explode the current notions about how much high fidelity should cost (or—more accurately—how little).

First, we resisted the temptation to take any shortcuts in the development of these new components . . . unless you count our computer, used to design new circuits in a fraction of the time needed by ordinary methods.

And we kept each component simple and easy to use, yet complete. Not that we stuck to just plain vanilla. You'll find thoughtful touches like an accurate zero-center FM tuning meter and combination balance control/stereo-mono switch included, for instance.

Finally, we knew that quality had to start high—and stay high. That's why we built spanking-new facilities, staffed with skilled craftsmen, and provided them with the most modern production equipment . . . an inspired combination.

The result? A new 30-watt stereo amplifier and a sensitive FM/stereo tuner, each priced well under $100.00. and the E-V 1180 receiver that combines these two components for even greater savings—just $176.00. Each built in the U.S.A. and each one warranted free from defects in materials and workmanship for two years. A warranty we'll back to the hilt.*

Listen to these exciting new components soon . . . now at most leading independent high fidelity showrooms. Critically compare them and you'll find that our bargains offer you more in the bargain!

*We don't expect much need for warranty service—but we're ready. Once the unit arrives at our factory or authorized service station, any defects we discover are repaired or replaced with no charge for parts, labor, or return transportation. Other repairs at nominal cost. Fair enough?

Electro-Voice®

A SUBSIDIARY OF GULTON INDUSTRIES, INC.

high fidelity systems and speakers • tuners, amplifiers, receivers • public address loudspeakers microphones • phonograph needles and cartridges • organs • space and defense electronics

ELECTRO-VOICE, INC., Dept. 484E
613 Cecil Street, Buchanan, Michigan 49091

Please send free literature on Electro-Voice high fidelity electronics and speakers.

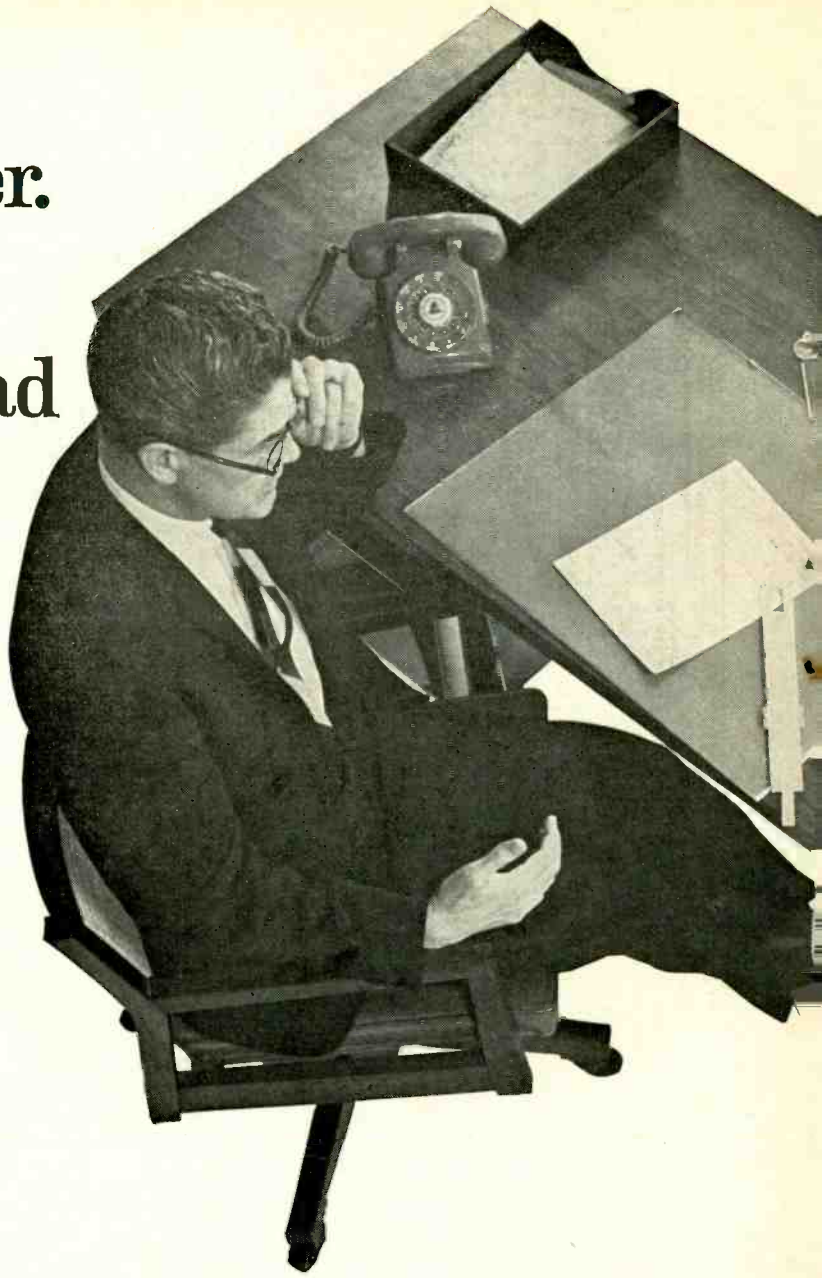
Name_____

Address_____

City_____ State_____ Zip_____

Circle 150 on reader's service card

"He's a good worker. I'd promote him right now if he had more education in electronics."



Could they be talking about you?

You'll miss a lot of opportunities if you try to get along in the electronics industry without an advanced education. Many doors will be closed to you, and no amount of hard work will open them.

But you can build a rewarding career if you supplement your experience with specialized knowledge of one of the key areas of electronics. As a specialist, you will enjoy security, excellent pay, and the kind of future you want for yourself and your family.

Going back to school isn't easy for a man with a full-time job and family obligations. But CREI Home Study Programs make it possible for you to get the additional education you need without attending classes. You study at home, at your own pace, on your own schedule. You study with the assurance that what you learn can be applied to the job immediately.

CREI Programs cover all important areas of electronics including communications, radar and sonar, even missile and spacecraft guidance. You're sure to find a program that fits your career objectives.

You're eligible for a CREI Program if you work in electronics and have a high school education. Our FREE book gives complete information. Airmail postpaid card for your copy. If card is detached, use coupon at right or write: CREI, Dept. 1404G, 3224 16th St., N.W., Washington, D.C. 20010.

Founded 1927

CREI

Accredited Member of the National Home Study Council

The Capitol Radio Engineering Institute
A Division of McGraw-Hill, Inc.
Dept. 1404G, 3224 Sixteenth Street, N.W.
Washington, D.C. 20010

Please send me FREE book describing CREI Programs. I am employed in electronics and have a high school education.

NAME_____ AGE_____

ADDRESS_____

CITY_____ STATE_____ ZIP CODE_____

EMPLOYED BY_____

TYPE OF PRESENT WORK_____ ☐ G.I. BILL

I am interested in ☐ Electronic Engineering Technology
☐ Space Electronics ☐ Nuclear Engineering Technology
☐ Industrial Electronics for Automation
☐ Computer Systems Technology

APPROVED FOR TRAINING UNDER NEW G.I. BILL

High-Gain IC Audio Amplifier
(continued from page 33)

high-impedance headphones can be used with this circuit. Power output is sufficient to drive the headphones without pushing the amplifier to its limits.

Applications

Some uses for this amplifier:

1. A booster to increase the power output of a portable tape recorder or transistor radio.

2. An audio amplifier for a small record player. If you use a high-output crystal cartridge, connect a 68,000-ohm carbon resistor in series with input capacitor C1 to reduce gain, to prevent overloading and to increase input impedance.

3. A CB speech amplifier (Fig. 3-a) for increased talk power and restricted bandwidth.

4. An amplifier for a hand-held walkie-talkie . . . serves as a booster amplifier to override noise on construction jobs, etc.

5. A signal tracer. Add headphones (Fig. 3-b) and an input probe (Fig. 3-c). Use a 100,000-ohm series resistor R5 in the probe and a 10,000-ohm resistor R6 to ground to avoid ruining the IC with excessive input voltage.

6. As a sound-level or "applause" meter. (Fig. 3-d.)

7. As an audio agc amplifier with a light-dependent resistor module. (Fig. 4.)

Figure 4 shows the CA3020 used as an audio agc amplifier. The signal is picked off from the preamplifier through C and R9. Potentiometer R_x is the main volume control for the power amplifier. The signal level to the IC amplifier can be adjusted with R9 and R1 used to control the volume. Potentiometer R1 should be set to light the No. 48 pilot lamp to full brilliance when R9 is at maximum. With R1 fixed, R9 is used to set the agc level. This will prevent burning out the pilot lamp. Since the lamp draws only 130 mW, there is ample power from the CA3020 to drive it to full brilliance on signal peaks.

The photocell connects between the slider of potentiometer R_x and ground. The lamp and photocell can be closely coupled and enclosed in any small light-tight case. Set R1 to allow a maximum of 2 volts rms, across the pilot lamp at full amplifier volume. It works like a rat race.

Resistance of the LDR goes down as the lamp gets brighter. The lamp gets brighter as the signal level goes up. As the resistance of the LDR goes down, less signal is fed into the amplifier.

This amplified control works well at low volume settings and is easily adapted to any sound system. Use two photocells with a single common lamp for stereo systems. Hook a photocell to each of the stereo volume controls. There are many possible variations of this scheme. For delayed agc, rectify the output from T1 with a diode and hook a 2,000-μF, 3-volt capacitor across the pilot lamp. You can use up to 10,000 μF for greater delay.

For simplicity, some connections to the CA3020 were omitted from Fig. 4. Values are the same as for Fig. 2. The amplifier is so small it may be fitted into portable equipment for agc. Agc is particularly useful with small portable tape recorders for interviews in the field. The volume will be held constant and you can avoid blasting from loud-mouths or low volume from those who talk weakly or too far from the mike. Agc is also useful for PA amplifiers to limit the volume and prevent blasting and feedback howl. **R-E**

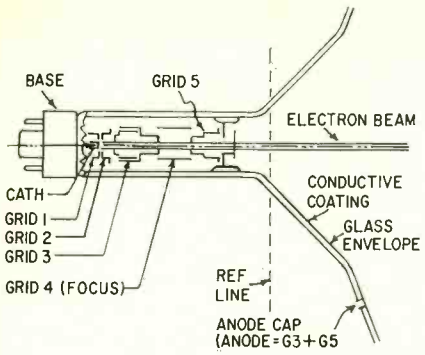


Fig. 1—Space between the control grid (G1) and cathode is critical. Creep (displacement of the elements in the gun) due to thermal cycling and fatigue can change a CRT's operating characteristics.

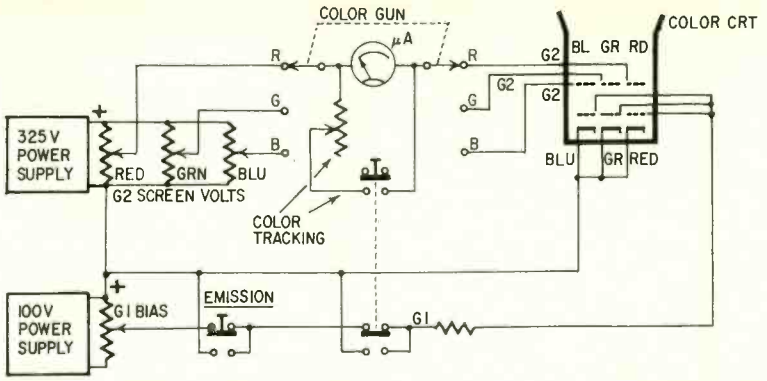


Fig. 2—Voltage applied to G2 in each gun can be adjusted to cut off the gun at a given G1 bias voltage. Depressing the Color Tracking pushbutton removes the cutoff bias voltage on G1 and permits the guns to conduct fully. The meter and switching arrangement permits monitoring and comparison of current flow in each gun.

CRT color tracking tests

(continued from page 60)

While the TV receiver has built-in circuitry to compensate for differences in its three gun structures, there is a limit as to how much these circuits can be made to do. The guns must be close enough in operating characteristics to fall within the limits of the set's compensating circuits.

Tracking tests

Test procedure based on actual operation of the tube in the TV set is desired. A relatively simple technique for determining the validity of a test is to see how it compares to what actually happens inside the TV set.

Tracking adjustments inside the TV set are made as follows:

1. Service switch, brightness, contrast and drive controls, etc. are set up to kill vertical sweep, to cut off video drive to the cathodes, and to fix G1 voltage to correspond to a barely visible trace on the screen.

2. The G2 controls are individually set to obtain a barely visible trace from each gun. Voltage of G2 is thus used to balance the characteristics of the guns so that the G1 cutoff point is the same for all three guns.

3. Normal operation is restored and a black-and-white picture viewed on the screen.

4. Drive to the three guns is then adjusted so that the highlights of the picture are pure white, thus compensating for whatever differences in high-drive beam current.

Now observe what happens when a tube is tested using procedures based on a set's operation:

A. Heater voltage is applied. G1 is set at a fixed value of about −45 volts. This corresponds to Step 1 in adjusting tracking.

B. G2 voltage is increased until a nominal cutoff current of about 10 to 20 μA is flowing. This corresponds to a barely visible trace when adjusting G2 in Step 2.

C. G1 voltage is reduced to zero and G2 current measured. This corresponds to restoring video and observing the picture highlights in Step 3.

D. When the preceding steps have been performed for all three guns, the current readings obtained in Step C are compared. This reveals whether the highlights can be adjusted to white and if a pure gray scale can be obtained.

In an acceptable tube the highest reading must be no more than 150% of the lowest. Some tube experts also advise comparing the G2 voltages observed in step B. If the highest G2 setting exceeds the lowest by more than 150% the tube may not track well.

This test has been proved to be reliable, and it is possible to perform on some presently used CRT testers. However, the procedure is awkward, time-consuming and error-prone. It requires repeated manipluation of selector switches, consistent accurate settings of 10-20-μA readings on meters that may read from 0.5 to 3 mA full scale, and manual logging and calculation of readings.

Fig. 3—Central portion of meter is calibrated to read out maximum permissible tracking variation, to predict ability to obtain proper highlights and gray scale.

A new type of CRT analyzer specifically designed to make this tracking test has been developed. Like a color TV set, the tester has three G2 voltage controls. A special color tracking circuit as shown in Fig. 2 eliminates the need for calculation.

There are several reasons why it is desirable to have three separate G2 controls. The cutoff settings of the three guns can be matched exactly and rechecked at any time simply by rotating the gun selector for comparison. The G2 voltages of the three guns can be compared at any time without recording them. The separate controls also make possible an "automatic" tracking test.

With the CRT tester shown, the tracking test is foolproof, simple and accurate. After the cutoff settings have been made on the three guns as in Step B of the basic tracking procedure, all that remains is to:

1. Press the COLOR TRACKING button and turn the GUN SELECTOR to the position that gives the highest reading.

2. Adjust the COLOR TRACKING control so the meter needle falls on the COLOR CAL line as shown in Fig. 3.

3. Turn the GUN SELECTOR to see that all guns read within the COLOR TRACK zone on the meter . . . no calculations required.

The COLOR TRACK button removes the G1 bias voltage and places a variable shunt across the 500-μA meter. The COLOR TRACK zone on the meter face extends from 2/5 to 3/5 of full scale. The ratio of 3/5 to 2/5 is 3 to 2, or 150%. If the meter is shunted down so that the highest gun reads 3/5 scale and the lowest gun then reads 2/5 or higher, then the highest reading does not exceed 150% of the lowest. Note, the actual current flowing in the guns of the CRT is not affected, but a readout does show the relative difference in each gun and if the difference is within limits. **R-E**

(continued from page 47)

feet at the lower channels, and increase sharply for higher frequencies.

Coaxial cable normally used in TV reception has a nominal impedance of 75 ohms, which will not match some antennas and receivers using 300 ohms. Such mismatching not only drops signal level but can also create standing waves on the line. These waves—reflected along the line from the mismatch—cause severe loss in signal strength as well as ghosts, and destroy picture sharpness.

Matching 75-ohm cable to 300-ohm antennas and receivers is accomplished with *baluns*, or matching transformers. The following rules apply:

a. If the antenna matches the transmission line, and the latter matches the tuner input, *best results are obtained.*

b. If the antenna does not match the transmission line, but the line matches the tuner input, *no standing waves* are produced, but signal pickup is poorer.

c. If the antenna matches the transmission line, but the line does not match the tuner input, *standing waves are produced* and signal pickup is poorer than if all elements were matched.

If you've rotated an antenna while watching color TV you have noticed the importance of aiming the antenna at the station. Proper orientation also minimizes ghost pickup and adjacent-channel interference. If most stations are in one direction, or in opposite directions, the pattern of Fig. 1 might be acceptable. If you must pick up stations from several directions, the pattern of Fig. 4 is highly desirable.

With such a sharp pattern, however, a rotator is a must for pinpointing the antenna properly. If the antenna has uhf elements, orientation becomes even more critical; rotation of even a few degrees in weak-signal areas can cause picture deterioration.

If ghosts and adjacent-channel interference persist, the rear pickup may be too great. It sometimes helps to add a few more reflector rods to the antenna. You can do this by stacking the reflectors in a vertical plane, each separated from the others by about 2 inches. This technique produces more shielding effect at the rear of the antenna.

A strip of wire fencing (such as chicken wire) cut to a width of 5 to 10 inches and having a length equal to the refector can also be used. Attach the wire directly to the reflector for added effect (see Fig. 6).

If the antenna installation is in low terrain surrounded by hilly country, it often helps considerably to aim the antenna slightly upward, instead of having it perfectly horizontal. In many instances a 5° or 10° upward tilt of the antenna end facing the station will minimize snow and provide a better picture on all channels received.

Multiple-set couplers

Even in a good-signal area it is poor practice to connect two or more sets directly to a single transmission line. Couplers should be used to provide proper isolation of receivers from one another and to maintain proper impedance matching.

An FM receiver with a 300-ohm input may sometimes be connected to a coupler for improved FM reception. Some TV antennas will pick up FM signals. Many, however, will not, as they are designed to eliminate FM-to-TV interference. It's often better to have a separate FM antenna.

For good reception areas, inexpensive couplers will suffice, but in the fringe areas, amplified couplers may be needed. Couplers are mounted in a small housing and can be placed on the back of one receiver, or between several, as shown in Fig. 7(a). If you suspect that an existing coupler is not functioning properly or that it's introducing too much loss, check it with the test setup of Fig. 7-b. Switch S1 (d.p.d.t.) connects the lead-in either to receiver No. 1 directly or to the coupler. Switch S2 (d.p.s.t.) connects the coupler to the first receiver, or disengages it, as needed.

To test the effect of the coupler on reception, connect the lead-in to the first receiver with S1. Then open switch S2 to remove the coupler. Tune the first receiver to a weak station for best reception quality. Now set switch S1 to the position which engages the coupler, and close switch S2 so the coupler feeds the first receiver. Note the difference in reception on the first receiver. If the picture is poorer and snow effect increases, the coupler is introducing too many losses for the signal strength in that particular area. A better coupler may solve the problem, or a recheck of the antenna system may be necessary to bring the signal strength up to handle more than one receiver. **R-E**

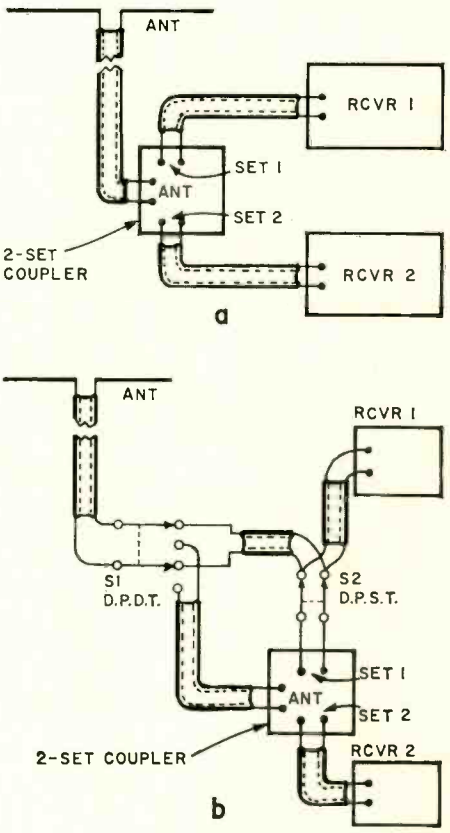


Fig. 7—A multiset coupler is attached between the antenna feedline and the receivers (a). To test the coupler (b) switch it in and out of the circuit while you observe the picture on receiver No. 1.

successful service shop beats rising costs with B&K television analyst

"As every serviceman knows, major TV repairs represent an increasingly large part of the service business and the average time per repair has increased"...

says Willard Horne of Horne Radio and Television in Evanston, Illinois.

After more than 25 successful years in the service business, twenty of them in the same location, Mr. Horne can be considered an authority on how to keep a business profitable. Mr. Horne says, "In order to be successful, our 3-man shop has to be competitive on the large jobs as well as the small ones. With the increase in bench time that we were experiencing and the limitations on what we could charge, there was a reduction of profit that had to be stopped. Then we bought a B&K Model 1076 Television Analyst."

"Now our customers get the same extra-value service on the big repairs and the small ones," said Mr. Horne. "We use the Television Analyst for troubleshooting a wide variety of complaints,* particularly for those that require touch-up alignment, location of IF overloads and color convergence. We are more competitive now that we use the B&K Television Analyst because we spend far less time on the jobs that used to be dogs, with benefits both to the shop and our customers."

*B&K Model 1076 Television Analyst checks every stage in a black and white or color TV receiver. Nine VHF RF channels, 20 to 45 MC IF, audio, video, sync, bias voltage and AGC keying pulse are available. The model 1076 provides its own standard test pattern, white dot, white line crosshatch, and color bar pattern slide transparencies. It includes a blank slide which can be used for closed-circuit-TV display floor promotion. Its net price is **$329.95.**

Find out how you will increase your *TV service profits with a B&K Model 1076. See your distributor or write for Catalog AP 22.*

B & K MANUFACTURING CO.
DIVISION OF **DYNASCAN** CORPORATION
1801 W. BELLE PLAINE AVE. · CHICAGO, ILL. 60613
Canada: Atlas Radio Corp., 50 Wingold, Toronto 19, Ont.
Export: Empire Exporters, 123 Grand St., New York 13, U.S.A.

Circle 29 on reader's service card

COMING NEXT MONTH

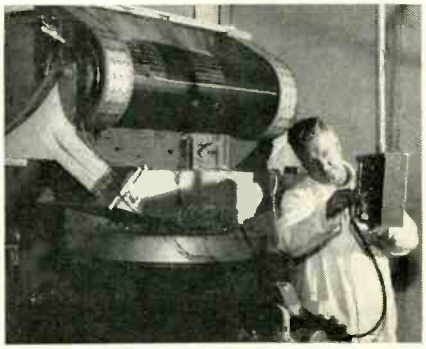
- **Big Boom In Sound**—There's a new look in sound systems—there's big dough in sales and service of this equipment, too.
- **Build: Signal Generator for FM Stereo Tuners and Receivers**—A solid-state project to satisfy the most discriminating hi-fi man.
- **How To Signal Trace Solid-State TV**—Modern TV set construction puts a greater onus on pinpointing a defect and less on cut and try.
- **Potpourri of Operational Amplifiers**—At the last count there were 20 applications and circuits. An excellent treatment of basics.
- **Build A Panic Button**—Just for relaxation, or just for a laugh. It's not really loud enough for a police siren, but there's nothing to prevent you from feeding the wailing sound into an amplifier.

NEWS BRIEFS

(continued from page 4)

Aviation Administration Common IFR Room at John F. Kennedy International Airport, New York, will show composite information, combining radar, computer alpha-numerics and video mapping for more accurate Air Traffic Control for the three major and sixteen satellite New York airports.

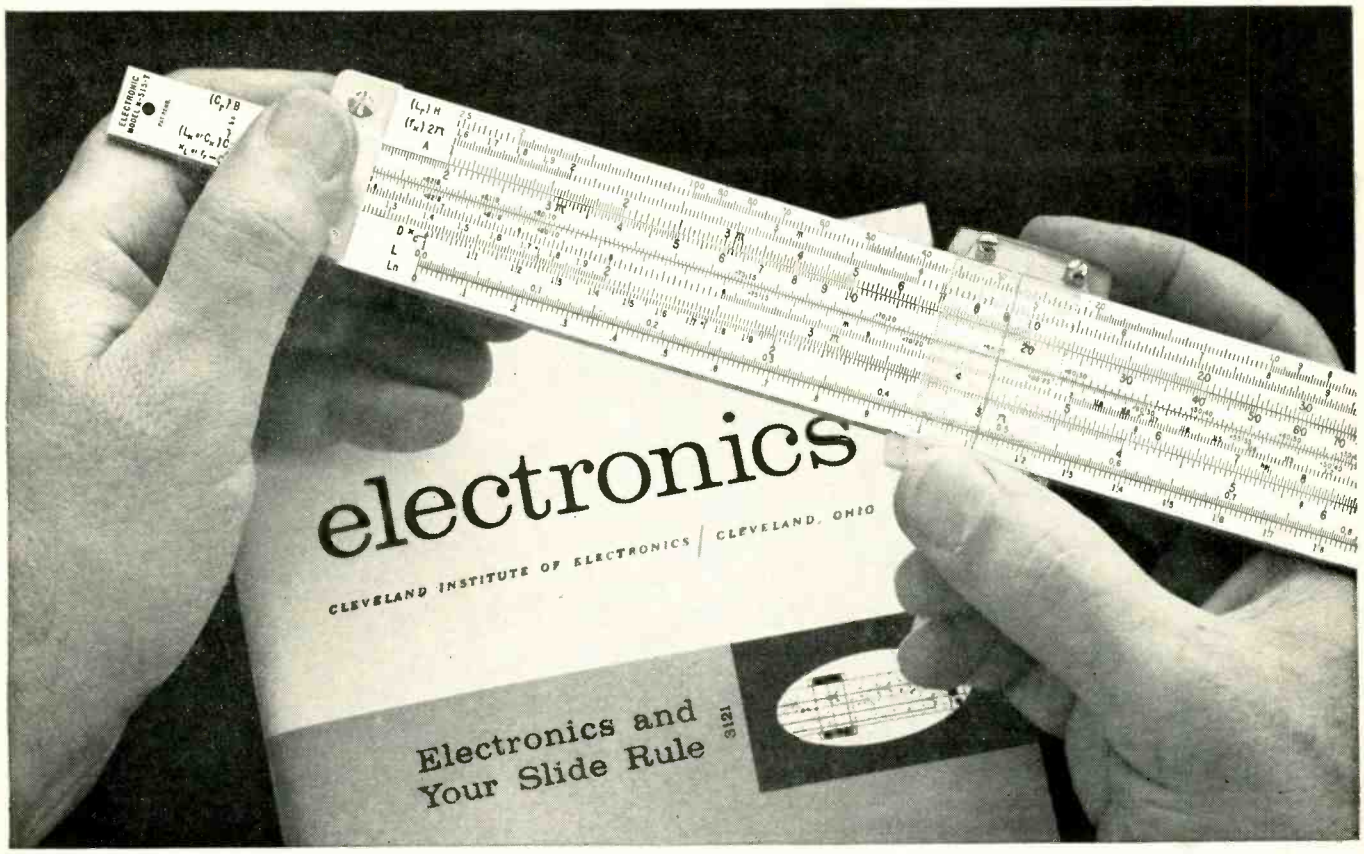
SINGLE VHF-UHF TUNER—A new solid-state TV tuner has been developed by Oak Electro-Netics. It uses common components for both vhf and uhf, reducing size and complexity. Not yet in production, tuner is three-band continuous-tuning type. It has one band each for channels 2–6, 7–13 and 14–83, with a switch to change bands. Tuner could simplify all-channel set production.



ROLL-OUT SOLAR PANEL—Undergoes vibration checks to determine ability of system to withstand launch shock. Panel on drum rolls out on signal from earth, gathers solar energy used for spacecraft's electrical power. Panel system was developed by Ryan Aeronautical Co. for Mars or Venus probes.

SORTING CHIPS—Hypodermic needle is used to sort good from bad semiconductor chips which measure only 5 x 20 mils. The needles are attached to vacuum hoses, permitting one chip at a time to be picked up. Chips are used to make transistors for television and telephone transmission systems. Technique is used by Western Electric. **R-E**

A New Electronics Slide Rule with Self-Training 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 $25. Send coupon for FREE illustrated booklet *and* FREE Pocket Electronics Data Guide. Cleveland Institute of Electronics, 1776 E. 17th St., Dept. RE-151, Cleveland, Ohio 44114.

*TRADEMARK

GET BOTH FREE!

Send coupon today →

Cleveland Institute of Electronics

1776 E. 17th St., Dept. RE-151 • Cleveland, Ohio 44114

Please send FREE Electronics Slide Rule Booklet.
SPECIAL BONUS: Mail coupon promptly . . . get FREE Pocket Electronics Data Guide too!

Name_____
(Please Print)

Address_____ County_____

City_____ State_____ Zip_____

A leader in Electronics Training . . . since 1934

Circle 31 on reader's service card

TESTING WITH BLACK NOISE

By PETER E. SUTHEIM

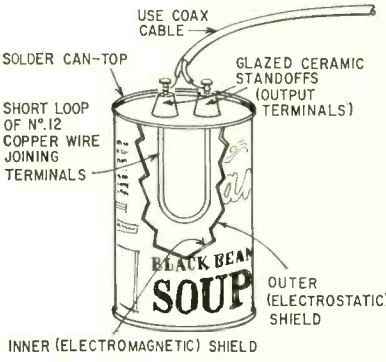
VERY LITTLE ATTENTION HAS BEEN PAID SO FAR TO A TESTING method and form of energy called *black noise*. It offers immense benefits, which can be summarized briefly as follows:

1. Measuring equipment can be extremely simple and not particularly accurate.
2. Calibration of test equipment is unnecessary.
3. The testing procedure can be completely silent.
4. There is no signal to obscure what is secretly going on in the circuit.
5. Circuit voltage readings remain at their no-signal values.

Curiously, most of the basic energy relationships in black-noise theory are at almost all points analogous to the more conventional voltage, current and power equations.

The most significant relationship is the one involving *black power*, which, as one might assume, is simply

$$\text{black power} = \frac{(\text{black-noise voltage})^2}{\text{resistance}}$$



The advantages of black noise are offset slightly by the difficulty that the best black-noise generators must be supercooled—brought as near to absolute zero as the state of the art permits. With present technology, that is expensive and cumbersome.

However, an acceptable black-noise generator for relatively noncritical work can be built as shown. Construction is not difficult, but the connections must be tight and the shielding as perfect as possible. The electro-magnetic shielding can be fabricated from a mu-metal oscilloscope CRT shield.

How to use black noise

To test, for example, an audio amplifier with black noise, connect the black-noise generator to the amplifier's input. Turn the amplifier on and turn the volume control up fully. Any noise you hear is from the amplifier itself, and only from the amplifier—assuming, that is, that you have built a truly good black-noise generator. Note that there is no tone, no hiss to obscure anything or cause tester-fatigue. If you hear anything at all, turn the amplifier off and reject it. It is obviously imperfect.

A similar technique can be used to test FM tuners and speakers. My experience has shown that all FM tuners are imperfect, because they produce a great deal of hiss when connected to a black-noise generator. Speakers, however, are practically perfect.

Meters and oscilloscopes can also be checked out with black noise. Note that in every case the need for calibration or careful listening and meter-reading has been eliminated.

As far as we have been able to determine, the black-noise spectrum produced by our generator extends into the shorter microwaves and beyond. Hence it should be adequate for checking any ordinary audio or radio equipment you are likely to encounter. **R-E**

("*April is the cruellest month . . .*"—T. S. ELIOT)

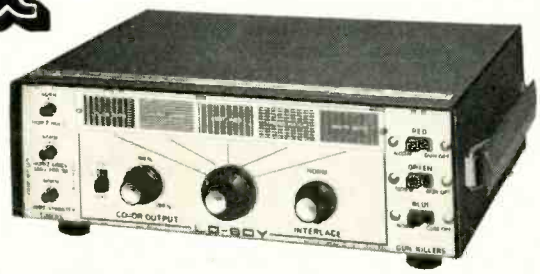
COLOR GENERATORS
FOR EVERY NEED

4 reasons why Sencore is your best buy in professional test instruments

1

LOBOY CG10
America's lowest priced professional quality standard color bar generator. All solid state. Battery powered for maximum portability.

$89.95



2

LOBOY CG12
AC operated version of the CG10. Also has 4.5 MHz crystal controlled signal for fine tuning adjustment.

$109.95

3

COLOR KING CG141
Absolute stability assured by exclusive "Temp Control" and new timer circuitry. All standard patterns, plus new movable single dot and single cross. Analyzing features too.

$149.95

4

COLOR ANALYZER CA122B
The complete analyzer for color and B&W—far more than just a color generator. Has variable RF and IF outputs, composite video, chroma, and horizontal and vertical sync pulses.

$187.50

Whatever the need, Sencore has the color generator that is just right for you. Each has the built-in quality you expect from Sencore. Each has standard RCA licensed color bar patterns.

Each is triple tested for guaranteed accuracy. Each is steel encased with chrome panel. See your distributor for more reasons why Sencore is your best buy, always.

SENCORE

NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT
426 SOUTH WESTGATE DRIVE, ADDISON, ILLINOIS 60101

Circle 34 on reader's service card

TECHNOTES

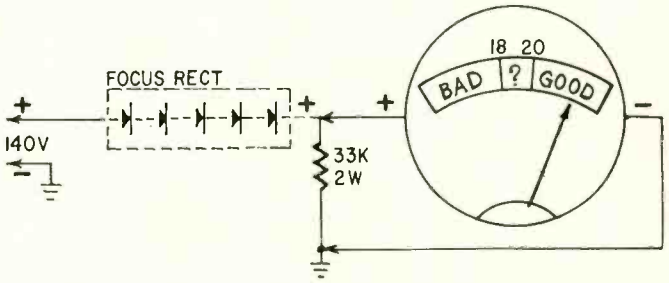
HIGH-VOLTAGE PROBES

Some high-voltage probes have negative-coefficient multiplier resistors that will cause readings to be 1500 volts low at 25°F. Using such a probe may cause you to set the picture-tube anode voltage 1500 volts too high.

In cold-weather areas, carry your meter and probe in a warm section of the service truck and make sure that the probe has reached room temperature before using it.—*G-E service Talk*

CHECKING SOLID-STATE FOCUS RECTIFIERS

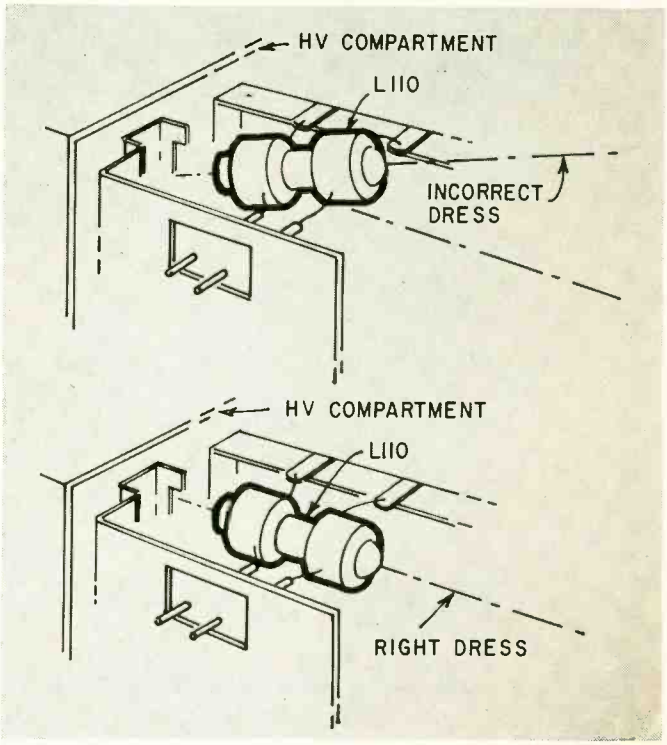
Solid-state focus rectifiers in color TV sets cannot be checked with an ohmmeter. The best method of checking them is by direct substitution. Lacking a substitute, you can use the test circuit shown. The rectifier anode is connected to +140 volts, and the cathode is connected to ground through a 33,000-ohm resistor.



The voltage measured across the resistor will be 20 or higher if the rectifier is good, 18—20 volts if it is doubtful. A reading of 18 volts or lower indicates that the unit is bad and must be replaced.—*Sylvania Service Notebook*

RCA KCS 158 TV CHASSIS

A 3½-inch horizontal bar (an apparent hum bar) has been traced to positioning of the dual line choke (L110) with respect to the yoke. The diagrams show correct and incorrect positioning of the choke.—*RCA Television Service Tips*



R-E

when everybody wants to get in on the act...

Shure Unidyne microphones at the Inter-American Defense Board, Washington, D.C.

SHURE

TOTAL COMMUNICATIONS

WITH SHURE MICROPHONES
AND
SHURE MICROPHONE MIXERS

Today, everybody wants to be heard. Whether it's in city hall, or the Rotary, or local fraternal organization meeting, or business seminar, audience involvement is the wave of the future! The truly functional sound system is built around Total Communications: that is, a superior sound system in which everybody who needs a microphone has one at his fingertips. Now, Shure not only makes the finest and broadest range of microphones for Total Communications sound systems—but offers you the practical key to hooking all these microphones into a single amplifier and loudspeaker set-up . . . the remarkably low-cost, versatile, and easy-to-operate Shure M68 Microphone Mixer.

Write for Audio Installers Catalog and Microphone Mixer Brochure / SHURE BROTHERS, INC.
222 Hartrey Avenue, Evanston, Illinois 60204

Circle 37 on reader's service card

RADIO-ELECTRONICS READER'S SERVICE

Here's how you can get manufacturers' literature fast:

1. Tear out the post card on the facing page. Clearly print or type your name and address.

   Include zip code! Manufacturers will not guarantee to fill your requests unless your zip code is on the reader service card!

2. Circle the number on the card that corresponds to the number appearing at the bottom of the **New Products, New Literature** or **Equipment Report** in which you are interested.
   For literature on products **advertised** in this issue, circle the number on the card that corresponds to the number appearing at the bottom of the advertisement in which you are interested. Use the convenient index below to locate quickly a particular advertisement.

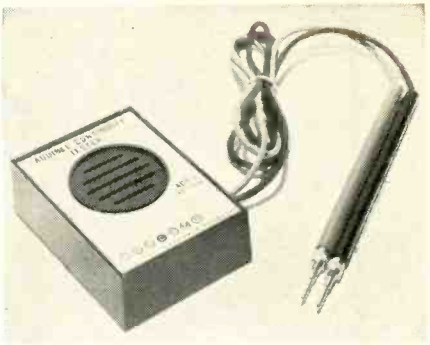
3. Mail the card to us (no postage required in U.S.A.)

Advertisements in this issue offering free literature (see the advertisements for products being advertised):

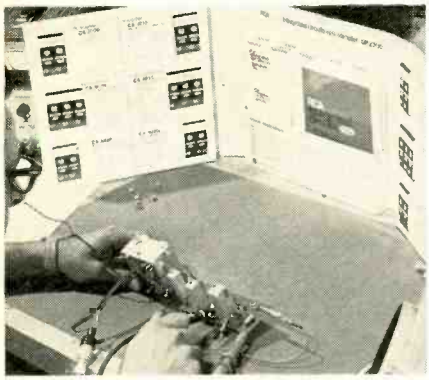
ACCURATE INSTRUMENT COMPANY (Pg. 27)	Circle 26
ALLIED RADIO CORPORATION (Pg. 91)	Circle 138
ARCTURUS ELECTRONICS CORPORATION (Pg. 96)	Circle 129
ARROW FASTENER COMPANY, INC. (Pg. 16)	Circle 17
B & K (Division of Dynascan Corporation) (Pg. 69)	Circle 29
BLONDER-TONGUE LABORATORIES, INC. (Pg. 25)	Circle 23
BROOKS RADIO AND TV CORPORATION (Pg. 92-93)	Circle 125
BURNSTEIN-APPLEBEE COMPANY (Pg. 72)	Circle 32
CAIG LABORATORIES INC. (Pg. 80)	Circle 109
CASTLE TV TUNER SERVICE, INC. (Pg. 84)	Circle 115
CLEVELAND INSTITUTE OF ELECTRONICS (Pg. 18-21)	Circle 38
CLEVELAND INSTITUTE OF ELECTRONICS (Slide Rule) (Pg. 71)	Circle 31
COOK'S INSTITUTE OF ELECTRONICS ENGINEERING (Pg. 68)	Circle 28
CORNELL ELECTRONICS COMPANY (Pg. 95)	Circle 135
DELTA PRODUCTS, INC. (Pg. 6)	Circle 11
DELTA PRODUCTS, INC. (Pg. 80)	Circle 108
EDITORS & ENGINEERS, LTD. (Division of Howard W. Sams & Company, Inc.) (Pg. 93)	Circle 126
EDMUND SCIENTIFIC COMPANY (Pg. 98)	Circle 133
ELECTRONIC CHEMICAL CORPORATION (Pg. 91)	Circle 137
ELECTRO-VOICE, INC. (Pg. 61)	Circle 150
ESSE RADIO COMPANY (Pg. 90)	Circle 120
FINNEY COMPANY (Pg. 7)	Circle 12
GAVIN INSTRUMENTS, INC. (Subsidiary of Advance Ross Corporation) (Cover III)	Circle 149
GC ELECTRONICS COMPANY (Pg. 14)	Circle 15
GENERAL ELECTRIC COMPANY (Major TV Department) (Pg. 22)	Circle 20
GRANTHAM SCHOOL OF ELECTRONICS (Pg. 2)	Circle 9
HEALD COLLEGES (Pg. 91)	Circle 123
HEATH COMPANY (Pg. 85-89)	Circle 119
INDIANA HOME STUDY INSTITUTE, THE (Pg. 94)	Circle 127
INJECTORALL ELECTRONICS CORPORATION (Pg. 82)	Circle 112
INTERNATIONAL CRYSTAL MFG., COMPANY, INC. (Pg. 100)	Circle 148
JFD ELECTRONICS COMPANY (Pg. 17)	Circle 18
E. F. JOHNSON COMPANY (Pg. 70)	Circle 30
KENZAC (Pg. 96)	Circle 130
LORAL DISTRIBUTOR PRODUCTS (Division of Loral Corporation) (Pg. 13)	Circle 14
MICROFLAME, INC. (Pg. 72)	Circle 33
MULTICORE SALES CORPORATION (Pg. 90)	Circle 139
MUSIC ASSOCIATED (Pg. 83)	Circle 113
OLSON ELECTRONICS, INC. (Pg. 82)	Circle 110
PERMA-POWER COMPANY (Pg. 79)	Circle 107
POLY PAKS (Pg. 99)	Circle 134
RADIO SHACK (Pg. 1)	Circle 8
RCA ELECTRONIC COMPONENTS AND DEVICES —Semiconductors (Pg. 23)	Circle 21
RMS ELECTRONICS, INC. (Pg. 82)	Circle 111
RYE INDUSTRIES, INC. (Pg. 66)	Circle 27
SALCH & COMPANY, HERBERT (Marketing Division of Tompkins Radio Products) (Pg. 97)	Circle 131
SCHOBER ORGAN CORPORATION, INC. (Pg. 26)	Circle 25
SCOTT, INC., H. H. (Pg. 26)	Circle 100
SENCORE (Pg. 15)	Circle 16
SENCORE (Pg. 73)	Circle 34
SHURE BROTHERS (Pg. 75)	Circle 37
SOLID STATE SALES (Pg. 97)	Circle 132
SONAR RADIO CORPORATION (Pg. 83)	Circle 114
SPRAGUE PRODUCTS COMPANY (Pg. 24)	Circle 22
SWING-O-LITE, INC. (Pg. 74)	Circle 35
TRIPLETT ELECTRICAL INSTRUMENT COMPANY (Cover II)	Circle 7
WARREN ELECTRONIC COMPONENTS (Pg. 95)	Circle 128
WUERTH PRODUCTS COMPANY (Pg. 92)	Circle 124
XCELITE, INC. (Pg. 12)	Circle 13
ZENITH (Pg. 84)	Circle 116

NEW TEST EQUIPMENT

More information on new products is available free from the manufacturers of items identified by a Reader's Service number. Turn to the Reader's Service Card facing page 76 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.



LINEAR IC SAMPLER, *2K2200*. Broad selection of linear integrated circuits provides an inexpensive way for the equipment engineer or experimenter to get started in microelectronics. 11 separate circuit types (26 devices total) plus technical bulletins and application notes



on each type are included in the kit. In addition, an RCA *Linear Integrated Circuit Fundamentals* manual, *Integrated Circuits Product Guide* and *IC Mounting and Assembly Instructions* are provided. $39.95—**Radio Corporation of America**

Circle 46 on reader's service card

RF SWITCH, *Model 4130*. Tests devices in the dc to 900-MHz frequency range. Designed for lab or test-bench applications, the 4130 is a manually operated unit consisting of a 75-ohm d.p.d.t. coaxial switch and an eight-pole, double-throw wafer switch. Coaxial switch permits selection of either of 2 rf signals. Coaxial switch section has fre-

quency range from dc to 900 MHz so that it can be used on TV subchannels, channels 2 to 83 and FM. Coaxial section also has 60 dB isolation, 1.22 VSWR for uhf and 1.13 for vhf. Impedance is 75 ohms. All switch contacts have a power-handling capability of 2 amps maximum.—**Blonder-Tongue Laboratories**

Circle 47 on reader's service card

AUDIBLE CONTINUITY TESTER. Tests electronic circuits without danger to components and replaces buzzers and bells with higher voltage drain and danger of inductive kickback. Completely reliable for delicate circuits and semiconductors. Continuity indicated by clear tone . . . pitch changed with resistance (0 to 50 ohms); open circuit 2.5 volts at the probe; short circuit 6 mA at the probes. Powered by 9 Vdc battery; 30-inch probe leads. $9.95—**CalComp Consumer Products** R-E

Circle 48 on reader's service card

79

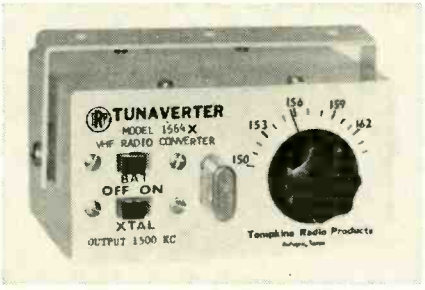
Circle 108 on reader's service card

New Communications Equipment

BUSINESS-BAND 2-WAY RADIO, *Courier Tradesman.* Unit provides power input of 5 watts, and when combined with *Courier ML-100 Mobile Linear Amplifier* (optional) delivers 100 watts. Features transmit indicator, single-knob tuning, modulation indicator and 100% modulation. Safety circuit protects against mismatched antenna, incorrect polarity and overload. Operates on low band and permits increased antenna height. Guaranteed for 10 years, unit is priced at $129. —**Courier Communications, Inc.**

Circle 49 on reader's service card

RADIO CONVERTER, *Tunaverter Model 1564 X.* Covers the 150–164-MHz band with both crystal-controlled and tunable provisions selectable with a switch. Permits monitoring any number of crystal-controlled channels by plugging in the correct crystal in the Tunaverter front panel. For outstanding performance peak each circuit for ultimate reception with the 3-gang tuning capacitor (with 6:1 reduction tuning), even in the crystal position. Designed for mobile operation, power is supplied by a 9-volt transistor battery. Accessories available. $32.95—**Tompkins Radio Products**



Circle 50 on reader's service card

CB BASE-STATION CONSOLE. Transforms any miniature solid-state CB transceiver into a full-sized base station with the addition of all important CB accessories in one cabinet. Designed around the Poly-Comm 23C 23-channel transceiver, the console is compatible with most CB radios on the market. Con-

Circle 109 on reader's service card

First twist-prong electrolytic to identify itself.

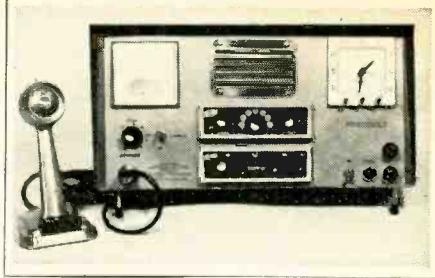
Add up the time you've lost waiting for countermen to look up part numbers for twist-prong electrolytic capacitors.

That's how much time you'll save—when your Distributor stocks new RCA "P" type and "R" type twist-prong electrolytics. The reason: new RCA twist-prong capacitors have self-identifying stock numbers . . . the first in the industry. Your counterman can forget his catalogs and go right to the shelf . . . because RCA stock numbers enable him to stock his inventory in voltage rating and capacitance value sequence. His shelves are his RCA catalog.

These twist-prong electrolytics are the beginning of a complete capacitor line from RCA.

Other General Purpose Electronic Parts, with RCA quality assurance, will be available from your RCA Distributor in the near future. Insist on RCA parts. Your customers will appreciate it.

RCA PARTS AND ACCESSORIES, Deptford, N.J.



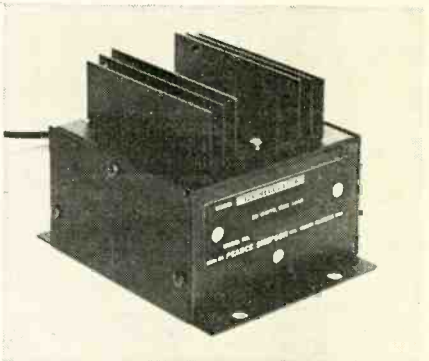
sole is equipped with panel-mounted ac and dc fuses, control switches, microphones, selective call, built-in speaker and microphone jack. Features an electric clock for monitoring the length of transmission, and a multifunction meter. $89. Transceiver and selective call optional.—**Allied Research**

Circle 51 on reader's service card

CB BASE STATION. *Eaglette.* 23-channel all-silicon-transistor mobile unit has illuminated S-meter and channel-selector switch, public-address system with separate jacks for PA and remote speakers with 3¼ watts of audio, squelch control, and a noise limiter. Adjacent-channel rejection is excellent and sensitivity is 0.35 μV for 10 dB signal-to-noise plus noise at 40% modulation. Steel case is finished in chocolate brown baked Armahyde, front panel is anodized gold. Comes with crystals for all 23 channels and a locking-type mounting bracket. $209.50—**Browning Laboratories, Inc.**

Circle 52 on reader's service card

CONVERTER, *Power Match.* Converts 32- and 24-volt electrical systems to 12 volts and handles loads of up to 30 watts of power drain. Specifically designed for industrial applications, this unit makes Pearce-Simpson electronic communication equipment adaptable to many fishing craft and to a wide variety of industrial equipment and rolling stock. The converter can be installed in 10 minutes.—**Pearce-Simpson, Inc.** **R-E**



Circle 53 on reader's service card

Circle 113 on reader's service card

NEW PRODUCTS

ATOMIC ENERGY LAB KIT. With this kit, a budding nuclear physicist can create cosmic-ray showers and actually track their vapor trails in a cloud chamber. He can also make auto-radiographs and check the ionization and radioactivity of everyday materials. Kit comes with atomic cloud chamber, projector illuminator, electroscope and spinthariscope (through which you can see exploding atoms). Kit is completely safe to use, contains 43 parts to put together. A 22-page instruction booklet suggests 8 experiments and explains the theories behind them. $8.75—Edmund Scientific Co.

Circle 54 on reader's service card

GARAGE-DOOR OPENER, *Liftmaster*. Includes three component elements: transmitter, receiver and operating mechanism. Portable radio transmitter comes with a 9-volt transistor radio battery. The receiver snaps onto the wall and has a pushbutton for electric (non-rf) operation. Operating mechanism has a built-in light socket and diffuser shade and handles loads up to 200 lbs. Radio controls operate in 27-MHz Citizens band.—Perma-Power R-E

Circle 55 on reader's service card

Circle 114 on reader's service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader's Service Card facing page 76 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

HEP CROSS-REFERENCE GUIDE. Lists over 12,000 transistors, rectifiers, Zener diodes, dual diodes and SCR semiconductor devices for hobbyists, experimenters and professional service dealers. Cross-referenced in alpha-numeric order, this useful and practical 55-page guide also gives tips on using universal replacement semiconductors, outline dimensions of HEP devices, and the HEP price list.—**Motorola Semiconductor Products, Inc.**

Circle 59 on reader's service card

CALCULATORS, 1968 CATALOG *No. 81* describes special-purpose slide rules, calculators, kits, books and other calculation and information aids. Also includes mechanical, electronic, reliability and QC, structural, fluids, data-processing and systems-design information. 24 pages.—**INFO, Inc.**

Circle 60 on reader's service card

PUBLIC ADDRESS AMPLIFIERS, *Catalog No. 326.* Describes the new Bogen line of Challenger CHS solid-state public address amplifiers using charts and numerous photographs. Models are the CHS-100, CHS-50, CHS-35 and CHS-20. One page is devoted to a list of accessories. All technical data and prices are included.

—**Bogen Communications Div., Lear Siegler., Inc.**

Circle 61 on reader's service card

ZENER REGULATOR CATALOG, *C-67/68.* Lists 66 series of Zener diodes ranging from 150 mw to 50 watts in 9 package designs. In addition, there are 11 series of voltage reference diodes with nominal temperature coefficient ratings to 5 parts per million, 34 low-power silicon rectifiers in current ranges from 0.4 to 16 amperes and voltage ratings (maximum peak reverse) from 50 to 100 volts. Catalog is indexed with numerical cross-reference lists and includes an easy-to-locate table of contents.—**International Rectifier**

Circle 62 on reader's service card

MATV DESIGN BOOKLET, 24 pages. Covers systems for homes, dealers' showrooms, apartment houses, hotels, motels, hospitals, nursing homes, etc. Features techniques such as cable-powered, remotely located amplifiers and a new method of on-channel uhf distribution. These techniques make it possible for the installer to design a system with a minimum of calculations. Includes 14 diagrams, bills of materials and typical costs.—**JFD Electronics Co.**

Circle 63 on reader's service card

CORRECTION

Price of Port-A-Pak Model PAP-1 (page 77, January, 1968) manufactured by Courier Communications, Inc. is $59.95 and not $12.95. A Charge-A-Pak for this battery is $12.95.

Now There Are 3 Heathkit® Color TV's

The NEW Deluxe Heathkit "227" Color TV

Exclusive Heathkit Self-Servicing Features. Like the famous Heathkit "295" and "180" color TV's, the new Heathkit "227" features a built-in dot generator plus full color photos and simple instructions so *you* can set-up, converge and maintain the best color pictures at all times. Add to this the detailed trouble-shooting charts in the manual, and you put an end to costly TV service calls for periodic picture convergence and minor repairs. No other brand of color TV has this money-saving self-servicing feature.

Advanced Features. Top quality American brand color tube . . . 227 sq. in. rectangular viewing area . . . 24,000 v. regulated picture power . . . improved phosphors for brilliant, livelier colors . . . new improved low voltage power supply with boosted B+ for best operation . . . automatic degaussing . . . exclusive Heath Magna-Shield to protect against stray magnetic fields and maintain color purity . . . ACC and AGC to reduce color fade and insure steady, flutter-free pictures under all conditions . . . preassembled & aligned IF with 3 stages instead of the usual 2 . . . preassembled & aligned 2-speed transistor UHF tuner . . . deluxe VHF turret tuner with "memory" fine tuning . . . 300 & 75 ohm VHF antenna inputs . . . two hi-fi sound outputs . . . 4" x 6" 8 ohm speaker . . . choice of installation — wall, custom or optional Heath factory assembled cabinets. Build in 25 hours.

Kit GR-227
$419.95
(less cabinet)
$25 mo.

Kit GR-227, (everything except cabinet)
. . . $42 dn., as low as $25 mo. **$419.95**
GRA-227-1, Walnut cabinet . . . no money dn., $6 mo. **$59.95**
GRA-227-2, Mediterranean Oak cabinet (shown above),
. . . no money dn., $10 mo. **$94.50**

Kit GRA-27
$19.95

New Remote Control For Heathkit Color TV

Now change channels and turn your Heathkit color TV off and on from the comfort of your armchair with this new remote control kit. Use with Heathkit GR-227, GR-295 and GR-180 color TV's. Includes 20' cable.

Kit GR-295
$479.95
(less cabinet)
$42 mo.

Deluxe Heathkit "295" Color TV

Has same high performance features and built-in servicing facilities as new GR-227, except for 295 sq. in. viewing area (industry's largest picture) . . . 24,000 volt picture power . . . universal main control panel for versatile in-wall installation . . . and 6" x 9" speaker.

Kit GR-295, (everything except cabinet), 131 lbs. . . .
$48 dn., $42 mo. **$479.95**
GRA-295-4, Mediterranean cabinet (shown above), 90 lbs. . . .
no money dn., $11 mo. **$112.50**
Other cabinets from $62.95.

Kit GR-180
$349.95
(less cabinet & cart)
$30 mo.

Deluxe Heathkit "180" Color TV

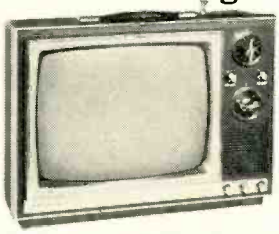
Same high performance features and exclusive self-servicing facilities as new GR-227 (above) except for 180 sq. in. viewing area.

Kit GR-180, (everything except cabinet), 102 lbs. . . .
$35 dn., $30 mo. **$349.95**
GRA-180-5, table model cabinet & mobile cart
(shown above), 57 lbs. . . . no money dn., $5 mo. **$39.95**
Other cabinets from $24.95

Deluxe 12" Transistor Portable B&W TV – First Kit With Integrated Circuit

Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); receives all channels; new integrated sound circuit replaces 39 components; preassembled, prealigned tuners; high gain IF strip; Gated AGC for steady, jitter-free pictures; front-panel mounted speaker; assembles in only 10 hours. Rugged high impact plastic cabinet measures a compact 11½" H x 15¾" W x 9⅜" D. 27 lbs.

Kit GR-104
$119.95
$11 mo.



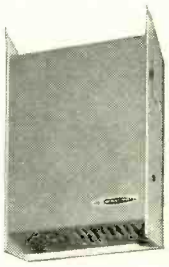
Kit GR-104, 27 lbs. . . . no money dn.,
$11 mo. **$119.95**

No Money Down On $25 to $300 Orders — Write For Credit Form

13 New Kits From Heath . . .

New! Heathkit Wireless Home Protection System for Your Family's Safety

GD-97
Utility Transmitter
for Universal Protection



GD-87
Wireless Smoke/Heat
Detector-Transmitter

GD-77 Wireless Receiver/Alarm
fail-safe, always alert

Applications Unlimited . . . Customize Your Own System. Here's reliable, low cost, 24-hour protection for your family and property. System warns of smoke, fire, intruders, freezing, thawing, cooling, rising or receding water, pressures . . . any change you want to be warned about. Uses unique new signaling method developed by Berkeley Scientific Labs.; exclusively licensed to Heath. Your house is already wired for this system, just plug the units into any AC outlet. "Load transmission" design (not a carrier type as in wireless intercoms) generates unusual signal that is practically unduplicable in other devices or random noise sources. Solid-state circuitry has built-in fail-safe capability to sound alarm if power fails, if power supply components in any unit fail, or if 50,000 hour bulb in smoke detector fails. Receiver/Alarm has 2800 Hz transistor alarm and receptacle for extra 117 VAC bell or buzzer to extend range, plus rechargeable battery (always kept charged) to sound alarm if power fails. Smoke-Heat Detector-Transmitter capability may be extended to other areas by adding extra heat sensors to its built-in sensor. Utility Transmitter accepts any type of switch or sensor for any purpose; examples: magnetic reed switches for doors and windows to warn of entry; step-on switches for door or driveway; micro switches with trip wire around yard; heat sensors; water pressure switches warn of pump failure; thermal switches warn of freezing in gardens, or thawing in freezers; two wires act as switch to warn of changing water levels in sump-pump wells, pools, etc. Units are small and unobtrusive in beige and brown non-reflecting velvet finish. Any number of units may be used in the system. All units feature circuit board construction; each unit takes only 3 hours to build. Operating cost similar to electric clocks. Invest in safety for your family now with this unique Heath system.

Kit GD-77, receiver/alarm, 4 lbs. **$39.95**
Kit GD-87, smoke/heat det.-trans., 5 lbs. **$49.95**
Kit GD-97, Utility trans., 4 lbs. **$34.95**
(numerous accessory switches available from Heath)

New! Low Cost Heathkit 5-Band SSB-CW Transceiver

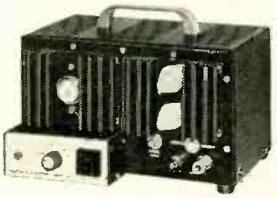
Kit HW-100
$240.00

You asked for it . . . a 5-band version of the Heathkit "single-banders" . . . a low cost SSB transceiver for 10 or 15 meters . . . an SSB transceiver equal or superior to many wired rigs but at much lower cost. It's the new HW-100, the most SSB equipment you can get for the money. Features build-it-yourself solid-state (FET) VFO; 80-10 meter coverage; switch-selected upper or lower sideband or CW; crystal filter; full coverage on all bands with 500 kHz per band segment; smooth vernier control; built-in 100 kHz calibrator; separate offset CW carrier crystal; TALC; quiet, enclosed relays; fixed or mobile operation with accessory power supplies; 180 watts PEP, 170 watts CW input; PTT or VOX on SSB; CW transceive by VOX from keyed tone using grid-block keying; less than 100 Hz drift per hour after warmup; less than 100 Hz variation under 10% line voltage variation; receiver sensitivity less than 0.5 uv for 10 dB S+N/N ratio for SSB operation; selectivity 2.1 kHz at 6 dB down, 7 kHz at 60 dB down; image & IF rejection better than 50 dB; easy circuit board construction with one large wiring harness; handsome 2-piece green wrinkle finish cabinet. It's a winner!

Kit HW-100, 19 lbs., no money dn., $22 mo. **$240.00**

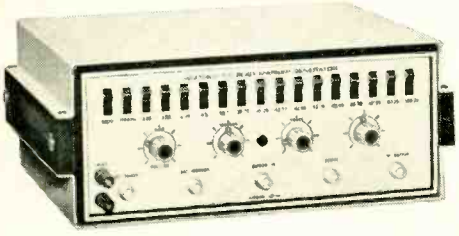
New! Heathkit High-Power Inverter for Boats, Cars, Campers

Kit
MP-14
$99.95



Powers Color & B&W TV's, power tools, radios, phonos, lights, tape recorders, hi-fi systems, shavers, PA systems, ham & CB rigs, any small appliance except compressor-type refrigerators and units having heating elements drawing over 400 watts. Also makes good source of limited emergency power at home. Delivers 500 watts intermittant; 400 watts continuous; freq. and output adjustable for best operation; remote control-output and cables included. 29 lbs.

New! Heathkit Crystal-Controlled Post Marker Generator

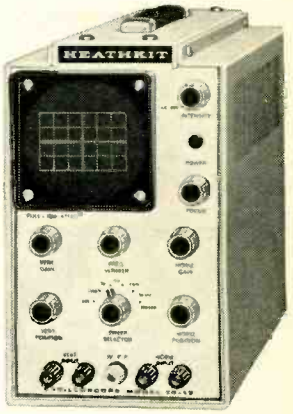


Kit IG-14
$99.95
$10 mo.

Fast, accurate color TV and FM alignment at the touch of a switch! 15 crystal-controlled marker frequencies. Select picture and sound IF's, color bandpass and trap freqs., 6 dB points, FM IF center freq. and 100 kHz points. Use up to six markers simultaneously. Birdie-type markers. Trace and marker amplitude controls permit using regular 'scope. 400 Hz modulator. Variable bias supply. Input and output connectors for use with any sweep generator. Also has external marker input. BNC connectors. Solid-state circuit uses 22 transistors, 4 diodes. Two circuit boards. Handsome new Heathkit instrument styling of beige and black in stackable design. Until now, an instrument of this capability cost hundreds of dollars more. Order your IG-14 now, it's the best investment in alignment facilities you can make.

Kit IG-14, 8 lbs., no money dn., $10 mo. **$99.95**

New! Low Cost Heathkit 5 MHz 3″ Scope



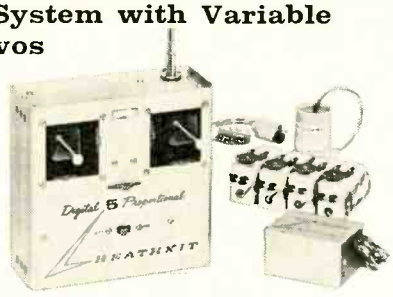
Kit IO-17
$79.95

Here is the wideband response, extra sensitivity and utility you need, all at low cost. The Heathkit IO-17 features vertical response of 5 Hz to 5 MHz; 30 mv Peak-to-Peak sensitivity; vertical gain control with pull-out X50 attenuator; front panel 1 volt Peak-to-Peak reference voltage; horizontal sweep from internal generator, 60 Hz line, or external source; wide range automatic sync; plastic graticle with 4 major vertical divisions & 6 major horizontal; front mounted controls; completely nickel-alloy shielded 3″ CRT; solid-state high & low voltage power supplies for 115/230 VAC, 50-60 Hz; Zener diode regulators minimize trace bounce from line voltage variations; new professional Heath instrument styling with removable cabinet shells; beige & black color; just 9½″ H. x 5½″ W. x 14½″ L.; circuit board construction, shipping wt. 17 lbs.

See 300 More in FREE Catalog

New! Heathkit/Kraft 5-Channel Digital Proportional System with Variable Capacitor Servos

System Kit GD-47
$219.95
$21 mo.



This Heathkit version of the internationally famous Kraft system saves you over $200. The system includes solid-state transmitter with built-in charger and rechargeable battery, solid-state receiver, receiver rechargeable battery, four variable capacitor servos, and all cables. Servos feature sealed variable capacitor feedback to eliminate failure due to dirty contacts, vibration, etc.; three outputs: two linear shafts travel ⅝" in simultaneous opposite directions plus rotary wheel. Specify freq.: 26.995, 27.045, 27.145, 27.195 MHz.

System Kit GD-47, all of above, 5 lbs. **$219.95**
Kit GDA-47-1, transmitter, battery, cable, 3 lbs. **$86.50**
Kit GDA-47-2, receiver, 3 lbs. **$49.95**
GDA-47-3, receiver rechargeable battery, 1 lb. **$9.95**
Kit GDA-47-4, one servo only, 1 lb. **$21.50**

World's Most Advanced Stereo Receiver

Kit AR-15
$329.95
(less cabinet)
$28 mo.

Acclaimed by owners & experts for features like integrated circuits & crystal filters in IF amplifier; FET FM tuner; 150 watts music power; AM/FM and FM stereo; positive circuit protection; all-silicon transistors; "black magic" panel lighting; and more. Wrap-around walnut cabinet $19.95.

Kit AR-15 (less cab.), 34 lbs. . . . $33 dn., $28 mo. **$329.95**
Assembled ARW-15, (less cab.), 34 lbs. . . . $50 dn., $43 mo. **$499.50**

New! Solid-State Portable Volt-Ohm-Meter

So Handy, So Low Cost we call it "every man's" meter. Just right for homeowners, hobbyists, boatowners, CBer's, hams . . . it's even sophisticated enough for radio & TV servicing! Features 12 ranges . . . 4 AC & 4 DC volt ranges, 4 ohm ranges; 11 megohm input on DC, 1 megohm input on AC; 4½" 200 uA meter; battery power; rugged polypropylene case and more. Easy 3 or 4 hour kit assembly.

Kit IM-17
$19.95

What would you expect to pay for a Vox "Jaguar" Combo organ with a 180-watt 3-channel amp? $1000? $1250? $1500? More?

Kit TOS-1
Organ, Amplifier & Speaker Kits
(240 lbs.)
$598.00

Kit TOS-2
Organ Kit, Assembled Amplifier & Speaker (240 lbs.)
$698.00

You can get both for only $598 during this Special Heathkit Offer!

Now you can get this famous professional combo organ with a versatile high-power piggy-back amp. and matching speaker system for just a little more than you'd expect to pay for the "Jaguar" alone! The Heathkit/Vox "Jaguar" is solid-state; two outputs for mixed or separated bass and treble; reversible bass keys for full 49 key range or separate bass notes; bass volume control; vibrato tab; bass chord tab; four voice tabs (flute, bright, brass, mellow); keyboard range C_2 to C_6 in four octaves; factory assembled keyboard, organ case with cover, and stand with case. Also available separately; you'll still save $150 (order Ki TO-68, $349.95).

The Heathkit TA-17 Deluxe Super-Power Amplifier & Speaker has 180 watts peak power into one speaker (240 watts peak into a pair); 3-channels with 2 inputs each; "fuzz", brightness switch; bass boost; tremolo, reverb; complete controls for each channel; foot switch; 2 heavy duty 12" speakers plus horn driver. Also available separately kit or factory assembled (Kit Amplifier TA-17, $175; Assembled $275; Kit Speaker TA-17-1 $120; Assembled $150; Kit TAS-17-2, amp. & two speakers $395; Assembled TAW-17-2, amp. & two speakers $545).

New! Heath/Mitchell COLORVAL Darkroom Computor . . . Kit or Assembled

Kit PM-17
$89.95
$9 mo.

Colorval takes the work out of color printing, leaves the creativity to you. Colorval is easy to set up . . . you "program" the scan filter pack for the type of film, paper, and equipment you use . . . we show you how. Unique Color Probe allows visual determination of ideal enlarger filter combination. Color Wheel and table shows what filter changes are needed. Exposure Probe scans shadows and highlights; exposure scale on Computer indicates proper contrast for color and b/w printing. Get started in color the right way, quickly, easily.

Kit PM-17, 6 lbs., no money dn., $9 mo. **$89.95**
Assembled PMW-17, 6 lbs. . . no money dn., $13 mo. . . **$125.00**

NEW FREE 1968 CATALOG!

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

HEATHKIT

HEATH COMPANY, Dept. 20-4
Benton Harbor, Michigan 49022
In Canada, Daystrom Ltd.

☐ Enclosed is $_____, including shipping.
Please send model (s)_____
☐ Please send FREE Heathkit Catalog.
☐ Please send Credit Application.
Name_____
Address_____
City_____ State_____ Zip_____

Prices & specifications subject to change without notice. CL-321

Circle 119 on reader's service card

FM/TV Antennas

(continued from page 37)

Figure 3 shows the response of a typical Yagi. Notice that, within channel 6, the response tilts by more than 5 dB. This generally causes no problem on black-and-white TV. On color TV, however, the story is quite different. Not only is the color subcarrier attenuated, but the respose tilt causes changes in phase relationships. Since color is detected in phase, this results in color distortion.

A couple of years ago, the log periodic antenna was popularized by JFD and the University of Illinois. Admittedly, the log-periodic does not provide as much gain as the Yagi (dollar for dollar or using a given amount of aluminum) but it is far superior to the Yagi in flatness—so essential to color TV reception. Further, engineers have overcome the problem of side lobes in the 3/2 wave-

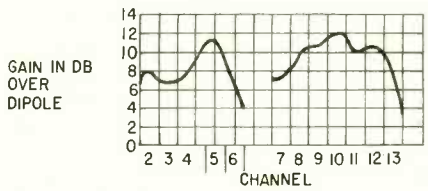


Fig. 3—Older antenna response was not flat; they do poorly with color sets.

length mode by "V"-ing the elements and by other ingenious methods.

Most major manufacturers now offer log periodics. (One exception is Gavin: they claim to have modified the basic Yagi to provide flatness and eliminate side lobes without sacrificing gain.)

A third factor in choosing antennas—and one that is often overlooked—is construction. If you wish to avoid damage brought on by wind, snow, ice, corrosion, etc., be on the alert for poor construction and structural defects.

How heavy are the elements? (Generally, the heavier the better.) Do the elements make solid contact when they're snapped into place, or can they be wiggled around? (Elements that vibrate in the wind may make and break contact, producing jumpy pictures.) Are the elements reinforced? (Unreinforced elements may break off in the wind.) Are insulators solid and nearly indestructible? Are the elements protected by a corrosion-resistant coating? On larger antennas, are solid boom braces used?

The antennas shown here are only a sample of what's available for TV and FM reception. **R-E**

Build A Voltage-Step Box

(continued from page 55)

have the same arrangement with the transformer primary leads transposed. The voltages are now in phase and we have a series-aiding connection, so the line voltage is increased.

In the center position, the transformer primary is shorted. If the short is omitted, the line-voltage regulation will be degraded. Provided with a short to reflect into the power line, the transformer acts as if we had actually shorted its secondary winding rather than its primary.

A nonshorting (break-before-make) switch is required for S2. A shorting or break-after-make switch will blow fuses by shorting the power line while going from one position to the next.

The Voltage-Step Box produces a step of 6 to 7.5 volts, depending upon load. This is about a 5% change, which is suitable for drift and stability testing. Most electronics gear is rated to work properly within ±10% of correct voltage, which could be obtained by using a 12.6-volt filament transformer.

Using the Voltage-Step Box

The box takes a standard cheater cord, and accepts normal two-prong line plugs. It goes in the power line of the device under test, as shown in Fig. 2. Allow a half-hour to an hour warm-up at normal line voltage.

Stepping the voltage up or down will cause drift, and there should be an opposite drift when the voltage is stepped the other way. Since the voltage changes by the same amount for each test, the drift can be measured in cycles, volts or other units per step.

If the cause of the drift is not immediately obvious, closer observation of its rate should provide a useful hint. For instance, if the drift occurs immediately after the voltage step and is completed within a few seconds, the circuit must be responding to a change in dc supply voltage.

A vacuum-tube device may appear stable after a voltage step, and then commence to drift. The drift goes on for a minute or two. In this case the drift is due to changing tube characteristics following a change in heater temperature.

And the slowest drift is that due to chassis temperature change. Temperature stabilization takes time, generally a few hours. And because the line voltage tends to vary on a similar scale, temperature-change drift tests require a stabilized power source. R-E

IC AND RECEIVER SALES—The Electronic Industries Association reports that the sale of integrated circuits climbed 58% during the first 10 months of 1967. In receiver sales, EIA reports total number of radios during first 9 months of 1967 at nearly 29 million (of which 55% were imported). Of this total, 28% were FM radios. During the same period, slightly more than 8 million TV receivers were sold.

NEW SEMICONDUCTORS

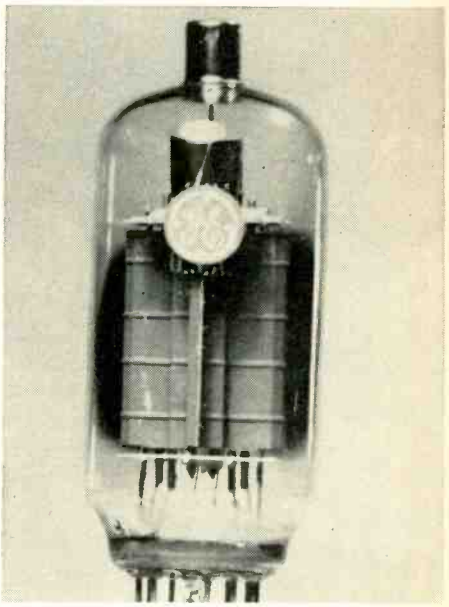
MICROMINIATURE ZENER DIODES

The 1N4460 through 1N4496 make up a series of thirty-seven 1.5-watt Zener diodes featuring reverse leakage currents as low 0.05 μA at 80% Zener voltage at 25°C. The Zener voltages range from 6.2 to 200 in steps conforming to EIA standard resistor values.

The hermetically sealed glass envelope is 0.085" in diameter and 0.1" long with 0.8" wire leads. Maximum power dissipation up to 4.5 watts is possible with suitable heat-sinking. The data sheet on these Centralab diodes (available from Semiconductor Products, Electronics Div., Globe-Union, Inc., 4501 N. Arden Drive, El Monte, Calif. 91734) carries full technical specifications and a nomograph for operating at power levels ranging from 0.22 to 4.5 W.

NEW COMPACTRONS FOR COLOR

The 6LG6 and 21LG6 are the latest additions to G-E's line of compactrons for color TV circuits. They are beam-power pentodes, identical except for heater characteristics and ratings. The tubes, designed for use as horizontal output amplifiers, have a very low knee



voltage, high plate-to-screen ratio and high peak-current capability. They can

AND MICROCIRCUITS

be used in circuits with shunt or variable bias type regulation and B+ supply voltages from 240 to more than 400. The low voltage minimizes snivets without having to apply special voltages to the beam plates.

The 21LG6 has a 21-volt, 0.6-ampere heater while the 6LG6 has a 6.3-volt, 2-ampere heater.

MATCHED-PAIR SILICON FET'S

Each TIS68, TIS69 or TIS70 consists of a pair of matched N-channel epitaxial planar silicon field-effect transistors. Each pair is supplied with a mounting clip.

These Texas Instruments plastic-encapsulated transistors have the following absolute maximum ratings at 25°C: Drain–gate voltage, 25; reverse gate–source voltage, –25; continuous forward gate current, 30 mA; dissipation up to 25°C free-air temp., 360 mW.

The type number is determined by the matching within the triode pair. For example, the gate–source voltage differential (when V_{DS} is 15 V and I_D is 50 μA) is 8 mV, 16 mV and 32 mV for the TIS68, TIS69 and TIS70, respectively. Other pertinent data can be obtained from Texas Instruments, Inc., Semiconductor Components Div., P.O. Box 5012, Dallas, Tex. 75222. **R-E**

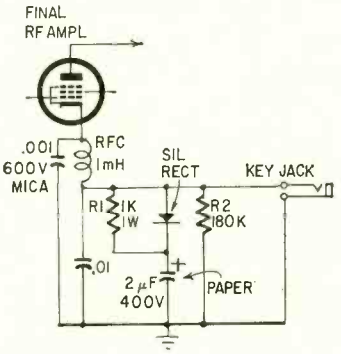
"The hard part of this job is trying to keep up with all the advances in the field."

NOTEWORTHY CIRCUITS

PREVENTING CW KEY CLICKS

Cathode-keying in the final amplifier is the simplest and most common method of keying CW transmitters. In most circuits, the abrupt cutoff of cathode current on the "break" produces key clicks and heavy arcing which pits and wears away the key contacts. Writing in *The Indian Radio Amateur*, VU2JN describes a key-click filter that softens the "break" and eliminates arcing across the key. The circuit is shown.

When the key is up C1, a 2-μF paper capacitor, is charged to the key-up cathode potential—around 200 volts for a rig running around 500 volts. As the key is closed, the tube starts to conduct and C1 discharges rapidly, but not instantly, through R1. When the key is released, cathode current does not cut off



abruptly. Instead, it continues to flow through D1 and C1 charges to the level determined by R2. This gradual cutoff of cathode current suppresses arcing and provides clickless "break" on dots and dashes.

FET AUDIO BANDPASS FILTER

CB, amateur and two-way business radiotelephone communication is most intelligible and less susceptible to interference when the audio bandwidth is restricted to a range of about 300 to 3000 Hz. Usually, the required bandpass is obtained by using small coupling capacitors to attenuate the lows and an L-C low-pass filter to roll off the highs. This type of arrangement (passive) has insertion losses which must be overcome by additional amplification.

Break-In, a New Zealand amateur radio magazine, carried an article by ZL2APC describing an FET audio

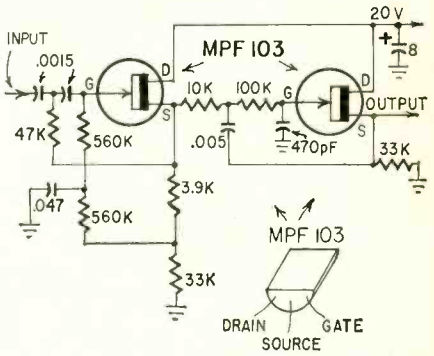


Fig. 1

bandpass filter (response down 6 dB at 380 and 3200 Hz) that he recommends for shaping the audio response in communications receivers and in phasing-type SSB transmitters.

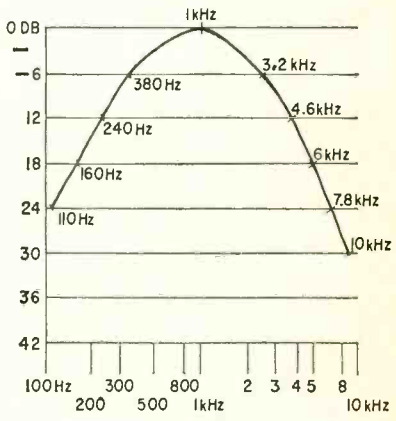


Fig. 2

The ZL2APC circuit is shown in Fig. 1 and its response in Fig. 2. The circuit consists of high- and low-pass filters combined to provide the required bandpass characteristic. The two transistors are used as source followers. Gain is unity at 1 kHz and drops off sharply on both sides as indicated by the curve in Fig. 2. The transistors are Motorola MPF103 n-channel FET's. Fairchild p-channel 2N4360 FET's may be substituted if you reverse the power supply polarity. **R-E**

MARKET CENTER

GENERAL

CONVERT ANY TELEVISION to sensitive Big-Screen Oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans $2.00. **RELCO**-A25, Box 10563, Houston 18, Texas

FREE ELECTRONICS (new and surplus) Parts catalog. We repair multimeters. **BIGELOW ELECTRONICS**, Bluffton, Ohio 45817

BACK-ISSUES, Electronic, Scientific Magazines. **SEMCO**, Box 130, Roxboro, Quebec, Canada

HOLSTER KIT (including: Cowhide, Buckskin, Thongs, Lacing, Tools, Patterns): $5.00. **LEATHERCRAFT**, 1720-2 Nogales, Sacramento, California 95838

TRANSISTOR RADIOS REPAIRED. Write for details. **TRANSERVICE**, Box 503, Marietta, Georgia 30060

MONEY—SPARE TIME OPPORTUNITY—WE PAY CASH FOR NOTHING but your opinions, written from home, about samples of our clients' products. Nothing to sell, canvass or learn. NO SKILLS. NO EXPERIENCE. Just honesty. Details from: **RESEARCH** 669, Mineola, N. Y. 11501, Dept. LN-21

WANTED

QUICK CASH . . . for Electronic EQUIPMENT, COMPONENTS, unused TUBES. Send list now! **BARRY**, 512 Broadway, New York, N. Y. 10012, 212 WALKER 5-7000

Wanted: Good POWER TRANSFORMER for OS/26/USM-24 Oscilloscope. **RALPH TOLBERT**, Route 1, Fayetteville, Pa. 17222

ELECTRONICS

BARGAINS in Canadian Electronic equipment and surplus. Send $1.00 for giant catalogs. **ETCO**, Box 741, Dept. R, Montreal, Canada

TUBES. "Oldies", latest. Lists free. STEINMETZ, 7519 Maplewood, Hammond, Indiana 46324

RECEIVING & INDUSTRIAL TUBES, TRANSISTORS, All Brands—Biggest Discounts. Technicians, Hobbyists, Experimenters—Request FREE Giant Catalog and SAVE! **ZALYTRON**, 469 Jericho Turnpike, Mineola, N.Y. 11501

SILICON RECTIFIER SALE

IMMEDIATE DELIVERY
FULLY GTD NEWEST TYPE
AMERICAN MADE FULLY TESTED

1 AMP TOP HAT AND EPOXIES

PIV	SALE	PIV	SALE	PIV	SALE
50 ☐	.05	800 ☐	.19	1800 ☐	.87
100 ☐	.07	1000 ☐	.31	2000 ☐	1.45
200 ☐	.08	1200 ☐	.44	3000 ☐	1.80
400 ☐	.11	1400 ☐	.62	4000 ☐	2.30
600 ☐	.16	1600 ☐	.72	—	—

"SILICON POWER DIODE STUD MOUNT"

PIV	3A	6A	12A	50A	100A	160A
50	.07	.18	.22	.50	.85	2.25
100	.09	.24	.29	.73	1.05	2.65
200	.15	.37	.48	1.23	1.60	3.50
400	.19	.48	.68	1.45	2.50	4.25
600	.28	.72	.95	1.75	3.75	6.50
800	.38	.87	1.15	2.20	—	—
1000	.53	1.10	1.40	2.60	—	—

"SCR" SILICON CONTROLLED RECT "SCR"

PRV	7 AMP	16 AMP	25 AMP	PRV	7 AMP	16 AMP	25 AMP
50	.45	.60	.70	400	1.60	1.85	2.10
100	.65	.85	1.00	500	1.95	2.35	2.50
200	.95	1.20	1.30	600	2.35	3.50	3.75
300	1.25	1.45	1.70	700	2.75	4.25	—

SPECIALS! SPECIALS!

Westinghouse 160 AMP, 500 PIV SILICON HI-POWER STUD RECTIFIER IN1666.
Limited quantity. $5.10 ea. 10 for $45.00

100 Different Precision Resistors ½—1—2 Watt ½%—1% TOL $1.25

Asst transistor Kit. P.N.P.—N.P.N. All popular types. Unchecked 100 for $2.95 500 for $9.95

Computer Grade Condenser 15,500 MFD 12 VDC American Mfg. .75 ea.

NEW DIODE KIT ALL POPULAR TYPES
IN34, IN34A, IN48, IN60, IN64 etc. 100 for $ 4.00
BEST QUALITY 500 for $15.00

Money Back guarantee. $2.00 min. order. Include additional $ for postage. Send check or money order. C.O.D. orders 25% down.

Warren Electronic Components
230 Mercer St., N. Y., N. Y. 10012 • 212 DR 3-2620

Circle 128 on reader's service card

CORNELL

One Year TUBES Guaranteed

Tubes are new or used and so marked. Lab-tested. Individually Boxed. Branded and Code Dated.

OZ4	3BZ6	6AB4	6AT6	6BA6	6BQ6	6CG7	6EA7	6K7	6SN7	6X4	12AD6	12BE6	12SQ7	77
1B3	3DG4	6AC7	6AT8	6BC5	6BQ7	6CG8	6EM5	6Q7	6SQ7	6X8	12AE6	12BF6	25L6	78
1J3/1K3	5U4	6AG5	6AU4	6BD6	6BZ6	6CM7	6F6	6S4	6SR7	7A7	12AF6	12BH7	25Z6	84/6Z4
1H5	5U8	6AK5	6AU5	6BG6	6C4	6CZ5	6GH8	6SA7	6U7	7A8	12AT7	12BL6	35W4	5687
1L4	5V4	6AL5	6AU6	6BJ6	6C6	6D6	6H6	6SH7	6U8	7B6	12AU7	12BY7	35Z3	6350
1T4	5Y3	6AN8	6AV6	6BL7	6CB6	6DA4	6J5	6SJ7	6V6	7C5	12AX7	12C5	50L6	6463
1U4	6A6	6AQ5	6AW8	6BN4	6CD6	6DE6	6J6	6SK7	6W4	7N7	12BA6	12CA5	24	7044
1X2	6A8	6AS5	6AX4	6BN6	6CF6	6DQ6	6K6	6SL7	6W6	7Y4	12BD6	12SN7	27	

Other tubes and CRT's at low prices- send for free list

NO SUBSTITUTIONS WITHOUT YOUR PERMISSION • YOUR ORDER FREE IF NOT SHIPPED IN 24 HRS.

33¢ PER TUBE
100 TUBES OR MORE: 30¢ PER TUBE

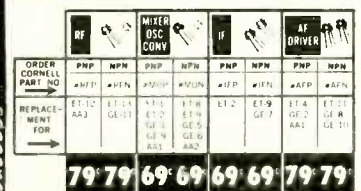
Special!
With every $10 Order
25¢ per tube
(No Limit) from this list.

6AG5		6SN7
6AQ5	6CB6	6S4
6AU6	6J6	6W4

TRANSISTORS

FAIRCHILD SEMICONDUCTOR

FOR—RADIO—TV—HI-FI—REPAIRS



Prestige & Success are yours as an ELECTRONIC EXPERT

Both above courses $6.00

TUBE CARTONS

HIGH GLOSS CLAY COATED RED & BLACK With Built in Diagonal Partitions

SIZE	FOR TUBE SIZE	PRICE PER 10 CARTONS (Shipping incl.)	PRICE PER 100 CARTONS (Shipping inc.)
MIN.	6AU6	.29	2.59
GT.	6SN7	.39	3.49
LG.GT	5U4GB	.59	5.29
G.	5U4G	.89	7.99

FREE **Send for CORNELL'S NEW 1968 CATALOG!!!** **FREE**
PICTURE TUBES!
MANY NEW ITEMS!!!

all purpose ELECTRONIC CLEANER 89¢ plus 20¢ shipping

CORNELL Dept. RE-4, 4217 UNIVERSITY AVE. SAN DIEGO, CALIFORNIA 92105

TERMS: ORDERS OVER $5.00: Add 3c per tube shipping. Prepay in full and avoid C.O.D. charges. Send $3.00 deposit on C.O.D. orders. No 24 hr. free offer on personal checks orders.
ORDERS UNDER $5.00: Add 3c per tube shipping plus 50c handling.
CANADIAN AND FOREIGN ORDERS: Add approximate postage. No C.O.D. orders.
COMBINE VARIED ITEMS TO BRING YOUR ORDER OVER $5.00

Circle 135 on reader's service card

MARKET CENTER

Discharge IGNITION, PHOTOFLASH. Free catalog parts, kits. **TRANSPARK,** Carlisle, Mass. 01741

RADIO & TV TUBES 33¢ each. On year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL,** 4217-E University, San Diego, California 92105

MESHNA'S TRANSISTORIZED CONVERTER KIT Converts car radio to receive police & fire. 35-50Mc or 100-200Mc. (one Mc tuning) with simple step instructions $5.00. **MESHNA,** No. Reading, Mass. 01864

GIANT JAPANESE ELECTRONICS CATALOG. $1. **DEE,** 10639A Riverside, North Hollywood, Calif. 91602

BRAND NEW TUBES. World's lowest prices on Radio, TV-industrial-special purpose tubes. Write for free parts catalog. **UNITED RADIO CO.,** Newark, N.J. 07101

"ARCTURUS" SALE

• Tube bargains, to name just a few:

#6146	$2.95	#5725/6AS6	79¢; 3 for $2.00	#6AQ5	61¢
#6360	3.50	#5842/417A	2.50	#6BQ7	94¢
#6688	3.50	#5847/404A	2.50	#6CG7	59¢
#6939	3.50	#1AX2	49¢; 5 for 2.00	#6J6	49¢
#7025	.59	#6K7	39¢; 3 for 1.00	#6T8	88¢
#7788	3.75	#12BN6	59¢; 3 for 1.49	#6U8	78¢
#2D21	.49	#25L6	59¢; 3 for 1.49	#12AU7	59¢

• Tube cartons: 6AU6 etc. size, $1.95 per 100. 6SN7 etc. size, $2.35 per 100. 5U4GB size, $2.75 per 100. 5U4G size, .03¢ each.

• Obsolete tubes: #UX200, $1.69; #80, $1.20; #10Y, 69¢

• 7 inch 90 degree TV bench test picture tube with adapter. No ion trap needed. Cat. #7BP7. $7.99.

• Silicon rectifier octal-based long-range replacement for 5U4, 5Y3, 5AS4, 5AW4, 5T4, 5V4, 5Z4. With diagram. Cat. # Rect 1, 99¢ each.

• Silicon rectifier replacement, octal based, for OZ4. Cat. # Rect 2, 99¢ each.

• 10 silicon rectifiers. 750 MA., 50 to 300 p.i.v. Cat. # 330F, 99¢ each.

• RCA-110 degree flyback transformer, latest type. Produces 10 KV. Includes schematic diagram application for any TV. Cat. # BR-1 $2.99.

• 5 transistor circuit boards containing up to 6 transistors, plus diodes, resistors, capacitors, etc. Cat. # TB10. 99¢

• Needles: values such as # AS22 sapphire, 39¢; diamond, 99¢

• Color yokes. 70 degree for all around color CRT's. Cat. # XRC70. $12.95. 90 degree for all rectangular 19 to 25 inch color CRT's, Cat. # XRC90, $12.95.

• Transistorized U.H.F. tuners used in 1965 to 1967 TV sets made by Admiral, RCA, Motorola, etc. Removable gearing may vary from one make to another. Need only 12 volts d.c. to function. No filament voltage needed. Easy replacement units. Cat. # U.H.F. 567, $4.95

• Flyback transformer in original carton. Made by Merit or Todd. Most with schematic drawing of unit. Please do not request specific type. Cat. # 506, 99¢ each.

• Kit of 30 tested germanium diodes. Cat. # 100, 99¢.

Send for our free catalog listing thousands of similar best buys in tubes, parts, kits, transistors, rectifiers, etc. Orders under $5.00, add 50¢ handling charge. Include 4% of dollar value of order for postage. Canadian postage $1.00 extra

ARCTURUS ELECTRONICS CORP.

502-22nd St., Union City, N.J. 07087 Dept. MRE
Phone: 201-UN 4-5568

Circle 129 on reader's service card

TV CAMERA KITS for experimental and industrial applications. Starter kits $18.95 up! Catalog free. **ATV RESEARCH,** Box 453-R, Dakota City, Nebr. 68731

INTEGRATED CIRCUIT KITS; COMPUTER LOGIC KITS; Others. Free catalog. **KAYE ENGINEERING,** Box 3932-D, Long Beach, Calif. 90803

MANUALS for surplus electronics. List 15¢. **BOOKS,** Box 804, Adelphi, Maryland 20783

PROXIMITY Switch. Detects nearness of human body! Free information. **ZONAR,** 860 Reed, Claremont North, Calif. 91711

SILICON metal $1.00/ounce. SELENIUM metal 3 grams $1.00. CATALOG of interesting projects, plans, kits. 20¢. **FRANKS SCIENTIFIC CO.,** P.O. Box 156, Martelle, Iowa 52305

BEGINNERS, BUILDER'S Giant Catalog—25¢, refundable. LABORATORIES, 12041-B Sheridan, Garden Grove, Calif. 92640

LIKE MUSIC WITHOUT COMMERCIALS?

The SCA-2B Sub-Carrier Adapter makes it possible for you to enjoy the background music transmitted on a 67KHz sub-carrier on many FM stations. (These programs cannot be heard on a FM set without an adapter) In the US there are approximately 400 FM stations authorized by the FCC to transmit the 67KHz programs. If you are within 50 miles of a city of 100,000 or more, it is probable that you are within the satisfactory reception range of one or more of these stations. If in doubt write for a list of such stations in your area.

Sub-Carrier Adapter, Model SCA-2B with two 36" shielded cables. Price $39.95.
117 Volt AC Operated Power Supply, PS-9, Price $4.95.

SCA-2B FEATURES

SIZE: 4" x 2⅞" x 1⅝". • Simple plug-in connections to your FM tuner/amplifier. (If your FM tuner does not have a multiplex output jack, we supply hook-up information). • No installation adjustments • All silicon transistors • Operates from our PS-9 Power Supply or 6 to 12 volts D.C.

One Year Factory Guarantee

For Custom Installations: Completely Wired SCA-2 PC card (size: 2½" x 3" x ¾") with installation instructions for $34.95.

Write for Dealer Quantity Discounts.

Also available in a General Electric Model T1220B table radio. This is a 6 tube, 3 transistor, AM/FM radio with a four-inch speaker for $59.95.

Send order to **KENZAC Co.**
P.O. Box 66251, Houston, Texas 77006

Circle 130 on reader's service card

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume responsibility for any errors which may appear in the index below.

CBer's C.T.S. KNIGHT CRYSTALS. Guaranteed $1.85 each. Postage Paid, Add 2% Sales Tax. Write E & S CB SALES & SERVICE. Route 4, Winchester, Indiana 47394

AUDIO — HI-FI

RENT STEREO TAPES—over 2,500 different—all major labels — free brochure. **STEREO PARTS**, 1616-R Terrace Way, Santa Rosa, Calif. 95404

WRITE for highest discounts on components, recorders, tapes, from franchised distributors. Send for FREE monthly specials. **CARSTON**, 1686-R Second Ave. N.Y.C. 10028

HI-FI COMPONENTS, Tape Recorders, at guaranteed "WE will not be undersold" prices. 15-day moneyback guarantee. Two-year warranty. NO Catalog. Quotations Free. **HI-FIDELITY CENTER**, 239R East 149th St., N.Y., N.Y. 10451

TAPE RECORDER SALE. Brand new, latest models, $10.00 above cost. **ARKAY SALES**, 1028-E Commonwealth Ave., Boston, Mass. 02215

STEREO TAPES, Save 30% and up; no membership or fees required; postpaid anywhere USA. FREE 70-page catalog. We discount batteries, recorders, tape/accessories. Beware of slogans, "not undersold", as the discount information you supply our competitor is invariably reported to the factory. **SAXITONE**, 1776 Columbia Road, N.W., Washington, D.C. 20009

TAPEMATES makes available to you ALL 4-TRACK STEREO TAPES—ALL LABELS—postpaid to your door—at tremendous savings. For free brochure write **TAPEMATES CLUB**, 5727 W. Jefferson Blvd., Los Angeles, Calif. 90016.

TAPE RECORDER BELTS for Grundig-Akai-Telefunkin. Give Model Number. **PUBLIC SOUND**, 9385 Bird Road, Miami, Florida, 33165

DISPOSAL—$80,000.00 hi-fidelity retail store inventory. New/used equipment; Ampex, Marantz, Fisher, others. Hewlett Packard test equipment. Free list—**MARCO ELECTRONICS**, Box 336 E, Winter Park, Fla., 32789

SCOTCH TAPE at discount prices, rent PRE-RECORDED tapes—no dues. East coast's finest selection. Postage paid. **THE TAPE LIBRARY**, Box 8146, DC 20024

A remarkable British made INTEGRAL AMPLIFIER and Pre-amp. 15 watts R.M.S. 30 watts peak Hi-Fi music power. Weight . . . 3 ozs. Free manual with each amplifier. New and guaranteed . . . Not surplus . . . Price $11 each. **ANTIGUA RADIO INDUSTRIES**, Sutherlands Development Area, St. John's, Antigua, British West Indies.

SPEAKER REPAIR. Hi-Fi, guitar, organ speakers reconed good as new at fraction of new speaker price. For details and Reconing Center in your area write WALDOM ELECTRONICS, INC. 9155-4, Dept, RE 4625 W. 53rd St., Chicago, Ill. 60632

INVENTIONS & PATENTS

MANUFACTURERS NEED NEW ITEMS! B. F. Goodrich, Black & Decker, South Bend Tackle and other million dollar corporations have authorized us to locate new products. For details regarding development, sale, licensing of your patented/unpatented invention, write: THE RAYMOND LEE ORGANIZATION, 230 Park Avenue, New York City 10017

BUSINESS AIDS

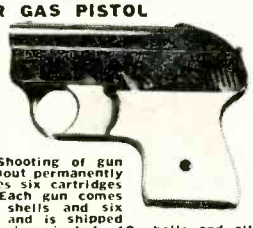
1,000 Business Cards, "Raised Letters" $3.95 postpaid. Samples. **ROUTH**, 5717 Friendswood, Greensboro, N. C. 27409

TWO-WAY RADIO SERVICE INVOICE FORMS—Detailed. Free Sample Form No. 50 and Catalog. **OELRICH PUBLICATIONS**, 6554 W. Higgins, Chicago, Ill. 60656

Attention: TV Service Dealers. HIGHLY DETAILED TV SERVICE ORDER FORM STOPS PRICE COMPLAINTS BEFORE THEY START. FREE CATALOG AND SAMPLE NO. 206. **OELRICH PUBLICATIONS**, 6554 W. Higgins, Chicago, Ill. 60656

DIAGRAMS, service information, Radio $1.00, Television $1.50. **HARTFORD**, 1760 Balsam, Highland Park, Illinois 60035

World Famed BREVETTATA
TEAR GAS PISTOL



Appearance of this fine tear gas weapon is similar to real gun. It is ideal for people who work in lonely dark locations and require protection. Men give this gun to wives and daughters for night security. Many industrial applications. Shooting of gun stops aggressor without permanently injuring him. It fires six cartridges without reloading. Each gun comes with six tear gas shells and six blanks for practice and is shipped prepaid. Gun unit prices include 12 shells and all shipping costs. and this pistol is not intended for sale or possession in any locality where it is prohibited by law. Not sold to minors.

- ☐ 1 Gun-unit at $13.07
- ☐ 2 Gun-units at $22.86 ..... ($11.43 ea.)
- ☐ 3 Gun-units at $29.94 ..... ($ 9.98 ea.)
- ☐ 4 Gun-units at $35.16 ..... ($ 8.79 ea.)

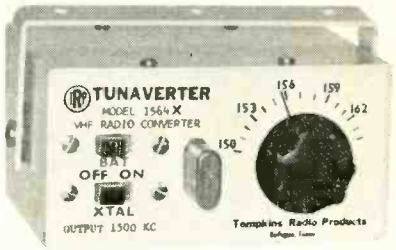
Extra boxes of ten tear gas shells at $1.50 per box (prepaid with gun orders). Extra boxes of blanks at $1.25 per box.

MEREDITH SEPARATOR CO.
Dept. REL. 310 W. 9th St., Kansas City, Mo. 64105

CHEMTRONICS
COLOR-LUBE
SPECIALLY FORMULATED TUNER CLEANER FOR COLOR TV TUNERS
Accept no substitutes

POLICE - FIRE - MARINE AIRCRAFT - AMATEUR CALLS

WITH NEW 1968
®TUNAVERTER X!
Crystal & Tunable—Versatility & Usability!



Crystal PLUS tunable (selectable with a switch) solid state converters to change your auto and home radios into excellent, sensitive, selective VHF receivers!

THE BEST — Versatile Calibrated Tuning! Drift Free Crystal Control!
PLUS — Complete Interchangeable Crystals Within Band!!

Models for AM & FM CRYSTAL & TUNABLE!

BAND	MODEL	COVERS	OUTPUT	PRICE
CB & 10 M	273X	26.9-30 mc	1500 kc	Each
6 meters	504X	50-54 mc	1500 kc	$32.95
2 meters	1450X	144-150 mc	1500 kc	ppd.
Police, fire	348X	33-48 mc	1500 kc	less
Marine	1564X	150-164 mc	1500 kc	crystal
Aircraft	1828X	118-128 mc	1500 kc	

Models for AM & FM TUNABLE ONLY

Marine	Marine	2.0-2.85 mc	550 kc	$19.95 ppd
SW & WWV SWL		9.3-10 mc	550 kc	$19.95 ppd

Coupling Loop & Extension Antenna for using TUNAVERTER with home-transistor radios $3.95 ppd
Mobile Battery Eliminator 12V to 9V .....$4.95 ppd
Crystals-State EXACT Listening frequency $5.10 ppd
Order from: FAST AIR MAIL add $.85 ea.

HERBERT SALCH & CO. Marketing Division of Tompkins Radio Products
Woodsboro RE, Texas 78393

Circle 131 on reader's service card

YOUR SERVICE AND QUALITY LEADER

INTEGRATED CIRCUITS

Our semiconductors have full factory length leads, are American made, unused, and in good physical condition. Our technical descriptions and pictures are accurate.

We promise to supply you with the highest quality products at the most attractive prices with the fastest service in the industry.

ZENERS

1 Watt 6-33V	$.50
10 Watt 6-200V	$.75
50 Watt 7-200V	$1.75

N-CHANNEL PLASTIC TO-18 FET's. Low noise, low leakage, 25 volts source to gate, 50 ma gate current, gain of 2000-9000μ mhos. $1.00

1 AMP
Top Hat & Epoxy

PRV	AMP
100	.07
200	.09
400	.12
600	.18
800	.22

PRV	AMP
1000	.35
1200	.50
1400	.65
1600	.80
1800	.90

TRIACS
TO-66
5 AMPS

PRV	
100	.90
200	1.40
300	1.75
400	2.25
500	2.60

☐ **SIM TO 2N3429 (NPN) SI, 7/8" stud,** min HFe of 30, 7.5 amps, 175 watts, VCe of 75. $1.75

☐ **SILICON BILATERAL SWITCH.** Replaces two SCR's by firing in either direction when breakdown voltage is exceeded. Used in light dimmers, etc. .....2/$1.00

☐ **1000 PRV** at 3A full wave bridge $3.50

☐ **NEON LIGHT of NIXIE TUBE DRIVERS.** An NPN, TO-18, Si Transistor with a V_{CBO} of 120 3/$1.00

☐ **500 HFe PLASTIC TRANSISTORS** (NPN) TO-18, S1 unit sim to 2N3565. 4/$1.00

☐ **SIM. to 2N2875 (PNP).** Silicon 20 watts with 30 MHz cut off $.75

☐ **HIGH-VOLTAGE NPN 150V V_{CBO}** at 2.5A, hi gain in TO-66 pack ..... $ .75

Silicon Power Rectifiers

PRV	3A	12A	20A	40A
100	.09	.30	.40	.75
200	.16	.50	.60	1.25
400	.20	.70	.80	1.50
600	.30	1.00	1.20	1.80
800	.40	1.25	1.50	
1000	.55	1.50	1.80	

SR FLIP FLOPS .....$ .90
DUAL NAND NOR GATES ...$1.00
SR CLOCKED FLIP FLOPS ...$1.15
8 INPUT NAND NOR GATES ..$1.00
DUAL AND GATE $1.00
QUAD NAND NOR GATES ...$1.00

TO-85 flat pack with holder. Guaranteed to work. They come complete with schematic, elect. characteristic sheet and some typical applications.

☐ **CADMIUM SELENIDE PHOTO CONDUCTIVE CELLS.** Dark resistance of 500 megohms. Sensitivity of 1-4.99 μa/ft candle with data sheet $1.00

Silicon Control Rectifiers
TO-66 pack — Studs

PRV	3A	7A	20A	70A
50	.35	.45	.70	
100	.50	.65	1.00	4.00
200	.70	.95	1.30	8.00
300	.90	1.25	1.70	
400	1.20	1.60	2.10	12.00
500	1.50	2.00	2.50	
600	1.80	2.40	3.00	16.00
700	2.20	2.80	5.00	

Terms: FOB Cambridge, Mass. Send check or Money Order. Rate companies 30 days net. Include Postage, Average Wt. per package ½ lb.
No COD's. Minimum Order $3.00

SOLID STATE SALES
POST OFFICE BOX 74D
SOMERVILLE, MASS. 02143
TELEPHONE (617)547-4005
Send For Our Spring Catalog Featuring Transistors, Rectifiers And Components
325 Elm Street, Cambridge, Mass.

Circle 132 on reader's service card

MAIL ORDER

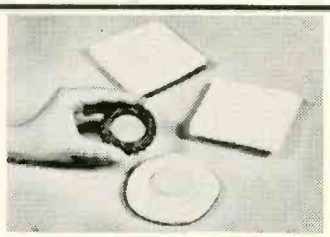
SHOPPING MART

UNUSUAL VALUES

A selection of products available by mail for readers of Radio Electronics.
All merchandise sold on a money-back guarantee. Order direct by Stock No. Send check or M. O.

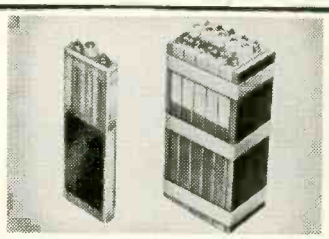
23 ELECTRONIC PROJECTS in 1 KIT

Now easily build 23 fascinating electronic projects that really work including transistor radio receivers, phono-amplifier, electronic organ, burglar alarm, flashing beacon, etc. Complete, foolproof individual template for each model clearly shows parts to be used. Pegboard assembly. Fully illustrated step by step procedures. No soldering or tools required. Put it together—work it—take it apart quickly and easily. Absolutely safe — uses inexpensive 9-V battery. Great fun — educational too.
Stock No. 70,904EH .....$27.95 Ppd.
STARTER KIT (Parts for 8 Projects)
Stock No. 70,903EH .....$17.95 Ppd.



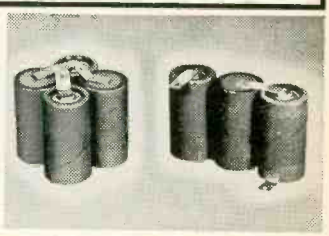
VERSATILE WHITE MODELING PLASTIC

Perfect for figures, forms, shapes, product & tool designs, negative molds, model making, etc. Easily shaped by hand, tools. Can be rolled flat, built up into figures. Permanently pliable until baked at 300° F. for 15-30 minutes in oven—no kiln nor plaster molds needed. Requires no curing. Won't shrink. Acquires permanent, non-brittle hardness when shaped & baked. Can be cut, sawed, drilled, sanded, painted, embossed. Smooth, non-sticky, harmless—will not stain or stick to skin.
Stock No. 60,656EH 3 lbs. $ 4.50 Ppd.
Stock No. 70,909EH 10 lbs. $11.50 Ppd.



NICKEL-CADMIUM BATTERY BARGAINS

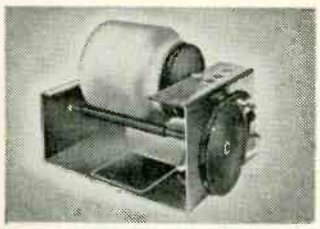
Terrific value—used government surplus. Quick-charge, lightweight 6-volt nickel-cadmium battery. 4-amp. hour capacity. Almost unlimited life. Charges in 1 hr. w/Edmund Charger Kit. Hundreds of uses. Few drops of water yearly for full maintenance. Minimum of electrolyte-sealed to prevent loss. Delivers 100% output at below freezing. Five vented 1.2 volt cells. 3½" x 2" x 6".
No. 70,942EH (Battery) . . $15.00 Ppd.
No. 41,109EH (1.2 V. Cell) $ 3.95 Ppd.
No. 70,807 EH (Charger Kit) $ 8.00 Ppd.



NEW SURPLUS Ni-Cd BATTERIES

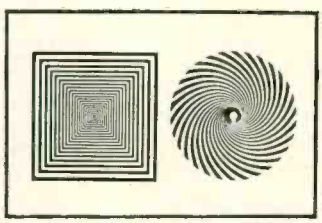
Save more than 50%! Long life—accept 300 charge and discharge cycles. 1.25 Volts per cell — 750 milliampere hours capacity. Excel. charge retention. Hermetically sealed. Indefinite storage life. Multiple cells welded in series—easily cut. Combine to form btry. ⅞" dia. x 1⅝" high. Spec. price for 100 up. Low-cost charger separate.

Order #	Cells	DC Volt	Price Prod.
40,986EH	1	1.25	$ 1.50
40,987EH	2	2.50	2.75
60,633EH	3	3.75	3.60
60,634EH	4	5.00	4.80
70,812EH	Trickle Charger (1-10 cells)		10.95



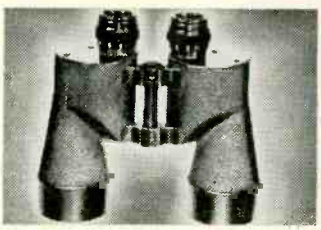
NEW LOW-COST GEM TUMBLER

Become a rockhound! Fascinating hobby . . . loads of fun, inexpensive, easy. Make jewelry of all kinds — decorative bookends, table tops, etc. Simply tumble-finish readily available gemstones . . . then polish to high lustre . . . brings out beautiful colors. Rugged 3-lb. capacity tumbler w/continuous duty motor compares to units selling for many times its price.
Stock No. 70,874EH . . . .$10.75 Ppd.
6-LB ROCK ASSORTMENT (10 TYPES)
Stock No. 70,868EH .....$ 9.00 Ppd.



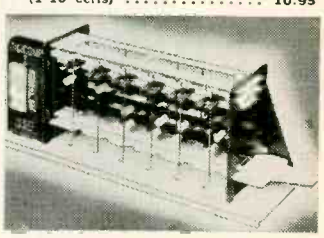
FASCINATING MOIRE PATTERN KITS

Now explore the world of "Op Photography"! Fantastic visual effects. Limitless applications. 1,000's of uses for hobbyists, photographers, home experimenters. Fun! Profitable! Contains 8 basic patterns on both clear acetate and white Kromekote, 150 dot screen on film, book. Other sets incl. negatives available. Write for details.
Stock No. 70,719EH .....$8.50 Ppd.
SAME KIT IN FULL COLOR
Stock No. 60,530EH .....$12.50 Ppd.



WAR SURPLUS! AMERICAN-MADE 7x50 BINOCULARS

Big savings! Brand new! Crystal-clear viewing—7 Power. Every optical element is coated. An excellent night glass—the size recommended for satellite viewing. Individual eye focus. Exit pupil 7 mm. Approx. field at 1,000 yds. is 376 ft. Carrying Case included. American 7x50s' normally cost $274.50. Our war surplus price saves you real money.
Stock No. 1544EH .....$74.80 Pstd.
Stock No. 963EH (6x30) . .$40.00 Ppd.



NEW MODEL DIGITAL COMPUTER

Solve problems, teach logic, play games with miniature version of giant electronic brains! Adds, subtracts, multiplies, shifts, complements, carries, memorizes. Colored plastic parts easily assembled. 12" x 3½" x 4¾". Incl. step-by-step assembly diagrams, 32-p instruction book covering operation, computer language (binary system) programming, problems and 15 experiments.
Stock No. 70,683EH .....$5.98 Ppd.

GIANT WEATHER BALLOONS

Available in big 8' and 16' diameter. Create a neighborhood sensation. Great backyard fun. Exciting beach attraction. Blow up with vacuum cleaners or auto air hose. Filled with helium (available locally) use balloons high in sky to attract crowds, advertise store sales, announce fair openings, etc. Amateur meteorologists use balloons to measure crowd heights, wind speed, temperature, pressure, humidity at various heights. Photographers can utilize for low-cost aerial photos. Made of heavy duty neoprene.
Stock No. 60,568EH 8' Dia. $2.00 Ppd.
Stock No. 60,632EH 16' Dia. $7.00 Ppd.

AMERICAN MADE OPAQUE PROJECTOR

Projects illustrations up to 3" x 3½"—enlarges them to 35" x 30" if screen is 6½ ft. from projector. larger pictures if screen is further away. No film or negatives needed. Projects charts, diagrams, color or black-and-white. Operates on 115 volts A.C. current . . . 6 ft. extension cord and plug included. Size 12" x 8" x 4½" wide Weight 1 lb. 2 ozs. Plastic case.
Stock No. 70,199EH .....$7.95 Ppd.

'PIPE' LIGHT INTO REMOTE AREAS

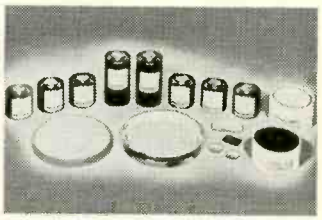
New, low-cost Flexi-I-Light "pipes" light around corners, thru small holes, into other areas previously inaccessible. Utilizes new 2' long flexible plastic light guide with .130" O.D. attached to chrome finished 5½" long rotary switch penlight. Perfect for technicians, electricians, mechanics, T.V., radio & appliance repairmen, hobbyists, etc. Easily converts to regular penlight by removing rubber centering guide and adapter. Weight complete 5 oz. Batteries not incl.
Stock No. 60,648EH .....$2.75 Ppd.

IT'S HERE—BIG, NEW DIGICOMP II!

If you think DIGICOMP I was something — wait 'til you use DIGICOMP II! Loads of fun! Terrific challenge! Actually works like electronic digital computer but needs no power. Adds, subtracts, multiplies, divides, memorizes. 1st mechanical computer w/auto. switch action. 1st model designed for programming. Speed reduced by factor of million to 1—you can see what's happening. Demonstrates 'new' math, computer techniques.
No. 70,946EH (Intro. price) $16.00 Ppd.

GIANT FREE CATALOG

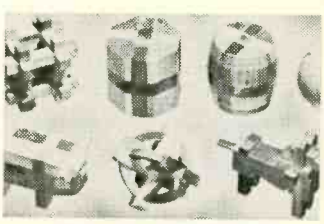
Completely new 1968 catalog. 148 pages packed with nearly 4,000 unusual bargains. Exciting new categories. Many new items, 100s of charts, illustrations. Many hard-to-get surplus bargains. Enormous selection of telescopes, microscopes, binoculars, magnets, magnifiers, prisms, photo components, etc. For hobbyists, experimenters, workshops. Shop by mail. No salesman will call. Write for free Catalog "EH".



ASTRONOMICAL TELESCOPE KITS

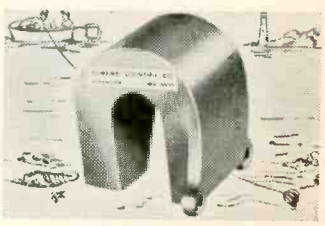
Grind your own mirror for powerful telescopes. Kit contains fine enameled pyrex mirror blank, tool, abrasives, diagonal mirror, and eyepiece lenses. Instruments you build range in value from $75 to hundreds of dollars.

Stock #	Diam.	Thickness	Price
70,003EH	4¼"	¾"	$ 8.00 Ppd.
70,004EH	6"	1"	$12.95 Ppd.
70,005EH	8"	1⅛"	$21.00 Ppd.
70,006EH	10"	1¾"	$34.25 f.o.b.



WOODEN SOLID PUZZLES

Here's a fascinating assortment of 12 different puzzles to provide hours of pleasure and stimulate ability to think and reason. Animals and geometric forms. Take them apart and reassemble them. Lots of fun for the whole family—young and old. Will test skill, patience and ability to solve problems. Order yours now.
Stock No. 70,205EH .....$3.50 Ppd.



"FISH" WITH A MAGNET

Go treasure hunting on the bottom! Fascinating fun & sometimes profitable! Tie a line to our 5-lb. Magnet—drop it overboard in bay, river, lake or ocean. Troll it along bottom—your "treasured" haul can be outboard motors, anchors, other metal valuables. 5-lb. Magnet is war surplus—Alnico V Type—Gov't. cost $30. Lifts over 150 lbs. on land—much greater weights under water.
Stock No. 70,571EH .....$12.50 Ppd.

ORDER BY STOCK NUMBER • SEND CHECK OR MONEY ORDER • MONEY-BACK GUARANTEE

EDMUND SCIENTIFIC CO. 300 EDSCORP BUILDING BARRINGTON, NEW JERSEY 08007

Circle 133 on reader's service card

EDUCATION/ INSTRUCTION

LEARN TECHNICAL WRITING—at home. High paying prestige careers not requiring college. Growing demand, all industries for tech writers now. Low monthly tuition. Easy to understand. FREE career book, sample lesson. APPROVED FOR VETERANS. **AMERICAN TECHNICAL WRITING SCHOOLS,** Dept. REC-28, 5512 Hollywood Blvd., Hollywood, Calif. 90028

LEARN ELECTRONIC ORGAN SERVICING. New home study course covering all makes electronic organ including transistors. Experimental kits—schematics—trouble-shooting. Accredited NHSC-GI Approved. Write for free booklet. **NILES BRYANT SCHOOL,** 3631 Stockton Blvd., Dept. F. Sacramento 20, Calif.

HIGHLY EFFECTIVE HOME STUDY REVIEW for FCC commercial phone exams. Free literature. **COOK'S SCHOOL OF ELECTRONICS,** P.O. Box 36185, Houston, Texas 77036

FCC First Class License in six weeks—nation's highest success rate—approved for Veterans Training. Write **ELKINS INSTITUTE,** 2603E Inwood Road, Dallas, Texas 75235

"SLEEP-LEARNING." Send for free brochure, "What's It All About." **TAPES,** Box-190RE, Quincy, Mass. 02169

WATCH REPAIRING. Learn to repair American and Swiss watches in spare time at home. Tuition $5 monthly. Diploma awarded. Free sample lesson. No obligation. **CHICAGO SCHOOL,** Dept. REQ, Fox River Grove, Illinois 60021

B. SC. ENGINEERING. MANAGEMENT—Correspondence Course Prospectus $1. **CANADIAN INSTITUTE OF SCIENCE & TECHNOLOGY,** 263 Adelaide St. W., Toronto.

GOVERNMENT SURPLUS

72 page illustrated Government Surplus Radio, Gadgeteers Catalog 25¢. MESHNA, Nahant, Mass. 01908

Silicon F.W.B. With 35A 150 P.I.V. Rectifiers $ 7.50
Germanium F.W. Bridge 10A 200 P.I.V. ..... $ 5.00
New GE S.S. Hi Volt DC Power Supply in.:
120v @ 50cy—out.: 6.9kv @ 2ma DC $18.00
Freed Model 1040 ACVTVM .01-.1-1-10 & 100 Volts $50.00
Mylar Inst. Rec. Tape ½"-1½ mil approx. 2500 ft. on 10" NAB Reel ..... $ 5.95
Daven Att.—60KΩ—2DB Steps to 60DB ..... $ 6.50
Tech Labs Att.—200/200T—3 Steps to 50DB .. $ 3.95
TECHNIONICS, INC.
351 Canal St., New York, N.Y. 10013—CA6-7640

WE IMPORT FOR YOU FROM JAPAN W. GERMANY HONG KONG
ANY ITEMS YOU NEED
SAVE ON YOUR COSTS
Components, parts, accessories, electric supplies, brushes, sundries. Inquiries invited for specialties made to order. *Telephone 212-532-7841*
GEMEXCO, inc. 419 Park Ave. South, N.Y.16

ROTRON 100 CFM FANS

	Each
Sentinal—4 11/16 sq x 1½ D, 115 V, 60 cy. ..	$7 95
Sentinal—4 11/16 sq x 1½ D, 220 V, 60 cy. ..	9.95
Gold Seal—4 11/16 sq x 1½ D, 115 V, 60 cy. .	6.95

4 Pole Single Throw Contactor—115 V 60 cy 15 Amps MFG AH & H, ROWAN, etc. ..... $9.95 each

All in fine condition, working, removed from equipment. Ship post paid anywhere Continental United States.

Leeds Radio, 57RE Warren St., N.Y.C., N.Y. 10007

BACK ON CORTLANDT STREET
At Hudson Terminal Promenade
CORTLANDT ELECTRONICS INC.
30 Cortlandt Street, New York 10008
(See our ad in Feb. Radio-Electronics)
Tel. (212) 964-8044 Send for our catalog

CLASSIFIED COMMECIAL RATE (for firms or individuals offering commercial products or services): 60¢ per word . . . minimum 10 words.
NON-COMMERCIAL RATE (for individuals who want to buy or sell personal items) 30¢ per word . . . no minimum.
Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. Misleading or objectionable ads not accepted. Copy for May issue must reach us before March 10th.

CLASSIFIED ADVERTISING ORDER FORM

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

_____ No. of Words { @ .30 Non-Commercial Rate / @ .60 Commercial Rate } = $_____

Total Enclosed $_____

Insert _____ time(s)

Starting with _____ Issue

Payment must accompany order unless placed through accredited advertising agency 28

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

SIGNATURE _____

MAIL TO: RADIO-ELECTRONICS, CLASSIFIED AD DEPT., 200 PARK AVE. SOUTH, NEW YORK, N.Y. 10003

FREE "HAM SHACK PAK" $25 WORTH OF TRANSISTORS RECTIFIERS RESISTORS CONDENSERS DIODES ■ ETC.
Add 25¢ for handling
PLUS ANY $1.00 * ■ ITEM FREE
* or Items totalling $1.00.)
BOTH FREE WITH ANY $10 ORDER

EPOXY TRANSISTORS & IC's
Fairchild, Motorola, Texas, Bendix

- ☐ 3—2N3683 1000 MC 200MW TRANSISTORS $1
- ☐ 4—2N3563 NPN, 600MC, 200MW Fairchild $1
- ☐ 4—2N3643 NPN, 250MC, 350MW Fairchild $1
- ☐ 3—B-5000 5W. 3Amp, NPN. Bendix transistors ... $1
- ☐ 4—2N4313 PNP 600MC, 200MW Fairchild $1
- ☐ 3—2N3565, 500HFE, NPN, 200MC by Fairchild $1
- ☐ 3—2N4265, 400HFE, NPN, 350MC by Motorola $1
- ☐ 1—DUAL 4 IN. GATE, EXPANDER by Fairchild $1
- ☐ 1—QUAD 2 IN. NAND/NOR GATE $1
- ☐ 1—703 LINEAR RF AMP. Fairchild $2.49

STEREO PREAMP 4.95 ☐
★ 8 TRANSISTORS by Fairchild
★ Ready to Play thru tape Amplifier, radio, TV
★ Volume, Tone, Controls sw

4 Transistor Amplifier

tuners, ☐ mikes, SOLID STATE phono- **3.95**

1 AMP TOP HAT AND EPOXIES

PIV	Sale	PIV	Sale	PIV	Sale
50 ☐	5¢	800 ☐	19¢	1800 ☐	82¢
100 ☐	7¢	1000 ☐	29¢	2000 ☐	1.25
200 ☐	8¢	1200 ☐	42¢	3000 ☐	1.50
400 ☐	10¢	1400 ☐	55¢	4000 ☐	1.95
600 ☐	15¢	1600 ☐	69¢		

Actual Size →

1 AMP MICROMINIATURE SILICON RECTIFIERS

PIV	Sale	PIV	Sale
50 ☐	7¢	600 ☐	20¢
100 ☐	9¢	800 ☐	25¢
200 ☐	12¢	1000 ☐	39¢
400 ☐	17¢		

2 AMP SILICON RECTIFIERS

PIV	Sale	PIV	Sale
200 ☐	12c	1000 ☐	45¢
400 ☐	16c	1200 ☐	59¢
600 ☐	19¢	1400 ☐	69¢
800 ☐	29¢	1600 ☐	89¢

1.5 AMP 2000 PIV SILICON RECTIFIERS ☐ **$1**

TRIACS * SCRS **

PRV	3A ** AMPS	6 * AMPS
50 ☐	.35 ☐	—
100 ☐	.50 ☐	.85
200 ☐	.75 ☐	1.35
400 ☐	1.25 ☐	1.95
600 ☐	1.80 ☐	2.60

SILICON POWER STUD RECTIFIERS

PIV	3A	6A	12A	55A
50	☐ .06	☐ .16	☐ .20	☐ .50
100	☐ .07	☐ .22	☐ .25	☐ .75
200	☐ .09	☐ .30	☐ .39	☐ 1.25
400	☐ .16	☐ .40	☐ .50	☐ 1.50
600	☐ .20	☐ .55	☐ .75	☐ 1.80
800	☐ .30	☐ .75	☐ .90	☐ 2.30
1000	☐ .40	☐ .90	☐ 1.15	☐ 2.70

SOLITRON DEVICES, **5 AMP Epoxy Rectifiers**

PIV	Sale	PIV	Sale
50 ☐	19¢	600 ☐	59¢
100 ☐	25¢	800 ☐	69¢
200 ☐	39¢	1000 ☐	89¢
400 ☐	45¢		

'GLASS AMP' ONE AMP
PRV may be exceeded without the rectifier breaking down.

SILICON RECTIFIERS

PIV	Sale	PIV	Sale
50 ☐	5¢	600 ☐	19¢
100 ☐	7¢	800 ☐	21¢
200 ☐	9¢	1000 ☐	32¢
400 ☐	12¢	1200 ☐	45¢

10¢ FOR OUR "SUMMER" BARGAIN CATALOG ON: ☐ Semiconductors ☐ Poly Paks ☐ Parts
POLY PAKS
TERMS: send check, money order, include postage—avg. wt. per pak 1 lb. Rated net 30 days. CODs 25%.
P.O. BOX 942R
SO. LYNNFIELD, MASS. 01940
"PAK-KING" of the World

Circle 134 on reader's service card

NOW A low cost Crystal for the Experimenter

International type "EX"

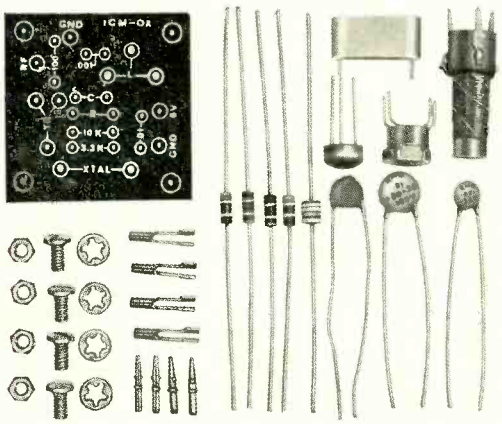
- LOW COST
- MINIMUM DELIVERY TIME

3,000 KHz to 60,000 KHz

$3.75 Postage Paid

SPECIFICATIONS: International Type "EX" Crystal is available from 3,000 KHz to 60,000 KHz. The "EX" Crystal is supplied only in the HC-6/U holder. Calibration is ± .02% when operated in International OX circuit or equivalent.

CONDITIONS OF SALE: All "EX" Crystals are sold on a cash basis, $3.75 each. Shipping and postage (inside U.S. and Canada only) will be prepaid by International. Crystals are guaranteed to operate only in the OX circuit or its equivalent.

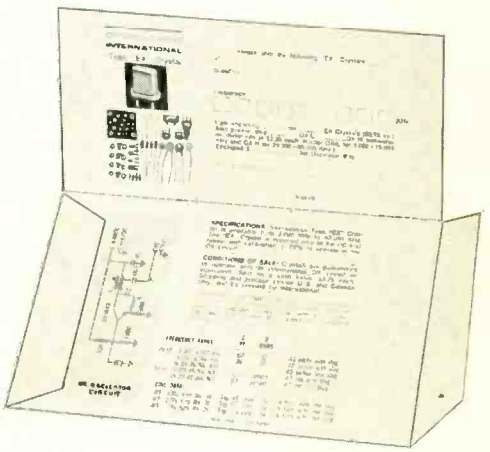


COMPLETE OX OSCILLATOR KITS

Everything you need to build your own oscillator. Two kits available. "OX-L" kit 3,000 to 19,999 KHz. "OX-H" kit 20,000 to 60,000 KHz. Specify "OX-L" or "OX-H" when ordering.

$2.35 Postage Paid

MINIMUM DELIVERY TIME We guarantee fast processing of your order. Use special EX order card to speed delivery. You may order direct from ad. We will send you a supply of cards for future orders.



ORDERING INSTRUCTIONS

(1) Use **one** order card for each frequency. Fill out both sides of card.

(2) Enclose money order with order.

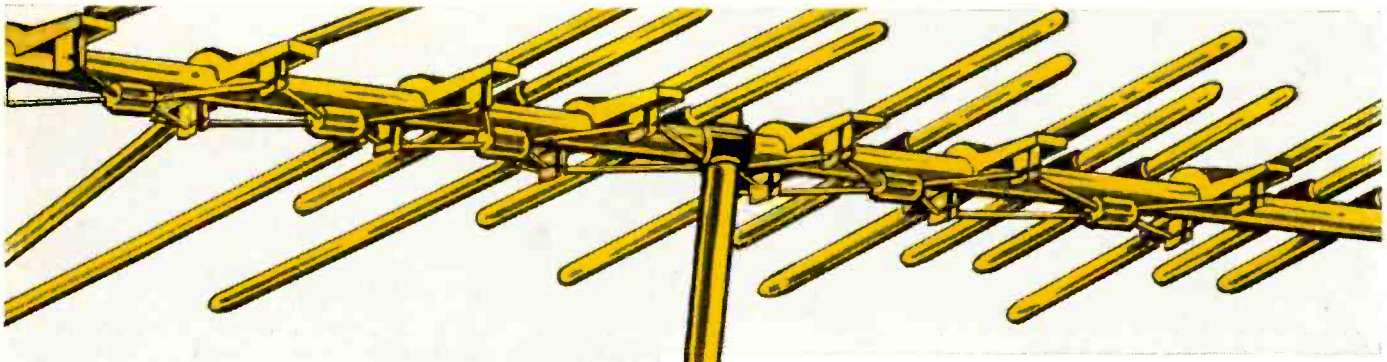
(3) Sold only under the conditions specified herein.

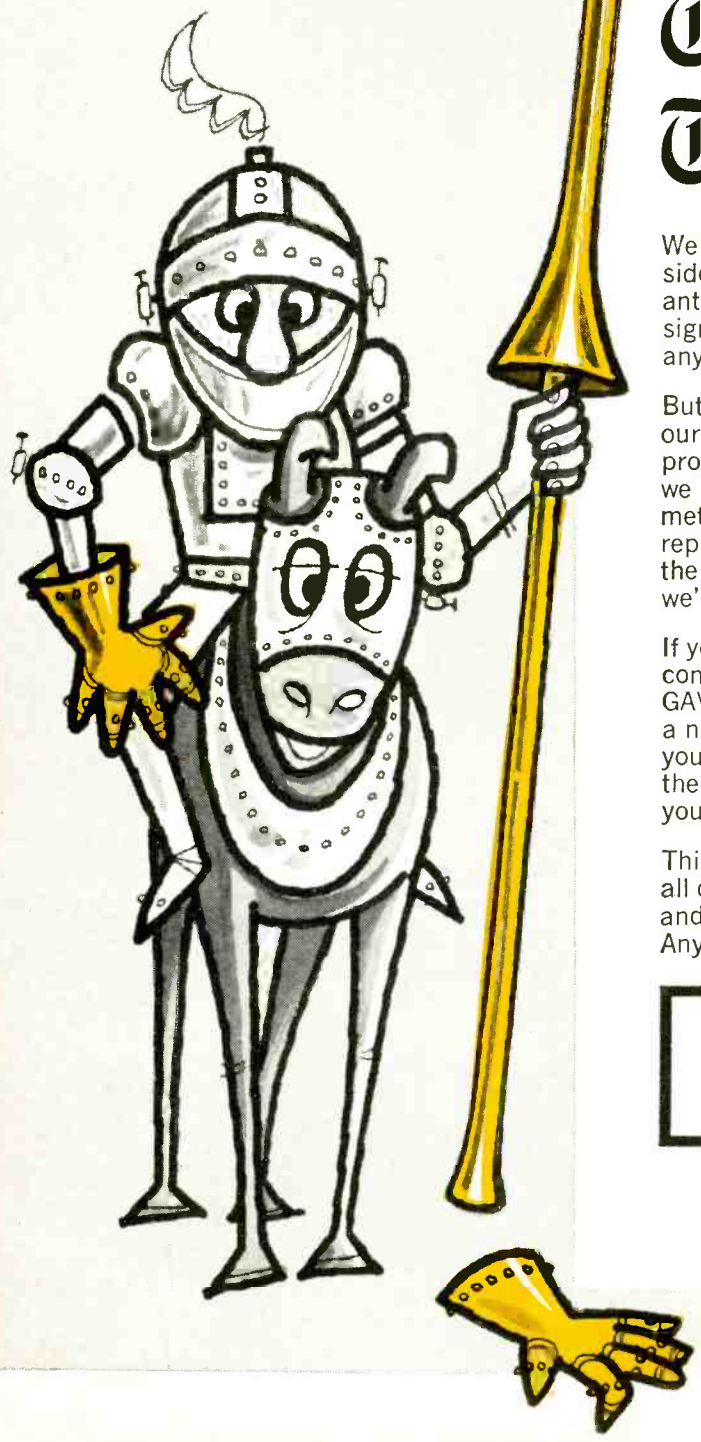
INTERNATIONAL

CRYSTAL MFG. CO., INC.

10 No. Lee • Okla. City, Okla. 73102

Circle 148 on reader's service card





Gavin Throws Down The Gauntlet!

We hereby challenge the entire antenna industry to side-by-side comparison tests. We claim that GAVIN antennas outperform all others. Our new V-Yagi design delivers stronger signals, better pictures than any other type antenna on the market.

But anybody can make claims. We're ready to back ours with objective proof, anytime, anywhere. The proof is simple. Using our specially equipped vans, we check your favorite antenna on a field strength meter and a color receiver simultaneously. Then, we replace your antenna with a GAVIN antenna, about the same size and costing the same or less. So far, we've never lost.

If you'd like to see a side-by-side comparison test, contact your local GAVIN representative or write us a note. We'll drive the van to your door — let you make all the adjustments and set up the test yourself, if you like.

This challenge applies to all distributors, installers, and antenna manufacturers. Any takers?

Gavin®

GAVIN INSTRUMENTS, INC.
Subsidiary of ADVANCE ROSS CORP.
Somerville, N. J. 08876 U. S. A.

Circle 149 on reader's service card

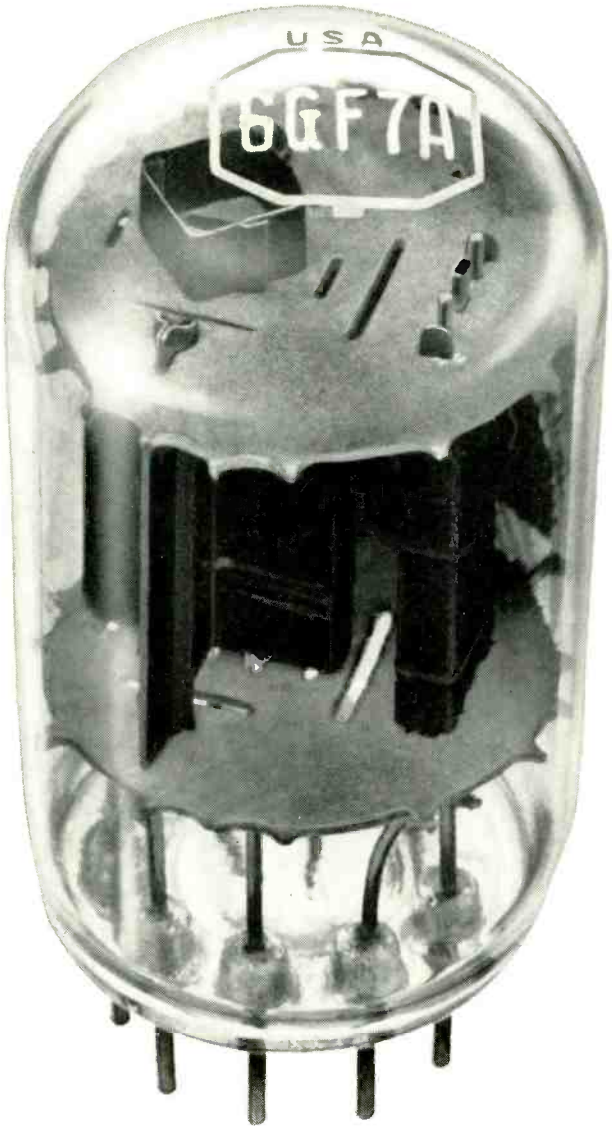
We can't leave well-enough alone...

...so we decided to redesign the RCA-6GF7A vertical deflection tube to practically eliminate low-line top-picture compression, high-line top picture stretch in color TV receivers.

We developed a cathode material that improves the tube's ability to provide uniform and consistent performance as a high-perveance, low-mu triode unit for vertical-deflection amplifier applications. A better grid-wire plating technique virtually eliminates cathode poisoning and grid emission problems. Linearity is 100% controlled. And for vertical-deflection-oscillator applications, we test for grid leakage at higher plate and grid voltages than would normally be found in TV applications so the picture won't creep up the screen as the vertical deflection tube warms up.

Innovations and improvements that make your service operation more reliable, efficient, and profitable are our constant aim. See your Authorized RCA Tube Distributor for quality RCA receiving tubes.

RCA Electronic Components and Devices, Harrison, New Jersey.



RCA