APRIL 1954

RADIO-ELECTRONICS

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

In this issue:

Killing TV Alignment Bugs

•

RADIO-ELECTRONICS Golden Ear Amplifier

•

Installing Marine Radiotelephones

•

Regenerative Transistor Receiver

35¢
U. S. and CANADA

Adjusting an Experimental Color TV Receiver

(See page 4)

RADIO-ELECTRONICS

Formerly RADIO-CRAFT • Incorporating SHORT WAVE CRAFT • TELEVISION NEWS • RADIO & TELEVISION

ON THE COVER: *Du Mont research engineers adjusting a developmental color television monitor receiver. The pattern on the receiver screen consists of the primary colors and their complements, in the form of vertical bars. This color-bar pattern is generated electronically, and is used to check and adjust the chrominance circuits of color receivers.*

Color original courtesy Allen B. Du Mont Labs.

CONTENTS

APRIL, 1954

Editorial (Page 31)

Specialization ....by Hugo Gernsback 31

Television (Pages 32-47)

Killing Those Alignment Bugs by the Engineering Staff, Scala Radio Company 32
Noise-Free Sync Circuits ....by Robert F. Scott 35
Basic Color TV, Part IV (First half—Elimination of Interference) by D. Newman and J. J. Roche 37
Key to Keyed A.G.C. ....by Wayne E. Lemons 39
Television—it's a Cinch, (Ninth Conversation, 2nd half—The iconoscope, image orthicon, electron multipliers) ....by E. Aisberg 41
V.H.F. Comes to a U.H.F. Area ....by Charles F. Mahler, Jr. 44
TV Service Clinic ....by Matthew Mandl 46
TV dx. April–June 47

Electronics (Pages 48-49)

The Cosmic Generator ....by Mohammed Ulysses Fips, I.R.E. 48

Audio—High Fidelity (Pages 50-66)

Milady's Golden Ear Amplifier ....by Joseph Marshall 50
Ground Loops and Hum ....by Hector E. French 56
Servicing High-Fidelity Audio Equipment, Part III—Measurements and Equipment ....by Joseph Marshall 58
High-Fidelity Laudspeakers, Part II—Mechanical and Electrical Features of Voice Coil Design ....by H. A. Hartley 60
High-Quality Audio, Part VIII—High-Quality Tuners ..by Richard H. Dorf 63

Radio (Pages 71-101)

Transistor Regenerative Receiver ....by Edwin Bohr 71
Installing Marine Radio ....by Elbert Robberson 78
A Few Unusual Service Cases 91
Radio 35 Years Ago 96
Transistor Oscillator Produces Subharmonics ....by I. Queen 97

Departments

The Radio Month	6	Radio-Electronic Circuits	110	With The Technician	118
Correspondence	12	Try This One	112	People	121
Business	14	Question Box	114	Electronic Literature	124
New Devices	103	Technotes	116	Book Reviews	126
New Patents	108				

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HUGO GERNSBACK, publisher of RADIO-ELECTRONICS has been named an Officer of the Order of the Oaken Crown by the Grand Duchess of Luxembourg, as a "savant and man of letters."

The citation and presentation was made at a banquet in New York City,

held on the birthday of the Grand Duchess. Beside the scroll shown, Mr. Gernsback received a decoration in the form of a cross-shaped medal surrounded by an oaken cluster. The award, coincidentally, was made on the 50th anniversary of the day Mr. Gernsback left Luxembourg to come to the United States.

EIGHT NEW TV STATIONS have gone on the air since our last report. These are:

KBID-TV	Fresno, Calif.	53
WRDW-TV	Augusta, Ga.	12
WTOC-TV	Savannah, Ga.	11
WMGT	Adams-Pittsfield, Mass.	74
WNEM-TV	Bay City - Saginaw, Mich.	5
KCEB	Tulsa, Okla.	13
WARM-TV	Scranton, Pa.	16
WKAQ-TV	San Juan, Puerto Rico	2

A third u.h.f. station has gone off the air—KCTY, Kansas City, Mo., channel 25. This brings the total number of stations on the air to 367 (128 of which are u.h.f.) as of February 13, 1954.

Canada has one new station this month, CKCO-TV, Kitchener, Ont., channel 13.

FIRST PRIZE OF $5.000 in the nationwide Raytheon transistor application contest, was won by Robert T. Bayne of Los Angeles. The winning entry was an audio frequency meter using two CK722 transistors and four CK705 germanium diodes.

Second prize of $2,000 was awarded to Peter G. Sulzer of Kensington, Maryland for his transistorized audio frequency and voltage standard. Third and fourth prizes were taken by G. F. Montgomery of Bethesda, Maryland and Lt. Robert Perkins, a Navy dental officer, respectively. Montgomery's entry was a general purpose a.c.-d.c. voltmeter using transistors, while Lt. Perkins' entry was a Vitalometer, a device for measuring the condition of tooth pulp, thus indicating the possibility of decay. Mr. Sulzer is already known to our readers, and they will see an article by Montgomery in one of our next few issues.

Presentation to the top four prize winners was made by John A. Hickey of the Raytheon receiving tube division, in ceremonies held in Philadelphia, Washington and Los Angeles.

ELECTRONIC BRAIN that operates an automatic punch press has been developed by G-E. Directions are fed to the punch press by an electronic digital computer, which reads information on size, number, and location of holes to be punched from a perforated card. The punch press automatically positions the material to be perforated and performs its punching operations within an accuracy of a few thousandths of an inch. This represents a substantial saving in jobs which require too large a number of chassis to permit profitable manual operation of the press, but which are not big enough to have special dies made to punch out the sheets or chassis.

In a talk presented at an Institute of Radio Engineers symposium on automation, the machine was described as

Electronic computer operates press

one more step toward the automatic factory of the future.

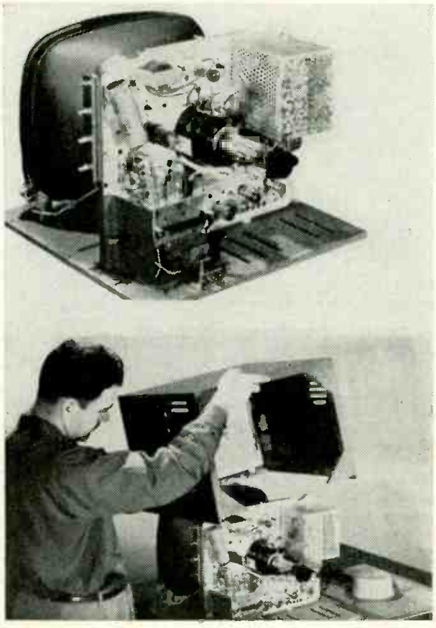
OUTSTANDING HAM J. Stan Surber, W9NZZ, of Peru, Ind., was winner of G-E Tube Department's Edison Radio Amateur Award for public service during 1953.

Surber, a ham for 31 years, won the Edison award for handling 12,000 letters during 1953 between weather men and servicemen at Arctic Islands, and their families elsewhere. Last year he transmitted and received over a million and a half words in Morse code to and from such points as T-3, an ice island near the North Pole.

Some of these far-northern stations receive mail only once or twice a year.

Surber also received a special citation from the U. S. Weather Bureau, and was made an honorary postman by Postmaster General Summerfield. G-E also cited Mrs. Surber as "the most understanding wife of the year".

COMPACT TV RECEIVER with cabinet dimensions scarcely larger than the face of its 17-inch tube has been introduced by Crosley. Called the Super V, the new receiver features a vertical chassis, and occupies one-third less space and is one third lighter than most other 17-inch receivers.



The easy-service set and its cabinet.

By using recently developed dual-purpose tubes, the set requires only 15 instead of 22 conventional tubes, thus eliminating circuitry and weight. Because of its vertical chassis, all tubes can be reached from the back of the receiver without removing the chassis from the cabinet. To get at the entire chassis, the service technician merely removes a few screws and lifts off the bonnet type cabinet.

10 MILLION COLOR TV receivers will be in the homes of American consumers by the end of 1958, W. E. Boss, manager of television market development for RCA, predicted before a meeting of the Electric League of Western Pennsylvania. He gave assurances that black-and-white receivers would remain popular. Boss based this on the compatibility of the present system, the relatively low price of black-and-white receivers, and the trend toward families owning more than one receiver.

TV AND USED CARS were coupled as a merchandising gimmick by an enterprising Buffalo, N. Y. television and appliance dealer. The maneuver consisted of offering a used car as a bonus with the purchase of a Hallicrafters console model TV receiver. The minimum receiver price was set at $299.95. At last reports, response to the promotion was described as "very satisfactory."

TELEVISION CONFERENCE sponsored by the Cincinnati section of the Institute of Radio Engineers will be held April 24 at the Engineering Society Building, Cincinnati.

The subject of this Eighth Annual Spring Conference will be black-and-white and color TV, and u.h.f. The program will include nine technical papers covering various phases of TV.

INTERNATIONAL SYMPOSIUM organized by the Polytechnic Institute of Brooklyn has been scheduled for April 12, 13, and 14.

The topic of this, the third annual symposium, will be Information Networks. At the two previous gatherings, attendance exceeded 500 engineers and scientists, including many from Canada and Europe. The program will take place at the Engineering Societies Building, N. Y. C.

FIRST WOMAN secretary of the Federal Communications Commission has taken over her new post. The new secretary, Mary Jane Morris, is no newcomer to the FCC; she has been an attorney in the FCC's Office of General Counsel since 1948. As secretary to the Commission, Miss Morris succeeds T. J. Slowie, who served for 16 years.

FM RADIO CHAIN to be known as the Good Music Network has been put into operation in Washington to continue an important FM broadcasting service which was privately financed for many years by the late Maj. Edwin H. Armstrong.

The network operates as a public service to replace the live high-fidelity programs from Washington formerly carried by Maj. Armstrong's privately operated Continental Network. That network ceased to exist after his death on Feb. 1.

Six stations, WFLN, Philadelphia, Pa.; WLAN-FM, Lancaster, Pa.; WNYC and WNYC-FM, New York City; WSNJ-FM, Bridgeton, N. J.; WTOA, Trenton, N. J. and WGMS—AM-FM, Washington, D. C. are the participating stations, with WGMS as the key station. It is expected that others will be added. At present the programs are largely picked up direct with telephone line use at a minimum.

CHEAP COLOR TV CONVERTER which may sell for $50 to $100 has been demonstrated by Airtronic Research, Inc., of Bethesda, Maryland.

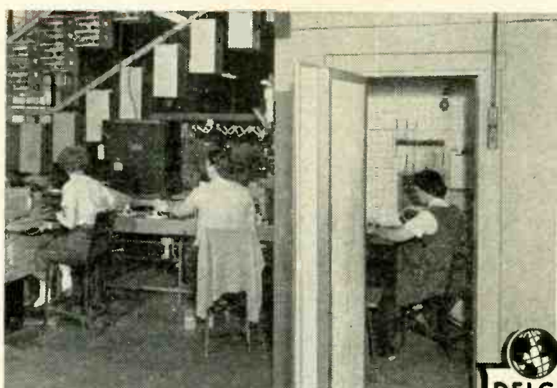
The adapter breaks down the NTSC-type signals and re-arranges them in the form of a sequential-field system, then uses a color wheel like the old-fashioned color receivers of a few years ago. The action is the reverse of that of the *Chromacoder*, a device which permits using a sequential-field camera, then converts the signals into the NTSC type for transmission.

One of the limitations of the receiver converter is the size of the color wheel, which must be twice that of the picture being viewed. The wheel rotates at 600 r.p.m. instead of the 1440 of the obsolete color system. Due to that and to the lower frame frequency of compatible television, more flicker is expected with the new converter than with the old CBS-type color television receivers.

END

Speaking of Speakers...

DELCO RADIO CAREFULLY CONTROLS THE MANUFACTURING OF ITS SPEAKERS TO ASSURE HIGHEST POSSIBLE QUALITY



In the audio test booth, the speaker is checked for its ability to deliver good listening. In the background you can see a small section of the speaker production line.

High quality in the final product can be had only through rigid quality control. Take speakers, for example. Speaker baskets are formed in our stamping department. Special machines wind the voice coils. On the assembly line the cones are secured to the voice coils and then assembled with the basket. All along the line inspectors have been checking and rechecking. Then, the speaker is magnetized and goes into a specially designed sound booth for a final check.

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HOW TO USE. Your CBS-Hytron Solder Dispenser comes ready to use . . . with 20 lengths of 0.050-inch, 40/60 activated rosin core solder.

To start: Point Dispenser vertically downward. Shake a length of solder into position . . . at the same time rotating the knurled wheel toward you to begin the feed. Roll out an inch of solder and go ahead with the job. Need more solder? Just rotate the wheel with your thumb. When through, turn wheel away from you to draw unused solder back into Dispenser.

Knurled cap of Dispenser unscrews for refilling. Your package of 80 specially cut and sealed Refills gives you four months' supply. Plus the month's supply already loaded in the Dispenser.

Your new Solder Dispenser is fun to use . . . a natural companion to your Soldering Aid. And your Dispenser saves you time and money, too. Get yours today!

FREE ... APRIL 15 THROUGH MAY 31

You can get this complete package free from April 15 through May 31. Your CBS-Hytron distributor will give you a free Solder Dispenser (loaded with 20 Refills) . . . and a plastic tube of 80 additional Refills. Enough to last 5 months.

WITH YOUR ORDER FOR CBS-HYTRON TUBES . . .
ONLY 75 RECEIVING OR 3 PICTURE TUBES

Just order 75 CBS-Hytron receiving tubes... or 3 CBS-Hytron picture tubes. Your CBS-Hytron distributor will *give* you this valuable, time-and-money saver . . . *free*. Remember, offer is limited to April 15 through May 31. And the unique Solder Dispenser and Refills are available *only* on this special offer.

ACT NOW!

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CORRESPONDENCE

WHERE'S THE MONEY?

Dear Editor:

I read your article, "Wanted: Technicians," in the February, 1954, issue of RADIO-ELECTRONICS and was indeed amazed at its contents—however, in a differing light.

I am employed with American Airlines as a radio operator. My age is 25. I have been in the field of radio and electronics for more than five years, and have an FCC 2nd Radiotelephone and Amateur license (WOGMH). Although I did not have an opportunity to acquire a degree in electronics, I feel I have a good understanding of this field. My salary after three years with American is about $325 a month. I have been looking for a job as a technician for better than 10 months and cannot find anything that will match the salary I am now making.

You stated there was an unprecedented shortage. Where??? You say the shortage has been acute since 1951. Where? Why? Maybe because of salary? A grocery clerk can make $75 or more a week with next to nil for education! Where are those handsome dividends and where can you name your salary? I am indeed interested and would like to know where these jobs are.

The St. Louis paper carries one or two electronic jobs daily, TV service $50 a week! Electronic technician $290 a month! Tops of $400 in 5 to 7 years. Are these good jobs???

Maybe I sound bitter about this but I am about to give up the field of electronics professionally and derive my enjoyment from ham radio and experimenting in my spare time. The incentive is lacking, as a guy just can't raise a family on these salaries. He can make more elsewhere without putting dollars and education into a job that pays peanuts.

Maybe there are jobs that the average guy doesn't know about. If so, I think you could help a lot of us in the industry—and yourself—by getting the word out where it will do some good.

Thanks for letting me blow my top on this subject. I enjoy the work and hate like heck to get out, but a guy has got to eat too!!!

JIM KAISER

St. Louis, Mo.

(See the editorial on page 31 of this month's issue—*Editor*)

FEBRUARY COVER

Dear Editor:

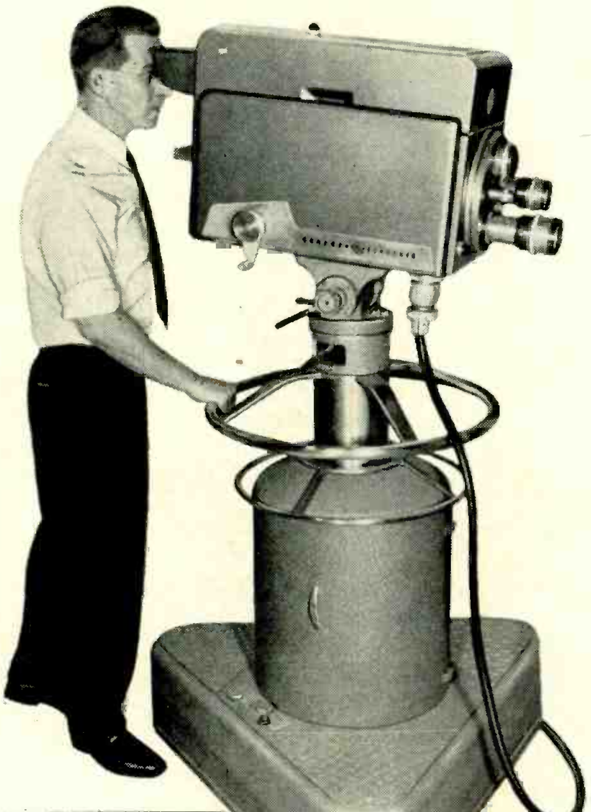
Some of the scientists up at Los Alamos think your photographer of the cover photo of your February issue should be censured for not using a smaller stop, and for incorrectly placing the flash bulb. It gives an uncanny penetrating look to Mona's eyes. They think it is more important to focus Mona sharply than the transistor. There are plenty of transistors at Los Alamos, but no Mona's! Anyway, they like your cover.

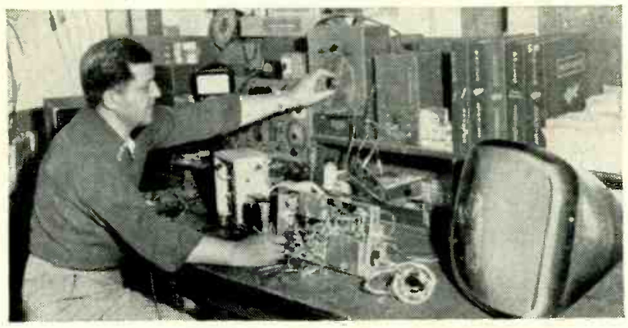
GEORGE PEARCE

Albuquerque, New Mexico

Get in on the TV boom...

starting today!





- ***Prepare now for the new Radio-TV-Electronics boom. Get in on VHF and UHF . . . aviation and mobile radio . . . color TV . . . binaural sound! The International Correspondence Schools can help you!***

If you've ever thought about Radio or Television as a career . . . if you have the interest, but not the training . . . if you're waiting for a good time to start . . . NOW'S THE TIME!

No matter what your previous background, I.C.S. can help you. If Radio-TV servicing is your hobby, I.C.S. can make it your own profitable business. If you're interested in the new developments in Electronics, I.C.S. can give you the basic courses of training you need. If you have the job but want faster progress, I.C.S. can qualify you for promotions and pay raises.

I.C.S. training is *success-proved* training. Hundreds of I.C.S. graduates hold top jobs with top firms like R.C.A., G.E., DUMONT, I.T.&T. Hundreds of others have high ratings in military and civil service. Still others have successful businesses of their own.

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Free career guidance: Send today for the two free success books, the 36-page "How to Succeed" and the informative catalog on the course you check below. No obligation. Just mark and mail the coupon. With so much at stake, you owe it to yourself to act—*and act fast!*

I. C. S., Scranton 9, Penna.

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☐ **RADIO OPERATING COURSE**—Special course to help you pass the Government examination for operator's licenses. Code. TV. FM. Radio regulations.

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ICS

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☐ Reading Blueprints
☐ Construction Engineering
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☐ Industrial Instrumentation
☐ Machine Shop Inspection
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☐ Stationary Fireman

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Occupation________

Canadian residents send coupon to International Correspondence Schools Canadian, Ltd., Montreal, Canada. . . . Special tuition rates to members of the U. S. Armed Forces.

BUSINESS

Merchandising and Promotion

RCA Tube Department, Harrison, N. J., announced a $50,000 prize contest for TV and radio service technicians. 400 prizes will be awarded to the entrants who give the best reasons for using and recommending RCA picture tubes and receiving tubes. The contest is the base of the company's consumer-aimed *Tell and Sell* sales promotion campaign. Winner of the first prize will be given the choice of a 1954 De Soto hard-top convertible or a 1954 Dodge panel truck plus a full set of RCA test equipment. Duplicate prizes will be awarded to distributor salesmen whose names appear on the winning entry blanks. Contest closes at midnight April 30, 1954.

Clarostat Manufacturing Company, Dover, N. H., released a new version of its Greenohm fixed wire-wound 10-watt power resistor kit. The new Greenohm kit consists of 20 wire-wound resistors of the most popular ohmages mounted on a two-color display board which also serves as an inventory reminder.

Ward Products Corp., Division of the Gabriel Co., Cleveland, Ohio., introduced a new promotion kit which includes display material, mailing stuffers, newspaper mats, TV slides, and radio commercials for promoting the company's new line of *Tele-vanes,* decorative TV antennas.

Federal Telephone and Radio Co., Clifton, N. J., sent a special poster-size message to 2,000 distributors


THE 1954 REPLACEMENT MARKET WILL BE GOOD!

Federal is confident that in the year before us the radio-TV replacement market will enjoy continuing prosperity. There are sound reasons for this belief.

In America today there are more than 100,000,000 radios in homes, institutions, business places and on the highways . . . an estimated 28,000,000 television sets in operation . . . plus thousands of converters, boosters and other units. These totals are sure to grow in '54 . . . to raise replacement potentialities to a new high!

Federal congratulates the distributors and servicemen of America on their contributions to the growth of the replacement market, and is confident that they will continue to meet its requirements with parts, components and service of the highest quality.

Federal will give its full cooperation in supplying this great market . . . in maintaining its consistently high standards of product quality . . . in helping in every way possible to assure more profitable selling.

Yes, the replacement market is big . . . is expanding . . . and it will be good in 1954 . . .!

SELENIUM RECTIFIERS • TV LEAD-IN • H-F CABLE • DIODES

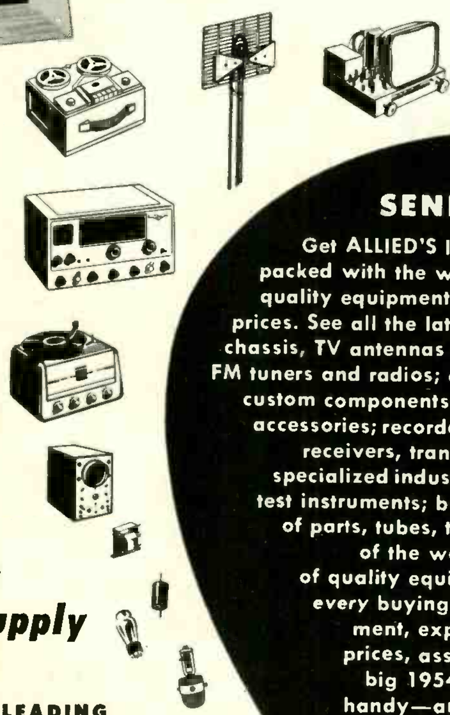
Federal Telephone and Radio Company
SELENIUM-INTELIN DEPARTMENT • 100 KINGSLAND ROAD, CLIFTON, N. J.

throughout the U. S., proclaiming the company's confidence that 1954 would be a good year for replacement sales. The poster is a reprint of a recent Federal advertisement. The blow-up is suitable for window or wall display.

General Electric Tube Department is advertising its aluminized TV picture tubes on *Today,* Dave Garroway's morning TV show on NBC.

Simpson Electric, Chicago, is conducting a series of servicing meetings the only COMPLETE catalog for Everything in TV, Radio and Industrial Electronics

FREE value-packed 1954 ALLIED 268-PAGE CATALOG



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- AM, FM Tuners and Radios
- Recorders and Supplies
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throughout the country, to which service technicians are invited to bring their "dog" receivers for diagnosis and repair by a field engineer. One of the popular demonstrations included in the company's service meetings concerns impedance-matching tests with the Genescope and the demonstration of methods for correcting mismatch conditions.

Hallicrafters, Chicago, is awarding an all-expense-paid round-the-world trip for the three top winners and their wives in its current distributor sales contest.

Imperial Radar and Wire Corp., New York City, is offering a sample card containing all the different sizes of wire it manufactures including the gauge, weight, breaking strength, etc.

New Plants and Expansion

Granco Products, Long Island City, N. Y., has broken ground for a new addition to its plant. The new building will more than double the company's present facilities.

Orradio Industries, Opelika, Ala., manufacturer of magnetic sound recording tape, opened an office in New York City at 458 Broadway. James F. Kenney, recording and broadcast engineer, was placed in charge of the new office.

Quietrole Co., purchased a site in Spartanburg, S. C., where it will erect a new plant.

Erie Resistor of Canada, Canadian subsidiary of Erie Resistor Corp., is completing a new, larger factory in Trenton, Ontario, Canada.

World Radio Laboratories, Cedar Rapids, Iowa, one of the country's largest distributors, is now located in its new building at 3415 West Broadway. Leo I. Meyerson, president of the company, announced that the fire which damaged the company's stocks last January was in the old building. The damaged stock has been completely replenished. The company has been operating at 100% capacity for some months.

Dalmo Victor Co., San Carlos, Calif., has been sold to Textron Inc., Providence, R. I. Dalmo Victor now operates as a wholly owned subsidiary of Textron with no change in personnel or policy.

Production and Sales

RETMA reported that production of 7,214,787 TV sets during 1953 was the second highest in history, more than 1,000,000 better than 1952. Radio output of 13,368,556 was the highest since 1950. The association also noted that 6,375,279 TV sets and 7,064,485 radios, exclusive of automobile sets, were sold at retail during 1953. Both figures were well above the 1952 period.

RETMA announced that 9,839,138 TV

picture tubes valued at $234,721,038 were sold by manufacturers during 1953. This compared with 7,635,666 sold in 1952. RETMA also announced that 437,091,555 receiving tubes valued at $303,675,313 had been sold during 1953 as compared with 368,519,243 valued at $259,116,089 in 1952.

Meetings and Conferences

RETMA Engineering Department will hold a conference on reliability of electrical connections April 15 and 16 at the Illinois Institute of Technology, Chicago.

Stanford Research Institute and the U. S. Air Force are jointly sponsoring a symposium on the automatic production of electronic equipment at San Francisco's Fairmont Hotel, April 19-20.

Business Briefs

. . . **An Operating Committee** of the Industry Relations Committees of six trade associations was formed recently to co-ordinate the various regional conferences sponsored by representatives. W. D. Jenkins, Radio Supply Co., Richmond, Va., is chairman *pro tem.* Two members representing each of the following, comprise the committee: Sales Managers Club, Eastern Group; Association of Electronic Parts & Equipment Manufacturers; NEDA; "The Representatives"; RETMA; and the WCEMA. Tentatively the committee will support the Southwestern Conference; the Minnesota Conference; and the Missouri Valley Conference in 1954, and a Rocky Mountain and Pacific Northwest; a Southeastern; and Northeast Conference in 1955.

. . . **RETMA** has prepared a standard parts tag as an aid to radio and TV service technicians in returning components to manufacturers for replacement under a set warranty.

. . . **Sylvania Electric Products'** director of sales research, Frank W. Mansfield, stated that electronics in the U.S. is currently an $8 billion industry which should exceed $13 billion within the next eight years.

. . . **RCA Tube Department,** Harrison, N. J., has developed a new tube inventory service to provide industrial users of RCA transmitting and receiving tubes with a systematic inventory and re-order control.

. . . **Wells & Winegard,** Burlington, Iowa, television accessory manufacturer, is now under the sole ownership of John R. Winegard, who purchased the interest of John Wells.

. . . **Tele King Corp.,** New York City, radio and TV manufacturer, filed voluntary proceedings for bankruptcy under Chapter XI. Petition estimates liabilities at $4,050,000 and assets at $4,439,000. They propose 100% settlement, payable in annual installments of 10%.

. . . **NTSC**, the industry-wide organization of electronic engineers and scientists which developed the color television standards recently approved by the FCC, disbanded early this year.

. . . **John F. Rider Publisher,** New York City, announced that it had been selected to publish the texts to be used in the RETMA courses in television servicing.

. . . **Channel Master Corp.,** Ellenville, N. Y., held a series of regional conferences for its distributors in Ellenville, N. Y. During the first of these conferences, Harold Harris, vice-president in charge of sales and engineering for Channel Master, predicted that the total volume of TV antenna sales in 1954 would be the largest in history both in units and dollars.

. . . **General Dry Batteries, Inc.,** Cleveland, now includes NEDA battery numbers on its cartons.

. . . **CBS, General Electric, Motorola, Philco, RCA, Sylvania, Westinghouse,** and **Zenith** were certified as "excellently managed" by the American Institute of Management.

. . . **Allen B. DuMont Laboratories,** Clifton, N. J., entered the field of mobile communications equipment with the formation of a new Communication Products Division, which will take over and expand the activities of the Television Transmitter Division. Herbert E. Taylor, Jr., manager of the former Transmitter Division, has been named to handle the new operation.

. . . **The High Fidelity Institute of the Electronic Industries** was organized as a non-profit association to promote the interests of the growing high-fidelity industry. It will work toward the establishment of uniformity of technical standards, new markets, equitable trade practices and effective promotional methods. Jerome J. Kahn was drafted as temporary commissioner. Temporary headquarters were set up in 1 N. LaSalle St., Chicago. A six man provisional Board of Governors was named which includes Charles A. Hansen, Jensen Mfg. Co.; Leonard Carduner, British Industries; Emmanuel Berlant, Berlant Associates; Gramer Yarbrough, American Microphone; John H. Cashman, Radio Craftsmen; and Walter O. Stanton, Pickering, Inc.

Electric Sweeper Service Co., 2034 Euclid Ave., Cleveland, O., designed a program whereby TV-radio service technicians may add to their regular income by servicing small appliances.

. . . **The International Sight and Sound Exposition, Inc.,** sponsors of the 1954 High Fidelity Show to be held in the Palmer House, Chicago, Sept. 30-Oct. 2, announced that contracts for display space are running better than 40% ahead of the amount sold for the 1953 show at this time last year. **END**

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P.R. MALLORY & CO. Inc.

the 1st . . . All-Channel UHF Converter Designed to fit *Inside* ANY VHF Set

Here's another first from Mallory . . . The Mallory Model '188' Concealed UHF Converter. It fits inside any VHF set to make it an all-channel receiver. And it's a sure-fire salesbuilder for you.

Look at these features of the Mallory '188'.

OUT OF SIGHT . . . The entire unit is mounted inside the cabinet. All that shows is a clear plastic selector dial and switch lever.

EASY TO INSTALL . . . No alteration in the set chassis is required and the '188' has its own power supply. Can be mounted inside the cabinet on either side or at the top. A bracket and four screws do the job on wood cabinets. On plastic or metal cabinets, the converter may be mounted on the fiber-board rear enclosure.

PROVED PERFORMANCE . . . The '188' offers you the same proved performance . . . the same high quality reception . . . as the Mallory '88' Cabinet Converter which has given outstanding performance in UHF areas across the Nation.

Give Yourself Greater Converter Sales . . .
By Giving Your Customers Their Choice
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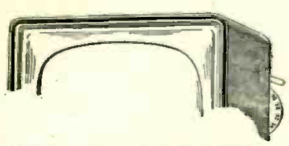
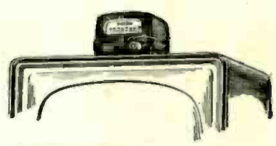


Mallory Concealed Converter —first on the market



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NO RADIATION PROBLEM!

Both Mallory Converters contain specially designed components to prevent troublesome interference from radiation—a problem common to low quality converters which ruin TV reception over a wide area.

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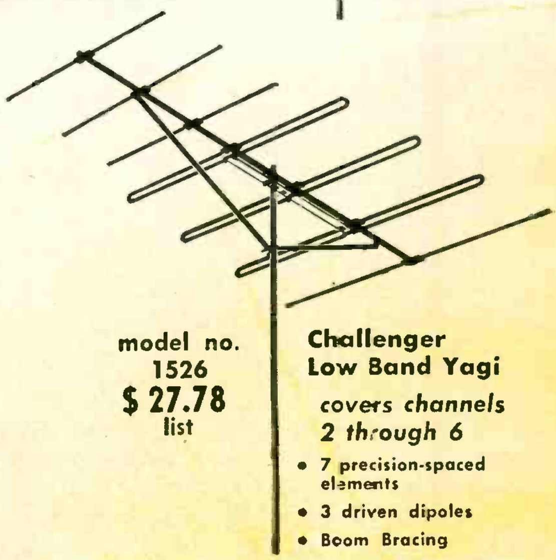
covers channels 7 through 13

model no. 1573
$ 14.58 list

- 10 elements
- Featuring "Tuning Fork" for flat gain level
- Transformer-type dipole

CHALLENGER BROAD BAND YAGIS

Here's Broad Band coverage with the high gain and directivity of the Yagi. Ideal for areas served at present by two or more VHF stations on the same band and areas where new VHF stations are being added to present ones, on the same band. Feature 100% aluminum construction; are completely preassembled. They give high gain across the band; high front-to-back ratio. Can be stacked for extra sensitivity.

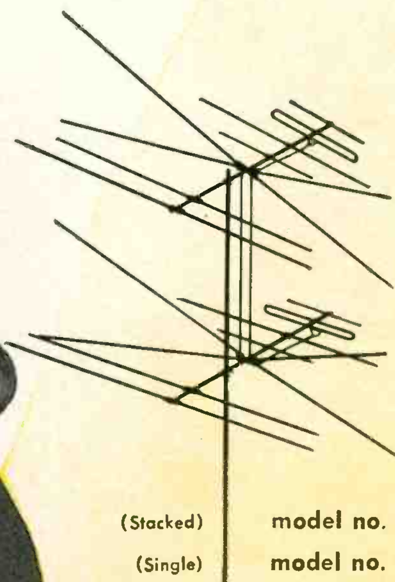


model no. 1526
$ 27.78 list

Challenger Low Band Yagi

covers channels 2 through 6

- 7 precision-spaced elements
- 3 driven dipoles
- Boom Bracing



GLOBE TROTTER

- All-channel VHF *fringe* area coverage.
- All-channel UHF *primary* area coverage.
- 100% aluminum construction.
- Completely preassembled — no loose hardware.

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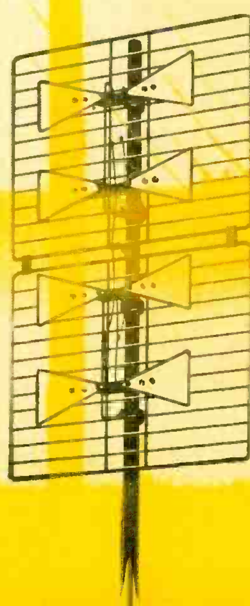
covers channels 14 through 83

- Outstanding fringe area reception.
- All-aluminum, solid sheet elements.
- "Free-Space" terminals.
- Heavy-duty welded wire screen, bright zinc electroplated.



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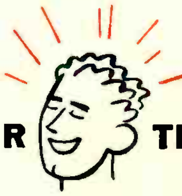
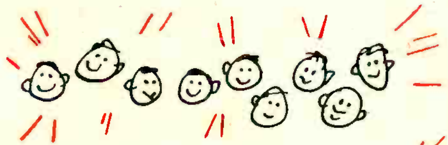


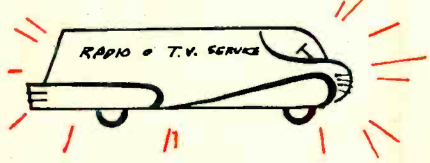
THAN YOUR COMPETITOR OR

because YOU EMPLOY MORE MEN



OR

because YOU HAVE FLASHIER TRUCKS



BUT... THEY WILL LOOK FOR YOU AND GIVE YOU

MORE BUSINESS* IF YOU ARE A

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and YOU'LL KEEP THE BUSINESS IF YOU USE

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because THEY ARE ***RIGHT...FOR SOUND AND SIGHT!***

BETTER ASK YOUR RAYTHEON TUBE DISTRIBUTOR IF YOU CAN QUALIFY FOR THIS EXCLUSIVE SALES STIMULATOR

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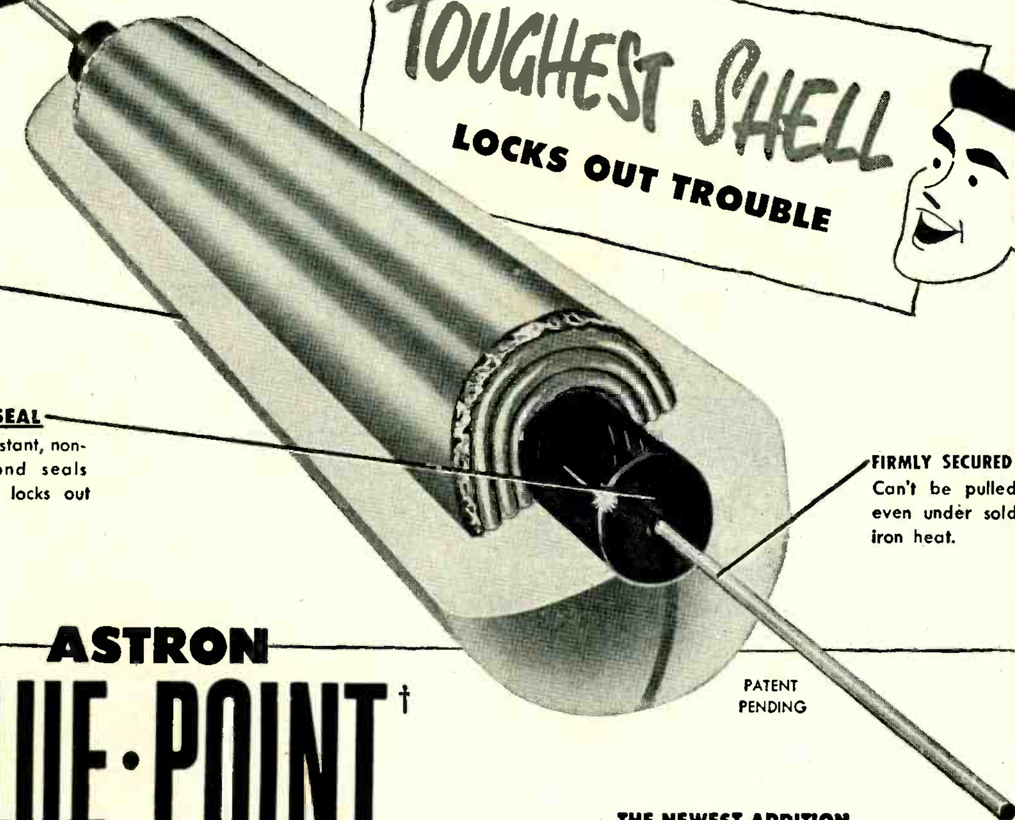
TIGHTEST SEAL
LOCKS IN PERFORMANCE

TOUGHEST SHELL
LOCKS OUT TROUBLE



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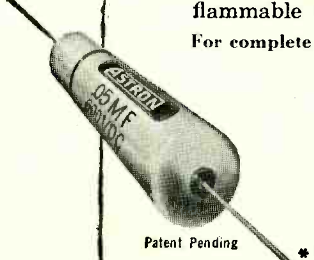
BLUE-POINT is suitable for continuous operation at 85°C. The bonded seal uses a special thermo-setting, heat-resistant, non-inflammable bonding agent—*positive* protection against moisture. Solder leads as close to the capacitor as you like—they *won't* pull out! Every BLUE-POINT is clearly marked with voltage and capacitance, bears outside foil identification. Every BLUE-POINT is *tested* and *guaranteed*. Look for the ASTRON BLUE-POINT when you buy capacitors from your jobber, or if he doesn't carry it, send us his name. Insist on ASTRON BLUE-POINT, the capacitor you *know* you can depend on. Order a supply today.

For complete performance characteristics, specifications and listings, write to Department RE for Bulletin AB-20A.



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A Brief Survey of COLOR TV

. . . how its complex character means job opportunity for you

—by E. H. RIETZKE,

President, Capitol Radio Engineering Institute

A GOOD MANY YEARS AGO, when he was a young fellow, my Dad was one of the country's fastest typesetters. He could go anywhere and get a highly paid job with any newspaper in the country. *Then came the linotype machine!* Before he knew it, my Dad's job was obsolete. He had to start all over in another line of work.

How will *you* get along in the age of *Color TV* that has already arrived? Will you have to start all over? Or will you be prepared? The choice is a matter of black-and-white—*or color.* As you may know, color TV involves handling an understandably much more complicated signal than for black-and-white; the components must be in perfect balance; the margin for error is practically zero. Technical personnel need new skills in working to closer tolerances. Microwave relays and coaxial cables require added equipment and special adjustments. Before a station can originate color it needs a great deal of additional equipment, much more expensive and vastly more complicated than that for black-and-white. Slide and film equipment also require additional components and maintenance. Color camera chains are much more complex, requiring more highly skilled adjustments and care. Reports of network experiments indicate that live telecasting in color increases technical man-hours required by 30 to 50%. Lighting personnel need more skill in handling new—and delicate—problems. That's a very quick run-down from the transmitter end. Every step is a technical opportunity.

What about color receivers? They'll be bigger—with roughly twice as many receiver tubes as black-and-white. There is at least one more tuning knob—the chroma control for color saturation. Maintenance is complicated, to say the least, with three highly critical video channels to trouble-shoot instead of one. Service contracts for color receivers will cost considerably more than for black-and-white, according to highly qualified sources—which should give you an idea of servicing complexity—and earnings possibilities. So much for transmission and reception. Manufacture of color equipment is another field for *trained* technicians.

Most well-informed sources agree that color television will be spread all over the U.S. by 1956 at the latest. *The years between now and then are crucial.* If you are interested in an honest-to-goodness career in this booming part of the booming electronics industry, here's how you can step ahead of competition, move up to a better job, earn more money, and be sure of a well-paid job: Study radio-television-electronics via CREI. You don't have to be a college graduate. You *do* have to be willing to invest some of your spare time—at home. You can do it while holding down a full-time job. Thousands have.

Since 1927 CREI has provided men with the technical knowledge that leads to more job security—and more money. CREI starts with fundamentals and takes you along at your own speed, not held back by a class, not pushed to keep up with others who have more experience. You master the fundamentals, then get into more advanced phases of electronics engineering principles and practice. Finally you may elect training at career level in highly specialized applications of radio or television engineering, or aeronautical radio. The coupon below, properly filled out, will bring you—without cost—a fact-packed booklet, "Your Future in the New World of Electronics," which includes outlines of courses offered, a resume of career opportunities, full details about the school, our Placement Bureau (with more requests for trained men currently on file than we can fill), and the names of some of the organizations using CREI training (like All American Cables & Radio, Inc., Canadian Broadcasting Corp., Columbia Broadcasting System, RCA Victor Division, United Air Lines, to name a few). I urge you—for your own good—to send for this free booklet immediately.

NOTE: CREI also offers Resident School instruction, day or evening, in Washington, D. C. New classes start once a month. If you are a veteran discharged after June 27, 1950, let the new GI Bill help you obtain resident (or home study) instruction. Check the coupon for more data.

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DEVELOPS BOTH RF AND VIDEO OUTPUT

A Must for Areas Where Continuous Station Broadcasts are Not Available

Now use the dot and line patterns from the new PHILCO Model G-8005 to check linearity, focus, astigmatism, blooming and high voltage regulation. Trouble shoot receivers on any channel, 2 through 6, or with video output. The PHILCO G-8005 Television Pattern Generator is an instrument especially adapted for service work . . . designed to save you time.

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2. Easy to operate: connect Pattern Generator output to TV set. Select proper test pattern. Accurately check both the vertical and horizontal sweep circuit performance.
3. External Sync. Jack improves stabilization in many special cases. Provides wide range operation.
4. A custom type instrument with new and novel circuits designed to reduce service time in both laboratories and service shops.

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A sensitive, portable unit adaptable to either bench or field service. VERTICAL AMPLIFIER: DC coupled, Sensitivity—0.05V rms/inch. Frequency Response—0-1 mc/s within 6DB. DC coupled Vert. Amplifier circuits and low capacity probes facilitate video circuit trouble shooting. Built-in voltage calibrator permits use as high sensitivity vacuum tube voltmeter. HORIZONTAL AMPLIFIER: Sensitivity—0.5V rms/inch. Frequency Response—10 cps to 125 KC/s within 6DB. Sweep Circuit Frequency — Variable 15 to 30,000 cps . . . preset frequencies at vertical and horizontal sweep rates.

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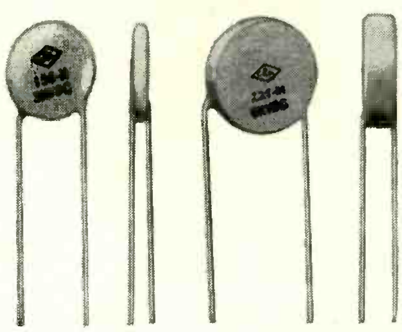

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There are other reasons why these CRL Hi-Vo-Discs help end profit-robbing call-backs: The heavy, special phenolic insulation has triple-high-temperature wax impregnation. Tolerances are held to ± 20%.

Send coupon for catalog sheet 28-2 —for complete information on these new CRL capacitors for bypass, coupling, and general applications.

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SPECIALIZATION

. . . In this age of specialization, ordinary training is no longer sufficient . . .

By HUGO GERNSBACK

THE editorial in the February issue, entitled "*Wanted: Technicians*," brought a variety of letters from readers. Many of these took issue with us; the writers seemed to think that there actually was an *over-supply* of technicians today.

One reader from Florida sent a page from a Miami newspaper containing dozens of advertisements of service technicians who were advertising their services. He jumped to the conclusion that here alone was a vast reservoir of technicians which should be tapped by the industrial firms requiring technical personnel.

He ended his letter with the remark: "Why don't the large corporations come to Florida and get their technicians here?"

Another letter from Ohio states that graduate electronic engineers are paid very little money, at the rate of only $2 per hour. It states that there seems to be an over-abundance of young men in this classification, and closes with: "If you doubt my statement, investigate the salaries paid by Convair, Pomona, Calif.; Hughes, Culver City, Calif.; North American, Downey, Calif.; and California Technical, Pasadena, Calif.

Another reader from Key West, Fla., writes as follows (*the spelling is his*): "I am a trained ambitious young man (22). I have a through background in electronic theory and approximately three years practical experience in electronics gained with the United States Navy. I have a good knoledgd of mathematics. I am presently taking a course in telivision engineering to further my knoledge."

He ends his letter by stating that when he is released from the Navy a year hence, he would like to know how to acquire a desirable position. He furthermore wants to know if we can help him and others like him, who want to put their present knowledge to use and advance themselves to worthwhile positions. Many other letters were written in similar vein.

It is unfortunate that the writers seemingly misread the gist of the February editorial. We were careful to point out that the technicians wanted were mostly those who had superior knowledge and training. In the third paragraph, which we repeat here, we stated: "Since 1951, the shortage of technical personnel—*particularly in the higher brackets*—has been acute. It is likely to become worse during the next few years, until we can make up the deficiency."

In the next paragraph we stated that *a complex knowledge* is required by the present-day radio-electronic specialist. We mentioned radio engineers, radio-electronic *specialists*, technicians, physicists and others.

The point we were trying to make was that the world is full of the average type electrician and technician, but *these are not the men who make from $15,000 to $25,000 a year salary.* The editorial in the February issue made this quite clear by giving two examples of unusual technical requirements, namely *Automation* and *Electronic Computers*.

It stands to reason that the average technician could hardly expect to fill such a position because it calls for specialists—*specialists of the highest order.*

The trouble is that too many young men think of themselves as high calibre specialists when they may be specialists in only a very narrow channel. Many radio or television technicians may be excellent specialists in trouble chasing of radio or television sets, but would they be qualified to design, for instance, a new color television set, or a new portable desk electronic computer, or a hundred other similar complex items? Not a chance in the world!

We discussed this problem at length in a former editorial entitled "Why Radio Specialization," in the March 1947 issue. We went to great lengths to point out that the age of electronic specialization was here and that there was a tremendous field for *advanced specialists*. This means high-grade men who have a *thorough* understanding of all phases of electronics. They must not only be thoroughly grounded in the electrical field, but they must be experts on vacuum tubes—nowadays transistors. They must know all about cathode ray tubes, multiplier tubes and a host of other tubes. They must know the mathematics of the field and, furthermore, should be well grounded in physics, particularly in connection with electronics.

This means a long road of specialized education, not necessarily college education, but knowledge of *EVERYTHING* connected with the art. This is not an easy road. It takes many years of studying, many years of actual work in the endeavor, to make one's self as near letter-perfect in the chosen profession as is humanly possible. The graduate engineer—or the technician with wide experience—will often have to take a low-paid beginners' job (in some important line of work, to be sure!) and continue to work *and study*, gaining valuable experience, till he is qualified to fill some of the higher technician shortages that certainly do exist in most plants.

People of this educational level do not find it very difficult to obtain high positions. If you set forth in a typewritten letter your entire past experience, your knowledge in a particular field or branch of electronics, and if this knowledge is adequate, it shouldn't be difficult to obtain a worthwhile position.

Usually men of this type have original ideas of their own, because in their work they come to conclusions usually not known to the ordinary type of man. A hint as to such a phase is usually sufficient to bring a rush call for the candidate.

It is not too much to say that it is the exceptional type of technician, *the man with an exceedingly high electronic I.Q.*, who is wanted, not only today, but in the future as well. The world is full of mediocrities. What the ranking leaders in radio-electronics desire mostly is men of exceptional intelligence and imagination who have the push and drive to put their ideas across, men with initiative and industry. Deservedly, they can name their own salary—and get it.

KILLING THOSE ALIGNMENT BUGS

Connection of the test equipment and precautions to be taken in i.f. alignment

By The Engineering Staff *Scala Radio Co.*

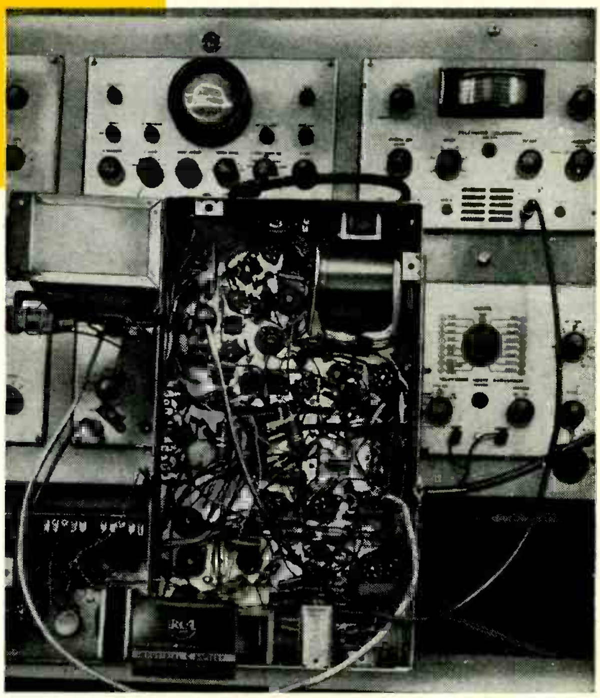


Fig. 1—Visual alignment test setup

WHEN the TV technician gets a job, he is expected to know the answers. Busy fellow workers have no time to show him the ropes, even if they had the inclination. So the technician must try to recognize as many alignment bugs as possible. This series of articles will present in an entirely practical form the result of many years' experience in this regard. Every technician who takes his job seriously should literally cut out each article and paste it on the wallpaper in the shop.

Fig. 1 shows a typical visual-alignment test setup. The best grade of work can be done with such equipment by a man who knows what he is trying to do. A novice can try the same job, with the same equipment, and fail completely. This article tells why.

Calibrating marker generator

When starting on an alignment job the first step is to check the calibration of the marker generator. Without marker accuracy, the local-oscillator, ratio-detector, and sound-trap adjustments present a hopeless problem in the busy shop. Many marker generators have built-in calibrating facilities. Indication of zero-beat points—by beating the output from the marker generator with the harmonics from a quartz crystal—may be either audible or visual. If a generator does not have built-in calibrating facilities, the technician should obtain a 1-mc, 2-mc, or 5-mc crystal oscillator, and use the calibrating arrangement shown in Fig. 2. It would be advantageous to use a voltage-doubler probe (no polarization), as seen in Fig. 3.

If the harmonics of the crystal oscillator become too weak to check the higher frequencies of the generator, the technician must obtain another signal generator. First, he calibrates the auxiliary generator from the crystal at as high a frequency as possible. Next, he substitutes the calibrated generator for the crystal oscillator. Thus, the auxiliary generator acts as a "stepping stone" to higher frequencies.

Setting the marker-generator dial to various frequencies may require a vernier scale, which can be used to split up the coarser divisions on the dial scale into very fine divisions.

Injecting the sweep signal

The sweep signal from the sweep generator must be injected into the i.f. circuits (as a preliminary operation) in a manner which will not disturb the operation of the i.f. amplifier. Some technicians connect the output cable from the sweep generator between the grid of the first i.f. tube and chassis. Such a connection shunts down the response of the first i.f. coil, due to the 75-ohm impedance of the sweep-output cable, and displays a response curve on the scope screen which has something missing—the contribution of the first resonant circuit in the amplifier.

To avoid this difficulty, most technicians use a so-called floating tube shield which is placed over the mixer tube in the front end of the receiver, as shown in Fig. 4. A floating tube shield is a tube shield which is slid over the tube, but which does not make contact with the chassis. By connecting the hot side of the sweep-output cable to the floating tube shield, and the braid conductor to chassis ground, a loose capacitive coupling is made to the plate of the mixer tube. This loose capacitive coupling permits ample injection of sweep voltage, without detuning the first i.f. circuit. This is a very important point which cannot be disregarded if a botched job is to be avoided.

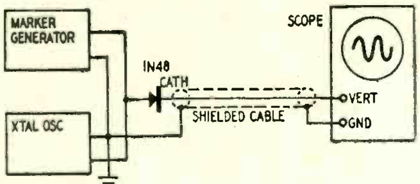


Fig. 2—Marker-generator calibration.

For operation in the 23-mc range, the sweep-output cable may be operated open-ended, as shown. When operating in the 45-mc range, terminate the sweep-output cable with a carbon resistor having a value equal to the characteristic impedance of the cable. Otherwise, standing-wave distortion may result.

Oscillator harmonic bugs

Since the sweep generator usually has harmonics in its output, and the local oscillator in the receiver is a powerful generator of harmonics, it is possible for the two groups of harmonics to cross-beat in the nonlinear mixer tube, and produce undesirable sweeps and markers which distort the response curve into absurd shapes. A situation of this type is shown in Fig.

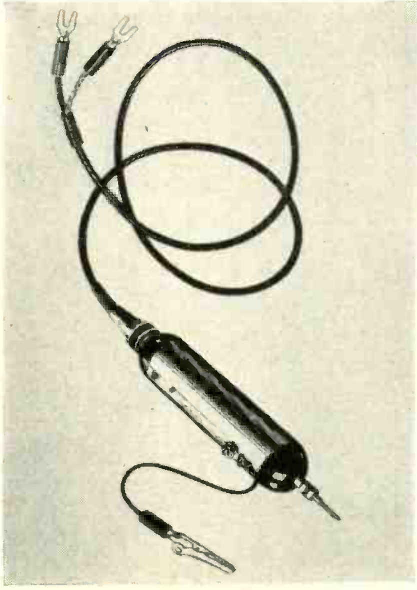


Fig. 3—Voltage-doubler crystal probe.

5. To check for this type of bug, the technician turns the channel-selector switch from one channel to the next. If the curve changes shape, he knows he has local-oscillator harmonics.

Local-oscillator harmonics can be killed either by unplugging the oscillator tube (if an individual local-oscillator tube is used) or by making up a dummy tube to disable the local oscillator and to permit the mixer section of the tube to continue normal operation.

In Standard Coil tuners, for example, the technician will usually remove the oscillator grid pin (pin 6) from the 6J6 local oscillator-mixer tube. Removing this pin converts the twin triode into a dummy tube. Inspecting the circuit diagram for the receiver is the only way to determine how to construct a dummy tube for visual alignment.

Mixer regeneration

In many cases—especially if a 45-mc i.f. amplifier is to be aligned—it may be found that although a dummy tube is used in the front end, the i.f. curve changes appreciably as the operator switches the channel selector from low to high channels. The greatest change in curve shape can be seen when he switches from channel 13 to channel 2. This change in curve shape is caused by mixer regeneration due to the frequencies shown in Fig. 6.

Triode tubes are commonly used as mixers, because triodes are low-noise tubes, and contribute less snow on weak signals than do pentodes. But a triode has the largest plate-to-control-grid capacitance, and hence is most susceptible to tuned-plate-tuned-grid regeneration in a mixer circuit. When the grid circuit is operating on channel 2, it is tuned in the vicinity of the 45-mc operating frequency of the plate circuit, causing maximum regeneration. However, when the grid circuit is operating on channel 13, it is tuned far from the vicinity of the 45-mc i.f., and tuned-plate-tuned-grid regeneration is negligible. (See Fig. 7 for a typical case of mixer regeneration.)

The effect of mixer regeneration is to make the response curve on channel 2 appear much narrower in bandwidth and more highly peaked than the response curve on channel 13. If no neutralizing circuits are provided in the mixer, as is often the case, the technician must then "split the difference" on low-channel and high-channel position of the selector switch. This means that the i.f. response curve will be less than ideal on both low- and high-channel positions, but it is the only practical solution to the problem. In severe cases, a tuner which has mixer neutralizing facilities should be installed.

Connection of scope

The scope is commonly connected at the output of the video detector. If a narrow-band (audio-frequency) scope is used, the marker indication on the response curve will be satisfactory when the scope is connected directly to the second-detector load resistor. A shielded cable should be used for this connection, to avoid pickup of stray fields from the sweep circuits as well as 60-cycle fields around the test bench.

However, if a wide-band troubleshooting scope is connected across the second-detector load, the technician will find that a beat marker appears very broad and fuzzy, and that the zero-beat point is difficult to locate. The solution is to use less of the bandwidth of the vertical amplifier in the scope. One method is to shunt a .005-μf capacitor across the input terminals of the scope. This sometimes leads to difficulties. There may be sufficient 45-mc i.f. voltage in the output of a video detector to resonate strongly in the cable, which then acts as a resonant stub. Violent oscillation, or at least instability, results from such a situation, and requires other means of marker filtering. The preferred method is to use as the signal take-off point in the receiver an isolating resistor of approximately 75,000 ohms in series with the shielded input cable to the scope.

Setting of sweep-width control

After the center frequency of the

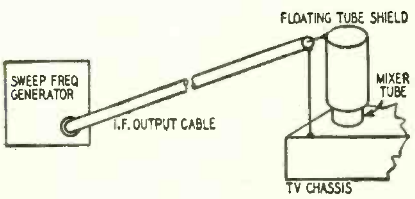


Fig. 4—Injecting an i.f. sweep signal.

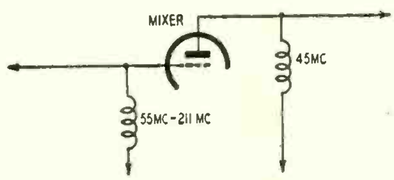


Fig. 6—Plate and grid frequencies.

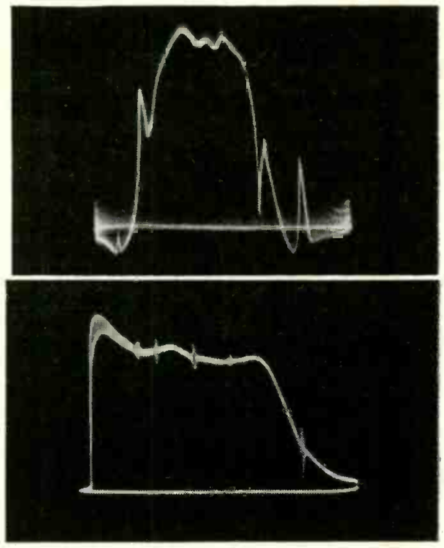


Fig. 5—Distorted response curves.

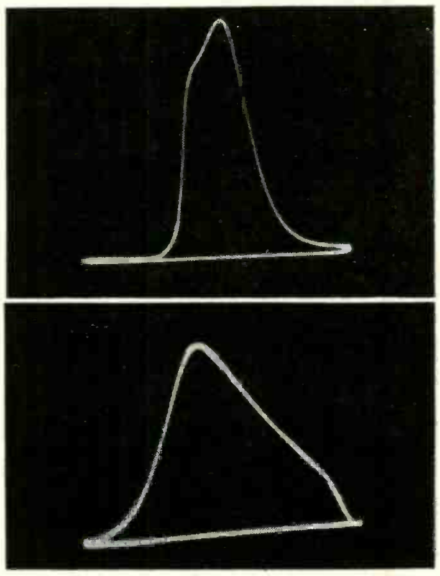


Fig. 7—I.f. response curves. Above, channel 2 setting; below, channel 13.

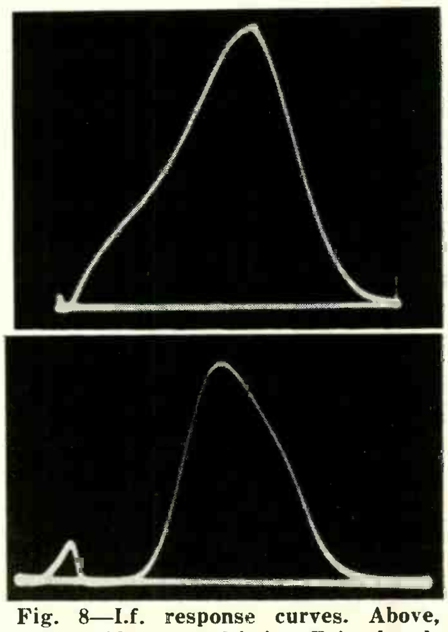


Fig. 8—I.f. response curves. Above, sweep-width control is insufficiently advanced; below, a proper adjustment.

sweep generator has been adjusted to coincide with the center frequency of the i.f. amplifier being aligned, a response curve will appear on the scope screen, as shown in Fig. 8. Then adjust the sweep-width control so that the entire response curve is displayed on the base line of the scope. Beginners sometimes lose time because they try to set the dial of the sweep generator with extreme accuracy. This is a misconception, because there is a wide tolerance on the center frequency setting; in fact, it is better practice to watch the scope screen while adjusting the tuning dial of the sweep generator, and to leave the dial at the point which centers the response curve on the scope screen. The dial may fail to read the center frequency accurately, because beat-frequency generators are notorious for drift when operating on a relatively small difference frequency.

The marker-generator dial, rather than the sweep-generator dial, should be set to a high degree of accuracy. The marker-generator is relied upon to identify various frequency points.

As shown in Fig. 9, the technician often fails to obtain markers which are satisfactorily large in the traps, near the base line, or out along the base line. This is because it is impractical to inject enough marker voltage through the receiver circuits to obtain a satisfactory marker indication. Various types of marker injection are used in practice, and some types provide better marker indication than others. One of the customary marker-injection methods is the chassis-current method shown in Fig. 10. The output cable from the marker generator is grounded at two separated points along the i.f. chassis. At these frequencies, there will be an i.f. voltage drop along the chassis, which is picked up by the various ground points of the i.f. components, thereby injecting the marker voltage into the swept circuits.

However, to obtain uniform markers at all times, *a bypass marker injector* should be used. The bypass marker injector is an instrument which develops the marker pip independently of the circuits under test, so that the marker size is constant at any point along the response curve, in the traps, or on the base line, as shown in Fig. 11.

Fig. 12 is a photograph of a bypass marker injector unit. The circuit diagram is shown in Fig. 13. A sample of the sweep voltage is mixed with a sample of the marker voltage as shown in Fig. 14, and the marker indication will continue to appear along the base line of the scope, even if the TV receiver is turned off. When the TV receiver is operating, the swept output from the receiver circuits is mixed with the marker voltage and applied to the scope's vertical input terminals.

A marker injector unit of this type is useful in ratio-detector alignment, and in video-amplifier adjustment where marking is often a severe problem. The unit also finds use in front-end alignment work, and in checking the impedance match of antennas to lead-ins, front-end input impedance, and characteristics of antenna matching units.

Many other alignment bugs lurk in waiting, ready to bite the unsuspecting and unwary technician. These various bugs will be described in following articles. END

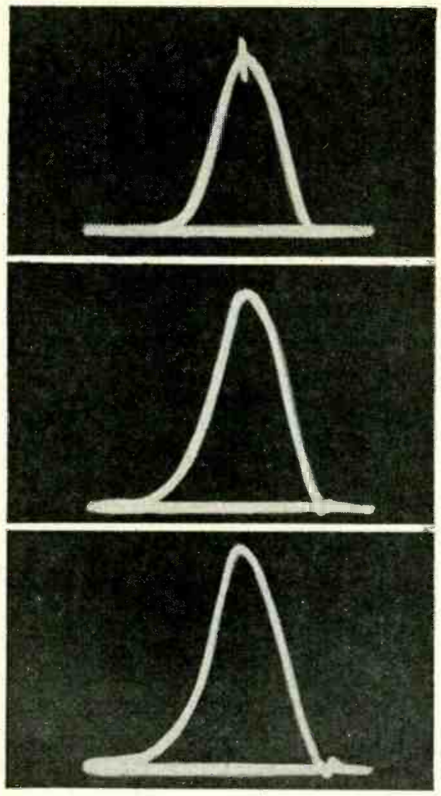


Fig. 9—Marker size diminishes as it gets further away from top of curve.

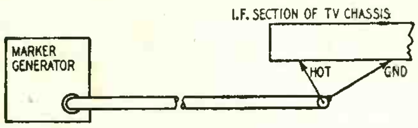


Fig. 10—Chassis current injection.

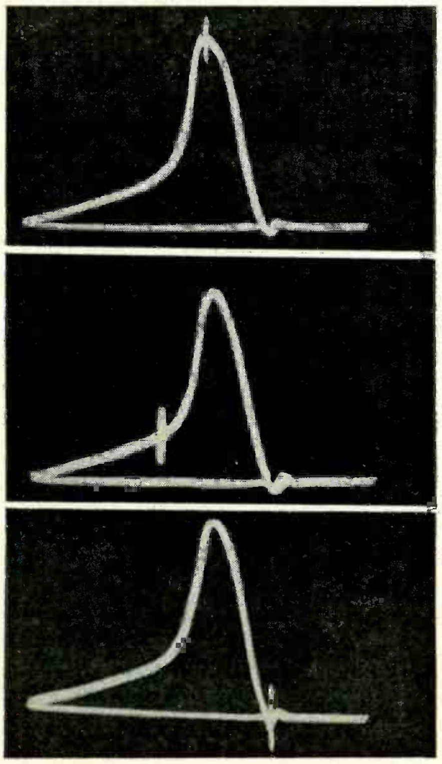


Fig. 11—Markers are of uniform size.

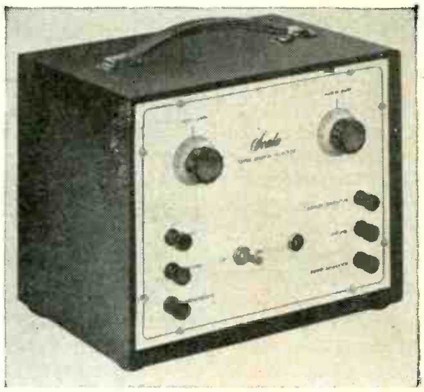


Fig. 12—Front view of marker injector.

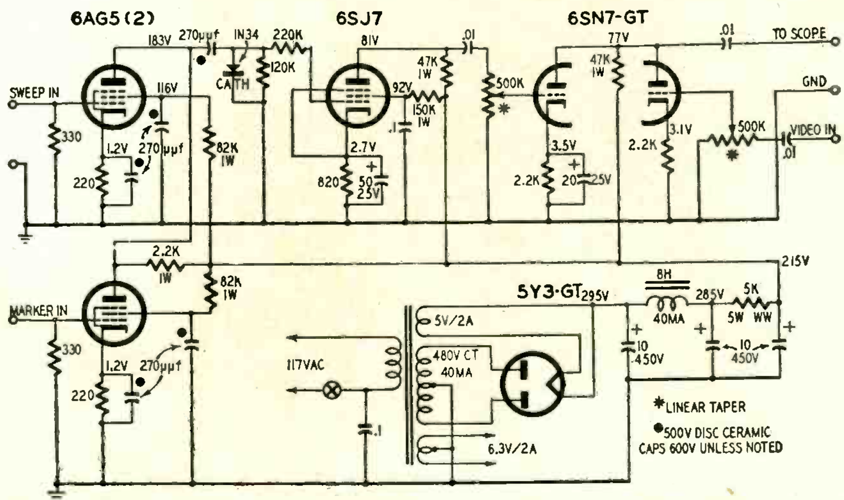


Fig. 13—Schematic diagram of the bypass marker injector shown in Fig. 12.

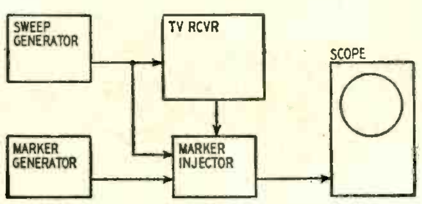


Fig. 14—Using the marker injector unit.

NOISE-FREE SYNC CIRCUITS

By ROBERT F. SCOTT
TECHNICAL EDITOR

DURING the last year or so, we have discussed three or four novel circuits which were developed to minimize the effects of noise pulses on the stability of sync circuits in TV receivers. Now, almost all TV set manufacturers have recognized the importance of noise immunity.

Westinghouse noise-free sync

A feature in some of the new Westinghouse TV receivers is a new sync system designed for high sync stability and noise immunity over a wide range of signal strengths. The circuit used in the V-2223-1 chassis is shown in Fig. 1.

The grid of the sync amplifier is direct-coupled to the video detector. The detector develops a video signal with a d.c. component negative with respect to ground. The major portion of this negative voltage appears across R1, which acts as the video detector load and the grid return of sync amplifier V1 and the video amplifier (not shown in Fig. 1). This negative voltage varies directly as the strength of the incoming signal. On strong signals, the detector output is sufficiently high for the negative-going sync pulses to drive the sync amplifier to cutoff so that the sync tips are compressed.

To prevent sync compression, a positive voltage is applied to the sync amplifier grid through R5 and R3. The positive voltage on the grid cancels a portion of the high negative voltage produced by the video detector. Since the negative voltage is determined by the signal strength, and the positive voltage is obtained from a fixed source, the positive voltage must be controlled so that it cannot exceed the negative d.c. component of the video signal. This must be prevented, because if the grid goes positive, conduction takes place between the cathode and grid. This causes a loss of video and sync signals.

The sync control tube (V2) automatically adjusts the positive voltage on the sync amplifier grid to the optimum value for any signal level. The plate of V2 connects to the junction of R4 and R5. Its grid receives the full a.g.c. voltage. When the incoming signal is strong, the a.g.c. bias cuts off the sync control tube. V2 now behaves like an open circuit and does not interfere with the application of the positive voltage to the grid of amplifier tube V1.

As the signal level drops, the a.g.c. voltage becomes less negative, and V2 begins to conduct. The plate-to-cathode resistance of V2 now acts as a variable resistance. This increases the voltage drop across R5 and reduces the positive voltage which can be applied to the grid of V1.

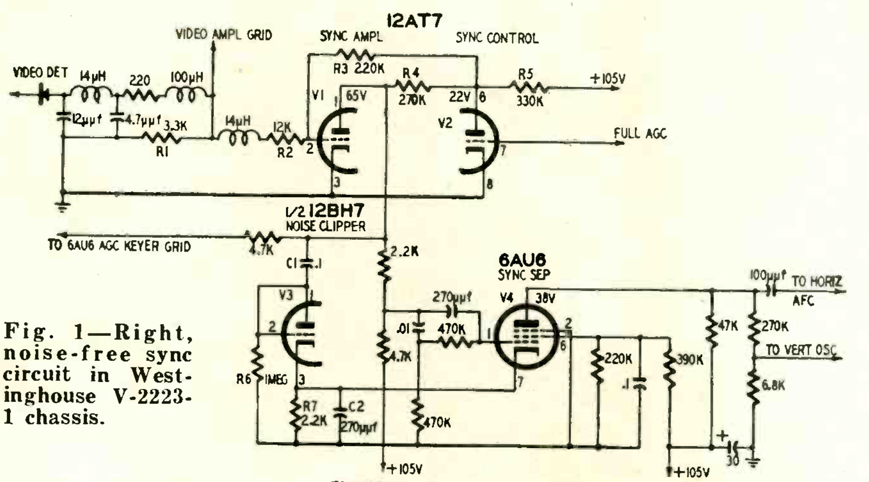


Fig. 1—Right, noise-free sync circuit in Westinghouse V-2223-1 chassis.

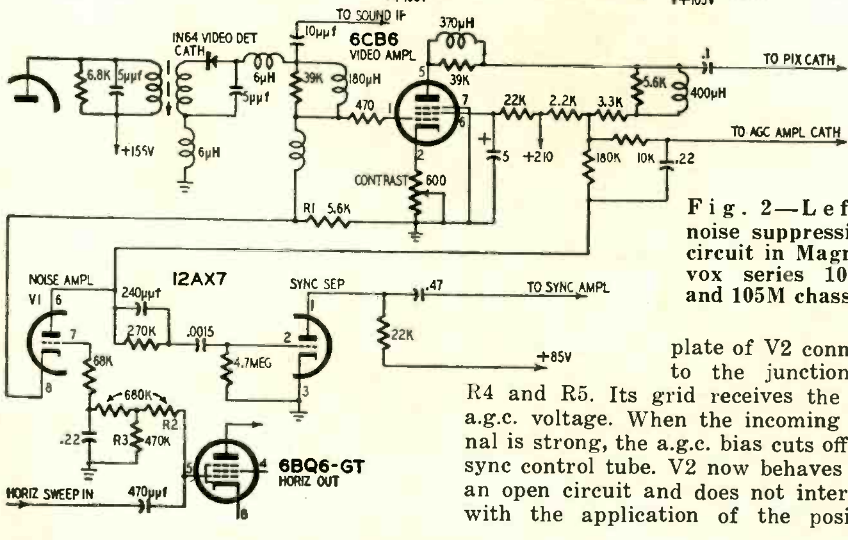


Fig. 2—Left, noise suppression circuit in Magnavox series 105L and 105M chassis.

The noise clipper

V3 is a diode noise clipper connected between the sync amplifier plate and the sync separator cathode. Positive-going sync pulses are fed from the sync amplifier to the plate of the noise clipper and to the grid of the sync separator (V4). Between sync pulses, C1 discharges slowly through R6, producing a negative voltage on the plate of V3. The time-constant of R6-C1 is much longer than the sync interval, so C1 discharges only slightly before the arrival of the next sync pulse. During each following pulse, V3 conducts just enough to restore the charge on C1. Thus, the plate of V3 is maintained at a negative potential controlled by the amplitude of the sync pulses.

When V3 is conducting, a small positive pulse appears across R7—the common cathode resistor for the noise clipper and sync separator. The time-constant of R7-C2 holds the voltage on the cathode of V4 constant during normal operation.

However, if a strong noise pulse reaches the plate of the noise clipper, it overcomes the negative voltage on the plate and causes the diode to conduct heavily and produce a large voltage pulse across R7.

Note that the positive-going sync and noise pulses are applied simultaneously to the plate of V3 and grid of V4. The noise pulse overcomes the negative bias on the plate of V3 and causes a positive pulse of equal amplitude to appear on the cathode of the sync separator V4. Since the noise pulses on the grid and cathode of V4 have the same amplitude and polarity, they cancel each other so that the sync separator is immune to the effects of the noise pulse.

Sync pulses do not cancel in the same manner because V3 is biased almost to cutoff immediately following the first sync pulse and thereafter conducts only on noise pulses whose amplitude exceeds that of the sync pulses.

Magnavox noise suppressor

The noise-suppression circuit in the Magnavox series 105L and 105M chassis (see Fig. 2) uses a grounded-grid type amplifier. A portion of the composite video signal is tapped off the video detector load resistor and is fed

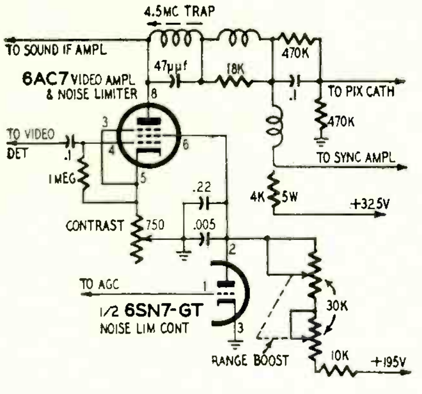


Fig. 3—Noise limiter and control circuit in Stewart-Warner 9210 chassis.

to the cathode of the noise amplifier (V1). The grid of V1 is biased highly negative by returning it to the junction of R2 and R3 which form the grid resistor of the horizontal output tube. The bias is sufficient to hold the noise amplifier cut off for normal video signals.

When a strong noise pulse arrives, the cathode is driven negative. This causes the noise amplifier to conduct and produce an amplified pulse on the grid of the sync separator. Simultaneously, the grid of the sync separator is fed with the composite video signal of positive polarity from the plate of the video amplifier. The circuit constants are such that the negative and positive pulses have equal amplitudes when they reach the sync separator and cancel each other just as in Fig. 1.

Since normal signals cannot drive the noise amplifier out of cutoff, they do not pass through. They reach the sync separator only through the plate circuit of the video amplifier.

The Stewart-Warner circuit

The noise-limiter and control circuit in the Stewart-Warner series 9210 TV chassis (Fig. 3) minimizes the effects of noise on the sync and picture by adjusting the video amplifier clipping to provide best performance.

The plate of the noise limiter (½ 6SN7-GT) is connected to the screen grid of the 6AC7 video amplifier. The RANGE BOOST control in series with the 10,000-ohm resistor form the video amplifier screen-dropping resistor. The voltage drop across this resistor combination is determined by the combined 6AC7 screen and 6SN7 plate currents.

The level at which clipping occurs in the video amplifier (6AC7) is determined by its screen-grid voltage. Low screen voltages cause early plate saturation and a low clipping level. The 6SN7 control tube is biased by the voltage appearing on the a.g.c. line. When the incoming signal is weak, the a.g.c. voltage is low and the 6SN7 plate current is high. This lowers the voltage on the 6AC7 screen and the 6SN7 plate. The RANGE BOOST control is adjusted so the video amplifier clips signals which exceed the height of the sync tips.

On strong signals, the a.g.c. line is more negative; the plate current decreases and the 6AC7 screen voltage increases just enough to prevent clipping the video signal of the sync tips.

Silvertone sync circuit

Although the Silvertone 132.044 chassis does not include actual noise suppression circuits like those just discussed, it is designed for good noise rejection. The composite video signal is taken off the video detector load resistor and fed to the grid of the sync stripper and amplifier (Fig. 4) through a double time-constant network C1-R1 and C2-R2. The plate voltage is held to a low value (about 35) by connecting it to voltage divider R3 and R4.

Grid current produced by the positive-going sync pulses causes C2 to charge and place a negative potential on the grid of V1. This negative bias voltage is sufficient to cut off V1 except for the sync pulses and the most positive (black) portions of the video signal. The low plate voltage compresses the sync pulse tips and any noise pulses in the video signal.

The signal from V1 is fed through a .047-μf coupling capacitor to the cathode of the grounded-grid amplifier (V2). This stage operates with its grid at ground potential and its cathode and plate 10 and 30 volts positive, respectively. The low plate voltage and high bias produce a desirable characteristic which squares off the tops of the sync pulses, clips noise pulses to the level of the sync tips, and compresses any remaining video information. The output of the grounded-grid sync separator is direct-coupled to the triode sync phase inverter which feeds the sync signals to the vertical and horizontal oscillators.

An adjustable noise eliminator

Fig. 5 shows the circuit used in the Emerson 120174B chassis. Composite video signals with negative sync are fed from the video detector to the grid of the sync amplifier. The amplified output of this stage appears across series load resistors R1 and R2. A portion of the output voltage is tapped off at the junction of R1 and R2 and is applied to the plate of the sync clamp tube V3, and the grid of noise inverter, V4.

High-amplitude sawtooth voltages are taken from the horizontal output transformer and applied to the grid of V3. Grid rectification develops a bias which holds the tube cut off between sync pulses on the plate. When a sync pulse is on the plate, V3 conducts and charges C1. Between sync pulses C1 discharges through R3 and develops a negative bias voltage which is equal to the peak voltage of the sync pulses. Thus, V4, the noise inverter, is held at cutoff by a bias which is equal to the sum of the positive voltage on its cathode and the negative voltage on its grid.

When noise pulses occur between sync pulses, they overcome the bias and drive V4 into conduction. The noise pulses are then amplified and appear with negative polarity across the 150,000-ohm plate-load resistor. The amplified and inverted noise pulses are applied to the grid of the sync separator V2 with the positive noise pulses from the sync amplifier.

Under normal operating conditions, grid-cathode rectification of the positive-going sync pulses produces a grid bias. This combines with the positive bias applied to the cathode through the variable FRINGE COMPENSATOR, to hold the tube at cutoff except for the positive peaks of the applied signal which exceed the blanking level. Since the noise pulses are negative, they cannot pass through the sync separator and upset the operation of the vertical and horizontal oscillators. END

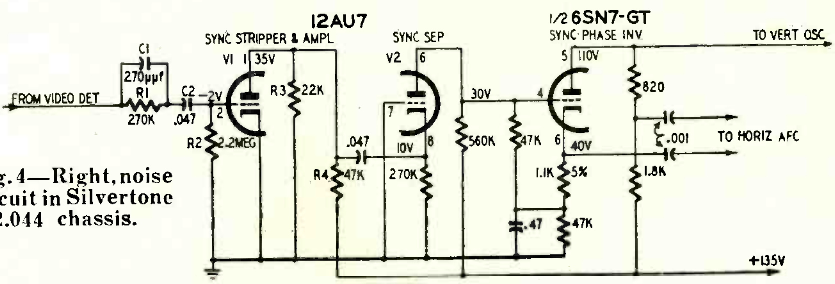


Fig. 4—Right, noise circuit in Silvertone 132.044 chassis.

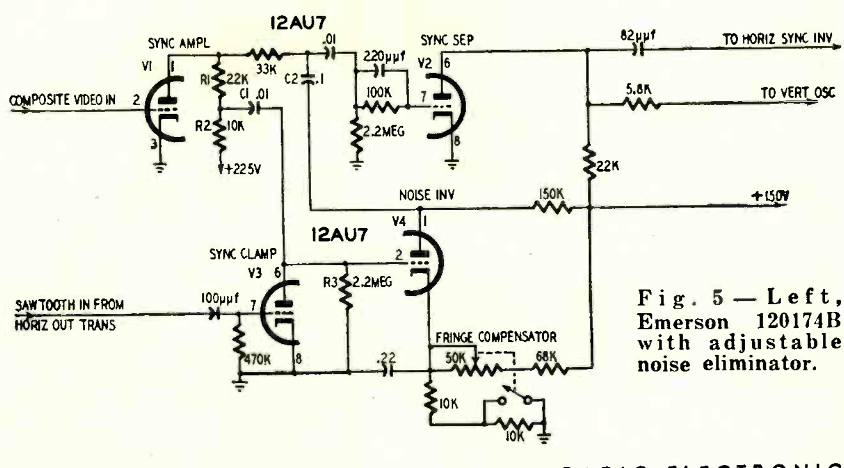


Fig. 5—Left, Emerson 120174B with adjustable noise eliminator.

BASIC COLOR TV

Part IV—First half, elimination of interference; a discussion on the important features in the NTSC system which reduces the visibility of the color sub-carrier beats

By D. NEWMAN* and J. J. ROCHE*

IN the last three articles we discussed techniques which make it possible to transmit and receive compatible color-television signals in a 6-mc channel. To do so, it is necessary to transmit the brightness and the two color-difference signals within the same channel. In addition, of course, the sound signal must also be transmitted.

With four separate pieces of information in the same channel it is logical to expect interference or cross-talk. In theory, we can almost completely eliminate such interference. In practice, the interference is not completely eliminated. However, the amount remaining is so very slight as to be unobjectionable.

Color signal—video carrier beat

In the color television system, the chrominance signal lies within 4 mc of the video carrier and produces an interfering beat at the output of the video detector in monochrome receivers. By properly selecting the color subcarrier frequency and suppressing the subcarrier, we can reduce the visibility of the beat so that it is not objectionable in monochrome (black-and-white) receivers.

As the frequency of the color subcarrier is increased, the separation between it and the video carrier becomes greater. As a result, the structure of the interference pattern becomes finer and less noticeable.

In addition, the video response of the average black-and-white receiver falls off at the upper end of the video passband. This means that as the frequency of the subcarrier is increased, the amplitude of the visible beat pattern will be reduced in monochrome receivers.

In color receivers, the response of the brightness channel is reduced just below the color subcarrier frequency, to minimize cross-talk. This sets the upper limit of the video passband and determines the maximum picture definition.

Thus we see that it is desirable to use as high a subcarrier frequency as possible for best operation of both monochrome and color television receivers.

We have learned that it is necessary to transmit two color-difference signals. One of these signals contains video frequencies up to approximately 1.5 mc, while the other contains video frequencies up to approximately 600 kc. This means that the sidebands of the chrominance signal will extend approximately 1.5 mc above and below the subcarrier frequency.

The sideband components of the chrominance signal which extend beyond 600 kc are a result of the wideband color difference signal, while those below 600 kc are due to *both* color-difference signals.

To transmit all the sideband components without attenuation, the color subcarrier would have to be approximately 1.5 mc below the upper end of the video passband. In other words, the highest color subcarrier frequency we could use would be 4.2 mc minus 1.5 mc, or 2.7 mc. (4.2 mc is the practical upper limit of the video channel.)

A certain amount of sideband attenuation is permissible without degrading color reproduction. This means we can move the color subcarrier frequency higher than 2.7 mc, attenuating the upper sideband of the chrominance signal. The subcarrier frequency can be moved up to approximately 3.6 mc without noticeable loss in color fidelity.

This leaves approximately 600 kc of the upper sideband of the chrominance signal remaining. Since the narrowband color-difference-signal upper sideband extends only about 600 kc above the subcarrier, it has not been disturbed. Only that portion of the wideband color-difference-signal upper sideband above 600 kc has been attenuated.

Dot interlace

If we were to set the color subcarrier at 3.6 mc, then slowly reduce its frequency while observing the interference pattern on a cathode-ray tube, we would pass through frequencies at which the visibility of the pattern would decrease to a minimum.

The frequencies at which the visibility of the interference pattern is minimum are odd multiples of half the horizontal scanning frequency, 15,750 c.p.s. One half of this is 7,875 c.p.s. If we multiply 7,875 c.p.s. by any odd number and use the resulting frequency as the color subcarrier, we will be operating at one of the frequencies at which the visibility of the pattern was observed to be minimum.

Recalling the previous discussion on the desirability of using the highest

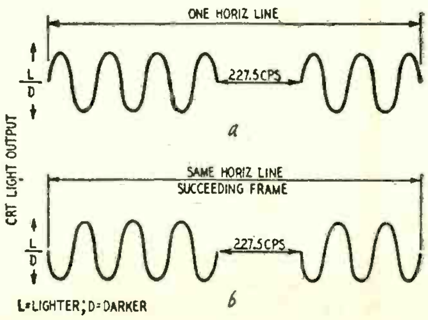


Fig. 1—Variations in light intensity.

*Allen B. DuMont Laboratories, Inc.

possible subcarrier frequency, a frequency as close as possible to 3.6 mc is selected. One convenient frequency close to 3.6 mc which results in minimum visibility of the beat pattern is the 455th multiple of 7,875 c.p.s., or 3,583,125 c.p.s. (This frequency also corres-

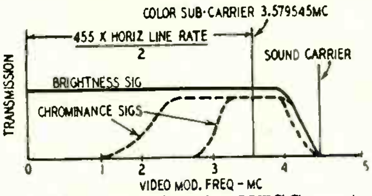


Fig. 2—Frequencies in NTSC system.

ponds to 277.5 × 15,750 c.p.s.).

The reason why minimum visibility of the beat pattern occurs at odd multiples of half the line frequency is illustrated in Fig. 1.

Fig. 1-a represents a period of time equal to the duration of one horizontal line. During this time there are 227.5 cycles of the beat between the video and the color subcarrier signals. This means that 455 variations in light intensity take place on each horizontal line, since each cycle represents two changes in light intensity. These would appear as tiny light-and-dark dots.

When this same line is scanned 1/30 of a second later, 227.5 cycles of the subcarrier frequency again occur. However, as shown in Fig. 1-b, the subcarrier frequency has now been shifted 180°, reversing the polarity. This means that the space originally occupied by the light dots will now be occupied by the dark dots, and vice versa.

Due to the viewer's persistence of vision, a blending or average process takes place in the eye, and as a result the visibility of the dot structure is minimized.

In addition, the *odd number* of dots per line causes the tiny light-and-dark dots to be displaced by one dot on successive lines. Since the scanning lines blend together at normal viewing distances, an additional cancellation effect occurs.

In practice, perfect cancellation does not occur; this is due to nonlinearities in the human eye as well as in the television transmitting and receiving equipment.

It is interesting to note that this type of canceling dot interlace is equivalent to frequency interlace, which was discussed in an earlier article. (Frequency interlace describes the condition in which the sidebands of the brightness and chrominance signals are interlaced in frequency with one another.) Thus, both terms describe the same condition.

Color—sound-carrier beat

With the color subcarrier tentatively located at 3.583125 mc, another beat possibility exists. This beat is produced between the chrominance signal and the sound carrier frequency (at 4.5 mc), and has a frequency of approximately 917 kc.

Being relatively low in frequency, the beat would be highly objectionable if permitted to appear. To minimize it, the sound carrier and the color subcarrier are frequency-interlaced, taking advantage of the cancellation effects previously described.

Frequency interlace between the color subcarrier and the video carrier, as well as the subcarrier and the sound carrier, is achieved by slight readjustment of the subcarrier frequency and the horizontal and vertical scanning rates.

The frequencies used in the NTSC system are 3.579545 mc for the color subcarrier, 15,734.264 c.p.s. for the horizontal line rate, and 59.94 c.p.s. for the vertical field rate. (Since the horizontal scanning rate must be 525 times the vertical frame rate, the vertical field rate changes from 60 to 59.94 c.p.s.)

This change in horizontal and vertical scanning rate amounts to only 0.1%. Since existing black-and-white receivers will tolerate changes in scanning rates of up to 1%, their operation is not affected.

Fig. 2 shows the actual frequencies used in the NTSC system. It is interesting to note that perfect frequency interlace between the color subcarrier and the sound carrier occurs only when the sound carrier is unmodulated. Since FM is used, the sound carrier varies above and below its resting frequency when modulated.

As a result, some of the benefit of frequency interlace between the subcarrier and the sound carrier is lost.

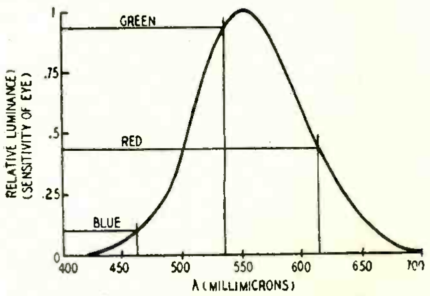


Fig. 3—Relative sensitivity of the eye to light of different colors.

Nevertheless, a worthwhile reduction in the visibility of the beat pattern is achieved.

Subcarrier suppression

Another important feature of the NTSC system which reduces the visibility of the color subcarrier beats is the use of subcarrier frequency suppression.

You will recall that in the preceding article we discussed the use of balanced modulators in the transmitter to greatly suppress the color subcarrier frequency.

As mentioned, carrier suppression results in transmitting only the sidebands of the chrominance signal. One important advantage of this is that the chrominance signal disappears when no color information is being transmitted. This means that the chrominance signal is not present when the color camera is scanning achromatic (white, gray, or black) objects. In addition, when scanning objects of low color saturation, the amplitude of the chrominance signal is low.

Low-color, or no-color conditions occur often in the average televised scene. Therefore subcarrier suppression results in a substantial reduction in the visible beats.

If ordinary modulation methods were used, the color subcarrier, and hence the interfering beats, would always be present. At least 67% of the energy available for the subcarrier video information remains in a subcarrier which uses conventional modulation. This portion of the subcarrier energy is eliminated by carrier suppression, and naturally helps to reduce beat visibility.

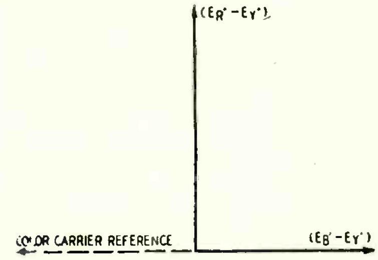


Fig. 4—Modulating the subcarriers.

It was pointed out previously that good color reproduction can be obtained by transmitting two color-difference signals. One signal contains frequency components up to approximately 1.5 mc, while the other signal consists of components up to approximately 600 kc. The third color component (green) does not have to be transmitted separately, since it can be derived at the receiver by adding the two color signals and subtracting their sum from the brightness signal.

Color-difference signals

As stated, the red and blue color components are transmitted in the form of color-difference signals, since complete information regarding the brightness of the televised scene is transmitted via the luminance signal.

The red color-difference signal is formed by taking the voltage output of the red camera tube and subtracting from it the voltage amplitude of the brightness signal. The brightness (Y) signal is formed by adding certain fixed percentages of the voltage outputs of the red, green, and blue cameras as follows:

$E_Y' = .59\ E_G' + .30\ E_R' + .11\ E_B'$

These particular percentages, of each color signal, were chosen to provide excellent tonal rendition in black-and-white receivers, when receiving color transmissions. The percentages correspond to the relative brightness sensations produced by fully saturated red, green, and blue objects of equal light energy.

For example, suppose we were to view a white screen which was illuminated by a red, a green, and a blue light, each of which radiated an equal amount of light energy. If we turned off the blue light, we might expect to see a 1/3 decrease in brightness. However, such is not the case.

Instead, we would observe a reduction in brightness of only about 10%. If instead we turned off the green light, we would observe a reduction in brghtness of approximately 60%.

This phenomenon is due to the eye not responding with equal sensitivity to light of different colors, as shown in Fig. 3.

Let us find how the color-difference signals are obtained. Assume that our color camera is scanning a saturated red object. In this case the voltage outputs of the three color cameras would be:

$E_R' = 1$
$E_G' = 0$
$E_B' = 0$

where E_R', E_G', and E_B' are the gamma-corrected red, green, and blue camera outputs respectively. Therefore, the brightness signal, E_Y', is, in volts:

$E_Y' = .59\ E_G' + .30\ E_R' + .11\ E_B'$
$E_Y' = .59\ (0) + .30\ (1) + .11\ (0)$
$E_Y' = .30$

And:

$E_R' - E_Y' = 1 - .30 = .7$
$E_G' - E_Y' = 0 - .30 = -.3$
$E_B' - E_Y' = 0 - .30 = -.3$

where $E_R' - E_Y'$, $E_G' - E_Y'$, and $E_B' - E_Y'$ are the red, green, and blue color-difference signals respectively.

In other words, by adding the stated proportions of the red, green, and blue camera outputs to form the brightness signal (E_Y'), and subtracting E_Y' from the individual voltage outputs of the red, green, and blue cameras, the three color-difference signals are obtained.

At the receiver, we can recover the original color cameras output voltages, E_R', E_G', and E_B', by simply adding E_Y' (which is transmitted separately) to each color-difference signal.

For example, using the voltages previously mentioned:

$E_R' = E_Y' + (E_R' - E_Y')$
$= .3 + .7$
$= 1$
$E_G' = E_Y' + (E_G' - E_Y')$
$= .3 + (-.3)$
$= 0$
$E_B' = E_Y' + (E_B' - E_Y')$
$= .3 + (-.3)$
$= 0$

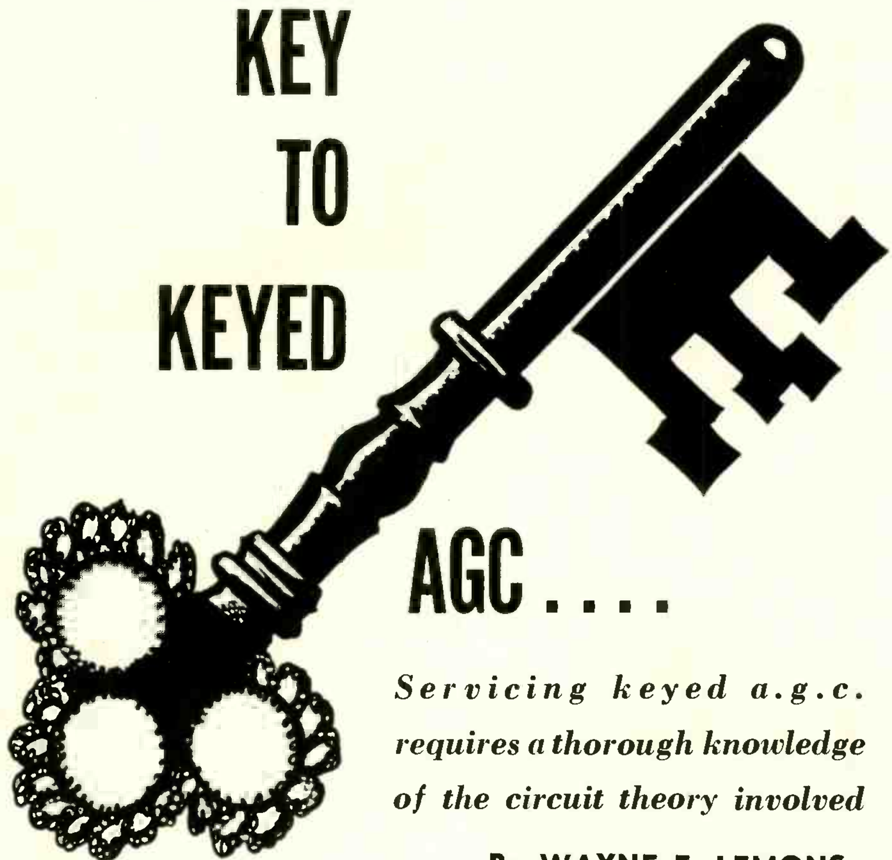
You may wonder why color-difference signals are used instead of the color signals themselves. The reason is that for a given change in color the amplitude of the corresponding color-difference signal changes less than that of the color signal from which it is derived. This reduces the amplitude variations of the chrominance signal, and consequently the amount of information which must be transmitted. It also amounts to a substantial reduction in the average amplitude of the chrominance signal.

The color-difference signals can be transmitted by modulating two subcarriers 90° out-of-phase with each other, to produce chrominance signal components, as shown in Fig. 4.

The next and concluding installment will discuss color reproduction above 600 kc, the I and Q signals, and will summarize this series of articles.

(TO BE CONTINUED)

KEY TO KEYED AGC....



Servicing keyed a.g.c. requires a thorough knowledge of the circuit theory involved

By WAYNE E. LEMONS

TROUBLE-SHOOTING a.g.c. circuits is perhaps the hardest job in a TV set. This is especially true of keyed or gated a.g.c. Trouble in the a.g.c. circuit is reflected to many other stages of the receiver. It causes overloading in the r.f. and i.f stages and compresses the sync pulses. Sync compression upsets a.g.c., aggravating the trouble, and so goes the vicious cycle.

A v.t.v.m. on the a.g.c. line quickly determines whether or not any a.g.c. voltage is present. If there is none, or if it is low or high, the v.t.v.m., scope, and other instruments are almost helpless in quick diagnosis, especially in weak-signal areas, unless other measures precede.

To accurately trouble-shoot a keyed a.g.c. circuit, we must know what the circuit does, or is required to do.

How keyed a.g.c. works

In Fig. 1 we have a simplified keyed a.g.c. circuit. The positive-going sync pulse from the plate of the video amplifier is very important to the proper operation of the circuit. The keying tube is biased to approximate cutoff by the current through the plate-load resistors of the video amplifier. Current flow down through the resistors causes the potential to be more negative at the plate side than at B plus. Now notice that this voltage is placed directly between the cathode and grid of the keying tube, usually a 6AU6. The tube will remain cut off indefinitely unless something comes along to upset the grid–cathode voltage. This "something" is our positive-going sync pulse.

If the keying tube has plate and screen voltage it will conduct by an amount proportional to the voltage of the pulse. Thus on a strong pulse, as would be developed by a strong signal, the keying tube will conduct more than on a weak pulse. This takes care of the input end of the keyer tube. It's as simple as that.

There is still another limitation to keyer-tube conduction. Looking at Fig. 1 again, we find that the plate of the keyer tube normally reads a few volts negative. Certainly this tube cannot conduct, regardless of the size of the grid pulse, until we have positive voltage on the plate.

We now begin to uncover the complications. The plate of the keyer tube also receives a pulse, but instead of from a variable source as is the sync pulse, it is derived from a steady source. This may be from an extra winding on the horizontal output transformer as in Fig. 1 or taken through a small capacitor from one side of the width coil. Regardless of how the voltage is tapped off, it usually is from 350 volts to 550 volts peak to peak depending upon the set and its design. This pulse to the plate of the keying tube arrives at a

15,750 c.p.s. rate. This means the keyer can conduct only while one of the 15,750-cycle voltage peaks is applied to the plate.

Timing is important and we see why as we go further. The sync pulse at the grid and the pulse at the plate arrive at the same time normally and the keyer tube will conduct proportionately to the amplitude of the sync pulses applied to the grid. The only d.c. return path for the plate of the keyer is through resistors R1, R2, and R3. As the keyer-tube plate current flow is through these resistors to ground, a negative voltage will be developed in proportion to the amount of tube conduction (plate current). This is the a.g.c. voltage.

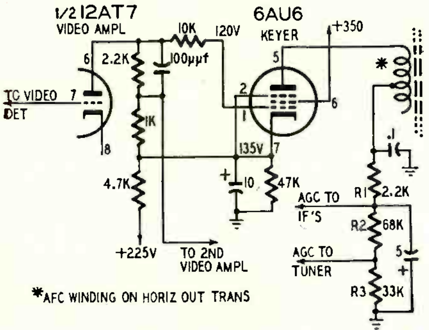


Fig. 1—Simplified keyed a.g.c. circuit.

We see then that any noise pulse arriving at a time different to that of the horizontal sync pulse cannot affect the over-all gain of the receiver.

Another interesting feature of this a.g.c. circuit is the seemingly high screen voltage, about 350 volts (in some sets it is not so large). Actually this is for two reasons. First, because the cathode of the keyer tube is approximately 135 volts positive, the relative screen voltage is only 215. This is still fairly high by most standards. This high screen voltage means that the keyer tube will not conduct until the plate pulse rises to well over 200 volts (remember the cathode is 135 volts positive). This has the effect of shortening the conduction time of the tube because the pulse must rise to a fairly high value before it can overcome the effect of the screen and cathode voltage. This prevents noise pulses that are very close to the sync pulse from keying the circuit.

Trouble-shooting

The first step in servicing keyed a.g.c. circuits is to replace the keyer tube and make a preliminary check of socket voltages. Usually the heater is at or very near the same d.c. cathode potential. In some sets the heater is at ground potential. In the event of excessive a.g.c. voltage in these circuits, always check for heater-to-cathode leakage. Sometimes it is necessary to try several tubes to find one with sufficiently limited leakage. Often new tubes have slight heater–cathode leakage that could very easily cause improper a.g.c. action.

Checking the circuit, it becomes immediately evident that the keyer can be made to conduct by a very simple method, provided the plate pulse is present and other voltages are correct, by merely shorting the grid to cathode. A v.t.v.m. on the a.g.c. line will read a large negative voltage in a properly operating circuit. This reduces our trouble-shooting job considerably.

A negative voltage on the a.g.c. line indicates:
(1) the keyer tube is working,
(2) the pulse is present at the plate, and
(3) the a.g.c. load resistors and capacitors are O.K.

If the voltage is more than minus 30 to 35 volts there is reason to suspect an open a.g.c. load resistor. In this case the only d.c. return path is through the input resistance of the v.t.v.m. and the negative voltage reading will remain for several seconds or even a minute or more after the grid-cathode jumper is removed.

If no negative voltage is present with keyer-tube grid shorted to cathode, then we can surmise that the tube is not conducting for one of the following reasons:

1. No pulse at the plate.
2. Below normal plate keying pulse.
3. Defective keyer tube.
4. Low or no screen voltage.
5. No heater voltage on keyer tube.
6. Poor socket connections.
7. Shorted a.g.c. capacitor.

The peak-to-peak voltage at the keyer plate may be measured with a peak-reading or peak-to-peak reading v.t.v.m. or a 20,000-ohms-per-volt meter. *Remember that a peak-reading-meter reads only one-half of the peak-to-peak voltage*, so it must be doubled to get the correct reading. The peak-to-peak voltage should be from 350 to 550 volts for most sets and in every case should be 50 to 100 volts or more higher than the d.c. screen voltage of the keyer tube.

If this pulse voltage is too low and is taken from a separate winding on the horizontal output transformer, we can be reasonably sure that the winding is defective if no raster defects such as low brightness, loss of linearity, narrowing or other troubles commonly associated with horizontal and damper circuits, are noted.

To determine if the winding is defective, connect a 100,000-ohm resistor from plate of keyer tube to ground, and attach a .001-μf, 600-volt capacitor between the keyer plate and the hot side of width coil or other point in horizontal circuit supplying a 450- to 600-volt peak-to-peak pulse. Place jumper from grid to cathode of keyer as before and check for negative voltage at keyer plate. If this restores the set to normal operation we can reasonably assume the winding is defective.

Poor socket connections can be elusive and may cause a.g.c. troubles that defy trouble-shooting. Always move the keyer tube from side to side while checking for a fluctuation of voltage on the a.g.c. bus.

A shorted a.g.c. capacitor will of course prevent the a.g.c. voltage from reaching the rest of the circuits. An ohmmeter usually will determine this type of trouble.

A leaky coupling capacitor from the flyback transformer to the keyer plate will cause a positive a.g.c. voltage and the keyer tube may be damaged by excessive current flow.

If a normal reaction is received when the keyer tube has a grid–cathode jumper, then we can assume that the trouble precedes or is in the input circuit of the keyer tube. The first check is the bias voltage. There should be from 12 to 20 volts from grid to cathode with the grid the most negative. Excessive bias voltage prevents tube conduction except perhaps on very strong signals. This may be caused by opening or increase in value of the video plate-load resistors. The video amplifier tube may be defective or incorrectly biased.

For further checks, we must restore the set to normal operation. We can do so by using a low-voltage battery connected across a 2,000-ohm potentiometer to supply a normal bias voltage to the a.g.c. line. A schematic is shown in Fig. 2. Connect the positive side to ground and the center tap of the control to the a.g.c. line. Vary the voltage until the set is restored to normal operation. Now we can check the pulses with a scope and determine where compression occurs.

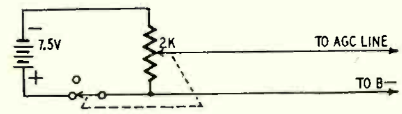


Fig. 2—Battery supplies a.v.c. bias.

A really tricky trouble is when we have slight leakage in an i.f. coupling capacitor. This may cause the a.g.c. line to be positive, thus affecting proper operation of the a.g.c. circuits. To trouble-shoot, attach the battery box to the a.g.c. bus and measure the voltage at each grid on the a.g.c. line. The grid that reads very near zero voltage has the offending capacitor tied to it. Remember that grid-to-cathode leakage in the r.f. or i.f. amplifier tubes may also cause this trouble.

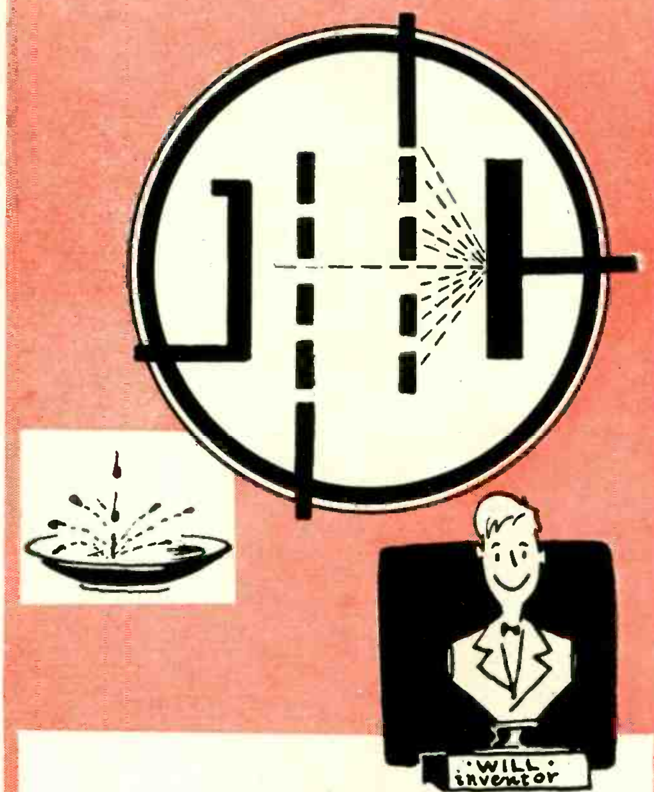
Servicing keyed a.g.c. circuits requires a workable knowledge of the theory involved, but it doesn't mean you have to have a bench full of expensive equipment. A screwdriver may be used very successfully for shorting the grid to cathode. A jumper wire with a couple of alligator clips is more convenient, however.

A little headwork and a little patience should make you very adept at trouble-shooting keyed a.g.c. circuits. But don't fall into a trap such as I once did. After repairing an a.g.c. winding on a horizontal output transformer, I still had the same trouble when the unit was slipped back in its shield can. I knew that I had repaired the defect—and yet I hadn't. I was several hours finding that I had failed to resolder a wire in the a.g.c. line that I had removed in a previous check. I had created the same trouble I had just repaired and had failed to recheck the circuits I had already found perfect. END

TELEVISION . . .
it's a cinch

By E. AISBERG

Ninth conversation, second half: The iconoscope—it's not so simple; image orthicon; electron multipliers



KEN—To tell the truth, it's really very complicated. Such little things as secondary emission mess up that simplicity you think you see.

WILL—Secondary emission! You mean like in a tetrode, where an electron hits the plate at high speed, and knocks off a number of others, which go back to the screen grid?

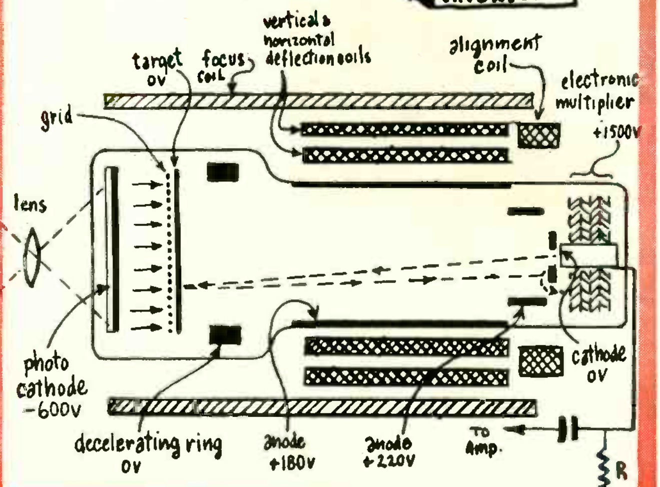
KEN—One of your good points is that if you ever learn something, you remember it! The iconoscope mosaic is bombarded with just such high-speed electrons, and they do knock off secondary electrons. Some of them get to the anode, but others just rain back on the mosaic, and make it slightly negative. So you can see that the action isn't quite as simple as you think.

WILL—You told me once that if you can make virtues out of the faults of people and things, you can really get somewhere. This secondary emission looks interesting. If one electron can set several into motion, why can't we use the effect to give us some amplification?

KEN—You were just born fifty years too late, Will! Your ideas would have made you the world's greatest inventor a half century ago!

WILL—And even today they're not so bad, either! I understand that this secondary emission *is* actually used for amplification.

KEN—Yes, and has been for some time, in a tube even more important to us than the iconoscope. It's the *image orthicon*, which is so much more sensitive than the iconoscope that it's the most widely used TV camera tube today. Here's a cross-section.



A tube that looks simple . . .

WILL—Well, it doesn't look quite as funny as the iconoscope. But what is this *photocathode* just ahead of what I take to be the mosaic?

KEN—It's one of the things that makes the tube more

sensitive. It's a thin translucent sheet with a sensitized inside surface. The light coming from the outside releases electrons from the inside surface.

WILL—Sort of mosaic in reverse, eh?

KEN—But it's not a mosaic. *All* the surface is conductive, with no waste space. So it's more sensitive than a mosaic. The electrons which leave it go to the *target*, which may be as much as 600 volts more positive than the photocathode, although at the same voltage as the regular cathode in the electron gun. The target is a very, very thin plate of glass.

WILL—About how thin is very, very?

KEN—In this case, it means you would have to stack up about 5,000 of them to get a pile an inch high.

WILL—And why would anyone want to go to the trouble of making glass that thin?

KEN—And real trouble it is, especially when you consider that this plate of glass has to stand up under the baking-out temperatures when the tube is evacuated! But it has to be done so that the charges which form on its opposite faces can leak through the glass in the time between successive scans—that is, in 1/30 second.

. . . but whose action is complex

WILL—What charges?

KEN—Hold the questions for a few minutes, Will, and you'll get your answers quicker. Those electrons emitted from the photocathode where the light strikes it form an electronic image of the televised scene. As I just told you, they are attracted by the more positive target. They are kept in straight lines by the focusing coil, so the electron image is transferred to the target intact. Each electron striking the target produces a number of secondary electrons, which are captured by a fine-mesh grid placed very close to the target and kept 1 volt more positive than it.

WILL—So we again have positive charges on the face of the target, and they are exactly proportional to the light that falls on each corresponding spot on the photocathode. Now what?

KEN—These charges move through the glass. That's why it has to be so thin, and of the right resistivity. If the charge can't all leak through the glass in 1/30 of a second, some of it may hang over to the next scan, and if it can travel too fast, it may spread out on the surface so that adjacent picture elements won't be sharply defined.

WILL—Quite a critical proposition! But once the charges get through the glass in good order, they are scanned just as in the iconoscope?

KEN—Not just as in the ionoscope. For one thing, this tube works with *slow electrons*. For another, the electron stream itself carries the signal to the amplifier. Notice the low voltages on the *accelerating* electrodes—only 220 on the first and 180 on the second anode (which is our metallized layer on the inside of the glass tube). Then just before the electron beam reaches the target there is a *decelerating ring* at zero volts. At the same time the electrons feel the pull of the 180-volt electrode behind them. The net result is that they are going to stop sooner or later, turn around, and go back down the tube again.

WILL—But they do scan the target first?

KEN—They do. The voltages are so adjusted that the beam just reaches the target—makes it a turnaround point. If there were no positive charges on the target, all the electrons in the beam would go back. But wherever the beam sweeps past a positive charge on the target, it loses just enough electrons to neutralize the charge. *So the returning beam varies with the amount and distribution of charge on the target.* You might say that every little bit of returning beam carries a message telling the amount of illumination on a given spot on the target. Or, you can say that the returning beam current varies much as did the current through resistor R in the iconoscope diagram.

WILL—Now the only thing to do is to get the video-frequency signals into an amplifier, I suppose.

KEN—We're going to do quite a bit of amplifying before we even leave the tube. Here's where we use your secondary emission for the second time. As our electrons start back, they are kept going in a reasonably straight line by the same focusing coil that kept them together on the way out. But now the voltages on the accelerators are increasing, and by the time they get back to the area of the cathode they are traveling at a pretty fair clip. Then they strike the first *dynode* of the *electron multiplier* . . .

WILL—Hey! What's that?

A day at the races

KEN—Just another of those things you could have invented yourself, if someone hadn't done it before you were born.

WILL—That's the way it always is with me! But before you start on something new, let's get straight on what we've gone over already. Light falls on a *photocathode* and produces an *electronic image*, which is transported to a *target*, where it produces *positive charges* by releasing *secondary electrons*. These charges are neutralized by being swept by an electron beam which leaves behind enough electrons to neutralize the charges. Because it has lost electrons in proportion to the size of the charges, it is *modulated* by them. The modulated beam now moves toward the *electron multiplier*. Is that right?

KEN—Spoken like an engineering instructor, Will! Now, about that electron multiplier . . . Have you ever played the horses, Will?

WILL—Hardly! If you can figure enough to use Ohm's law, you know better than to try to beat the odds at the races. But what has that to do with electrons?

KEN—You'd be surprised at the number of good mathematical minds who spend their time and money at the tracks. But I think I can give you an example without leading you astray. Suppose you go to the races with $10 to bet. You put it all on a horse in the first race. He wins, and brings you in $50. Let's suppose you're not wise enough to pocket your winnings, but put it all on another horse, and he wins, also at five to one. Now you have $250, and if you have the spirit of a true gambler, nothing in the world could keep you from trying to lose it all in the next race, and—since it's necessary for our example—suppose your horse comes in first, giving you a cool $1,250. And so it is also with the fourth and fifth races. You leave the course with $31,250 in your pocket.

WILL—I wouldn't leave. I'd phone for an armored car and wait right there for it! But I don't understand why you're wasting all this time. Don't you think I understand a straight geometric progression?

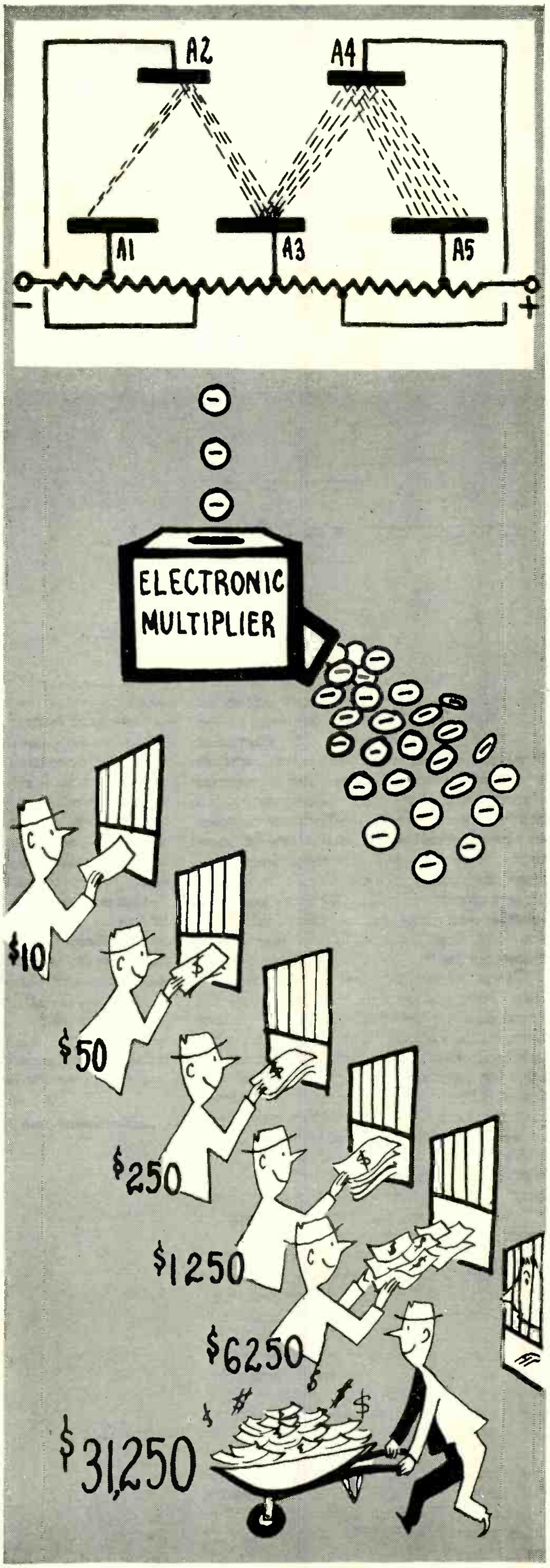
KEN—Don't get excited! I've been describing an electron multiplier. It is composed of a number of targets, or dynodes, each one operating at a higher voltage. When our modulated stream of electrons gets back to the first of these dynodes (shaped like a disc with a hole in the center to let the electron beam from the gun through), it knocks several electrons loose. The only thing around that isn't at a lower voltage than the first dynode is the second dynode, so most of the electrons are attracted to it, and are also speeded up by its higher voltage. So if your original electron caused 5 electrons to reach the second dynode, they might jar loose enough to send 25 to the third one. Actually you do get gains of 200 to 500 in the 5-stage multiplier of an image orthicon. It has 1,500 volts on the last stage. The intermediate stages are connected to taps on a voltage divider incorporated in the tube.

WILL—Now I can see why—with sensitivity like that—they don't need so much lighting in modern studios. Why, the image orthicon ought to work with ordinary room light!

KEN—It will. I've seen part of a demonstration program televised with the light from a kitchen match! But with a little better lighting, the camera men can stop down their lenses and increase the definition and the depth of focus. So they get a clearer picture without losing any brightness.

WILL—Well, you've said that the image orthicon is the most widely used tube today, so you can't finish up our conversation in the usual way, by saying that all the things we've been talking about are long abandoned.

(TO BE CONTINUED)



V.H.F. COMES TO A U.H.F. AREA

Antenna and tuner problems in a u.h.f. area that took on v.h.f.

By CHARLES F. MAHLER, JR.

WHAT happens when a u.h.f. area gets its first v.h.f. channel? This question was asked by everyone in Portland, Oregon, when our first v.h.f. station went into action. There was a popular opinion that the u.h.f. antennas would have to be changed to all-channel types, or else special installations would have to be made for each channel. Some said that the u.h.f. Yagis would act as a direct short on v.h.f. Others said the bowtie antennas would work all right on v.h.f. and u.h.f. No one seemed to have the facts.

Up to now, the new u.h.f. channels have been going to areas where no TV existed or where v.h.f. channels have been on the air for some time. The only problem was the job of converting old sets or adding u.h.f. "strips" to the tuner. Often the v.h.f. antennas worked satisfactorily. U.h.f. antennas were added only when necessary.

We found over 50% of the antenna installations made in or around Portland were straight u.h.f. type. Channel 27 came on the air last year with a transmitter that had been used by RCA on an experimental basis in Connecticut. From this transmitter were patterned most of the u.h.f. units later designed. The power radiated from this transmitter was so low that some points less than a mile away were considered impossible areas for clear reception. This condition made it extremely difficult to get snow-free pictures on most of the sets. Special u.h.f. antennas had to be installed to try to compensate for the low power output of the station and the poor sensitivity of the receivers. All-channel antennas were installed when possible. Built-in antennas were rarely used.

Channel 6, our first v.h.f. station, was eagerly awaited. It promised more power and better coverage. TV dealers anticipated a boom in business. But the burning question was: "What will be necessary to pick up channel 6?"

It looked like we were going to be the guinea pig again. It was rumored that all sets using a dual-conversion system would require retuning. Dual-conversion is the method some manufacturers used to convert u.h.f. to v.h.f. Either a u.h.f. unit was put in the set at the factory or the dealer or distributor had to install it. Some units were external and others were cut into the front or side of the cabinets. The units turned on and off with the set. Some were given the name "continuous-tuner", but usually a manual operation was required to switch from one tuner to the other. Most of the units were designed for channel 5 or 6.

It was feared that channel 6 would come in so strong that it would feed through to the v.h.f. tuner in the set when operating on u.h.f. There was also the feeling that channel 6 would slop over into channel 5. Actually, no slop-over of any great degree has been noticed. Of course it was necessary to retune the converters set for channel 6 to channel 5. Radiation on channel 6 from a converter-booster was noticed up to 100 feet from the unit. The unit had to be retuned to either channel 5 or 4.

All the u.h.f. antennas are picking up channel 6 with amazing results. Good, clean, ghost-free and snow-free pictures are the rule rather than the exception. The folded-dipole Yagis are

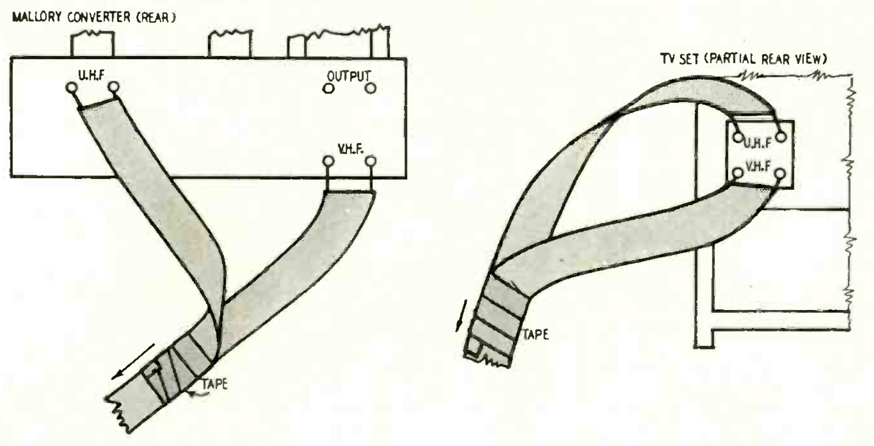


Fig. 1—When a outside u.h.f. antenna is used in a situation that calls for a u.h.f. and v.h.f. input, a capacitance coupling arrangement could be used. A short length of 300-ohm flat lead is connected to the v.h.f. input. The other end is taped parallel to the u.h.f. lead-in as shown above.

performing very well on v.h.f., but the Yagis with a straight dipole are not doing as well.

The bowtie and corner reflector type antennas used in difficult locations are delivering a satisfactory picture on v.h.f. In fact, when too strong a signal is encountered on v.h.f. and a weak signal on u.h.f., they have been found to be excellent. But usually it has been found that an installation change was necessary. This change consists of mounting a good v.h.f. antenna below the u.h.f., on the mast. Care had to be taken when this was done. We didn't want to lose any of the u.h.f. reception that the customer had paid good money for. We did not find it profitable to try to put an all-channel antenna in place of the corner reflector or bowtie antennas. These antennas were generally used because of a severe ghost problem on u.h.f., and to remove these antennas in favor of all-channel type was found to be a waste of time. The method used to couple these antennas together will be dealt with later in the article.

Collinear type u.h.f. antennas are performing equally as well as the folded-dipole type Yagis. However, there has been some indication that antennas with all-metal construction are doing better than the same type with the insulated elements. This might lead us to believe that the more metal you have in the air the better chance your u.h.f. antenna has of delivering a good v.h.f. picture.

Many installations of the all-wave type antenna gave good reception on u.h.f. but have been picking up ghosts on v.h.f. Special v.h.f. Yagis had to be installed to overcome this condition. The most widely used all-channel antennas have been the V type and rhombic. The V type antenna seems to increase in gain with frequency. The higher the frequency the more wavelengths each leg of the V resonates to. However, this type antenna on v.h.f. is as broad as a barn. Some of them are bidirectional. But on u.h.f. the angle of direction is very critical. Where no ghost or reflection problem is evident, they are very satisfactory.

The sensitivity of today's receivers has had a lot to do with the success we have had with u.h.f. antennas on v.h.f. The new continuous tuners being offered this year on most of the chassis has boosted the sensitivity of some sets on u.h.f. to the same level as on v.h.f. There is no amplification at u.h.f. The idea is to get the u.h.f. signal converted down without any loss. Most of the new sets this year using continuous tuners convert the u.h.f. signal directly down to the i.f. A good continuous tuner will outperform a strip type tuner in a rough area.

Many sets have two antenna inputs—one for v.h.f. and the other for u.h.f. When only one external antenna is used, a method must be devised to couple these inputs together so they both can use the outside antenna. In some cases it was found that by connecting the built-in antenna in the set to the v.h.f. terminals, a satisfactory picture was obtained, leaving the u.h.f. input for the outside antenna. In most primary areas this was all that was necessary. But when snow or ghosts were encountered with the built-in antenna on v.h.f., it was necessary to connect both inputs of the set to the outside antenna.

A very effective way to do this is to capacitance-couple the two (Fig. 1). Leaving the u.h.f. antenna alone, we cut a piece of 300-ohm flat lead about two or three feet long. The exact length is not important. Connect one end to the v.h.f. terminals of the receiver, leaving the other end open. Tape about six inches along the lead-in coming from the outside antenna. This short piece of lead-in taped parallel along the outside antenna lead-in picked up enough signal from the outside antenna to deliver a snow-free picture on v.h.f.

If it is found that this capacitance coupling attenuates the u.h.f. signal, move the short piece back and forth on the antenna lead-in until a spot is found which does not attenuate. This has the same effect as sliding a piece of tinfoil along the line. When the correct spot is found, tape the short piece of lead-in along the antenna line, as much as it takes to deliver a snow-free picture—presuming, of course, the outside antenna is picking up a good v.h.f. signal.

When it is necessary to connect two or more outside antennas to a set which has only one input it will usually be necessary to use a matching device to couple the multiple lead-ins into one lead. Some types of matching transformers should be avoided if much wet weather is encountered; they will split open at the seams during a hot spell and water will seep in during the first rain—water is murder in u.h.f. Mount the transformer under the roof eaves or attach onto the back of the set. (Fig 2.) There is a slight loss at u.h.f. through these devices on all the brands tested. However, it will not be noticeable in good signl areas. The new antennas with a matching transformer mounted on the antenna with a broad-band u.h.f. and broad-band v.h.f. antenna such as a conical and fan coupled together, have worked well. However, there is a condition on one make of conical and fan combination where the lobe on the u.h.f. fan is not in the same direction as the lobe on the v.h.f. conical behind it. This can become a problem when both signals are coming from the same point of origin. (Fig 3.) Another manufacturer has a Yagi mounted in front of a broad-band dipole combination with printed circuits providing proper match. The printed circuit connecting the two antennas is not reliable in wet weather. The manufacturer has sent us improved replacement circuits, but we still have not been able to use this antenna with any degree of success.

I think we should not underestimate the brute-force power of v.h.f. as compared to u.h.f. That these u.h.f. antennas are working well on v.h.f. indicates there are open fields ahead in the design of efficient all-channel antennas.

END

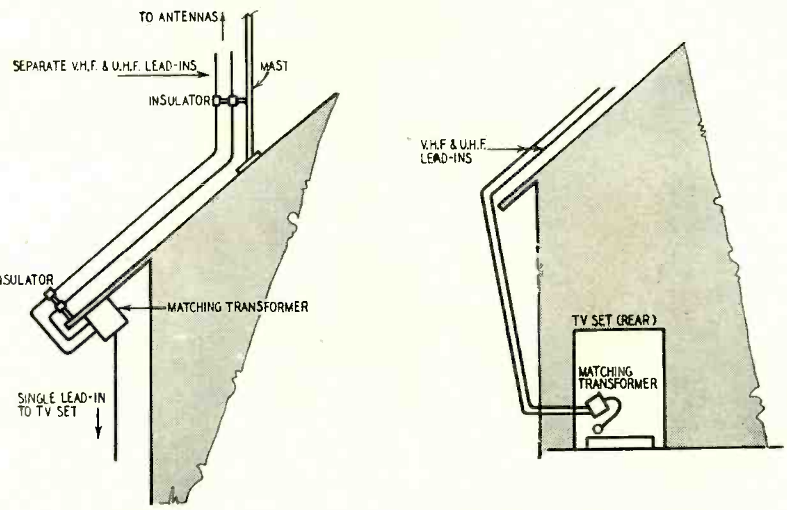


Fig. 2—Diagrams show location of matching transformer to protect it from rain.

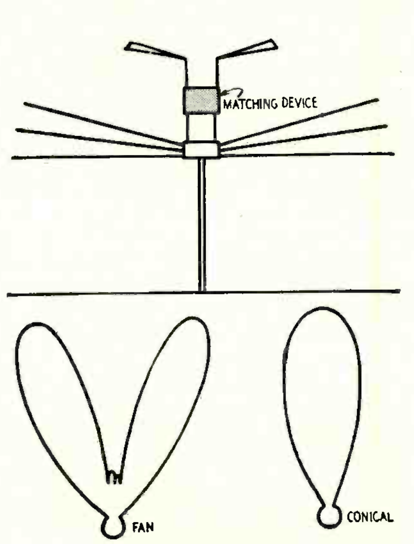
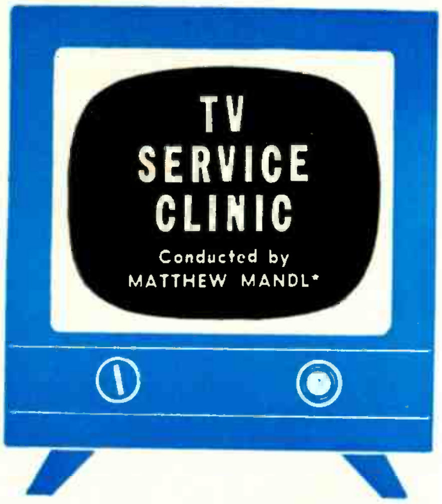


Fig. 3—A conical and fan combination where the direction of the lobes differ.



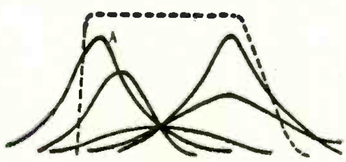


Fig. 1—Stagger-tuned characteristic.

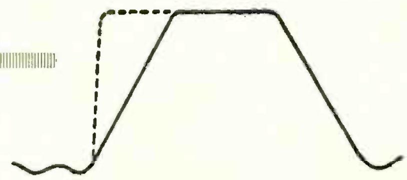


Fig. 3—"A" circuit reduces bandpass.

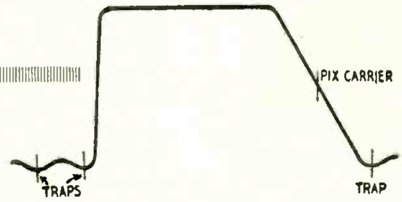


Fig. 2—Overall bandpass for Fig. 1.

JOSEPH HESS of Philadelphia wrote us about an item which is often a stumbling block in video i.f. alignment. He emphasizes that technicians not only should check all tubes before aligning the receiver, but should replace any tube weaker than the others even if it checks *good* on a tube tester. This is particularly true in stagger-tuned i.f. systems where each stage is tuned to a different frequency.

The importance of this can be seen in Fig. 1. This is a typical response curve for stagger-tuned systems used in the popular 630 type receiver, as well as the Admiral 30A1 and others. With intercarrier receivers the response curve will be somewhat different, but the same factors will apply if the i.f. system is stagger-tuned.

Fig. 1 shows five tuned circuits, each having a response curve different from the other with respect to amplitude and width.

Thus, the over-all response as shown by the dotted line of Fig. 1 will appear as in Fig. 2 when the set is aligned properly. However, suppose that the tube associated with tuned circuit A is weak. This would prevent tuning that stage to the peak indicated, with the result that the bandpass would appear as shown in Fig. 3. In this instance some of the high-frequency sideband components are lost and picture detail is poor (Fig. 4); the vertical wedge is hazy and the individual lines are hardly visible. Note the difference in Fig. 5, which illustrates the same receiver at a later date when a weak video i.f. tube was replaced and the i.f. stages re-aligned. Picture quality is much better.

To get a flat response for the desired 4 megacycles, you would have to adjust the other tuned circuits to have less gain in proportion to circuit A. Thus, total gain would be down and insufficient contrast may result.

Vincent Halbauer of Kansas City, Mo., reports about vertical foldover. This is usually caused by a defective coupling capacitor to the vertical output amplifier. In a Motorola 17T5D receiver, however, he found an open 8,700-ohm resistor (3 watts) going to ground from the vertical linearity control. This proved particularly difficult to find because the resistor was intermittent and would work well for hours while the set was on the bench.

Bruce Moore of Reagan, Texas, finds that tuner tracking and video i.f. alignment is critically important when using split-carrier receivers for u.h.f. reception. He reports that in a Philmore receiver reception was good for both sound and picture on channels 2 to 6, but from channel 7 to 13 it was difficult to get *both* the picture and sound well. On channel 34 (using strips in the tuner) it was possible to receive either the picture or the sound, and not both.

When the receiver is aligned properly, the condition is minimized for all but the weaker stations. If reception is to be improved for the latter, a higher or better antenna is recommended, plus a good booster.

Centering troubles

I am having trouble centering the picture in a Radio Craftsman 201 receiver which uses a 17BP4B and a permanent-magnet centering and focus arrangement. I have tried the suggestions given in the January, 1954, issue, page 73, but evidently something else is wrong with this receiver. When the arm of the picture-centering adjustment is in its extreme position for moving the picture to the right, it still is about an inch or so from the edge of the mask. Are there any other procedures I can undertake? J. E. B., Richford, Vt.

The trouble may be caused by incorrect line-up of the yoke with respect to the focus unit. Check the yoke-holding bracket to make sure it lines up with the axis of the yoke and focus device. In most instances the picture tube will have to be removed and the yoke and focus assembly aligned optically. The holding bracket of a yoke may require bending to get proper line-up. You can also replace the focus assembly with a larger type for better results. The focalizer bolt should be loosened and the focalizer shifted around to aid in getting perfect alignment. Also observe the action of the focalizer shunt ring and see if there are any burrs or binding which would prevent the adjustment from going through its complete range. Also make sure the yoke is set firmly against the flare of the picture-tube neck.

21EP4B vs. 21FP4A

A Capehart CX-36 receiver uses a 21FP4A picture tube and I would like to replace it with an aluminized tube such as a 21EP4B. However the 21FP4A is an electrostatic focus tube and the 21EP4B is electromagnetic focus. Can you suggest means of making this change-over: and do you think such a change would be worth the effort and expense involved? G. W. C., Portland, Oregon

The 21EP4B tube can replace the 21FP4A tube without any circuit changes. The 21FP4A tube has pin 6 connected to the focus electrode variable resistor, but the 21EP4B has no connections to pin 6, and therefore the old focus control can be left in the circuit and it will be inoperative. For the 21EP4B a focus magnet ring can be used. These have a lever for adjusting picture centering, as well as a focus adjustment.

Whether the change is worth while depends on the condition of the original tube. If the old tube is still giving good results the only difference noted would be increased brilliancy for daylight viewing. With the aluminized tubes the high-voltage system must be operating at peak efficiency for best results.

12VP4 to 12LP4

A 12VP4 picture tube is used in a Sylvania 1-245. The picture tube requires replacement and I would like to use the more popular 12LP4 which has a second grid and a double ion trap. What must be done for this replacement? O. W. P., Holland, Ohio

The 12VP4 has no first anode, while the 12LP4 does. The first anode terminal is pin 10. Thus, when a 12LP4 is installed you will have to apply approximately 300 volts to pin 10 of the picture tube. You can get this voltage from the low-voltage power supply.

*Author: Mandl's Television Servicing.

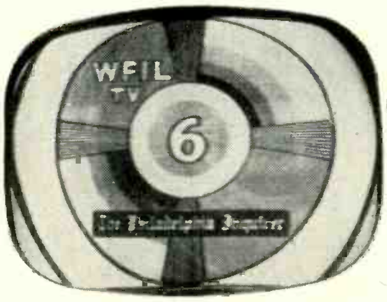


Fig. 4—High frequency sideband loss.

Fig. 5—Fig. 4 condition corrected.

Instability in Zenith

I'm working on a Zenith 23H22 receiver which has poor sync stability, both vertically and horizontally. I've tried all new tubes from tuner up to the horizontal output section. I've also checked all voltages throughout the receiver, as well as checking all parts and substituting any in question, but to no avail. W. K., N. Y.

In some of these receivers such troubles occurred because of loose rivets in the Phonevision connector plug. Since you have made a thorough check of all other factors, you should examine the rivets in that plug and tighten any which are loose. Also look out for any portions of the plug which might be shorting intermittently to adjacent wires or terminals.

Selenium rectifier failures

In an Emerson model 649A I've experienced repeated selenium-rectifier failure. I have even tried 350-milliampere rectifiers instead of the 200- and 250-milliampere ones that were originally in the receiver. In a relatively short time, however, I get low voltage and accompanying loss of vertical and horizontal size and contrast. I have been planning to eliminate these rectifiers in sets of this type in the future and have been wondering if there is a simple type of replacement power supply I could use.—G. S., Union City, Conn.

As with many receivers using selenium rectifiers for the low-voltage power supply (and bias supply) peak current limiting resistors are used in series with the rectifiers and the line voltage. Thus, if the two 15-ohm resistors in series with the 80-µf capacitors and rectifiers are off value, they could cause this trouble. In some instances these resistors increase in value and should be replaced with new ones of the proper value.

Another possibility is that some of the filters are leaky and are drawing an excessive amount of current. For this reason the power factor of each capacitor should be checked with a capacitor checker. Replace if they are loading the power supply too much. We do not recommend your replacing this power supply with the transformer type. This would require an extra-heavy-duty transformer to accommodate the large current requirements. Besides this, a negative supply would also have to be used to furnish the necessary minus 225 volts.

Stacking factors

I'm trying to improve reception for u.h.f. channel 34 in this area and would like to stack the ordinary u.h.f. antenna to favor this channel. I notice that some antennas are stacked a half wavelength apart, while others are stacked only a quarter wavelength. I would like to know just what is the correct wavelength?—B. M., Reagan, Texas.

If only one channel is to be used, best results are obtained by stacking the antennas one-half wavelength apart. When manufacturers use a quarter wavelength for stacking, they do so with antennas which are designed to pick up more than one station. In broadband antennas the quarter wavelength spacing favors the higher channels. This is advantageous since the higher channels are usually weaker because of increased losses after transmission of the signal.

Uhf drift

I have recently installed u.h.f. strips for channel 34 in a Tech-Master 630-type receiver. I find that the sound drifts considerably and requires retouching of the fine-tuning control quite often. What procedures do you suggest for correcting this drifting?—D. S., Bristol, Ind.

Try a new local oscillator tube in the tuner. If the local oscillator drifts slightly for v.h.f. the condition will be aggravated for u.h.f. reception. On occasion the crystal mixers in the channel strips are not up to standard and may introduce some drift. When the local oscillator has been corrected for good stability and drift is still present, try new u.h.f. strips. END

tv dx

APRIL-JUNE

IF you've been wondering what this business of TV dx is all about, the next three months is the time to find out for yourself. This is the season that TV dx enthusiasts and hams who work on the v.h.f. bands live for—the period when anything can happen on the frequencies from 50 mc up.

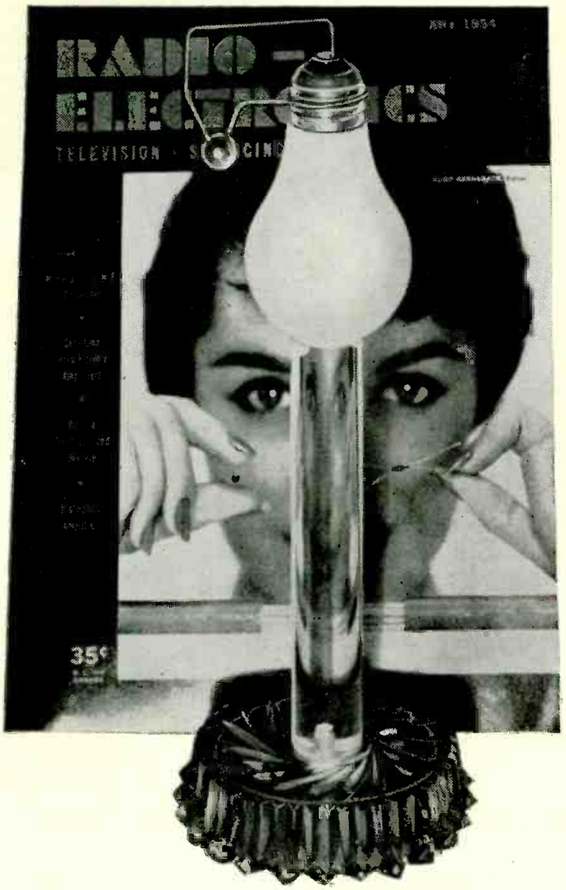
In the more southerly parts of the country things will be happening before the end of April, though above Latitude 40 or so it may be the first week in May, or even later, before the first dx breaks through. Watch particularly during the early evening hours, and on channels 2 and 4, for the first signs.

Your chances of seeing dx are best if you have no local service on one or the other of these channels, as the first dx is likely to be too weak to override a local signal. With stations now operating in Alaska, Hawaiian Islands, Mexico, Cuba, Venezuela, Brazil, and Argentina this year, the chances of record-breaking dx are better than ever.

As the season advances, dx will develop more frequently, show up during a greater portion of the day, and come through from more widespread areas. By the latter part of May it should be possible to catch something every few days; and years of records prove that June allows hardly a day to pass that dx is not recorded somewhere.

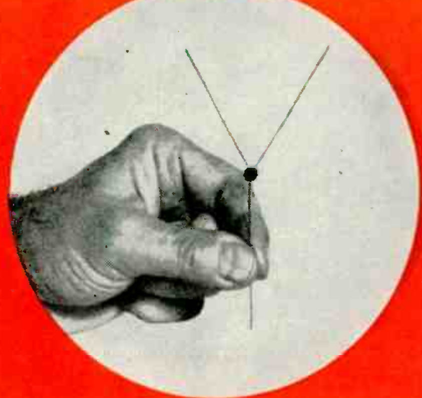
Tropospheric reception will begin to improve as the weather moderates with the advance of spring. If there are warm days and cool nights, barometer readings of 30.0 or higher, calm weather with a gradually thickening overcast, large slow-moving high-pressure centers drifting across your locality on the daily weather maps—all these are the signs that point to improved fringe-area reception.

Anyone who thinks that TV dx can be seen only in the warm months should have a look at the pile of reports that have come in from year-round dx observers in the past three months. Joe Foyer, Westville, Ill., has logged 57 v.h.f. and 15 u.h.f. stations, many of them during the winter months. Albert Brant, Salem, Ore., Caught KFMB, San Diego, Cal., channel 8, late in the fall, a distance of about 900 miles, and he received low-band dx frequently during November and December. Scores of observers report sporadic-E dx reception during the minor dx period in December and January. Perhaps the most interesting of these reports comes from northern Venezuela, where Miami and Cuban stations have been picked up since TV service was inaugurated in Caracas. Has anyone seen Venezuelan stations in this country? END



Above: A view of the Cosmic Generator. Note 60 watt 110 volt bulb mounted on top of the transparent lucite column. The Cosmic Generator at top left supplies the full voltage which keeps the lamp going for a number of years.

Cosmic GENERATOR



A close-up of the Cosmic Auto-Transistor, which is self-powered by cosmic energy. Its diameter is ¼ inch.

By MOHAMMED ULYSSES FIPS, I.R.E.*

FOR over 40 years scientists have wrestled with the problem of what they mistakenly call *cosmic rays*. Actually, they are not rays at all, but the most powerful *radiation* in the Universe—streams of heavy particles: *protons*, flying at terrific speeds from one-tenth to one-fifth the speed of light.

Cosmic radiation—as the term cosmic implies—comes from outer space. *It comes from all directions of the compass*, indicating its universality in Nature. The cosmic particles, heavier than iron, are—as I have been able to prove in my researches—*created spontaneously by gravitational stresses throughout the Universe*. These stresses, existing in all gravitational fields, continuously create unbelievably large surges of power. *This is the source of all cosmic radiation.*

This theory, incidentally, fits in exactly with Einstein's universal field theory, linking gravitation with all electromagnetic phenomena.

To prove my theory, I set out to do something about it. Knowing that cosmic radiation pierces lead shields many feet thick, it was obvious that *we must first find a means to contain them*, if we ever wished to make use of this titanic energy that makes the most powerful atomic radiation look and act, by comparison to it, like mere cigarette smoke.

It is easy enough to capture cosmic radiation, but accumulating it and putting it to work are different and far more difficult undertakings.

I knew that not a single one of the 99 known atomic elements was suitable for my researches, so it became necessary to explore the unknown. *Eka-holmium*, element No. 99, with an atomic weight of 247, was the last discovered element of the series.† (Element 100—unnamed—was also discovered in Feb. 1954.)

I soon discovered element No. 103—atomic weight 251—but this so-far unnamed metal also was too radioactive.

The next element, No. 104, with an atomic weight of 252, which I have named *isolium*, proved to be the missing link. Weakly radioactive, with a chromium-like color, this heavy metal is soft, like lead.

By means of a simple electronic device, cosmic radiation could be stored in an isolium box. This device, not unlike a storage battery—except that it contains no liquids—can store cosmic radiation for long periods of time, simply by converting the radiation DIRECTLY into electrical current.

But my researches soon showed that if cosmic radiation is universal, it must be possible to generate it spontaneously. As cosmic radiation was known to possess enormous amounts of energy, exceeding many billions of electron-volts, I also knew the potential danger to man. For that reason, I proceeded cautiously. In due time, I isolated a small speck of pure *cosmium*—element No. 105, with an atomic weight of 253! The heaviest of all elements, it is a bluish metal which continuously gives off cosmic-radiation bombardment. Even a small speck of the element generates lethal radiation, killing frogs and other small animals at a distance of 20 feet. *When working with cosmium, in the laboratory, one must be shielded with isolium.*

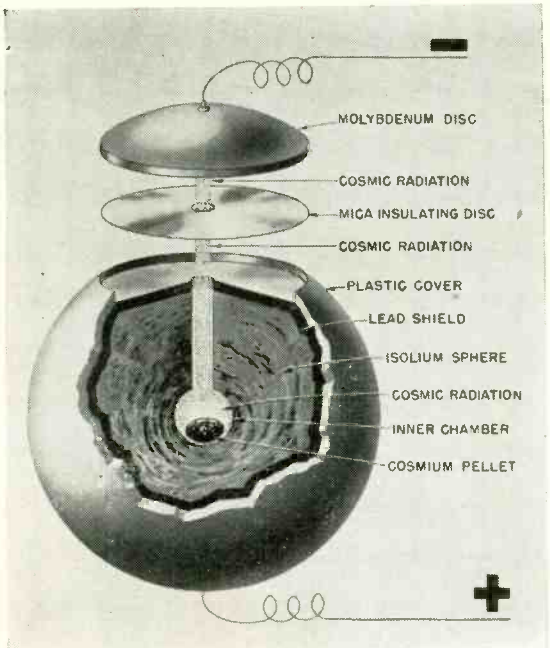
To use cosmium for useful work, it must be contained in an isolium enclosure, the latter (being radioactive) shielded with lead.

(For military reasons—cosmium is several million times as powerful as an H-bomb, gram for gram—no details as to its manufacture can be divulged.)

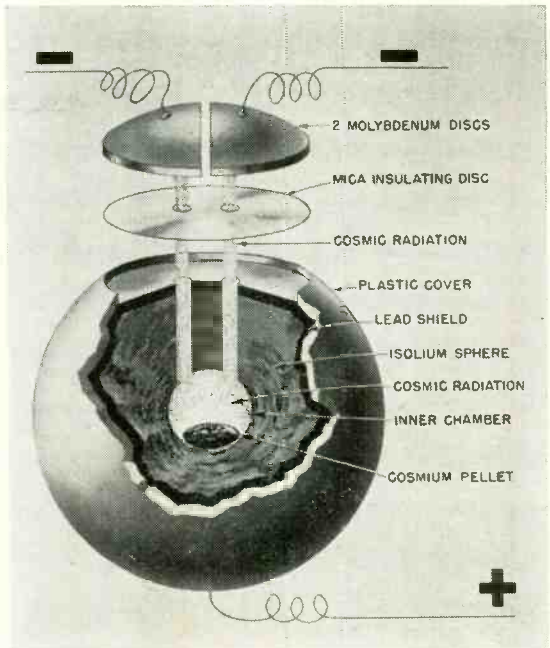
However, I am permitted here to show several practical applications. The first is the basic cosmic generator. It is a rather simple sphere measuring only ½ inch in diameter. A speck of cosmium is held in a thick isolium

*Institute of Radiation Engineering

†Eka-holmium (tentative name) was announced on February 1, 1954, by the Atomic Energy Commission. It was first made in the University of California's cyclotron at Berkeley, California.



Left: Cross-section of Cosmic Generator showing *modus operandi.* The cosmic radiation goes up through hole of isolium sphere is absorbed in molybdenum disk, thus generating electric current.



Right: Cosmic Auto-Transistor is self-powered. Cosmium pellet gives off cosmic radiation through two holes which, impinging on two molybdenum disks, operate the Auto-Transistor.

shield. The latter is enclosed in a lead shield. A fine hole pierces the isolium and lead shields. A sheet of mica also pierced with a fine hole, covers the flat top of the assembly. On top of the mica sheet we have a thick wafer of molybdenum metal.

The latter now is bombarded with protons from the cosmium, through the fine hole. Each proton liberates billions of electrons from the molybdenum, giving rise to a powerful electric current which will go on for several hundred years.

Our photograph shows the cosmic generator operating a 110-volt, 60-watt lamp, mounted on a transparent lucite rod.

Another illustration shows the *cosmic auto-transistor*, which is self-powered, requiring no battery, as it generates its own current. Made into a powerful radio receiver the size of a lipstick, it can operate a loudspeaker with volume sufficient to fill a large auditorium. The photograph shows this somewhat startling assembly.

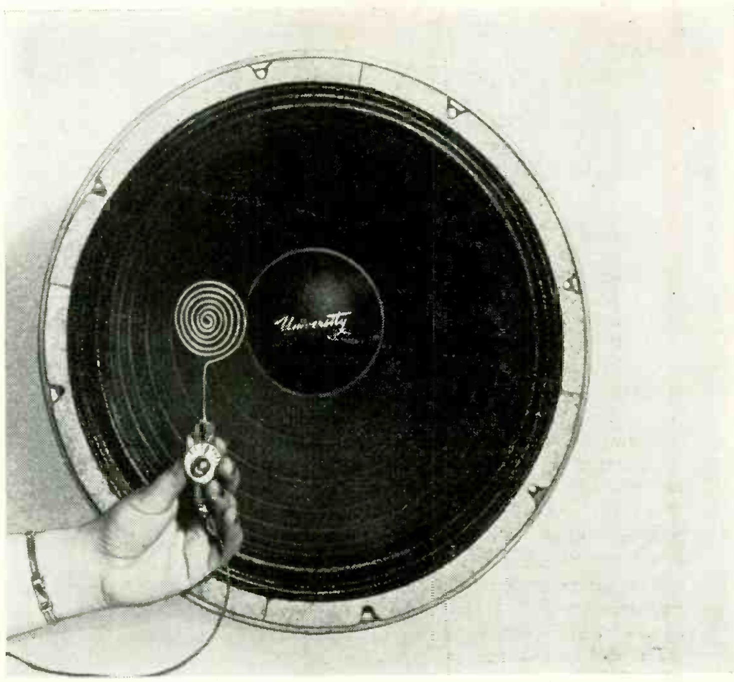
A further illustration also depicts the cosmic auto-transistored radio schematic.

There is no end to the versatility of *cosmic-electronics*. It will, in time, surpass all other radio-electronic developments. There is conceivably only one thing that will hold back its quick ascendency—the Russians. Naturally, we don't want such a potential weapon as cosmium to fall into their hands. Therefore, it will not be possible for some time to manufacture it for public and private use. Hence you will not be able to buy even a speck for experimental purposes.

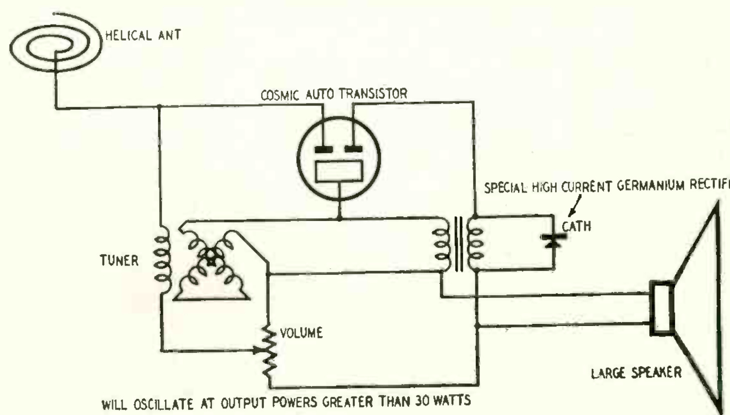
This is a very sad state of affairs for scientific progress. Unfortunately, nothing can be done about it.

Perhaps there will be better news for all by next

APRIL 1



Right: Cosmium Auto-Transistored Radio mounted in lipstick case. This mini-radio set has sufficient power to drive a 15-inch loudspeaker to fill an entire auditorium.



Circuit diagram of Cosmic Auto-Transistor receiver seen in photograph above. Tiny cosmic vest-pocket radio gives sufficient power to operate several large auditorium speakers.

MILADY'S GOLDEN EAR AMPLIFIER

We are proud to present the latest in the *Golden Ear* series, designed and built to our order by Mr. Marshall, and tested by our editors

By JOSEPH MARSHALL

Now it came to pass that Homo Sap was bitten by the high-fidelity bug. Not having the funds to purchase a commercial amplifier with less than 1% distortion, a bandwidth as great as an autobahn, and enough output to heat the house, he decided to build his own, following a design in one of the magazines. After heroic labors with drill, reamers, files, hacksaw, and even a hammer and chisel—aided and expedited by some fearful Elizabethan oaths—he managed to cut out a sufficient number of holes in a blank chassis to accommodate the various transformers, tube sockets, filter capacitors, etc. The chassis was no longer a thing of beauty. He had made a couple of miscalculations in layout with the result that the amplifier boasted several gaping holes which contributed nothing but ventilation. This didn't bother him. It was what came out of the amplifier that interested him. When at last he tried it out he was in raptures.

"Most beautiful music this side of heaven," he said.

"Maybe," milady of the household said, looking sourly at the pride and joy as it stood on an open bookshelf, "but it's the ugliest thing this side of hell. Get it out of sight."

His neighbor, Joe Doakes, profiting from this experience, played it safe. He purchased a kit with two punched chassis and a decalled escutcheon. Most of *his* mistakes were hidden underneath the chassis. Placed on the bookshelf the finished product, though not beautiful, had a sort of functional handsomeness —if you like functional handsomeness and Mrs. Doakes wasn't crazy about it. Still Milady Doakes, though she did not think the amplifier complemented the decor, made no serious objections to having it around—at first. But, coming home from his bread-winning pursuits one day, Joe was amazed to find the helpmeet facing him with a crudely bandaged hand and sparks in her eyes.

"Listen," she ultimated; "get that damned amplifier of yours out of sight and out of reach."

"But sweet," Joe protested. "What's the trouble? You know we can't afford any fancy cabinet for it."

"We can't afford any divorces either," Milady replied; "and that's what we're going to get if you don't get that thing out of sight. It attracts dust like a platinum blonde attracts frustrated husbands. I burned my hand on one of the tubes trying to get it dusted clean. So either it goes out of sight or I go to my lawyer!"

Believe me, brethren of the bond, I know whereof I speak from actual experience, not mere book learning.

Clearly what is needed in high-fidelity is some kind of design which will hide most of the tool marks and mistakes, and will not rouse the antagonism of the others in the household by catching dust and clashing with interior decorations.

Therefore, I present Milady's Golden Ear which claims electrical performance right up there with the best of commercial gear, and at the same time a retiring, house-broken disposition, calculated to win milady's tolerance if not love. As the photos show, it blends inconspicuously into its environment. Moreover, it has no dust-catching projections or burn-producing hot spots. Milady's Golden Ear is flexible and compact; it can be tucked into any odd corners of cabinet or closet. For, although it puts out 20 watts of very pure sound, it occupies less than ½ cubic foot of space.

The circuit

Regular readers of this magazine will recognize the circuit (Fig. 1) as a modified form of the Golden Ear presented in my article of last November. The new circuit is adapted to tubes of the Williamson class requiring around 40 volts-per-grid of drive and delivering an output of from 10 to 20 watts. It also embodies a new combination of current and voltage feedbacks which seems to me to deliver a remarkable degree of faithfulness in reproducing the input waveform both in form and in amplitude.

The output stage is the now familiar Ultra Linear version of the Williamson (as developed by Hafler and Keroes), using the Williamson biasing arrangement. The input section is the Golden Ear combination of cross-coupled inverter (developed by Van Scoyoc) direct-coupled to a voltage amplifier. This section has no phase shift at the low-frequency end because there is no internal coupling capacitor. There is very little low-frequency phase shift at the input either. The input tubes are cathode followers with extremely high input resistance, and this is increased by the current feedback of the outer loop. Any value of input capacitor in excess of about .025 μf will pass signals below 10 cycles. It is important, however, that the input capacitor be free of d.c. leakage, for any d.c. voltage appearing at the grid of the input tube will disturb the balance of the amplifier. To insure against this, I include a .05 μf input capacitor. The capacitor at the output of control unit, the tuner, or other device will be in series and therefore the leakage is reduced by at least 6 db, which should be more than sufficient. Provided the capacitor at the output of the tuner, preamplifier, or other device, is .05 μf or larger, the amplifier will still pass a 10-cycle wave with little distortion.

The high-frequency response is similarly good. Since the input tubes are cathode followers they have a very good high-frequency response. The inverter, since it is fed by the low impedance of the cathode followers, has very little

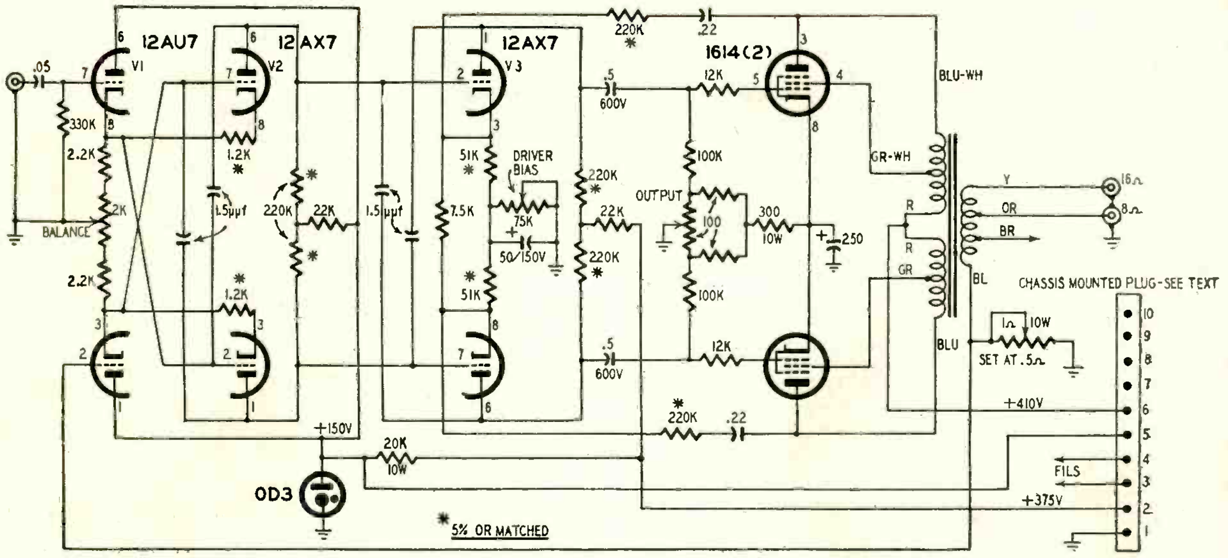
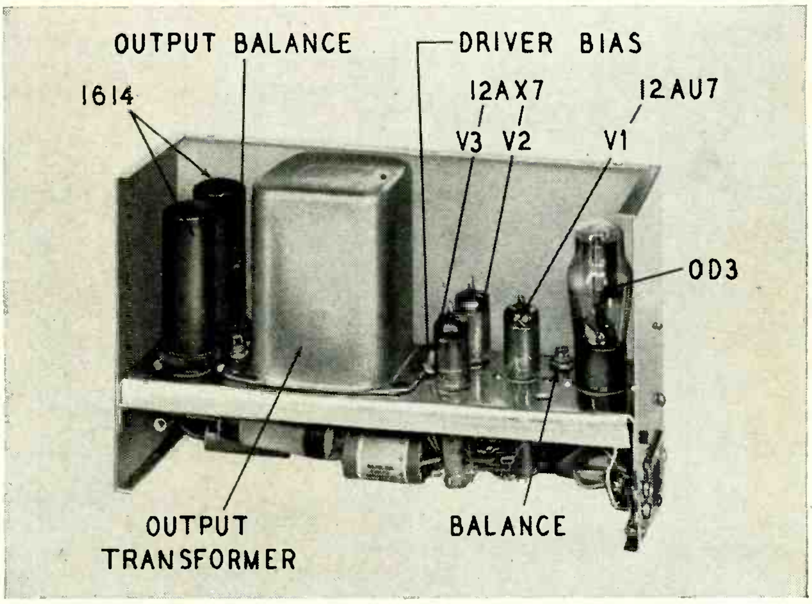
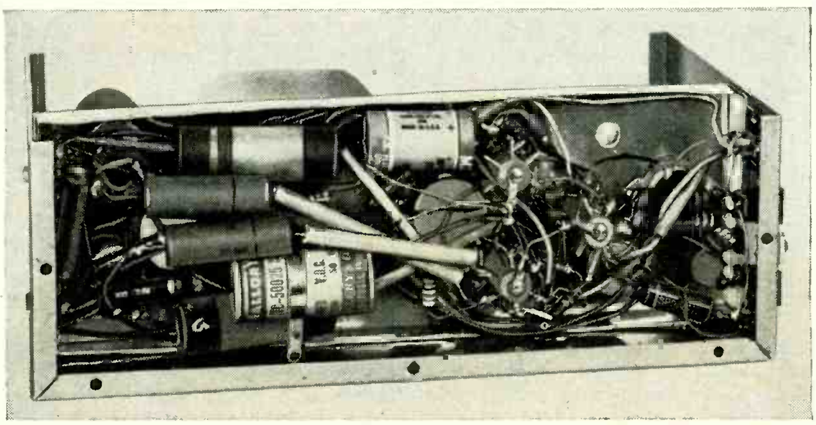


Fig. 1—The schematic diagram of the amplifier section of the RADIO-ELECTRONICS Golden Ear. All values are shown.

Miller effect and this is further minimized by neutralization with 1.5-μμf capacitors. The 12AX7 driver also is neutralized. The result is that this section goes to 50,000 cycles with a slight droop of 1 or 2 db in the last octave.



Milady's Golden Ear amplifier. Vector sockets are used to simplify the wiring.



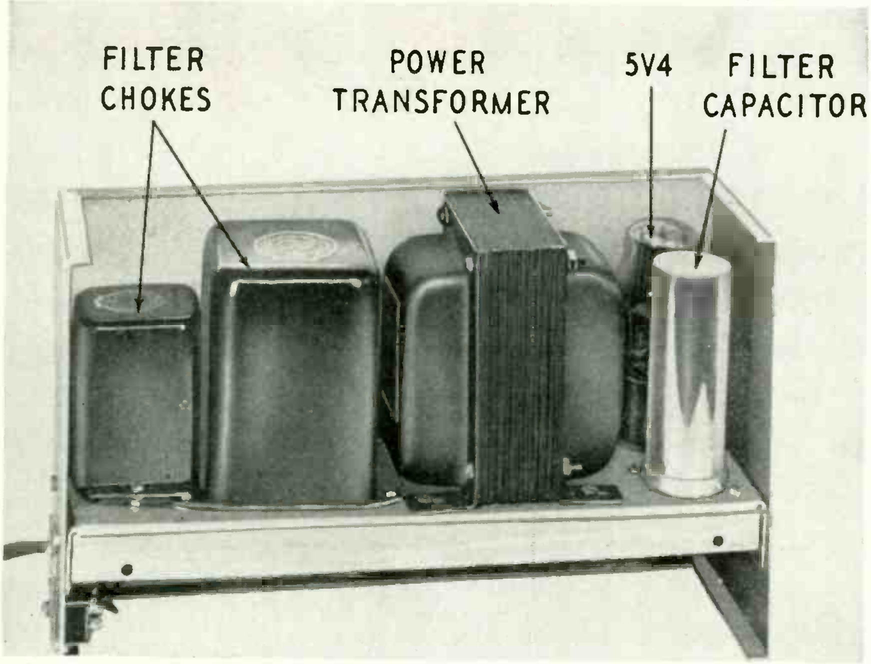
Vector socket wiring leaves ample room for placement of the larger components.

The only coupling capacitor, and therefore the only point of phase shift within the amplifier, occurs between the front section and the Williamson style output stage. Because of the low value of grid resistors the time-constant is short, even with the very large capacitors. However, this phase shift is at least partially, if not entirely, neutralized by the inner feedback loop which goes from the plates of the output tubes to the cathodes of the driver. This is achieved by making the time-constant of the loop the same as that of the coupling between drivers and output tubes. The effect of the time-constant in the loop is the opposite to that of the interstage capacitance; one produces a lag and attenuation, the other produces a lead and boosting. Thus, the total effect is more or less to neutralize the interstage time-constant.

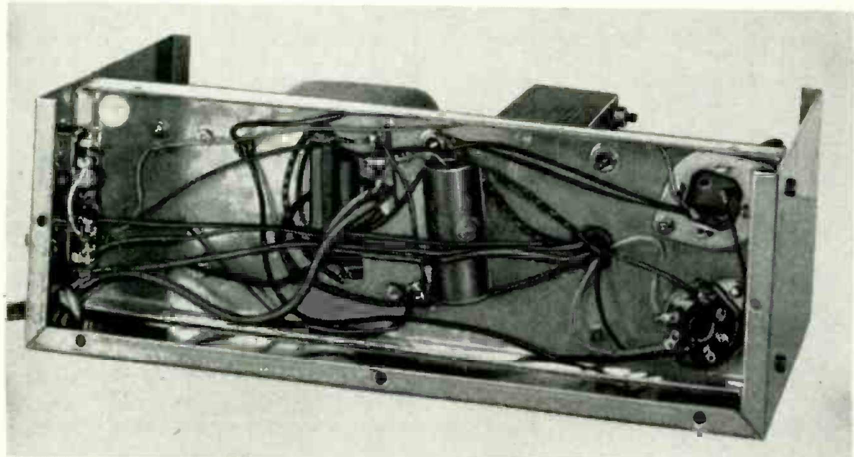
This is the critical point in Golden Ear design. On one hand the high value of cathode resistance in the drivers makes it easy to obtain a complementary time-constant in the loop with reasonable capacitances; on the other hand, the very same high resistance results in large amounts of degeneration of the drivers. In the Junior Golden Ear amplifier, which was designed for maximum quality at normal home levels with inexpensive components, I deliberately made no compensation for the degenerative feedback in the drivers; with the result that with this factor and the voltage feedback too, the stage had no gain but some loss. This was alright at low levels, but people who wanted to drive it to maximum output had trouble supplying sufficient undistorted drive.

I made one serious oversight in the article describing that amplifier. In hurrying to write it, I failed to point out the necessity for making changes in the driver stage and feedback loops to produce enough sensitivity to drive larger tubes. Curiously enough, no one who reported modifying a Williamson complained of poor performance, and all reported an improvement in quality. Obviously they were people who were much more interested in day-to-day performance than in maximum-output demonstrations.

The circuit used in Milady's Golden Ear makes the necessary corrections to



Golden Ear power supply. Select parts carefully to fit the chassis and case.



Underchassis view of the power supply. Anchor parts securely to the chassis.

achieve normal power outputs with moderate input voltages, and it can be applied to any Williamson tube simply by changing the front section. It will provide well in excess of 40 volts per grid of drive and can be used with any tubes up to and including the 6B4 series.

I have tried many combinations of current and voltage feedback in the driver stage. Either type reduces driver distortion of course; but for phase-shift neutralization the voltage feedback should be at least 12 to 14 db. Of all the combinations I tried, the one shown in Fig. 1 works best. The cathode bias is supplied by a combination of independent and common bias resistors. The independent resistors develop the feedback; the bypassed common resistor stabilizes the direct-coupled stage. The two are proportioned so that about 40% of the bias is developed in the independent resistors. A rheostat or potentiometer is used to establish the exact bias, because the 2 volts required is less than 1% of the plate voltage and even 1% resistors might vary enough to miss the exact value bias by a great many volts.

Even with this proportion of bypassed to unbypassed resistors, the current feedback is still excessive. It could be reduced by decreasing the size of the independent resistors and increasing the common one. This would require very large capacitors in the feedback loop to duplicate the time-constant of the coupling capacitor. Therefore, the current feedback is reduced by shunting the cathodes. With the shunt value given, the current feedback is reduced to 6 db. Of course, the shunt also reduces the voltage feedback. Thus, a much higher proportion of the output voltage must be fed back. Still, the R-C combination permits us to obtain the required time-constant with a reasonable size capacitor. The voltage feedback is around 14 db. The net gain of the 12AX7 is reduced by the combination of current and voltage feedbacks to about 7 times. The inverter therefore has to deliver about 6½ volts per grid for maximum output with the 1614's or similar tubes. Since the inverter is capable of putting out 50 volts grid-to-grid with some distortion, and 25 volts with very little distortion, the 11 volts required presents a very modest demand on it and the inverter always works on the straightest portion of its curve.

Correction of phase shift below 20 cycles is nearly complete in the case of output tubes used as triodes, since the loss in the feedback loop is about the same as the gain in the output stage. It is not complete in the case of tetrodes in Ultra Linear form since the gain of such stages is about 10. However, the Acrosound transformer is so flat at the low end that complete correction is not essential. The improvement over a completely uncorrected phase-shift is in any case marked, especially in the clean bass and transient abilities.

The output stage consists of 1614's operated Ultra Linear. These tubes are used because they are capable of somewhat higher outputs than 6L6's and are cheaper than 5881's, 807's, KT66's, and the like. They give excellent performance. However, any of the other tubes can be used interchangeably and without any changes in the circuit.

Recently my attention was attracted to the use of current feedback in the White Powrtron amplifiers to correct for the power compression which pure negative-voltage feedback produces. The general idea can be summarized thus:

Although voltage feedback damps the loudspeaker, it also damps the amplifier, and results in a certain amount of power compression. Voltage feedback tends to maintain a more or less constant voltage condition in the output, and flattens peaks more than diminuendos. White suggests and uses a certain amount of current feedback to compensate for this. Negative current feedback is proportional to the current flowing through the load rather than the voltage developed across it. It is relatively insensitive to variations caused by changes in speaker impedance, but it is highly sensitive to variations in the power delivered to the speaker. It responds to such variations by raising the effective load resistance, and therefore results in a larger voltage drop across the load. The effect of a combination of current and voltage feedback is rather comparable to that of having both loud and soft pedals in a piano. The theory is that each form will do its job without canceling the good work of the other, and that a proper proportioning of the two types will produce a condition in which the power delivered to the speaker will be unaffected by either variations in speaker characteristics or changes in waveform produced within the amplifier.

Obviously, working out the right combination is a tricky business, as I discovered immediately when I started to experiment with the idea. For instance, the design diagramed appears to be the optimum combination from the distortion control point of view.

Any increase in either the current or voltage feedback increases the intermodulation (IM) distortion. This is a most curious phenomenon which I don't quite follow but it certainly worked out in this instance. I made many adjustments of both, tried another overall loop of voltage feedback, changed the ratios of each loop and of the two together. The present design resulted in the lowest IM figures on a Heathkit IM analyzer with either a 3,000- or 7,000-cycle high-frequency tone and 60-cycle low frequency (4-1 ratio).

The current feedback is developed across the power resistor in series with the output-transformer secondary and ground. The resistor is a 10-watt, 1-ohm, adjustable; approximately half value appears to be optimum. This loop provides about 14 db of current feedback. So the total feedback applying to the output stage is about 26 to 28 db, and the drivers have an additional 6 db of current feedback. This reduces distortion to an extremely low level. The current feedback is applied to the off grid of the input tubes. Actually, as applied, the feedback is positive; however, the phase cancellation effect of the inverter produces precisely the same result that negative feedback to the other grid would produce.

The result of the combination of the two loops is very gratifying to me. The amplifier measures well and sounds even better in my living room and with my speaker system. However, not everybody will like the effect of the current feedback and it will not be entirely satisfactory in all rooms and with all speaker systems. The most noticeable effect is a definite bass boost. Whether this is caused by lessened damping of the speakers, or by power expansion, I do not know. Actually, my own measurements with my own speaker system, indicate that the damping factor remains excellent; but the measurements of others, on other amplifiers, seem to indicate that the damping is reduced substantially. In any event, in a room which is quite "live" the bass may be excessive and boomy. Also, the cavity resonance of such resonant enclosures as the bass-reflex, is accentuated; although with non-resonant systems, the effect is good and without peaks.

If you do not like the effect, or if it does not work well in your living room and with your speaker system, you can easily correct matters. Remove the current feedback loop entirely; ground the lower end of the output transformer, and connect a 39,000-ohm resistor from the 16-ohm tap of the output transformer to whichever cathode of the 12AU7 produces a reduction in volume. This will provide about 14 db of negative voltage feedback. Then readjust the BALANCE and DRIVER BIAS controls.

It will be noted that 5% resistors are specified and were used in the prototype. This does not produce optimum balance, even though there is a balancing control, and therefore maximum benefit of push-pull distortion cancellation is not obtained. Also, no attempt was made to match the coupling or feedback capacitors. As a matter of fact, in the prototype, a mixed 60-cycle and 7,000-cycle signal is unbalanced at the grids of the 1614's by a little more than 5%, principally because of variations in the reactance of the coupling capacitors at 60 cycles, and also because of slight unbalance due to the use of 5% resistors. And yet, the IM figures with an 8-ohm *loudspeaker* load are as follows: at output levels below 1 watt IM runs from 0 to .001%; at 1 watt—0.2%; at 10 watts—0.6%; at 20 watts—1.8%.

Improvements in balance make a very marked difference in distortion levels. This is easily demonstrated on Golden Ear amplifiers by varying the balance slightly with the balance control. Presumably, therefore, the more complete balance which could be obtained by the use of 1% resistors and matching the capacitors would lower these figures further.

Actually, however, it would appear that 5% resistors and run-of-the-stock capacitors are adequate for low-level home listening. With speakers of any efficiency, Milady's Golden Ear will deliver a volume level loud enough to drive most people out of the house on less than ½ watt of output. At this level, with the 5% resistors, IM is scarcely measurable, and undetectable to any ear. Even a crescendo which drove the amplifier to 10 watts or more, would be free of significant distortion. 1% resistors would add about $4 to the cost, and matching capacitors would call for a bridge or an a.c. voltmeter and audio generator and a stock of a half-dozen capacitors to chose from. Those who can afford the additional trouble and expenditure will buy good insurance by using 1% resistors; however, I repeat, 5% resistors will produce performance with which even the most meticulous cannot quarrel.

No measurements were made of harmonic distortion. However, since it is almost invariably lower than the IM, and since listening tests discerned none, even at maximum output, it seems safe to assume that it too is below 1% throughout the useful range.

The band-width is exceptional even by today's standards when many amplifiers boast a band width of 13 to 15 octaves and despite the fact that the overall feedback loop (whether the current or voltage type is used) is only 14 db as against 20 db on most commercial amplifiers in the same class. At low levels the amplifier is perfectly flat from 20 cycles to 80 kc and the response extends considerably beyond these limits. The power output depends somewhat on the line voltage. Here at home, where our line voltage runs high and averages 125 volts, it delivered almost 20 watts before clipping was evident on the scope. In New York where line voltage is average or a little low, it delivered 16 watts at 1000 cycles before clipping was evident. At this 16-watt level, the amplifier delivered 14 watts at 20 cycles and 20,000 cycles without clipping, and *5 watts at 100,000 cycles*. Neither of the audio oscillators used went below 16 cycles and I'm not sure of the response below this point. The scope I used at the time Milady was measured was not too kind to a 20-cycle square wave; but as near as I could determine, the amplifier passed the 20-cycle square wave with no significant deformation, which would indicate very little slope at least down to 5 cycles. These curves compare very favorably with those of the best commercial amplifiers. There is no sign of ringing at any frequency at maximum output; in contrast some very high priced commercial amplifiers I have tried showed signs of ringing at or around maximum output, and this despite the fact that they used "anti-ringing" capacitors in the feedback loop, whereas Milady does not.

A V-R tube regulates the voltage to the cross-coupled stage. This produces more complete hum filtering, improves the stability of the direct coupled section and, equally important, produces a very high degree of decoupling. This decoupling, with the cross-neutralization, makes Milady so nonresonant, nonregenerative, and, of course, nonoscillating, that it is all but incapable of hangover. The transient response is in consequence superb. Indeed, I think it is unequaled even by amplifiers which use multiple power supplies.

The power supply (Fig. 2) is conventional except for the positive bias (about 50 volts) on the filament string. The hum level of Milady's Golden Ear is inaudible even when used with corner horns. In fact, it is so low that you are likely to forget to shut off the amplifier when finished with it at night. Thus, I recommend the addition of a

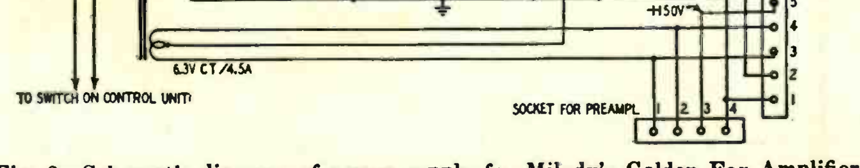


Fig. 2—Schematic diagram of power supply for Milady's Golden Ear Amplifier.

pilot light to the power supply. I did not install one in the prototype shown because I overlooked ordering one and didn't have one on hand.

Stability of the direct-coupled section is further improved by the 22,000-ohm series resistors in the plate return circuits and by the high value of the common bias resistor in the driver stage. Milady will maintain her balance nicely indeed, and is no worse than ordinary R-C coupled amplifiers in this respect. Because of the Ultra Linear output stage the plate supply drain is constant and relatively low for an amplifier of this much power output. The 150-ma power transformer is adequate, in fact, it can also supply power to the Golden Ear preamp and control unit.

You will note that the cathodes of the output tubes are bypassed with 250 μf and that the common portion of the driver bias resistance is also heavily bypassed. Both these capacitors are essential to hold distortion down to the specified levels, especially at high output levels.

Adjustment procedure

1. Interconnect the two units, without tubes in the amplifier. Check with an ohmmeter for possible shorts from B plus to ground; also for a short from either side of the filament string to ground. (Such a short might apply 50 volts to the filaments and burn them out). The resistance from either side of filament string to ground should be around 20,000 ohms. From B plus to ground, you should measure about 30,000 to 50,000 ohms. Now turn on the power and check voltages. B plus, without a load, will run to nearly 500 volts.

2. Now insert output tubes and balance them. This is done by connecting a high-resistance v.t.v.m. from plate to plate of the output tubes, using a 25-volt scale at first and then shifting to the 5- or 2.5-volt scale, and adjusting the 100-ohm OUTPUT BALANCE control until you get a zero reading.

3. Insert the other tubes. Check to see that the V-R tube glows. Now connect a v.t.v.m. from either cathode of the driver stage to the grid of the same stage and adjust the DRIVER BIAS control for about 2 to 2.5 volts. (Be sure it is *minus* 2 volts; it is quite possible to get a positive voltage here which would produce positive bias on the drivers.)

4. Now connect the v.t.v.m. from cathode to cathode of the drivers and adjust the BALANCE control carefully for zero voltage on a 5 or even 3-volt scale. With care you can get exact balance at this point.

5. Move the v.t.v.m. to one cathode and grid and check bias again and adjust for exactly 2 volts. Check the balance again and adjust if necessary. These two steps are interrelated and it may take several adjustments to arrive at proper bias and complete balance. Once this is done, the bias potentiometer can be locked, and further adjustments of balance, with changes of tubes, aging, etc., can be done with the balancing control only.

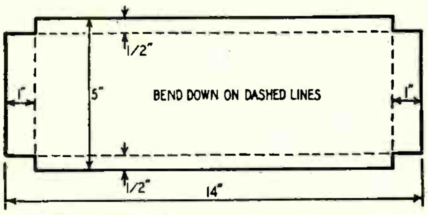


Fig. 3—Diagram shows chassis layout.

The amplifier is now balanced and ready to go. It would be a good idea to check the balance periodically, preferably once a month.

Construction

The amplifier is divided into two parts: the power supply and the power amplifier. Each is housed in a 5 x 7 x 12-inch Flexi-Mount aluminum case with Hammertone gray finish. These cases are available at most parts distributors. The only modification is that of drilling ventilation holes. (It is likely that these cases will soon become available with ready-punched ventilation holes). The two subchassis are formed from a single, standard 10 x 14-inch aluminum bottom plate which is cut in half to make two 5 x 14-inch strips. These strips are then cut as indicated in Fig. 3 and bent to make the subchassis. When making these bends, be careful to check with the cases, to insure an exact fit. Once they are formed to fit the case, you can drill the four holes necessary to mount the chassis to the case. Self-tapping screws are most convenient for fastening the chassis to the case.

Once a fit is assured, the chassis is removed and the case put aside. The chassis is drilled and punched for the various components. The exact power transformer specified should be used; it fits the case exactly. The Acrosound output transformer also fits exactly. Probably other chokes can be used with no trouble. However, for the least trouble, I suggest duplicating the listed components exactly.

The tubes are placed nearest to the front of the cases, although a more conventional layout would put the output and power transformers in these positions. This is important. The tubes radiate the most heat. Placed nearest the front, the heat will be dissipated most completely when the units are installed in shelves or cabinets. The power supply is no problem in this respect, since it warms up very little even with day-long periods of use. But the two output tubes put out a lot of heat. As designed, the cases will protrude an inch or more beyond the edge of any bookshelf; this will provide good ventilation. The front of the amplifier case may attain a temperature of between 125° and 150° after long periods of continuous use; but the combination of ventilation holes and aluminum case produces satisfactory dissipation of the heat.

All the wiring, testing, adjusting, trouble-shooting, etc., is done with the chassis removed from the case. When the units operate properly the chassis can be mounted in the cases. In this way, the finish of the case will not be marred. If your craftsmanship is faulty, or you make mistakes, all this will be hidden and locked tight within the cases. The fact that the prototype, a development model, has a commercial appearance, is the best evidence.

I recommend the use of the Vector sockets (the 6-lug type specified in the parts list, not the 9-lug type shown in the photos). These sockets eliminate the need for terminal strips; they produce a more compact layout; and they lower the stray capacitances by elevating most of the components above the chassis. A common ground bus should be run from the ground terminal of the input jack through the lugs on the bottom of the turrets, and all ground connections should be made to this bus. The output stage and the V-R tube use ordinary sockets. Two 3-terminal lugs should be attached to the output tube sockets at the panel end. This leaves room for the very large capacitors and resistors. The only critical problem in placement is the output balance control. It has to fit between the tube sockets underneath the chassis and yet clear the output transformer on the top. Be careful to leave room for it by allowing space between the output transformer and the tubes.

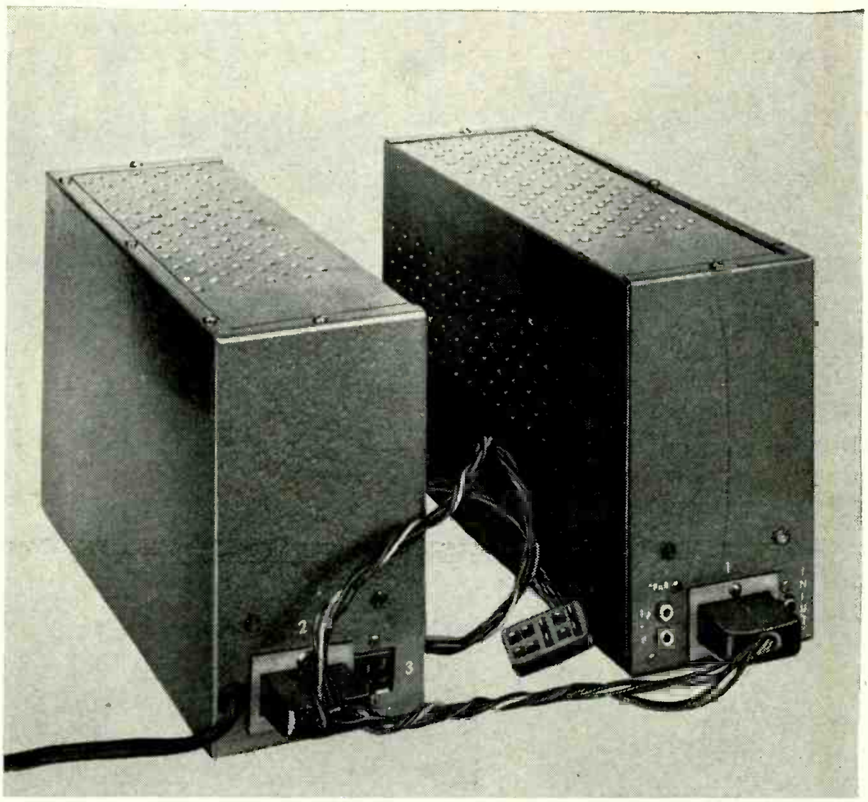
The only troublesome problem in chassis work is that of providing holes on the cases for the cable jacks. A ¾-inch square punch would make the forming of these holes a breeze. In the absence of such a punch, the bigger hole can be made by drilling three ¾-inch round holes and squaring off the sides and corners with a file; the aluminum can be worked easily and this isn't at all difficult. The smaller hole for the 4-point plug can be made with a single cut of the ¾-inch square punch, or by squaring up a ¾-inch hole. If you cover the case with paper, held in place with celophane tape, you'll take almost no risks in marring it.

The holes for ventilation require an electric drill and a 3/16-inch bit. Lay out the pattern of holes on one of the covers with a combination square and a pencil. A knife point, or an awl, can be used to form small dents for each hole. After the first cover is drilled, it should be deburred. An old wood-chisel is ideal for this. Now this cover will serve as a template for the other cover.

The wiring is simple and straightforward. Wire the turrets individually before mounting them on the chassis. The resistors go from socket terminals to the terminals at the other end of the turret. Neutralizing capacitors go around the turret. On the socket for the 12AX7 driver, use this procedure: (1) run the far ends of both plate resistors to a common lug at the turret; (2) run the ends of the two independent cathode resistors to a common lug; (3) run a jumper from each cathode to a separate terminal on the turret; (4) wire the shunt resistor across these two terminals; (5) run a jumper from one grid to a terminal on the turret. These terminals are now easily accessible points to which a meter can be connected for checking the bias and balance of the amplifier.

Just a note to the rare uncautious constructor: This is a main amplifier only—does not even have an on-off switch or volume control. They are on the Control Unit described last month, or may be installed on the control unit of your choice.

The book-style lettering can be duplicated with Tekni-Cals. The titles have to be assembled from capital letters. Here is a suggestion: When removing the lacquer film with lacquer solvent and a brush, wipe off the scum, immediately after brushing, with a soft cloth slightly moistened with solvent. Do only one big letter, or two or three small letters at a time. This will produce a very clean panel with little or no trace of lacquer or scum.



Exterior views of the RADIO-ELECTRONICS Golden Ear Amplifier and power supply.

Conclusion

Once in operation Milady's Golden Ear should please not only milady but also the master with the golden ear. Actually, when the editors of RADIO-ELECTRONICS and I started discussions about this version we referred to it as the Adolescent or Silver Ear, presuming that the compromises I would have to make in the interest of low cost and simplicity would reduce the performance sufficiently to keep it out of the Golden Ear class. In actual fact, I believe the performance will stand comparison with any amplifiers in or out of the same class. To really appreciate the performance a very wide-range speaker system is necessary—especially one with a bass response down to 30 cycles. At first hearing Milady's Golden Ear may seem slightly lacking in both bass and treble. Actually it is fantastically flat within the entire audible range. When used with the Golden Ear phono preamplifier and the control unit described last month it has some bass and treble boost in normal positions of bass and treble controls. But the almost complete absence of distortion, especially transient distortion and hangover at low frequencies, produces an extreme cleanness at both extremes. Just wait, however, for some real bass tones to come along and you'll see it has a most genuine, fundamental bass; as for the treble, listen to high-frequency transients—all that is lacking is the distortion, too typical of many high-fidelity amplifiers. Milady was in operation in our household for 8 to 10 hours a day for two weeks at high volume levels. No one complained of headaches or irritation, and the illusion of presence, especially with the voice of announcers of FM stations, was so startling that often we were fooled into thinking a visitor had entered the house. The difference between Milady's Golden Ear and the Master Golden Ear, which costs about three times as much, is so slight that only the most highly experienced and critical ears can discern it.

To hear the Milady's Golden Ear at its best, try it with really critical test records, such as the new Capitol recording, *A STUDY IN HIGH FIDELITY*, and with a fine speaker system. Listen especially to the two percussion bands on this record, especially the final burst of the Chinese gong in band 2 of the classic music side. This gong takes nearly 15 seconds to decay, and as it decays a beat note of apparently not over 20 cycles is plainly audible with the Golden Ears but not with all other amplifiers.

There is just one trouble. The slightest distortion in records and radio programs will now be plainly audible. You'll need to change needles more often and perhaps to discard your records sooner. Perfection is indeed difficult to attain. The more closely it is approached, the more apparent the imperfections. But Milady's Golden Ear will take you a long way along the road and at a relatively low price.

(As the photographs show, power is fed into the main amplifier through a 10-point *socket* on one end of the case. The exposed tips of the power-cable plug create a serious shock and fire hazard if the cable pulls loose from the power amplifier or control unit (March, 1954) while the power is on. To eliminate this hazard, the diagram and parts list have been modified to permit chassis-mounting *plugs* on the main amplifier and control unit. The remote ends of the power cables should then be terminated with cable-end type sockets.—*Editor*)

The Golden Ear Preamplifier mentioned in this article will be described in this magazine soon. END

Certified Parts List

2—1,200-ohm resistor, ½ watt, 5%
2—1,200-ohm resistor, ½ watt
2—2,200-ohm resistor, ½ watt
1—7,500-ohm resistor, ½ watt
2—51,000-ohm resistor, ½ watt, 5%
6—220,000-ohm resistor, ½ watt, 5%
1—330,000-ohm resistor, ½ watt
2—100-ohm resistor, 1 watt, 5%
2—22,000-ohm resistor, 1 watt
2—100,000-ohm resistor, 1 watt, 5%
1—22,000-ohm resistor, 2 watt
1—100,000-ohm resistor, 2 watt
1—300-ohm resistor, 10 watt
1—20,000-ohm resistor, 10 watt
1—1-ohm resistor, 10 watt, adjustable
1—100-ohm potentiometer
1—2,000-ohm potentiometer
1—75,000-ohm potentiometer
4—1.5-μμf ceramic capacitor
1—.05-μf 400-volt paper capacitor
2—0.22 μf 600-volt paper capacitor
2—0.5-μf 600-volt paper capacitor
1—50-μf 150-volt electrolytic capacitor
1—20-μf 150-volt electrolytic capacitor
1—250-μf 50-volt electrolytic capacitor
1—40-40-μf 500-volt electrolytic
2—12AX7 tube
1—12AU7 tube
2—1614 tube
1—OD3/V-R 150 tube
1—5V4-G tube
3—Vector noval sockets, 6 point
4—Octal sockets
1—Acrosound TO-300 output transformer
1—Power Trans. 750 v.c.t., 150 ma; 5 v, 3 amp.; 6.3 v.c.t., 4.5 amp (Stancor PC 8411)
1—Choke, 8 h, 105 ma, 100 ohms (Chicago RC 8150)
1—Choke, 10 h, 55 ma, 230 ohms (Chicago RC 1055)
2—4 x 7 x 12-inch Flexi-Mount case
1—10 x 14-inch aluminum chassis
2—Jones sockets, type S-310-CCT
1—Jones plug, type P-310—CCT
1—Jones socket, type S-304-AB
1—Jones plug, P-310-AB
1—Jones socket, S-310-AB
1—Pilot light and mount
1—Panel mounted fuse holder
1—2 ampere fuse
1—Line cord
Total cost of parts, $79.04

GROUND LOOPS and Hum-m-m-m

A common source of hum frequently overlooked can be eliminated

By **HECTOR E. FRENCH**

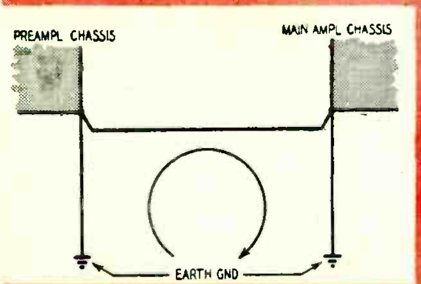
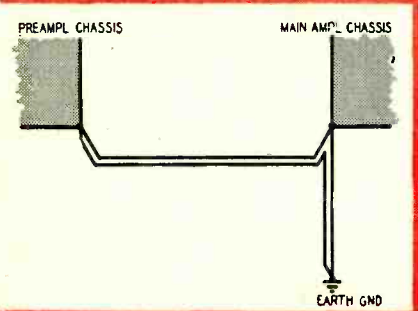


Fig. 1—Basic form of ground loop.



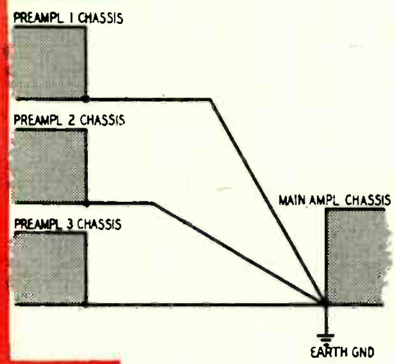


Fig. 2—Reducing ground loop area. Fig. 3—Using one ground connection.

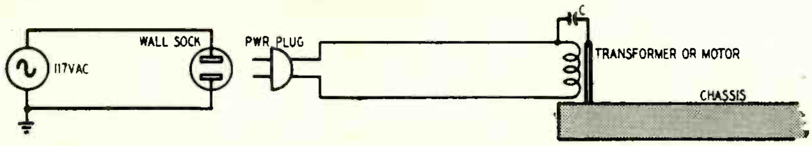


Fig. 4—Coupling effect is equivalent to a capacitor connected to the line.

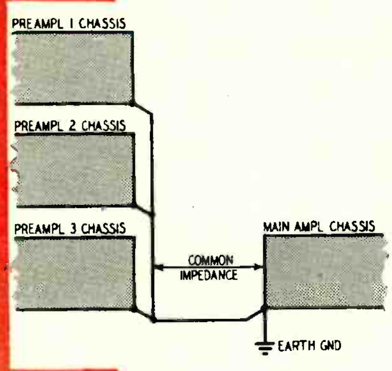


Fig. 5—Common impedance coupling.

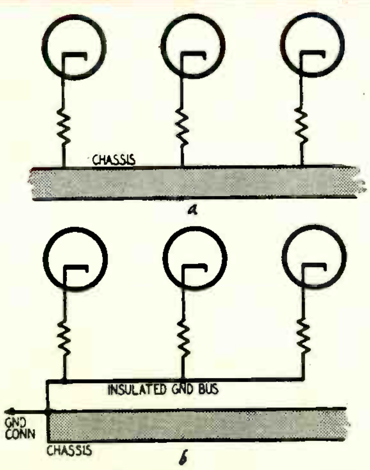


Fig. 6-a—Individual stages are grounded. Fig. 6-b—Using a common ground.

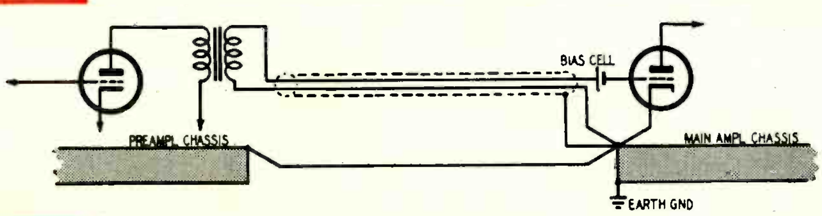


Fig. 7—Separating the signal circuit ground from chassis-to-chassis ground.

GROUND loops, and their resulting hum, are a much more common problem today than they were several years ago. One reason lies in the greater complexity of modern equipment. The older amplifiers were seldom called upon to do more than one or two jobs, such as amplifying the output of a 78 r.p.m. crystal pickup and the output of an AM tuner. Also the conventional practice was to have all the components, including the power supply, on the same chassis.

But those days have gone. Now, an up-to-date amplifier has to operate from an imposing list of inputs: AM, FM, TV; phono 33⅓ r.p.m., 45 r.p.m., 78 r.p.m.; and tape (plus a couple of other stand-by input circuits waiting for some new audio mediums to be invented). It is expected to perform with less noise, distortion, intermodulation, and hum than even laboratory equipment of 10 years ago.

Another factor making modern equipment more susceptible to hum is the extension in the range of bass-frequency reproduction. Obviously, the hum won't bother you if you can't hear any of its effects. If the woofer runs out of woof at 70 cycles, a lot of 60-cycle hum can go into the speaker before much comes out (unless the speaker starts to generate hum harmonics or intermodulation products or frequency-modulation of the signal).

Still another factor that makes some modern systems more susceptible to hum is the way the complete system is spread all over the house—the TV in one corner, the AM-FM tuner in another, the phono pickup in still another, the amplifier down in the cellar, and a big speaker assembly built into the wall of the living room. This is an open invitation to hum.

Electrostatic hum pickup can usually be controlled by using a good grade of shielded wire for all the high-impedance or low-level signal leads, being careful to keep the cable capacitance low to avoid losing the high frequencies. This type of hum can frequently be identified by the characteristic buzzing quality of its tone.

But sometimes even the most perfect shielding won't clear up all the hum—and then the fun begins.

When this kind of hum appears, the first cure is to connect each chassis to a good ground, such as a water pipe. Though this is a completely logical way to try reducing the hum, the hum is often made worse than ever!

When this happens, usually a ground loop is at fault. And a ground loop has some of the most puzzling characteristics that can be imagined. For example, the better the grounding connection, the worse the hum becomes.

The reason for this unusual result is easy to understand when the ground loop is reduced to its basic form, as shown in Fig. 1. The ground side of the signal circuit connects the two chassis together, and the individual lead from each chassis to ground completes a loop. This loop has no apparent source of voltage, but this circuit is actually a one-turn pickup loop, which immediately proceeds to couple itself enthusiastically to every power line in the vicinity. Since often there are a.c. lines running through the floors and walls, it isn't hard to visualize the induced circulating current.

Once this circulating current is set up, there will be a voltage drop along the ground wire between the two chassis, which appears at the input to the main amplifier as a 60-cycle hum mixed with the signal (or 50-cycle hum, in the 50-cycle power areas). To make thngs even worse, the lower the resistance from each chassis to ground, the higher this circulating current and the louder the hum.

The cure is simple. Since the amount of hum depends on the area of the loop, reducing the loop area should reduce the hum. Fig. 2 shows how this can be done, by running the grounding wire of the preamplifier right along with the other conductors. This approach makes the circulating current vanish when the area of the loop becomes very small.

This might be all right with just one amplifier and preamplifier, but when there are a number of preamplifiers feeding one main amplifier (such as a phono preamplifier, a tape preamplifier,an FM preamplifier, etc.), the resulting wiring can become a major project. Then it becomes much easier to break the ground loop completely. This is done by grounding only the main amplifier and depending on the ground side of the signal circuit from each preamplifier to bring all the chassis to the same potential, as shown in Fig. 3.

But even here, it is possible to run into trouble if a few simple precautions are not observed. Each ground line between the chassis must be solidly made, with heavy wire. Each preamplifier must have its own individual ground wire to the main amplifier. Each ground wire must run in straight lines, with no coils or loops, and these grounding line connections must be made between points on the various chassis that are at a true ground potential.

The reasons for using a low-resistance connection between the chassis is obvious, since the whole intention of the connection is to bring the two chassis to the same potential. If the ground side of the signal circuit has a questionable resistance, as is sometimes the case with braided shielding, it will do no harm to run a heavy chassis-to-chassis wire in parallel with the signal-circuit wiring to make sure the resistance is low. Be careful to keep this wire as close to the signal circuit as possible, otherwise another one-turn inductive loop may be set up, and the same old trouble will appear again. Or, use a multiconductor shielded cable between the chassis, with the extra conductors as the chassis-to-chassis connection.

Capacitive coupling

The precaution that each preamplifier have its own individual ground wire to the main amplifier is to remedy a certain disagreeable habit of power transformers, phonograph motors, tape drive motors, and similar components, of creating capacitive coupling to the power line through the transformer or motor.

This coupling effect is usually shown as being due to one equivalent capacitor, connected to one side of the power line, as in Fig. 4. Since one side of the power line is grounded, with the standard grounded-neutral wiring, it is obvious from following through the schematic that when the power plug is inserted the wrong way, the entire power-line voltage is capacitively coupled to the chassis. To demonstrate, just connect an ordinary 1,000-ohm-per-volt a.c. meter between the chassis of an amplifier and a water-pipe ground. With the meter set to the 10-volt scale, each volt indicated on the meter means 100 microamperes of charging current is flowing into the capacitor and then to ground through the meter. Reversing the power plug will change the current.

Ordinarily, this charging current flows directly to ground and can be forgotten. But when more than one preamplifier is connected to the same chassis-to-chassis ground wire, the current from one preamplifier will raise the potential of the next chassis up above ground again (Fig. 5). This is the same old trouble that existed at the beginning, where the different chassis all had different potentials with respect to ground. Plugging in the power cord the right way on all the units will reduce the effect, but it is obviously much better to avoid the whole problem by providing each preamplifier with its own grounding wire to the chassis of the main amplifier.

Connecting two capacitors in series across the power line *inside the chassis*, with the junction of the two capacitors grounded to the chassis, is often given as a sure cure for hum reduction or preventon. The reason this does not always work is that it is effective only for shorting out the *high-frequency* interference, which is often hum-modulated, and therefore appears as hum when it is rectified somewhere inside the equipment. The *power-frequency charging* current is always increased by this type of simple filter, and this current can cause additional hum if it is not allowed to flow to ground through its own ground wire.

Grounding the connections between points on each chassis which are at a true ground potential is especially important when a power transformer or motor is mounted near the chassis. The magnetic field around the motor or transformer will induce circulating currents in the chassis itself. As a result, two points only a few inches apart on the chassis can be at different potentials, even with a good, heavy chassis. So if any part of the chassis is included in the signal circuit, a hum problem can develop. Some of this hum is introduced into the signal by the grounding of the individual stages of the amplifier, as shown in Fig. 6-a. If the heater current of the tubes or the charging current of the first filter capacitor should pass through the chassis, a hum problem is practically built into the equipment.

The only sure way to avoid this kind of hum is actually very simple and requires only a little planning when wiring the equipment. This is to use an insulated ground bus inside the chassis for the ground point of all the circuits. Then connect this bus to the chassis at only one point—the point where the ground connection *between* the chassis is connected, as shown in Fig. 6-b.

Even after taking all these precautions, there is sometimes a small amount of hum present. In such a case, especially with high-gain equipment or when there is a considerable distance between the preamplifier and the main amplifier, there is a simple change in the circuit design which will usually eliminate all remaining traces of chassis-to-chassis hum. This change requires only a transformer at the preamplifier, with the connections made as shown in Fig. 7. With this hookup, the signal circuit ground line and the chassis-to-chassis ground line are in two separate circuits, and any hum developed between the chassis does not appear in the signal circuit. Using a grid bias cell instead of the usual cathode biasing resistor and capacitor, adds the finishing touch to what can be an entirely hum-free installation. END

SERVICING HIGH-FIDELITY AUDIO EQUIPMENT

Part III—Measurements must be made with specialized audio test equipment

By JOSEPH MARSHALL

IT IS possible to provide emergency servicing of high-fidelity equipment with only a v.t.v.m. and headphones. But to do a good job, some specialized instruments are necessary. High-fidelity is achieved principally by taking infinite pains with little details. Very often the defect which mars the performance is due to a very small departure from permissible tolerances. So the shop which does, or expects to do, a good deal of high-fidelity servicing, should invest in a few specialized audio instruments.

There was a time when good audio instruments were fully as expensive as they were scarce. Today, however, the market offers every type of instrument necessary for proper servicing of high-fidelity equipment.

The characteristics of high-fidelity equipment which require accurate measurement and testing are the following:

Frequency response

Ideally the performance of any piece of equipment ought to be measured and judged with the material it is normally called upon to handle. And, indeed, the final, crucial test of all high-fidelity equipment is that made by listening with a critical ear as it reproduces various types of music and speech. This is a matter we shall cover in detail in one of the succeeding articles.

Unfortunately, the waveforms of music and speech are too complex to use for measuring the electrical specifications and characteristics of amplifiers and they cannot be duplicated in the form of standard signals. However, we can get a pretty accurate idea of performance by measuring the response to waveforms such as sine and square waves. At one time we depended nearly entirely on sine-wave measurement; today we know that sine-wave measurement, though quick and convenient, is not adequate in itself. Therefore, we also measure and test response to square waves—a waveform which resembles the waveforms of complex music but is even more difficult to reproduce with faithfulness than musical waveforms—rather on the principle that a garage big enough to handle a Cadillac will take a Chevvy nicely.

Distortion

No matter how carefully we coddle the signal as it passes through a reproducing system, we inevitably distort it. Some of these changes are not significant; but others are so serious that they not only destroy the fidelity of the system but may be outright annoying. In good high-fidelity systems distortion is always held below the point of annoyance. However, even small amounts of distortion, not noticeably annoying in themselves, may destroy the realism of the system by masking the more subtle components of music, thus destroying its ability to distinguish the fine details of music. There are many forms of distortion:

1. Amplitude distortion produces sounds which are harmonics of the original sound. For instance, harmonic distortion of a 400-cycle tone would produce sounds of 800, 1,200, 1,600, 2,000, etc., cycles. This type of distortion is not too serious in small amounts since the harmonics resemble the natural harmonics produced by musical instruments themselves. The situation is rather like that existing when a pedigreed bitch has a litter by an equally pedigreed dog; there are more dogs than one wants but since all are thoroughbreds the over-all aesthetic effect isn't too bad. The effect is different with intermodulation.

2. Intermodulation (IM) produces sounds which are the sums and differences of two or more frequencies passing through the system. Thus a 60-cycle tone and a 2,000-cycle tone would produce sounds of 1,940 and 2,060 cycles respectively. These new sounds have no relation to the original and are nonmusical since they are not in the musical scale. It is as if the pedigreed bitch had strayed across the tracks to produce a litter of ugly, nondescript and dissimilar mutts.

Obviously the situation is worse if amplitude distortion is also present, as it always is; for if we have not only the 60- and 2,000-cycle tones but also their harmonics, then the sum and difference frequencies increase fantastically. We would have not only the intermodulation product of the original two tones but also the products of the harmonics of each tone, the harmonics of one beating with the harmonics of the other, and even the sum-and-difference products of the intermodulation sounds themselves.

3. Transient distortion, hangover or ringing. If any portion of the reproducing system is resonant it may turn into a generator and produce sounds of its own. It may do so constantly, if it is oscillating, or it may do so only when triggered into momentary oscillation by a suitable signal. The triggered signal does not have to be related to the resonant frequency of the guilty system; any strong signal may do the job, just as a stick, a stone, or even a ripe tomato, will produce a boom if they hit a drum hard enough. The jukebox boom of some speaker cabinets is just such a generated tone—the generator being the resonant cavity of the enclosure.

A related form of distortion is produced by a system which, though not resonant, or only broadly resonant, is not highly damped. The condition is very much like that which exists when one depresses the loud pedal of a piano: the undamped strings will now produce sound if the piano case is struck; and when a key is struck we obtain not only the tone produced by the original striking of the string but also echoes of the original which continue for some time. Similarly, a poorly damped reproducing system—especially a loudspeaker—will produce echoes of each peak of the waveform. A certain amount of hangover is not unpleasant, since it gives a vibrant, live effect, similar to that produced by playing an instrument in a room with very live acoustics; and indeed some loudspeakers have been designed deliberately to produce hangover and thus to increase the illusion of presence. It is clear, however, that such echoes not only change the character of the original music, but they also degrade the definition by obscuring the fine detail of the music.

4. Phase distortion does not ordinarily produce additional sounds, but it is of great practical importance in obtaining and maintaining high performance. To increase the bandwidth of a system and to reduce the distortion we use large amounts of feedback. How much feedback we can use without generating transient distortion depends principally on the phase shift of the amplifier. Therefore, the measurement of phase shift is one of the most valuable procedures in servicing high-fidelity equipment.

There is considerable difference of opinion about what constitutes permissible levels of distortion in high-fidelity systems. Generally speaking, most of the popular equipment has a distortion level of less than 2% at rated power output, and in some of it distortion has been reduced to levels as low as 0.1% at maximum rated output.

Measuring and checking harmonic distortion is rather difficult. Actually it is not as significant in indicating the performance of equipment as intermodulation or IM distortion. On the other hand, two-frequency IM distortion measurements yield significant information on over-all distortion characteristics.

There is a relationship of some sort between harmonic and IM distortion. Both are products of nonlinearity and they are invariably found together. Unfortunately, however, we do not yet know exactly what this relationship is. It used to be accepted that IM and harmonic distortion were present in a ratio of approximately 4 to 1, with the IM on the high side of the ratio line. This simple and convenient relation, however, has not stood the test of greater knowledge. It does appear to hold fairly well for high output and high distortion levels, but breaks down at low output and low distortion levels. In any event, the measurement of IM distortion is the most important single measure of audio distortion; and present high-fidelity practice calls for IM distortion levels of 2% or less at an output power of 6 watts or more.

Power output, efficiency and Sensitivity

None of these items is of really critical importance in high-fidelity performance. A system needs adequate power to handle the dynamic range of the signal and a little to spare; but at present most high-fidelity amplifiers are, if anything, over-designed in this respect because this is the easiest way to achieve low distortion. Sensitivity and efficiency are way at the bottom of the high-fidelity totem pole. Nobody cares how much input power is wasted in heat; and as for sensitivity, another very easy way to achieve low distortion is to operate every stage at a very low level, throwing away much of the possible gain.

However, power output and sensitivity are both significant clues to the behavior of a high-fidelity system. For instance, a falling off in tube performance decreases the power output, and measuring the power level while changing tubes is one of the best indications of the value of new tubes. Similarly, reduced gain may result in distortion through overloading or through a shifting of the operating curves; and gain measurements provide clues to the point in the system where low gain is producing the harmful effects.

All the tests essential for servicing and adjusting equipment can be made with four or five instruments: an audio signal generator; frequency test records to provide standard signals for phono testing; oscilloscope; a.c. v.t.v.m.; audio wattmeter; and intermodulation analyzer.

Audio signal generator

For high-fidelity servicing an audio signal generator should have these specifications:

1. Adequate frequency range—at least from 20 to 20,000 cycles. A range of 2 to 200,000 cycles would be even better and is often used for design purposes; however, it is difficult to obtain so wide a range without some sacrifice of other necessary qualities, and such instruments are more costly.

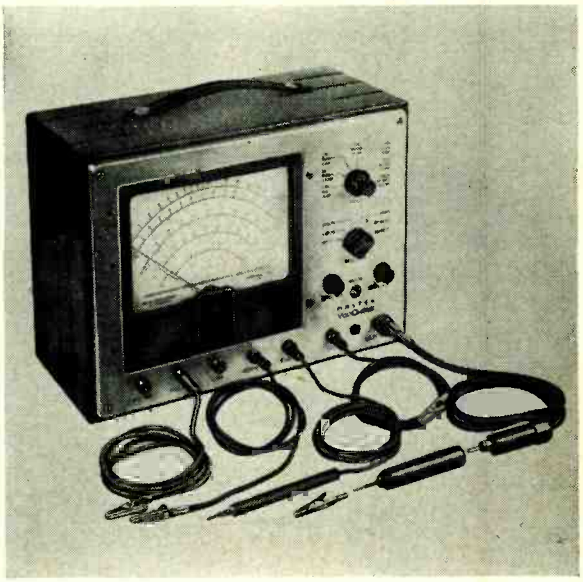
2. Constant output. To simplify the setup necessary for accurate frequency runs, and to reduce the number of instruments, the output of the generator should be as nearly as possible uniform over the full range. My own instrument, for instance, delivers an output over its full range of 20 to 20,000 cycles, which does not vary by more than ½ db except at around 20 cycles and 20,000 cycles where it departs from flatness by an additional ½ db or 1 db in all. This means that it is not necessary to monitor the output of the generator, as well as the output of the equipment under test; a saving of one instrument.

3. Low distortion. Since, as we have seen, the permissible distortion of high-fidelity equipment has to be extremely low, it is very important that the signal used for testing and measuring distortion be as free as possible of all forms of distortion. The R-C type generators, fortunately, produce almost pure sine waves, and if the associated amplifiers are adjusted for minimum distortion the total distortion can be held below 1%. Mine has less than ½%. Incidentally, the distortion of such generators can often be reduced by as much as 50% simply by adjusting the amplifiers or feedback network for minimum gain and minimum output. This may reduce the normal 10-volt output to 5 volts or even 2 volts, but actually this is more than sufficient.

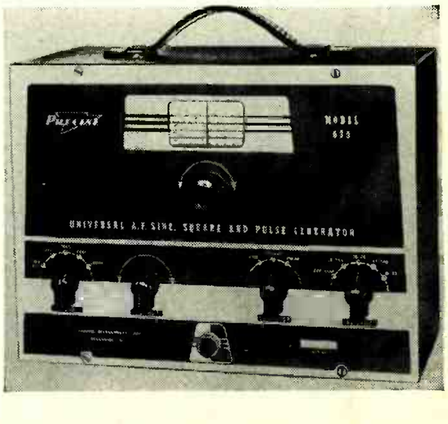
4. Provisions for supplying square waves. Suitable square waves can be produced by clipping the output of a sine-wave generator. Many generators include such a clipper and therefore provide a source of square waves as well as sine waves. Clipped sine waves are not as square as square waves generated by other means, and this should be taken account of in making tests. Examine the square wave at the output of the generator on a scope and note its shape—especially departures from classic square-wave patterns—so that you will not ascribe such departures to the behavior of the amplifier under test. A square-wave range of 20 to 20,000 cycles is ideal for high-fidelity purposes, although a 60- to 15,000-cycle range will serve.

5. Adequate range of output. For servicing purposes the test signal does not have to be high. The 10-volt output of typical generators is more than sufficient, and as little as 2 volts will do. It is more important that the minimum output be low enough to feed into low-level stages without overloading them. My generator, for instance, delivers a minimum signal of 1.5 mv and is adjustable to any value above that. Therefore I can check phono preamplifiers, mike input transformers, etc., without causing them to operate at distortion-producing high levels.

(TO BE CONTINUED)



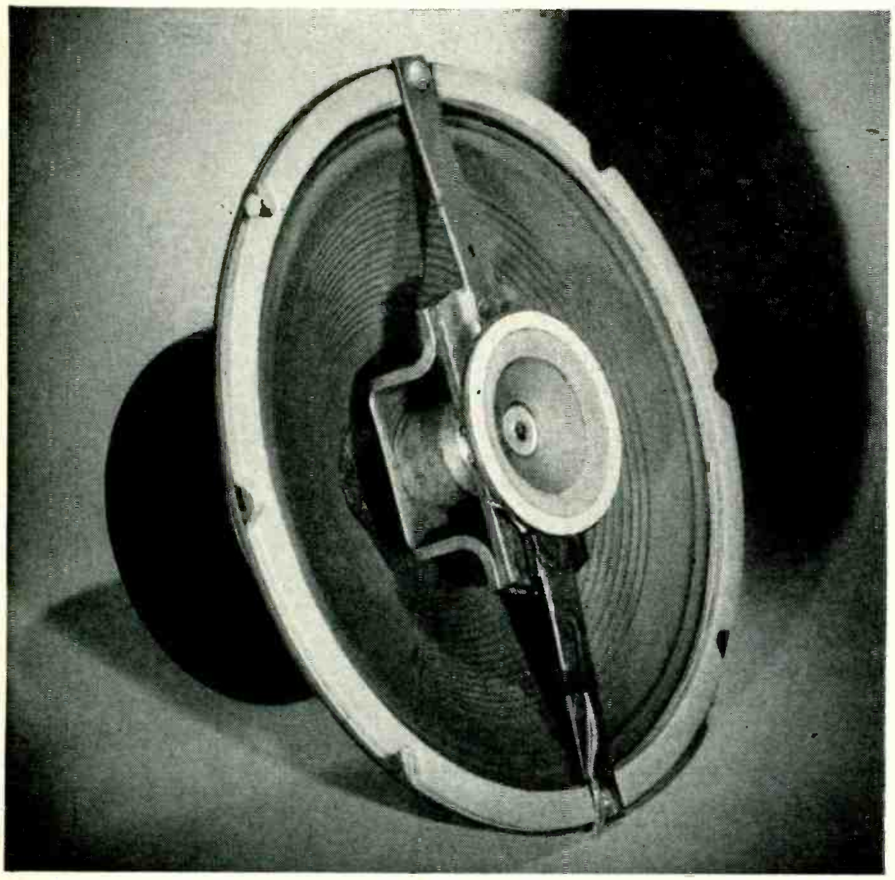
Typical test equipment necessary for high-fidelity servicing; distortion must be kept to an extreme minimum.



HIGH-FIDELITY LOUDSPEAKERS

By H. A. HARTLEY

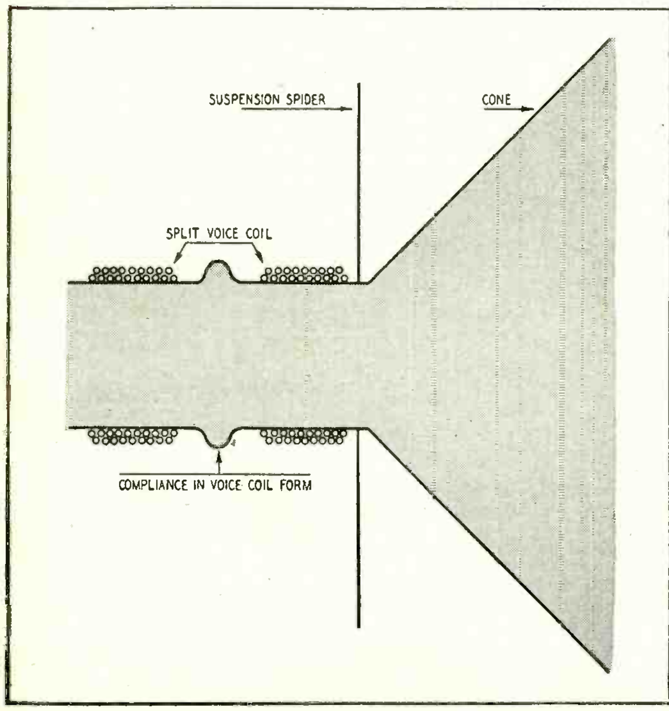
Part II—Mechanical and electrical features of voice-coil design



A Stromberg-Carlson coaxial speaker. Note difference in voice-coil diameters.

IN the previous installment it was shown that the mass of the cone has a direct bearing on the treble response of a speaker. Since the voice coil is attached to the cone, the mass of the voice coil is equally important.

There are two ways by which the voice coil can be made *selective* for treble and bass. The simpler way is to wind the coil in two sections separated by a space, on an elastic or compliant form (Fig. 1). At high frequencies the coil nearest the cone apex drives the cone directly, but because of the elastic form the weight of the more distant half is "left behind"; at low frequencies the elasticity is not effective and the entire coil drives the cone. It would seem, however, that if this is what actually happens, then the sensitivity of the speaker at high frequencies is reduced, since only half of the coil is cutting the flux in the gap—or rather, only half of the coil is actually driving the cone. In the other method a *metallic* tube is firmly cemented to the cone apex (aluminum being chosen to save weight); over the metal tube is stretched a flexible sleeve. The voice coil is wound on a nonmetallic form, the internal diameter being such that it snugly slides over the flexible sleeve (Fig. 2). The diameter of the aluminum tube is now increased (spun out from the inside) so that the



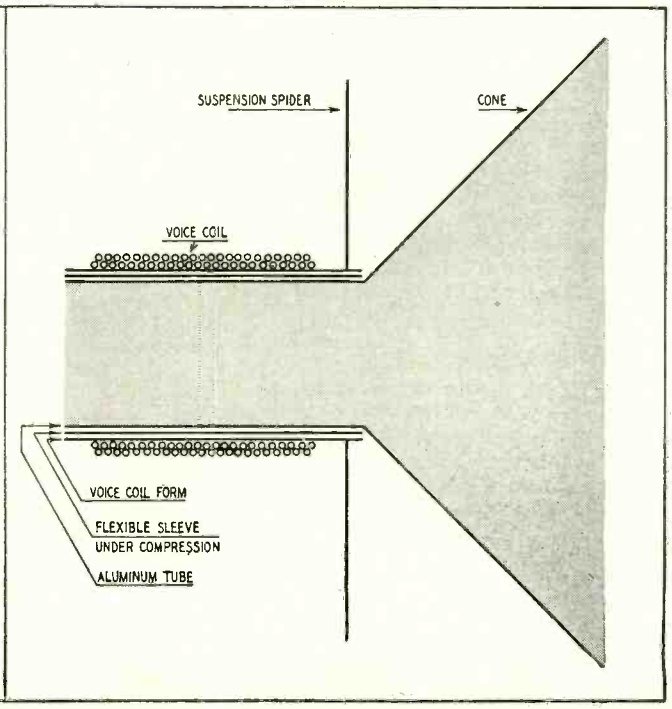


Fig. 1—(Left) Diagram shows split voice coil wound on compliant form. Fig. 2—(Right) Unusual voice coil coupling.

sleeve is subjected to compression. The voice coil and the internal tube form a transformer, the secondary being a single turn. This transformer, being air-cored, is effective for high frequencies but not for low. The presence of the flexible sleeve allows for some independence of movement axially between the metal tube and the voice coil winding.

When a high-frequency signal is applied to the winding, a current is induced in the aluminum tube, the secondary of the transformer; because this tube is loosely coupled (mechanically) to the voice coil, it can move independently and drive the cone without the handicap of the mass of the voice coil. At low frequencies there is no induced current in the tube and the flexible sleeve is under too great a compression to permit movement between the tube and the coil; therefore the drive is direct from the voice coil to the cone. A little thought will show that this arrangement is virtually a mechanical cross-over filter.

One final point in cone design does not seem to have been mentioned by other writers. The cone partially encloses a body of air, as does an organ pipe or a speaker cabinet. This air has its own resonant frequency, called air-column resonance. When this body of air is set in motion it resonates at its natural frequency and this acoustic output will be added to the normal output of the speaker. The effect is extremely difficult to measure and is best judged by the sound of the speaker. As would be expected, exponential cones do not suffer from this fault, since the amount of air enclosed is small, but large straight-sided cones give a pronounced hoot at some frequency between about 500 and 1,000 cycles. Smaller cones necessarily enclose air too, but the resonant frequency of small volumes of air is high enough to compensate for the natural loss of output resulting from the mass of the cone. A smart designer can proportion the cone so that this air-column resonance can fill up a hole in the response curve. Normally speakers do not have dips in the curve between 500 cycles and 1,000 cycles.

Voice coil design

Returning to the voice coil, we are concerned mainly with mechanical and electrical features. Special voice coils for acoustical effects have been mentioned, but, generally speaking, a voice coil is just a voice coil. The coil should be rigid and remain circular under temperature extremes so that, with small gap clearances, it never rubs on the pole pieces. It should be as light as possible so that the treble response is not impaired and transients are not distorted. Two layers of wire are necessary so that the points of entry and exit can be brought out at the same end, nearest the suspension. Some coils have four layers, seemingly to provide a higher impedance, but there is nothing to be gained by this, and there are disadvantages, such as lack of rigidity.

Design features for baffle-loaded speakers.

1. A single speaker capable of reproducing the frequency range needed for high-fidelity reproduction requires great skill to design, but is possible.

2. A complex wave is reproduced by a single diaphragm because of cone breakup. For best results this breakup must be carefully controlled. The apex of the cone reproduces the highs; the entire cone moving as a piston reproduces the bass.

3. The harder the cone material the better the treble and bass response, but this interferes with cone break-up. Concentric ridges in the cone do not appear to affect the break-up, but improve the bass response by stiffening the cone radially and so counteract the development of nodes.

4. Large cones node radially more easily than do small ones, and exponential cones node axially. Nodes reduce bass output and introduce undesirable harmonics.

5. The cone material should be acoustically inert. Metal diaphragms produce a characteristic *ringing* coloration.

6. Narrow-angle cones cause excessive focusing of the high frequencies. Wide-angle cones give better diffusion but tend to node more easily.

7. Large cones are too massive for good treble response and transient reproduction. Their size can cause phase distortion of the low-frequency components of a heavy transient.

8. Small cones cannot reproduce low frequencies with sufficient output unless the suspension is free enough to enable them to move the same amount of air as a large one.

9. Subsidiary tweeter cones give more treble, but the undamped outer rim causes feathery reproduction if driven hard. The narrow angle of the tweeter cone also causes excessive focusing of the highs.

10. Large straight-sided cones cause the enclosed air to resonate at its own natural frequency, causing a superimposed hoot. Exponential and small cones do not suffer audibly from this defect.

11. Treble response can be improved by specially designed voice coils, where the diaphragm is relieved of the weight of the coil at high frequencies.

12. The voice coil should be as light and rigid as possible, with only two layers of wire. The wire should be double-silk-insulated to provide a good key for the varnish. A 1-inch coil is more rigid than a 2-inch, but a 2-inch pole piece allows for a greater flux density in the gap.

13. Tight suspension gives a high bass resonant frequency, and frequencies below this will be reproduced mainly as third harmonic. Free suspension can introduce intermodulation distortion and nonlinear distortion.

14. To avoid intermodulation distortion the voice coil must cut constant flux at all points in its excursion. The coil must be substantially longer than the gap.

15. To avoid nonlinear suspension distortion the magnetic field must be symmetrical about the gap. If the center pole is shouldered, a flat front magnet plate cannot give a symmetrical field.

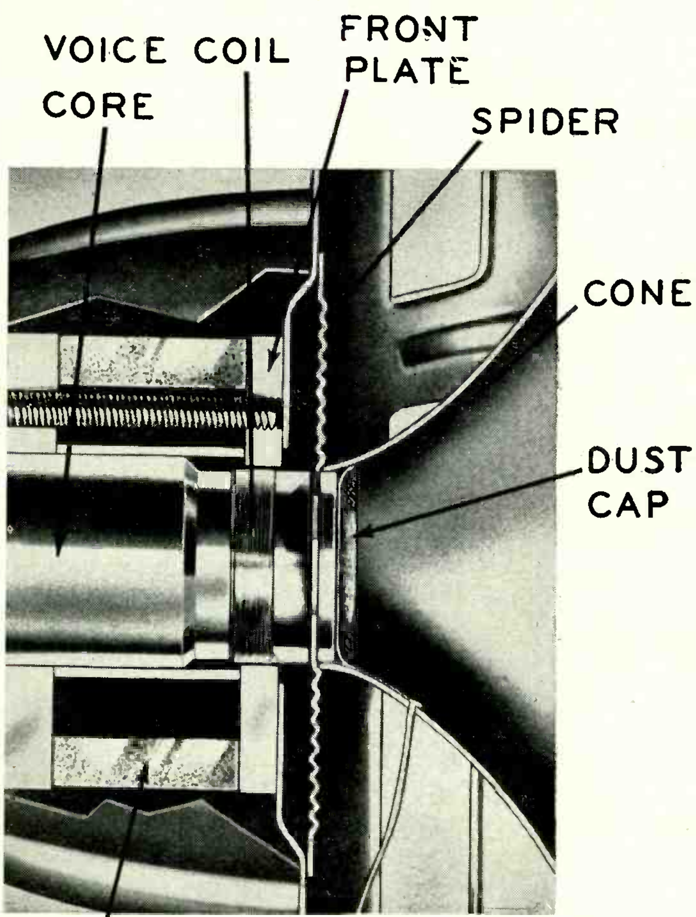
I am of the opinion that the wire should be double-silk-wound to provide the best tooth for the cement which must be applied to prevent loose turns. Enameled wire is most frequently used, but this is false economy. The cement or varnish will penetrate the silk layers and give a strength not otherwise obtainable.

The diameter of the coil is dependent on what the designer is trying to do. A one-inch coil is more rigid than a two-inch, but a one-inch magnet pole is more quickly saturated than a two-inch. The diameter of the center pole determines the attainable flux density in the gap. If, for a given gap width, the flux obtained with a one-inch pole is 12,000 lines per square cm, no increase in the quantity or quality of the magnetic material can improve on this figure; if the diameter of the center pole is increased to two inches, the flux can be raised to 17,500 lines. On the other hand the lesser rigidity of the two-inch coil demands greater clearances in the gap and this will reduce the flux to some extent. Free suspension also requires greater mechanical clearances.

The design of the voice coil must be determined by the freedom of suspension, as must that of the magnet system. The ordinary speaker has little freedom of movement, so the magnetic gap need not be long. (Most cheap speakers have a gap about 3/16 inch.) The voice-coil winding is made a little longer than this, so that the fringing flux is cut, to improve sensitivity. Concentration of the flux in a short gap also saves magnetic material. Such a design is useless for high-fidelity reproduction, since a tightly suspended speaker may be unable to reproduce any frequency below approximately 100 cycles.

With free suspension new problems are met. A short coil moving in a short gap will cut fewer lines as it moves from its normal position. Under this condition the sensitivity will be reduced. If the displacement is brought about by a low-frequency signal (as it normally would be) then a simultaneous high frequency will result in the high-frequency output being modulated by the low, owing to the periodic desensitizing of the speaker. This has been called the Doppler effect, because of the assumption that the movement of the diaphragm was what produced the wobble.

This is a mistake, as can easily be proved by constructing a speaker in which the coil remains in a constant field of flux while simultaneous propagation of a high and low note produces no wobble. Some designers have resorted to multiple-speaker systems in the belief that they could avoid the so-called Doppler effect, yet the effect can be heard on any woofer if the coil is allowed to move into a weaker magnetic field. The trouble can be avoided if the coil is long with respect to the gap, or the gap is long with respect to the coil; but a long gap demands a powerful magnet. The usual method is to keep the coil long.



Sectional view of the G-E S-1201-D showing suspension of voice coil in magnetic gap.

Cone suspension

If the cone is very freely suspended and the magnetic field is not absolutely symmetrical about the gap, the phenomenon of electromechanical rectification can be seen when a signal of about 50 cycles is applied to the speaker. In conventional magnet design the fringing flux is stronger behind the front plate of the magnet than in front of it, and with the application of the 50-cycle signal the coil crawls out of the gap and stays out. This is due to the first half-cycle driving the coil into a weaker field and the second half-cycle not having the same restoring force due to the weaker field.

Most speakers use a corrugated surround for the cone and a somewhat restricted rear suspension spider for the voice coil. These limit the movement; they also provide a powerful restoring force. The rectification effect therefore is not very obvious, but nevertheless it exists, and it is in conflict with the restraining suspension. A properly designed speaker will show the cone-coil assembly oscillating symmetrically about the gap, the suspension being used only to hold the coil concentric with the gap.

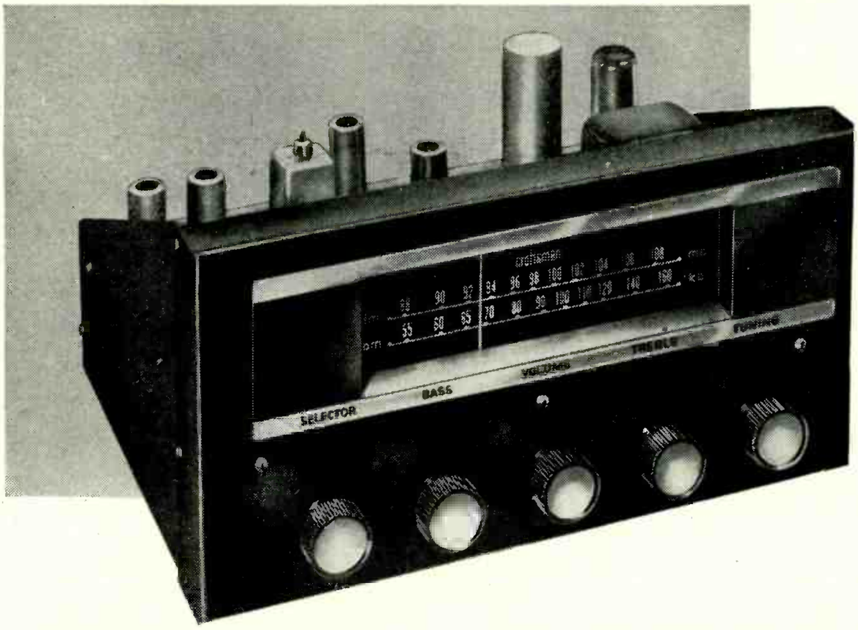
If, however, an asymmetrical magnetic field causes the coil to move out from the gap, even by a small amount, then movement will not be symmetrical about the mean position and the suspension will be strained to keep the coil centered. In other words, with the application of a steady signal, the suspension will not be linear, and the acoustic output of the speaker will contain nonlinear distortion.

The foregoing discussion has been somewhat long and involved, yet without it a proper appreciation of all the factors in baffle speaker design cannot be acquired.

As in all technical subjects the study of fundamentals is rarely exciting. However, it is only through this method that we can ascend to a plain of thorough understanding of the comprehensive subject. From my discussion in this and the previous article, we are now prepared to examine conventional present-day types of loudspeakers.

This "High-Fidelity Loudspeakers" series will continue in the future on a bi-monthly basis. The next installment, Part III, will appear in the June issue. It will discuss horn-loaded speakers and multiple-unit speaker systems. END

HIGH-QUALITY AUDIO



Part VIII—High-quality tuners; AM and FM amplification and detection

By RICHARD H. DORF*

Fig. 1—Radio Craftsman type 800 tuner.

HOME music systems are by no means useful only for listening to phonograph records. Many owners derive their greatest enjoyment from the reproduction of good radio programs, at least in those areas where good programs (from a technical viewpoint) are available.

A good radio tuner is not cheap; yet it is important to the over-all sound quality of the system.

FM and AM tuners have existed as long as radio itself, but the tuners in radio sets and radio-phonograph combinations of what we like to call the department-store variety have always been on the same chassis as the audio amplifier and power supply. More important, the tuner quality has been on a par with the rest of such mass-produced merchandise—adequate, but hardly what we consider suitable for high-quality system use.

In principle, the tuners which are now supplied as separate units for high-quality systems are similar to the traditional ones. Their function is to tune in the station and demodulate the signal. But, just as in audio amplifiers, the resulting sound is good, mediocre, or bad, depending on the circuits and parts used in the tuner.

Tuner quality

What makes for quality and what should we look for when selecting a tuner? You can buy a rather nice table-model FM-AM receiver for less than $100, and yet, you can't buy many tuners for less than $100.

Fig. 1 is a photo of the Radio Craftsmen type 800 tuner. It is representative of several tuners on the market. It tunes both AM and FM, and has tone controls and phonograph preamplifier.

* Audio Consultant, New York City

Fig. 2 is a block diagram of the 800. Starting at the AM antenna, the first stage is a 6BJ6 r.f. amplifier. R.f. amplifiers are not usually found on ordinary receivers. A better and more descriptive name for this stage is preselector, because its purpose is not only amplification but also rejection of undesirable signals. Containing at least one tuned circuit, it discriminates between the desired signal and an image signal—one removed in frequency from the desired signal by twice the intermediate frequency.

Existence of a preselector or r.f. amplifier stage is obviously a quality factor and should be expected in any high-quality tuner. It also improves the signal-to-noise ratio. In Fig. 2 the FM section also begins with a preselector stage, a 6CB6.

The local oscillator is one-half of a 12AT7 and is used for both AM and FM. Naturally, there is a difference in the operating frequencies for the two bands, but there is no reason why (with proper design) a single oscillator will not work for both.

The mixer stages are one-half of a 12AT7 for FM and another for AM. The pentagrid mixer commonly found in ordinary receivers is there as a matter of economy. In a high-quality tuner a separate oscillator tube is a quality factor. Oscillator frequency drift can be a major FM problem, but by use of stabilizing circuits and components with proper temperature coefficients, a separate oscillator stage could be made extremely stable. The triode mixer is a nonlinear amplifier fed directly by the preselector and through a small gimmick or pickup coil from the oscillator tank circuit.

The i.f. amplifier in Fig. 2 has three stages for FM and two for AM. The stages common to both AM and FM use the same tubes but separate i.f. transformers. The bandwidth of a tuner depends largely on the i.f. section. On this tuner the AM band is 13 kc wide, giving AM frequency response to about 6,500 cycles. While AM could in theory be as high in sound quality as FM, that is impractical, especially in crowded areas, because of band crowding and increased noise with wider bands. Some tuners have an adjustable AM bandwidth, allowing a wider band —perhaps to about 9,000 cycles—when conditions warrant it. The FM bandwidth on the RC-800 is 190 kc, sufficient for receiving the full FM bandwidth set by the FCC at a maximum of plus and minus 75 kc from the carrier frequency—a total of 150 kc. Smaller-bandwidth i.f.'s would clip audio peaks.

The gain of an FM i.f. stage is less than that of an equivalent AM stage. First, the band is wider, meaning that the tuned circuits have a far lower Q. Second, at the higher frequency (10.7 mc is the usual FM i.f.; 455 kc for AM), gain from a given tube is always somewhat smaller. In addition, limiter stages reduce the signal amplitude at the detector.

The AM detector is one of the diodes of a 6AV6 duo-diode-triode, the other diode plate is used for a.v.c. The a.v.c. on AM is conventional. Following the AM detector there is a 10-kc trap that filters out the whistle which might result from the heterodyning of two stations separated by the 10-kc AM bandwidth. This trap is a high-quality feature; before the popularization of high-quality home systems it almost never appeared in anything but professional type equipment. From the trap, the AM audio goes to a point on the switch provided to select various sound sources.

A third FM i.f. amplifier is provided for additional i.f. gain. This is followed by two of the most important stages in the tuner—the limiters. The presence or absence of limiters and the type of FM detector is one of the important quality-determining factors

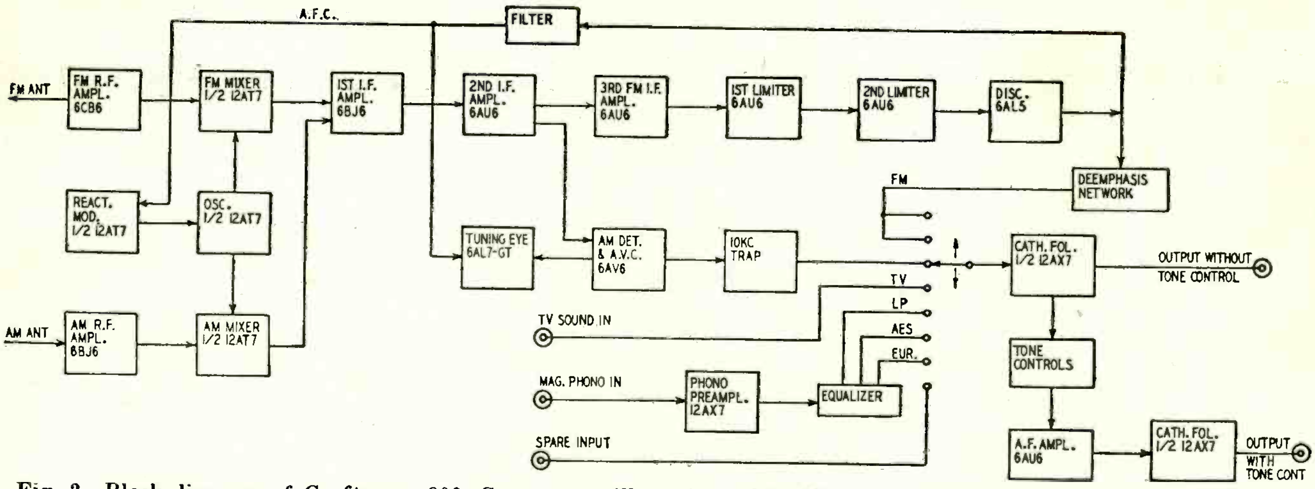


Fig. 2—Block diagram of Craftsman 800. Common oscillator is used for FM and AM. Switch selects various audio inputs.

of a tuner.

Features of FM reception are wide, low-distortion, audio-frequency range and low noise. I.f. amplifiers of adequate bandwidth maintain a good signal-noise ratio and keep amplitude distortion low. Some cheaper receivers and tuners do not have adequate bandwidth because the manufacturer wished to economize by reducing the number of i.f. stages. To get adequate gain he had to peak the i.f.'s.

Most atmospheric noise is principally AM—it exists as variations in amplitude. The FM signal consists of variations in the frequency of a constant-amplitude signal. The trick in the receiver is to recover the frequency variations of the signal without passing the amplitude variations of the atmospherics. The limiter does this by acting as an amplitude clipper.

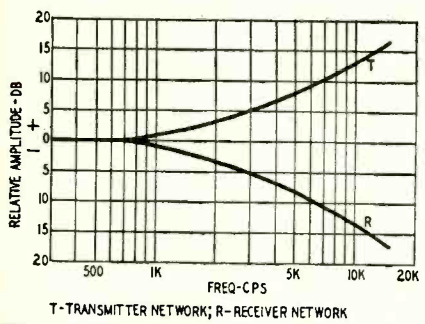


Fig. 3—Complementary response curves.

The number of limiters in a particular receiver—one or two—determine the signal-to-noise ratio of the final audio. The ratio detector has some inherent amplitude-limiting action, and is sometimes used without any i.f. limiter stages as a matter of economy. In practice, the ratio detector does not limit sufficiently, and tuners which use it should have at least one separate limiter stage. It is better practice to use two limiters and a detector of the Armstrong type.

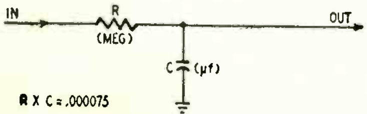


Fig. 4—Simple de-emphasis network.

The audio which modulates every FM transmitter passes through an equalizer which emphasizes the treble in accordance with a 75-microsecond curve. This simply means that a high-pass R-C or L-C filter is used which has a time constant of .000075 second. The resulting pre-emphasis curve is shown in Fig. 3. It has a turnover (3-db boost) point at slightly over 2,000 cycles and rises approximately 6 db per octave.

At the receiver the audio circuit following the detector should have an exactly complementary network to reduce highs at this rate so that an over-all flat transmission results. At the same time, of course, any noise which may have crept in between transmitter and detector and which is in the region above 2,000 cycles will be attenuated by the receiver network.

There are some tuners which do not have the proper de-emphasis network, probably because the manufacturer felt that exaggerated treble would impress buyers. The network consists only of a single resistor and capacitor as illustrated in Fig. 4. The user should either buy a receiver with the right values or insert them himself. To check values it is necessary only to know that R × C should equal .000075, with R in ohms and C in farads, or, R in megohms and C in micromicrofarads, with 75 as the desired result. Typical values are 750 μμf and 100,000 ohms, or .0075 μf and 10,000 ohms.

The last point to be gathered from Fig. 2 is the a.f.c., a circuit which makes FM receivers more convenient to tune, and minimizes drifting. The latter is important, because distortion is created whenever the signal is not tuned to exact center. This is due to

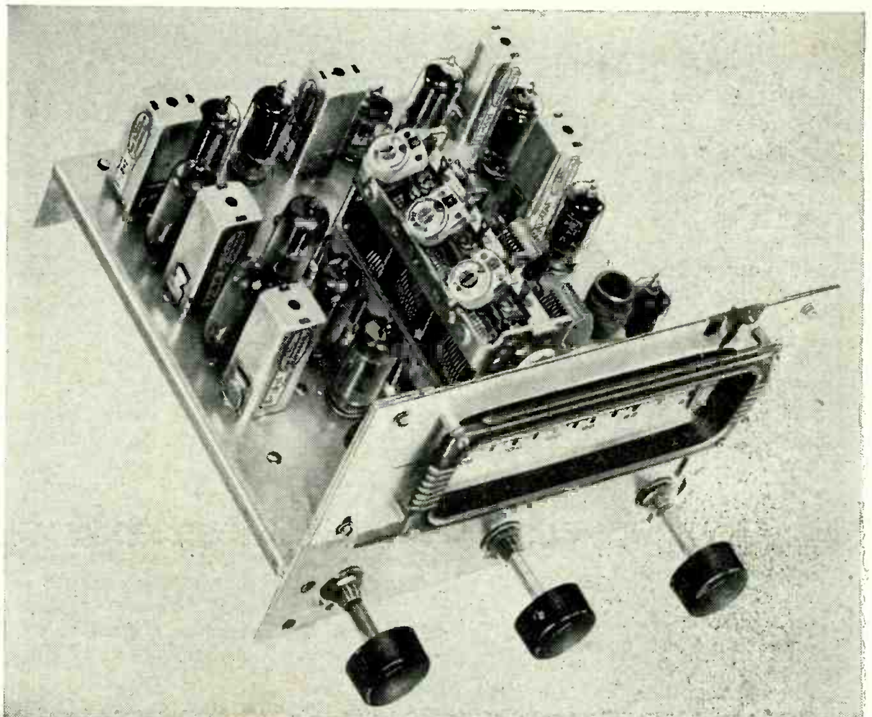


Fig. 5—The Approved type A-710 AM-FM tuner, typical of present day design. Layout of tuner makes for simplification of operation and ease of servicing.

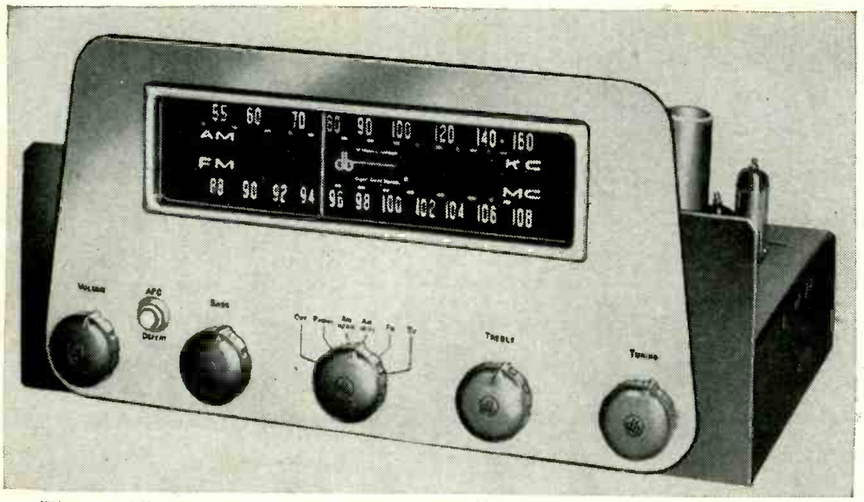


Fig. 6—The Bogen model R701 FM-AM tuner features high sensitivity.

the response of the i.f. stages being no longer symmetrical with respect to the carrier center.

Excellent and simple a.f.c. is possible because an FM detector actually produces from the i.f. signal a direct current whose polarity and value depend on the signal frequency variations with respect to the center frequency. If the signal is tuned to one side or the other, the average d.c. level assumes a particular polarity and amplitude. A reactance modulator is connected across the local oscillator tank circuit so that with zero grid voltage its reactive shunt value tunes the oscillator to the frequency corresponding to the dial setting. When there is no signal or when the signal is tuned exactly right this condition exists because the detector output averages zero.

However, when the signal drifts to one side or is manually tuned incorrectly—which is to say that the local oscillator frequency is incorrect—the detector output biases the reactance tube grid in such a way as to add or subtract reactance to the oscillator tank and correct the condition. A.f.c. cannot correct for really large errors nor can its correction be absolutely perfect—if there is no error signal there can be no correction. In practice it provides a kind of *slot* tuning. The dial is turned and suddenly the signal drops into the slot and is heard, without the *tuning-in* sound normally heard. It is still very desirable to tune to center manually by observing the double-beam electron-ray tube (which also operates from the a.f.c. voltage), for if the a.f.c. is required to make too much correction it is unable to perform at its best; in addition, the preselector circuits will not be correctly tuned.

The Craftsman 800, as do many other tuners, includes some audio amplification, a function switch, tone control, phono preamplifier, and so on. These are not related to the tuner, and some people feel they should not be included, since their presence detracts from the idea of selecting each component separately.

We can sum up the specifications to be examined in an FM-AM tuner with comments on what may be expected.

Tube complement is not important, though probably a simple tuner (without extra gadgetry) with less than 10 tubes or so will lack gain or some one of the quality features we have discussed. But do not buy a tuner just because it has more tubes than another.

Controls should be sufficient to do the job and no more. Essentials are a tuning knob, volume control, FM-AM switch, and power switch which may be on the volume control.

Antenna requirements should be easy to meet. Most tuners incorporating FM have 300-ohm inputs for the ribbon-line normally used for TV reception. Where signals are not excessively poor, most family television antennas should be satisfactory for tuner use. Connect it to both the TV receiver and tuner by using a two-set coupler.

Sensitivity is defined differently for AM and FM. On AM, between 5 and 10 microvolts for 1 volt audio output is very good sensitivity. In normal- and high-signal areas much less sensitivity (larger input for the same output) is adequate. On FM, sensitivity is defined as the input required for a certain quieting action by the limiters. This is affected both by the gain of the antenna-tuner system and by the limiters. The RC-800, for example, is rated at 5 microvolts for 30 db quieting, which is excellent performance.

Audio output and distortion figures are easy to understand. A tuner should give at least 1 volt output, and preferably slightly more, since most amplifiers require this level. Distortion originating in the tuner's detector and audio stages should be negligible—well below 0.5%. Incidentally, some tuners have cathode-follower output stages which are advantageous because they permit a fairly long transmission line between the tuner and the rest of the equipment without noise pickup or treble bass.

Intermediate frequencies are of no interest from a quality standpoint. They are usually 455 kc and 10.7 mc for AM and FM respectively.

Bandwidth is important. It must be over 150 kc for FM and may be up to 20 kc for AM in rare cases.

Frequency response can be judged as it would be in any other equipment. There is no excuse for anything poorer than 20 to 20,000 cycles within 1 db.

Distortion originating in the tuner components and the i.f. section should be well below 1% on both AM and FM.

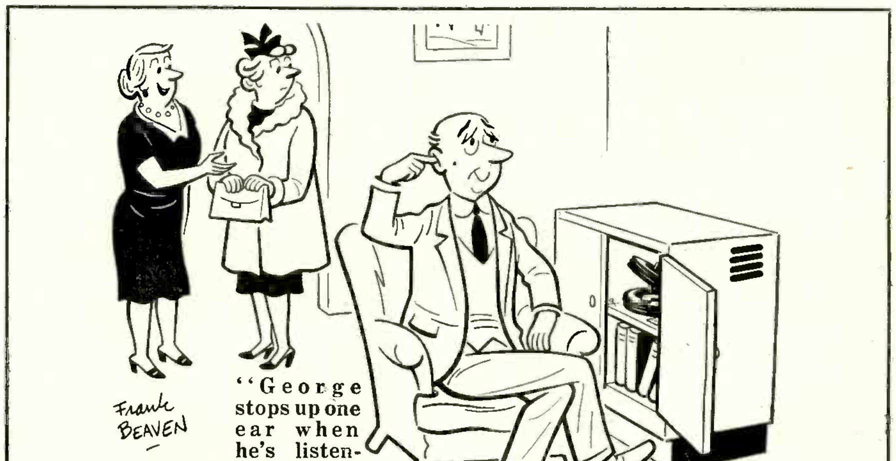
Selectivity is normally rated for AM only, where it can be judged by examining ratings of various tuners. High selectivity is not usually demanded on FM, where a large response is required. On AM the RC-800 has 60 db rejection at 20 kc from the carrier.

Hum and noise originating in the tuner should be very low, 50 to 60 db below rated audio output. This is another point of departure from the standard receiver where hum is usually quite audible.

Power consumption is unimportant, 40 to about 75 watts being common.

The fact that the Craftsmen 800 has been used here for illustration does not imply any preference for it, though it is an excellent tuner; it was simply very suitable for a talking point. Whereas only a very few good tuners were available a few years ago, today many acceptable to excellent units are made. An example is the Approved type A-710 shown in Fig. 5, and another is the Bogen type R701 of Fig. 6.

(TO BE CONTINUED)



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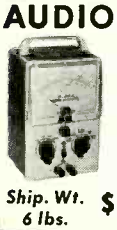

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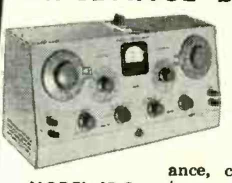

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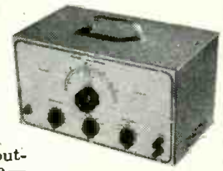

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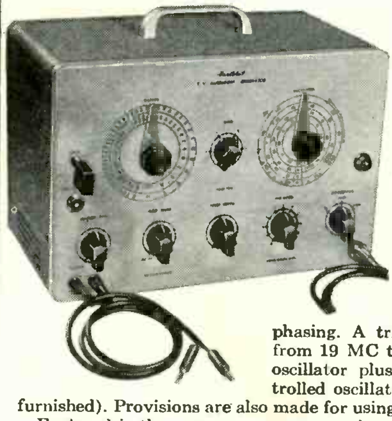

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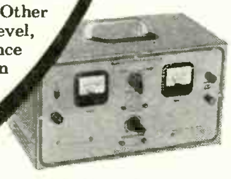

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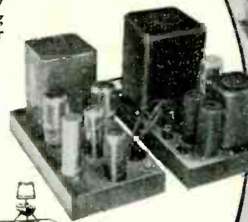

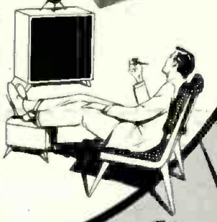

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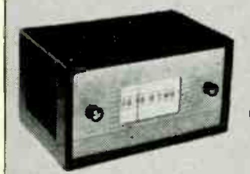

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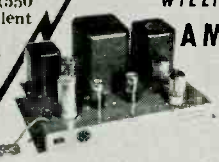

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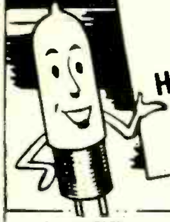

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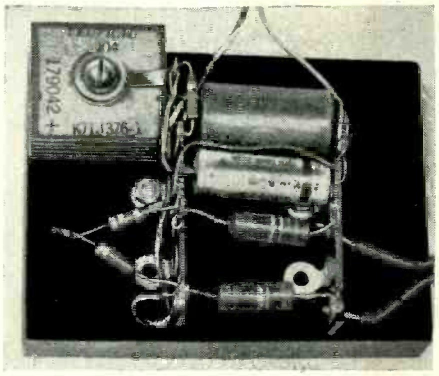
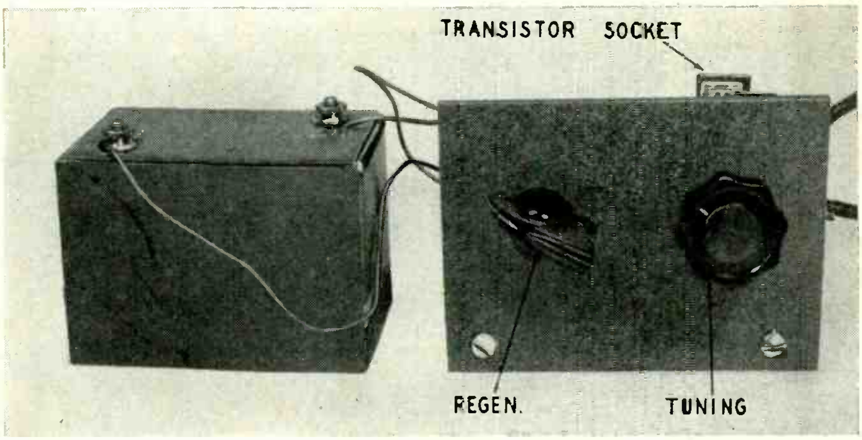
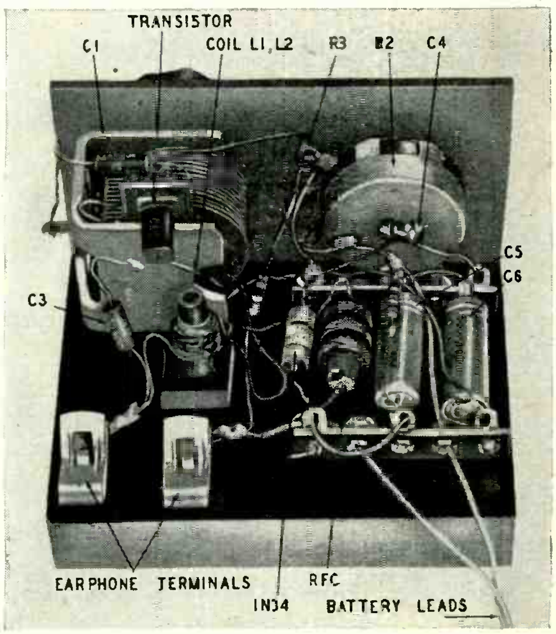


Top, a.c. power supply for receiver. 100 ma selenium rectifier and components are mounted on a bakelite chassis.



Center, with only two controls, operation is simple. Low current drain insures long battery life.



Right, layout of the regenerative receiver. Mounting strips permit neat arrangement of parts.

REGENERATION "soups up" the performance of transistor receivers. Simple transistor radios without regeneration are just crystal detectors followed by audio amplification. There is no r.f. amplification, and sensitivity and selectivity are always poor. In contrast, the regenerator has high gain and sharp selectivity.

You or your friends may have attempted to build a transistor regenerator and found it did not work. Several factors make the design of a workable transistor regenerator different from the vacuum-tube equivalent.

First, the transistor must be able to sustain r.f. oscillation throughout the entire broadcast band. Whether or not this can be done successfully depends upon the design of the feedback and tuning circuits. Unlike vacuum-tube oscillators, transistor oscillators are not inherently self-starting. Tubes draw heavy current when they are first turned on and shock their circuits into oscillation. The transistor circuit must have starting features built into it. Furthermore, the transistor must be made d.c. stable or it may lock itself into a condition of inoperation.

Fig. 1 is the successful regenerative transistor circuit. Feedback is from collector to emitter. The emitter circuit impedance is very low, unsuitable for a parallel-tuned circuit. This is the reason the tuning capacitor and coil are placed in the collector circuit. Here the impedance is moderately high. The tickler winding feeds the emitter.

With tubes, detection or demodulation takes place in the tube. The grid rectifies the r.f., charging a grid-leak capacitor. The voltage across the grid-leak follows the modulation, placing an audio signal on the grid. Unfortunately, this scheme of things will not work with the junction transistor.

The reason it does not work is simple. To cause enough collector current to flow for r.f. oscillation, the emitter must have a constant bias current flowing through it. This emitter-current flow ruins the emitter's effectiveness as a detector-rectifier. This means the signal must be detected by something other than the transistor. *The problem of allowing the transistor to oscillate and still detect the signal can be solved by using a separate rectifier (a1N34).*

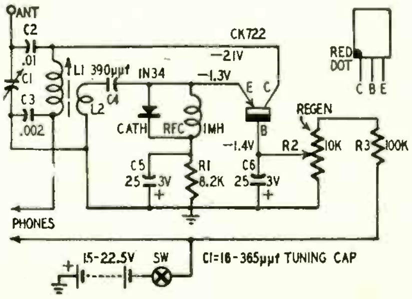


Fig. 1—Regenerative transistor circuit.

Let us get a complete picture of the circuit operation by following an r.f. signal through the detector. The signal, arriving from the antenna, is fed into L2 by transformer action from L1. The signal then passes through C4. This capacitor prevents the d.c. emitter bias from shorting to ground through the tickler coil (L2). It also blocks the audio signal that will be developed by the 1N34. C4 and R1 provide an action without which most transistors will not oscillate past a frequency of 600 or 700 kilocycles.

From C4 the r.f. flows both to the 1N34 and to the emitter. The r.f. choke RFC prevents the r.f. signal from bypassing to ground. The r.f. that reaches the emitter is amplified in the transistor and is fed back into L1. This feedback gives r.f. amplification by reducing the r.f. resistance of the tuning circuit.

Part of the r.f. signal reaches the 1N34 and is rectified by it and charges C5. The charge on C5 then varies with the modulation frequency and amplitude. This audio voltage flows easily through the r.f. choke (RFC) and varies the emitter current. From here, it is amplified in the transistor, flows through the tuned circuit and into the earphones.

Some will ask why the 25-μf capacitor (C5) does not shunt all the audio to ground. The answer is the low impedance of the emitter. For all but the very highest audio frequencies, the emitter impedance is lower than the shunt reactance of C5. Therefore the emitter absorbs the audio power. Experiment will bear this out. Try low values for C5—say .05 to 0.5 μf—and the audio amplification will be very low. The same thing results if the 1N34 is disconnected. Without the 1N34 rectifier, detection will take place only with the regeneration control rotated all the way to ground. Then the set will not regenerate!

Potentiometer R2, in the base circuit, controls the emitter bias and r.f. gain. Capacitor C6 bypasses audio and r.f. around the potentiometer. Here, 25 μf is a good bypass value because of the higher impedance of the base.

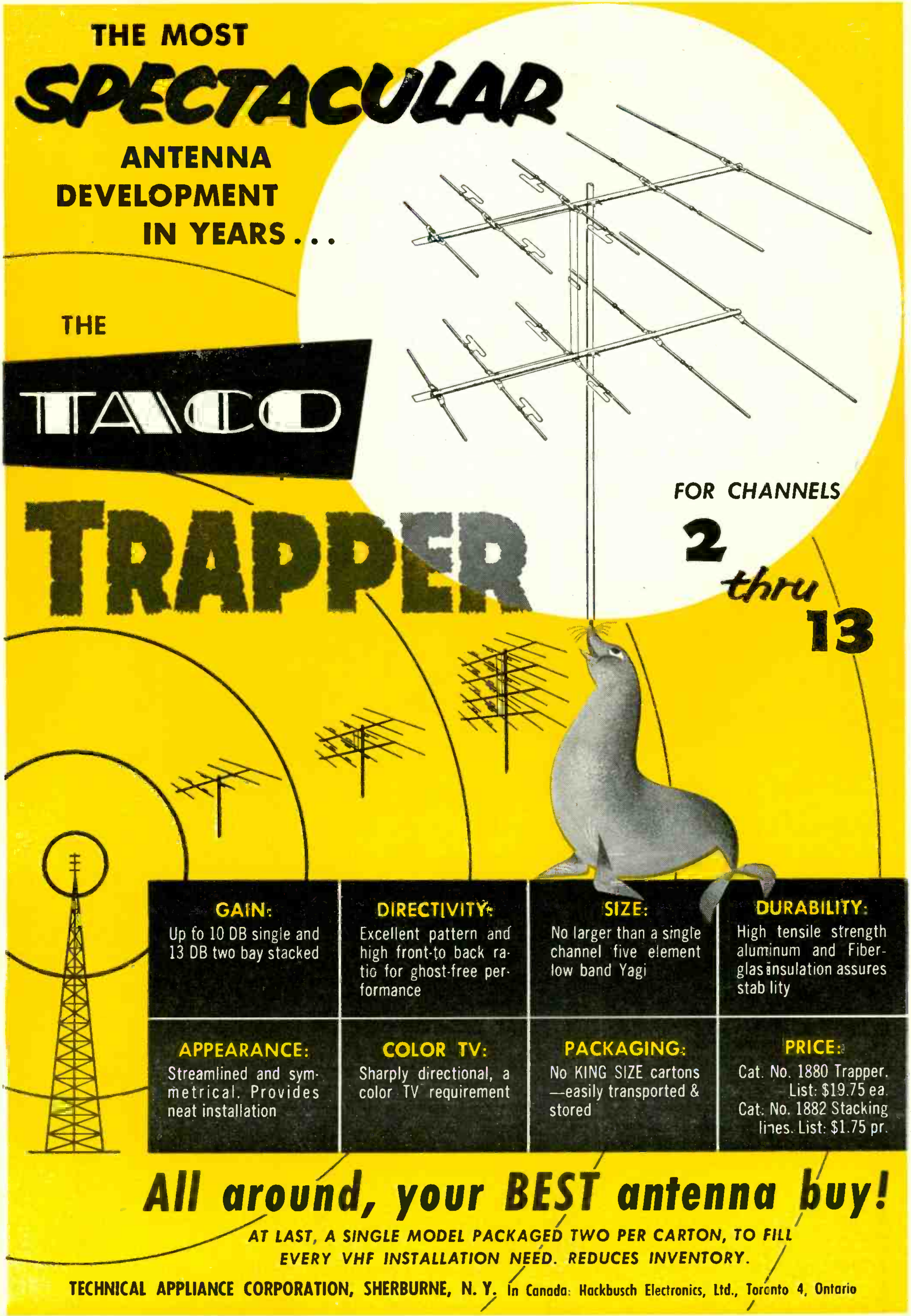
Capacitor C2 isolates the battery voltage from the tuning-capacitor plates.

Construction

The small size of the transistor and its socket makes wiring difficult. Two wires are about all that can be soldered to the tiny terminals on the socket. This makes it necessary to mount the receiver components on terminal strips onto which the many connections can be soldered. From these terminal strips, wires are run up to the transistor socket. None of the lead lengths are critical.

A metal front panel is very necessary. Without the panel, hand capacitance effects make tuning extremely difficult.

The electrolytic capacitors may have any rating of 3 volts or higher. Any commonly used voltage rating will do for the paper and ceramic capacitors.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Capacitor values may vary 50% from those specified. The resistors may be 1/3 watt or larger.

The tuning coil is a modified *Ferri-Loopstick*. The extra-high Q of the loopstick is responsible to a large extent for the easy oscillation of the circuit through the entire broadcast band. Every CK722 we have used oscillated easily. None of the other coils experimented with worked nearly as well.

To modify the loopstick, first remove the cardboard sleeve that covers the winding. The short antenna supplied with the coil is discarded. Remove 5 turns of wire from the free end of the coil. When this is done, L2 is wound directly over the loopstick winding. L2 is 7 turns of about No. 22 wire (the exact size of the wire is not important). A single twist of the free ends keeps the coil from unwinding. Push the iron core into the coil until it extends an equal distance from each end of the coil.

When the receiver is put in operation it will be necessary to slide the core out slightly to adjust the tuning range. The length of antenna connected to the receiver also changes the tuning range. The slug will compensate for this too.

Operation

After the set is wired, check off all parts and connections against the diagram. Make sure the electrolytics are wired properly—positive side to ground.

Plug in the CK722 transistor before the battery is connected. Connecting the battery backward can damage the transistor. Be sure the negative battery terminal is fastened to the earphones and 100,000-ohm resistor, R3.

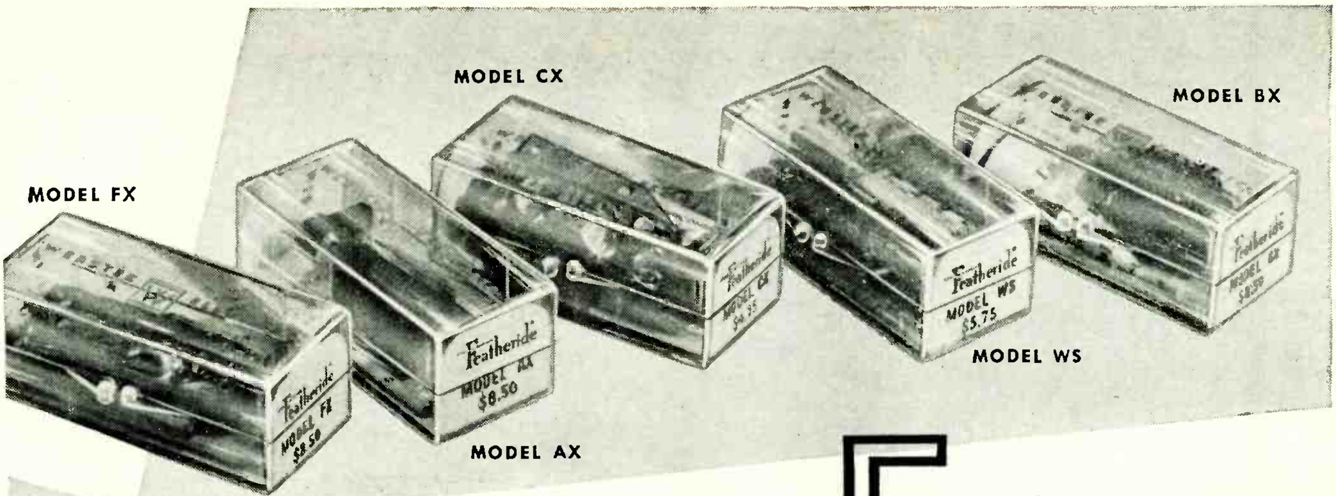
With the earphones and battery connected, a "rushing" sound should be heard in the phones. The lack of this sound does not indicate a bad transistor. The only possible reason for the sound not being heard is that something is wired wrong. This sound is the noise generated by all transistors.

For a voltage check of the circuit, typical voltages are shown on the diagram. These measurements were made using a 10,000-ohms-per-volt meter with the regeneration control in mid-position.

The rushing sound is heard at any setting of the control regardless of whether or not the set is regenerating. However, the loudness of the rushing will increase slightly with clockwise rotation of the regeneration control.

Connect an antenna 25 feet or longer to the stator terminal of the tuning capacitor. When tuning, have the regeneration control advanced all the way. This does not give best reception but each station that is passed—even one too weak to be heard—will sound a tweet or whistle.

At some settings—usually near the center of the dial—the receiver tends to motorboat at critical regeneration. Weak stations come in better just below critical regeneration; strong stations, above this point.



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A good antenna and ground reduce the tendency to motorboat; and the detector will pass over critical regeneration with a single "plop" sound.

The regeneration control setting affects the tuning slightly. On the high end of the dial, moving the control may detune the station, making a tuning readjustment necessary.

If it is impossible to pick up a station at either extreme of the tuning capacitor, the iron core can be adjusted in the coil to bring in the station.

Power supply

A small a.c. power supply for the receiver is shown in Figure 2. *Do not use a direct earth ground* with the power supply. Two .001-μf capacitors

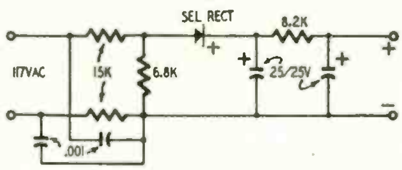

Fig. 2—Schematic of a.c. power supply

in the diagram are not shown in the picture—they were added later. Any ordinary receiving type selenium rectifier will work. A 100-ma rectifier was in the parts box. This is the reason for the large unit pictured. The resistors can be any wattage. We made the 6,800-ohm resistor from two smaller ones because they were at hand, not for more power.

(The reader can make a much safer supply with a 12.5-volt filament transformer and a small germanium rectifier. The present job—if used—should be enclosed and treated with caution.—*Editor*)

From a small country town, in two weeks of listening with a 25-foot antenna, 12 stations were recorded. The nearest powerful station was more than 100 miles away. No ground was used.

The regenerator circuit is a good starting point for experimentation. With a hearing-aid battery, padder type tuning capacitor, and a smaller regeneration control, the circuit will shrink to shirt-pocket size.

The radio is a real performer considering its very small power consumption. The audio gain is much better than some vacuum-tube circuits operating on this low voltage. In the same location mentioned, a transistor radio without regeneration was able to pick up just two stations—and it was almost impossible to separate them. With regeneration many more stations were received, all with good selectivity.

Parts list for receiver

Resistors: 1—8,200, 1—100,000 ohms, ½ watt; 1—10,000 ohms, potentiometer (linear).
Capacitors: 1—16-365 μμf, variable; 1—390 μμf, ceramic; 1—.01 μf, 200 volts, paper; 2—25 μf, 3 volts, electrolytic.
Miscellaneous: 1—CK722 transistor and socket; 1—1N34; 1—1-mh r.f. choke; 1—Ferri-Loopstick; 1—battery, 15-22½ volts; 2—Fahnstock clips; 1—antenna wire (25 feet or more); 1—metal front panel; 1—bakelite chassis; 2—mounting strips.

Parts list for a.c. power supply

Resistors: 1—6,800, 1—8,200, 2—15,000 ohms, ½ watt.
Capacitors: 2—.001 μf, 200 volts, paper; 2—25 μf, 25 volts, electrolytic.
Miscellaneous: 1—selenium rectifier, 25 ma min.; 2—mounting strips; 1—bakelite chassis.

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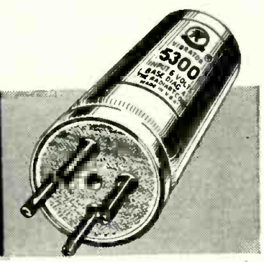

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INSTALLING MARINE RADIO

An opportunity for you landlubbers to get your sea legs in a rapidly expanding field

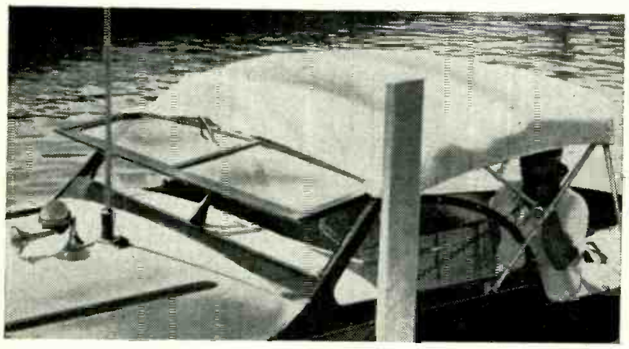
By ELBERT ROBBERSON

ALTHOUGH marine radiotelephony is similar in some ways to radio broadcasting, to amateur communications, and to big-ship radio, the procedures in these fields cannot be directly applied to the small boat.

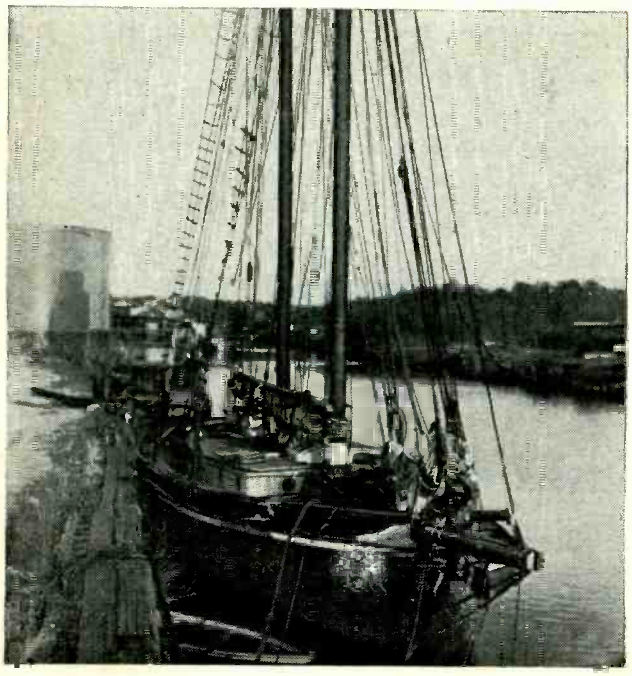
Indeed, since it is a relatively new field, service technicians have had to work out their own techniques. This article is intended to start the beginner off on the right course.

The very first technical requirement for a marine radiotelephone service technician is that he hold a valid first- or second-class radiotelephone or radiotelegraph license issued by the FCC. The Commission requires that all adjustments and tests on transmitting equipment must be made by a licensed technician, who then enters the data in the log and signs it.

On the water, there are two main departures from shoreside radio practice—one philosophical, and one technical.



Tubular antenna is mounted on a combination base insulator and loading coil.



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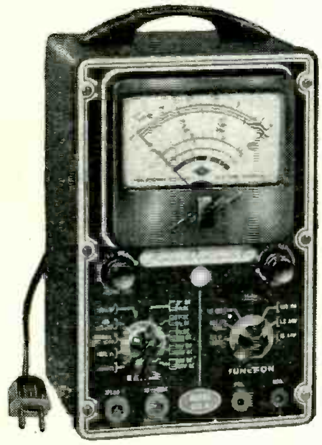


Superior's new Model 670-A

SUPER METER

A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Quality test for electrolytics)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries
DECIBELS: —6 to +18 +14 to +38 +34 to +58

ADDED FEATURE:

The Model 670-A includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

The Model 670-A comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40 NET

Superior's new Model TV-11

TUBE TESTER

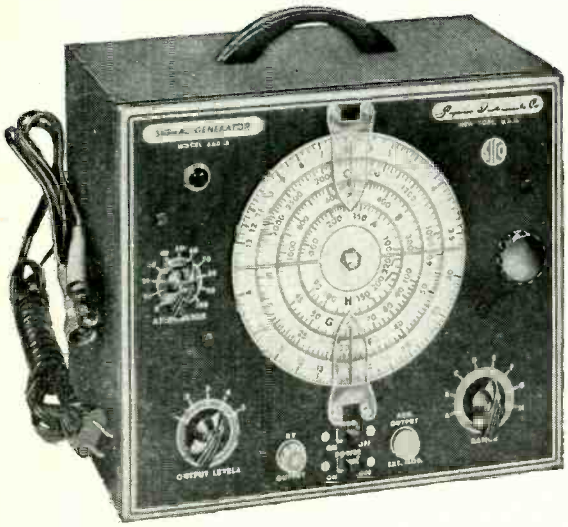
SPECIFICATIONS:

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.
★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.
★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
★ Free-moving built-in roll chart provides complete data for all tubes.
★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.
★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRA SERVICE—The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover

$47.50 NET



Superior's New Model 660-A **AN AC OPERATED**

SIGNAL GENERATOR

PROVIDES COMPLETE COVERAGE for AM-FM & TV Alignment

SPECIFICATIONS:

● Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 220 Megacycles on powerful harmonics. ● Accuracy and Stability are assured by the use of permeability trimmed Hi-Q coils. ● R.F. available separately or modulated by the internal audio oscillator. — Built in 400 cycle sine wave audio oscillator used to modulate the R.F. signal also available separately for audio testing of receivers, amplifiers, hard of hearing aids, etc. ● R.F. Oscillator Circuit: A high transconductance heptode is used as an R.F. oscillator, mixer and amplifier. Modulation is effected by electron coupling in the mixer section thus isolating the oscillator from load changes and affording high stability. ● A.F. Oscillator Circuit: A high transconductance heptode connected as a high-mu triode is used as an audio oscillator in a High-C Colpitts Circuit. The output (over 1 Volt) is nearly pure sine wave. ● Attenuator: A 5 step ladder type of attenuator is used.

TUBES USED:

1—68E6 as R.F. Oscillator, mixer and amplifier.
1—6BE6 as Audio Oscillator.
1—6H6 as Power Rectifier.

The Model 660-A comes complete with coaxial cable test lead and instructions.

$42.95 NET

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. B-96, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked. I am enclosing the down payment with order and agree to pay the monthly balance as shown. It is understood there will be no carrying, interest or any other charges, provided I send my monthly payments when due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

Name..

Address..

City.......................... Zone...... State..........

☐ MODEL 670-A ......Total Price $28.40 $7.40 down payment. Balance $3.50 monthly for 6 months.
☐ MODEL TV-11 ......Total Price $47.50 $11.50 down payment. Balance $6.00 monthly for 6 months.
☐ MODEL 660-A ......Total Price $42.95 $12.95 down payment. Balance $5.00 monthly for 6 months.
☐ I enclose $.........as down payment.
☐ Ship C.O.D. for the down payment.

Philosophy is never mentioned in radio texts, but, to be successful in the marine field, the service technician must be familiar with a sort of *Code of the Sea*.

When men venture out in a small boat, what they are doing is for keeps, and no excuses are accepted. Lives may depend upon some fabrication of wood and metal; the marine service technician must accept the responsibility. All work must be *solid*—this is no place for chewing-gum splices, or anything slapdash and flimsy. This is for keeps!

Installation

This brings us to the technical department. Installation of a radiotelephone on a boat consists of securing the equipment in place, installing power wiring, providing the antenna and ground, putting the transmitter and receiver on the air, treating engine noise, and instructing the boatman in operation. If the first steps are done properly, the last will be easy.

After the equipment has been tentatively set in place on the boat to "try for size", get the gear out of the way and bore all of the holes required for the cable runs. In routing power cables, keep clear of the ship's compass. Most owners want the cabling routed so it is largely concealed or can be covered with a molding.

In this respect, make a definite agreement with the owner as to the placement of the equipment, the routing of the cable, the number and nature of the holes to be drilled in the boat, and whether cabinet work and molding (if required) are to be done by and at the expense of the radio installer or the owner. Situations may be found in the glossier barges where the cabinet work of imported mahogany may run into a greater expense than the cost of the radio installation. Who is to foot this bill should be clearly understood at the beginning.

After the holes are bored the equipment may be put in place—and from there on *everything* must be screwed down.

In placing a TV set in the parlor, it is sufficient merely to set it down without scratching the floor. When a radiotelephone is installed on a 40-footer the technician must be careful not only to avoid scratching any of the expensive paint, varnish, and chromium, but also to use shiny noncorrosive screws. On a boat this is called "securing" the telephone. It should be secured to the bulkhead (wall) or deck (floor) so solidly that the owner and all his crew can hang on it without anything tearing away or coming adrift. The motion of a boat in a seaway is sometimes so violent that anything not bolted down is liable to end up in the bilge or over the side.

This applies to cable as well as equipment. Use brass or plastic cable clips as often as required by the weight of the wire, and fasten in place with brass or chromium-plated screws—never nails. The common insulated staples used to tack wires in place ashore don't belong

Push the tube that PROTECTS YOU TWO WAYS!

Be sure to show your customers the name SYLVANIA now etched on the lower left face of every Sylvania Picture Tube.

These letters are small in size (imperceptible when the tube is lighted), but they're mighty big in importance! For, they identify a genuine Sylvania Picture Tube...the tube found best in exhaustive tests conducted by an independent laboratory on tubes of 9 different makes.

Naturally, this high performance record helps maintain your reputation. It also helps protect your profits . eliminates customer complaints and costly call-backs.

Remember, most customers regard a picture tube as an important investment. So, you're doing them a valuable service when you sell them the best their money can buy . a SYLVANIA! For new characteristics booklet covering all the latest Sylvania Picture Tubes, call your regular Sylvania Distributor or write direct to Dept. 4R-3804 Sylvania today!

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Most of your customers have seen and heard about Sylvania's high quality during the big popular show "Beat the Clock" on CBS-TV. Week after week, from coast to coast, the facts about Sylvania quality are being demonstrated to millions.

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LIGHTING • RADIO • ELECTRONICS • TELEVISION

WIN $8,000.00

STAN MUSIAL

1ST PRIZE $1,000.00 CASH

MICKEY MANTLE

Westinghouse LEAGUE LEADERS

AND DEALERS AID CONTEST

You never saw such an easy contest! Just fill in the names of the teams which were leading each major league on August 1, 1953. Then you have the first leg on the $1,000 CASH First Prize in the exciting League Leaders and Dealer Aid Contest.

Fill in the Entry Blank on the opposite page. Have your distributor salesman certify that you have purchased 25 Westinghouse Receiving Tubes OR 1 Westinghouse Picture Tube. And mail your Entry Blank NOW! An early entry can win one of the big prizes for you.

After naming League Leaders on August 1, 1953, write your answer to the cartoon situation pictured on the Entry Blank. Winners will be judged on the basis of correctness of team selection, and aptness, originality and effectiveness of cartoon solution.

Enter as often as you wish. The more entries you submit, the better chance you have at the 209 Big Cash and Merchandise Prizes. Ask your distributor salesman for additional entry blanks. He will be glad to sign them when he takes your tube order.

ET-95051

YOU CAN BE SURE...IF IT'S Westinghouse

RELIATRON® TUBES

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

IN PRIZES...

209 PRIZES FOR SMART SERVICE MEN

2ND PRIZE — $700 in YOUR Choice of Merchandise

3RD PRIZE — $400 in Merchandise YOU Select

4TH PRIZE — $300 YOU Choose the Merchandise

FIRST, SECOND, THIRD AND FOURTH PRIZE WINNERS WILL MEET MICKEY MANTLE OR STAN MUSIAL IN THE BIG PRIZE AWARD DINNER WESTINGHOUSE HAS PLANNED FOR YOU IN NEW YORK

5 Fifth Prizes of $140 Each in Merchandise • 30 Seventh Prizes of $35 Each in Merchandise
20 Sixth Prizes of $70 Each in Merchandise • 50 Eighth Prizes of $20 Each in Merchandise
100 Ninth Prizes of $15 Each in Merchandise

FILL IN THIS ENTRY BLANK TODAY!

1. League Leaders on August 1st, 1953, were:

AMERICAN LEAGUE	NATIONAL LEAGUE

2. Here is what I would say to the lady in the Cartoon:

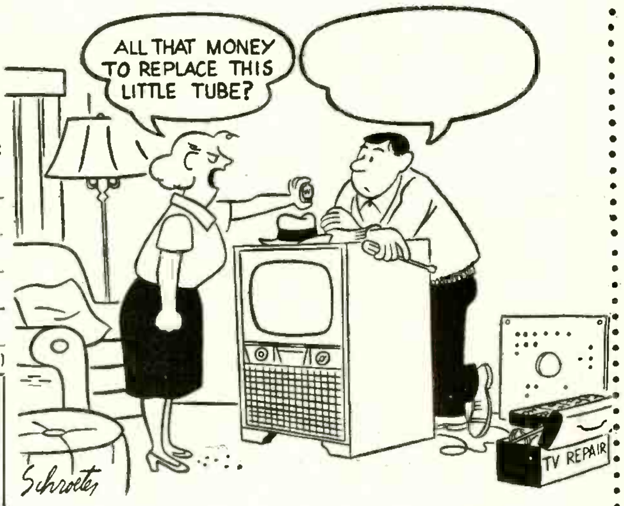
(ATTACH AN ADDITIONAL SHEET OF PAPER IF NECESSARY—100 WORDS MAXIMUM)

MY NAME ....

SHOP NAME ....

STREET ....

CITY .... STATE ....



THIS SPACE FOR DISTRIBUTOR SALESMAN'S

CERTIFICATION

I certify this Entry Blank has been qualified by the purchase of (25 Westinghouse Receiving Tubes) (1 Westinghouse Picture Tube)

SALESMAN'S SIGNATURE ....

COMPANY NAME ....

CITY .... STATE ....

SEND ALL ENTRIES TO:

WESTINGHOUSE TUBE CONTEST

Box 610, Grand Central Station, New York 17, New York on a boat. They rust, pull out, and will usually weaken the insulation of the wire.

Another departure from home radio practice is that *heavy* wire must be used. Lamp cord is not suitable for any part of a marine radio installation. Solid wire may crystallize and break from vibration or flexing, so it should never be used. Stranded cable only, of No. 10 gauge or larger, is the absolute minimum requirement for seagoing service.

The proper size of cable is usually recommended by the radiotelephone manufacturers, and depends on the maximum current drain of the gear, and also on the supply voltage. Small boats commonly have only a 6-volt engine battery aboard, and on these craft be prepared for some really husky wire (see Table). Equipment can perform in its rated manner only if the specified input voltage is applied to its terminals. For instance, if a marine radiotelephone is supposed to have a transmitter power of so-many watts with 6 volts input, and line loss on the boat reduces the voltage at the set terminals to 5 volts, the actual output will be less than 80% of what the customer paid for.

MINIMUM WIRE SIZES FOR 25-WATT UNIT

Distance from battery	12 volts	32 volts
1 to 15 feet	No. 4	No. 8
15 to 30 feet	No. 2	No. 8
30 to 40 feet	No. 0	No. 6

The heaviest, best insulated wire in the world is of no use whatever if it falls off the terminal—or is poorly connected—as might well be the case when it is subject, as always on a boat, to the dual effects of vibration and corrosion. For example, a service shop may receive a call that a transmitter is not working. When the technician boards the vessel, he sees that the full battery voltage can be measured across the radiotelephone terminals and the receiver is working. But, when the "transmit" button on the handset is pressed and the dynamotor should start humming—nothing. Even the receiver goes dead. This sounds like a dead short in the transmitter—serious trouble—and it *would* be if it happened with no technician on call, 200 miles off-shore in a heavy sea or on a disabled boat. But actually, this is just a symptom of a poor connection, either loose or corroded, in the battery circuit. Enough power gets by the high-resistance connection to supply the relatively light drain of the radiotelephone receiver, but when the heavy load of the transmitter is shunted onto the line, all of the voltage drop takes place across the loose or corroded connection with none left to energize the transmitter dynamotor.

The rule is (and it should be steadfastly adhered to) that twisted connections, or wires simply wrapped around terminals, are taboo. Every wire used

CHECK These Terrific RAD-TEL Tubes and Parts SAVINGS!

70% to 90% OFF on TUBES INDIVIDUALLY BOXED FULL YEAR GUARANTEE!

SAME DAY SERVICE . . . OVER 300 TYPES IN STOCK AT ALL TIMES!

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
OA2	.74	1T4	.49	6AK5	.55	6BQ7	.90	6SH7GT	.49	7C5	.69	12BE6	.39	14AF7	.59	42	.42
OA4	.68	1U4	.49	6AK6	.59	6BZ7	.90	6SJ7GT	.41	7C6	.59	12BF6	.39	14H7	.59	43	.55
OB2	.81	1U5	.43	6AL5	.38	6C4	.37	6SK7GT	.41	7E5	.59	12BH7	.63	14J7	.30	45	.55
OC3	.72	1V	.53	6AQ5	.39	6C5	.39	6SL7GT	.48	7E6	.30	12BY7	.65	14N7	.84	45Z3	.44
OD3	.70	1X2A	.63	6AQ6	.37	6C6	.58	6SN7GT	.52	7E7	.59	12BZ7	.65	14W7	.30	45Z5	.49
OZ4M	.55	2A3	.30	6AR5	.37	6CB6	.44	6SQ7GT	.37	7F7	.79	12C8M	.34	19BG6	.95	50A5	.55
1A5	.30	2A4G	.24	6AS5	.50	6CD6	1.11	6SR7GT	.45	7G7	.89	12H6	.56	19C8	.70	50B5	.43
1A7GT	.47	2W3	.38	6AT6	.37	6D6	.59	6SS7GT	.42	7H7	.59	12SC7M	.63	19T8	.69	50C5	.39
1AX2	.62	2X2	.59	6AU4GT	.68	6E5	.48	6T4	.99	7J7	.79	12J5	.42	19V8	.79	50L6GT	.61
1B3GT	.68	3A4	.45	6AU5GT	.82	6F5GT	.39	6T8	.56	7L7	.59	12J7	.49	24A	.39	50Y6	.49
1C5	.43	3E5	.46	6AU6	.38	6F6	.59	6U4	.60	7N7	.69	12K8	.59	25AV5GT	.83	50Y7	.50
1E7	.29	3Q4	.48	6AV5GT	.83	6G6	.52	6U6	.59	7X7	.70	12Q7	.59	25BQ6GT	.79	55	.49
1G6	.24	3Q5GT	.49	6AV6	.37	6H6GT	.41	6U8	.61	7Y4	.69	12S8GT	.62	25L6GT	.39	57	.58
1H4	.30	3S4	.49	6AX4GT	.53	6J5GT	.43	6V6GT	.39	7Z4	.59	12SA7GT	.65	25W4GT	.59	58	.60
1H5GT	.49	3V4	.51	6B4	.64	6J6	.52	6W4GT	.44	12A6	.54	12SF5	.50	25Z5	.66	70L7	.97
1L4	.46	5U4G	.50	6BA6	.39	6J7	.43	6W6GT	.44	12A8GT	.61	12SG7	.51	25Z6	.49	75	.49
1L6	.59	5W4GT	.50	6BA7	.57	6K5	.47	6X4	.37	12AL5	.37	12SJ7M	.67	26	.45	76	.44
1LA4	.59	5Y3GT	.37	6BC5	.49	6K6GT	.37	6X5GT	.37	12AQ5	.52	12SK7GT	.63	27	.39	77	.57
1LC5	.59	5Z3	.45	6BD5	.59	6K7	.44	6X8	.75	12AT6	.37	12SK7M	.63	32L7	.89	78	.47
1LC6	.79	5Z4	.59	6BD6	.45	6L6	.64	6Y6G	.48	12AT7	.66	12SL7GT	.47	35	.58	80	.35
1LD5	.59	6A6	.51	6BE6	.39	6L7M	.68	7A4	.47	12AU6	.38	12SN7GT	.52	35B5	.40	83V	.68
1LE3	.59	6AB4	.44	6BF5	.41	6Q7	.45	7A5	.59	12AU7	.54	12SQ7GT	.56	35C5	.39	84/6Z3	.46
1LH4	.69	6A7	.69	6BF6	.37	6R7	.69	7A6	.69	12AV6	.39	12SR7M	.49	35L6GT	.41	85	.59
1LNS	.59	6AC7M	.86	6BG6G	1.25	6S4	.38	7A7	.69	12AV7	.63	12V6GT	.46	35W4	.37	117L7	.99
1N5GT	.67	6AF4	.90	6BH6	.46	6S7M	.79	7A8	.68	12AX4	.56	12X4	.38	35Y4	.54	117P7	.99
1P5GT	.57	6AG5	.48	6BJ6	.43	6S8GT	.53	7AF7	.53	12AX7	.56	14A5	.59	35Z3	.59	117Z3	.37
1Q5GT	.58	6AG7M	.99	6BK7	.80	6SA7GT	.43	7B4	.44	12AY7	.99	14A7	.63	35Z4	.47	117Z6	.69
1R5	.49	6AH4	.57	6BL7GT	.83	6SD7GT	.41	7B6	.69	12BA6	.38	14B6	.63	35Z5GT	.47	807	.99
1S4	.59	6AH6	.73	6BN6	.59	6SF5GT	.46	7B7	.49	12BA7	.60	14B8	.63	36	.39	866A	1.39
1S5	.43	6AJ5	.65	6BQ6GT	.79	6SG7GT	.41	7C4	.59	12BD6	.45	14C7	.79	41	.42	HiPo567	1.39

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TV BOOSTER

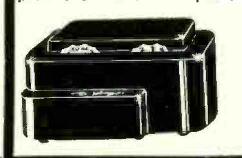
Made by PHILCO, famed for quality and precision communications equipment. Completely self-contained, including 2 tubes . . 1 for High Channels and 1 for Low Channels and selenium rectifier plastic cabinet. In factory-sealed cartons, complete with instructions.

10.95

In Lots of 3 **9.95**

STANDARD BOOSTER

12 channel RF Amplifier with self-contained AC power supply. Handsome plastic cabinet. List price $23.00



7.95 each

Lots of 3 **7.45** ea.

Granco "Star"

UHF CONVERTER

Brand new! Latest model! Unit is highly engineered, receives all UHF channels. Co-axial tuned cavity elements complete with 6AF4 oscillator, 6CB6 I-F and crystal mixer. Shipped ready to install and operate. List Price $29.95 **22.45**

De luxe model Five Star UHF Converter. Preselector 1N82—6BQ7 cascode and 6AF4 oscillator. List price $39.95 **29.97**

FLYBACK TESTER

Your Price **39.95**

A Must for every Service-Man!

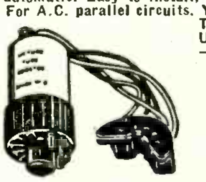
Fast, sure a 1-turn short. Tested while in receiver! Tests continuity on yokes, coils, speakers, switches, etc.

FREE! Flyback & Yoke with each order!

CATHODE RAY

TUBE REJUVENATOR

Fits all makes of picture tubes. Completely automatic. Easy to install, no tools needed. For A.C. parallel circuits. Your Old Picture Tubes Are Still Useful. List price —$5.95.

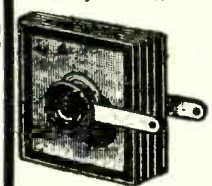


1.39

Lots of 10 **1.29**

SELENIUM RECTIFIERS

Mfd. by FEDERAL



65 . . . . .59¢
75 . . . . .69¢
100 . . . . .79¢
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200 . . .1.25
250-1010A 1.75
250-1028A 1.75
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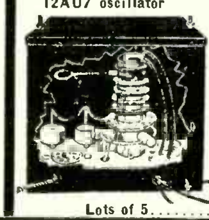
POWER SUPPLY

4500 VOLTS 6 MA.

12AU7 oscillator 1B3 rectifier



Completely wired, enclosed in shielded metal case, removable cover. Improve performance of your scope; use as R.F. high voltage supply. BRAND NEW!

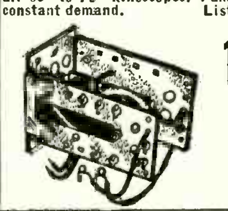
2.95

*Kit of 2 tubes for above—$1.22

Lots of 5. . . . . . .$2.75 ea.

UNIVERSAL FLYBACK

High efficiency FERRITE core horizontal transformer . . . supplies 14,000 Volts. For all 65° to 70° kinescopes. Famous Type. In constant demand. List price 11.50



1.95 each

Lots of 3 **1.85** each

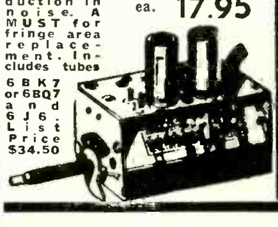
Famous Standard Coil

CASCODE TUNER

Famous standard tuner TV front end. Double the gain with a great reduction in noise. A MUST for fringe area replacement. Includes tubes 6BK7 or 6BQ7 and 6J6. List Price $34.50

ea. **18.95**

Lots of 2 ea. **17.95**



Famous Make

CLOCK RADIO

With Telechrome luminous clock. Automatic shut-off and wake-up features. Starts coffee perking; switches on appliances. 5 tubes including rectifier. Built-in antenna. 60 cycles AC. U. L. approved. Pure bakelite or ivory body. Color-molded pure plastic grille.

Ebony—$22.95
Lots of 5—$22 ea.
Walnut—$23.95
Lots of 5—$23 ea.
Ivory—$24.95
Lots of 5—$24 ea.

Famous Make Personal Portable

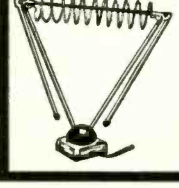
BATTERY RADIO

4 TUBES (2 DUAL-PURPOSE) Has extra long life hundred hour batteries. Long distance reception. Large dynamic speaker. Thumb wheel tuning. All stations, plastic case, with collapsible handle. Rich gold finish trim. Red, brown or grey. Complete with batteries and leather case. each 19.95 complete Lots of 3 $19. ea.

Sensational! New! Famous 3-Way

INDOOR ANTENNA

For UHF, VHF and FM radio. Delta-beam. 50% increase in pulling power by extending dipoles. For average, fringe and UHF areas. For movie-clear pictures. Single antenna $5.95



Lots of 6—$5.37
Lots of 12—$4.83
Lots of 24—$4.47

UHF J.S.C. VHF

300 OHM TWIN LEAD

TV Lead-In Wire

AWG 20 strand copper. 55 mil. web poly.
$2\frac{1}{2}$¢ per foot
$1.95 per 100 ft.
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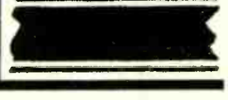

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in the installation should be ended in a good solid lug, secured under the terminal with a lockwasher.

Soldering is difficult on most boats, so screw-type or crimping lugs will be found simplest to apply.

If the supply voltage is only 6 or 12 volts, the voltage drop across a small fuse may be considerable. If more than 0.1 volt loss is encountered, use heavier fuses, and if necessary add additional fuses in parallel. Any switch used in the power circuit should have a continuous current rating greater than the maximum drawn by the transmitter. After the transmitter has been in operation for a few minutes, inspect all installation wiring. Anything that is hot is too light—replace or add a parallel circuit now, rather than have something happen later when the boat is in the middle of a fogbank.

Always make sure that the grounded polarity of the battery is followed in the equipment. One make of boat may have a positively grounded battery, while another may be negative—and at least one very popular make of boat with two engines has one battery with a positive ground, and the other negative. If the radio equipment is accidentally installed with an opposite ground, the technician may soon suffer the embarrassment of having to poke around the mud in the bottom of the bay, looking for the boat. Fittings that keep out the water have been known to become eaten away in a matter of hours when such a mistake is made.

The antenna

A feature of marine radiotelephone installations that requires more than ordinary care, both in planning and construction, is the antenna system.

The installer is likely to find the equipment must be accommodated to one of two extremes—either the boat cannot carry an antenna large enough to be efficient or the antenna will be too large for efficiency. Incredibly, these conditions are the two most common ones, and which of the two will exist depends on whether the small boat is a motor vessel or sailboat.

Marine radiotelephone transmitters are designed to operate at the base of a Marconi type antenna. On a small motor yacht or workboat, the size of the vessel limits antenna height to from 12 to 25 feet, which is a small fraction of a wavelength on the more common marine frequencies.

Such short antennas have an extremely low radiation resistance, from about 0.3 ohm for a 12-footer to 1.8 ohms for an antenna 25 feet high. With such low resistance, ground current is heavy in comparison to that found in other types of radio stations, so to keep losses low an exceptionally good ground is required. This necessitates putting a large-area copper plate on the hull below the water-line, the installation of which is a shipyard haul-out job. If this is impractical, the engine, or any other "wetted" metal, such as a keel or rudder, may be used temporarily. The ground wire from the transmitter should be the heaviest cable that can be wrestled into place.

Short antennas are also highly reactive, which means that r.f. voltage will be high. To prevent leakage, very good insulation must be used. Glass is best, but glazed porcelain is satisfactory if it is protected from moisture by silicone or waterproofing wax.

If the power boat has a mast high enough, a satisfactory antenna can be erected. Lacking this, a light mast of spruce or bamboo can be mounted on the boat, guyed, and the wire antenna hung from it with standoff or strain type insulators. Another method is to use one of the many self-supporting antennas on the market. In any case, the antenna should be well insulated, and this alone rules out the wrapping of wire of any description on a wooden or bamboo pole. Wrapped-pole antennas lose their "oomph" when wet.

All rigging work in connection with antennas should be just as substantial as power wiring, with terminals and lock washers at points of connection, and eye-splices or cable clamps used for mechanical strain points. Wire should be larger than No. 10 gauge, and insulated at every point of contact with any foreign object. Phosphor-bronze stranded cable is the best, since it combines the good conductivity, high tensile strength, and resistance to corrosion necessary in marine use.

The other extreme is the sailing vessel with a lofty guyed spar or two. The problem on these vessels is to find an area clear of rigging, close enough to the set to keep the under-the-deck portion of the lead-in at a minimum.

On a small sailboat it is possible to insulate the top and bottom of a permanent backstay and use it for the radiotelephone antenna. In larger vessels, however, the usual location of the radiotelephone lies amidships. Therefore, the lead-in must run below decks and near the waterline, by the engine, surrounded by other wiring. The length of the usual standing backstay plus this lead-in (half the length of the boat) adds up to more than a quarter length on the marine band, which complicates transmitter tuning.

The most successful large sailing vessel installations require some modification in the usual procedure. This may be carried out in one of two ways —by locating the equipment aft, at the foot of the backstay antenna, and having only a remote-control station amidships in the quarters; or by keeping the equipment in the main cabin and using a coaxial line to feed a tuning and coupling unit at the bottom of the antenna.

If this kind of rig cannot be arranged, a movable wire can be hung from a spreader or the masthead, in a position that will be out of the way of the boom when the telephone is not in use, and hauled out and secured to an "eye" on deck (as much in the clear as possible) when it is desired to place a call.

On vessels having hollow spars, antennas have been hung down through the center of the mast. This is not good practice, because nearby there is usually a metal sail track, one or more wire halyards, and masthead and spreader-light power cables. Also, the antenna at this point is almost completely enclosed by the standing rigging. The farther from this mess of wire the antenna can be hung the more successful the installation is likely to be.

Interference

Ignition and electrical noise is more troublesome on boats than in automobiles, due to the low power of marine transmitters; the network of power and light wiring usually strung around the boat; and, unlike the car with its metal body, there is nothing to shield or confine noise energy to a small area. Thus, the best way to quiet a gasoline engine is to install a complete ignition harness of flexible conduit, such as used on aircraft. Another method is to use suppressor spark plugs, and bypass capacitors on generators, electric motors, fuel pumps, and wires leaving the engine compartment.

Electrical racket is by no means confined to gasoline engines, however. Some of the most difficult cases are often encountered in diesel craft, which may not even have a spark plug on board. Varying electrolytic currents, frictional electricity from belts, generators and voltage regulators, and even the rigging, can generate noise.

These "transmitters" must painstakingly be tracked down individually and taken off the air by bypassing, shielding or grounding. Some success has been had in quieting noisy engines by the enclosure of the engine compartment in a copper screen, similar to a laboratory screened room. This system has the disadvantage of requiring constant maintenance to combat the loss of contact between its elements due to corrosion and vibration.

Finally, the antenna on any boat, either power or sail, should be safeguarded against lightning. A heavy switch can be installed to ground the antenna while it is not in actual use, or a lightning gap can be used. The open type, preferably with a lightning choke, is best for transmitter use, as it has the least leakage loss and also will be less likely to break down under the transmitter output voltage than other types. Most types of shoreside lightning arresters are not suitable for this use—they corrode and short out.

Up to this point it has been pretty largely all work—but now the technician can brush himself off, button his wilted collar, and engage in tuning and testing the equipment.

At first the service technician may find it takes a couple of days to make a complete radiotelephone installation, but if he keeps a notebook, learns the shortcuts, and works out a standard procedure for the different makes of boats, he will soon find himself installing one of these miniature broadcasting stations in half a day. That leaves half a day for basking at the beach—or making another installation. END

A FEW UNUSUAL SERVICE CASES

THE MAN IN THE RADIO

If you are a service technician you have probably met mothers who warn their children about "the small man who talks from inside the radio!" I was servicing a console, and my job was almost over. I was tuning in short wave and checking calibration. The customer's kid, a 3-year-old stick of dynamite, was plying me with questions about "the small man in the radio."

"Of course he's asleep," I told him, "and you better not knock on the radio if you don't want him to awake and scream!".

"I like him when he screams," was the kid's reply as he gave the radio's cabinet three knocks and said, "Little man in the radio wake up and scream!"

Then I distinctly heard the loudspeaker say: "Who is this? Who is this? Who are you?" I was paralyzed. It couldn't be!

I just couldn't believe it. I knocked three times on the radio's cabinet. Three similar knocks were the answer.

The kid was happily repeating, "The small man in the radio is awake!" I neared the speaker and shouted: "Can you hear me?"

"Yes I can, who are you?" was the answer. Only then I noticed a strong carrier was tuned in on short wave with plenty of modulation hum.

"Where are you?" I asked.

"In 7 Park Street!" It was the address where I was.

I said, "I'm in 7 Park Street too, on first floor. What floor are you on?" There was an exclamation, and the voice continued,

"I'm Mr. Davis on the second floor!"

I found that Mr. Davis was tuning on short wave at the time when he picked up a strong carrier and heard the knocks, and the kid's voice. He too was scared when he found his radio answering him. I located the phenomenon.

Both local oscillators were beating together, and as both sets had a tendency to microphonics a sort of FM was established by shouting toward the tuning capacitor. I tried it out in my shop too, and it worked on several sets.—*E. Sternklar*

UNUSUAL ACCELERATION

My most unusual service job was on a battery radio in the mid '20's. I sold a set to a lady about 20 miles out on a farm, and told her if she had any trouble the first three months I would service the set free of charge. I heard nothing from her until the morning of the last day of the guarantee. Then she phoned and told me the set was not working right and to please come over to her place that day by all means.

There was about a foot of snow on the roads and the temperature was near zero. I had some doubts as to whether the Model T could get through even with chains, but I hired a boy for $3.00 to shovel and push, and we started.

It took two hours to make the 20 miles, and I was colder than I have ever been before or since—I spent 30 minutes hugging the stove before I even thawed out enough to turn the set on. When I did, a station in the next State popped in like a local.

I let the set play about 15 minutes while I continued to absorb heat, then ran the dial from the top to bottom several times as stations bounced in from all over the country. I checked the batteries and found them O.K., so turned to the lady—who had just come in from feeding the chickens—and asked what was the exact nature of the trouble? "The set plays too fast on some stations," she told me, "and I want you to slow it down."

I was so hot when I left that I never even got chilled on the return trip! —*James R. Journey*

UNUSUAL HUM

After a small 5-tube a.c.-d.c. table radio had been returned to our shop because of a persistent hum at certain points on the dial, we discovered the metal pointer on the end of the tuning capacitor shaft was shorting to the grounded metal foil on the face of the dial at certain spots.

Bending the pointer away from the foil cleared the trouble, only to reveal a smaller hum caused by an unusual quirk.

On some small sets, the tuning capacitor is isolated from the chassis by rubber grommets around the mounting bolts. If one of these rubber grommets is cut through or slips out of position, the tuning capacitor shorts to the chassis, causing a hum.—*Harvey Muller*

TELEPHONE INSTALLATION

When one of our customers bought a new house and couldn't get a telephone immediately, we installed a mobile phone in his car. When he gets a call while the car is in his garage, a relay-operated mike rings a bell in his house.

Since then we've installed similar equipment on the cars of home-buyers. This has helped builders sell their houses promptly. In reciprocation, these contractors have thrown appliance sales our way.—*H. Josephs*

UNUSUAL COMPUTER

No matter how expert and well acquainted a service technician is with the theory and practice of electronics, some unrelated fact or condition may be the key to the solution of a whole problem. And it may be overlooked or undiscovered if he keeps his nose too close to the grindstone (service bench).

The set was an a.c. radio of reputable make. The customer complained of abnormal maintenance cost. The radio with its built-in amplifier and a record player with its own a.c. amplifier were

used with a very fine and expensive high-fidelity speaker, housed in a large cabinet type baffle. The owner had the three units arranged so that he could plug the speaker into the radio when it was in use and into the record player amplifier when it was used.

The two amplifiers were of the same type with identical tubes in push-pull output. The 3-wire cable from the output transformer on the PM speaker to the amplifier was conventional (one wire to B plus and one wire each to the plates of the output tubes). Everything was normal here.

The customer complained that over a comparatively short period he had three different service organizations repair the radio. As the record player was used more than the radio, he could not understand why the radio broke down so often.

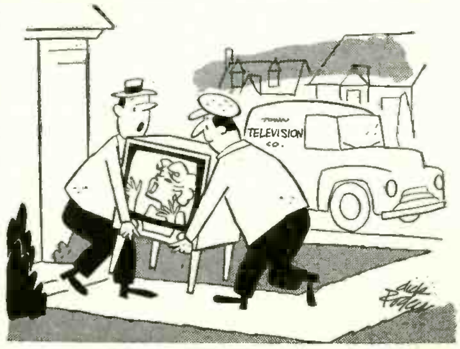
The past repair bills showed that the work had been done by reliable service organizations. Replacement parts were of high quality. This indicated that the cause of the trouble was probably abnormal. Almost the same parts had been replaced for each repair job. These consisted of tubes and filter capacitors.

A service check at the bench showed that about the same components had failed again. Conditions pointed to just one fact: abnormally high B plus voltages were breaking down the filter capacitors and causing the tubes to become gassy. These conditions would be caused by switching the radio on when the speaker was disconnected. No plate current would be drawn by the power-output tubes, and the rectifier voltage would rise abnormally high.

The radio could on occasion be turned on when the speaker was not connected, but should someone do this he would normally switch the radio off if he heard nothing. An occasional mistake like this would cause no harm, since the radio components are subjected to the same conditions during the warmup period when the speaker is connected.

These facts pointed to only one thing—prolonged use of the radio with the speaker not connected. But could there be a use for a soundless radio? There was!

A telephone conversation with the owner confirmed this fact. It seems that when record player and amplifier were used with the speaker, the children used the radio for a game. The radio was equipped with a motor-driven push-button slide-rule type dial, and the chil-



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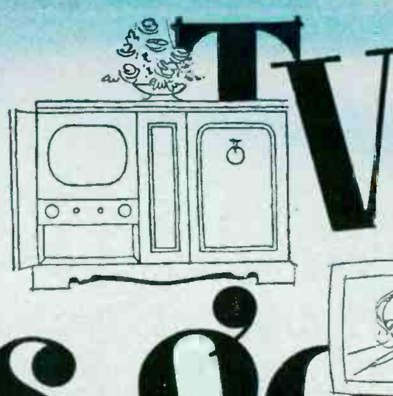

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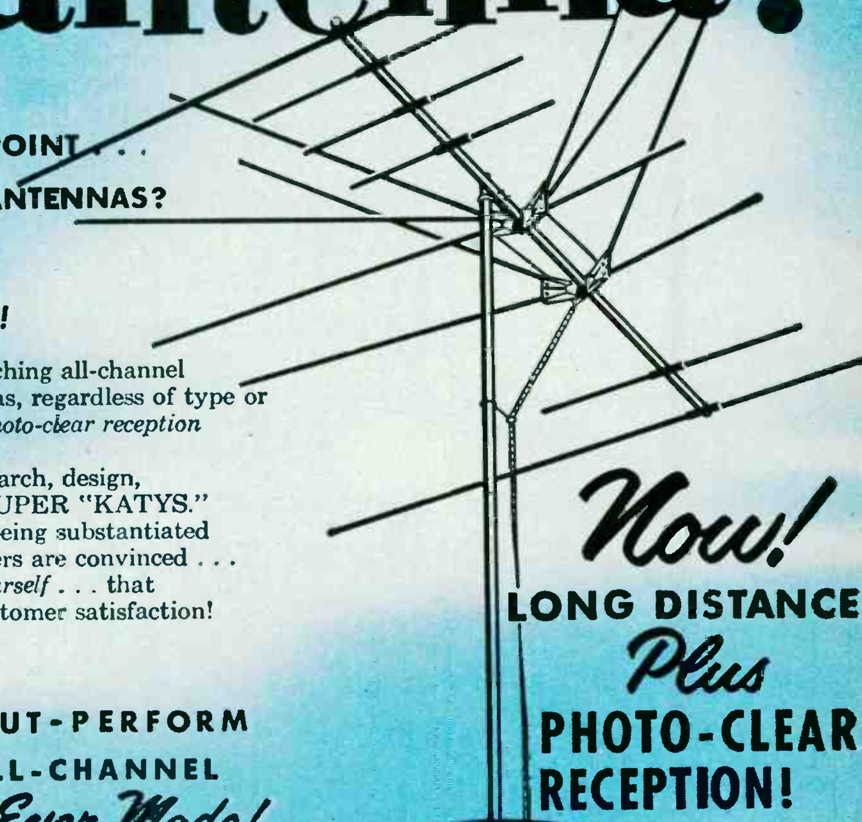

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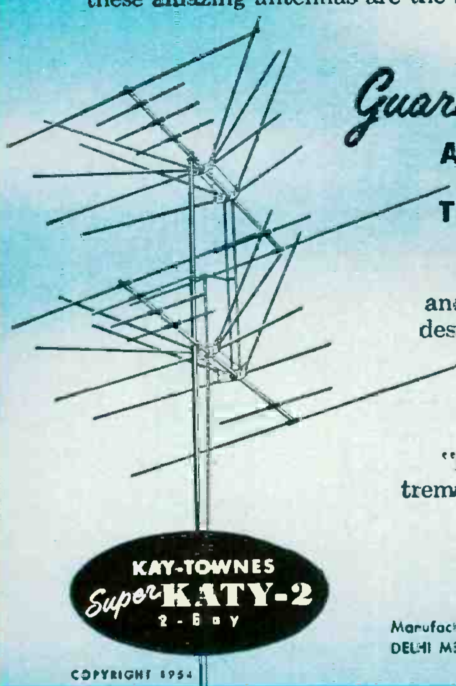

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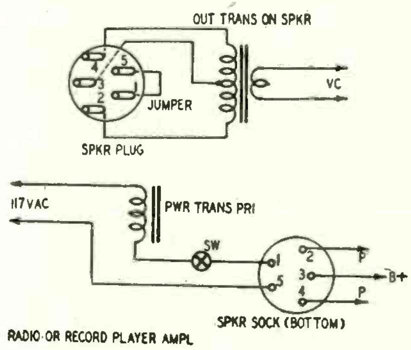
LEADERS IN THE FIELD OF FRINGE AREA ANTENNA DESIGN dren used it for an electronic computer (something they had picked up on "Space Cadets"). The owner did not realize that any harm could be done to the radio if used without the speaker, as he thought that only the dial lamps and motor were consuming power.

A simple explanation of comparing the operation of his radio under such conditions with the wide-open throttle of his automobile when out of gear enlightened him.

To prevent any future trouble, the 117-volt a.c. line to both the radio and amplifier of the record player was wired as shown on the diagram, so that when the speaker plug was removed from either unit the 117-volt a.c. power would automatically be cut off.

This remedy will not only reduce the expense of service calls and repairs, but will prevent the gradual deterioration of performance through the overheating of resistors and the strain put on the other components.

Removing a similar motor-driven push-button slide-rule dial from a discarded radio and installing it in a suitable cabinet solved the electronic computer problem.—*C. W. Battels* END



Removing speaker plug breaks a.c. line.

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TRANSISTOR OSCILLATOR PRODUCES SUBHARMONICS

By I. QUEEN

IF you like to experiment with new, unconventional circuits, try this one. It is a subharmonic *crystal* oscillator using a junction transistor. It acts just like an oscillator with a crystal frequency between 75-125 kc. Crystals in this range are very expensive and not generally available. We get the same results with a surplus crystal in the 400-kc range. The cost of transistor *plus* surplus crystal is actually less than that of a standard low-frequency crystal.

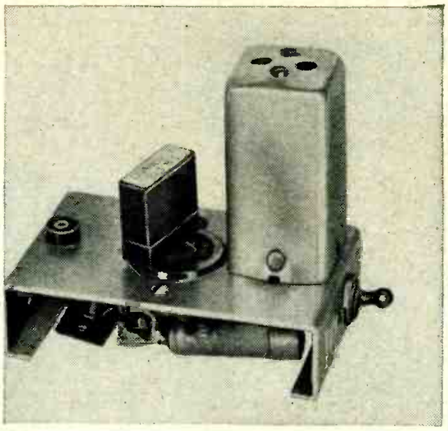
The circuit uses a CK722 transistor. This is the low-cost junction unit now available at most parts distributors. The crystal is connected between emitter and collector as shown in the diagram. If desired, it may be connected between emitter and base instead, results being about the same.

The two coils are part of a 262-kc i.f. transformer with about 30% of the turns removed from the primary (red-blue) winding. Without the crystal, this circuit looks and acts like a conventional Hartley (tapped coil) circuit. It generates a low-frequency signal with strong harmonics through the broadcast band. The oscillator frequency is approximately 140 kc, and harmonics can be heard at 560 kc, 700 kc, 840 kc, etc. One or both trimmers may be used to vary the fundamental over a small range. These self-excited signals will sound about T7 or T8. Like those from any low-C oscillator they will be shaky and susceptible to hand capacitance and other external effects.

To set the subharmonic generator, tune the circuit (still without crystal) so that its output is slightly lower than the desired subharmonic. For example, if you use a 375-kc crystal and want a 125-kc subharmonic, set the oscillator to about 120 kc. You will hear harmonics at 600 kc, 720 kc, etc. When you insert the crystal into its socket, the signal will change to a pure T9 tone. It will suddenly become highly stable regardless of hand capacitance.

Adjust one or both trimmers for maximum stability and output. A good test is to turn the battery on and off several times to see if the oscillations start each time. If you have a 400-kc crystal, and wish to build a 100-kc crystal oscillator, tune the i.f. transformer to about 100 kc or slightly below. If 100 kc is too low for your transformer, you may need added capacitance across the secondary (green-black) winding (see dotted lines in diagram).

A single 1.5-volt penlight cell supplies sufficient power for the transistor. Its drain is low, so battery life should approach shelf life.



The complete subharmonic oscillator.

A few different transistors were tried in this circuit. All functioned satisfactorily. All were good subharmonic generators, and in each case the harmonics were strong—well into the high-frequency spectrum. For example, a 100-kc subharmonic generator (using a 400-kc crystal) provided harmonics beyond 20 mc. For greatest output, connect the antenna lead of the oscillator to the receiver antenna post.

I arrived at this unusual circuit while experimenting with transistor crystal oscillators. I am not sure what the theory is, but the following may come quite close to the truth. Evidently the two coils in series act like a Hartley tank, tapped near the middle. The tank resonates near 125 kc, and may be adjusted over a narrow range by tuning either trimmer of the transformer. This is the frequency which I have observed when the crystal is removed from its circuit. Now, one of the

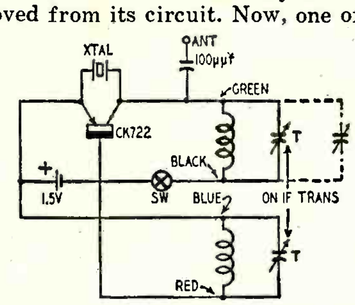


Diagram of the subharmonic generator.

transformer coils alone resonates near 400 kc, the crystal frequency. The coil is between collector and base, and acts like the plate tank of a conventional tube oscillator. The "plate" coil, with the crystal, makes a crystal oscillator. Thus we have two signals, one near 125 kc, the other, approximately 400 kc. The first signal is self-controlled, the other is crystal-controlled. By tuning one or both trimmers we can adjust these frequencies so that one is an exact subharmonic of the other. When this happens, the low-frequency signals can be heard but their quality equals that of the high-frequency crystal tone. In other words, they are synchronized and controlled by the crystal.

A similar explanation is offered by Frank Dukat of Raytheon. He says:

"It looks as if we have two oscillators operating somewhat independently, but when one is a harmonic of the other, they lock together at the fre-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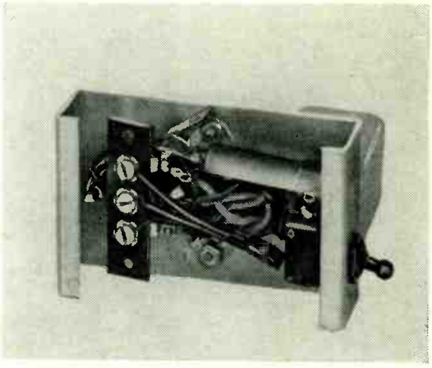
quency of the more stable one, or, in this case, at a sub-harmonic of the crystal. It appears that the lower frequency oscillator is a Colpitts oscillator. This is the upper tuned circuit, and its feedback is set by collector-to-base and base-to-emitter capacitance within the transistor. We think that the crystal oscillator is a Hartley oscillator with feedback due to the inductive coupling between the



Transistor is mounted below chassis.

coils and only able to oscillate at 400 kc because at other frequencies the lower tuned circuit is shunted out by the crystal."

Not all transistors tried in this circuit act alike. I tried three and all gave satisfactory results. However, one transistor generated much lower frequencies than the other two. For example, with the crystal removed from its socket, we have a self-controlled oscillator as already explained. Now with the tank values we have we would expect a fundamental frequency near 140 kc. This is what I observed when two of our transistors were used. The third generated a frequency only half as much, 70 kc, and without changing the tuning of the transformer. Possibly this particular transistor is more active than the others. Evidently it acts as a "halver" as well as subharmonic generator. Other tests show that this transistor performs better than the ohers in high-frequency circuits.

The transistors which generate os-

"Funny, I brought it to four radio repair shops and they all just nodded and laughed."

cillations near *140 kc* are used to generate 125 kc from a 375-kc crystal. With a small capacitor across the transformer winding (black-green) we can reach 100 kc. This gives the equivalent of a 100 kc-crystal oscillator when we plug in a 400 kc crystal. As for the transistor which oscillates near *70 kc*, I am using this in a 75-kc crystal oscillator by plugging in a 375-kc crystal. With slight change in trimmer tuning, I have an excellent 80-kc crystal oscillator when I insert a 400-kc crystal.

If your transistor does not generate low enough oscillations and you want a *very* low-frequency oscillator, shunt the transformer coils until you reach the desired frequency. Of course it is preferable not to use a capacitor across the transformer if you don't need it. For one thing, the instrument will be smaller.

Regardless of what actually makes this circuit "tick", there are many useful applications for it. A low-frequency crystal oscillator provides numerous stable check points over the broadcast band. It generates standard frequencies on the ham bands, and for testing receivers. There is nothing to plug in and nothing to tune (once the instrument is working). Also, if your oscillator does not start each time you switch it on (due to sluggish crystal or other causes) flip the switch on and off a few times or simply disconnect and reconnect the transistor oscillator antenna lead.

END

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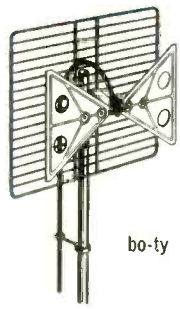

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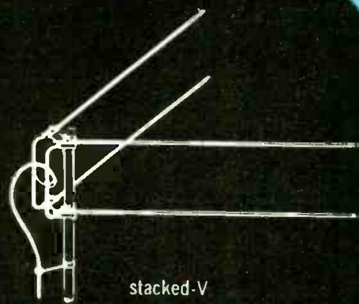

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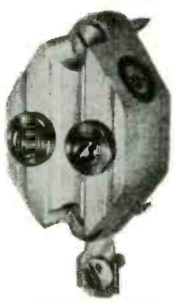
Proved by time and every test, AMPHENOL Flat Twin-Lead and AIR-CORE Tubular Twin-Lead (U.S. Pat. No. 2,543,696) assure low-loss transmission of the signal. Flat Twin-Lead is designed for VHF while unique AIR-CORE Tubular is best for UHF.

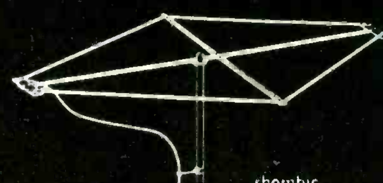
New AMPHENOL Isonet provides highly efficient coupling of UHF and VHF antennas to a single lead-in. Lumped-circuit-constants-filter-network assures extra low-loss performance. Attractive blue case adds to installation appearance.

Lowest measurable loss of any lightning arrestor! New UL approved Lightning Arrestor gives full protection to the signal as well as to the set. Accommodates flat, open or tubular type lead-ins. Makes positive "bite" on heavy line.

isonet



lightning arrestor

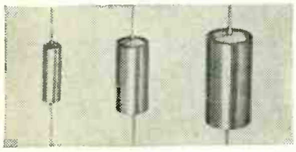


rhombic

AMPHENOL AMERICAN PHENOLIC CORPORATION *chicago 50, illinois*

MINIATURE CAPACITORS

National Capacitor Co., 385 Washington St., Quincy, Mass., has announced its line of *TI* capacitors for exceptional stability between temperature extremes. The capacitance variance is less than 5% from minus 80°C to plus 200°C. Insulation resistance, even at 150°C, will definitely exceed 1,000 meg-

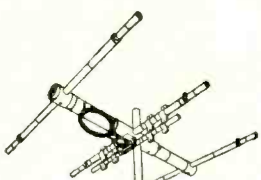


ohms. Capacitance is substantially unaffected by frequency and has a dissipation factor less than .0008.

These capacitors are hermetically sealed with tin-coated glass-kovar end seals. They are available in the complete RETMA capacitance series in standard tolerances of ±10% and can also be obtained with tolerances of ±5% and ±2%.

ROTARY ANTENNAS

Telrex, Inc., Asbury Park, N. J., is producing a line of rotary antennas for 10-, 15-, and 20-meter performance, the *Beamed Power Rotaries*. All of

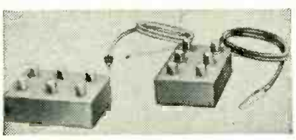


these antennas are equipped with preassembled "Perfect Match Balun" and T-match for optimum coupling. They are designed to be fed with 50- or 75-ohm coaxial lines.

INSTALLATION AID

Mosley Electronics, Inc., 8622 St. Charles Rock Rd., St. Louis 14, Mo., has designed an aid for u.h.f. and v.h.f. antenna orientation, the *Orientor*.

The device consists of two pocket-size units comprising an isolation net-



work that permits the single transmission line to carry the signal to the television set and return the video signal without interaction and with little or no insertion loss. The video signal can then be read in terms of relative strength by means of an ordinary portable volt-ohm-meter. Thus, the installer on the roof can tell instantly when the TV set is receiving maximum video signal.

This eliminates the need for an extra man standing by the TV set and the need of a telephone to relay information to the installer on the roof.

AM-FM TUNER

Newcomb Audio Products Co., 6824

Lexington Ave., Hollywood, Calif., has announced a self-powered, dual-knob, high-fidelity AM-FM tuner, the *Classic 200*, designed for use with amplifiers that have their own controls.

The unit features an improved a.f.c. circuit which may be disabled for tuning to weak stations adjacent to stronger ones. The circuit is adjustable to meet local conditions. The model 200 has a new a.v.c. dual-triode cascode front end, a TV type high-efficiency mixer, dual limiters, Foster-Seeley discriminator, Armstrong circuit, and drift-compensated oscillator. It offers 1-microvolt sensitivity for 20 db of quieting, 20-20,000-cycle response ± ½ db, and distortion below 1%.

MICROPHONES

American Microphone Co., 370 S. Fair Oaks, Pasadena 1, Calif., has announced a new line of hand-held dynamic and carbon mikes, known as the *501* series. This series is designed for mobile police, ship-to-shore, and aircraft communications, as well as amateur radio, paging, and intercom systems.

The units are finished in gray and weigh 10 ounces exclusive of cable or plug.

AMATEUR AID

Electro-Voice, Inc., Buchanan, Mich., is producing an operating aid for radio amateurs, the *Second Op*. This device is a 10½-inch circular computer which has data on every country and amateur-recognized subdivision.

Included are data on prefixes, great circle beam headings, times and dates at dx locations, postage rates, international reply coupon exchange rates, dx zones, prefix-to-country translations, and QSL Bureau addresses. There is also a log for date of contact and receipt of the QSL card for each country.

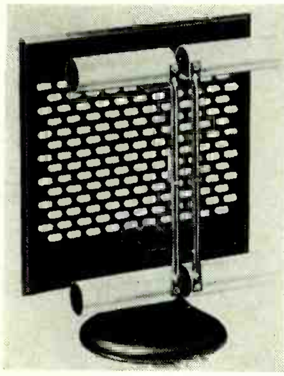
POWER RESISTORS

Clarostat Manufacturing Co., Inc., Dover, N. H., has added a 15-watt Series C8JJ resistor to its *Greenohm Jr.* line. Axial pigtail leads provide support and connections in point-to-point wiring. Leads are 1½-inch length No. 20 tinned copper wire.

The 15-watt unit measures 2 x ½ inches, compared with the 5-watt unit measuring 1 x 5/16 inches and the 10-watt unit which measures 1¾ x 5/16 inches. The units are available in a resistance range from 1 ohm to 10,000 ohms.

UHF ANTENNA

Ward Products Corp., Division of the Gabriel Co., 1148 Euclid Ave., Cleveland 15, Ohio, has announced an indoor antenna for u.h.f., model TV-215. It is finished in simulated wrought iron and bronze, and is called the *Can-Can*.



LIGHTNING ARRESTERS

RCA Tube Dept., Harrison, N. J., has announced two quick-service types of u.h.f. lightning arresters designed to protect home u.h.f. TV receivers from damage by lightning and static charges.

The two arresters are a screw type (234A1), for direct mounting to baseboards or window sills, and a strap type (235A1) for attachment to antenna masts and cold-water pipes. Both are listed by Underwriters Laboratories, Inc.

The arresters can be installed in most applications in four quick steps which eliminate such procedures as splicing wires, stripping insulation, and soldering. A screw cap forces the line against staple contacts in the arrester which pierce the insulation and make electrical contact with the wire.

The units can be used with virtually all types of 300-ohm u.h.f. transmission lines—tubular, oval, foam, and jacketed—and do not affect the electrical characteristics of the line.

DISTRIBUTION UNIT

Waldom Electronics, Inc., 911 N. Larrabee St., Chicago 10, Ill., has announced an electronic distribution amplifier which permits the use of two TV sets from a single antenna and acts as a booster to improve the picture reception on both sets.

The *Duo-tenna* is said to be ideal for color reception because of its broad bandwidth. The unit can also convert two sets to u.h.f. reception from a single u.h.f. converter.

HI-FI PHONOGRAPH

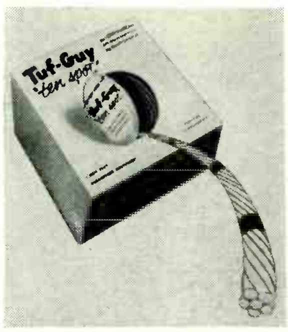
Hallicrafters Co., 4401 W. Fifth Ave., Chicago 24 Ill., has introduced a low-priced high-fidelity phonograph with a frequency response ranging from 30 to 16,000 cycles per second. The *Virtuoso*, as it is called, features a 3-speed record changer with a variable-reluctance pickup, bass and treble controls, a loudness control, and a control for compensation.

The audio system is an 8-watt, low-distortion push-pull output with inverse feedback. The 5-tube and 1-rectifier transformer type amplifier supplies sufficient volume for auditorium use. Two speakers are used.

The set measures 20 x 25½ x 11¾ inches. Its legs are 14½ inches high. The *Virtuoso* is done in contemporary styling and is available in blonde or mahogany finishes.

GUY WIRE

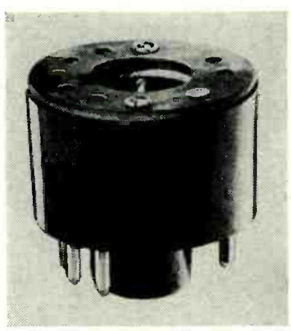
Fenton Co., 15 Moore St., New York 4, N. Y., has introduced a guy wire packed flat in a box instead of being wound on conventional spools. The flat pack is called the *Tuf-Guy Ten Spot*, since the wire is marked every 10 feet for easy measuring. A 7-inch circle on the top of the box is perforated for easy lifting.



BAR GENERATOR

Perma-Power Co., 4727 N. Damen Ave., Chicago 25, Ill. has placed a new horizontal bar generator on the market. The neon-tube relaxation oscillator provides a series of equally spaced horizontal lines to indicate picture linearity. The unit provides precise setting of yoke, accurate positioning of focus coil or magnet, and quick adjustment of vertical linearity, height, and centering.

Completely self-contained, the bar generator plugs on picture tube. Simple instructions are included.

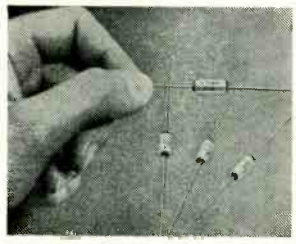


SUB-MINIATURE UNITS

Cornell-Dubilier Electric Corp., South Plainfield, N. J., has developed a compact subminiature tantalum electrolytic capacitor. The tiny units measure 9/16 inch in length and 3/16 inch in diameter. They are especially well suited for application in transistor circuits.

These sub-miniature tantalum electrolytic capacitors cover an operating temperature range from —55° C to 85° C, and have considerably lower leakage current than other electrolytic types. Power-factor characteristics are excellent even at lowest rated operating temperature. The wound-foil type construction results in excellent frequency characteristics.

Thirty-five new subminiature units are available, ranging in capacitance from 0.01 to 8.0 μf and from 3 to 150 v.d.c. (working), in both polarized and non-polarized types.



V.O.M. CASE

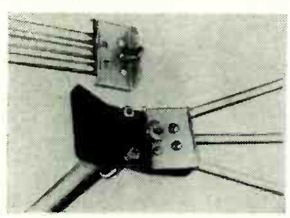
Triplett Electrical Instrument Co., Bluffton Ohio, is producing a Neolite case to house its three v.o.m. models, Nos. 630, 630-A, and 630-T.

The case has a built-in stand that rests the unit at a convenient 45° angle when in use. It also has a back compartment that contains sufficient room to store an instruction book, leads, the stand, and small tools.

The No. 639-N case has a firm handle for carrying.

VHF CONICAL

Trio Manufacturing Co., Griggsville, Ill., is now offering a conical v.h.f. antenna, the *Colorite*, available in single or two-bay models, complete with phasing harness. Element ends are securely riveted to the head, so there is no danger of loosening or "shedding."



UHF CONVERTER

Granco Products, Inc., 32-17 20th Ave., Long Island City 5, N. Y., has developed a rear-attached, out-of-sight u.h.f. converter which mounts on the rear protective cover of the usual TV set. The converter is based on a new version of the company's coaxial-cavity tuner. The simplified and more compact tuner is adjusted by tuning knob extending at one side of the TV set cabinet and providing 10-to-1 tuning ratio. A miniature slide-rule tuning dial can be seen by looking to the rear edge of the TV set cabinet. A v.h.f.-u.h.f. switch cuts in the converter when u.h.f. reception is desired. The u.h.f. signal is fed into the set tuned to channel 5 or 6.

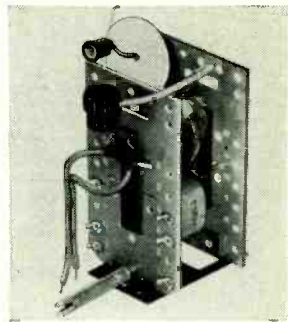
Three models of the new converter will be made available shortly. The first type gets its power supply from the TV set by means of an adapter socket, eliminating any wiring alterations. The second type is self-powered, while the third type includes high-gain amplification for use in low-signal-level areas or locations. A fourth model mounts on the front panel of the TV set for a built-in installation, and has been in use for some time.

INSTRUMENT STAND

Electronic Measurements Corp., 280 Lafayette St., New York 12, N. Y., has announced an instrument stand for the service technician. By placing his v.o.m. or v.t.v.m. on the stand, the instrument scale is at an easy, convenient angle, and the instrument cannot tip over. Known as model IS, the stand is rubber-covered to protect the instrument.

REPLACEMENT TRANSFORMER

Halldorson Transformer Co., 4500 Ravenswood Ave., Chicago 40, Ill., has announced flyback transformer FB412, an exact replacement for Part No. C-201--21025-1 used in Airline, Raytheon and Truetone TV sets.



The new unit features a variable-gap width control, tapped a.g.c. winding, and a special mounting base. The FB412 services 84 models and chassis of the manufacturers mentioned.

MARKER-GENERATOR

Electronic Measurements Corp., 280 Lafayette St., New York, N. Y. has announced a new r.f.-a.f. crystal marker-TV bar generator, model 700. The unit gives complete coverage from 18 cycles to 108 mc on fundamentals.

Model 700 provides a bar generator for TV adjustment, with a variable number of bars available for horizontal or vertical alignment, and a square-wave generator to 20 kc. It has a Wien bridge a.f. oscillator with a sine wave output from 18 cycles to 300 kc, and crystal marker and amplitude control.

PORTABLE SPEAKER

Jensen Manufacturing Co., 6601 S. Laramie Ave., Chicago 38, Ill.., has introduced a portable version of the 2-way loudspeaker system, the *Duette*, model DU-202. The unit is designed for use with tape recorders, portable record players, musical instruments, and band sound reinforcement.

The loudspeaker equipment is the same as that of the *Duette* home model, and is housed in a black leatherette case measuring 11 x 23¼ x 11¼ inches and weighing 21 pounds.

ARE YOU SATISFIED with the position you now hold? Do you feel you're worth more money? Are you pleased with yourself, your work, your associates . . . and your future? What does the next year hold for you . . . and the year after that?

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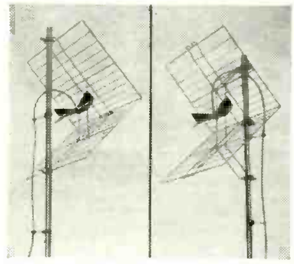
NEW DEVICES

CORNER REFLECTOR

Channel Master Corp., Ellenville, N. Y., has announced a new u.h.f. corner reflector, model 409. This antenna features optional two-way mounting and can be mounted either behind or in

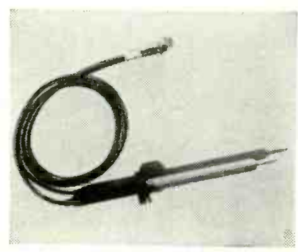


front of the mast. Gain across the u.h.f. band ranges up to 12½ db. Directivity patterns are sharp.

HIGH-VOLTAGE PROBE LEAD

Radio City Products Co., Inc., 152 West 25th St., New York, N. Y., has brought out a new high-voltage multiplier probe lead for extending the d.c. voltage ranges of their model 655 peak-to-peak v.t.v.m.

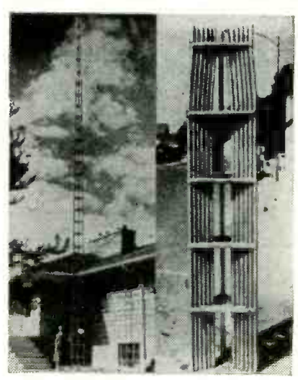
The new probe comes complete with multiplier resistor and terminals and is of the heavy-duty type with safety barrier. It multiplies the scale used by 100.



NEW TOWER DESIGN

Spaulding Products Co., Tipton, Ind., has designed a self-supporting tower, the *Strato-Tower*, with all-riveted construction. The six sections of the tower nest together so compactly that 100 feet of tower occupies less than 2½ feet of warehouse space.

The tower has heavily galvanized, all-steel construction, and all-riveted bracing with no welds. No additional accessories are needed to install rotators down inside of the tower.



TINY TRANSFORMER

J. W. Miller Co., 5917 S. Main St., Los Angeles 3, Calif., has added a subminiature 455-kc transformer to their K-Tran line. The unit is ½ inch square and 1½ inches high. Its over-all height, including terminals, is 1$^{15}/_{16}$ inches.

The intermediate frequency transformer is smaller than a miniature tube, while retaining all the desirable features of the conventional size i.f. transformers. Through the use of a ferrite shell core material, the i.f. transformers offer the gain and bandwidth characteristics necessary.

ANTENNA COUPLER

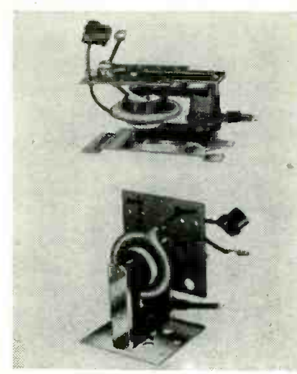
Tele-Matic Industries, Inc., 1 Joralemon St., Brooklyn, N. Y., has announced their *Add-A-Set* coupler, model AM-74, which operates two TV sets from one antenna on all v.h.f. channels on 72- or 300-ohm line.

The unit is an inductive coupler incorporating an efficient transformer with a special high-frequency core. This maintains a constant impedance over the entire band and a minimum of loss as compared to a resistance-network coupler.

The AM-74 isolates the antenna and receivers by the use of individual windings of the transformer and therefore minimizes inter-receiver action.

FLYBACK REPLACEMENTS

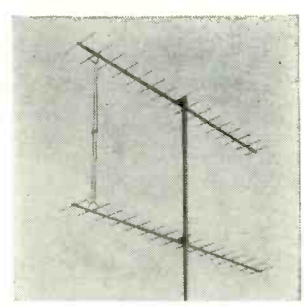
Chicago Standard Transformer Corp., Addison and Elston, Chicago 18, Ill., has added three replacement flyback transformers to its Stancor line. The units—A-8230, A-8231, and A-8232—are used in Air King, CBS-Columbia, Emerson, Firestone, and Silvertone sets. They cover 88 chassis and 194 models.



16-ELEMENT YAGI

Channel Master Corp., Ellenville, N. Y., has developed a 16-element u.h.f. Yagi for fringe-area reception, the *Sweet 16*. This antenna, model 420, has its elements welded on to the cross-arm, and has a delta-matched dipole for good 300-ohm match.

Model 420 can be designed to cover as many as 21 different channels. The average gain is 11 db single and 14 db stacked.



Since all the elements except the dipole are welded in position at the factory, the antenna is ready for installation within seconds after it is removed from the box by the technician. END

All specifications given on these pages are from manufacturers' data.

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"You may now have a successful TV servicing business. When color sets come to your bench for servicing, will you be able to handle them?

"Color Television is a vast new field, embodying entirely new concepts . . . principles of light and vision, radically new circuitry."

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Planned and written by RCA instructors, the entire course is based on the practical experience of RCA engineers—the men who have pioneered in the research and development of color television since the very first color experiments, many years ago.

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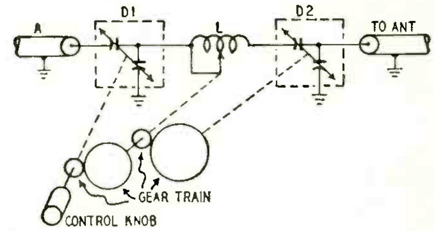
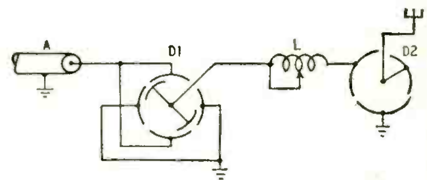
IMPEDANCE MATCHING

Patent No. 2,657,362
William H. Epperson, Coral Gables, Fla.
(assigned to Aeronautical Communications Equip., Inc.)

Many hams and commercial operators use the Collins (pi) network or a similar type. It is an efficient arrangement for matching a final amplifier to any antenna system. However, it requires several adjustments. In its simplest form, there is an input capacitor, an output capacitor and an inductor, all of which may need adjustment. This patent is a single dial control for obtaining optimum impedance match.





In the diagram, transmission line A (from final amplifier) feeds voltage divider D1. The output of D1 then flows through variable inductor L to a second divider, D2. D1 and D2 are differential capacitors with split stators. For example, as D1 varies it may *increase* its series capacitance while *decreasing* its shunt capacitance. After the rotor passes a stator, this is reversed. D1 and D2 may rotate continuously; the effect is that of a tap that moves continuously up and down on each divider.

Using a train of gears, D1, D2 and L are controlled simultaneously by a single dial: but each varies at a different speed. The variation of L is slowest. It makes only one complete variation (from maximum to minimum or vice versa) while D2 undergoes 15 complete cycles, and D1 makes 600 complete cycles.

To tune the network, L is adjusted first. Its variation is slow, so it remains nearly constant while the optimum setting for D2 is located. Finally, the dial is rotated further to tune D1. The latter requires relatively little dial rotation, so its tuning does not disturb the other two components which are already tuned to the best operating point.

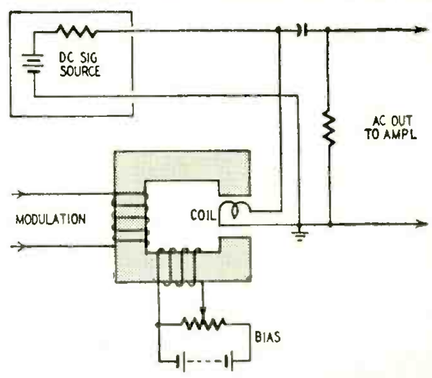
Because of its single-dial feature, this invention may be adapted for automatic control. It is operated by a motor which rotates until maximum power is delivered to the antenna.

D.C. TO A.C. CONVERSION

Patent No. 2,659,043
James E. Taylor, New York, N. Y.
(assigned to Norden Laboratories Corp., White Plains, N. Y.)

A.c. amplifiers are more stable than circuits for d.c. The d.c. amplifier requires direct coupling, so they may be troubled with random emission, drift, etc. For best results, a weak d.c. should first be converted to a.c., then amplified.

This converter uses a bismuth coil in the gap



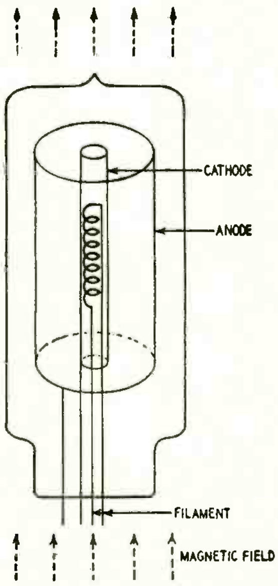
of an electromagnet. Bismuth has the property of varying resistance in a magnetic field. For example, its resistance becomes three times greater if placed in a field of 34,000 gausses. The electromagnet is energized by a.c. This produces an alternating field which modulates the resistance of the coil. Thus, although the coil is fed from a d.c. source, its current has an a.c. component that can be amplified.

The coil's resistance depends only on the *strength* of the field, not its direction. Thus the positive and negative half-waves of modulation have the *same* effect on the resistance. The resistance of the coil undergoes two complete cycles of variation for each cycle of a.c. If this is not desirable, a d.c. supply should be added (as shown) to bias the electromagnet. This produces a direct (but pulsating) field. The a.c. output has the same frequency as the modulation, when d.c. bias is added.

NOISE GENERATOR

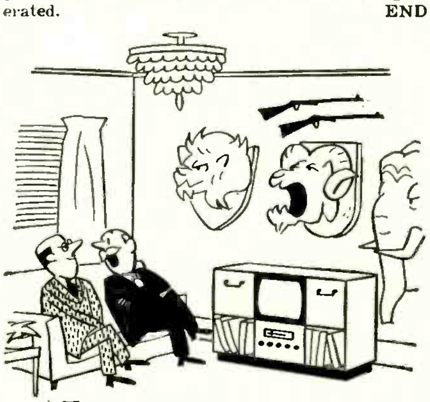
Patent No. 2,658,149
Charles J. Gallagher, Schenectady
and Stanley Ruthberg, Middletown, N. Y.
(assigned to United States of America as represented by the Secretary of War)

A noise generator covers a wide band of frequencies. This generator produces a uniform signal that ranges from audio frequencies to several megacycles. It uses a diode within a magnetic field.



The diagram shows how the tube is constructed. Its cathode and anode are cylindrical. The tube is filled with argon to a pressure of 15 microns and is placed in a vertical magnetic field of about 830 gausses.

Under the influence of the positive anode and magnetic field, electrons leave the cathode and move along spiral paths. These spirals fall short of the anode, so the electrons soon return to the cathode. Practically none arrive at the anode. Due to continual collisions between electrons and gas molecules, a continuous noise spectrum is generated. END

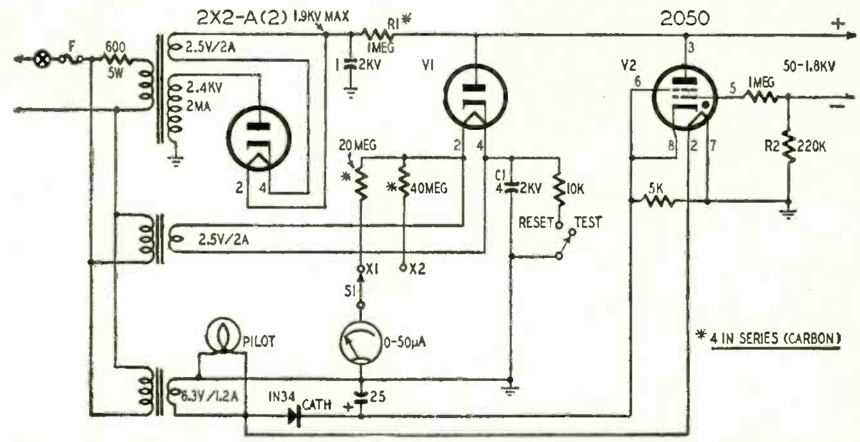


"You'll never guess where they installed the speaker"

VOLTAGE BREAKDOWN TESTER IS HARMLESS TO SPECIMEN

This voltage breakdown tester was developed to measure the breakdown voltage of insulating films on a conductive base. Some instruments of this type apply a high variable a.c. voltage across the material being tested. At the instant that the insulation breaks down, the resulting arc often severely damages the specimen. Too, when the voltage is high, corona discharges may cause errors in the voltage readings.

This circuit, developed at the National Bureau of Standards and described in *The Review of Scientific Instruments*, uses a d.c. test potential which automatically varies from about 50 to 1,800 volts or to the point of breakdown. The current through the material is only a few microamperes and it is automatically cut off after about 10 μsec so damage to the sample is minimized.



The material to be tested is connected between the output terminals. When the TEST-RESET switch is thrown to TEST, C1 begins to charge through R1 and V1 in series. As the charge increases, the charging current decreases, and the voltage across the sample increases. When the sample breaks down, the voltage across R2 fires the 2050 thyratron (V2). When V2 conducts it shorts the positive voltage terminal to ground, thus removing the voltage from the sample and stopping the charging of C1.

C1 cannot discharge back through V1 to ground so it must discharge through the 20- or 40-megohm meter multiplier resistor in series with the meter. The time-constant of the multiplier and C1 is long enough to permit the operator to read the peak voltage across the sample material at the instant of breakdown.

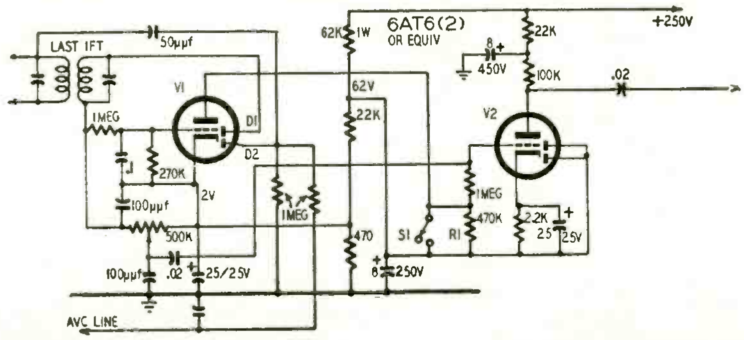
When the switch is thrown to RESET, the 10,000-ohm resistor is across C1 so that the potential across it is held to less than 20 volts until it is again thrown to TEST. The 50-μa meter and the multipliers form a 20,000-ohms-per-volt voltmeter which measures the potential across C1. The full-scale range is 1,000 volts when S1 is in the X1 position and 2,000 volts when the switch is set to X2.

A SIMPLE AUDIO SQUELCH CIRCUIT FOR AM RECEIVERS

Diagrams and circuit details on FM squelch circuits have been described in these pages several times during the last year or so, but not one was applicable to AM receiver circuits without considerable modifications. The AM squelch and interstation noise suppressor shown in the diagram was published in the "Query Corner" (question-and-answer column) of *Radio Constructor* (London, England). It shows how the circuit can be added to a conventional superheterodyne with a duo-diode triode second detector and first a.f. amplifier.

The triode section of V1, the first a.f. amplifier in most sets, is converted into a d.c. amplifier which controls the gain of V2 which is added to the circuit as the first a.f. amplifier. The grid of V1 is direct-coupled to the detector output so it receives the full d.c. voltage developed across the detector load—the 500,000-ohm volume control.

The 470,000-ohm resistor (R1) is the plate load resistor for V1 and a part of the grid return for V2. When no signal is coming in or when the signal is very weak, the voltage on the grid of V1 is low, so it conducts heavily. The plate current flows through R1 and develops enough voltage drop to bias V2 to cut-



off. When a reasonably strong signal is received, the detector output biases V1 to cutoff. There is no current through R1, so V2 operates normally. When V1 and V2 are 6AT6's or British type EBC41's, the circuit constants shown permit the squelch to open at the same level that the delayed a.v.c. goes into operation. The squelch circuit can be disabled by closing the switch across R1.

The a.v.c. voltage is delayed by returning the cathode of V1 to a point about 2 volts positive on a voltage divider. The a.v.c. diode plate (D2) returns directly to ground so it is normally negative with respect to its cathode.

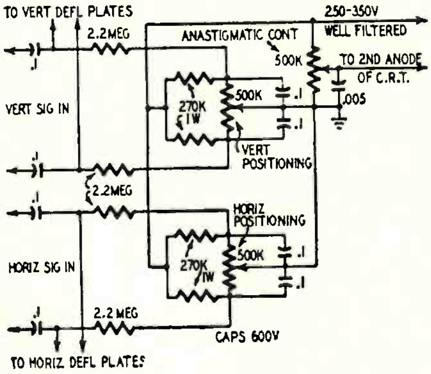
Materials for AM squelch

Resistors (½ watt or larger unless noted): 1—470, 1—2,200, 2—22,000, 1—100,000, 1—270,000, 1—470,000 ohms; 1—62,000 ohms, 1 watt; 4—1 megohm; 1—500,000 ohms, potentiometer with audio taper.
Capacitors: 1—50, 2—100 μμf mica or ceramic; 2—.02, 1—0.1 μf, 400 volts, paper; 1—8 μf, 450 volts, 1—8 μf, 250 volts, electrolytic; 1 (unmarked on schematic) .05 μf, 600 volts, paper.

C-R TUBE BEAM POSITIONING

While constructing an oscilloscope, I was faced with the problem of using single-ended beam-positioning circuits or buying new dual controls. A conventional single-ended control would do the job, but it permits serious defocusing of the beam as it sweeps across the screen. The problem is not nearly so bad with dual controls because the d.c. voltage on the deflection plates varies in opposite direction while the average voltage between them and the second anode remains almost constant.

This circuit shows how a single potentiometer can be used to approximate the performance of a dual control by simultaneously varying in opposite directions the voltage on both of a pair of deflection plates. The circuit also includes an anastigmatic control to further minimize defocusing.



Each deflection plate is about 150 volts positive with respect to ground and the positive side of the high-voltage supply (assuming a 300-volt B supply). The positioning controls are linear types so the resistance from the center to each end will equal the value of the series resistors

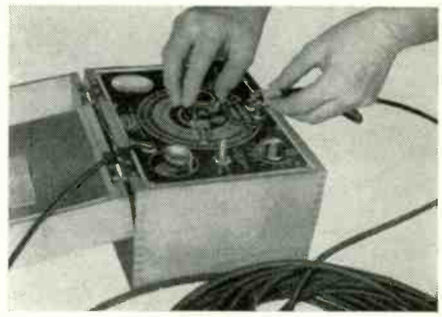
The anastigmatic control permits varying the second-anode voltage as much as 150 volts above or below the average on the deflection plates to minimize defocusing of the beam at the edges of the screen.—*L. H. Trent* END

LOCATING A BREAK IN OPEN CABLE

Finding the break in a bad piece of cable can be a discouraging bit of guesswork, and for short lengths of inexpensive cord it is probably best to replace the entire section. However, for multiconductor cables it may be worth while from a cost point of view to locate and repair the break.

The simple method described here, using measurements made with a capacitor checker, has been found to be quite accurate. In one case where an open occurred in the cable for an Altec Lansing 21-B microphone, the break was found within half an inch of the calculated location. This particular cable has lines for filament, B plus, ground, and signal, so random cuts for testing would probably have been extremely risky.

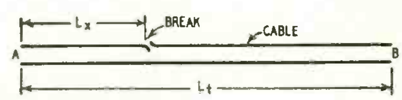
As shown in the photo, the cable end



is connected directly to the capacitor analyzer terminals with short pieces of wire, to avoid uncertain capacitance between the leads of the tester. An ohmmeter was used to identify the open conductor and one good conductor. Measure capacitance on these two leads from both ends of the cable, and then compute the distance by the formula:

$$L_x = L_t \times \frac{C_a}{C_a + C_b}$$

where L_x is the unknown distance in feet from A to the break, (see diagram) L_t is the total length of the cable, C_a



is the capacitance at end A, and C_b is the capacitance at end B, in μμf. For example, when L_t is 50 feet and C_a and C_b are 250 and 500 μμf respectively:

$$L_x = 50 \times \frac{250}{250 + 500}$$
$$= 50 \times 250/750$$
$$= 16.66 \text{ or } 16 \text{ feet and } 8 \text{ inches}$$

From this procedure you can see that cable length and capacitance go right along together. Thus, for a certain over-all length there is a certain capacitance, and for a fraction of this length there will be the same fraction of capacitance.

It is good practice to have the two ends handy at the tester terminals at the start so the cable will not have to be disturbed, because this may change the condition at the break.—*Hugh Lineback*

TUBE IDENTIFICATION

Most service technicians and experimenters have a set of good tubes which they use only as substitutes for questionable ones when testing or repairing equipment. Sometimes the tubes get mixed and it is difficult to tell which tube is the orginal and which is the substitute.

Confusion can be avoided if the test tubes are marked. Stickers marked TEST can be glued to the tubes, or the bottoms of bakelite-based types can be notched with a file or marked with nail polish.—*B. W. Welz*

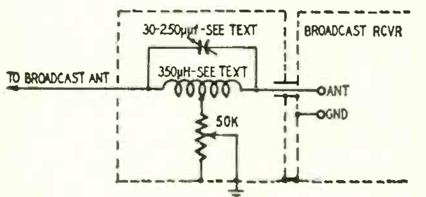
HOT-TUBE PULLER

A corrugated insert from inside a miniature tube carton can be used to avoid burning your fingers while removing hot tubes from tight spots in a radio or television set. Simply slip the insert over the tube before removing it.—*R. B. Frank*

HIGH-EFFICIENCY WAVE TRAP

Blanketing and overloading often cause serious interference problems on radio receivers operated in the immediate vicinity of powerful broadcast transmitters. There are a number of ways of combating this type of BCI. The trap shown in the diagram is one of the most effective for this purpose that I've ever seen. When properly constructed and adjusted on the broadcast band, it is possible to have 30-db rejection at the carrier frequency while signals 10 kc on either side are hardly affected.

For broadcast stations between 540 and 1600 kc, use a 30–250-μμf capacitor and a 350-μh, high-Q, low-loss inductor wound in a single layer and tapped at the exact center. (The author did not include coil-winding data. You can use about 120 turns of No. 18 enameled wire close-wound on a 2½-inch low-loss form.—*Editor*) The trap components must be mounted in a shielded box and there should not be any exposed lead between the shield and the receiver's antenna post. If necessary, use coaxial between the trap and the receiver. Mount the tuning capacitor clear of the shield and use an insulated flexible coupling and a plastic rod in

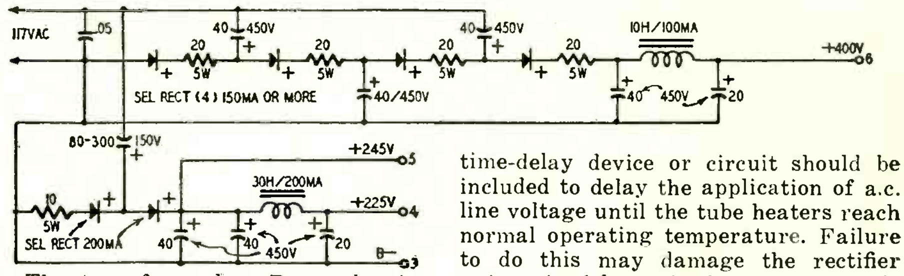


order to bring the shaft through the shield can.

When adjusting the trap, set the potentiometer for maximum resistance, tune in the unwanted station on the receiver, tune the capacitor for minimum signal, adjust the resistor for a deeper minimum, and then touch up the capacitor setting.—*CP1BK* END

VOLTAGE MULTIPLIERS FOR TRANSFORMERLESS TV SUPPLY

? I am constructing the DeLuxe Televiser from details given in the January through May, 1950, issues. A suitable power transformer is difficult to find, so I have decided to substitute a transformerless B plus supply if you will kindly print a diagram.—G. S., Philadelphia, Pa.



A. The transformerless B supply circuit shown consists of a quadrupler delivering 400 volts and a voltage doubler delivering a maximum of about 245 volts.

When using a supply of this type, insulate the B minus bus from the chassis and connect it to the chassis through a resistor of about 200,000 ohms or so bypassed by a capacitor of about .001 µf. Even then, use extreme caution when handling the chassis (or that of any other receiver using a transformerless supply).

The quadrupler output voltage is about 400 under load and is quite a bit higher before the load is applied, so, a time-delay device or circuit should be included to delay the application of a.c. line voltage until the tube heaters reach normal operating temperature. Failure to do this may damage the rectifier units. A delay of about 30 seconds should be sufficient. Thermostatic-type delay relays made by Amperite and others are readily available from most radio and electronic parts distributors.

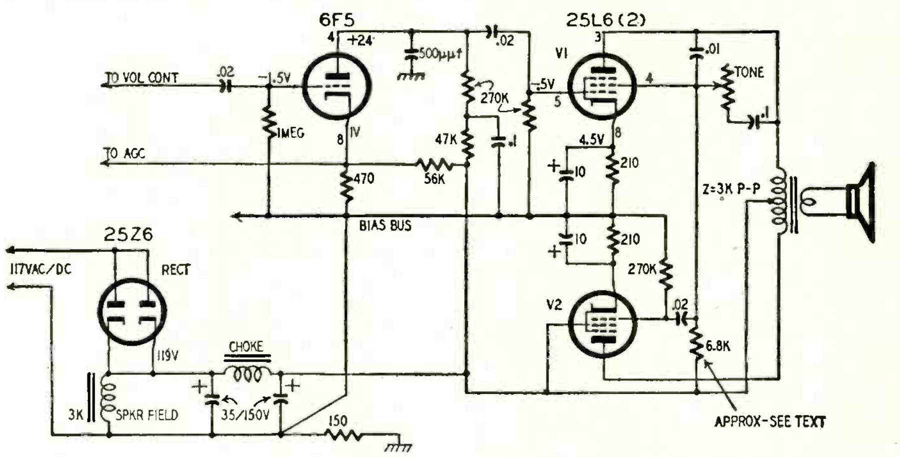
The output terminals are numbered to correspond to those on the original receiver diagram in the March, 1950, issue.

CONVERTING ZENITH MODEL 7D222 TO PUSH-PULL OUTPUT

? I would like to convert the output stage of a Zenith 7D222 a.c.-d.c. radio into a push-pull circuit using as many of the original components as possible. Please print a circuit showing a simple modification.—C. H. L., St. Louis, Mo.

A. The diagram shows one method of converting the power amplifier circuit to push-pull. A resistor of approximately 6,800 ohms is inserted in series with the screen grid of the driven output stage (V1). The screen voltage swings with the audio signal on the grid. The audio signal on the screen of V1 is fed to the control grid V2. Adjust the value of the 6,800-ohm screen resistor for equal signal voltage on the 25L6 control grids.

If you replace the 25Z6 rectifier with a 100-ma selenium rectifier, you can use the socket for the extra 25L6. This arrangement will also make it possible to add the extra tube without changing the value of the filament-dropping resistor.



CONSTRUCTING A 10-ELEMENT YAGI FOR CHANNEL 7 AND 9

? I want to construct 10-element Yagi antennas for TV channels 7 and 9. Please print diagrams showing the pertinent dimensions.—Z. S., Mercedes, Argentina

A. The diagram (Fig. 1) shows the construction of a 10-element Yagi with constants which may be used to find the dimensions in *inches* for any frequency for which a Yagi is practical. Simply divide the constants by *f*, the low-frequency end (in megacycles) of the desired channel. For example, *f* is 174 for channel 7 and 186 for channel 9. The spacing between the reflector and radiator and between the directors is set at about 0.2 wavelength to provide high gain with a good back-to-front ratio.

The folded-dipole radiator should consist of 1-inch and ⅜-inch conductors spaced 1 inch center-to-center to match a 300-ohm lead-in.

There are a number of ways to connect the ends of the dipole conductors. Perhaps the simplest is to use metal clamps or straps made of the same ma-

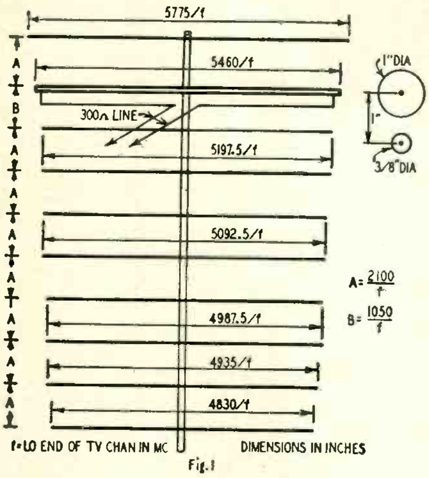


Fig. 1—Diagram of 10-element Yagi.

terial as the dipole conductors. Fig. 2 shows two types of straps. The type at *a* is easier to construct since it can be bent from comparatively thin sheet metal. One piece is needed for each end

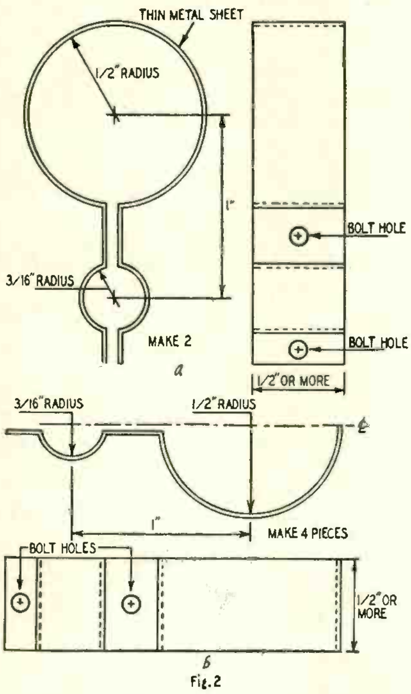


Fig. 2—Two types of mounting straps.

of the dipole. The type at *b* is more difficult to form because thicker metal is required. However, it is not too hard a job if you have access to a fairly heavy bench vise. END

Dear Lady

by Jeanne DeGood

Don't let your husband keep his threat
To fix your TV set;
If anything will make it rattle,
That'll!

AIR-KING 700-93

A loud hum or strong buzz in these sets has been traced to pickup in the 6SQ7-GT tube. To remedy this, replace the tube with a metal type or install a good tight-fitting metal shield. Although this trouble occurs most frequently in the 700-93, it has been noticed in other models.—*Wayne Miller*

EMERSON 686 TV SET

The set produced a raster but the sound and video circuits were dead. Tubes were substituted without localizing the trouble. All voltages checked O.K. at the tube sockets. While double-checking the voltage readings, the sound and picture came on momentarily when I pressed down on the plate pin of the 6AU6 second picture i.f. amplifier.

Since the plate voltage was correct, I checked continuity between the socket pin jack and the plate pin at the base of the tube. The circuit was open. There was a break in the socket between the two bakelite wafers where it could not be seen. Replacing the socket restored operation to the sound and video circuits.—*Andrew B. Lucas, Jr.*

PHILCO 46-480

A slight crackling noise that is noticeable at low volume has been traced to a defective 220,000-ohm plate-load resistor in the first audio-amplifier stage. This resistor will test O.K. but should be replaced because it is starting to crystallize.

If noise originates in the converter stage or if 7F8 converter tube fails frequently, the difficulty can be eliminated by replacing the 4,700-ohm resistor in the mixer plate circuit with a 47,000-ohm unit and removing the 100,000-ohm resistor between the mixer cathode and B plus.—*John Flint*

EMERSON GC CHASSIS

When one of these sets operates on batteries but not on a.c. or d.c. lines, check the two resistors mounted upright on the chassis near the 117Z4-GT rectifier. These resistors, R16 and R17 on the manufacturer's diagram, should be 1,500 and 950 ohms respectively. They frequently increase in value and cause the set to fail on line operation. Replace them with 10-watt units of the required value.—*Lyle Briggs*

U.H.F. TV OSCILLATOR TUBES

Frequently, intermittent operation or failure of 6AF4 and 6T4 oscillators in u.h.f. converters and tuners is caused by slight corrosion or oxidation of the silver-plated base pins. Cleaning the pins with crocus cloth restores the tubes to operation temporarily, but heat of operation causes reoxidation and the trouble returns within a few hours.

Such tubes can be restored to reliable operation by replating the pins with pure silver. If you don't have facilities for electroplating, comparable results can be obtained with a new liquid sold at large department stores for touching-up worn silver-plated tableware and similar items. Apply the solution to the pins with a saturated cloth and then rub them for a few seconds with a second cloth. Be sure to clean off all dried solution which may have gotten on the glass envelope. If allowed to remain, it will disturb the interelectrode capacitances of the tube.—*Horace S. Harmer*

STROMBERG-CARLSON SERIES TC-125

Here are some minor circuit changes that improve the performance of early Stromberg-Carlson TC-125 series receivers:

To improve the signal-noise ratio of the ratio detector for clearer audio reproduction, change capacitor C56 (Fig. 1) from 1.0 to 5.0 μf.

To improve vertical scanning and increase the height, change R49 (Fig. 2) from 8,200 to 470 ohms and R131 from 1.5 megohm to 500,000 ohms.

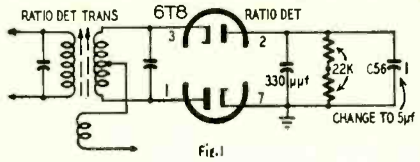


Fig.1

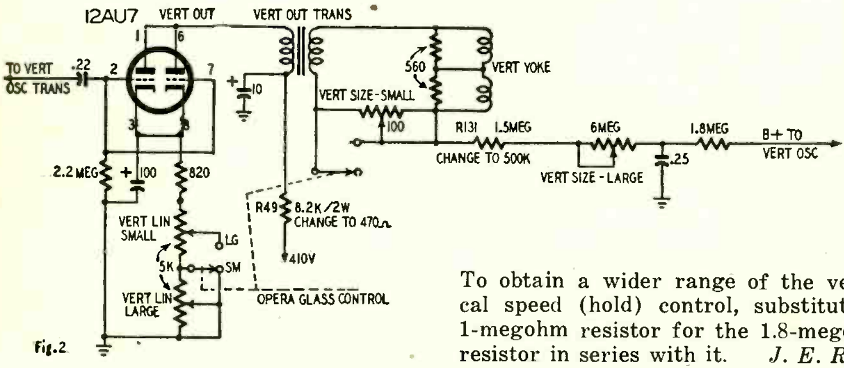
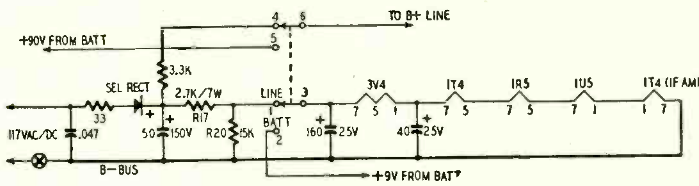


Fig.2

To obtain a wider range of the vertical speed (hold) control, substitute a 1-megohm resistor for the 1.8-megohm resistor in series with it. *J. E. Ryan*

RCA BX6 3-WAY PORTABLE RADIO

This set was dead on a.c. line operation but operated normally on batteries. B plus voltage checked O.K., thus eliminating the selenium rectifier, the 33-ohm current limiting-resistor, and the B plus filter capacitors as possible causes of the trouble. When the d.c. voltmeter was connected across the 15,000-ohm bleeder (R20) to check the filament voltage, its needle vibrated violently about the 5-volt mark. R17 (a molded wire-wound unit mounted above the chassis next to the 3V4) and R20 were well within normal tolerances when checked on an ohmmeter. The 40- and 160-μf, 25-volt electrolytics on the filament line were temporarily replaced without restoring the original performance of the set. Replacing R20 did not cure the trouble, so this left only R17 the series filter resistor under suspicion.

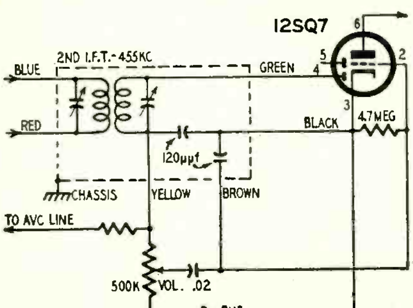


Evidently the 2,700-ohm, 7-watt resistor had a high-speed intermittent which opened and closed, causing the meter to act as it did, because performance returned to normal when it was replaced with a new unit. The manufacturer's type number is 74319. —*Edward Lee*

RCA MODEL 55X RADIO RECEIVERS

If these sets lack volume and the last i.f. trimmer capacitor has no effect on the response, the trouble is probably caused by a short in the combination i.f. trimmer and r.f. filter unit built into the transformer.

The most efficient method of eliminating the trouble is to replace the output i.f. transformer. This trouble may occur also in the RC-1001, RC-1003, and RC-462 series chassis. The diagram shows color coding and connections to the second i.f. transformer in a typical set of this type.—*Milo Bannister*



AUTOMATIC MODEL 620 RADIO

The audio on this receiver kept going on and off as I tuned across the dial. A check showed that the oscillator was intermittent. Changing the converter tube showed no improvement. I then noticed that the oscillator coil on this permeability-tuned receiver moved back and forth as I turned the tuning dial. A resistance measurement disclosed an intermittent open, caused by this motion.—*S. E. Kay* END

WITH THE TECHNICIAN

COLUMBUS SENDS NEWS

A special issue of the mimeographed *Associated Radio-Television Service Dealers' News* announces the 1954 officers and committees.

The 1954 officers are: Fred Oberle, president; Harry Walcutt, vice-president; Bob Duckworth, secretary; and Jim Cumbow, treasurer.

Standing committees include membership, publicity and public relations, ethics, trade relations, price stabilization, educational and technical, and entertainment. In addition to these committees, which include from two to four members each, there is listed the editor of the *ARTSD News* and a special committee expeditor.

The two-sheet paper uses illustration, special borders, carefully planned layout, and excellent mimeographing to make an attractive appearance and ensure that it will be read by the members.

TULSA ADOPTS BY-LAWS

A constitution and set of by-laws has been adopted by the Tulsa (Oklahoma) Radio and Television Association, which had been operating as a temporary group. Membership is limited to service shop operators, managers, and technicians in the Tulsa area.

Permanent officers elected were: Lee Ackley, president; Carl Lindsey, vice-president; Clarence Snead, vice-president in charge of public relations; Mickey Holt, secretary; Howard Hunter, treasurer; and Virgil Weaver, chairman of the association's executive committee.

The association states that its purpose is to protect the public against service organizations not qualified to provide satisfactory service. A list of the association's Code of Ethics was recently placed as an ad in the *Tulsa Tribune*, and was stated to be the first of a projected series of advertisements by the association.

COLOR TV IN TEXAS

A lecture on color TV was announced by the San Antonio Radio and Television Association Inc. Speaker was C. R. Bowman of P. R. Mallory Co. A G-E Business Course was also planned, to start with the last meeting in March. The expenses of the course, which amount to $5 per student, are being borne by Modern Radio Co., which insists, however, that each person taking the course pay $5 to the association treasurer as a means of increasing the financial strength of San Antonio RTA.

Officers for 1954, announced in the same release, are: Albert R. Niehaus, president; Elmo Bohmann, vice-president; Ora G. Fretz, secretary; Thomas F. Boyd, treasurer. H. M. Willman, and Esteban S. Viera are directors.

TWO TV PROBLEMS

Two prime elements in the television service business will always cause difficulty, according to Norman Foster, owner of a prosperous TV service-while-you-wait business in Chicago.

One of the difficulties, says Mr. Foster, is the fact that a TV set is—and is likely to be for some time—a very complicated piece of equipment. The other is that there are—and always will be—some very complicated TV set owners!

EASTERN CONFERENCE

The Eastern Television Service Conference will be held in Philadelphia, April 2, 3, and 4. The Philadelphia Council of Radio and Television Service Associations will handle local arrangements during the three-day conference. All service technicians and service dealer groups throughout the U.S. and Canada are welcome to participate, but it is expected that the attendance will be largely from the northeastern section of this country.

Harold B. (Dusty) Rhodes of Paterson, N. J., was elected chairman of the 1954 conference. Committees include: publicity, J. Palmer Murphy, Paterson; banquet, Albert Haas, Philadelphia; program and agenda, Sam Brenner, Philadelphia, and Max Liebowitz, New York City; industry co-ordination, Milan Krupa, Wilkes-Barre, Pa.; credentials, Roger Haines, Haddonfield, N. J.

Special attention will be paid to color TV and u.h.f. at this year's conference. More than 12 sessions will be devoted to color, and a full line of color receiving equipment will be on hand. Arrangements to receive live color pictures are under way, with every prospect of success. An attendance of more than 300 is expected. The conference will be held in the Bellevue-Stratford Hotel.

BBB ACTS IN ST. LOUIS

Because of a rash of advertising offering service calls at $2.50 or $3.00, the Better Business Bureau of St. Louis has asked all advertising media to observe a new set of regulations when accepting ads from TV service companies. The president of the BBB pointed out that these ads are merely a gimmick to get the company's representative into the home, rather than actually to repair the sets as the ads claimed.

Typical excerpts from the regulations are:

"Advertisers who offer to service television sets shall make no reference to repairing in the home.

"Advertisers who quote a price for a service call shall state definitely the period of labor time included in that price and rate per hour to be charged for labor time in excess of that period. For example: Service call $5—includes 15 minutes' work; additional work at rate of $5 per hour; plus cost of necessary parts."

The city's large metropolitan dailies, the *Post-Dispatch* and the *Globe-Democrat*, both stated that after Feb. 1, 1954, all TV service advertising would be required to conform to the BBB regulations.

The BBB president emphasized that the questionable service practices represent a small minority in the industry.

LICENSES FOR MICHIGAN?

A bill to license Michigan TV and radio service technicians has been proposed by Representative Michael Novak of Detroit.

Michigan licenses barbers and plumbers, and licenses for service technicians are equally important, declared Representative Novak. A television set, he said, is a complicated thing and "it does not take much for an unqualified man to gum up the works."

The proposal was to create a state board to examine and license qualified service technicians.

OPPOSES LICENSING

A city council proposal to license TV and radio technicians in Binghamton, N. Y., was condemned by the Southern Tier Chapter, Radio Servicemen of America, at a recent meeting.

A resolution was drawn up to be forwarded to the city council. It stated in part:

"We do not believe the licensing of technicians will stop the complaints aimed at the radio and television servicing profession.

"However, should the legislative body of this city deem licensing imperative, it would be acceptable to us only on a state-wide basis."

The resolution went on to say:

"We feel that TV and radio service technicians are being singled out and condemned for some customer reaction that exists in any trade or business." It further pointed out that the customer is able to select a service technician who is reliable, capable, and experienced, because "there is now, and has been for 20 years, a reliable service technicians' organization in this city, whose members are capable of rendering such service and can give a guarantee on their work that is backed by the organization."

K. C. ELECTS OFFICERS

The Television Service Engineers, Inc., of Greater Kansas City, has announced its 1954 slate of officers.

Ray Crawford, AAA Television Service, is president; Bob Hester, Hester Radio and Television Co., Mission, Kan., vice-president; Walter Nieswonger, Telorad Radio Sales and Service, secretary; and Bill Dunfee, Dunfee Television Sales and Service, treasurer. Al Richards, past president, was elected to be chairman of the board of directors to be. END

Hopscotch

by Jeanne DeGood

When I'm dx-ing on TV,
I try to catch sporadic-E
Before it makes another skip
And gives my TV set the slip;
For yesterday, sporadic-E
Skipped completely over me.

Charles F. Stromeyer, recently appointed executive vice-president of CBS-Hytron, Danvers, Mass., was named president of the company, succeeding **Bruce A. Coffin**, founder and president of the company since 1921. **Lloyd H. Coffin**, treasurer of CBS-Hytron, also announced his retirement. Both Bruce Coffin and Lloyd Coffin will retain their memberships on the Board of Directors of CBS, Inc. Stromeyer was subsequently elected a vice-president and a director of CBS, Inc.

F. N. McGlynn was promoted to sales manager, AC Motors, of General Industries Co., Elyria, Ohio, and **M. L. Young** was upped to assistant sales manager, AC Motors. McGlynn was formerly in charge of the Chicago sales office and Young was a sales engineer.


F. N. McGlynn


M. L. Young

William H. Rickards joined Ward Products Corp., Division of the Gabriel Co., Cleveland, as director of engineering. He was formerly with Radiart and Cleveland Electronics.


W. H. Rickards


E. S. Todd

Emory S. Todd was promoted to vice-president for sales of Krylon, Inc., Philadelphia. He was previously field sales manager of the Protective Coating Division of the company.

Merle (Bud) Cain was named distributor sales manager of V-M Corp., Benton Harbor, Mich. He was formerly Chicago District representative for General Electric, and more recently was assistant TV sales manager for Hallicrafters.


Left, Merle (Bud) Cain; right, K. L. Bishop, V-M general sales manager.

Gerald Florence, president of Benchmaster Manufacturing Co., Gardena,

WATCH FOR OUR MAY ISSUE AT YOUR DEALER'S APRIL 23

Calif., announced the purchase of Clear Beam Television Antenna Co., Burbank, and Tempo T. V. Products Co., Los Angeles, television mast manufacturers. **Harold Florence** was elected as president of Clear Beam and **Harry Lieb** as president of Tempo.

H. Florence

Dr. William Osborn and **Dr. Miao Yung-Miao** joined the engineering staff of Channel Master Corp., Ellenville, N.Y. Dr. Osborn, formerly with the University of Virginia's Naval Ordnance Research Laboratory, will be project engineer in the development of new v.h.f. and u.h.f. antenna types. Dr. Miao, formerly with International Harvester Corp., will be project engineer in the development of mechanical test equipment for antennas.

Left, Dr. Yung-Miao; right, Dr. Osborn.

W. Walter Jablon was named sales manager, Home Instruments Division, of Freed Electronics Controls Corp., New York, N. Y. Jablon, a veteran in the electronics industry, joined Freed late last year.

W. W. Jablon

Vito Racanelli joined Chicago Standard Transformer Corp., as advertising manager. He was formerly with Edward C. Kennedy Co., advertising agency.

Obituary

Einar W. Nielsen, a founder and president of Best Manufacturing Co., Irvington, N. J., died recently of a heart attack while vacationing in Fort Lauderdale, Fla.

Personnel Notes

... Robert A. Seidel was appointed vice-president of the RCA Sales and Service Subsidiaries Division, with headquarters in New York City. He will be responsible for the activities of RCA Institutes, RCA Service Co., and RCA Distributing Corp. Seidel has been a vice-president of RCA since 1949.

. . . **Guy A. Wilson**, former assistant purchasing agent for United Motors Service Division of General Motors Corp., Detroit, Mich., was appointed general purchasing agent.

. . . **Michael F. Callahan** was promoted to vice-president in charge of manufacturing for all CBS-Hytron plants. Other executive promotions at CBS-Hytron include: **Edgar K. Wimpy**, to director of general engineering; **Dr. Russell R. Law**, to director of research and development; **Clifford Hughes**, to plant manager of the Newburyport, Mass., receiving tube plant; **Elwood W. Schafer**, to manager of color planning; **J. Farley**, to director of quality control; and **David A. Sokolov**, to supervisor of development of receiving tubes.

. . . **Captain John N. Boland**, USN, (ret.) was appointed manager of the Raytheon Manufacturing Company's Washington, D. C. office. He formerly did Government liaison and contract work for the company.

. . . **Albert Lederman** was appointed engineering specialist in the new Mechanized Circuits Department of Sylvania Electric Products, with headquarters in Long Island City, N. Y. He was formerly a technical representative for Sylvania in Washington, D. C.

. . . **John J. Corcoran** was promoted to sales representative and commercial engineer on the West Coast for Tung-Sol Electric, Newark, N. J. He was previously an initial-equipment tube salesman for the company.

. . . **Robert A. Hoagland** joined Aerovox - New Bedford Division, Aerovox Corp., New Bedford, Mass., as sales manager. He had been with Mills Industries.

. . . **Alfred Y. Bentley** was placed in charge of advanced planning for the Television Receiver Manufacturing Division of Allen B. DuMont Laboratories, Clifton, N. J. He had been head of the Division's Engineering Department for the past year.

. . . **Larry F. Hardy** was named vice-president in charge of Product Development for Philco Corp., Philadelphia. He was formerly president of the Television and Radio Division. At the same time, **John M. Otter**, vice-president and general manager of the Refrigeration Division, was placed in charge of Consumer Product Divisions, and **Morgan Greenwood**, advertising manager of the Television and Radio Division, was upped to general advertisiing manager of Philco.

. . . **David H. Kutner** joined Motorola, Chicago, as director of advertising. He formerly held a similar position with the Norge Division of Borg-Warner.

. . . **Edwin Cornfield** joined Pilot Radio Corp., Long Island City, N. Y., as sales manager. He comes to Pilot from Hudson Radio and Television Corp. END

Watch for the May Issue of RADIO-ELECTRONICS At Your Dealers April 23

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. All literature offers void after six months.

ELECTRONIC COMPONENTS

Bud Radio's Catalog No. 154 is a well-illustrated 52-page book listing electronic components and sheet-metal products. Among the many products listed are racks, panels, chassis, enclosures, antenna hardware, amateur equipment, capacitors, chokes, connectors, and coils.

Obtainable free from Bud Radio Corp., 2118 E. 55th St., Cleveland 3, Ohio.

COLOR TV FACTS

The Better Business Bureau's booklet, *The Facts About Color Television,* is a tool with which dealers can clarify for themselves and the public some of the rumors, misinformation, and wishful thinking which has been stimulated by the advent of color television.

It offers information on the development of color TV, the meaning of compatibility, the facts about conversion, availability of color programming and receivers, prices, and picture sizes.

This booklet is being distributed free through General Electric dealers and distributors.

METER-RELAY CIRCUITRY

Assembly Products has issued an 8-page bulletin explaining the functioning of 11 control and alarm circuits using meter relays. Circuits for battery-charging control, null-balance pulsing, over- or under-voltage current alarm, and temperature control are among those described. These circuits have been adapted for vacuum pump control, radiation detection, and microwave stand-by transmitter control, and other applications.

With each control diagram is a list of components for use in the circuit. Plug-in assemblies from which the controls can be made are also listed. Complete control units to accomplish a given purpose are described with each circuit.

Ask for Bulletin 112 from Assembly Products Inc., Chagrin Falls, Ohio.

AMPLIFIER DATA

Stancor has issued a bulletin describing the construction of their Ultra-Linear high-fidelity amplifier, with chassis drawings, schematics, and parts lists. Data on converting the Stancor Williamson amplifier to Ultra-Linear operation is included in the bulletin.

Write for Bulletin 479, available without charge from Chicago Standard Transformer Corp., Standard Division, Addison and Elston, Chicago 18, Ill.

RELAY DATA FILE

Price Electric Corp. is offering a handy relay data file containing specifications and photographs of relays of 42 types, both commercial and military.

There are no loose sheets or attachments. All information is printed on the body of the folder itself. Information provided includes contact arrangements and rating, coil data, dimensions, and weight.

Available free on letterhead request from Price Electric Corp., Frederick, Md.

CANNON CONNECTORS

A new 8-page loose-leaf brochure describing Cannon's new series E line of AN-type lightweight vibration-proof connectors with integral cable clamps and grounding lugs has just been issued.

Free upon request to Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

NEEDLE GUIDE

Jensen has issued an 8-page needle catalog, No. 53, three pages of which are a guide for replacement needles. Data included are cartridge manufacturer, cartridge number, point material, point size, picture of needle, cartridge manufacturer's needle number, Jensen needle number, list price, usage per 1,000 needles, and number of the correct substitute needle.

Available free from Jensen Industries, Inc., 329 S. Wood Street, Chicago 12, Ill.

SPEAKERS AND ENCLOSURES

Kingdom has issued a 4-page catalog illustrating and describing Lorenz woofers and tweeters, Kingdom cabinets, and Kingdom-Lorenz combination units. Construction notes and plans for speaker enclosures are included in the catalog.

Free from Kingdom Products, Ltd., 23 Park Place, New York 7, N. Y. END

MOST-OFTEN-NEEDED TELEVISION SERVICING INFORMATION (Volume TV-8), compiled by M. N. Beitman. Published by Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. 8½ x 10¾ inches, 192 pages. Price $3.00.

Diagrams, chassis layouts showing the location of tubes, alignment, and test points; oscilloscopic waveform patterns—these and other pertinent servicing information are supplied on approximately 120 different chassis used in hundreds of TV receiver models of 23 different makes; all designed to facilitate servicing.

The usefulness of the manual is obvious to the service technician. Students, instructors, engineers, and other interested persons will find it useful in comparing and analyzing circuits in a great many of the modern TV receivers.—*RFS*

THE RADIO AMATEUR'S HANDBOOK, 31st (1954) edition. Published by The American Radio Relay League, Inc., West Hartford 7, Conn. 6½ x 9½ inches, 300 pages. Price $3.00.

The latest edition of "the Handbook" is revised to provide the reader with details on all that is new or novel as well as expanded treatments on subjects that are taking on ever-increasing importance in the lives of amateurs. For example, there is a new section on crystal diodes and transistors, the latest developments in mobile converters, transmitters, and antennas are discussed and described; and the section on interference has been revised to include suppression measures for interference at ultra-high frequencies and color TV.

The tube data section has been brought up to date with the addition of about 150 new tube types, about 40 of the recently developed transistors, and the latest types of germanium diodes. To engineers and students, this feature alone is well worth the price of this 31st edition of an old standby.—*RFS*

AMECO RADIO AMATEUR QUESTION AND ANSWER LICENSE GUIDE. Published by American Electronics Co., 1203 Bryant Ave., New York, N. Y. 6 x 8¾ inches, 32 pages. Price 50 cents.

The first 12 pages of this book are devoted to the novice, with 60 questions on basic electricity, power supplies, transmitters, and rules and regulations. The second section, "General and Technician Practice Questions," contains 128 questions on the subjects mentioned and also on vacuum tubes and audio amplifiers. The questions are of the multiple-choice type used in FCC examinations, and a typical examination closes each section.

Answers to all questions are given on page 30. Pages 31 and 32 carry diagrams which answer those questions that require the drawing of figures.—*FS* END

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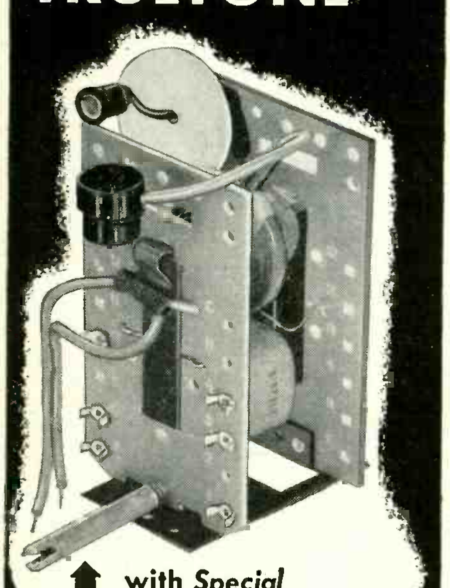

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ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

All Channel Antenna Corp. .... Inside Back Cover
Allied Radio Corp. 15
American Microphone Co. 72
American Phenolic Corp. 102
Amplifier Corporation of America 122
Arkay Radio Kits, Inc. 89
Astatic Corp. 14
Astron Corp. 25
Atlas Sound Corp. 86
Audel Publishers 122
Barry Electronics Corp. 128
Beeco 101
Belden Manufacturing Co. 99
Bell Telephone Labs 22
Brach Manufacturing Co. 106
Brooks Radio & TV Corp. 92, 93, 101
Burstein-Applebee Co. 96
CBS Hytron (Division of Columbia Broadcasting System) 10
Cannon Electric Co. 98
Capitol Radio Engineering Institute 27, 125
Centralab—Division of Globe Union 29
Century Electronics Co. 100
Channel Master Corp. 20, 21
Chicago Standard Transformer Corp. 26
Clarostat Manufacturing Co. 79
Cleveland Instituta of Radio Electronics 11
Collins Audio Products Co., Inc. 91
Concord Radio 121
Cornell-Dubilier Electric Corp. 90
Coyne Electrical & TV Radio School 101, 113
Delco Radio (Division of General Motors Corp.) 9
DeVry Technical Institute 7
Doc's Radio Tools 121
Douglas Instrument Laboratory 125
Edlie Electronics 97
Electric Sweeper Service Co. 112
Electro Products Labs., Inc. 112
Electro-Voice, Inc. 6
Electron Tube Wholesalers, Inc. 116
Electronic Equipment Co. 123
Electronic Instrument Co. 30, 76, 113, 116
Erie Resistor Corp. 82
Fair Radio Sales 88
G & H Wood Products Co. 86
General Industries Co. 111
General Test Equipment 125
Gould Green 116
Halldorson Transformer Co. 128
Harvey Radio Co., Inc. 108
Heath Co. .... 67-70 inclusive
Hickok Electrical Instrument Co. 24
Hudson Specialties Co. 89
Hughes Research & Development Labs. 18
Indiana Technical College 112
Instructograph Co. 111
International Correspondence Schools 13
Jensen Industries 118
Jones & Laughlin Steel Corp. 94
Kay-Townes Antenna Corp. 95
Kirby Products 76
Krylon, Inc. 109
Lafayette Radio 125
Leotone Radio Corp. 119
Macmillan Co., The 126
Mallory & Co., Inc., P. R. 19
McGraw-Hill Book Co. 122
Metalace Corp. 109
Moog, R. A., Co. 111
Moss Electronic Distributing Co. 80, 81
National Electronics of Cleveland 124
National Radio Institute 3, 129
National Schools 5
New Jersey Television Supply Co. 100
Ohmite Manufacturing Co. 74
Opportunity Adlets 100
Orradio Industries Inc. 115
Part-Mart Co. 86
Permo, Inc. 92
Permoflux Corp. 12
Philco Corp. 28
Precise Development Corp. 89
Precision Apparatus Co., Inc. 90, 96
Pres-Probe Co. 113
Progressive "Edu-Kits" Inc. 103
Pyramid Electric Co. .... Inside Front Cover
RCA Institutes, Inc. 105, 107
RCA Victor Division (Radio Corporation of America) .... Back Cover
Rad-Tel Tube Co. 87
Radelco Manufacturing Co. 120
Radiart Corp. 77

RADIO SCHOOL DIRECTORY
PAGE 127

Candler System Co.
Grantham School of Electronics
Indiana Technical College
Indianapolis Electronic School
Milwaukee School of Engineering
RCA Institutes, Inc.
Tri-State College
Valparaiso Technical Institute
Western Television Institute

Radio-Television Training Ass'n. 17
Raytheon Manufacturing Co. 23
Resi-Sphere 125
Rider, Inc., John F. 119
Rinehart & Co., Inc. 72, 98, 114, 120, 124
Rogers Electronics Corp. 125
Sams & Co., Inc., Howard W. 16, 110
Scala Radio Co. 108
Service Instruments Co. 117
Sprayberry Academy of Radio 65
Stan-Burn Radio & Electronics Co. 109
Standard Wood Products 123
Steve-El Electronics Corp. 88
Sun Parts Distributors Ltd. 92
Sylvania Electric Products 83
Tab 130
Technical Appliance Co. 73
Television Communications Institute 115
Teltron Electric Co. 82
Transamerica Electronics 118
Transvision, Inc. 119, 120, 121
Tung-Sol Electric Co. 16
Turner Co. 8
United Catalog Publishers 118
V.A. Enterprises 121
V-M Corporation 126
Waldom Electronics 88
Webster Electric Corp. 75
Westinghouse Electric Corp. 84, 85
Windsor Electronic Tube Co. 123
Xcelite Inc. 106
Zingo Products 113

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0B3/VR90	.82	6BA6	.60	7B7	.76
0C3/VR105	.80	6BC5	.69	7B8	.78
0D3/VR150	.89	6BE6	.63	7C4	.29
0Z4/0Z4A	.55	6BG6G	1.79	7C5	.69
1A7GT	.77	6BH6	.80	7E5	.39
1B3GT	.85	6BJ6	.85	7F7	.85
1B27	11.50	6BK5	.95	7F8G	1.55
1H5GT	.77	6BK7	1.10	7H7	.70
1L4	.60	6BL7GT	1.00	7N7	1.20
1L6	.95	6BN6	1.20	7Q7	.98
1LA6	1.10	6BQ6GT	1.17	7X7	.90
1LB4	1.10	6BQ7A	1.23	12AT6	.50
1LN5	1.10	6BY5G	1.95	12AT7	.89
1N5GT	.95	6BZ7	1.28	12AU7	.79
1R4	.59	6C4	.50	12AV6	.50
1R5	.75	6C6	.50	12AV7	.90
1S5	.70	6CB6	.65	12AW6	.88
1T4	.75	6CD6G	1.80	12AX4	.90
1U4	.50	6CU6	2.10	12AX7	.70
1U5	.70	6D6	.75	12AY7	1.90
1V	1.03	6F4	3.50	12B4	.98
1V2	.90	6F5	.68	12BA6	.65
1X2A	.85	6F5GT	.68	12BD6	.75
1Z2	3.25	6F6	.70	12BE6	.64
2X2	.35	6F6G	.80	12BH7	.85
3A4	.59	6F8G	.85	12BY7	1.05
3B7	.39	6G6G	.85	12BZ7	1.10
3Q4	.89	6H6	.52	12SA7	.64
3Q5GT	.90	6J4(RCA)	5.75	12SF5	.70
3S4	.75	6J5	.50	12SG7	.80
3L4	.90	6J6	.75	12SH7	.63
3V4	.75	6J7	.75	12SJ7	.55
5AW4	1.55	6K4/6K4A	2.25	12SK7	.61
5R4GY	1.50	6K6GT	.59	12SL7GT	.65
5U4G	.56	6K7	.60	12SN7GT	.75
5V4G	.92	6L6G	1.10	12SQ7GT	.55
5W4G	.80	6L6GA	1.10	12SR7	.69
5X4G	.75	6L6M	1.25	12SX7GT	1.10
5Y3GT	.44	6L7	.80	14F7	.75
6A8GT	1.10	6N7M	.70	19BG6G	2.05
6AB4	.65	6Q7GT	.80	19T8	.85
6AB7	.95	6S4	.58	25BQ6GT	1.25
6AC7	1.04	6S7M	.98	25L6GT	.62
6AF4	1.39	6SA7	.64	25W4GT	.65
6AG5	.71	6SC7	.88	25Z5	.70
6AG7	1.10	6SD7GT	.80	25Z6GT	.59
6AH4GT	.80	6SG7	.66	28D7	1.55
6AH6	.88	6SH7	.98	35A5	.62
6AJ5	1.30	6SJ7	.65	35B5	.60
6AK5	.79	6SK7	.61	35C5	.62
6AK5-W	1.50	6SL7GT	.65	35L6GT	.65
6AK6	.98	6SN7GT	.73	35W4	.45
6AL5	.55	6SQ7	.58	35Z3	.70
6AN4	1.50	6T8	.89	35Z5GT	.48
6AQ5	.55	6U8	.90	50A5	.75
6AQ6	.73	6V3	1.15	50B5	.65
6AS5	.70	6V6GT	.61	50C5	.65
6AS6	1.95	6W4GT	.59	50L6GT	.65
6AS7G	3.75	6W6GT	.75	80	.66
6AT6	.48	6X5GT	.50	81	.75
6AU6	.59	6X8	.85	83V	1.15
6AV5GT	1.10	7A7	.75	84/6Z4	.65
6AV6	.48			117Z3	.75
6AX4GT	.72			117Z6	.98

SPECIAL PURPOSE TUBES

1N21B	1.88	211/VT4C	.88	CK1005	.65
1N23B	2.20	304TH (Surplus)	7.75	1616	.85
1N34A	.78	310A(WE)	3.75	1619	.33
1N48	.55	407A(WE)	4.95	1622	1.95
1N54	.75	408A(WE)	3.00	1625	.30
2C51	4.85	803	3.25	1626	.20
2E26	3.40	805	2.95	1629	.25
2E30(Hyt)	2.20	807	1.55	2050	1.40
2J39	12.50	809	3.50	5516	7.65
2J61	29.50	812A	3.65	5528/C6L	5.00
2J62	25.00	816	1.40	5654	1.75
2K28	25.00	830B	2.75	5656	10.00
3BP11	7.00	851	39.95	5670	3.25
3B28	4.95	866A	1.25	5687	2.95
3C23(GE)	6.75	Large Quantity 872A(GE)	3.25; 10 for 29.50	5691	7.00
3C24/24G	1.00	955	.45	5693	6.20
4B24	4.50			5814	1.75
5C22	44.95			6096	1.85
5D21	11.90			9003	1.45
7C25	110.00			9004	.30
7C30	85.00			9006	.25

Above is only a partial listing of our huge stock. Types not listed may be ordered at approx. the same savings. Many new special purpose types in stock.

AUTHORIZED DISTRIBUTORS
CBS-HYTRON EIMAC WESTINGHOUSE

ORIGINAL JOBBERS' BOXED TUBES
In Stock—Late Dates,
AT WHOLESALE PRICE LEVELS!

TWO-COLORED TUBE CARTONS, with new Safety Partitions. Prevents Tube Breakage. This Super-Gloss Red and Black Carton is the Most Distinctive Box Available Today! Minimum: 100 any one size. Quantity prices on request.

SIZE		EACH
Miniature	(6AU6, 6AL5, etc.)	$.01
GT	(6SN7, 6W4, etc.)	.0125
LARGE GT	(1B3, 6BQ6GT, etc.)	.015
LARGE G	(5U4G, 6BG6G, etc.)	.02

Terms: 25% with Order, balance C.O.D.
All Merchandise guaranteed. F.O.B. NYC.

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BARRY ELECTRONICS CORP.
136-B LIBERTY ST. N. Y. 6, N. Y.

An Invitation...

To men who want to *"go places"* in TV SERVICING

Find out about this NEW, ALL-PRACTICE WAY of becoming a Professional TV SERVICEMAN

If you have some Radio or Television experience, or if you know basic Radio-Television principles but lack experience—NRI's new Professional Television Servicing course can train you to *go places* in TV servicing. This advertisement is your personal invitation to get a free copy of our booklet describing this training in detail.

Learn-by-Doing "All the Way"

This is 100% learn-by-doing, practical training. We supply *all* components, *all* tubes, *including* a 17-inch picture tube, and comprehensive manuals covering a thorough program of practice. You learn how experts diagnose TV defects quickly. You see how various defects affect receiver performance—picture and sound; learn causes of defects, accurately, easily, and how to fix them. You do more than just build circuits. You get practice recognizing, isolating, and fixing innumerable troubles.

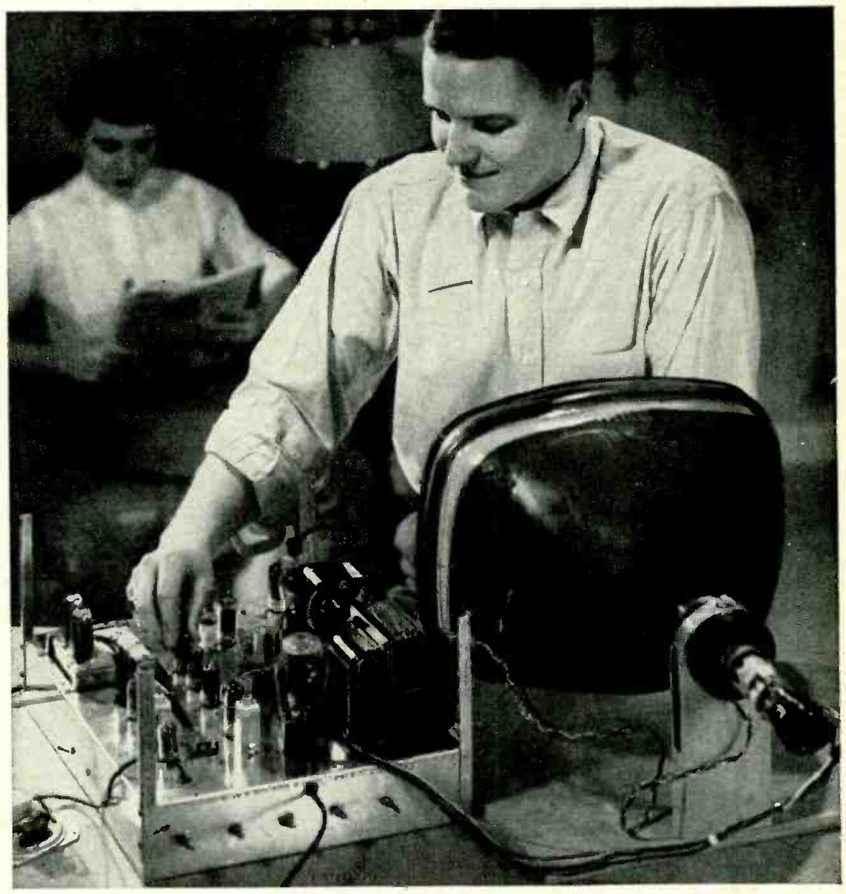
You get actual experience aligning TV receivers, diagnosing the causes of complaints from scope patterns, eliminating interference, using germanium crystals to rectify the TV picture signal, obtaining maximum brightness and definition by properly adjusting the ion trap and centering magnets, etc. There isn't room on this or even several pages of this magazine to list all the servicing experience you get.

UHF & COLOR TV Making New Boom

Installing front-end channel selector strips in modern UHF-VHF Television receivers and learning UHF servicing problems and their solution is part of the practice you get. To cash in on the coming color TV boom you'll need the kind of foundation in knowledge and experience this training gives.

Get Details of New Course Free

Once again—if you want to go places in TV servicing, we invite you to find out what you get, what you practice, what you learn from NRI's new course in Professional Television Servicing. See pictures of equipment supplied, read what you practice. Judge for yourself whether this training will further your ambition to reach the top in TV servicing. We believe it will. We believe many of tomorrow's top TV servicemen will be graduates of this training. Mailing the coupon involves no obligation.



Train at home easily, quickly, for TV's top servicing jobs. NRI's Professional Television Servicing course includes a 17-inch picture tube and all other tubes and components to build a complete TV Receiver, Oscilloscope, Signal Generator, H.F. Probe. Complete training, including all equipment, available now for a low introductory price—under $200 on easy terms.

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Please send my FREE copy of "How to Reach the Top in TV Servicing." I understand no salesman will call.

Name.................................Age..........

Address...

City..........................Zone....State......

CRYSTAL DIODES

1N21 Lots of 50 35¢ ea

Smaller qty. .70¢; 10 for $5.00
Kemtron—W.E.—Sylvania

1N23B ....$2.10; 5 for $ 9.50
1N21A ....$1.55; 5 for $ 7.00
1N21B ....$2.10; 5 for $ 9.50
1N27 .....$1.55; 5 for $ 7.00
1N46 ....69¢; 5 for $ 3.25
1N47 .....$4.00; 5 for $16.25

TUBE SPECIALS

YOU PICK THEM **39¢ ea** lots of 10

Cracked base or broken key electrically perfect
TESTED & 90 DAY GUARANTEED
ORDER NOW, WHILE THEY LAST
5U4G — 6SN7 — 25L6 — 25BQ6
5Y3GT — 6K6GT — 12SA7GT — 6H6
6V6GT — 6B06 — 6W4GT — 12SG7

ZIMPHONE INTERCOM

(2) TELEPHONE HANDSETS, WALL BRKTS, BATTERIES, 50 FT. WIRE, MAKERS ONE YEAR GUARANTEE. OPER. UP TO 1-MILE. CLEAR AS A BELL. ......Postpaid $4.39
With Built in Signal Buzzer P'paid $5.98

YOU PICK THEM **59¢** WHILE THEY LAST
LOTS OF 10

Your selection of 10 at 59¢ each or smaller quantity at indicated prices.

ELECTROLYTIC CONDENSERS

2X 20MFD/450VDC. .69¢; 3 for $1.95
3X 15MFD/450VDC. .98¢; 3 for 2.50
3X 20MFD/400VDC. .79¢; 2 for 1.29
25MFD/450VDC .....69¢; 3 for 1.95
20MF/450V&20MF/25V ..3 for 1.95
50 mf/350vdc FP ....5 for 1.00
30-15-10 mf/250vdc .....5 for 1.00
30-2x20mf/450-25vdc ....3 for 1.00

INFRARED SNOOPERSCOPE

SEE-IN-DARK TUBE

Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—data & tube, ea. ....$7.98; 2 for $13.98

SNOOPERSCOPE PWR SUPPLY

1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Stockets, Resistors, Capacitors and Diagram $6.98

"TAB" THAT'S A BUY

WATCH! THIS SECTION EVERY MONTH

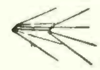
FOR TREMENDOUS BARGAIN PRICES

RF PI CHOKE 20MH/500MA 89¢; 12/7.49
RF PI CHOKE 20MH/200MA 39¢; 6 for $2.
FILTER GE 100AMP/50V $1.50; 2 for $2.00
5" DYNAMIC SPEAKER & Transf-Pent, 3000 ohm field $1.19; ....6 for $5.00
20 Resistors on fibre strip ½ & 1W
10% Sig #3Z6961-7 ....7 for $1.00
Antenna Sections MS49 & MS50 3 ft. each section.......2 for 49¢; 25 for $3.00
PE94 Pwr Supp P/o SCR522 $5.98;

METER SPECIALS

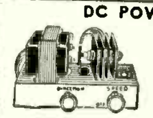
0-30 VDC "AN" 2.98; 3 for 8.00
0-60 ADC "AN" Type
Less Shunt ....2.95; 2 for 5.00
0-150 VAC WSTGHS/
2½/RND 60 cyc. 3.49
0-150 VAC/25-125cy/3½"SQ/RA35 . 5.98
0-1 MADC WSTGHS/3½"SQ/RA35 . 5.98
0-120 MA RF 3½" RND Weston 301 11.98
0-800 MADC 3½" RND . ..4.49; 2 for 7.98
0-1 MADC MINI 1½" DIA 3.98; 2 for 6.98
300-0-300 Micro Ammeter Movement
50 Div Scale 3½" RND. Hickock.... 4.49

TELEVISION ANTENNA



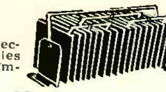
VEE CONICAL Broad response, all channel, powerful for fringe areas. .$8.95
FOLDED DIPOLE Hi & low antennas, all channel, sturdy construction $4.95
TV CONICAL ANTENNA All Channel, Sturdy Inclds 8 elements & 100 ft. Twinex. $5.25
DOUBLE-V Ant. All Channel, Sturdy Cons. w/Mtg Clamps & 100 ft. Twinex....$4.49
WINDOW CONICAL All Channel $3.95
5 FOOT Interlocking Mast Sections, Hvy Duty, rustproof......2 for $1.49; 10 for $7

DC POWER SUPPLY



Variable DC Power Supply. Full Wave rectification, 6000Mfd filter Condenser, fused. Rated 6.3V or 12.6V at 2 amp, operates 115V/60cy. Model 2DCF...$12.98
As above except 4 amp. Model 4DCF...$20.98

SELENIUM RECTIFIERS



We specialize in Rectifiers, Power supplies to specifications. Immediate delivery.

Curr. Cont.	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1AMP	1.35	2.15	3.70	8.50
2AMP	2.20	3.60	6.00	10.50
4AMP	4.25	7.95	12.95	25.25
6AMP	4.75	9.00	13.50	33.00
10AMP	6.75	12.75	20.00	44.95
12AMP	8.50	16.25	20.50	49.00
20AMP	13.25	25.50	38.00	87.50
24AMP	16.25	32.50	45.00	95.00

Rectifier & Transformer

115V/60 cy inputs.

up to 14VDC at 12 Amps ....$ 19.98
up to 28VDC at 4 amps......... 14.98
up to 28VDC at 12 amps........ 29.98
up to 28VDC at 24 amps........ 63.98
up to 28VDC at 50 amps........ 127.00

Rectifier & Transformer & Variac

up to 14VDC at 12 amps........$ 30.98
up to 28VDC at 12 amps........ 45.50
up to 28VDC at 50 amps........ 167.00
C "TAB" fast delivery SPECIALS

HIGH CURRENT PWR SUPPLIES

Variable 0-28VDC, Completely Built, Ready to Go. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. In Heavy Duty Steel Cabinet.

Stock Number	Continuous Rating	With Meters
T28V4A	0-28VDC at 4 Amp.....	$43.00
T28V12A	0-28VDC at 12 Amp.....	89.00
T28V24A	0-28VDC at 24 Amp.....	129.50
T28V50A	0-28VDC at 50 Amp.....	239.50

RECTIFIER XFMRS

Primary 115V 60 Cyc
Secondary 0-9-12-18-24-36V
4 Amp ....$ 8.75
12 Amp $16.75
24 Amp $35.75
18 Volt, 2 Amps ......$ 1.98

RECTIFIER CHOKES

4 Amp .07 Hy .6 Ohm $7.95
12 Amp .01 Hy .1 Ohm 14.95
24 Amp .004 Hy .025 Ohm 29.95

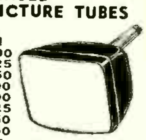
FEDERAL "ITT" SELENIUM BATTERY CHARGER RECTIFIER

10-0-10V (CT) 100 Amp., fan cooled. Replace your old inefficient sulfide rectifier w/new selenium type. SPECIAL...$11.98

TV & COAX CABLE

300 Ohm Twinex. Heavy duty 65 mil copper TV lead in.
per ft. 2¢; 100 feet **$1.39**
1000 Ft $11.95; 5000 Ft. $50.00
RG59U 73 ohm TV Coax Cable MFGRD to rigid UHF specs.
per ft. 5¢; 100 feet $4.50
SPECIAL 500 feet $22.00
RG8U Cable 52 Ohm Per Ft. ....16¢; 100 Ft. $14.98
HiVolts 15KV Wire Per Ft. 3¢; 50 Ft. 1.25

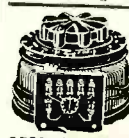
RCA LICENSED ONE YEAR GTD PICTURE TUBES



Tube Type	Dud Return	No Dud
10"	$10.00	$12.00
12"	12.00	14.25
14"	14.00	16.50
16"	16.00	19.00
17"	17.00	20.00
19"	19.00	22.25
20"	20.00	23.50
21"	21.00	24.50

IMPORTANT! Ship Dud with order prepaid only. Prices indicated are for Glass Tubes. Metal or Electrostatic add 10¢ per inch. If you return your old tube, use Dud Return Prices. All Prices F.O.B. N.Y.C. Add Shipping Charges.

VARIABLE VOLTAGE TRANSFORMERS



VARIAC—GR—STACO

0-135V/3A 11.25
CSD/135V/7.5A ..20.70
U-CSD/135V/7.5A .16.20
CSD/270V/3A 23.40
U-CSD/270V/3A ..18.00
CSD/0-135V/15A .41.98
CSD/0-270V/9A ..41.98
GR50A/0-135V/45A/LN 100.00
GR50B/0-270V/31A/LN 115.00
3000B/0-135V/30A/* Cased 55.00
3000BU/0-135V/30A/* Uncased ...49.00
3020BU/0-270V/18A/* Uncased .. 49.00
3020B/0-270V/18A/* Cased 55.00
STACO/LRL5/Metered/140V/5A .. 41.50
STACO/Pal-7/Metered/135V/7.5A . 40.50
Write for Qty Price & Catalog
(LN) Like New Complete Guarantee

.75 Meg "MVP" 10W 10KV .79 10/$ 5.00
2 Meg "MVG" 4W 5KV ...89 10/$ 7.50
2 Meg SPRG 5W 10KV....99 10/$ 8.50
2.5 Meg "MVA" 20W 25KV 1.50 10/$12.00
2.5 Meg "MVT" 5W 7.5KV .89 10/$ 7.00
7 Meg "MVP" 10W 10KV 1.35 10/$12.00
10 Meg "MVP" 10W 10KV 1.69 10/$15.00
12 Meg SPRG 10W 10KV..1.69 10/$15.00
20 Meg "MVO" 35W 50KV 2.25 10/$20.00
50 Meg "MVE" 25W 40KV 2.75 10/$25.00
100 Meg "MVP" 10W 10KV 2.25 10/$20.00
WRITE FOR QUANTITY PRICE

TUBES

*From This Special List We Ship $10.00 and Up Tube Orders At Our Expense (Postpaid) Within Continental Limits of U.S.A.
90 Day Gtd. When ordering mention 4RE

0A2	.88
0A3/VR75	1.04
0B2	1.37
0B3/VR90	.96
0C3/VR105	.92
0D3/VR150	.92
1B3/8016	.80
1L4	.48
1L6	1.35
1LD5	.98
1LN5	.98
1P5	.78
1U4	.52
1U5	.54
1X2A	.98
2A4G	1.18
2X2	.42
2X2A	1.53
5R4GY	1.20
5R4GYW	1.75
5T4	1.48
5U4G	.55
5Y3GT	.43
6AC7	.80
6AG5	.63
6AG7	1.14
6AH6	1.89
6AJ5	1.40
6AK5	.77
6AK6	.92
6AL5	.48
6AL7GT	.98
6AN5	3.27
6AQ5	.52

6AQ6	.81
6AQ7GT	1.29
6AR6	3.27
6AS5	.79
6AS6	2.22
6AS7G	3.48
6AT6	.54
6AU5GT	1.10
6AU6	.56
6AV5GT	.98
6AV6	.49
6AX4/6U4	.74
6B4G	1.18
6BA6	.54
6BA7	1.09
6BC5	.63
6BC7	1.23
6BD6	.63
6BE6	.54
6BF5	.98
6BG6G	1.58
6BH6	.63
6BJ6	.69
6BK7	1.58
6BL7GT	1.19
6BN7	2.69
6BQ6GT	1.20
6BQ7	1.65
6C4	.52
6C5	.68
6CB6	.59
6D4	2.70
6F6GT	.79

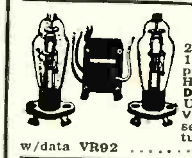
6H6	.60
6J4	6.66
6J5	.54
6J6	.58
6J7	.72
6K6	.54
6K7	.58
6K4A	3.68
6K6GT	.54
6L6	1.48
6L6G	1.08
6L6GA	1.08
6L6GAY	1.98
6SA7GT	.66
6SC7	.90
6SF5	.78
6SF7	.73
6SG7	.64
6SH7	.61
6SJ7	.58
6SK7GT	.56
6SL7GT	.64
6SN7GT	.68
6SQ7GT	.62
6SR7	.62
6SS7	.88
6T8	.96
6U4	.74
6U8	.99
6V6	1.39
6V6GT	.59
6W4GT	.52
6X4	.49

6X5	.54
6Y6G	.88
7A8	.68
7C7	.76
7F7	.82
7F8	1.24
7H7	.72
7N7	.72
7V7	1.06
7Y4	.68
12A6	.48
12AH7GT	1.45
12AL5	.54
12AT6	.54
12AT7	.89
12AU6	.72
12AU7	.69
12AV6	.52
12AV7	.98
12AW6	1.18
12AX7	.98
12AY7	1.69
12BA6	.59
12BA7	.94
12BD6	.59
12BE6	.59
12BF6	.85
12BH7	1.29
12C8	.62
12H6	.64
12J5	.52
12K8	.68
12Q7GT	.55
12SA7GT	.68

12SC7	1.08
12SF7GT	.84
12SG7	.80
12SH7	.63
12SJ7GT	.54
12SK7	.66
12SL7GT	.62
12SN7GT	.68
12SQ7GT	.54
19BG6	1.98
19V8	1.98
25BQ6GT	.98
25L6GT	.58
25Z5	.78
25Z6GT	.58
28D7	1.94
35B5	.52
35L6	.58
35Z5GT	.54
35Y4	.68
45Z3	.88
50A5	.76
50B5	.54
50C5	.54
50L6GT	.62
RK61/XFG1	2.65
80	.58
81	1.38
83	1.12
83V	1.22
84/6Z4	.62
117L/M7GT	1.98
117Z6GT	.96
CK502AX	1.49
CK503AX	1.49
CK505AX	1.79
CK512AX	1.45
CK531DX	1.89
CK532DX	1.89
CK533AX	1.29

CK534AX	.99
CK536AX	.99
CK538DX	.98
CK539DX	2.19
CK543DX	.99
CK544DX	.99
CK546DX	1.99
CK571AX	2.49
CK1005	.68
2050	1.48
CK5672	1.20
CK5678	1.28
5687	3.74
CK5702	2.90
CK5703	1.29
Xtal Diodes	
1N21A	1.55
1N21B	2.10
1N22	1.22
1N23	1.35
1N23A	1.89
1N23B	2.10
1N25	4.98
1N26	8.75
1N27	1.55
1N34	.64
1N34A	.77
1N35	1.65
1N38A	1.29
1N41	8.95
1N42	16.95
1N45	1.45
1N46	.69
1N47	4.00
1N48	.47
1N51	.45
1N54	.78
1N60	.60
1N63/K63	2.49
1N69	.98

866A KIT and XFORMER

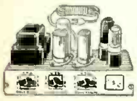


2 Tubes, Sckts, xmfr, 115v60cyc Inpt, output 2.5vct/10A/Hivins $4.98
DIODE PROBE TUBE Unexcelled for No-Loss VHF testing. Ultra-sensitive subminiature-envelope. **NEW.** w/data VR92 ....25¢; 5 for $1

100 WATT SEC PHOTOFLASH KIT

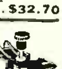
Includes ML Flash Lamp Rated 150 Watt Second, Flash Gun and Reflector & Cable, Power Trans & Condensers (10) 100 MFD/450V/100 Watt Sec. Resistors, Capacitors, Rectifiers & Sockets $29.98
Above Photoflash Kit with only (2) Cndsrs 525MFD/450V (1050MFD) 100 Watt Seconds $36.98
100 Watt Second Condenser Bank, 72MFD/1800V per unit/85 units equals 61.2MFD/100 W.S. SPEC. $6.98
525MFD 450V "CD" ....$9.00; 2 for $16
16MFD/600VAC 1800VDC/2800V Intermittent C'dubilier $5.95
WRITE FOR DETAILS & SPECIAL PRICES

AUDIO AMPLIFIERS READY TO GO



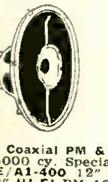
MODEL TU5P Ultra Hi-Fi 5 watts, with built in Pre-Amp, 15DB Bass boost & cut same for trbl, 4 inputs, 4 controls, 40-15000 cy, satin finish chassis & removable control face for custom mtg. "TAB" special $27.49
TECHMASTER Ultra Linear Williamson
TMD15A Deluxe amplifier, kit $48.95
TMD15A completely assembled ...$63.00
TM15P 4 channel Pre-Amp kit $19.95
TM15P completely assembled $31.00
GARRARD-RC80 & **GE-RPX050** $47.00
GARRARD-RC80 & RPX052 dual Diamond & Sapphire $59.70
GARRARD-RC90 & RPX050 ....$66.68
WEBSTER 3 speed changer & dual crystal "TAB" special $32.70

AUDIO COMPONENTS



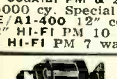
Electrovoice triplay cart. $1.98
GE RPX040/78 Goldtone $5.25
GE RPX041/MG Goldtone $5.25
GE RPX050/Dual triplay $5.25
GE RPX052/Dual .001 diamond & .003 sapphire $17.75
GE RPX053/.001 & .003 diamonds $25.98
"TAB" GTD Phono Needle Replacements
RPJ010 Dual .001 & .003 sapphire. .$1.98
RPJ012 Dual .001 & .003 diamonds.$21.98
RPJ001/78 or RPJ004.001 sapphire.$1.35
RPJ003/78 or RPJ004/LP diamond.$11.98
RPJ013 Dual diamond & sapphire $12.98

COAXIAL SPEAKERS



All 8 ohm. V.C., Alnico V Magnets, Inbuilt Network, 2 wires needed for HF & LF Response. Famous Hi-Fi Speaker Mfgrs.
15" Coaxial PM & 5" Tweeter, 25 watt/20-17500 cy. $23.75
12" Coaxial PM & 3½" Tweeter, 12watt/45-15KC "TAB" SPECIAL P12U0 ......$12.75; 3 for $35
8" Coaxial PM & 2½" Tweeter, 8 watt/70-15000 cy. Special P8CO $8.95
GE/A1-400 12" coax 40-15kc prepaid $37
12" HI-FI PM 10 watt/35-14kc $7.25
8" HI-FI PM 7 watt 45-14kc $9.95

TACHOMETER GENERATOR



MARK V STUD MTG
GENERAL ELECTRIC
Part #2CM5-AAK-20
New Orig Carton
$3.98 ea.
SPECIAL 2 FOR $7.50; 10 FOR $30.00

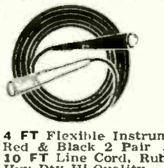
KITS AND COMPONENTS

Oil Condensers Assorted.. 5 for $1.25
Electrolytics Assorted..... 5 for 1.25
Silver & Mica Cndsrs..... 15 for 1.25
Controls, Popular Values. 5 for 1.25
Resistors, ½ & 1W.......100 for 1.25
Vitreous W W Resistors.. 8 for 1.25
Sockets, Asstd. 8, 7, 5, 4P 12 for 1.25
Iron Core Slug & Screw. 50 for 1.25
Knobs, Asstd. w/Insert.. 10 for 1.25
"TAB" SPECIAL YOU PICK 'EM **$1.00** Lots of 5

RHEOSTAT SALE

2 ohm 50W Model J. ..2.25; 5 for 10.00
6 ohm 25W Model LH ..1.49; 2 for 2.49
20 ohm 50W Model J ...1.98; 2 for 3.50
60 ohm 50W w/knob ...2.25; 2 for 3.98
100 ohm 50W Model K ..1.98; 2 for 3.50
300 ohm 225W Model P..2.98; 2 for 5.00
350, 500, 5000 ohm Slotted shaft, 25 watt ....79¢; 3 for 2.00

TEST CORDS



8 FT 26 Strand Wire Alligator Clips, as Shown 3 PR ...$1.00
CD277 8 Ft/6 Conductor, With AN Connector, P/O BC312 ....$1.25
15 FT Extension SJ Cord Heavy Duty, Rubber Insul. .$1.00
4 FT Flexible Instrument Test Leads Red & Black 2 Pair $1.25
10 FT Line Cord, Rubber Insul & Plug, Hvy Dty Hi-Quality ....2 for $1.00

TRANSFORMER SPECIAL

6.3 VOLT 3¾ AMP

Continuous Duty, 115V/60CY Input
SIZE 2 5/16"H/2"L/1⅛"W; MTG CNTR 2⅜" HVY CHANNEL MTG. WGT 1 LBS RM, SM, MFGRS, JOBBERS, DLRS ORDER NOW THIS $1.98 VALUE.
Special $1.00; 12 for $10; 50 for $36

FILAMENT TRANS.

2.5VCT/10A 12.5KVINS. .$5.50; 3 for $14
2.5VCT/10A 5KVINS $3.59; 2 for $6.50
7.5VCT/12A 15 KVINS 10.95; 2 for $17.50
24V/1.25A CSD ....$1.98; 2 for $3.49
42.5V/2A Sel Rect Xfmr $2.95
64V/1 Amp HMSLD $3.49; 2 for $5.00
PRI 220/440V Sec 3X 2.5V/5A, 2.5V 15A $4.95; 2 for $8.00

TRANSFORMERS

All 115 V 60 Cyc Input TV, & CR pwr Xmfr up to 20" tubes, Hi VOLTS to 20 KV (w/quadrupler ckt.) ALL tubes, PL & FIL wndgs 300 VDC/275 Ma Full-Wave: 6.4V 10.3A. 5.4V/8A. 2.5V/3A Hypersil Core. Oil Fill $4.98; 2 for $8.50; 6 for $22
1600VCT/5MA, 6.3VCT/3A, 6.3VCT/10A, 2.5VCT/5A SPECIAL ....7.95; 2 for $14.00
1000VCT/45MA, 795VCT/80MA, 360VCT 55MA 3X5V/3A, 6.3VCT/1A, 6.3VCT/3A CSD HYINS CAN BE USED 2X RATING
RAYTHEON ....$4.00; 2 for $7.00
900V/35MA 2X2.5V/2A, XCLENT 1800V DRIER TWO 2X2 FIL WNDGS $2.25
850VCT 148MA, 5V/3A, 6.3V/5A, 6.3V/3A ....$4.98; 2 for $9.00
778VCT/200MA, 5V/3A, 6.3VCT/5A $4.98
780VCT/250MA, 5V/6A, 12.6V/5.5A $7.95
770VCT/200MA, 5V/6A, 12.6V/5.5A $6.95
770V/2.5MA, 2.5V/3A, HYINS HMSLD includes FILTER PARTS 4/scope.....$2.95
700VCT/120MA, 2X6.3V/3A, 6.3V/1A Price ....$3.98; Two for $7.25
680VCT/200MA, 5V/3.5A, 6.3V/4A. 78V/1A ....$4.39; 3 for $12
600VCT/50MA, 6V/3A, 6V/1.5A, 5V/1A $2.49; 2 for $4.50; 10 for $20.00
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6 12, 24, 115VDC & 115 & 230 VAC @ $1.49

FILTER CHOKES

12Hy/80ma/H'sld/3KVins 2.25
10Hy/125ma/UTC/Csd/H'sld/1Kvins 1.98
50Hy/125ma, CSD, H'sld 2.89
20 Hy/300ma or 15HY/400ma 12KVins 8.95
13.5Hy 1 amp 17 Kvins Raytheon. .35.00
6 Hy/175ma, 250 ohm...1.49; 2 for 2.49

"TAB" PHOTOFLASH LAMPS

"Tab" No.	Replaces	Max. W-Sec.	Each
TLW	FA104/U5W	150	$5.98
THI	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
TLIO	GE FT 118	150	5.98
V4X4	X400	200	10.98
TLX	FA100/DX	150	9.00
353GTQ	FT 503	2000	49.98
53GT	FT 403	500	13.50
TRIGGER COIL FOR GE 86G41			$1.47

SOLDERING GUNS FAMOUS MAKE GTD

Lenk #77LP Blow torch. Instant light no priming, no soot or odor, adj flame $3.75
Extra fuel tanks, only................. .79
Lenk #501 soldering gun, 180 watt, hvy dty XFMR, perfect balance, 7.45
TAS-4 soldering gun 115VAC/135watt 7.89
TAS-5 soldering gun 115VAC/250watt 8.77
TAD-4 dual heat 100-150 watt......... 9.65
TAD-5 dual heat 200-275 watt 10.53
TA-32 soldering iron 115V/60watt.... 1.20
TA-250 soldering gun 2 tips 115VAC/250W focus light, built for comfort and efficiency 10.29

OIL CONDENSER SPECIAL

10 MFD 600 VDC $1.75 ea lots of 3

Case dimensions, not including insulators 4⅛H x 3¾W x 1¼"D
Smaller Quantities, special $1.98

OIL CONDENSERS NEW WAREHOUSE LIST

.00025MFD/25KV ......$6.00; 2 for $10
.0016MFD/15K ....$7.00; 2 for $12
2X.1MFD/2000V ....$1.39; 2 for $2
.5MFD/600V ....25¢; 6 for $1
.5MFD/1500V ....85¢; 6 for $2
1MFD/500V ....33¢; 4 for $1
1MFD/600V ....39¢; 3 for $1
1MFD/1000V ....39¢; 3 for $1
2MFD/600V ....59¢; 5 for $2
4MFD/3000V ....$7.98; 2 for $14
4MFD/5000V ....$19.95; 2 for $35
5MFD/600V ....$1.50; 3 for $4
10MFD/600V ....$1.98; 2 for $3.50
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Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order F.O.B. N.Y.C. Add Shpg. Charges or 25% Dep. Tubes Gtd. via R-Exp. only. Prices subject to Change Without Notice. Phone Rector 2-6245. CABLE: "TABPARTS"

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FACTS NOT JUST CLAIMS

FACT- 53 CLAIMS GRANTED IN 5 UNITED STATES PATENTS—
#2,585,670; 2,609,503; 2,625,655; 2,644,091; 2,661,423, others pending.

FACT- These antennas positively receive ALL channels 2-83 from ALL directions without a rotor motor.

FACT- These antennas have consistently OUT-GAINED and OUT-PERFORMED all others in actual public demonstrations.

FACT- These antennas will unquestionably OUT-PERFORM all others, on YOUR roof, with YOUR set, or YOUR money back.

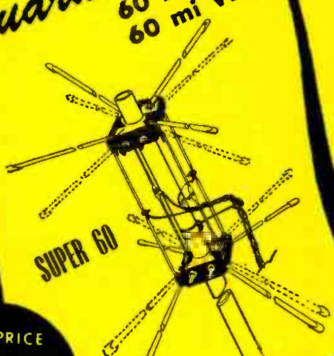
FACT- SAVES YOU MONEY. Eliminates rotor motor, uses only ONE transmission line, uses only ONE antenna for both UHF & VHF—and only ONE simple, quick installation.

FACT- Perfect pictures have consistently been received as far as 3 times the guaranteed distances.

FACT- ONLY one antenna, ONLY one transmission line, ONLY one installation. You solve once and for all your PRESENT and FUTURE antenna problems.

MONEY BACK GUARANTEED TO RECEIVE *All* CHANNELS 2-83 FROM *All* DIRECTIONS AND POSITIVELY OUTPERFORM *All* OTHER ANTENNAS WITH OR WITHOUT A ROTORMOTOR

Guaranteed 60 mi UHF 60 mi VHF



LIST PRICE **$36.75** SEE YOUR JOBBER

Guaranteed 100 mi VHF 30 mi UHF

LIST PRICE **$43.50** SEE YOUR JOBBER

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PRICE INCLUDES
Antenna arrays - necessary stacking bars - 9 position switch - switch-to-set coupler - necessary hook-up harness - 7½" stand-offs Individually boxed in mailable carton.

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- Low Loss External Air Dielectric
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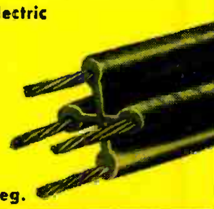

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$50,000 "TELL & SELL" CONTEST

400 FABULOUS PRIZES

For Dealers and Servicemen* who use RCA Tubes

1954 Dodge, Deluxe ½-Ton Panel Truck —complete with "Truck-o-matic" transmission, radio, heater and accessories . . . *plus a full set of RCA Test Equipment,* aluminum ladder, and winner's business name and address on truck panel.

1954 DeSoto Automatic "Hard-Top"—170-H.P. Fire Dome V8 engine, Power-Flite Transmission, Power Steering . . . completely equipped, including radio and heater.

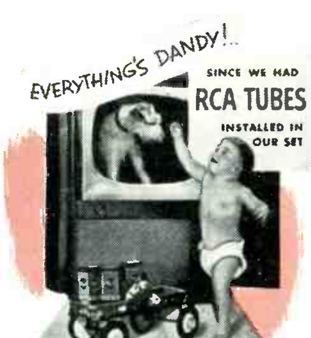
HURRY, HURRY, HURRY . . . contest closes April 30, 1954. See your RCA Distributor Salesman right away, and get your copy of the "clue book" that includes complete contest rules, official entry blank, and clues that will help you win.

* **Your RCA Distributor Salesman will be glad to help you . . . because if you win, he wins a duplicate prize!**

PLUS Powerful promotion campaign to help you sell more in '54

The RCA "Tell and Sell" campaign was designed to help you sell your service *on a local level.* Everything you need, from giant illuminated signs and window displays, to a consumer booklet that will give your customers the facts of TV servicing—is available from your RCA Distributor. See him today!

Consumer Booklet
Tells the customer what is needed to bring him expert service. Points you out as "the man who keeps the show going."



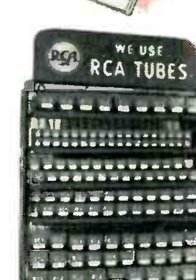
1954 RCA BABY DISPLAY

NEW GIANT OUTDOOR SIGN

NEW RCA SERVICE DECAL

RCA DOOR-BELL FLIPPER

DRAMATIC "EDGE-LIT" SIGN



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ELECTRON TUBES **HARRISON, N.J.**