Beginning in this issue: New printed-circuit TV i.f. amplifier
See page 4
Exclusive mounting makes the heater an integral part in the Teletron gun. In the Du Mont Teletron, the heater “feet” are welded to stainless steel lugs which accurately position the heater on a ceramic disc. The result is a firmly welded, vertically aligned assembly which is inserted in the control grid cup and automatically positions the heater within the cathode. This eliminates critical, uncontrolled hand positioning of the heater. Positive centering prevents chafing of the delicate heater coating and avoids heater-to-cathode shorts.

**Less open-heater failures**
Stronger connections obtained by welding the tungsten heater “feet” to the stainless steel lugs rather than directly to the nickel stem leads, greatly reduce open heater failures.

**Greater heater efficiency**
When the control grid is assembled, the distance between the top of the heater helix and the outer ridge of the ceramic disc controls the depth to which the helix is seated inside the cathode. Optimum-depth seating is thus predetermined, insuring maximum heater efficiency.

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The new RCA tandem 40-mc i.f. amplifier which uses printed circuit techniques throughout, and a printed-circuit i.f. transformer.

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THE FATHER OF RADIO

Lee de Forest, celebrated his 80th birthday August 26 at his home in Los Angeles. Dr. de Forest, active in spite of his years, still takes long hikes, though he no longer attempts the mountain climbs which formed part of earlier birthday observances (as reported in this magazine's account of his 70th birthday, in the October, 1943, issue).

Nor has de Forest the inventor been inactive recently. To his more than 200 patents—most of them in the field of electronics—he has added two more which were reported during the past year. Patent 2,594,740, taken out with Dr. Wm. A. Rhodes of Phoenix, Arizona, is for a light amplifier, a device to intensify radiation either visible or invisible. It was described in Radio-Electronics for October, 1952, on page 114. Another patent, No. 2,617,875 (Radio-Electronics, February, 1953, page 100) is for a color-TV system which eliminates the large rotating wheel that has been a feature of certain color television setups. Though the development of three-color tubes may make this impractical for general TV broadcast reception, it is useful for closed-circuit medical and other color-TV systems where the wheel is still used. The patent has been purchased by Allen B. Du Mont Laboratories, presumably for such applications.

FIFTEEN NEW TV STATIONS went on the air between our last report in this column, and July 11. Seven of these are v.h.f. stations: KCSD-TV (5), Pueblo, Colorado; KFXD-TV (8), Nampa, Idaho; KCNC-TV (6), Texarkana, Texas; KIDO (7), Boise, Idaho; KlAS-TV (8), Las Vegas, Nevada; KTXL-

Dr. Lee de Forest.

Painting by George Camarero, South American painter. This painting was commissioned and is now owned by Hugo Gernsback. It was painted in 1952.

TV (8), San Angelo, Texas; and KTVH (12), Hutchinson, Kansas.

The new u.h.f. stations are: WTVE (24), Elmira, N. Y.; WCKW-TV (27), Madison, Wisconsin; WNAO-TV (28), Raleigh, N. C.; KIMA-TV (29), Yakima, Wash.; WMTV (33), Madison, Wisconsin; WOSH-TV (48), Oshkosh, Wisconsin; WTVI (54), St. Louis, Mo.; and WISE-TV (62), Asheville, N. C.

In addition, two older stations shifted to new channels: WBHM-TV, Chicago, moved from channel 4 to channel 2; and WTMJ-TV, Milwaukee moved from 3 to 4.

CBS APPROVED NTSC color at the NTSC meeting July 21. Columbia's Dr. Peter Goldmark himself seconded the notion asking FCC to adopt new color standards. FCC's approval is expected to come about the end of 1953.

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WORLD'S SMALLEST RADIO of the standard portable type was introduced recently by Emerson. It is known as the Pocket Radio, is 6 inches long, 3½ inches high, and 1¼ inches deep and weighs less than a pound. It is actually a good fit for a shirt— if not for a vest—pocket. Smaller radios have been made, but they have been special jobs, with earphones and trick outside antennas.

The Pocket Radio is a standard portable in every respect as judged by equipment, volume and wiring methods. It is variable-capacitor tuned, has an almost flat 2½-inch speaker and standard wiring. The ferritloop antenna, now practically universal on small portables, is a flat bar inside the base of the handle. Circuit is superhet; four subminiature tubes.

The method of removing the chassis is especially ingenious. It is held against the back of the cabinet by little tabs which are part of the chassis frame, and which slip under loops molded in the plastic cabinet. It is necessary only to slip the chassis an eighth of an inch to the side and lift it right out.

THE FCC UPHOLDS HAMS' right to operate in the 21-mc band even though such operation causes interference with certain television receivers. In response to complaints received from TV-set owners the Commission declared that interference from properly operated amateur transmitters in this band is "due principally to characteristics in the design of the television receivers," which can be cured in many cases "by simple and inexpensive means." The FCC's statement also called attention to the more than 300 TVI committees made up of set owners, amateurs, and industry representatives who have already succeeded in solving interference problems in various parts of the country.

"BOTTLE-CAP" SOFAR BOMB has been developed by the U.S. Navy for quickly locating ships in distress or aircraft forced down at sea in the eastern North Pacific area. The bomb, loaded with four pounds of TNT, is detonated under water automatically and sends out extremely powerful sound waves in all directions. These are picked up by hydrophones at several SOFAR (Sound Fixing And Ranging) stations in Hawaii and California and on the site of the explosion is obtained almost instantly by comparing the bearings obtained at the various stations.

The new bombs can be set to go off at any depth from 1,000 to 4,000 feet. The adjustment is made in 500-foot steps by removing caps like those used for sealing soft-drink bottles from the neck of the bomb.

THE 1953 AUDIO FAIR in New York City, scheduled for October 14, 15, 16, and 17, is expected to attract more than 20,000 visitors, by far the largest crowd to visit any similar exhibit. As an indication of the growth of the audio industry and the high degree of public interest, the 1953 fair will occupy three floors of the Hotel New Yorker, in contrast to two floors in 1951 and 1952, and will feature a record-breaking number of exhibits by more than 100 manufacturers.

As in previous years, the Audio Fair will coincide with the annual convention of the Audio Engineering Society. The fair will be open to everyone, free of charge.

NEW RCA TRANSISTORS now oscillate at frequencies as high as 425 mc, far beyond any types previously reported. Previous reports had indicated a high of 225 mc. Experiments with these newly developed point-contact types were described by F. L. Hunter. RCA transistor engineer, at the joint I.E.E.-A.I.E.E. conference held in July at Pennsylvania State College.

Work done by Mr. Hunter and B. N. Slade with both positive- and negative-type germanium shows that point-contact transistors made of the P-type are capable of reaching the highest frequencies in oscillator circuits.

NINTH ANNUAL National Electronics Conference will be held September 28, 29 and 30, at the Hotel Sherman, Chicago, Ill. The technical program will comprise 99 papers, and there will be exhibits from 140 manufacturers.

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in up against, you'd buy him a steak for his

NICE GUY... with a black eye

We'll wake you to thoughts on approval a TV-Radio Service Dealer, who knows how to handle you out of your apprehension. This natural black eye gives the TV-Radio Service profession by the public is unspoken. When TV-Radio Service Dealers are subject to the spectacles of the public's affairs, they're virtuously honest in their efforts to make mistakes, but not to their money. This casts light on the TV-Radio Service Dealers as capable, efficient, thorough. The service dealers are the Raytheon Bonded Electronic Technicians, who have been trained and qualified through certification of the Raytheon Bonding Company, America's largest surety company. In over 100,000 Radio and Television Service Dealers, they have been working with the highest standards of qualification. Bonded dealers have handled on sales, and of the millions of parts that have been sold, the Raytheon Bonding Company has issued service dealers at the United States, and of the millions of parts that have been sold, the Raytheon Bonding Company has issued service dealers at the United States, and of the millions of parts that have been sold, the Raytheon Bonding Company has issued service dealers at the United States, and of the millions of parts that have been sold, the Raytheon Bonding Company has issued service dealers at the United States, and of the millions of parts that have been sold, the Raytheon Bonding Company has issued service dealers at the United States, and of the millions of parts that have been sold, the Raytheon Bonding Company has issued service dealers at the United States, and of the millions of parts that have been sold, the Raytheon Bonding Company has issued service dealers at the United States, and of the millions of parts that have been sold, the Raytheon 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START ON THE ROAD TO SUCCESS

Study the RCA TV Servicing Course
in your spare time

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?

Are you content merely to plod along through the best years of your life...or do you want to get into more pleasant work...hold a well-paid job...perhaps establish your own business?

If you are looking for a real opportunity...If you want to Grow with a Growing Industry...If you want to grasp the success that should be yours, then we say to you, study TV Servicing.

Everyone knows that Television is the fastest growing industry today. Opportunities are going begging for men who have the training and ability to grasp them. Now is the time to start on the road to success in TV Servicing.

Study at Home in your spare time

The RCA Institutes Home Study Course in TV Servicing is easy to learn. You progress rapidly, step by step, as you learn the procedure of servicing and trouble-shooting TV receivers and installing TV antennas. Hundreds of pictures and diagrams help you understand the how-it-works information and the how-to-do-it techniques.

A Service of Radio Corporation of America

The RCA Institutes TV Servicing course was written and planned by instructors with years of specialized experience in training men. You get up-to-the-minute information, too, because you study right at the source of the latest developments in Television. Your lessons are carefully examined and accurately graded by competent teachers who are interested in helping YOU to succeed.

RCA Institutes is licensed by the University of the State of New York...an affiliate member of the American Society for Engineering Education...approved by leading Radio-Television Service Organizations.

It costs so little to gain so much

RCA Institutes makes it easy for you to take advantage of the big opportunities in TV Servicing. The cost of the TV Servicing Home Study Course has been cut to a minimum. You pay for the course on a pay-as-you-learn unit lesson basis. No other home study course in TV Servicing offers so much for so little cost to you.

SEND FOR FREE BOOKLET—Mail the coupon—
today. Get complete information on the RCA INSTITUTES
Home Study Course in Television Servicing. Booklet gives
you a general outline of the course by units. See how this
practical home study course trains you quickly, easily.
Mail coupon in envelope or paste on postal card.

MAIL COUPON NOW!

RCA INSTITUTES, INC., Home Study Dept. RE-953
350 West Fourth Street, New York 14, N. Y.

Without obligation on my part, please send me copy of booklet “RCA INSTITUTES Home Study Course in Television Servicing.” (No salesman will call.)

Name: _____________________________
(Address)

(please print)

City ______ Zone ______ State ______

RCA INSTITUTES, INC.
A SERVICE OF RADIO CORPORATION OF AMERICA
350 WEST FOURTH STREET, NEW YORK 14, N. Y.
You can build a reputation on Tung-Sol Quality

TUNG-SOL makes:
All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV, Special Purpose Electron Tubes, Semiconductor Products.

TUNG-SOL ELECTRIC INC.
Newark 4, New Jersey
Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Seattle

BAROMETER of the PARTS INDUSTRY

During July, 90 of the leading 400 manufacturers of Radio-Television-Electronics parts and equipment made changes in their lines. There was an increase in "change activity" as compared to June.

In price revisions by the number of manufacturers and products affected, the following summary illustrates the comparative trend for the months of June and July.

<table>
<thead>
<tr>
<th>Product Group</th>
<th>June</th>
<th>July</th>
<th>Increased Prices</th>
<th>Decreased Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennas &amp; Access.</td>
<td>6 28*</td>
<td>8 50*</td>
<td>18 153*</td>
<td>10 68**</td>
</tr>
<tr>
<td>Capacitors</td>
<td>0 0</td>
<td>1 443*</td>
<td>1 228*</td>
<td>0 0</td>
</tr>
<tr>
<td>Controls &amp; Resistors</td>
<td>0 0</td>
<td>0 0</td>
<td>1 116*</td>
<td>0 0</td>
</tr>
<tr>
<td>Sound &amp; Audio Prod.</td>
<td>12 163**</td>
<td>4 19**</td>
<td>33 231*</td>
<td>19 65**</td>
</tr>
<tr>
<td>Test Equipment</td>
<td>0 0</td>
<td>1 17**</td>
<td>6 8**</td>
<td>2 8*</td>
</tr>
<tr>
<td>Transformers</td>
<td>2 241*</td>
<td>1 170*</td>
<td>3 134*</td>
<td>3 77*</td>
</tr>
<tr>
<td>Tubes</td>
<td>4 71**</td>
<td>5 17**</td>
<td>7 47**</td>
<td>5 18**</td>
</tr>
<tr>
<td>Wire &amp; Cable</td>
<td>1 250*</td>
<td>1 86*</td>
<td>2 64*</td>
<td>2 17**</td>
</tr>
</tbody>
</table>

For a summary of the most active product categories, see the following table:

<table>
<thead>
<tr>
<th>Product Group</th>
<th>No. of Mfrs.</th>
<th>No. of Products</th>
<th>Increased Prices</th>
<th>Decreased Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennas &amp; Access.</td>
<td>6</td>
<td>28*</td>
<td>8</td>
<td>50*</td>
</tr>
<tr>
<td>Capacitors</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>443*</td>
</tr>
<tr>
<td>Controls &amp; Resistors</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sound &amp; Audio Prod.</td>
<td>12</td>
<td>163**</td>
<td>4</td>
<td>19**</td>
</tr>
<tr>
<td>Test Equipment</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>17**</td>
</tr>
<tr>
<td>Transformers</td>
<td>2</td>
<td>241*</td>
<td>1</td>
<td>170*</td>
</tr>
<tr>
<td>Tubes</td>
<td>4</td>
<td>71**</td>
<td>5</td>
<td>17**</td>
</tr>
<tr>
<td>Wire &amp; Cable</td>
<td>1</td>
<td>250*</td>
<td>1</td>
<td>86*</td>
</tr>
</tbody>
</table>

Merchandising and Promotion

Sylvania Electric Products, Inc., is offering a new TNT (Tube 'N Tool) Chest to TV-radio service technicians in a promotional campaign running from August 1 through November 15. In another promotion, the Sylvania Radio Tube and Electronics Division is conducting a co-operative campaign for distributors, consisting of six mailings aimed at general users, manufacturers, and small industries.

Raytheon Manufacturing Co., Wal- tham, Mass., conducted another in its "How to Interpret What You See in UHF" lectures for service technicians in Boston recently in cooperation with local Raytheon distributors. William Ashby of Raytheon's lecture staff was the principal speaker.

Channel Master Corp., Ellenville, N. Y., has made available to distributors a four-color counter display merchandiser for its interaction filters. The three units, the Tenna-Tie for v.h.f., and the Triple-Tie and Ultra-Tie for both v.h.f. and u.h.f. are mounted right on the card.

Radelco Manufacturing Co., Cleveland, is offering an automotive antenna floor displayer with the purchase of its DB-40 assortment of Radelco auto antennas.

Duotone Co., Inc., Keyport, N. J., is offering an inspection kit including a microscope and a tool for replacing phono needles, in a special purchase deal.

JFD Manufacturing Co., Inc., Brook- lyn, N. Y., launched a two-pronged promotional campaign designed to sell (CONTINUED ON PAGE 22)
A new line of High-Fidelity Reproduction Equipment for Volume Sales...Record Profits!

Here's the line of high-fidelity reproduction equipment that will bring customers to you! It offers the ideal answer to the growing demand for matched units in home sound systems. For the first time quality voice and music reception is available to every family...at prices they can afford!

The General Electric Variable Reluctance Cartridge started this business of high-fidelity. Today's G-E announcement of a new line of reproduction equipment completes the home sound picture. Your customers get the dual advantage of purchasing individual components or the complete ensemble for a home decorator installation.

Whether you sell or install high-fidelity sound equipment you'll want to have these units on hand. Be ready for the tremendous market they'll create...order today! Call the local General Electric distributor or write today to: General Electric Company, Section 4593 Electronics Park, Syracuse, New York.

You can put your confidence in...

G E N E R A L  E L E C T R I C

S E P T E M B E R, 1 9 5 3
FACTS YOU SHOULD KNOW ABOUT UHF CONVERTERS

Many converters on the market today are unsatisfactory in fringe and shadow areas where signal strength is low. Before you install a UHF converter in these areas you should know these facts:

1. Signal power loss in the preselector seriously affects picture quality. Most UHF converters use sliding contacts, which reduce the power loss of UHF signals to .6 db. The Turner converter uses Hi-Q coaxial cavity tuners with no sliding contacts. Signal power loss is cut to 3 db. The resulting low noise figure keeps picture quality high.

2. Oscillator radiation often causes disturbing interference with neighboring sets. In the Turner converter the oscillator tube socket and all associated circuits are inside the coaxial cavity, self-shielded. Removable covers provide a second shield against radiation.

3. High amplifier noise figure can further damage picture quality. The Turner converter uses a special broadband amplifier with Cascode circuit. It retains the preselector signal savings without appreciably increasing the noise figure. The Turner amplifier noise figure is only 3 db.

Whether you're selling converters for installations in shadow or fringe areas or putting one in your own home, remember the Turner converter often means the difference between good reception and bad.

EXCLUSIVE TURNER FEATURES
- Higher sensitivity
- Extremely low noise figure
- Exceptional frequency stability
- Double shielding
- Hi-Q silver plated coaxial cavities
- No sliding contacts

OTHER MAJOR TURNER FEATURES
Continuous single-knob tuning, illuminated slide-rule dial. Smaller size: 8" x 11/2". Use with UHF or combination antennas. Self-powered, uses channels 5 or 6. Complete installation instructions for 110-120 volts 50-60 cycles AC. Schematic included.

In VHF fringe and shadow areas, the Turner Booster is a superior performer, too.

THE TURNER COMPANY
933 17th St., N.E., Cedar Rapids, iowa
Export: Ad Auriemo, Inc., 89 Broad St., New York 4, N.Y.
Canada: Canadian Mercani Co., Toronto, Ont. & Branches

Webster Electric Co., Sound Sales Division, Racine, Wis., is offering parts distributors a cartridge dispenser which will hold 50 crystal cartridges. A replacement chart is included with each dispenser.

JFD Tele-plex set couplers as well as additional TV sets in the home. The campaign is highlighted by a four-color, three-dimensional display for window or counter. Pamphlets for direct mail or point of sale are also included.

Radiant Corp., Cleveland, designed a new point-of-sale display for its CDR rotor which permits the customer to operate the rotor.

NOW! GET THE PROOF FOR YOURSELF!
We'll send you a Free Photofact Folder on any receiver covered in Sets No. 101 and following.

Learn for yourself—at our expense—how Photofact pays for itself by earning bigger profits for you! Select any Folder appearing in Photofact Sets Nos. 101 and following, from the PF Index. (If you haven't a copy, see your distributor.) When you write for your Free Folder, be sure to state Photofact Set and Folder Number as shown in the Index (offer limited to Folders in sets subsequent to No. 101). Get your Free Folder now. Examine, use, compare—see why Photofact belongs in your shop!

HOWARD W. SAMS & CO., INC.
2205 E. 44th St., Indianapolis 5, Ind.
No matter where you live or what you are doing now...

I WILL TRAIN YOU FOR A HIGH PAY JOB IN TELEVISION

NO EXPERIENCE NECESSARY
LEARN IN YOUR SPARE TIME!

GET MORE! LEARN MORE! EARN MORE!

I give you ALL the equipment and training you need to prepare for the BETTER PAY jobs in TV. While training, many of my students make $25.00 a week repairing Radio-TV sets in their spare time...start their own profitable service business.

MORE EQUIPMENT!
You build and keep this professional GIANT SCREEN TV RECEIVER complete with big picture tube (designed and engineered to take any size up to 21-inch). Also all units illustrated, plus additional equipment! Everything supplied complete with all tubes.

FREE FCC COACHING COURSE!
Prepares you at home for your FCC License. The best jobs in TV and radio require an FCC license. My FCC Coaching Course is given to you at NO EXTRA COST after TV Theory and Practice is completed.

BECOME A TV CAMERAMAN!
TV Cameraman & Studio Course Advanced training for men who have had radio & TV training or experience. I train you for an exciting big pay job as the man behind the TV camera. Work with TV stars in TV studios or "on location" at remote pick-ups.

FM-TV TECHNICIAN TRAINING!
My FM-TV Technician Course will save you months of training if you have previous Armed Forces or civilian radio experience. Complete with kits, BIG SCREEN TV RECEIVER, and FREE FCC Coaching Course.

NEW YORK ROUND TRIP!
Exclusive! Only RTFA gives you a ROUND TRIP TO NEW YORK CITY at Y1 EXTRA COST! Yes, from anywhere in the continental U.S. or Canada, I'll pay your way to New York and return after you finish your complete Radio-TV course. Get 2 FREE weeks, 50 hours of advanced study at our affiliated PIERCE SCHOOL OF RADIO & TV. Operate modern TV studio and camera equipment at TV center! (Available only to students enrolled for complete Radio-TV Technician Course.)

VETERANS! CIVILIANS!
Thousands of new jobs in TV are opening up in every state as new stations go on the air. You too can take your place in America's booming TELEVISION and Electronics Industry...enjoy the success and happiness you always wanted out of life! Now...prepare for a lifetime career as a trained TV TECHNICIAN, after this...using the same successful "learn-by-doing" home study methods that have helped hundreds of men with NO PREVIOUS TRAINING!

MY SCHOOLS FULLY APPROVED TO TRAIN VETERANS UNDER NEW G.I. BILL. If discharged after June 27, 1950—CHECK COUPON BELOW! Also approved for RESIDENT TRAINING in New York City...qualifies you for full subsistence allowance up to $160 per month.

MAIL COUPON TODAY!
MY 4 FREE AIDS SHOW YOU HOW AND WHERE TO GET A BETTER PAY JOB IN TELEVISION! See for yourself how my simple, practical methods make success easy.

NO SALESMAN WILL CALL!
Mr. Leonard C. Lane, President
RADIO-TELEVISION TRAINING ASSOCIATION
1629 Broadway, New York 19, N. Y. Dept. H-9A

Dear Mr. Lane: Mail me your NEW FREE BOOK, FREE SAMPLE LESSON, and FREE aids that will show me how I can make BIG MONEY IN TELEVISION. I understand I am under no obligation and no salesman will call.
(PLEASE PRINT CLEARLY)

NAME ____________________________________________
ADDRESS ___________________________________________

CITY _______ STATE _______ ZIP _______

I AM INTERESTED IN:

□ Radio-TV Technician Course
□ FM-TV Technician Course for Training under NEW VETERANS!
□ TV Cameraman & Studio Course G.I. Bill

RADIO-TELEVISION TRAINING ASSOCIATION
1629 Broadway, New York City 19, N. Y.
LICENSED BY THE STATE OF NEW YORK

SEPTEMBER, 1953
12 reasons why it pays to replace with Sylvania Picture Tubes

Independent laboratory tests show these 12 outstanding qualities of Sylvania Picture Tubes

1. No tube failures (after 1500 hours).
2. No trend toward slumping emission or low light output.
3. No excessive leakage.
4. No excessive gas present.
5. Excellent grid control.
6. Excellent emission characteristics.
7. No stray emission.
8. Low electrical breakdown.
9. Very good color control.
10. Excellent spot centering.
11. Low screen burning (no rejections).
12. Excellent physical conditions.

Only Sylvania showed no tube failures

Here is proof that Sylvania Picture Tubes are first in long life and finest in all around performance of all tubes tested.

The above record was established in comparison tests of the tubes of 9 different manufacturers. All tests were conducted under identical conditions by an outside testing agency.

Set owners everywhere are being told again and again about Sylvania's superiority on the big, nationwide TV show "Beat the Clock."

The Picture Tube for Reliable Replacement

Of course, the name Sylvania has always stood for highest quality. Now, more than ever before, Sylvania Picture Tubes mean better business for jobbers and service-dealers alike. If you would like the full story of these recent tests to show your customers how Sylvania Picture Tubes won over all others tested, simply mail the coupon now.

SYLVANIA
LIGHTING • RADIO • ELECTRONICS • TELEVISION

In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg.
St. Catherine St., Montreal, P. Q.

Send for this report

Sylvania Electric Products Inc.
Dept. 3R-1701, 1740 Broadway, N.Y. 19, N.Y.

Please send me the official report of the tests made on Sylvania Picture Tubes in competition with other makes.

Name ____________________________
Company _________________________
Street ____________________________
City __________________ Zone ______
State ____________________________

REPORT
MONEY BACK GUARANTEED
TO RECEIVE All UHF and All VHF STATIONS IN All DIRECTIONS FOR 60 MILES WITHOUT A ROTORMOTOR OF ANY KIND!!

WORLD'S MOST POWERFUL UHF—VHF TELEVISION ANTENNA

While antenna reception is guaranteed for 60 miles, perfect pictures have been consistently received as far as 160 miles from stations.

All NEW DESIGN FOR '54
- LOW-LOSS SWITCH
- LOW-LOSS PHENOLIC INSULATORS
- USES NEW 4-CONDUCTOR MATCHED IMPEDANCE LINE
- ONLY 10 INCH SPACING BETWEEN ANTENNA BAYS

ONE INSTALLATION  ONE ANTENNA
ONE TRANSMISSION LINE

Maury Back Guarantee
IN ALL LOCATIONS  IN EVERY AREA
WITH STATIONS IN ALL DIRECTIONS

The new All Channel Model Super 60 is guaranteed to bring in, immediately on installation, every UHF and every VHF station within 60 miles in any direction, giving clearer and sharper pictures than any antenna or combination of antennas with or without rotor motors.

If, immediately on installation, it fails to do this, we agree to refund to the jobber to whom we sold and shipped it, his full purchase price.

BE READY NOW — FOR THE FUTURE

LIST PRICE
$36.75
SEE YOUR LOCAL JOBBER

All Channel Antenna Corp., 70-07 Queens Blvd., Woodside 77, New York

SEPTEMBER 1953
You can see the difference...

ARThUR GODFREY, FAMOUS CBS-TELEVISION STAR

NOW CBS-HYTRON MIRROR-BACK BIG-SCREEN TUBES

27EP4 . . . 24TP4 GIVE YOU BRIGHTER PICTURES!

HOW MIRROR-BACK TUBES ARE MADE

Screen phosphors are applied to the face plate as usual. Next lacquer is applied over this screen. Finally the screen is vacuum-sprayed with aluminum. Baking removes lacquer, leaving the brilliant Mirror-Back coating. Mirror-Back reflects light that would otherwise be lost to the rear of the screen.

ADVANTAGES OF CBS-HYTRON MIRROR-BACK TUBES

1. Stepped-up light output.
2. Brighter picture.
3. Greater contrast.
4. Reduced strain on component parts.
5. Full effective screen potential maintained by metallic contact between anode and screen.
6. Longer life . . . drain on cathode materially reduced.

Leading TV set makers demand maximum brightness from their large-screen sets — without strain on component parts. For them, CBS-Hytron introduced its Mirror-Back 27EP4 and 24TP4 (both spherical, electromagnetic types). Mirror-like effect of their aluminum-backed screens reinforces light output. Given brighter, sharper pictures.

You, too, will want CBS-Hytron Mirror-Back big-screen tubes for replacement. In 27- and 24-inch sizes, they are a must. Take a tip from leading TV set makers. Try the CBS-Hytron 27EP4 and 24TP4. See the difference for yourself. Let your customer see it too. Order performance-tested Mirror-Back tubes from your CBS-Hytron distributor.

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EXTRA SERVICE. Many service technicians continue to complain in letters to the editor how difficult it is to make a living these days. This is not particularly new, because it has been going on ever since radio servicing started. Nor is it a complaint of radio and television technicians alone—it seems to be universal in all branches, whether radio, plumbing, automotive, typewriter repairing, watch repairing, or hundreds of other servicing lines.

There will always be those service technicians—and they are by far in the majority—who do make a good living and always have more work than they can handle. Then there is the minority who never can make ends meet, complain of competition and other troubles. This, too, is true of all services of every kind. After all, the wide-awake, businesslike individual knows what he is about, is a good student of human nature, and gives service plus. Usually he complains little.

This brings to mind a recent case we came across and which might be apropos.

A householder had called in a radio technician to make a minor television repair. There was one tube to be replaced and within ten minutes the service technician had finished the job. This man, however, is the type who gives extra service. He always carries with him a wood finishing kit, which takes up remarkably little room. He proceeded to polish the television set, which had a few scratches on it. This took less than five minutes. He did not charge for this. The lady of the house was amazed at this, it being the first servicing call this technician had made on her. She was so pleased that she asked him to call on her sister, who lived a few blocks away, and who owned a very expensive television set that had a bad dent in it. She wondered if he could fix it; he assured her he could.

A phone conversation arranged that the service technician should make the call immediately.

At the other house he found a rather large and deep dent in the top of the expensive walnut cabinet. It was caused by a large oil painting falling upon the set when the rusty wire holding the painting had given way. The service technician filled the hole with a special plastic cement he carried for this purpose, and told the new customer that no one was to touch the set until the cement had set. He would be back after 48 hours to finish the job. This he did, and after sandpapering the cement and refinishing the top, the dent had become almost invisible.

The lady of the household was so impressed with this job, for which he had charged a reasonable sum that she asked him to go over the TV set and replace all weak tubes. As she was living alone and used the television receiver constantly, she asked the technician to come back once every six months and put in new tubes wherever required. Evidently well-to-do, she could well afford this.

The moral of this story is that extra service usually pays real dividends at little extra cost to the service technician.

TV IMPSION. Television picture tubes are well protected in the average receiver by glass or heavy plastic in front of the screen. But when the chassis is removed from the cabinet, the service technician no longer has adequate protection. Sometimes he becomes careless and forgets what may happen when a picture tube "lets go." It should always be remembered that the vacuum in such tubes is high and in consequence, the atmospheric pressure exerts a tremendous force on the face of the tube. Thus a 17-inch screen tube supports a pressure of 672 lbs., or 1.60 tons; a 24-inch tube supports a weight of 10,378 lbs., or 5.19 tons!

If a picture tube caves in suddenly, the air within the vicinity is pulled into the tube violently, creating a powerful implosion. Immediately thereafter particles of glass are ejected forcefully on the rebound and freon gas and also the electron gun is pulled out and possibly hurled a varying distance.

Recently in Chicago, at a hospital which we visited, we met a TV service technician who told us the following account. He had taken a set apart and when he was carrying the picture tube to his bench, it "let go." His face was showered with glass and his nose in particular was fearfully cut. He did not know what had caused the implosion and had to be hospitalized.

While picture tube implosions are comparatively rare, technicians frequently handle these tubes carelessly. Often they are touched while the technician has a screw driver or other tool in one hand. It should be noted that a tiny scratch on the face of the tube is a serious matter; such a tube may explode at any time thereafter. The face of the tube should never be touched with anything metallic, such as screwdrivers or pliers.

Not so long ago, we visited a large tube plant. Some of the men were severely reprimanded by their superior because they used a steel, 6-inch pocket ruler to make a measurement on the face of the tube. Most rulers of this type have sharp corners which may scratch the face of the picture tube—even a microscopic scratch may spread and cause an implosion later.

If picture tubes must be handled by the service technician, a pair of heavy gloves should always be used, and the bare hand should never be placed on the face of the tube. "Insulate" yourself with a thick piece of cloth, wood preferably.

FREE TV SERVICE. A Buffalo appliance store—Meyers—offers "5-Year Free Service" with each TV receiver it sells. The "free service" does not include parts out of warranty, however. About 90% of the firm's service calls are completed in the customer's home and service is restricted to the hours between 9 am and 5:30 pm. The store has been offering similar free service on other appliances since 1936. It does a big business, selling television sets, etc., onOOO.

Although this idea may spread, it would seem to be good business for a retail store.

Naturally, this is not good news for the independent service technician. But insignificantly, he has come across free deals of all types before this, threat is probably no more of a menace than other "free" deals. To begin with, only large stores, doing an annual business of over a million dollars, can give such free service—if it is really free, that is. The work cannot be compensated for and probably will not be too severe for the independent service technician in the future.

The TV service business, after hours service probably will not be given by such establishments, and it is here where the independent technician, if he is alert, can cash in. In his community or in his servicing zone, where he normally operates, he should not be too difficult to find out who owns television sets.

Every up-to-date independent service technician should have a mailing list of all the owners of television sets in his neighborhood. If he can possibly arrange it, either he or a partner or a special employee should be able to give service after hours, say from 5 to 9 pm. Inasmuch as most people use television sets in the evening, a large percentage of television service occurs—or are discovered—during that period. Often an important program is to go on the air that evening and the owner wishes to see it; therefore he requires immediate service. If the service technician can circulate his prospective customers with a business card which may read "Get TV Service When You Need It. We make calls from 5 to 9 pm at reasonable prices. Phone us in case of trouble," he is sure to find it worth while. This idea may spread, and the current literature to prospects will often bring in a good deal of business, particularly over the weekend when most people do not wish to be without a live radio or TV set. Such special service rates higher prices too.

As it has been often experienced, once you get a new customer and have done him a favor, he will remember it. It is true that night service may be a nuisance, but the prospect has been prepared in such a manner that if the service technician himself cannot take on the job, he may have an alternate or alternates who can be reached by telephone. That is up-to-date servicing that pays dividends.
PART I of a series of articles devoted to ear-pleasing audio and methods by which it may be attained

By RICHARD H. DORF*

Even if you are not a devotee of Bach, Beethoven, or boogie-woogie, you would have a hard time closing your ears to the growing boom in high-quality audio. The technical press is full of it; for the first time in electronics history nontechnical and semitechnical friends and neighbors wrap their tongues around words like "intermodulation" and "transient response" and discuss the merits of woofers and tweeters with the same nonchalance that used to accompany their critiques of the latest movies. If your list of acquaintances is anything like ours, you probably can't accept an invitation to dinner or a friendly evening of cards or conversation without being asked to lend a critical ear to your host's latest acquisition from the sound department of the local electronics jobber.

Yes, large segments of the public have caught on to the fact that there is such a thing as good sound reproduction, and out of that realization is growing a good-sized industry of manufacturers and installers of custom home-music systems. To the service technician the new audio era means that the old knowledge and techniques which were sufficient to take care of ailing radio-phonograph combinations are no longer sufficient. Not only are the new home-music systems more complex and of higher quality, but the owners are vastly more critical, and many have picked up enough knowledge to know what repairs should be made and to detect lack of knowledge on the technician's part.

This series of articles is written not only for the benefit of the service technician, but for everyone who would like to have a thorough look into the purposes, ingredients, and techniques of high-quality home-music systems. We shall try to tie together and systematize much of the information that has been available up to now only in scattered form.

A little history

For many years we listened to records and radio programs as they were reproduced by what we might now call "department-store audio." The instruments themselves were ordinary AM radios and radio-phonograph combinations. The first step toward improvement was the advent of FM back in 1941. FM gave us noise-free reception and—at least at the broadcast-station end of the link—made it possible to transmit a wide audio-frequency range with relatively low distortion.

But the FM receivers were still of the department-store variety and in the AM tradition. Most were table models; their small speakers could not reproduce bass; and because their audio circuits were traditional, inexpensive, minimum-quality types, they generated a good deal of distortion. But they had good treble ranges (though response was not smooth), and these made the distortion all the more apparent. As a result, most people who were introduced to these receivers as "high-fidelity" models decided they did not like high fidelity.

For many years department-store radio-phonographs were built to minimum or—at best—mediocre fidelity standards. Speakers had restricted frequency ranges with response curves far from smooth. The ordinary cabinet—though much emphasis was placed on it as a piece of furniture—was a dismal failure as a speaker enclosure. Single-ended audio-output stages were the rule. Crystal phonograph pickups worth only about a dollar or two at retail prices were found in practically all machines; they too had an extremely restricted range, with sharp peaks and valleys in response. Tone controls were always provided so that the customer could reduce the needle scratch caused by inferior records and equipment, and could produce the blurry juke-box effect which was euphemistically labeled "mellow" on the control panel.

Even the best records (with very few foreign exceptions) were noisy, restricted in both frequency and dynamic ranges. They were all 78's, with playing times of only 3 to 5 minutes. Changers were often cruel to records. Pickups and arms, with steel needles and heavy stylus pressures, were crueler still, so
that almost any record was sure to be permanently damaged after two or three playings.

The first major glimmer of the high-quality audio era came shortly after the end of World War II with the introduction of G-E's variable-reluctance phonomograph pickup. It was good to records and produced clean, faithful sound. Better amplifiers began to appear; then high-quality speakers, which had been available for some time in the broadcast and motion-picture industries, were offered to home users. Other pick-ups, speakers, and amplifiers of excellent quality were developed and marketed. Then first-class accessories—turntables, arms, equalizers, FM and AM tuners, joined the parade.

As an important part of our new program of extended high-quality audio coverage, Radio-Electronics commences in this issue a series of articles which will deal with high-quality audio from the human point of view. It is, as Mr. Dorf points out, perhaps possible to design a calculator or a multiband receiver on a purely slide rule basis; but the development of high-quality audio can neither be sparked by or judged in the light of science entirely, for its purpose is to arouse the emotions of human beings—animals who cannot be measured by objective means and whose responses are not predictable except in the light of long experience. It will be an important purpose of these articles to go beyond the purely technical details and treat the subject of music reproduction as an extension of the art of music in general, thus complementing and completing the more electronic and technical articles which appear in this section.

The year 1948 brought the first major advance in the development of the record industry since the introduction of electronic recording and reproduction—Columbia's LP Microgroove record. Not only did this convert and reconvert millions to record-listening by eliminating mood-breaking pauses: the LP record was almost noiseless and could be used with wide-range equipment because of the vast improvement in signal-to-noise ratio. RCA followed with the 45-r.p.m. record, also almost completely noiseless and capable of superior sound quality. Today all major companies and a flood of smaller ones make small-groove records; the sale of 78's is almost at a standstill.

The postwar development of the tape recorder was an important adjunct to all this. Tape made it possible to record complete works without interruptions and to edit them for perfection. Smaller recording companies found it feasible to get in on the business by having tapes made abroad with comparatively low-paid, nonunion musicians. The ordinary individual could at reasonable cost a device which enabled him to preserve anything originating in his home or on the air. More important, he himself could produce almost perfect tape recordings without being forced to learn the special techniques necessary with disc recorders. As a result, the tape recorder is an important element in many home music systems.

The home music system

A home music system like the one pictured in Fig. 1 represents the culmination of many years of development in the audio field; it also represents a typical product of the audio system custom-builder or assemblers—a unique thing to his (or the customer's) taste and pocketbook and assembled them in either custom-made or standard parts in an arrangement to suit highly personal ideas of maximum convenience and best appearance.

The number and selection of components in the system and the over-all arrangement are subject to many variations. The basic system always includes at least an amplifier and a speaker system. A surprising number of builders and clients include phono gram but no radio, or FM but not AM. TV is definitely an option. The "purists" prefer plain turntables (good ones, of course) to record changers. There may or may not be a separate phono preamplifier, which, in turn, may or may not be the central control point for the whole system. The speaker may be a single unit, or a whole system in itself, with anywhere from two to as many as four or five separate speakers. The symmetry varies as widely as the human imagination. Sometimes there is little at all, with components mounted in bookcases, walls, closets—in the most unlikely as well as the most obvious places. The whole system may be compressed into an all-in-one chassis set, or housed in a single large combination cabinet. In contrast to this very compact idea, some systems are spread all over a home-control unit at chairside, amplifier in a linen closet, speaker in or against the opposite wall, phono gram and radio tuner equally dispersed. The sky is the limit!

What is high-quality sound?

The prime characteristic—indeed the raison d'être—of any home music system is its high-quality sound, so we are justified in trying to see from a purely subjective viewpoint what the term means. Later on in this series we will analyze the term more precisely and technically.

The primary characteristic that determines quality in sound reproduction is not wide frequency range but freedom from harmonic, intermodulation, and transient distortion. Before we try to make music sound more lifelike we must remove several definitely annoying and fatiguing troubles in reproduction. The troubles stem from the three kinds of distortion we have mentioned. A fourth kind, frequency distortion, may also be annoying, but not to the same degree. Still another type, spatial distortion, is almost inevitable and is one of the limitations which is to accept, like the lack of a fourth wall in a stage setting. Let us take them up one by one.

Harmonic distortion occurs when some component of a reproducing system contains a nonlinearity which adds to the tones passing through it, new frequencies which were not present in the original tones. Suppose we feed a sine wave (Fig. 2-a) into the system from a radio or a phonograph. Suppose we put in the amplifier there is a tube whose grid bias is smaller than the peak value of the sine wave. At a certain point on the positive half-cycle (the
instant the signal amplitude exceeds the grid bias) the tube begins to draw grid current. This limits further rise of the sine wave. The output of the stage and of the loudspeaker (disregarding any polarity reversal in the amplifier, which will not alter the effect on the ear) is now a sine wave with a flattened top (Fig. 2-b). Our original sine wave is now beginning to resemble a square wave which we know is very rich in harmonics, while a sine wave is not. Thus the output obviously contains harmonics that were not in the original.

The sound will be much more harsh and strident than the original. Aside from the shape of the wave the waveform has been changed by the amplifier and no longer represents the original sound quality.

Intermodulation distortion is still more annoying. It occurs when two or more tones pass simultaneously through a nonlinear part of the system—which again may be a badly biased grid or a saturating transformer or any one of a thousand troubles that might make output not proportional to input. When two or more tones are present the nonlinear device acts as a detector, or like the mixer in any superheterodyne receiver—that is, it produces sum and difference frequencies in addition to the original.

Suppose, for instance, the tones E and G above middle C passed through the system. These tones are harmonious; their frequencies are 329.6 and 392.0 cycles respectively. The nonlinear “mixer” produces the sum frequency of 721.6 cycles, and the difference frequency of 62.40 cycles, neither of which is even in the musical scale, much less being in harmony with the original E and G. The result is an unpleasant dissonance, complicated still further by more spurious frequencies produced by the new frequencies beating with each other and with all the new and old tones—plus all their products!

Transient distortion occurs when the loudspeaker cone continues to move after the electric impulse that drives it dies out or is removed. Suppose in the middle of a symphony we have a sudden sharp drumbeat, causing the speaker cone to move quickly outward. Ideally, the cone should now move back to its center position and stay there until the next audio signal comes through. But the cone has mass—and mass means inertia; furthermore, its support is not rigid. Therefore, if we strike it suddenly with a single short electrical impulse it tends to vibrate back and forth until the energy it has accumulated from the electrical kick of the drumbeat has been expended. Any movement other than the single clear impulse and back again movement disturbed by the drumbeat is spurious, and creates additional false sound waves in the air. The total effect is that instead of a single clear impulse, a sharp drumbeat produces a muddied blur of sound, because it sets the speaker cone vibrating in a train of damped oscillations.

Transient distortion can also take the opposite form—that is, excessive inertia or damping can prevent the cone from responding at all to a short impulse like our single drumbeat. This can be as objectionable in its own way as the other form, since it deprives us of some of the most effective parts of the music. Both forms of transient distortion can be produced not only in the speaker, but in other parts of the system as well.

Transient distortion is usually evaluated by feeding a square wave (Fig. 3-a) into the system and watching an oscilloscope across the speaker. Fig. 3-b shows the damped-wave train representing spurious oscillation. It gives a muddy effect to reproduction.

Frequency recognizability stems when the frequency range and linearity of the system are not good enough to provide at the output the same frequency content in the same relative quantities as the input contained. There are two important facets of frequency distortion: range and linearity.

The range of human hearing includes sounds from roughly 20 to 17,000 cycles, depending on the individual. For this reason, any system which does not produce such output when excited at any frequency between at least 40 and 15,000 cycles lacks the frequency range to merit the title of “high-quality,” especially today when it is so easy to attain this in most loudspeakers, traditionally the final stumbling block.

Even more important is frequency linearity. The sound of the cello, for instance, consists largely of fairly low-frequency fundamental tones but its peculiar, recognizable quality stems from its harmonic content and from the particular combination of harmonics it produces as distinguished from those produced by, say, a trombone. To carry that recognizable quality to the ear at home the music system must present each harmonic in its true perspective.

If the fifth harmonic at 523 cycles is the most prominent in the original tone, but the system response has a dip between 400 and 600 cycles, the harmonic will not be reproduced with its true value and the character of the cello tone will not be really cello-like. The importance of frequency linearity can be realized from the formant nature of musical tone quality, outlined in the writer’s articles in the August and December, 1951, issues of Radio-Electronics.

In addition to sometimes making instruments recognizable, frequency distortion may also be highly annoying in other ways. Many phonographs have strong peaks in the region around 3,000 cycles, caused by mechanical resonance in the crystal-plated pickup—very much like peaks emphasize record surface noise and cause that trident, harsh quality so unpleasantly familiar in department-store audio. Peaks in the bass range are common, too, usually caused by resonances in the pickup-arm, the loudspeaker, or by a poor speaker enclosure. The result is a typical juke-box boom, where all bass notes have the same apparent pitch or none at all.

Spatial distortion occurs in every music system where all sounds issue from a single location rather than from a separate location for each instrument to correspond with its actual placement on the studio or concert-hall floor. Spatial distortion also stems from the difference in character between the living room in which we listen and the hall in which a recording or broadcast was made—and from the difference between the volume levels at which the sound is present in the two places. There is very little we can do about either of these problems, and the “point source” must simply be accepted as a physical limitation; but fortunately, it is not inherently annoying or discordant in any way. So-called “binaural” sound is a fad in some quarters today, with separate channels feeding two speakers, each channel and speaker representing one of the two human ears. Since there is no way to prevent sound from the “left-ear” speaker from reaching the right ear of the listener, and vice versa, binaural sound is perhaps a slight improvement at relatively low and modestly pressed levels at an average room cost, but spatial distortion it is simply a snare and a delusion—unless we listen to the two channels with individual headphones.

So far we have concentrated on what the high-quality system does not contain—distortion. (Naturally, there is always some distortion: the measure of a system’s quality is the relative amount.) Next month we shall discuss what it does contain, and begin to analyze in detail each of the components that contribute to the happy end result.

(TO BE CONTINUED)
The "goodness" of an amplifier is not shown by its circuit diagram. Circuits have no inherent magic properties, but are merely the tools with which the designer seeks to achieve a certain result, and different designers—provided always that they have the same high standards in view—may achieve the same results by different means.

—D. T. N. Williamson

High-Quality Circuits

Observations on Ultra-Linear, plus circuit features of three high-quality power amplifiers

By JOHN K. FRIEBOHN

SINCE Williamson published the first description of his "High-Quality Audio Amplifier", in 1947, other audio amplifier designers have had two apparent choices, "beating him or joining him." A popular compromise is to adopt his general circuit arrangement, but to replace the class-A triode output stage with another type giving higher efficiency. The Ultra-Linear version of the Williamson amplifier is the solution which recently has received the largest amount of publicity in this country. Amplifiers made by two American manufacturers utilize a type of output stage which is less well-known, but which Williamson himself regards as a more substantial improvement than the Ultra-Linear. Still another American amplifier uses a type of output stage which apparently can give results better than some of us expect of it.

Ultra-Linear

Where the original Williamson circuit uses triode-connected beam tetrodes in this output stage, the Ultra-Linear version has the screens connected to taps on the output transformer primary. A typical example of an Ultra-Linear Williamson is the Brociner model UL-1. (Fig. 1.) One explanation of the low distortion of this output circuit is that, since connecting the screens to the plate terminals of the transformer primary (the triode connection) produces a plate characteristic which is nonlinear in one direction and...
connecting the screens to the E plus
terminal of the transformer (the te-
tetrode connection) produces a char-
acteristic which is nonlinear in the other
direction, screen connections to point s-
awhere between the center and the
ends of the primary will produce ap-
proximate linearity. (See Fig. 2)

Williamson points out that the
Ultra-Line circuit is in effect a
tetrode circuit with negative feedback
from plate to screens and that the
same improvement in linearity can be
obtained with other circuits which give
equivalent amounts of negative feed-
back. In fact, he remarks that equally
good results can be obtained with an
ordinary beam-tetrode output circuit by
using sufficient feedback around the
total amplifier. The disadvantage of
that arrangement is that sufficient over-
all feedback to enable a tetrode output
circuit to better the performance of the
original triode Williamson may be dif-
ficult to obtain without instability. It
can be done, as one of the amplifiers
to be discussed in this article demonstrates.
Inserting some feedback in the output stage makes it possible to re-
duce the distortion any specified amount with less over-all feedback.

Coupling from plates to screens is
only one way in which feedback can be produced in the output stage. Feedback
voltage can be inserted between the grid and cathode and it would be more
effective than feedback voltage inserted
between the screen and cathode. Such
an arrangement has been used in a
British amplifier, the Acoustical, and
in the two American amplifiers re-
ferred to above, the Bell model 2200
(Fig. 3) and the Bogen model DB20
(Fig. 4). It can be seen from the dia-
agrams that the voltage across the feed-
back winding of the transformer ac-
tually varies both the cathode-to-grid
voltage and the cathode-to-screen volt-
age (inverse feedback is applied to both
the grids and the screens). Figures 2
given by Williamson indicate that this
arrangement gives less distortion in the
output stage alone than either the triode or the Ultra-Line tetrode
circuit. Specifications published by
the manufacturers of both the Bell and the
Bogen amplifiers indicate a harmonic
distortion of 0.3% for a. output of
20 watts. Variations of distortion in
the Bogen model DB20 with power and
with frequency are shown in the curves
of Figs. 5 and 6, which were furnished
by the manufacturer.

Bell model 2200

The Bell amplifier has a few notable variations on the conventional arrange-
ment, aside from the output stage. The
arrangement of two resistors and one
capacitor in the cathode circuit of the
first stage serves two purposes. First,
the cathode resistor is partially by-
passed, so that there is less feedback
within this stage and greater over-all
gain without feedback. For the same
amount of over-all gain with feedback,
the amount of feedback which can be
used, and the reduction in over-all
distortion, is greater. Second, since
the negative feedback path is through
the capacitor, less feedback results at
low frequencies and the gain is in-
creased to compensate for the low-fre-
quency loss in the coupling capacitors.
The phase inverter in this amplifier is
direct-coupled, as it is in most varia-
tions of the Williamson amplifier. No 1% resistors are used in the push-
pull stages, but other provisions are
made to reduce the amount of unbal-
ance. The push-pull voltage amplifier
has an extra resistor, R1, common to
the cathode circuits of both tubes. The
usual cathode potentiometer for bal-
ancing the output stage tubes is used.
(The tube heater which is connected
in the cathode circuit of the output
stage belongs to the preamplifier. Each
of the amplifiers described in this ar-
ticle, except the Brociner, includes a
four-stage preamplifier, equalizer, and
tone-control circuit, using two twin
triodes. Only the main power amplifiers
will be described in detail.)

Bogen model DB20

The Bogen amplifier has other un-
usual features in addition to the output
stage design. It is particularly notable
for its many uses of feedback. In ad-
in to inverse current feedback in
six of its eight stages, due to unby-
passed cathode resistors, interstage
negative feedback is used in the equal-
izer and in the tone-control circuit (not
shown in Fig. 4). The power-amplifier
section has not only the output-stage
feedback previously mentioned and
over-all negative feedback, but also
positive feedback between the cathodes
of the last two stages.

This amplifier has the conventional
direct-coupled phase inverter (VI-b).
The plate voltage of VI-a and the grid
voltage of VI-b are adjusted with R1
so that the distortion in the VI-b stage
will be a minimum. Few critical com-
ponents or adjustments are used. The
phase inverter load resistors, R2 and
R3, are matched by selection of pairs
from ordinary production tolerance
types. Other resistors are unselected.
The common cathode resistor in the
push-pull voltage amplifier stage im-
proves the balance in that stage. The
use of multiple feedback loops in the
amplifier makes it possible to obtain the
Fig. 5—A graph showing the variation in harmonic distortion at various power output levels in the Bogen model DB20.

Fig. 6—Harmonic distortion in the DB20 at the 10-, 15-, and 20-watt levels for frequencies up to 20 kilocycles.

Fig. 7 (above)—The Stromberg-Carlson AR-425 amplifier in the schematic has a sensitivity of 2 volts input for full rated output. Fig. 8 (left)—A graph of the harmonic distortion variation in the AR-425 amplifier at different frequencies as well as power output levels.

specified level of distortion without critical balancing of the output stage.

**Stromberg-Carlson model AR-425**

The power-amplifier section of Stromberg-Carlson model AR-425 custom amplifier is shown in Fig. 7. A direct-coupled phase inverter circuit is used, but the push-pull voltage-amplifier stage does not have a common cathode resistor and close-tolerance resistors are not used for balancing. A simple beam tetrode power stage is used in this amplifier, with no intrastage feedback, yet the harmonic distortion at 20 watts output is approximately the same as in the other amplifiers described in this article, according to curves furnished by the manufacturer (Fig. 8). Using frequencies of 60 cycles and 7 kilocycles in a 4 to 1 voltage ratio, this amplifier develops only 0.7% intermodulation distortion at 15 watts output. Using 40 cycles and 7 kc, the intermodulation distortion is 1.2% at 15 watts. When making power runs to determine the percentage of intermodulation distortion, the 15-watt complex waveform measured by the distortion meter is equivalent to 23.5 watts of sine-wave signal having the same peak value as the resulting signal produced by intermodulation within the audio amplifier.

The low distortion is accounted for partly by the large amount of over-all negative feedback used. To overcome the resulting tendency to oscillation at high frequencies, the gain of the first two stages at high frequencies is reduced by two separate means.

The output of the first stage is shunted by a combination of two capacitors and one resistor, C1, C2, and R1, so that the effective load impedance at high frequencies is reduced. Also, negative feedback at high frequencies is provided between the plate of the second stage and the cathode of the first, through C3 and R2.

All four of the amplifiers discussed in this article have damping factors of around 15, compared with 30 for classical triode versions of the Williamson. That is, the various tetrode versions have an output impedance of about one-fifteenth the speaker voice-coil impedance, against one-thirtieth for the triode circuit. Williamson points out that the effective damping resistance is the sum of the amplifier output resistance and the speaker voice-coil resistance. The tetrode circuits therefore have total damping resistances, not twice as great as the triode circuit, but only about 3% greater.

**References**


SEPTEMBER, 1953
Some unexpected things happen in feedback amplifiers. This article tells the reasons and cures for some of them.

At first glance, the general idea behind feedback seems sound enough: Plenty of feedback improves amplifier performance, and to get a large amount of feedback we must feed back a voltage from the output to a stage where the signal voltage is quite small. Bland acceptance of this fact as the only requirement has encouraged the design of a number of amplifiers in which feedback is applied from the output stage back almost, if not quite, to the input stage.

The snags

The owner of such an amplifier will probably be all too familiar with some of the snags attending over-all feedback, but there are others that are perhaps less obvious. Many proud possessors of high-fidelity equipment have been puzzled by experiences like this: The complete chain sounds horrid—shriill resonances, intermodulation, and other forms of distortion; a check of the amplifier with dummy load shows everything O.K. in that part of the system; the speaker sounds fine on another amplifier; all impedances match correctly: the chain works nicely on phone input but not on radio (or maybe vice versa): but everything is O.K. when a different speaker is used. Where does the trouble lie? To see how such snags arise let's consider first how feedback is obtained.

From the viewpoint of the output end there are two methods of applying the feedback: series injection and shunt injection. In the former, the signal feed back is injected in series with the original input signal (Fig. 2-a), while in the latter (Fig. 2-b) it is injected in shunt with it.

A point that is often overlooked is that when the feedback loop includes both the input and output circuits of an amplifier, the impedance of the input-signal source, and the impedance of the output load affect the amount of feedback.

For example, with voltage feedback, if the load impedance is reduced to zero there will be no feedback at all; similarly, when current feedback is used there will be no feedback at all if the load impedance is an open circuit.

At the input end of the amplifier the method used to inject the feedback depends on the impedance of the signal source. With series injection the source impedance connected to the input must be low compared to the grid-circuit impedance of the first stage, or it will reduce the amount of feedback; if the input source impedance becomes an open circuit there is no feedback.

In practice the input circuit is closed either by the secondary of an input transformer or by a grid resistor, so that there is always a complete feedback path, although the impedance connected to the input will still modify the feedback characteristic somewhat.

Shunt feedback injection depends on the source impedance connected to the input being high, since a short circuit across the input will reduce the feedback to zero.

The reader is probably quite familiar with the properties of inverse feedback in improving frequency response, reducing distortion, and modifying input and output impedances. For example, the internal output impedance of the amplifier, which serves as loudspeaker damping, can be reduced considerably by the liberal use of inverse feedback.

Similarly, the input impedance can be modified made either higher or lower—according to whether series or shunt injection respectively is used.

Where an input transformer introduces an undesirable resonance peak, appropriate connection of the feedback circuit may damp out this resonance, and produce a satisfactory over-all response; but a change in the load impedance connected across the output will alter the actual amount of feedback reaching the input, and thus change the effective response of the input transformer again. Similarly, changing the input impedance can sometimes affect the damping at the output.

Various arguments in their favor have been used by designers and manufacturers of such amplifiers, but I believe that with a really good amplifier we should not be so fussy about the impedances connected to it. Correct matching is obviously desirable, but one cannot prevent the loudspeaker impedance from having a frequency characteristic (Fig. 4) and affecting the feedback.

Internal noise

Another feature detracting from the advantages of over-all feedback is its effect on output hiss and other noises generated in all high-gain amplifiers. It has generally been preached that inverse feedback, however used, reduces distortion and noise, but this is not quite true. Harmonic and intermodulation distortion are periodic signals added to the original signal; with inverse feedback we can build up an out-of-phase component of the distortion signal and combine the two so as to reduce it; but noise, especially output hiss, is not a periodic signal. Rather, it is a random movement of charges or currents occurring over an infinitely wide range of time intervals so that it contains frequency components effectively from zero to infinity. It is true that the frequency response of the amplifier restricts the range of noise frequencies that reach the output, but the foregoing statement is true at the point where noise is generated. This means that to neutralize noise completely, an out-of-phase signal of the same amplitude must be fed back absolutely instantaneously coincident with each "hiss" so that both have the same form.

Why feedback so far?

By N. H. CROWHURST

Fig. 1—The standard feedback systems.

Fig. 2—The two methods of injection.
back to produce the same cancellation for noise that it does with distortion.

Taking the over-all result when inverse feedback is used, extra gain is required to offset that used up by the feedback. This means that in a feedback amplifier the output noise will receive far more amplification than in the same amplifier without feedback. If feedback could cancel noise to the same extent that it can cancel harmonic distortion, the noise would finish up at about the same level as in the amplifier without feedback, provided the over-all gain remained the same; but because the inverse feedback is unable to cancel the noise as completely as it does the periodic distortion waveforms, the resulting noise in the output of the feedback amplifier is actually higher. This explains what some workers have noted: that a feedback amplifier seems to have more hiss than a non-feedback amplifier with the same gain but without feedback.

The alternative

All these disadvantages of over-all feedback can be overcome by restricting the number of amplifier stages over which feedback is applied.

Fortunately, coupling impedances between stages are not subject to variation as source and load impedances are, so the possibility of impedance changes at both ends of the loop no longer arises. Besides, it is generally unnecessary to apply feedback to reduce distortion in the early stages of an amplifier where signal level is so small that curvature distortion cannot arise anyway; in fact, it is better to operate the low-level stages at maximum gain to maintain a good signal-to-noise ratio. Sometimes single-stage feedback may be used in a low-level stage for tone control, but this can still be applied after sufficient amplification has been

eeding the stage are so low that they absorb an appreciable proportion of the available output power, which is clearly undesirable.

The solution

Basically, the solution is fairly simple, but (as usual) there is a practical snag which explains why it has not yet been more widely applied. As we explained above, the impedance on the primary side of the output transformer is high, so that, although more than adequate voltage for feedback purposes is available, the feedback resistor chain will absorb more current than can be spared. On the transformer secondary the resistance of the feedback arrangement absorbs negligible energy because plenty of current is available, but the voltage is insufficient. What we need is an impedance between these extremes.

An amplifier designed to feed constant-voltage lines makes the matter quite simple because both the voltage and the impedance are about right to give a reasonable degree of feedback without absorbing an undue proportion of the output power. But it is not necessary to use constant-voltage output with an additional stage in the loudspeaker merely to get satisfactory feedback.

The output transformer can still provide for direct connection to the voice coil, if it has taps on the primary (Fig. 5-a) or an additional winding, (Fig. 5-b) so that a suitable intermediate impedance point is available for feedback purposes. The separate-feedback-winding (tertiary) method is preferable because it eliminates the blocking capacitors needed when taps on the primary are used. Because the feedback circuit consumes negligible power, the tertiary can be wound with fine-gauge wire, and need occupy only negligible space.

The idea of a separate feedback winding on the output transformer is not new; in fact, several transformer manufacturers already include models with this provision in their lines.

There is another advantage in having an extra tapped winding on the output transformer from the development angle. When the development engineer has his amplifier on the bench, and is experimenting with various values in the feedback circuit, he can select different values of resistors and capacitors immediately from stock and simply connect them in until suitable results are achieved; but if he wants an additional winding on the output transformer it involves a tantalizing delay; it cannot just be connected in but means ordering another transformer or waiting while the winding shop produces the modifications. END

**Fig. 3—Circuit of a typical amplifier with over-all voltage feedback.**

**Fig. 4—Voice coil impedance variation.**

**Fig. 5—Types of short-loop feedback.**

**Fig. 6—Two better feedback circuits.**
COMMERCIAL transistor hearing aids employ type CK718 junction transistors. The CK718 is a special type supplied to manufacturers of hearing aids. The simple hearing aid described in this article uses type CK722 transistors which are available to the experimenter.

The task of developing a transistorized hearing aid that might be duplicated by any electronic-technician proves intriguing, but this author met obstacles at every turn. First, no amount of experimenting with the CK722 in resistance-coupled circuits seemed to give the required gain and power output with tolerable noise level, even when four R-C stages were cascaded. Transformer coupling finally was used. Also, the much desired operation on a single 1½-volt cell did not pan out. We had to go to 15 volts. Undoubtedly, the CK721, with its higher power gain and different coefficients, would furnish the required drive. But this is an expensive type, and is not as readily available to the private experimenter as the CK722. And finally, most of the subminiature circuit components we wanted to use just were not to be had. So we used the smallest parts available to the general radio public and made them work in a small space.

The finished hearing aid is shown in photo. It is built into a du Maurier cigarette tin. Many types of inexpensive housings were considered, but preference finally was given to this extra-light, attractively colored aluminum box with hinged lid. Over-all dimensions are 3¾ inches high, 3 inches wide, and ¾ inch thick. As Fig. 1 shows, the instrument is just slightly larger than the standard cigarette package beside which it is posed. In fact, it is only 2.8 cubic inches larger and it weighs only approximately 3 times as much as the full pack of cigarettes.

This hearing aid will fit easily into a man's shirt pocket. It is entirely self-contained except for the miniature earphone. Operating current is supplied by a single 15-volt Burgess U10 hearing-aid battery, 1 ½ x 15/16 x ½ inches in size; total current drain is 1.4 milliamperes.

Fig. 2 is the complete circuit schematic. Three ground-emitter amplifier stages are used. Transformer coupling is used between stages and between the crystal microphone M and the first stage. The crystal earphone P is bridged directly across to the collector-output circuit of the last stage. It is possible also to use a 1,000- to 3,000-ohm magnetic earphone by connecting it in place of the 25,000-ohm resistor. If the magnetic unit is used, some system of volume control other than that shown in Fig. 2 must be employed. A satisfactory alternative would be a 10,000-ohm potentiometer connected across the secondary of transformer T3, with the wiper (center contact) of this potentiometer connected to the coupling capacitor.

To match the high collector impedance of one stage to the low base-input impedance of the following stage, transformers T2 and T3 are used backward. That is, the collector is connected to the normal secondary (high-impedance winding) and the following base to the normal primary (low-impedance winding). Input transformer T1 is connected so that its high-impedance winding goes to the microphone, and its low-impedance winding to the base-input circuit of the first transistor. While the sub-bouncer transformers shown here do not provide perfect impedance matches, the discrepancy does not appear to hamper good performance, and an important point is that these transformers are available now at radio stores. Undoubtedly, the tiny new Stancor transistor transformers (type UM-110 inter-stage, and UM-112 crystal microphone) would do the job more satisfactorily, and by the time this article is printed they probably will be obtainable from jobbers' stocks.

The coupling capacitors are necessary to prevent short-circuiting the transistor bases to ground through the transformer windings. They should be as high in capacitance as possible for the necessary small physical size, in the interest of good low-frequency response. One microfarad is as high as the author could obtain readily in "smallish" size. The components shown here are Astron Metalite 200-volt metalized-paper 1-µf tubular units. The new tantalum electrolytic capacitors, when available will be considerably smaller, and should aid materially in reducing the size of homemade hearing aids.

The four fixed resistors must be selected by experiment for the individual transistors. There is enough normal variation in CK722 characteristics to necessitate this picking process. The base resistors may be expected to vary between 100,000 ohms and 3 megohms. The collector resistance in the output of the last transistor will vary from 15,000 to 100,000 ohms. At least, that has been this author's experience. The best test procedure is to connect a variable resistor (potentiometer) temporarily in the position to be occupied by the base resistor, and then to vary it until the best compromise is obtained between low collector current, loud signal with minimum distortion, and lowest noise output. When the best setting has been obtained, remove the variable resistor from the circuit, measure its resistance setting carefully, and replace it in the circuit with the same amount as the full pack of cigarettes.
of fixed resistance. Finally, try it in place of the single collector resistor, and adjust for highest undistorted output with low collector current.

To facilitate these tests, the reader may start out with the author's values as given in the schematic, then substitute the variable resistor progressively in each position. In this way, the entire system will be in operation while one stage is being "pruned." During this test, the microphone may be disconnected temporarily and a 1000-cycle signal fed into transformer T1 from a low-distortion audio oscillator. An a.c. vacuum-tube voltmeter or oscilloscope may be connected in parallel with the earphone for quantitative observations of output while listening to the signal.

In general, it is a good procedure to minimize the noise level by making adjustments in the input stage, and to maximize output by means of adjustments in the output stage, although some compromise necessarily must be reached between adjustments in each of the three stages.

Once the fixed resistors have been installed, swapping transistors between stages will not be practical. But no inconvenience should arise from having to keep each transistor in its own stage, since their life is said to be 70,000 hours (approximately 8 years if you run the hearing aid 24 hours continuously each day!).

Speech at a comfortable conversational level originating about 4 feet from the microphone will produce a 1-volt swing across the crystal earphone when the VOL control is set for maximum volume. At this setting, the residual noise level varies from 0.05 to 0.1 volt and is a gentle rushing sound. The noise level may be higher or lower with other transistors. It does not appear that any noise sorting goes into selection of ordinary CK722's.

The volume control is a Centralab type B16-218 subminiature potentiometer with ganged switch S. This unit is smaller than a dime, and is in the lower right-hand corner of the case in Fig. 1. The back of the control, showing the three potentiometer lugs and the two switch lugs, can be seen in the lower left-hand corner of the opened lid in one of the other photographs.

**Construction**

Construction details are shown in the photographs.

The microphone is mounted in the upper center portion of the hinged lid of the cigarette case. A %-inch-diameter hole is cut with a socket punch. This hole is then covered with a square of gauze cloth which serves as a grill when Duco-cemented inside the lid back of the hole. A square washer of thin sponge rubber then is cemented around the hole, over the cloth, and the microphone is cemented to this rubber. This makes a good shock mount.

The volume control is mounted through another %-inch-diameter hole in the lower right-hand corner of the lid. One switch lug must be bent temporarily slightly perpendicular to allow passage of both lugs through the hole. The control is held by small screws (furnished) which pass through holes in the switch lugs. One of these screws (and the corresponding switch lug) accordingly must be insulated from the metal lid. This is the lug connected to the positive terminal of the battery.

Cellophane (Scotch) tape was used for this insulation in the author's instrument.

One photo (Fig. 4) shows how the circuit components are mounted on a thin plastic card. The three transistors are Duco-cemented to the card, and their leads are passed through holes. The pigtails leads of the transistors and of the three 1-nf capacitors likewise are passed through holes. Circuit connections are completed under the card by soldering together appropriate pigtail leads. The four fixed resistors are under the card. To prevent short-circuits, leads that must cross each other are covered with thin spaghetti tubing. After the under-card wiring is completed, coil dope is brushed copiously over the wiring to form a solid cake that prevents grounding to the metal case. Leads are soldered directly to the battery terminals and a covering of Scotch tape is used to insulate the terminals after the connection has been made. As can be seen in the photographs, the thin earphone cord passes out of the edge of the case through a hole lined with a baby rubber grommet.

Very thin plastic-covered flexible wire is used for the connections from the volume control, switch, microphone, and battery. Note that the transformers have been mounted with their cores at right angles to minimize undesired coupling. The transformer lead colors are indicated in the schematic, to permit proper connections to be made with least confusion. If oscillation should arise, reversing the leads of one of the transformer windings usually will correct it.

Howling due to acoustic feedback will occur whenever the earphone is held close to and pointed at the microphone. With the plastic ear plug attached, the earphone must be placed within 1 inch of the microphone to start the howl. The plug's narrow canal introduces some attenuation of sound, and without it whistling occurs when the earphone faces the microphone from 1 foot away.

**Conclusion**

Without apology, it should be pointed out that this instrument does not represent the ultimate in subminiaturization and low power drain that may be possible to obtain in transistorized hearing aids. Rather, it is an answer to a challenge to develop the smallest practical instrument that can be built from parts obtainable, which would use the readily available CK722 transistor, and which we might reasonably expect a radioman to duplicate with ordinary tools.
Subminiature audio amplifiers need not lack power. This tiny job delivers about 3 watts of audio.

By HARRY D. PARKER, JR.

HERE is an experimental subminiature audio amplifier that packs an amazing amount of power. The entire circuit—except for the output transformer—fits on a 4 x 1¼-inch chassis, and the push-pull output stage delivers a full 3 watts of power. The over-all voltage gain is 5,400.

Fig. 1 shows the amplifier circuit. Alternative types are suggested for some of the tubes, since the current military demand for subminiatures may lead to short supplies for civilian equipment.

The interstage transformer is a U.T.C. Ouncer type #0-6, single plate to push-pull grids. Since this transformer is not designed to carry any appreciable amount of d.c., the plate current in the primary circuit must be limited. By keeping the plate voltage on the driver tube (6K4 or CK5703) to between 90 and 100 volts, the current drawn will be about right. (The bias resistors shown in Fig. 1 and in Table I will do this).

The miniature-electrolytic filter and decoupling capacitors are standard, but it took considerable shopping around to find them. These are Cornell-Gulibier type BBR's. The 20-µf, 150-volt units measure a mere 1½ inches high by ¾ inch in diameter, while the 25-µf, 25-volt cathode-bypass capacitors are only 1¼ inches high by ⅛ inch in diameter.

The push-pull output transformer is mounted on the speaker. The amplifier-output leads are tied to three miniature tie-points on the chassis, and connected to the speaker through a 3-conductor cable.

A filament transformer was out of the question in a self-powered unit as small as this. A series-parallel filament hookup was required, as the various tube heaters have different current ratings. Fig. 2 shows two alternative arrangements, depending on the tubes used in the first and second stages. The shunt resistor across the low-current tube heaters was made from an adjustable 5-watt wirewound unit. After set-
ting the slider to the exact value, the excess resistance was sawed off, and the slider end was soldered directly to the chassis. Of course, the necessary values can also be obtained by connecting small composition resistors in series or parallel.

If you have to use a combination of one 200-ma tube and one 150-ma tube in the first two stages, the shunting resistor across the paralleled heaters should be 63 ohms. Of course, with an external 6.3-volt filament transformer, all heaters can be wired in parallel.

Construction

Some of the tubes used were experimental subminiature types which are probably not now obtainable. The present-day commercial equivalent is given in all such cases. The CK5702 and the CK5703 use in-line subminiature 5- and 7-pin sockets, available from most supply houses. The clamps for mounting the tubes and the filter capacitors were made from shim brass strips ⅛-inch wide. These were

Fig. 2—Alternative heater arrangements. See text for other combinations.

short enough to surround the tube or capacitor and allow a lip at each end which is drilled to take a small bolt and nut to facilitate replacement. One edge of the clamp is soldered to the chassis as shown in the photographs. Shim brass solderers beautifully and is carried by most hobby and metal-supply houses.

The chassis is 4 inches long by 1½ inches wide by ⅛ inches high, and was also made of shim brass. All holes were laid out carefully and drilled before forming. Since the 100-ma selenium rectifier has to be mounted close to the chassis, it is a good idea to put a piece of thin fiber insulation under it to avoid possible shorts.

When wiring the circuit, wire in the resistors first, then the filament and

hot iron and resin flux. Pick up a tiny bit of solder on the iron and just touch it to the joint. Solder all joints as quickly as possible, with a minimum amount of heat.

Tiny jewelers' side-cutters and long-nose pliers, as well as tweezers for holding small parts in place while

soldering, are practically a must for subminiature work. Use a pencil-type soldering iron with good-quality solder and resin flux. No. 22 stranded, tinned, plastic-covered hookup wire was used to wire the amplifier.

The 1-megohm volume control is a miniature unit measuring only ⅛ inch in diameter. A standard RCA phono jack is used as an input connector. Typical operating values for various tubes are given in Table I. Note that type 5702 is a pentode. If one of these is used in place of the 5719, a 500,000-ohm screen resistor and a 0.1-

Materials for amplifier

Resistors: 1-4, 7 megohms; 1-220,000; 1-39,000; 1-450, 1-230 ohms, 1½ watt; 1-2, 200 ohms, 1 watt; 1-190 ohms, 2 watt; 1-200 ohms, 5 watt; 1-120 ohm, 50-watt line-cord resistor; heater shunt (see text); 1-1-megohm potentiometer.

Capacitors: (Electrolytic) 5-20 µf, 150 volts; 1-25 µf, 35 volts, Cornell-Dubilier type 88 or equivalent. (Paper) 1-06 µf (Cornell-Dubilier type mp, MTW, or equivalent).

Miscellaneous: 1-interstage a.f. transformer, single plate to push-pull grids (U.T.C. type 6A4 or equivalent); 1 push-pull output transformer, 8,000 ohms to voice coil; 1-100 ma selenium rectifier; tubes as indicated in schematic and text; miniature sockets to suit; shim brass for chassis and brackets; terminals; wire; solder; hardware.

TABLE I

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Fig. 3—Basing diagrams of subminiature tubes suggested for the amplifier.

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Fig. 3—Basing diagrams of subminiature tubes suggested for the amplifier.

end of the chassis, it is a good idea to put a piece of thin fiber insulation under it to avoid possible shorts.

When wiring the circuit, wire in the resistors first, then the filament and


Undistorted wideband response is a must for hi-fi. The author tells you how to achieve it.

By JOSEPH MARSHALL

Part 1

It is not very many years since we judged the quality of an audio amplifier in terms of its behavior over the audible range of 20 to 20,000 cycles, and considered that any amplifier flat within those limits met the specifications for high fidelity. But today we design audio amplifiers for flat response between 10 cycles and 100,000 cycles and even try to extend this an additional octave or more at each end. To many people this seems like guarding the lily, especially in view of the fact that few signal sources—whether broadcast or recorded—provide much if any signal material below 50 cycles or above 15,000 cycles. But there are excellent reasons for extending the response of high-fidelity amplifiers as much as two or three octaves above and below the audible range, and the fine performance of many modern amplifiers is due to the fact that they possess this extreme bandwidth.

Nonlinearity

First of all, distortion is always the product of some form of nonlinearity. Obviously, the way to eliminate or minimize distortion is to make the circuit as a whole, as well as its individual elements, as linear as possible. There is a naive tendency to believe that nonlinearity (and therefore distortion) is limited to vacuum tubes. Nothing could be further from the truth. Vacuum tubes are merely circuit elements, fully comparable and indeed reducible to combinations of resistance, capacitance, and inductance. The fact is that any circuit element which departs from linearity in any way can produce distortion.

Moreover, a vacuum tube does not operate by itself, but in combination and relation with its associated capacitances, resistances, inductances, and voltage sources; and behaves as a sort of organism composed of all these elements or behaving as a unit. Similarly, a complete audio amplifier is simply a more complex organism, and its performance is based not only on the behavior of the individual elements which comprise it, but also on its behavior as a unit. In other words, not only may the individual circuit elements in an amplifier produce distortion, but the amplifier itself as a unit also may produce distortion in the nonlinear portion of its operating characteristics.

If audio waveforms were composed only of frequencies strictly within the audible range, it might be sufficient to demand linearity only over the audible range. But typical audio waveforms contain frequency components that lie below and above the audible range. These are beat notes, transients, harmonics, and subharmonics. Even if they did not have all these frequency components originally, they would acquire them in passing through the amplifier if any element in the circuit is nonlinear. And although these frequency components are not audible in themselves, they can produce serious distortion within the audible range by intermodulation, by driving tubes into their nonlinear regions, or by triggering resonant circuits into oscillation, which, in turn, can drive the amplifier into nonlinear operation, not only in the nonaudible range but also in the audible range.

Bandwidth requirements

Because pure audio tones are sine waves, we tend to labor under the misconception that an audio amplifier deals with sine waves exclusively. Nothing could be further from the truth. Almost all musical tones have very complex waveforms and actually resemble square waves more than sine waves. Television has taught us that to reproduce square waves accurately we require at least ten times the bandwidth that we need to reproduce sine waves. Because the complex waveforms of musical sounds—composed as they are of fundamentals, harmonics, beat notes, and transients—resemble square waves more than sine waves, it is obvious that to reproduce them accurately we require a much greater bandwidth than would be necessary if we were in fact dealing with sine waves.

Finally, there is one more compelling and highly practical reason for extending the bandwidth of amplifiers for two or three octaves above and below audibility. Although it may be theoretically possible to design perfectly linear, distortionless amplifiers, in practice we always generate some distortion. We can minimize it by operating tubes far below their normal output ratings, by push-pull operation, by maintaining the best possible balance; but in spite of these measures we normally have to face a residual distortion of perhaps 2 percent. This is...
still too great for acceptable reproduction of the whole audible spectrum. Fortunately, we have a wonderful weapon for reducing this to an insignificant number of feedbacks. By proper design we can obtain feedback factors of anywhere from 10 to 50, which means reducing distortion by a factor of 10 in the first case and 50 in the second. Thus, our 2-percent residue could be reduced to 1/2 of one percent in the first case, and only 1/5 of one percent in the second case. Somewhere within that range the distortion could be dismissed as of no practical consequence even to a "golden ear."

**Feedback problems**

Unfortunately, we can apply this much feedback only at the risk of introducing other types of distortion, namely: overdrive, ringing, or outright oscillation. This is because inverse-feedback cancels distortion only over the frequency range in which the waveform fed back is 180 degrees out of phase with the input voltage. To maintain that relationship, we must keep the phase shift of the amplifier component not only over the entire audible range but far below and above it. If an amplifier were absolutely flat from d.c. to infinity there would be no limit to the amount of feedback we could employ. Actually, however, even the best amplifier will have some phase shift at the low end and a resonant peak at some high frequency. At very low frequencies the feedback may be sufficiently in-phase to produce regeneration—if not outright oscillation (motorboating). The high-frequency resonance peak will reverse the phase of the output signals at the resonant frequency, and shift those near it enough to start parasitic oscillations. To obtain the large amounts of feedback necessary to reduce residual distortion to an acceptable minimum without generating transient distortion, we must reduce the phase shift of the whole amplifier, not only throughout the audible range, but for several octaves above and below it.

This is precisely the same thing as saying that we must extend the bandwidth of the amplifier at each end of the audio range.

So much for the necessity. Now how do we go about the bandwidth of an audio amplifier? The place to start is at the weakest point—the output transformer. The development of excellent phase inverters, and the use of big tetrodes as triodes, with low driving requirements, have eliminated the need for interstage and driver transformers in high-fidelity amplifiers. There have been attempts to dispense with the output transformer as well. At least one commercial amplifier couples the output tubes directly to a 500-ohm voice coil. There are several circuits also that have multiple output tubes either as parallel cathode followers or in bridge circuits for coupling directly to low-resistance voice coils, and eventually—especially with transistors—we shall probably eliminate output transformers altogether. At present, however, the application of these circuits is handicapped either by their very poor efficiency or by the required large amounts of feedback required to establish the phase correct voice coil carry at least part of the d.c. plate current. This introduces serious difficulties in wire sizes, mass, and heat dissipation.

So, for the moment at least, we are still dependent on output transformers. Fortunately, these have been improved tremendously in the past few years. Whereas previously even the best ones had flat frequency response only within the audio range, there are transformers available today that are inherently flat from 10 cycles to nearly 100,000 cycles.

The use of one of these transformers is a very long step on the way to that extended bandwidth. But it goes only part of the way (which is not final, because few designers have trouble to go the rest of the way). Some of these wideband transformers permit us to use as much as 30 db of feedback, and in most cases this is sufficient to reduce distortion to an inconsequential low level. Nevertheless, even this has not completely satisfied the critical ear. Perfection is a hard taskmaster and the new output transformers do not, of themselves, satisfy the demands of the most critical. The horse and cart have been reversed, so to speak. Instead of the output transformer being worse than the rest of the amplifier, it is now much better. Fortunately, it is not too difficult or too expensive to make the rest of the amplifier as good as the output transformer and thus bring the entire reproducing system another step nearer perfection.

**Improving i.f. response**

The low-frequency response of an amplifier is limited principally by the series or coupling capacitances. To extend the response downward we must reduce the series coupling reactances and increase the time-constants. One way to do this is to use larger coupling capacitors. Unfortunately, we cannot get very far with this method. While it improves the low-frequency response, the need for better high-frequency response as well calls for reducing the plate and grid loads; so, if we do both, we may actually end up with the same time-constant as when we started.

A fruitful form of design logic is to start with the theoretically best means of achieving an end, and work down to a less perfect, but more practical compromise. Obviously, then, as far as low-frequency response is concerned, the best thing would be to eliminate the coupling capacitances altogether. A few years ago much work was done on direct-coupled amplifiers and this magazine published a great deal of material on the subject. These old direct-coupled amplifiers produced the finest reproduction of their day, but they were difficult.
to adjust, had poor stability, and required high-voltage or multiple power supplies.

Though the all-direct-coupled amplifier is a rarity today, most high-quality amplifiers now employ some direct-coupled stages. The Williamson uses direct coupling between the voltage amplifier and phase inverter; and many others use direct coupling between cathode-follower drivers and output tubes. Today, fortunately, many of the original difficulties can be eliminated or minimized.

As an illustration, the cross-coupled phase inverter provides completely balanced inversion and a means of adjusting and maintaining balance over several direct-coupled stages, so that a two- or three-stage direct-coupled amplifier is quite practical today. Fig. 1 shows a three-stage inverter-voltage amplifier which might be used as the input section of a high-fidelity system. The first two tubes provide the phase inversion and have a gain of around 15. The total gain of the tube used in the third stage. A 12AU7 will give an output of around 125 volts plate to plate and a gain of around 300, while a 12AX7 will give a slightly lower output voltage but will increase the overall gain to between 750 and 900. The low-frequency response is flat right down to zero cycles—in other words, the amplifier responds to d.c. Thus there is no phase-shifting network at the low end.

But what happens now? We could direct-couple this amplifier to an output stage, but there are serious deterrents. First of all, the circuit calls for between 300 and 400 volts at the plates of the third tube. Since modern power tubes require an effective plate voltage of about 400, such direct coupling would call for a 700- to 800-volt power supply or two 400-volt supplies in series. Moreover, there is the problem of providing proper bias for the output tubes, since their grids would be some 250 volts above ground. These problems are not insuperable, but they call for a simpler solution. Fortunately, there is one.

Reducing phase shift

Phase shift is cumulative. The overall phase shift in an amplifier is the sum of the phase shifts of the individual stages. Obviously, if we can reduce the number of phase-shift points in the amplifier, we can achieve a great improvement. By using the direct-coupled voltage amplifier of Fig. 1 we eliminate two phase-shift points, and minimize one other: The input stage is a cathode follower and its input impedance is many times higher than a conventional amplifier. This allows us to use a very high value for Rc, and thus the phase shift with any reasonable input capacitor will be several times better than with the same capacitor in a conventional circuit. If we are forced to use a coupling capacitor at the output of this voltage amplifier as well, we will miss perfection but still will achieve a great improvement over the conventional design.

Let us see what happens in the two possible cases—that is, coupling to output tubes with self-bias and to output tubes with fixed-bias. Cathode bias permits a grid resistor of around 500,000 ohms maximum. An 0.5-uf coupling capacitor would therefore yield a time constant of 0.25 second, and bring down the frequency at which phase shift is noticeable to 4 cycles or less. In any case the phase-shift characteristic would be as least one octave and possibly two octaves better than that of the best output transformer. As a matter of fact, we can even improve on this, as we shall see later on.

The solution with fixed bias is even more satisfactory. Unless we use a driver transformer—which is undesirable for many reasons—the only really satisfactory way of coupling fixed-bias output tubes to an R-C-coupled amplifier is through a cathode-follower driver. But the driver itself can be direct-coupled to the output tubes as shown in Fig. 2. We now have two direct-coupled sections: the first one includes the cross-coupled phase inverter and the voltage amplifier, and the second takes in the driver and output tubes. Coupling these sections directly would present many serious problems. But fortunately it is not at all necessary. Remember that a cathode follower has an extremely high input resistance—some 10 times the grid resistor, or 5 megohms in this instance. Therefore if we used 0.5-uf capacitors to couple the two sections together, the time-constant would be 2.5 seconds, yielding a frequency of 0.4 cycles at the phase-shift point. This is unnecessarily low. If we used 0.1-uf coupling capacitors, the point of phase shift would be 2 cycles. Even this is better than we need, and we would now have an amplifier which, though not direct-coupled all the way, would be just as good at audio frequencies as an all-direct-coupled amplifier, and which requires only a single power supply, and also is much more stable.

In any case, whether we use fixed- or self-bias in the output stage, we would have an amplifier with only a single internal coupling capacitance and a single point of internal phase shift. The amplifier would now have good enough low-frequency response for any output transformer and indeed be good enough to improve the performance of the best available transformers by allowing us to use more feedback.

Moreover, unlike the older types of direct-coupled amplifiers, these amplifiers—which we might call virtual direct-coupled—are easy to balance and keep in balance. The 2,000-ohm balancing control (R1) in the cathode legs of the input stage not only will balance the direct-coupled front section for d.c., but also will balance the entire amplifier at audio frequencies. The d.c. balance is checked by connecting a high-resistance voltmeter from plate to plate of the third stage and adjusting R1 for zero voltage. (We are assuming, of course, that the circuit has been balanced physically by the use of matched resistors and tubes throughout.) The output tubes can be balanced for d.c. with the 50-ohm potentiometer in the cathode return.

Over-all dynamic balance is obtained in this way: Disconnect the grid of the lower triode in the input stage from ground and connect it to the grid of the upper triode (input grid). Feed a single-frequency signal into the amplifier and adjust R1 for zero or minimum output. (This may upset the d.c. balance of the input section slightly, but this is inconsequential in an R-C circuit.) The balance obtained by this method should hold over almost the full dynamic range of the amplifier.

Part II of this series will cover methods for extending the high-frequency response of the amplifier.

(TO BE CONTINUED)

"Don't mention fringe area again — Rodney is very sensitive!"

RADIO-ELECTRONICS
**Broadband Yagi antennas**

The basic Yagi is a narrow-band antenna. Designers use various tricks to widen the bandpass for TV applications.

By MATTHEW MANDL and EDWARD M. NOLL

For fringe-area reception few antennas can match the popularity of the Yagi types. They are less cumbersome than other high-gain antennas and have excellent rejection for signals from the sides and back. The special gain of the Yagi is achieved by using a reflector behind the antenna and one or more directors in front. While adding directors to an antenna system increases its gain and sharpens director elements mean higher gain.

For maximum efficiency the directors should be spaced 0.1 wavelength from each other and from the antenna.

Manufacturers sometimes space the reflector and directors at greater distances to minimize the decrease in antenna impedance which results from such close element spacing. If the reflector is spaced 0.15 wavelength behind the antenna the gain is 5.5 decibels over a dipole, but the antenna impedance drops to 35% of the original value. If the reflector is spaced 0.25 wavelength behind the antenna the gain over a dipole would be 4.5 db, but the influence of the reflector will reduce the dipole impedance only about 20%. Unless special measures are taken to raise the antenna impedance again it would be preferable to use the wider spacing—even with its lower gain—to minimize mismatch between the antenna and the transmission line.

The four-element Yagi shown in Fig. 1 would have a 9-db gain if the directors were spaced 0.1 wavelength and the reflectors 0.15 wavelength. The antenna impedance, however, would drop to only 10% of its original value! Thus, if a straight dipole were used, its impedance would drop from 73 ohms to 7.3 ohms, while a folded dipole with a normal impedance of 300 ohms would have an impedance of only 30 ohms because of the influence of the nearby reflector and directors.

The antenna impedance can be raised by any of the methods shown in Fig. 2. One variation is to make the unbroken element of a folded dipole larger in diameter than the fed element as shown at a. Another method often used is to employ two unbroken elements as shown at b. This is equivalent to doubling the diameter of the unbroken element of the folded dipole. The delta-match arrangement can also be used as shown at c. Here a single unbroken antenna element is used and the transmission line is fanned out until the right impedance match is secured.

Fig. 1—Basic Yagi antenna. Extra directors may be added to raise gain and sharpen forward-directivity pattern.

Its forward directivity, the span of frequencies which the antenna will handle is materially reduced. Thus a Yagi antenna such as shown in Fig. 1 has maximum gain on only one television channel, and will not work well on adjacent channels unless the stations are quite close to the receiver.

The conventional design formulas for a Yagi antenna specify that the reflector be cut 5% longer than the antenna and the directors 4% shorter. There is no theoretical limit to the number of directors that can be used, though an excessive number may make the antenna useless for television reception by narrowing the frequency range enough to cut off vital sideband components of the video and sound signals. Few manufacturers use more than 10 directors even in their most elaborate models.

The reflector is most effective when it is spaced approximately 0.15 wavelength behind the antenna. Additional reflectors generally do not improve rejection because the first reflector shields those behind it from the source of signals. Directors, on the other hand, are between the antenna and the desired signal source, and for this reason more...
spacing between the two directors is 5.8 inches.

By thus proportioning the lengths of various elements to meet the requirements of the three channels desired, the antenna takes on wider band characteristics than a conventional Yagi. The advantages of broad-band reception, however, are not obtained without some sacrifice in gain, and there will be a loss of approximately 2 db with this arrangement compared with the four-element Yagi shown in Fig. 1. The lost gain can be salvaged, however, by adding several more directors to the array. With the right lengths and spacing of the extra directors, a six-element broad-band Yagi will give the same 9-db gain as the antenna in Fig. 1.

When this broad-band design is applied to a u.h.f. antenna the frequency acceptance in channels increases considerably. This is indicated when we consider the frequency span of the antenna shown in Fig. 3. This takes in everything from the low end of channel 8 (180 mc), to the high end of channel 10 (198 mc). This span of 18 megacycles is 10% of the lowest frequency, and the same type of antenna designed for u.h.f. reception would have the same 10% ratio of bandwidth to frequency. For example, at channel 27 (542 mc) the u.h.f. version would have a bandwidth of over 54 mc. This would cover 9 channels in the u.h.f. band.

Several manufacturers have further improved the broad-band characteristics of the Yagi by utilizing an end-fire arrangement. This is based on the principle that two antennas connected as shown in Fig. 4 and spaced one-quarter wavelength apart, have the uni-directional pattern shown in Fig. 5. This is similar to the popular double-V type of antenna. This employs the same principle except that straight dipole elements instead of folded dipole elements are used. The end-fire arrangement can be applied to a Yagi antenna by the method shown in Fig. 6. Here the reflector would be cut for the lowest channel to be received (say channel 2). The first folded-dipole section would be cut for channel 3, and the other folded-dipole cut to the mid-frequency between channels 4 and 5. The first director would have a length designed for channel 5, while the last two directors are shortened to aid reception on channel 6. Naturally, this antenna will not have the peak gain that would be achieved if all elements were cut for the same channel, but it has more gain than a biconical with reflector on the lower channels. For u.h.f. a similar arrangement would accommodate considerably more stations than its low-frequency counterpart. The end-fire folded-dipole arrangement gives a good match between antenna and transmission line to minimize losses. It must be pointed out here that a mismatch between the antenna and the transmission line is not as undesirable as a mismatch between the receiver and the transmission line. The latter causes line reflections because the receiver cannot accept all the energy sent down the lead-in. The unaccepted signals may travel back up the line and down again several times, and produce enough ghosts to blur the detail.

All the antennas previously discussed can be stacked for increased signal pickup. Generally, stacking increases the rated gain of an antenna by 3 decibels. A spacing of one-half wavelength at the frequency of the lowest channel will give best results. If you want more gain on the higher channels, space the antennas a half-wavelength at the center frequency of the group desired. This arrangement will diminish the gain somewhat on the lower channels because the spacing at their frequencies will be less than a half-wavelength. Most manufacturers of broad-band conical arrays space stacked arrays a quarter-wavelength at the low end to favor the higher channels and minimize the higher transmission lines losses which will be found there.

Calculating lengths

The experimenter can try various antenna lengths and different sizes of reflectors and directors in any desired combination to favor higher or lower channels in a particular group. For instance, if the higher-channel stations of a group you want to receive are nearer than those at the lower frequencies, the latter can be favored by making most of the elements nearer the size required for low-frequency channels. Thus, if channel 2 is farther away than channels 4 and 5, the antenna and reflector can be cut for channel 2, while the directors can be made the proper lengths for channels 4 and 5. If the end-fire antenna arrangement is used, the second antenna can be designed for the frequency between channels 4 and 5. In this manner the gain of the antenna system can be altered to suit the need.

The length of a half-wave antenna in inches is equal to:

$$l = \frac{540}{f}$$

Frequency in megacycles

This calculation is suitable for both v.h.f. and u.h.f. stations. For reflectors add 5% to the length calculated, and deduct 4% for directors.

Calculations for channel 27, for example, indicate that the antenna should have an over-all length of 10 inches. The reflector should be 10.5 inches long, and the directors should each have a length of 9.6 inches.

Commercial types

A number of manufacturers utilize the principles detailed here. The Taco 1800 twin-driven Yagi is shown in Fig. 7. This model has two antennas in a phased end-fire arrangement, one reflector, and seven directors. According to the manufacturer, the gain of this antenna over a matched reference dipole is 11 db. When two of these units are stacked the gain increases 3 db as mentioned previously, bringing the total gain of the array up to 14 db. The model 1800 covers channels 2 to 6 inclusive, with maximum gain on channels 3, 4, and 5. A similar model also is available for channels 7 to 13.

Channel Master Corporation uses the double-folded-dipole principle in its Futuramic Yagi antenna formation in Fig. 8. Single-bay antennas of this type also are available for both the low and high v.h.f. bands. Spacing between the folded-dipole elements is 45 degrees (equivalent to one-eighth wavelength). The dipoles are interconnected with a section of twin lead, and the latter is transposed so that its effective length is 135 degrees. This assures a substantial improvement over the span of frequencies to be covered and minimizes mismatch between the antenna and the 300-ohm lead-in. Fig. 9 shows the spacing and feed arrangements used in this system.

Model 1125 covers channels 2 to 5 inclusive with substantially uniform gain of more than 8 db, over these channels. Stacking gives an additional 3 db increase. Model 1136 is for channels 3 to 6 inclusive, while model 1173 covers channels 7 to 13. (Theory and construction of the Channel Master Futuramic was described in the October, 1952 issue of RADIO-ELECTRONICS.—Editor.)

The Snyder Manufacturing Company uses the type of broad-band design shown in Fig. 10. Here, two reflectors are used with one mounted over the other so that both are effective. In the low-band version one reflector is cut...
for channel 2 and the other is cut to the mid-frequency between channels 3 and 4. The antenna elements are interconnected with a transmission-line phasing section. The folded dipole B is cut for a frequency between channels 2 and 3, while D is cut for channels 4 and 5. Director C is cut for channel 5, while directors E and F are cut for channel 6. The gain of this antenna averages 9 db for channels 2 to 6.

A similar version of this antenna covers channels 7 to 13. The u.h.f. broad-band types are also similar in design and a typical arrangement for the UHF-3 series is shown in Fig. 11. The UHF-3A covers channels 14 to 48; model UHF-3R covers channels 27 to 62; and UHF-3C covers channels 47 to 83. The number of elements employed, plus the end-fire arrangement of antennas, permits somewhat greater spacings between elements than the 0.15 and 0.1 wavelength previously discussed. This minimizes the drop in impedance and provides a gain that compares favorably with the conventional narrow-band Yagi types (9 db). Stacking two units increases the gain by 3 db the same as for v.h.f. types.

Other manufacturers also have broad-band u.h.f. Yagis. These antennas have much higher gain than the popular bowtie type though they do not, of course, provide the same full-band reception. Generally the bowtie u.h.f. antennas will give a substantially flat response from channels 14 to 83, though gain is nowhere comparable to the Yagi types even with flat-screen reflectors. For a bowtie type antenna to even approach the gain of Yagi antennas, it would have to have a corner reflector.

Stacking factors

In stacking antennas, a common transmission line is recommended only when the antennas are identical. If dissimilar antennas are stacked (such as a low-band Yagi and a high-band type) one will load down the other and reception will be poorer than if either one were used separately. When dissimilar antennas must be employed it is best to use separate transmission lines for each. A double-pole, double-throw switch can be installed at the receiver for selecting the desired antenna. When both antennas are installed on one mast the spacing between the two should be greater than a half-wave length at the lowest frequency to minimize interaction.

Only when both antennas are identical in design and oriented in the same direction is the 3 db increase in gain realized. Thus, when four Yagi antennas are stacked, as much as 18 db can be attained as compared with a reference matched dipole.

The advantages of stacking are easily obtained at u.h.f. because of the small physical sizes of the antennas involved. In a 2-bay system the transmission line is attached to the center of the stacking bars as shown in Fig. 12-a. For a 4-antenna system, the arrangement shown in Fig. 12-b can be used. This effectively parallels the two double-stacked arrays by attaching the lead-in to the center point of the structure.

Installation precautions

Of primary importance in u.h.f. antenna installation is to keep all losses at an absolute minimum. Use a good grade of lead-in and keep it as far away as possible from drain pipes, tin roofs, conduits, etc. Shunt-capacitance effects are much more pronounced at the higher frequencies, and the technician should not overlook any precautions which will minimize losses. Since the length of the transmission line determines the db loss, it is important to make the run from the antenna to the receiver as short and straight as possible. Under no circumstances should excess transmission line be rolled up at the receiver terminals. Leave only enough slack so the receiver can be pulled forward for cleaning or adjustment.

If there are standing waves on the lead-in due to an impedance mismatch, a section of tinfoil wrapped around the transmission line will help considerably. A 2 x 6-inch length will be suitable, and it should be moved up and down the line for each station to get maximum results. This is usually most effective on channels 7 to 85, but results vary depending on the extent of the mismatch and the ability of the receiver to maintain a fairly constant input impedance for the different channels.

Generally, the higher the antenna the greater the signal pickup, though results are often unpredictable, particularly at u.h.f. Sometimes an increase in height puts the antenna in a "space node" of lower than normal signal strength, and it has to be raised still further to realize any benefits. Points of minimum and maximum signal strength are more numerous at u.h.f. than at v.h.f., and in ultra-fringe areas a little investigation of existing conditions can save considerable time.

Even in metropolitan areas of high signal strength, the technician can improve reception by increasing the antenna height to minimize noise, or by replacing an indoor antenna with an outdoor type. Indoor types are affected by persons near the antenna, room reflections, and even by passing cars.
**THE SPOT WOBBLER**

The wobbler coil as it appears in the British EKCO TV receiver.

**THE EVOLVING SIZE OF TELEVISION picture tubes has intensified the problem of visible line structure in the picture. This is especially true in the home, where ingrained viewing habits, furniture arrangements, and space limitations generally make it impossible for the viewers to move far enough away from the screen so that the normal loss in resolving power of the eye can allow the lines to be blended together.

Some way of overcoming this difficulty had to be found, and at least two methods have been developed. One is to alter the spot shape from circular to elliptical by a magnetic field. This is the simplest and cheapest method, but it has been found extremely difficult to maintain the desired elliptical spot shape over the entire raster, and especially in the brightest parts of the picture.

The other method—which is described in detail in this article—is to wobble the spot vertically at a very high frequency. This increases the apparent thickness of each line, and fills in the raster structure.

A number of methods of applying spot wobble have been tried with varying degrees of success. The first and simplest method from the point of view of components, wiring, and ease of operation is to put a pair of deflecting plates inside the picture tube close to the gun structure; and wobble the beam electrostatically by applying a suitable a.c. voltage to the plates. This method would require no mechanical alignment and would operate on a very small amount of power, but it is considered impracticable because it would entail the development and manufacture of special nonstandard picture tubes.

The second method is to use magnetic deflection, applied in the same manner as the normal electromagnetic vertical-deflection field. This may be done in three ways:

1. By superimposing the wobble current on the normal sweep current in the vertical-deflection windings of the yoke.
2. By adding a small additional winding to the yoke to carry the wobble current only.
3. By using a separate wobbler coil, isolated from the deflection yoke.

In the case of method 1 there does not appear to be any simple practical method of introducing the wobble current into the vertical yoke windings. Although only a small amplitude is required, the large distributed capacitance of the yoke windings, the copper losses due to the proximity of the horizontal coils, and r.f. losses due to the iron yoke core, would require an impracticable amount of power to make it operate satisfactorily.

Method 2 has been made to work in the laboratory by making the small additional field-coil winding part of the wobble-oscillator tank circuit. However, this suffers in the same manner.

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*E. K. Cole Ltd.*
Southend-on-Sea,

A successful British approach to the problem of overcoming "lineiness" on the TV screen.

By G. H. HART, N. T. ATKINSON and A. W. MARTIN*

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*Radio-Electronics*
as method 1 from the damping effects of the other yoke windings and the iron core to such an extent that it requires an excessive amount of r.f. power. This has two main disadvantages. First, a large oscillator has to be used, which means a heavy drain on the receiver's B supply. Second, but by no means less important, is the problem of shielding. Radiation from the wobbler winding will produce considerable interference in the short-wave broadcast bands, and its harmonics may also affect one or more picture channels.

In view of these difficulties, method 3 was finally adopted, and a small pair of deflector coils was fitted to the picture-tube neck close to the deflection yoke but as far as possible from the focus coil or magnet. This latter consideration is highly important, as the iron in the focus magnet will introduce severe losses at the high wobble frequency if too close to the deflector coils.

Another advantage of using separate wobble deflector coils is that they may be rotated on the tube neck until the wobble coil is in the same direction as the normal vertical deflection. Although the wobble plane may vary 10 degrees either way without distorting the picture noticeably, it is obvious that any wobble in a direction other than vertical at the viewing screen will require more amplitude to close the line structure. Even more important is the fact that as the wobble tends to approach the direction of scanning it will result in a loss of horizontal definition.

### Wobble frequency

From the point of view of achieving the required result in the picture the exact wobble frequency is not very critical but it should be high enough to produce about 1,000 complete cycles of equal up-and-down wobbles in each line. In the British system, the visible portion of each line represents 83.5% of the whole horizontal sweep time, and 1,000 wobbles per line will produce 835 wobbles across the width of the picture; the wavelengths of each wobble in a picture 13 inches wide is then 13/835 inch, which is roughly .015 inch. The wobble amplitude required depends on course on the vertical spread.

For Britain's 405-line, 25-frame system, 1,000 wobbles per line call for a wobble frequency of slightly over 10 mc. In practice, this frequency is adjusted to a value near 10 mc whose harmonics will not operate with exception—in fact, this adjustment is made with the receiver tuned to the desired channel.

### The wobbler circuit

The circuit of the wobbler used in the Ekco type T164 TV receiver is shown in Fig. 1. The wobbles of these coils themselves are the tank inductance of a normal Colpitts oscillator, with the connecting leads between the coils and the oscillator socket twisted to reduce radiation. These leads are covered with good-quality sleeving. Fig. 1 shows three controls. First, an on-off switch in the B plus line which allows the wobbler unit to be switched off to permit accurate focusing of the line structure. Second, an amplitude control potentiometer which is adjusted to the point where the line structure just barely disappears. (Excessive wobble amplitude results in the apparent doubling of the line structure coupled with loss of vertical definition.) The third control is a preset "postage-stamp" trimmer for setting the oscillator frequency so that its harmonics fall outside the normal television channels, and prevent objectionable audio squeals and herringbone picture interference.

The wobbler coils are two 6-turn "pancake" windings, with the dimensions shown in Fig. 2. These are wound flat between two plates, then impregnated with low-loss coil dope and allowed to dry. After drying, they are formed by bending along the dashed line until they fit the tube neck. They are then mounted in a plastic sheath which holds the opposite sides of the neck, and are connected in series-aiding. (If wired in opposition, it will be impossible to obtain sufficient wobble amplitude.)

These coils are then slid along the neck close to the yoke. (Note: English tubes are apparently longer than ours, with considerable space between the yoke and focus coil. We found it necessary to take the coils out of the sheath, lay them in position on the neck of the tube and wrap one layer of Scotch electrical tape over them. Then it was slid carefully inside the yoke, positioned near its rear end. Besides being a good position for deflection, it also shields the receiver well."

When setting up the wobbler unit for the first time, it is easy to obtain an approximately correct frequency by bringing the antenna lead of a short-wave receiver to the wobbler coils and tuning the receiver to about 10 mc (15.75 mc in the U. S.) Then the trimmer is adjusted until the oscillator is heard on the set. Final frequency adjustments are made with the television receiver operating and with the trimmer opened or closed as much as may be necessary to leave the sound free from whistles and the picture clear of herringbone patterns. Next, the amplitude control is turned up until the picture lines show signs of disappearing. At this point the wobbles are rotated slightly on the neck in either direction until the wobble has maximum amplitude. The optimum position is generally with the axis of the pair of wobbles about 45 degrees from the axis of the vertical deflection coils in the yoke. The wobble amplitude control is then readjusted until the line structure just disappears.

The Ekco television receiver, type T164, was the first commercial receiver to employ spot wobble, although it is not claimed that the idea was original. It has met with considerable success in Britain on 15- and 16-inch tubes.

It would appear that with larger tubes and with 525- or 625-line systems spot wobble would be even more valuable.

![Fig. 2—Winding details of the wobbler coils. Two identical windings as shown above are required. Spacing between turns in the drawing is only for clarification—coils are close-wound with No. 28 silk-covered wire and doped.](image)

To apply the same standard of 1,000 wobbles per line to American TV receivers would call for a nominal wobble frequency of 15.75 mc, with a similar range of adjustment to avoid harmonic interference with the TV picture or sound carriers. There is also the serious problem of possible interference in the l.f. amplifier itself, especially with the new 44-mc l.f. strips.

Another factor that complicates the application of spot wobble to multi-channel American receivers is the probable need for a different wobble-oscillator frequency for each channel. This calls for either an extra front-panel tuning control, or some type of switching arrangement ganged with the channel selector. This might not be too difficult on v.h.f.—but adapting it to u.h.f., especially with continuous tuners, is another matter.

And how about interference to other receivers? It may be comparatively easy to get the wobbler harmonics off the channel you are tuned to, but they are certainly going to fall on another one. One solution, of course, is to shield the receiver as completely as possible. Several methods have been suggested—for example, painting the inside of the cabinet with colloidal graphite, or lining it with metal foil, grease paper, or a similar material but without the axis of the pair of wobbles about 45 degrees from the axis of the vertical deflection coils in the yoke. The wobble amplitude control is then readjusted until the line structure just disappears.

(But the idea is certainly worth trying, especially with 24- and 27-inch rectangular and 30-inch round pi tube tubes. The authors say the wobbler oscillator can be built on a small sub-chassis, or on the main chassis itself, as long as the leads to the wobbler coils on the neck of the picture tube are not more than a foot long.—Editor)
FROM a theoretical standpoint, reception of u.h.f. TV signals on an indoor antenna ought to be practically impossible. The factors working against it are: the greater signal requirements of u.h.f. receivers (2 millivolts minimum); increased attenuation by dielectric materials such as foliage, building walls, and windows; reduced signal strength during bad weather; and sensitivity of signals to the movement of human bodies within the area of the antennas.

In spite of all these theoretical obstacles, the fact remains that many successful u.h.f. indoor-antenna installations have been made, starting with the first ones in the Portland area and continuing everywhere that new u.h.f. stations open up. Tests in Chicago and New Jersey have confirmed the fact that u.h.f. signals can be received successfully with indoor antennas even in congested metropolitan districts inside the primary service areas of the stations.

From an evaluation of these tests it should be understood that each installation is an experiment and the results are completely unpredictable. Some amazing results have been obtained even in rooms that were completely blocked off—without even a window facing the u.h.f. transmitter. One logical explanation for this successful performance is that the home or the apartment had a metal structure which functioned as a waveguide for the particular u.h.f. channel or channels. It is well known in radar work that u.h.f. signals can be guided along many paths by suitable waveguides. Therefore we can assume that u.h.f. TV signals can enter one room and be reflected or guided to another room where the indoor antenna is installed. But even with such favorable possibilities, one of the more irritating customer complaints about indoor u.h.f. installations will probably be about the way the pictures flicker when some member of the household walks in the path of the TV signals.

Universal antenna

As we must develop the largest signal possible with the u.h.f. indoor antenna, a horizontal-V design is recommended. This has higher gain than the familiar vertical-V ("rabbit-ears") used for indoor v.h.f. reception. (A horizontal-V design would probably work better at v.h.f. too, but has never been used for indoor antennas because the element lengths would make it a hazard in the living room.)

The simple horizontal-V antenna for u.h.f. gives best results when adjusted for 18-inch element lengths with an angle of 90 degrees between them. The indoor antenna shown in Fig. 1 is an example of a good combination v.h.f.-u.h.f. type. Each element has three telescoping sections which can be adjusted as required in length and position for v.h.f. reception. A special eccentric rotating joint allows the user to flip the elements to a horizontal-V position for u.h.f. reception and locks the elements automatically at a 90-degree angle. With the telescoping sections fully retracted, the elements are approximately 18 inches long, which gives a desirable ratio between the 90-degree angle of the V and the element length for matching 300-ohm line. (The original idea for the theory behind this universal antenna is credited to J. D. Callaghan of the RCA Service Co., Inc.)

The type of 300-ohm lead used with u.h.f. indoor antennas is of little importance, as they are not exposed to the weather and the lead length is usually only a few feet so that the attenuation is negligible. But take care not to run the 300-ohm lead over metal objects. These can produce troublesome standing waves. Even a lead as short as five feet is several wavelengths long at the upper end of the u.h.f. band.

Preliminary tests show that surface corrosion on brass antenna elements attenuates u.h.f. signals; therefore plated-brass antenna elements are recommended for dependable u.h.f. indoor reception.

Bowties

Fig. 2 shows a bowtie u.h.f. indoor antenna which should be useful in areas which have u.h.f. transmissions only. The bowtie is bidirectional like any simple dipole. (Its triangular elements give it the necessary constant-impedance characteristics for uniform re-
sponse over the entire u.h.f. band.) This bowtie is elevated on a plastic base to prevent a metal-top TV set from influencing its performance.

The bowtie is built of lightweight corrosion-resistant aluminum which makes it easy for the customer to handle. The main difficulty in adjusting this antenna is to keep the hands and body away from the bowtie when adjusting the base. The unit shown can be placed on a window sill, table, or any other flat surface, but the antenna elements are so light that the base can be fitted with suction caps, hooks, or brackets, so it can mount on a wall or even hang from the chandelier if that proves to be the best location for the antenna.

Interior decorators will probably have some influence on indoor bowtie design, and some weird bases will surely be developed. It is possible to perforate the bowtie and round the edges to improve its style without seriously affecting its performance.

Service technicians who expect to make or install u.h.f. indoor antennas are offered the following advice on their business relationships with the consumer.

Charges: It may cost almost as much to install a u.h.f. indoor as an outdoor antenna, especially in combined u.h.f.-v.h.f. areas where the customer may have to be given considerable instruction in finding the best operating positions for each one of several u.h.f. channels.

Guarantees: Experience may finally show that seasonal changes—both outside the home (summer foliage), and inside (rearrangement of furniture, drapes, etc.)—may make an otherwise satisfactory installation unsatisfactory during certain periods. Also, in u.h.f. areas where no TV reception was previously available, the new set-owner may accept almost any kind of picture at first, but he's certainly going to squawk later when he sees what beautiful pictures his neighbor gets with an outdoor antenna.

Indoor antennas—successfully installed—are always gratifying to the TV-set owner and profitable to the TV dealer who likes to give away the indoor antenna as part of his merchandising technique. We can therefore expect that in 1953 many consumers and service technicians will take on the project of experimenting with u.h.f. and combined u.h.f.-v.h.f. reception indoors.

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**DISMANTLING BOMBS BY TV**

By PARRIS EMERY

Television has taken over the Ordnance Department's highly dangerous job of renovating and rebuilding World War II bombs for further use. Bombs are disassembled either because their explosive contents or metal components have become unserviceable with age, handling, or exposure to the weather, or because the design of the bomb does not meet present combat requirements.

The hazards arise out of the manufacturing process of casting the explosive charge inside the body of the bomb. This sometimes leaves a residue of explosive in and around movable parts—especially the threads in the tail plug. The friction of turning these threaded parts in the dismantling operation may ignite the residue and explode the bomb.

At the Umatilla Ordnance Depot, Oregon, Oregon, all types of bombs are disassembled safely with the aid of television. As shown in the photographs, the bomb is mounted on a cradle, and the tail plug is unscrewed by a motor-driven shaft controlled by an operator inside the bomb-proof shelter. The television camera is focused on the moving parts, and the operator watches the entire operation on a receiver in the shelter. If he detects the slightest smoke rising from the operation, he stops the motor immediately. He is protected by the shelter if the bomb explodes.

Faulty bombs are destroyed. Dismantled bombs are washed out, the explosive salvaged and reprocessed for use in other bombs. Taxpayers are saved millions of dollars every year by this renovating process.

An engineer at Umatilla Ordnance Depot (Oregon) focuses TV camera on the tail of a 2,000-lb bomb, at the point where the plug will be unthreaded.

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Capt. Guy F. Bohn, bomb-renovation officer, watches plug-untwisting process on the television screen inside the bombproof shelter where he controls the entire dismantling operation as he watches the screen for any sign of untoward activity during the process.
New Printed Circuit I. F. Amplifier

This new approach to production of critical assemblies may herald great changes in manufacturing techniques

By ERIC LESLIE

As frequency goes up, so does the importance of close tolerance on components, exact lead dress and uniformity in circuit constants. Yet with increasing frequency, it becomes increasingly hard to maintain uniformity and close tolerances. Broadcast coils can be wound with a uniformity within a few percent with ease; at 40 mc the small physical dimensions of coils cause a slight irregularity to make a much bigger difference. Tolerances of as much as 15 to 20% in bandwidth may be found in some 40-mc i.f. transformers.

The difficulty of maintaining close tolerances was only one of the reasons for the development of the RCA printed-circuit tandem 40-mc i.f. TV amplifier, but the high degree of uniformity obtained was enough to make the work worth while.

The circuit might better be termed "photo-engraved" than "printed." The chassis consists originally of a plastic sheet covered with a layer of thin copper foil. The foil is coated with a photosensitive material, on which is printed (photographically) the image of the circuit. Then the rest of the photosensitive material is removed by a process similar to the development of a photographic negative. The plate is then etched, and the parts not protected by the photosensitive material are eaten away, leaving the circuit lines in copper. See "Plated Chassis" in the December, 1952, issue.

All components such as resistors and capacitors are mounted on top of the panel, with leads brought down through holes to make contact with the leads below. Then the lower surface of the plate is contacted with the surface of a bath of molten solder, making firm contacts with all the leads in a single operation. Components such as i.f. cans

Schematic of the 207E1 tandem i.f. amplifier. The amplifier proper is enclosed in the dashed lines; the 6J6 is part of the tuner.
are mechanically secured in place as well as grounded by the soldering operation.

The printed circuit has other advantages over the older system of wiring. Some of the larger areas of metal left on the bottom of the chassis sheet are there for shielding purposes. Thus the "wiring" serves both for shielding and for connections. The system is used for shielding in another way. Wherever it is expedient to run two wires close together, they can be decoupled if advisable by running another—connected to ground—between them. This not only shields them electrostatically, but also prevents any electrical leakage from one to the other.

The i.f. transformers also use the printed circuit technique, as well as a special type of trimmer. Metal discs may be screwed closer to or further away from the coils, reducing their inductance as they approach it, somewhat in the manner of brass slugs in conventional coils. The discs are adjusted through the holes in the side of the can. Note these holes in the can held in the photograph. The screw lugs indicate that it is a type intended for use with conventional chassis—cans put into manufacturers' equipment have flat metal lugs which are secured in the dip-soldering process. The leads on this transformer are also slightly different than those supplied to manufacturers for original equipment. The coils can be inductively coupled by leading an end turn—or part of a turn—from one coil around the other, or alongside part of one of its turns. Thus any degree of coupling—from very loose to over-coupled—can be attained very easily, conveniently, and precisely.

![Fig. 2—Response of the last stage, with transformers T1 and T2 aligned.](image)

The circuit (Fig. 1) is most interesting. Besides the usual transformer-tuned circuits (in the output stage) it uses a special tandem trap and band-pass filter coupling coils. L2 (top section) is a coupled coil, and is tuned for maximum response. The bottom section of L2 is a trap for the adjacent-channel picture i.f. channel, and is tuned for greatest rejection at 39.75 mc. L3 and L4 are coupled coils, tuned for maximum response, in accordance with specimen curves given on the service sheet. L5 is composed of two coils which act individually as traps, one tuned to 41.25 and the other to 47.25 mc. The two in combination act as an antiresonant circuit tuned approximately to the mid-point of the pass-band, and supply mutual coupling between L3 and L4. The 24,000-ohm resistor between grid of V3 and plate of V2 is in a bridging circuit, serving effectively to neutralize the apparent resistance introduced into the circuits by L5.

The circuit is presaligned, but instructions for realignment, whenever that might be necessary, are provided, and give an excellent idea of the functions of each of the circuits. The last two transformers are aligned—using sweep generator and scope—to give the curve in Fig. 2. Then the upper screw disc of L5 is adjusted for minimum response at 47.25 mc and the lower disc to give minimum response at 41.25 mc. L3 and L4 are then adjusted to give the response curve of Fig. 3. The lower screw disc of L2 is next adjusted to give minimum response at 39.75 mc and the upper one—as well as the inductance of L1 on the tuner—to give the final response curve of Fig. 4, at the head of this column.

Thus aligned, the 207E1 has a full 3.9-mc bandwidth, with maximum usable selectivity, and delivers an output of 500 microvolts input at the first i.f. grid. This means that with a good cascade tuner, an input of only 7.5 microvolts at the antenna terminals is needed. It is extremely likely that this amplifier will be the pioneer of a new type of transmitter, which will find wide use where the need for close tolerances and uniformity of output are dominant or influential factors in design.

![Fig. 3—The notches at 41.25 and 47.25 mc are made by tuning the two coils of L5. L3 and L4 are adjusted to bring up response and produce the curve above.](image)

![Fig. 4—Final curve for the completely aligned amplifier. The notches at 39.75 mc is made by the lower coil of L2, which acts as an acceptor at that frequency. Upper coil of L2 is adjusted to bring up response, and plate load coil L1 in the tuner is also adjusted.](image)

Through sporadic-E dx will be a rarity for several months to come, the next few weeks could be packed with interest for the enthusiast. The last days of summer and the first few weeks of fall provide us with the best tropospheric dx of the entire year. To be sure, this is not the flashy, here-one-minute, gone-the-next sort of thing, we've been chasing earlier in the summer, but with the advent of better receivers and more awareness of the causes of tropospheric bending, the fall days can be expected to produce some TV dx that will be well worth watching for.

This is the time when you can use well-known weather signs to tell when dx will be coming through. When the barometer is high, and holding steady; when the days are warm and cloud, and the nights cool; when there has been a spell of fair weather and a change is in prospect—these are the times to be checking up on all the channels, but particularly the high ones. There should be something doing in u.h.f., too, particularly if you have a really good receiver and antenna installation. Nobody can be quite sure just what is in store for us on the u.h.f. channels, so this fall we will all have a chance to make worthwhile contributions to propagation knowledge.

Let's not sell u.h.f. short on the basis of the short ranges repeatedly reported in most areas. Very few of the receivers in use have appreciable sensitivity as yet, but already dx is being reported. First place in the u.h.f. dx marathon is now held by R. J. Walker, Daytona Beach, Fla., who has received WCONS, Columbia, S. C., (25) on at least two occasions. His antenna is a rhombic, about 165 feet over-all, cut for channel 2, 55 feet high. The distance is well over 300 miles, mostly over water. A word of caution about when to try for u.h.f. dx reception: Don't rely too completely on the condition of v.h.f. reception. Experience in amateur work on the 145-Mc and 420-Mc bands is showing that fairly often signal levels on the higher frequency outrun those on the lower. U.h.f. is not likely to be good if v.h.f. is really poor, but if v.h.f. is fair to good, u.h.f. may be better. 

Watching for u.h.f. dx in the morning, around sundown, and in the late evening hours, particularly, though we don't know enough about it by any means to be too positive in these recommendations. Your location, particularly where it is possible to compare u.h.f. with v.h.f., will make interesting reading for other dx-ers. What have you been getting?

SEPTEMBER, 1953
TELEVISION

... it's a cinch!

By E. AISBERG

Sixth conversation, first half:
In which Will learns something about teaching methods, as well as time bases using thyratrons

Dear Ken:

Everybody's patience has to come to an end sooner or later. Mine did since our last conversation. You've been kidding me along in a way I don't like! How often have you spent a lot of time carefully explaining something I really wanted to know? That's what happened with mechanical scanning. And, to make matters worse, you've been using various devices to help explain it. Then, after all that work, you lay it all off as you told me at the end of our last conversation. Now I'm wondering what you're going to do with it?

The subject is television. We're never going to learn about things that are never going to be of any use. Don't be surprised if I don't show up for our regular conversations when I get back to town.

Will
Dear Will:

I can see why you're annoyed. But don't think I've been trying to kid you! I admit I've described to you in detail some things that are never used in television. But you haven't wasted your time. Learning how these simple things work has helped you understand more complicated methods a lot better.

There was a good reason for talking about the neon lamp. It isn't used in actual television—for several reasons. It's hard to regulate the amplitude of its sawtooth oscillations, they have too much curvature for us to linearize easily, and they're hard to synchronize. But by discussing the neon tube, we found ourselves able to dissect the fundamental principles of all time-bases which use a charged capacitor in series with a resistor. You can say that all these devices are made up of three essential parts:

1. The charging circuit (the voltage supply, the resistor the charging current has to pass through, and the capacitor that accumulates the charge).
2. The switch that closes at just the right instant to release the charge built up in the capacitor (our neon tube, in this case).
3. And finally, the discharge circuit (which, in the case we were talking about, was that same neon tube). Once ionized, its resistance is so low that the discharge can be very rapid, almost as if it were a mechanical switch.

Now that you have analyzed the simplest time-base, you won't have any trouble figuring out the more complex ones. What would you say—for example—about a neon tube with a grid?

I'll be seeing you, I hope, as soon as you get back.

Ken

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The thyratron—a gas triode

Ken—Glad to see you back, Will. How's fishing?

Will—You ought to know, after baiting your hook with that neon triode of yours! I suppose that's what you call it, isn't it?

Ken—You can call it that if you like. But the ordinary name for a triode that contains gas (neon, argon, or helium) at low pressure is a thyratron.

Will—Don't tell me we've got to study gas tubes now—from the diode to the octode—same as we did ordinary high-vacuum tubes?

Ken—No danger! The three electrodes of the thyratron are plenty to make a fine switch and discharge circuit—just what you need for a good time-base. There are thyratron tetrodes, but we won't have to talk about them.

Will—That's better! But how do you use this thyratron? You can't hook up a triode like a neon lamp.

Ken—Here's the complete diagram. You see it's quite a bit like the neon-tube circuit. First of all, here's the charging circuit—capacitor C and resistor R across the B plus line.

Will—But why's the resistor at the negative end instead of the positive end of the circuit?

Ken—It doesn't make any real difference. The resistor and capacitor are in series; it doesn't matter which comes first. But you can switch the resistor around to point A if it'll make you feel any better.

Will—No need. I can see that in this case it doesn't make much difference which of the components the electrons run into first while they're making their trip around the circuit.

Ken—Now take a look at the discharge circuit. It's the cathode-anode space of our gas tube—again like the neon tube.

Will—Not exactly. You have R2 and R3 in series with that space. Now the discharge circuit is two resistors and the tube resistance in series with capacitor C.

Ken—Yes, R2 does look like a plate load. Actually it's a small limiting resistor of just a few hundred ohms. The cathode-anode resistance of a thyratron is so small that when it discharges it can pass enough current to damage itself if it doesn't have some such protection.

Will—And I take it that R3—between cathode and B minus—is a standard bias circuit?

Ken—You're right. R3—together with C2 across it—is the standard bias circuit. And will you please do me a favor and—for just a few minutes—forget about C1, which couples the grid to something called “synchronization”?

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September 1953
The grid has something to say

Will.-This looks practically the same as a neon-lamp circuit. I suppose capacitor C charges till the voltage across it is high enough to ionize the gas in the tube. Then the tube's cathode-anode resistance falls to a very low value and the capacitor discharges till the voltage across it gets low enough to stop the ionization. At that point the tube stops conducting and the cycle starts all over again.

Ken—You have it exact.

Will.—But then why go to the trouble of using a thyratron, if it works just like a simple neon diode?

Ken—The grid is what makes the difference. Will. Its bias determines the anode voltage the tube will ionize at. For example, if you have a high negative voltage on the grid, the plate voltage has to be much higher before the tube will break down than if the grid voltage were zero.

Will—I think I see. Where the grid voltage in a high-vacuum tube controls the amount of current that will flow through the tube, in a thyratron it sets the ionization voltage.

Ken—Exactly! But the instant the anode voltage is high enough to give the electrons sufficient velocity to break down the molecules of gas they collide with.

Will.—Then, in the shock of those collisions, one or more electrons are likely to be knocked off each of the gas molecules that get in the way, and so the current of electrons moving toward the anode is increased correspondingly.

Ken—And what do you think happens to those wrecked molecules that the electrons have left along the road?

Will—Losing electrons leaves them positive. So they'll drift off looking for negative electrodes.

Ken—And which is the most negative electrode in the tube?

Will.—The grid, of course!

Ken—So the grid will be buried in a big cloud of positive ions as soon as the tube starts to conduct. But let's go back for a moment. In a neon tube, the anode voltage that starts ionization is always the same; but in a thyratron it depends on the grid voltage.

Will—Sure! The more negative the grid is, the more positive the plate has to be to neutralize the grid's influence.

Ken—That's it! And, for each type of thyratron, there's a constant relation between the ionization voltage and the negative grid voltage. You can call it the control ratio. It usually runs between 10 and 40.

Will—If I understand you, a thyratron with a control ratio of 20—for example—and with 15 volts negative on the grid, would need 15 x 20, or 300 volts, on the anode, before it would break down?

Ken—Your figures are absolutely correct, Will. Now you see that the ionization voltage can be fixed simply by adjusting the grid voltage. That's why R3 is made variable.

Will—I suppose the grid voltage sets the extinction voltage of the tube, too?

Ken—You never were more wrong in your life! This grid of ours is so wrapped up in its cloud of positive ions that it's completely isolated from the rest of the tube and can have no effect on the electron flow whatever!

Will—Then the grid lets us regulate the plate voltage that starts the discharge, but the voltage at which the discharge finishes is always the same. So, by adjusting the grid voltage, we can vary the size of our sawtooth waves, instead of having them fixed for us they were with the neon lamp.

Ken—That's right. And you can get oscillations several times bigger with a thyratron than you could with a neon tube.

Will—So I have to think of R3 as the sawtooth amplitude control. And I suppose that C2 is there to pass the a.c. component of the current?

Ken—Roughly. Yes. To be more exact, it equalizes the large variations in the anode current so that the grid bias remains practically constant. At the instant of ionization, the heavy current charges it. Then—at the end of the discharge—when there's practically no current—it starts to discharge through R2. If C2 is big enough, the current through R3—and therefore the grid voltage—will stay pretty much the same throughout the whole cycle.

(TO BE CONTINUED)
TV service organizations have gone broke for lack of good records. Here is a system to prevent that.

How do you handle your incoming service-call records? Is your system foolproof? Does it automatically assure that each customer will be taken care of? Is it simple and inexpensive? Does it provide a permanent record of the call while giving the outside service technician full and accurate information without further writing? Does it expedite billing? If the answer to any of the above questions is no, you ought to be interested in the following system. It is simple and as well-suited to the one-man shop as to larger organizations.

The basic elements of the system are the perforated sheets of 8½ x 11 inch gummed paper which are sold in all office-supply or large stationery stores. These sheets usually contain 33 gummed labels and are used most commonly for typing addresses to be pasted on envelopes. They come in several colors and cost about 2 cents per sheet. To make up the call-record book, assemble the sheets in sets of three: a pink label sheet on top, a blue label sheet in the middle, and a sheet of plain white typewriter paper (unperforated) on the bottom. The three sheets may be stapled (at the top only) to a cardboard backing, or may be held in a clip-board after moistening the label sheets at a few places at the top edge. Two carbon paper sheets complete the set.

At the top of the backing (which should be a few inches longer than the sheets) the data to be recorded on each label should be listed in a logical sequence. This might include: (1) The name of the customer. (2) Address. (3) Apartment number. (4) Phone number. (5) Set make and model. (6) Complaint. (7) Date call received. (8) Date and time of appointment for technician.

Whenever a call comes in this data is recorded in proper sequence on the next available label. All labels are numbered in advance.

How the labels are used thereafter depends on individual preferences and requirements. The following are merely suggested:

Pink labels—used for scheduling calls. At the end of each day the labels are separated and pasted on daily route cards in the most desirable order. The route cards should have enough space next to each label to tell what was done (for example: "set pulled and brought to shop," or "fixed in customer's home"). If money was collected the amount is listed. If the set is pulled, the service technician marks the chassis with the same serial number as appears on his label.

Blue labels—used for checking calls for completion. The service technician must either turn in the payment received for the call, deliver a chassis to the shop, or explain. Completed calls for which the service technician delivers cash or satisfactory explanations are charged off at once by pasting blue labels over the corresponding pink ones on the route cards. The blue labels of sets being worked on in the shop remain in the call book until the jobs are completed, returned, and paid for. Since the route cards are dated and may be hung on a wall until closed out, the pink labels stand out as warnings of uncompleted calls, unpaid bills, or any unusual delay.

The white bottom sheet constitutes a master record in case any labels are lost. It also forms a valuable list for direct-mail advertising and follow-up business. To make up a batch of address labels, a typist puts a sheaf of the perforated label sheets in the typewriter and copies the names and address from the white sheet. As many as five duplicate addresses can be made at one time by this method so prospects can be reached several times with minimum clerical cost.

The system can be elaborated by using more sheets if desired, or simplified for the one-man shop by using only one label sheet and one carbon. Either way the system will be found to be handy, inexpensive, and practically foolproof. Try it—it works.
Cascode Type Front Ends

By David T. Armstrong

Cascode tuners are not all alike. The author discusses three different types.

(Second of two parts)

In the preceding article we discussed the origin and advantages of the cascode amplifier. In this part we will consider two practical forms of the cascode circuit.

Pentodes versus triodes

The basic design problem of the r.f. stage is a compromise situation of devising an amplifier that contributes maximum gain with minimum noise. It has long been known that pentodes are more noisy than triodes, but triodes have not been much used because they have relatively low gain and require neutralization to prevent oscillation and regeneration. What is desired in an r.f. section is a combination to produce the high gain and good stability of a pentode with the low noise characteristics of the triode.

In addition to the noises listed in last month’s article pentodes have “partition noise” as a result of random division of cathode current between the plate and screen. The relative noise of a tube is usually expressed as the value of an actual resistor which would contribute that much noise to a circuit. Lower resistance values indicate lower noise. A 6J4 triode (a special-purpose type) has an equivalent noise resistance of about 200 ohms, whereas a pentode like the 6AK5 has a value of approximately 1,880 ohms. It is possible to reduce the noise figure of a pentode by connecting it as a triode; with a 6AK5 this reduces the equivalent noise resistance to 400 ohms. The 6J4, 12AT7, 6BZ7, 6BQ7, and 6BZ7 dual triodes, and the 6J4, 6C4, 6AB4, etc., in the single-triode types are all suitable for cascode application.

There is one serious disadvantage in a circuit employing triode amplifiers. In the grounded-cathode r.f. amplifier the plate-to-grid capacitance provides feedback which makes the amplifier unstable and encourages it to oscillate; this tendency increases with improvement in gain. Neutralization may prevent oscillation and reduce in-

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Fig. 1—Standard Coil model TV-2232 television tuner with cascode r.f. amplifier has direct coupling between input and output sections of the 6BQ7.

Fig. 2—Front end of the Browning RV-31 FM tuner has a 12AT7 twin-triode cascode r.f. amplifier, and a.f.c. on the local high-frequency oscillator.

Fig. 3—Cascode-type r.f. amplifier using separate 6C4 triodes in the Altec-Lansing model 303A FM tuner. Both 6C4’s are operated with grids grounded.

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stability, but it is better to use a circuit that utilizes the triodes in relatively low-gain amplifier stages. This is an inherent virtue of the cascode r.f. amplifier.

On the other hand, a grounded-grid amplifier has excellent stability because the grid shields the input from the output circuit. But gain attainable with a grounded-grid amplifier is much less than the gain possible with a grounded-cathode amplifier. Any signal voltage which tends to make the cathode negative with respect to the grounded grid and increase the plate current is opposed, since the increased plate current flowing from ground to cathode tends to make the cathode more positive than the grid. This reduces both gain and sensitivity to weak signals.

**Design considerations**

Some careful attention to these design considerations will provide optimum amplifier performance:

1. The antenna input circuit should be balanced to ground since 300-ohm lead-in is standard for practically all TV and FM receiver inputs. This may be accomplished most readily by transformer-type coupling, but in some cases balanced impedance coupling may be used.

2. The antenna impedance should be transformed by the input circuit to a value close to the optimum source resistance for the triode used. This requirement may be met in the nearly by winding the transformer for optimum noise rather than for perfect impedance match.

3. If possible, the input transformer should be so wound that a voltage ratio step-up is provided.

4. Capacitance tuning is undesirable for TV because it will vary the bandwidth of the circuit unless considerable loading is used. It may be useful for FM because the frequency coverage there is relatively narrow (about 1.2/1).

5. If broadening is necessary it should be accomplished by some means other than by the use of loading resistors. Resistors in low-level circuits contribute thermal noise. This would defeat the basic design virtues of the cascode.

**Source resistance**

Optimum source resistance varies inversely with frequency. Thus for the TV band it will be necessary to design the turns ratio of the primary and secondary of the input transformer so that the apparent antenna resistance is the optimum source resistance at the grid. The input section of the cascode amplifier.

The optimum source resistance for a triode-connected 6AK5 is approximately equal to 70,000 ohms divided by the operating frequency. For 50 mc this would make optimum driving resistance of 1,400 ohms; for 300 mc this would mean an optimum driving resistance of 700 ohms; for 200 mc this would mean an optimum driving resistance of about 350 ohms.

It is usually unnecessary to tune the interstage coupling circuit because the coupling between the grounded-cathode and the grounded-grid stages is loaded with the very low input resistance of the grounded-cathode stage. Hence variable tuning is generally desirable only at the input to the grounded-cathode stage and in the output circuit of the grounded-grid stage (the input circuit of the mixer). In some cases it may not be desirable to have the input to the grounded-cathode stage to eliminate feedback through the rotor shaft common to r.f., mixer, and oscillator stages, or to simplify tracking problems.

Fig. 1 shows a popular commercial application of the cascode circuit. This is the Standard Coil TV-2232 television tuner. The coils L1 and L2 are wound on one snap-in strip (as shown by the dashed outline), and L3, L4, and L5 are wound on plug-in ferrite cores. Both strips are changed automatically when changing channels. L7 is a peaking coil which improves the over-all gain—particularly on the high-band v.h.f. channels. Grid-plate neutralization is provided in the grounded-cathode half of the 6BQ7 by C9, which feeds approximately the same voltage to the bottom end of L2 (terminal 11) as the plate-grid capacitance of the triode feeds to the top end (terminal 7). The identical feedback voltages at both ends of L2 cancel.

The variable capacitors C3, C6, and C13 are adjusted for full-channel bandwidth and maximum gain on channel 10. This gives substantially uniform results on all channels.

**Cascodes for FM**

Fig. 2 is the circuit of the cascode front end used in the Browning RV-31 FM tuner. This is the Standard Coil TV-31 tuner, this has direct coupling between the grounded-cathode and grounded-grid sections. L1 resonates with the output capacitance of the grounded-cathode stage and the input capacitance of the grounded-grid stage to form a low-pass filter. The 6J6 a.f.c. tube, of course, has no relation to the cascode r.f. section, but keeps the oscillator tuned 10.7 mc above the signal.

Fig. 3 is a somewhat different form of cascode circuit used in the Altec-Lansing 305A FM tuner. Separate 6C4 triodes are in the cascode stage, both operated as grounded-grid amplifiers. This eliminates the need for neutralization, and allows practically direct coupling (through C1 and C2) between the antenna and the input stage for a high signal-to-noise ratio. L1 resonates broadly in the FM band. Putting the first variable-tuned circuit between the two halves of the cascode amplifier raises the coupling impedance and increases the gain of the input section. Note that capacitance signal coupling is used between the two sections, so that both cathodes are only a few volts above ground for d.c.

**MY MOST UNUSUAL TV SERVICE JOB**

T HE job that will live longest in my memory was on a G-E 1949 10-inch set. The picture tube was a 10FP4, with an aluminum-backed screen, requiring no ion-trap magnet. The complaint was unstable sync. Everything from tube changing to a modification of the sync take-off circuit was tried on this set, but to no avail. With the contrast control set at minimum, the picture would roll vertically, but the horizontal sync was O.K. When the contrast was advanced to overcome the vertical roll, the picture would pull horizontally at the top of the frame, and at times would tear out altogether. In sheer desperation, after many, many hours of sweat and tears, we substituted another picture tube—a 10BP4 with an ion-trap magnet. Lo and behold, the set worked perfectly!

Our guess is that the original tube was drawing too high a beam current, and was loading the low-voltage supply to cause instability in the sync circuits. What's your guess?—Harry M. Leonuder.

(Many of these early G-E TV receivers had the picture-tube input circuit shown in the diagram. This one is taken from the model 800 schematic. The sync take-off point is at the plate of the d.c.-restorer diode. If the original picture tube was gassy, had a contaminated grid, or a high-resistance leak between grid and cathode or between grid and heater, it would act as a short—or at least a shunt—across the d.c. restorer circuit. This would reduce the amplitude of the sync pulses enough to cause the trouble you described.—Editor)
W e get so many questions regarding the function and adjustment of the drive control that we feel a restatement of the factors involved would benefit a number of readers.

The drive control is either in the plate circuit of the horizontal oscillator or in the grid circuit of the horizontal output tube and sets the amplitude of the sweep signal fed to the output tube. Two typical drive-control circuits are shown in Fig. 1. The grid of the output tube draws current on the positive peaks of the sweep signal. This charges the coupling capacitor, which in turn discharges across the grid leak during the time the signal swings in a negative direction. The bias developed across the grid leak controls the plate current of the output tube. With insufficient bias the average d.c. plate current in the output tube runs high and the tube may overheat. With too much bias the peak voltage and current developed at the plate during the retrace interval becomes excessive and may break down the tube. Since the bias depends on the amplitude of the drive signal, it is very important that the drive control be adjusted properly. Even a slight amount of overdrive will shorten the life of the horizontal output tube.

Besides this, overdrive may increase the high voltage to the point where corona and arcing occur. Excessive high voltage also tends to reduce the size of the raster because the resulting increase in beam velocity makes it more difficult to deflect the beam fully. Overdrive also increases the signal amplitude in the horizontal deflection coils and thus produces greater flyback voltages. These may overload the damper tube, and, besides affecting its life, white-bar instability may appear on the screen.

The most common symptom of overdrive is left-hand stretch, as shown in Fig. 2. You will note that the left-hand wedge is wide enough that the black section at the end of the flare is off the screen. Since the grid of the horizontal output tube consumes power, overdrive will often impose an extra load on the horizontal oscillator and lead to sync instability. This may cause weaving at the top of the picture or make the hold-control setting critical. Note the curvature of the vertical wedge at the top of Fig. 2. A further increase in drive would compress the picture at the center and possibly produce a white vertical transient bar. See Fig. 3. The drive control should never be used to increase picture width. If the picture does not fill the mask properly, even at the maximum setting of the width control, tubes, voltages, and component parts should be checked to find the defect which is causing reduced width. Increasing the drive to fill the mask will not only result in poor linearity, but will also cause repeated tube and component failures.

The left-hand stretch may not always be too clearly evident, especially if the width control has been adjusted to decrease picture width. As shown in Fig. 3, however, several clues are present. The white vertical bar near the center of the picture indicates excessive drive, while the black area at the flare of the left horizontal wedge is wider than the right wedge. In a case like this the drive should be reduced and the width control advanced to improve the linearity. In the absence of a station pattern, use a cross-bar generator and set the drive control just below the point where left-hand stretch and center compression occur. After that, adjust the vertical and horizontal linearity controls for best linearity and use the centering lever or control for proper picture positioning within the mask. This may call for readjusting the height and width controls and a final touch-up of both linearity controls.

If the drive control can't eliminate left-hand stretch or the white bar, check the resistors and capacitors in the grid circuit of the horizontal output tube against the values given in the service notes for the receiver. Also check the B voltages in the entire horizontal sweep system.

The single white vertical bar near the center must not be confused with the one or two vertical bars which often appear at the left of the screen. The latter are caused by improper damping, and usually call for a new damper tube or a check of component parts in the damper circuit. Even though the drive control is adjusted properly, such transient bars will appear when trouble occurs in the damper circuit.

**Exclusive blanking**

I have applied a retrace-blanking circuit to an Ambassador model T1720 receiver. It eliminated all the vertical retrace lines very effectively, but now three vertical shadows appear on the left side of the screen which vary in width from 1 to 2 inches. What caused this trouble? J. B., Rego Park, N. Y.

This indicates excessive blanking-signal amplitude. This can be minimized by juggling the R-C values of the retrace-eliminating circuit. Try various values until the shadows are no longer visible.

**High-voltage resistors**

In a Philco 52T2256 there is a bluish glow around resistor R1 (Fig. 4). This condition prevails when the brightness control is only slightly advanced, and when the control is advanced fully the resistor area over to the envelope of the 1B3 or to the cage. With the high-voltage probe connected to test point A, I get a reading of 5,000 volts with the brightness turned down. This drops to zero when the brightness control is advanced. The reading at point B is 11,000 volts. I have tried changing the high-voltage rectifier, the damper.
in SEPTEMBER, 1953

check necessary dress also additional cement or have poor

If the trouble. Intermittent changes. the voltage and changes

In an Admiral 321DX there is bad intermittent streaking across the picture tube, plus an arcing sound in the receiver. At times the whole raster is torn by this interference. Recently the ratio detector was replaced and I am wondering whether this change caused the trouble. M. A. D., Cheney, Kan.

It is highly unlikely that the ratio-detector tube would arc. This trouble usually occurs in the high-voltage compartment of the receiver. You can generally locate the source of the arc by turning the receiver on and watching the back while the room is darkened. If a tube is not at fault, inspect the insulation at the point where the arc occurs and replace any leads which have poor insulation. Also a plastic cement or anti-corona spray can be applied to such sections to provide additional high-voltage insulation. Lead dress also is important and it may be necessary to space wires farther apart and round off any sharp joints. Also check the drive control setting.

RCA 621 conversion

I would like to install a 12LP4 tube in an RCA 621 receiver. What changes are necessary in using this tube? E. Z., Milwaukee, Wis.

This receiver uses a 7-inch tube with electromagnetic deflection and electrostatic focus. The high-voltage output in this receiver is 7,500 volts, which may not give adequate brightness with the 12LP4. For best results a new horizontal output transformer and the mounting yoke must be installed. Kits are available for this purpose, with complete instructions regarding the change. A magnetic-focus assembly and a double-magnet ion trap will be needed.

14HP4 to 14BP4

I have a Motorola 14T4 with a bad 14HP4 picture tube. I have been advised by my parts distributor that this tube has been discontinued by the tube manufacturers. Would you please advise me on a substitute tube and necessary circuit changes? J. L., Altoona, Pa.

A 14BP4 can be used instead of the 14HP4 in this receiver. The 14BP4 is an electrostatic-focus type, and has the focus-control circuit shown in Fig. 5-a. This control should be removed and the circuit rewired as shown in Fig. 5-b. A focus-magnet assembly and a double-magnet ion trap will also be needed with the 14BP4.

Yoke matching

I would like to convert a Tele-King model 310M from a 10-inch receiver to a 17-inch tube. I have a Merit HVO-7 transformer and am wondering if I could use a yoke by another manufacturer. If not, what is the matching yoke for the transformer mentioned? G. B., Milwaukee, Wis.

We recommend using a matching yoke made by the same manufacturer. In most instances we have found less trouble with conversions if the yoke and transformer are made by the same concern. Even a slight mismatch often results in insufficient width or other conversion difficulties. For this reason a matched kit is usually preferable. For additional information on replacements, see pages 64 and 68 of the January, 1953, RADIO-ELECTRONICS.

Du Mont RA-113 dial cord

In a Du Mont RA-113 television receiver the dial cord is broken. No dial-cord replacement information is available in service publications which I have checked. This receiver uses the Du Mont Inputverter with a variable-pitch cam wheel on the tuning shaft. The cord has to be strung over this to operate another wheel which turns the indicator needle over the tuning scale. All my efforts to replace this cord in the proper manner were futile and I would be greatly indebted to you if you would let me know how to do it or tell me where I can obtain the necessary information. G. T., Plainfield, N. J.

Fig. 6 shows the dial stringing diagrams which appear in the Du Mont manual for this receiver. First remove the three pilot lights with their clips and also remove the dial pointer by pulling outward. Straighten the four twisted tabs which hold the dial to the mounting plate, and remove the dial. Remove the defective dial cable retaining the tension spring B. Rotate the tuning shaft full counterclockwise, which places the cam assembly D in the position shown. Place the pointer pulley E in the position shown and fasten the cable tension spring to the loop at the end of the dial cable. Now string the dial cable as shown. Start by placing the cable guard F in position. Use both hands and string two halves of cable as illustrated. Make sure the cam follower is not disengaged from the cam D. If there is insufficient tension in the cable, ran the cable tension spring B around the pointer pulley E hub in the direction opposite to that shown. Now replace the dial, and fasten by slight twisting of the four tabs. Replace the pilot lights and the receiver is ready for operation. Tune in a known high-channel station and set the dial pointer in the correct position. It will then be calibrated.

END
Part II—All changers have common troubles. These troubles and their cures are listed.

**By JOHN B. LEDBETTER**

1. No current at motor. (Check a.c. leads, plug, and switch, for open or cold-soldered connections.)

2. Defective motor. (Remove turntable and check motor without load. If current is reaching motor but drive spindle does not rotate, rotate motor for repair or replacement.)

**Mechanism jams; irregular operation.**

1. Ratchet lever or pawl on drive cam loose or improperly adjusted (See Fig. 1).

2. Separator link-and-lever assembly not positioned correctly.

**Fig. 1—Drawing of the mechanism of the RCA type RP-176 automatic record changer. The codes indicate points which are potential sources of trouble. Keys to the codes are below the drawing.**

3. Mechanism clogged with dirt or foreign matter. (If mechanism has slipped adjustment or jumped gear, disassemble or remove the drive cam—see manufacturer's instructions or service manual—and re-assemble in the correct position with relation to the pawl or ratchet wheel. Check the separator link and assembly for binding, clogging, and proper positioning. Clean the mechanism if necessary with carbon tetrachloride.)

**Records jam or bind between separator knife and support shelf (slicer-type changers).**

1. Slicer blade is set too low. (If blade has setscrew adjustments, loosen blade and raise for proper clearance. If blade is fixed to the separator shaft, it may have to be warped carefully or filed for proper clearance.)

2. Separator blade catches on record above; may drop two at once.

3. Separator blade is set too high. (Check adjustment and clearance as described above.)

**One edge of record releases before the other; center hole cracks out or pinches (slicer-type changers).**

4. Separator blades out of adjustment. (Check for loose or improper adjustment of one separator shaft; tighten and re-align blades so that both clear edges of record simultaneously. Also check separator blades for binding or improper clearance between blades.)

**Records jam or stack is unsteady.**

5. Record is warped, too thin, too thick, or has rough edges.

6. Spring inside separator-knife assembly is too strong.

7. Teeth on bottom of separator knife and on top of separator shelf are binding or burried.

8. Edges of separator knife too sharp, burried, or bent.

9. Record sitting unevenly on support shaft. (Center hole may be out-of-round or off position.)

**Records do not drop at proper time (slicer-type changers).**

1. Record-separator knife incorrectly adjusted. (Typical check: Turn record supports to "10-inch" position and place a 10-inch record on support shelf.)
The knife-edge of the separator should be approximately 3/4 inch from the edge of the record. If not, loosen the record-separator set-screws and turn separator shaft for the proper clearance. A slight readjustment may be required if 12-inch records do not then drop correctly. See Fig. 2 for typical adjustments on RCA RP-176.

Two records drop at once.
1. Hole in record too large.
2. Record too thin.
3. Spindle slide not fully down (toggle-post changers).
4. Foreign matter in spindle offset, causing release latch to stick.
5. Spindle warped or bent out of shape.
6. Record support is binding or spindle is bent out of square with record-support shaft. (Bend spindle carefully with fingers if necessary, and straighten record support if it is not square with shaft. See that hole in record support is centered over spindle; bend support-post if necessary for proper centering. If record support is loose on its shaft, retake it carefully with a hammer and punch.)
7. Record pusher (toggle-post changers) is deformed or defective. (Replace if necessary.)

Records strike tone arm (toggle-post changers).
1. Pusher inside spindle does not move far enough to eject record.
2. Loose set-screw in lift arm.
3. Pusher extends beyond outside diameter of spindle.
4. Tone arm is not properly adjusted.

Records strike separator post or will not stay on record shelf.
1. Incorrect spacing between record posts, or between spindle and record-support or separator posts. (On a changer like the RCA RP-176, set the record-support post on "10-inch" position and loosen support-post set-screws. See Fig. 2. Hold separator post against end of slot in motorboard, turn belt drum to take up extra slack in belt, and tighten separator-post set-screws. Then loosen set-screws which adjust the reach of the record-support plates and move shelf out until edge of 10-inch record sets about halfway up the sloping knife-edge of the shelf. Turn support shelf to "12-inch" position and repeat this adjustment on the 12-inch shelf with a 12-inch record in place. These adjustments will be essentially the same with other slicer-type changers. The only difference is the method of varying or moving the separator knife under or away from record.

Vertical movement of tone arm is rough or erratic.
1. Eject lever or tone-arm lift pin is binding. (Clean out dirt and lubricate.)
2. Slide and cam are binding. (Check all bearing points; clean and lubricate.)
3. Burrs in main slot in slide and cam. (Remove burrs with a small file.)
4. Tone-arm shaft binding against sleeve. (Clean and lubricate.)

Horizontal movement of tone arm is rough or erratic.
1. Tone-arm return locator is too tight.
2. Tone-arm return spring too weak or improperly hooked up.
3. Washer (under tone-arm return locator) missing, broken, or bent.

Pickup repeats grooves.
1. Tone-arm pressure too light (counterbalance spring too strong).
2. Binding in tone-arm swivel.
3. Metal filings or foreign matter in ball bearings of tone-arm swivel.
4. Spring on trip lever too strong.
5. Binding in trip-lever pivot.
6. Trip-lever pawl too blunt.
7. Trip-lever ratchet defective or binding.
8. Record defective or chipped.

Cartridge drags on record.
1. Needle bent or cartridge mounting screws loose. (Tighten screws; replace needle if necessary.)

Needle will not track across record.
1. Changer not level (this is extremely important in some models).
2. Excessive vibration (unsteady mounting, floor vibration, passing of heavy traffic) especially noticeable on long-playing records.
3. Needle clogged with lint, dirt, etc.; sapphire chipped or dulled.
4. Locator housing or set-down mechanism fails to disengage after completion of cycle. (Check all associated parts for binding, burrs, clogging, and lack of lubrication.)

Incorrect feed-in to record (tone arm does not set down at right place).
1. Trip-lever spring missing.
2. Stud on trip lever loose.
3. Spring on feed-in lever missing.

Tone arm will not clear record stack.
1. Loose or improperly adjusted set-screws in tone-arm elevating mechanism (elevating rod in some changers, a disc, cable, link, or cam-lever in others).
2. Tone-arm elevating rod or mechanism bent. (Realign or bend carefully for proper clearance.)

Needle does not set down properly on 7-inch records.
1. Bent or damaged tailpiece on set-
down locator plate (some changers); similar mechanism on others. (Some models use segment cams, index fingers on ratchet lever, etc. Straighten carefully and adjust, or realign. Replacement may be necessary in some of these cases.)

**Needle does not set down properly on 10-inch records.**
1. Tone arm improperly adjusted.
2. Hinge catch (or segment cam in some changers) not returning to "10-inch" position when changer cycles. (Lubricate hinge bearings with Lubriplate or light grease; try readjustment in case of segment cams.)
3. Safety spring binds against locator housing of tone arm. (See if locator casting turns freely in locator housing; remove, burrs or sharp edges on safety return spring, and stretch spring slightly if necessary to increase tension. Check clearance between locator plate and its housing; remove burrs if present with fine file.)
4. Hinge catch (some changers) not disengaging from hinge cam. (Check for proper clearance; file edge of hinge catch for slight clearance—at least 1/32 inch—if necessary.)
5. Needles bent (rough handling may have bent one or both styluses in dual- or 3-speed changers).

**Needle does not set down on 12-inch records.**
1. Diameter of 12-inch record is undersize.
2. Center hole in record is too large.
3. Tone arm improperly adjusted.
4. Safety spring (some changers) binding against locator housing of tone arm.
5. Index lever on trip mechanism does not cock when 12-inch record drops. (Some changers use segment cam which engages the index lever on tone-arm return lever. See Fig. 3.)
6. Hinge catch (where used) does not engage catch properly when index finger is depressed. (Check for binding between hinge body and hinge bearing. Burrs on bearing surfaces or lack of proper lubrication may be causing this difficulty.)

**Set-down position of tone arm cannot be adjusted.**
1. Defective tone-arm shaft and sleeve assembly, or loose or stretched cable in some changers. (In the first case, assembly replacement may be necessary.)
2. Tone arm holds records against spindle when it rises, or strikes tone-arm rest when it moves out. (1) Height of tone arm improperly adjusted. (Adjust by bending carefully, or by set-screw adjustments where used. In some models it may be necessary to place shims or washers under the tone-arm support if arm is too low, or file small amount off support if tone arm is too high.)

**Needle sets down properly on 12-inch records, but glides over several grooves before seating.**
1. Needle pressure too light.
2. Pickup leads too tight.
3. Incorrect needle tip (be sure the microgroove or L-P needle is used—33-1/3 or 45-r.p.m. microgroove records.)
4. The needle may be chipped or damaged.

**Change cycle starts before end of record.**
1. Not enough vertical clearance between lip of velocity-trip lever and edge of main cam (hooked end of trip lever will not engage trigger on main cam.)
2. Trip lever rubbing or binding against cam drive gear.
3. Insufficient clearance between hook end of velocity trip and the main-cam actuating gear. (Bend lever slightly if necessary.)
5. Disengage roller on velocity trip (some changers) broken.
6. Hole in record too large (grooves may be eccentric to the spindle under this condition, causing trip mechanism to work or trigger into operation prematurely.)
7. Trip link or ratchet binding or clogged.

**Tone arm continues to come down on "Rest" position (some changers).**
1. Improper adjustment of index finger and segment cam (on tone-arm return lever).
2. Pivot bearing of tone-arm-return lever binding or clogged.
3. Spring on tone-arm return lever missing.
4. Record-separator shaft binding, either inside the separator support or below the separator segment cam (slizer-type changers).
5. Tone arm binding above or below tone-arm swivel bearing.

**Changer trips continuously.**
(Typical action shown in fig. 1.)
1. Ratchet-lever spring loose or missing.
2. Excessive play in ratchet-lever bearing.
3. Notch in drive cam burred.
4. Surface of ratchet-lever tip rounded; will not hold drive-cam pawl.
5. One or more points on the OPERATE or REJECT-MANUAL control are burred or binding.

**Motor rumble and wows.**
1. Distorted or damaged rubber rim on the idler wheel.
2. Bent or warped turntable.
3. Turntable may hang too low and drag on motorboard. (Make sure that the turntable is level and that all shipping bolts have been removed.)
4. Motor armature (rotor) may be bent, unbalanced, or out of alignment.
5. Blades of cooling fan on motor may be bent out of alignment.
6. A low-pitched rumbling sound is heard when a record is being played. Check the motor mount to be sure that the motor is suspended freely on springs or rubber grommets. Power cord to motor may be too tight to permit the motor to float freely. Lengthen leads so the motor floats.

Thanks are due RCA and Philco for photos and service information. A further article in this series may appear in an early issue.
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SEPTEMBER, 1953
Another new, outstanding instrument design so typically characteristic of Heathkit operation in producing high-quality instrument kits at the lowest possible price. A new, improved model Impedance Bridge Kit featuring modern cabinet styling, with slaved measurement for convenience of operation and interpretation of scales at a $10.00 price reduction over the preceding model. Built-in adjustable phase shift oscillator and amplifier with all tubes of the battery operated type completely eliminates warm-up time. The instrument is entirely AC line operated. No bothersome battery replacements.

The Heathkit IB-2 Impedance Bridge Kit actually represents four instruments in one compact unit. The Wheatstone Bridge for resistance measurements, the Capacity Comparator Bridge for capacity measurements, Maxwell Bridge for low Q, and Hay Bridge for high Q inductance measurements. Read Q, D, QD all on one dial, thereby eliminating possible confusion due to the incorrect dial reference or adjustment. Only one set of instrument terminals necessary for any measurement function. Panel provisions provided for external generator use.

A newly designed two section CRL dial provides ten separate "units" switch settings with an accuracy of .5%. Fractions of units are read on a continuously variable calibrated wire wound control. A special minimum capacity, shielded, balanced impedance matching transformer between the generator and the bridge. The correct impedance match is automatically switch selected to provide constant load operation of the generator circuit. The instrument uses 1% precision resistors and condensers in all measurement circuits.

The new Heathkit IB-2 provides outstanding design features not found in any other kit instrument. The single low price includes the power supply, generator, and amplifier stages. No need to purchase separate instrument accessories in order to obtain the type of operation desired.

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**Heathkit IMPEDANCE BRIDGE KIT**

**MODEL IB-2**

**$59.50**

**SHELLING WT. 15 LBS.**

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**Heathkit AUDIO WATTMETER KIT**

**MODEL AW-1**

**$29.50**

**SHELLING WT. 6 LBS.**

A new Heathkit design for the audio engineer, serious hi-fi enthusiast, recording studio, or broadcast station; the Heathkit Audio Wattmeter Kit. This specialized instrument instantly indicates the output level of the equipment under test without requiring the use of external load resistors. All readings are taken directly from the calibrated scales of a 4½" 200 microampere Simpson meter.

The Heathkit Audio Wattmeter features five full scale power measurements ranging from 5 milliwatts up to 50 watts with dB ranges of -15 dB to +48 dB. The instrument has a power measurement rating of 25 watts continuous and 50 watts maximum for intermittent operation. Non-inductive resistance load impedances of 4, 8, 16, and 600 ohms are provided through a panel impedance selector switch. Frequency effect is negligible from 10 cycles to 250 kc. A conventional VTVM circuit utilizes a 12AU7 twin triode tube. The meter bridge circuit uses four germanium diodes for good linearity.

With the Heathkit AW-1 desired information can be obtained instantly and conveniently without bothering with the irksome setups and calculations usually required. Useful for power curve measurements, frequency response checks, monitoring indicators, etc. Convenient calibration directly from 110 volt AC line source. This new instrument will help to supply the answers to your audio operating or power output problems.

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**Heathkit LABORATORY GENERATOR KIT**

**MODEL LG-1**

**$39.50**

**SHELLING WT. 16 LBS.**

Another welcome addition to the popular line of Heathkit instruments, the Heathkit Laboratory Generator. Specifically designed for flexibility of operation, accuracy and versatility beyond the performance level provided by the conventional service type generator. Frequency coverage of the Colpitts oscillator is 150kc to 30mc in five convenient ranges with provisions for internal or external modulation up to 50%, and .1 volt RF output throughout the frequency range. Panel mounted 200 microampere Simpson meter for RF "set reference level" to provide relative indication of RF output. Individually shielded oscillator and shielded variable and step attenuator provide flexible control of RF output.

The circuit features a 6AF4 high frequency oscillator, a 6AV7 amplifier with grid modulation, 12AU7 400 cycle oscillator and modulator, OB2 voltage regulator tube, and a selenium rectifier for the transformer operated power supply. The smart professional instrument appearance and overall flexibility of operation will prove a decided asset to any industrial or educational laboratory. The Heathkit Laboratory Generator sets a new level of operation, far superior to any instrument in this price classification.
CHECK THESE Features

- New SUP1 CR tube
- Re-trace blanking
- Voltage regulation
- Extended band width
- Peak-to-peak calibrating provisions
- Good square wave response
- Asigmatism control
- New heavy duty shielded power transformer

Announcing the latest addition to a brilliant series of Heathkit Oscilloscopes, the new Model O-9. This outstanding instrument incorporates all of the features developed and proven in the production of well over 50,000 kits, in addition to a host of many new design features for truly outstanding performance. This new scope features a brand new (no surplus) commercially available SUP1 cathode ray tube for fine focusing, high intensity, and freedom from halation. The 5" CR tube is the standard size for design and industrial laboratory, development engineers, and service men. The only size CR tube offering a wide range of types, colors, phosphors, and persistence. The answer to good oscilloscope performance lies in improved basic design and operating characteristics, and now in the use of larger CR tubes.

VERTICAL AMPLIFIER — New extended band width vertical amplifier with sensitivity of .005 volts per inch, down 3 db at 2 mc, down only 5½ db at 3 mc. Three step vertical input attenuator, quality ceramic variable capacitors for proper input compensation, provisions for calibrated 1 volt peak-to-peak reference, with calibrated screen for direct reading of TV pulses.

NEW 5" Heathkit OSCILOSCOPE KIT

MODEL O-9

$59.50

SHIPPING WT. 28 LBS.

HORIZONTAL AMPLIFIER — New input selector switch provides choice of horizontal input, 60 cycle sweep input, line sync, internal sync, and external sync. Expanded horizontal sweep produces sweep width several times the cathode ray tube diameter. New Blanking amplifier for complete retrace blanking and new pulsing control.

POWER SUPPLY — New high voltage power supply and filtering circuit for really fine hairline focusing. New heavy duty power transformer with adequate operating reserve. Voltage regulated supply for both vertical and horizontal amplifiers for absolutely rock steady traces and complete freedom from bounce and jitter due to line variations.

The acid test of any oscilloscope operation is the ability to reproduce high frequency square waves and the new Heathkit O-9 will faithfully reproduce square waves up to 600 kc. This is the ideal all around, general purpose oscilloscope for educational and industrial use, radio and TV servicing, and any other type of work requiring the instantaneous reproduction and observation of actual wave forms and other electrical phenomena.

Heathkit LOW CAPACITY PROBE KIT

NO. 342

$3.50

SHIPPING WT. 1 LB.

Oscilloscope investigation of high frequency, high impedance, or broad bandwidth circuits encountered in television work requires the use of a low capacity probe to prevent loss of gain, distortion, or false service information. The Heathkit Low Capacity Probe features a variable capacitor to provide the necessary degree of instrument impedance matching. New probe styling with bright polished aluminum housing and polystyrene probe ends.

Heathkit ELECTRONIC SWITCH KIT

MODEL S-2

$23.50

SHIPPING WT. 11 LBS.

The basic function of the Heathkit S-2 Electronic Switch Kit is to permit simultaneous oscilloscope observation of two separate traces which can be either separated or superimposed for individual study. A typical example would be observation of a signal as it appears at both the input and output stages of an amplifier. It will also serve as a square wave generator over the range of switching frequencies often providing the necessary wave form response information without incurring the expense of an additional instrument.

Continuously variable switching range in three ranges from less than 10 cps to over 2,000 cps. Individual controls for each input channel and a positioning control. The five tube transformer operated circuit utilizes two 6G17, two 6SN7, and one 6X5 tubes. Buy this kit and enjoy increased versatility of operation from your oscilloscope.

Heathkit SCOPE DEMODULATOR PROBE KIT

NO. 337-B

$3.50

SHIPPING WT. 1 LB.

In applications such as trouble shooting or aligning TV, RF, IF, and video stages, the frequency ranges encountered require demodulation of signals before oscilloscope presentation. The newly-designed Heathkit Demodulator Probe in polished aluminum housing will fulfill this function and readily provide its value as an oscilloscope service accessory. Detailed assembly sheet provided, including instructions for probe operation.
The beautiful Heathkit Model V-6 VTVM, the world's largest selling kit instrument, now offers many outstanding new features in addition to retaining all of the refinements developed and proven in the production of over 100,000 VTVM's. This is the basic measuring instrument for every branch of electronics. Easily meets all requirements for accuracy, stability, sensitivity, convenience of ranges, meter readability, and modern styling. It will accurately measure DC voltages, AC voltages, offers tremendous ohmmeter range coverage, and a complete db scale for a total of 35 meter ranges.

Now 1/2 volt full scale low ohms provides well over 214" of scale length per volt. Upper DC scale limit 1,500 volts. DC ranges 0-1.5, 5, 15, 50, 150, 500, 1,500 volts full scale. AC ranges 0-1.5, 5, 15, 50, 150, 500, 1,500 (1,000 volts maximum). Seven ohmmeter ranges from .1 ohm to 1,000 megohms. For added convenience a DC polarity reversing switch and a center scale zero adjustment for FM alignment.

The smartly styled, compact, sturdy, formed aluminum cabinet is finished in an attractive gray crinkle exterior. The beautiful two-color, durable, infra-red, baked enamel panel further adds to the over-all professional appearance.

Top quality components used throughout. 1% precision resistors — silver contact range and selector switches — selenium rectifier — transformer, operated power supply. Individual calibration on both AC and DC for maximum accuracy. DB scale printed in red for easy identification, all other scales a sharp, crisp black for easy reading. A variety of accessory probes shown on this page still add further to over-all instrument usefulness.

### Features
- New 1/2 volt full scale low range
- 1,500 volt upper limit DC range
- Increased accuracy through 50% greater scale coverage
- High impedance 11 megohm input
- Center scale zero adjust
- Polarity reversal switch
- 1% precision resistors
- Clearly marked db scales

**Heathkit 30,000 Volt DC PROBE KIT**

For TV service work or any similar application where the measurement of high DC voltage is required, the Heathkit Model 336 High Voltage Probe Kit will prove invaluable. A precision multiplier resistor mounted inside the two-color, sleek, plastic probe body provides a multiplication factor of 100 on the DC ranges of the Heathkit 11 megohm VTVM.

The entire kit includes precision resistor, two-color plastic probe, tip connector spring, test lead, phone plug panel connector, and complete assembly instructions.

**No. 336**

**Heathkit PEAK-TO-PEAK PROBE KIT**

Now read peak-to-peak voltages on the DC scales of the Heathkit 11 megohm VTVM. Readings can be directly made from the VTVM scale without involved calculations. Measurements over the frequency range of 5 kc to 5 mc. Use this probe to extend the usefulness of your VTVM in radio and TV service work. The Peak-to-Peak Probe Kit features the new polished aluminum bodying with two-color polysyrene probe ends. Detailed assembly sheet including instructions for probe operation.

**No. 338-B**

**Heathkit RF PROBE KIT**

The Heathkit RF Probe used in conjunction with any 1 megohm VTVM will present RF measurements up to 250 mc, ± 10%. A useful, convenient accessory at those occasions when RF measurements are desired. The RF probe body is housed in a polished aluminum probe body featuring two-color polysyrene probe ends and a low capacity flexible shielded test lead. The kit is complete with all necessary material and a detailed assembly sheet as well as instructions for probe operation.

**No. 309-B**

**Heathkit AC VACUUM TUBE VOLTMETER KIT**

**Model AV-2**

The new Heathkit AC VTVM that makes possible those sensitive AC measurements required by laboratories, audio enthusiasts, and experimenters. Especially useful for hum investigation, sensitive null detection, phono pick-up output measurements, making frequency response runs, gain measurements, ripple voltage checks, etc. Low level measurements are easy to make because of the complete voltage coverage of the instrument and the one knob operation.

The large 200 microampere Simpson meter has clearly marked and easy to read meter scales. Ten voltage ranges covering from .01 rms full scale to 300 volts rms full scale, with frequency response ± 1 db from 20 cycles to 50,000 cycles. Instrument input impedance 1 megohm, ten db ranges from ~52 db to ~15 db. For stability and good linearity characteristics the meter bridge circuit features 4 germanium diodes. Attractive instrument styling, a companion piece for all popular Heathkit VTVM and the new AW-1 Audio Wattmeter.

**No. 336**

**Heathkit VOLTMETER KIT**

**Model V-6**

**$24.50**

**Shipping WT 6 LBS.**
The most important Heathkit announcement of the year, the new 20,000 ohms per volt Heathkit Multimeter, Model MM-1. The universal service measuring instrument, accurate, sensitive, portable, and completely independent of AC line supply. Particularly designed for service use incorporating many desirable features for the convenience of the service man. Full 20,000 ohms per volt sensitivity on DC ranges—5,000 ohms per volt sensitivity on AC—polarity reversal switch, no bothersome transferring of test leads—1% precision multiplier resistors — large 4½" recessed non-glare 50 microampere Simpson meter — conveniently slanted control panel — recessed safety type banana jacks — standard universally available batteries — rugged practical sized cabinet with plastic carrying handle, and a total of 35 calibrated meter ranges.

**Ranges**

Voltage ranges selected entirely for service convenience. For example 1½ volt full scale low range for measuring portable radio filament voltages, bias voltages, etc., 150 volt full scale range for AC-DC service work, 500 volt full scale range for conventional transformer operated power supply systems. Complete voltage ranges AC and DC, 0-1.5—5—50—150—500—1,000—5,000 volts. DC current ranges, 0-150 microamperes—15 milliamperes—150 milliamperes—500 milliamperes—15 amperes. Resistance measurements from .2 ohms to 20 meg-ohms x 1 x 1,000 x 10,000. DB coverage from —10 db to +65 db.

**Construction**

Entirely new design permits assembly, mounting and wiring of precision resistors on a ring-switch assembly unit. The major portion of instrument wiring is completed before mounting the ring-switch assembly to the panel. No calibration procedure is required, all precision resistors readily accessible in event of replacement.

**Cabinet**

Strikingly modern cabinet styling featuring two piece construction, durable black Bakelite cabinet, with easy to read panel designations. Cabinet size 5½" wide x 4" deep x 7½" high. Good cabinet physical stability when operated in vertical position.

The Heathkit MM-1 represents a terrific instrument value for a high quality 20,000 ohms per volt unit using all 1% deposited carbon type precision resistors. Here is quality, performance, functional design, and attractive appearance, all combined in one low priced package.

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**Heathkit Battery Tester Kit**

The Heathkit Battery Tester measures all types of dry batteries between 1½ volts and 150 volts under actual load conditions. Readings are made directly on a three color Good-Weak-Replace scale. Operation is extremely simple and merely requires that the test leads be connected to the battery under test. Only one control to adjust in addition to a panel switch for "A" or "B" battery types. The Heathkit Battery Tester features compact assembly, accurate meter movement, and a three deck wire-wound control, all mounted in a portable rugged plastic cabinet. Checks portable radio batteries, hearing aid batteries, lantern batteries, etc.

**Heathkit Handitester Kit**

The Heathkit Model M-1 Handitester readily fulfills major requirements for a compact, portable volt ohm milliammeter. Despite its compact size, the Handitester is packed with every desirable feature required in an instrument of this type. AC or DC voltage ranges full scale, 0-10—30—500—1,000—5,000 volts. Two milliammeter ranges, 0-3,000 and 0-300,000. Two DC current measurement ranges, 0-10 milliamperes and 0-100 milliamperes. The instrument uses a Simpson 400 microampere meter movement, which is shunted with resistors to provide a uniform 1 milliampere load on both AC and DC ranges. Special type, easily accessible, battery mounting bracket—1% deposited carbon type precision resistors—hinging aid type ohms adjust control. The Handitester is easily assembled from complete instructions and pictorial diagrams. Necessary replaceable leads are included in the price of this popular kit.
Here is the new Heathkit Battery Eliminator necessary for modern, up-to-date operation of your service shop. The Heathkit Model BE-4 furnishes either 6 volts or 12 volts output which can be selected at the flick of a panel switch. Use the BE-4 to service the new 12 volt car radios in addition to the conventional 6 volt radios.

This new Battery Eliminator provides two continuously variable output ranges, 0-8 volts DC at 10 amperes continuously, or 15 amperes maximum intermittent; 0-16 volts DC at 5 amperes continuously or 7.5 amperes maximum intermittent. The output voltage is clean and well filtered as the circuit uses two 10,000 mf condensers. The continuously variable voltage output feature is a definite aid in determining the starting point of vibrators, the voltage operating range of oscillator circuits, etc. Panel mounted meters constantly monitor voltage and current output and will quickly indicate the presence of a major circuit fault in the equipment under test. The power transformer primary winding is fuse protected and for additional safety an automatic relay of the self-resetting type is incorporated in the DC output circuit. The heavy duty rectifier is a split type 18 plate magnesium copper sulfide unit used either as a full wave rectifier or voltage doubler according to the position of the panel range switch.

Here is the ideal battery eliminator for all of your service problems and as an additional feature, it can also be used as a battery charger. Another new application for the Heathkit Battery Eliminator is a variable source of DC filament supply in audio development and research. More than adequate variable voltage and current range for normal applications.

**Heathkit VIBRATOR TESTER KIT**

Your repair time is valuable, and service use of the Heathkit Vibrator Tester will save you many hours of work. This tester will instantly tell you the condition of the vibrator being checked. Checks vibrators for proper starting and the easy to read meter indicates quality of output on a large Bad-?-Good scale. The Heathkit VT-1 checks both interruptr and self rectifier types of vibrators. Five different sockets for checking hundreds of vibrator types.

The Heathkit Vibrator Tester operates from any battery eliminator capable of delivering continuously variable voltage from 4 to 6 volts DC at 4 amperes. The new Heathkit Model BE-4 Battery Eliminator would be an ideal source of supply.

**NEW Heathkit VARIABLE VOLTAGE ISOLATION TRANSFORMER KIT**

The new Heathkit Isolation Transformer Kit provides line isolation for AC-DC radios (not an auto transformer), thereby eliminating shock hazard, hum problems, alignment difficulties, etc. The output voltage is variable from 90 to 150 volts AC and is constantly monitored by a panel mounted AC volt meter. Use it to increase AC supply voltage in order to induce breakdown of faulty components in circuits thereby saving service time. Use it also to simulate varying line voltage conditions and to determine the line voltage level at which oscillator circuits cease functioning, particularly in three-way portable radios. Rated at 100 watts continuous operation and up to 200 watts maximum intermittent operation. A useful radio and TV service tool.

**Heathkit TECHNICAL APPLICATION BULLETINS**

An exclusive Heathkit service. Technical application bulletins prepared by recognized instrument authorities outlining various combinations of instrument applications. Available now with 40 four-page illustrated bulletins and an attractive flexible loose-leaf binder. Only $2.00. (No c.o.d. on this item, please.)
Proudly announcing an entirely new, advanced model TV and FM Sweep Generator, the Heathkit Model TS-3. This new design provides features and combinations of functions not found in any other service type instrument. Every design consideration has been given to the requirements of the TV service man to provide a flexible, variable sweep source with more than adequate RF output and complete frequency coverage throughout the TV and FM spectrum.

The frequency range of the TS-3 is from 4 mc to 220 mc in four switch selected ranges. All frequency ranges are overlapping for complete coverage. A particularly important feature of the instrument is that the oscillator operates entirely on fundamentals, thereby providing complete freedom from spurious oscillation and parasitics normally encountered at beat frequency type oscillators. This circuit assures a much higher total RF output level and simplifies attenuation problems.

The new TS-3 features an entirely new principle of sweep operation. Sweep action is entirely electronic with no moving parts or electro-mechanical devices as commonly used. The heart of the sweep system is a newly-developed INCREDUCTOR controllable inductor. With this system, the value of inductance of each oscillator coil is electrically varied with an AC control current, and the inductance variation is achieved by a change in the magnetic state of the core on which the oscillator coils are wound. This system provides a sweep deviation of not less than 12 mc on all TV frequencies, and up to a maximum of 30 mc on TV IF frequencies. The high RF output level throughout the instrument frequency range overcomes the most common complaint of the older type sweep generators. A new, automatic amplitude control circuit maintains the output level flat to ± 2 db throughout the instrument range. For convenience of operation a low impedance 50 ohm output is used.

Operation of the instrument has been simplified through the reduction of panel controls and separate panel terminals provide for external synchronization if desired. The circuit uses a voltage regulator tube to maintain stable instrument operation. A built-in variable oscillator marker further adds to flexibility of instrument operation. Provisions are also made for the use of an external marker, such as your service type signal generator, if desired. Use the Heathkit TS-3 for rapid, accurate TV alignment work, and let it help you save those time consuming, irksome problems so frequently encountered.

NEW Heathkit

SIGNAL GENERATOR KIT

MODEL SG-8

$19.50

SHIPPING WEIGHT
8 POUNDS

Announcing the new Heathkit Model SG-8 service type Signal Generator, incorporating many design features not usually found in an instrument in this price range. The RF output is from 160 kc to 100 mc in five ranges, all on fundamentals, with useful harmonics up to 200 mc. The RF output level is in excess of 100,000 microvolts throughout the frequency range.

The oscillator circuit consists of a 12AT7 twin triode tube. One half is used as a Colpitts oscillator, and the other half as a cathode follower output which acts as a buffer between the oscillator and external load. This circuit eliminates oscillator frequency shift usually caused by external circuit loading.

All coils are factory wound and adjusted, thereby completely eliminating the need for calibration and the use of additional calibrating equipment. The stable low impedance output features a steep and variable attenuator for complete control of RF level. A 6CA4 triode acts as a 400 cycle sine wave oscillator and a panel switching system permits a choice of either external or internal modulation.

The transformer operated circuit is easy to assemble, requires no calibration, and meets every service requirement for an adjustable level variable frequency signal source, either modulated or un-modulated.

NEW Heathkit

BAR GENERATOR KIT

MODEL BG-1

$14.50

SHIPPING WEIGHT
6 POUNDS

The Heathkit BG-1 Bar Generator represents another welcome addition to the fast growing line of popular Heathkits. The station transmitted test pattern is rapidly disappearing, and the bar generator is the logical answer to the TV service man's problem in obtaining quick, accurate adjustment information without waiting for test patterns.

The Heathkit BG-1 produces a series of horizontal or vertical bars on a TV screen. Since these bars are equally spaced, they will quickly indicate picture linearity of the receiver under test. Panel switch provides "stand-by position" — "horizontal position" — "vertical position." The oscillator unit utilizes a 12AT7 twin triode for the RF oscillator and video carrier frequencies. A neon relaxation oscillator provides low frequency for vertical linearity tests. The instrument will not only produce bar patterns but will also provide an indication of horizontal and vertical sync circuit stability, as well as overall picture size.

Instrument operation is extremely simple, and merely requires connection to the TV receiver antenna terminal. The unit is transformer operated for safety when used in conjunction with universal or transformerless type TV circuits.
The new Model TC-2 Heathkit Tube Checker features many circuit improvements, simplified wiring, new roll chart, drive and illumination of roll chart. The instrument is primarily designed for the convenience of the radio and TV service man and will check the operating quality of tubes commonly encountered in this type of work. Test setup procedure is simplified, rapid, and flexible. Panel sockets accommodate 4, 5, 6, and 7 pin tubes, octal and locatol, 7 and 9 pin miniatures, 5 pin Hytron and a blank socket for new tubes. Built-in neon short indicator, individual three-position lever switch for each tube element, spring return test switch, 14 filament voltage ranges, and line set control to compensate for supply voltage variations, all represent important design features of the TC-2. Results of tube tests are read directly from a large 4½” Simpson three-color meter, calibrated in terms of Bad–Good. Information that your customer can readily understand. Checks emission, shorted elements, open elements, and continuity.

The use of closer tolerance resistors in critical circuits assures correct test information and eliminates the possibility of inaccurate test interpretation. Improvement has been made in the mechanical roll chart drive system, completely eliminating diagonal running, erratic operation, and backlash. The thumb wheel gear driven action is smooth, positive, and free running. As an additional feature, the roll chart is illuminated for easier reading, particularly when the tube checker is used on radio or TV home service calls.

Wiring procedure has been simplified through the extended use of multicable, color coded wires, providing a harness type installation between tube sockets and lever switches. This procedure insures standard assembly and informs that “factory built” appearance to instrument construction. Completely detailed information is furnished in the new step-by-step construction manual, regarding the set-up procedure for testing of new or unlisted tube types. No delay necessary for release of factory data.

The new Heathkit Tube Checker will prove its value in building service prestige through usefulness—simplified operation—attractive professional appearance. Don’t overlook the fact that the kit price represents a savings of $40.00 to $50.00 over the price of a comparable commercially built instrument. At this low price, no service man need be without the advantages offered by the Heathkit Tube Checker.
CHECK THESE Features

- Visual and aural signal tracing
- Two channel input
- High RF sensitivity
- Unique noise locator circuit
- Decade condenser
- Substitution wattmeter
- Utility amplifier
- RF, audio probes and test leads included

An entirely new type of signal tracer incorporating a combination of features not found in any other instrument. Designed expressly for the radio and TV service man, particularly for the servicing of AM, FM, and TV circuits. Here in a tube, transformer operated instrument are all of the useful functions so necessary for speedy, accurate isolation of service difficulty.

This new signal tracer features a special high gain RF input channel, used in conjunction with a newly-designed wide frequency range demodulator probe. High RF sensitivity permits signal tracing at the receiver antenna input. A separate low gain channel and probe available for audio circuit exploration. Both input channels are constantly monitored by an electron ray beam indicator, so that visual as well as aural signal indications may be observed. The instrument can also be used for comparative estimation of gain per stage.

A decidedly unusual feature is a noise locator circuit in conjunction with the audio probe. With this system, a DC potential is applied to a suspected circuit component and the action of the voltage in the component can be seen as well as heard. Unavailable for ferreting out noisy or intermittent condensers, noisy resistors, controls, coils, IF and power transformers, etc. A built-in calibrated wattmeter circuit is very useful for a quick preliminary check of the total wattage consumption of the equipment under test. Separate panel terminals provide external use of the speaker or output transformer for substitution purposes. Saves valuable service time by eliminating the necessity for speaker removal on every service job. The terminals are in addition the utilization of other shop equipment, such as your oscilloscope or VTM. The T-3 Signal Tracer can be used as a high gain amplifier for checking tuners, record changers, microphones, phono crystals, etc.

Don't overlook the interesting service possibilities provided through the use of this new instrument and let it work for you by saving time and money. The kit is supplied complete with all tubes, circuit components, demodulator probe, audio probe, and additional test leads.
Here is the latest Heathkit addition to the ham radio field, the AT-1 Transmitter Kit, incorporating many desirable design features at the lowest possible dollar-per-watts price. Panel mounted crystal socket, stand-by switch, key click filter, AC line filtering, good shielding, etc. VFO or crystal excitation — up to 35 watts input. Built-in power supply provides 425 volts at 100 ma. This kit features pre-wound coils, single knob band switching, 52 ohm coaxial output, plug in chassis provisions for VFO or modulator and rugged clean construction. Frequency range 80, 40, 20, 15, 11, and 10 meters. Tube line-up 6AG7 oscillator-multiplier, 6L6 amplifier doubler, 3U4G rectifier. Physical dimensions 8½ x 13½ x 7½ deep.

This amazingly low kit price includes all circuit components, tubes, cabinet, punched chassis, and detailed construction manual. The ideal kit for the novice just breaking into ham radio. It can be used later on as a stand-by rig or an all band exciter for higher powered transmitter.

New Heathkit Antenna Coupler Kit, specially designed for the Heathkit AT-1 Transmitter. The Antenna Coupler can be used with any 52 ohm coaxial input — up to 75 watts power. Low-pass filter with cutoff frequency of approximately 36 mc — L section tuning network - neon tuning indicator — rugged, compact construction — transmitter type variable condenser, and high Q coil are all outstanding features. The AC-1 has both inductance and capacitance for maximum operating versatility. Dimensions 8¼ x 4½ x 4½" deep.

Heathkit Communications Receiver Kit. The perfect companion piece for the AT-1 Transmitter kit. Many outstandingly desirable features have been incorporated in the design of the AR-2; such as, electrical bandwidth, for logging and tuning convenience — high gain miniature tubes — IF transformers for high sensitivity and good signal to noise ratio — separate RF gain control with optional automatic volume control or manual volume control, in addition to the conventional audio gain control. Noise limiter — stand-by switch — stable BFO oscillator circuit — headphone jack — transformer operation, etc. all contribute to a high performance standard. Frequency coverage is continuous from 335 kc to 35 mc in four ranges. For added convenience, various ham bands have been separately identified in respect to their relative placement on the slide rule tuning scale. A chassis mounted, 5½" FM speaker is included with this kit. Tube line up 12BE6 mixer oscillator, 12BA6 IF amplifier, 12AV6 detector AVC audio, 12BA6 BFO oscillator, 12AG6 beam power output, 5Y3GT rectifier.

Heathkit Antenna Impedance Meter

Use the Heathkit Antenna Impedance Meter for determining antenna impedance for line matching purposes — adjustment of beam antennas — phone monitor, etc. It will determine antenna resistance at resonance, match transmission line for minimum SWR, determine receiver input impedance, and provides a rough indication of SWR. Precision resonator, germanium diode, 100 microampere Simpson meter. Dial calibrated from 0-500 ohms. Shielded aluminum cabinet. Dimensions 7½ x 2½ x 3½" deep.

Improved Heathkit Grid Dip Meter Kit

The invaluable instrument for service men, hams, and experimenters. Useful in TV service work for alignment of traps, filters, IF stages, peaking compensation networks, etc. Locates spurious oscillation, provides a relative indication of power in transmitter stages, use it for neutralization, locating parasitics, correcting TVI, measuring C, L and Q of components, and determining RF circuit resonant frequencies. With oscillator energized, useful for finding resonant frequency of tuned circuits. With the oscillator not energized, the instrument acts as an absorption wave meter. Variable meter sensitivity control, head phone jack, 500 microampere Simpson meter. Continuous frequency coverage from 2 mc to 250 mc. Pre-wound coil kit and rack, new three prong coil mount, 6A48 high frequency triode.

Two additional plug-in coils are available and provide continuous extension of low frequency coverage down to 355 kc. Dial correlation curves included. Shipping weight 1 lb., kit 341, $3.00.

Heathkit AMATEUR TRANSMITTER KIT

MODEL AT-1

$29.50

SHIPPING WEIGHT 16 POUNDS

CHECK THESE NEW FEATURES

* Single knob band switching
* Pre-wound coils
* Metered operation
* 52 ohm coaxial output
* Crystal or VFO excitation
* Built-in power supply
* Rugged, clean construction

Heathkit COMMUNICATIONS RECEIVER KIT

MODEL AR-2

$25.50

SHIP. WT. 12 LBS.

Here is the new receiver kit you have repeatedly asked for, the Heathkit Communications Receiver. The perfect companion piece for the AT-1 Transmitter kit. Many outstandingly desirable features have been incorporated in the design of the AR-2; such as, electrical bandwidth, for logging and tuning convenience — high gain miniature tubes — IF transformers for high sensitivity and good signal to noise ratio — separate RF gain control with optional automatic volume control or manual volume control, in addition to the conventional audio gain control. Noise limiter — stand-by switch — stable BFO oscillator circuit — headphone jack — transformer operation, etc. all contribute to a high performance standard. Frequency coverage is continuous from 335 kc to 35 mc in four ranges. For added convenience, various ham bands have been separately identified in respect to their relative placement on the slide rule tuning scale. A chassis mounted, 5½" FM speaker is included with this kit. Tube line up 12BE6 mixer oscillator, 12BA6 IF amplifier, 12AV6 detector AVC audio, 12BA6 BFO oscillator, 12AG6 beam power output, 5Y3GT rectifier.

RECEIVER CABINET

Proxylon impregnated, fabric covered, plywood cabinet with aluminum panel designed expressly for the AR-2 Receiver. Part 91-10, shipping weight 5 lbs., $4.50.

Heathkit ANTENNA COUPLER KIT

MODEL AC-1

$14.50

SHIP. WT. 3 LBS.

Heathkit ANTENNA IMPEDANCE METER

MODEL AM-1

$14.50

SHIP. WT. 3 LBS.

IMPROVED Heathkit GRID DIP METER KIT

MODEL GD-1B

$19.50

SHIP. WT. 4 LBS.

The invaluable instrument for service men, hams, and experimenters. Useful in TV service work for alignment of traps, filters, IF stages, peaking compensation networks, etc. Locates spurious oscillation, provides a relative indication of power in transmitter stages, use it for neutralization, locating parasitics, correcting TVI, measuring C, L and Q of components, and determining RF circuit resonant frequencies. With oscillator energized, useful for finding resonant frequency of tuned circuits. With the oscillator not energized, the instrument acts as an absorption wave meter. Variable meter sensitivity control, head phone jack, 500 microampere Simpson meter. Continuous frequency coverage from 2 mc to 250 mc. Pre-wound coil kit and rack, new three prong coil mount, 6A48 high frequency triode.

Two additional plug-in coils are available and provide continuous extension of low frequency coverage down to 355 kc. Dial correlation curves included. Shipping weight 1 lb., kit 341, $3.00.

The HEATH COMPANY

...BENTON HARBOR 20, MICHIGAN...
Another outstanding example of successful Heathkit engineering effort in producing a Q Meter Kit within the price range of TV service men, schools, laboratories, and experimenters. This Q Meter meets RF design requirements for rapid, accurate measurement of capacity, inductance, and Q at the operating frequency and all indications of value can be read directly on the meter calibrated scales. Oscillator section supplies RF frequencies of 150 kc to 18 mc. Calibrate capacitor with range of ±0 mmf to 450 mmf, with vernier of ±3 mmf.

Particularly useful in TV service work for checking peaking coils, wave traps, chokes, deflection coils, width and linearity coils, etc. At this low kit price research laboratory facilities are within the range of service shops, schools, and experimenters.

Heathkit AUDIO GENERATOR KIT

A Heathkit Audio Generator with frequency coverage from 20 cycles to 1 mc. Response flat ±1 db from 20 cycles to 400 kc, down 3 db at 600 kc, and down only 8 db at 1 mc. Calibrated, continuously variable, and step attenuator output controls provide convenient reference output level. Distortion is less than .04% from 100 cps through the audible range. The ideal controllable extended frequency sine wave source for audio circuit investigation and development.

Heathkit INTERMODULATION ANALYZER KIT

The Heathkit IM-1 is an extremely versatile instrument specifically designed for measuring the degree of interaction between two signals in any portion of an audio chain. It is primarily intended for making tests of audio amplifiers, but may be used in other applications such as checking microphones, records, recording equipment, phonograph pick-ups, and loud-speakers. High and low test frequency source, intermodulation unit, power supply, and AC vacuum tube volt meter all in one complete instrument. Per cent intermodulation is directly read on the calibrated scales, 0%, 10%, and 50% full scale. Both 4:1 and 3:1 ratios of low to high frequency easily set up. With this instrument the performance level of present equipment, or newly developed equipment can be costly and accurately checked. At this low price, you can now enjoy the benefits of intermodulation analysis for accurate audio interpretation.

Heathkit AUDIO OSCILLATOR KIT

Sine or square wave coverage from 20 to 20,000 cycles in three ranges at a controllable output level up to 10 volts. Low distortion, 0.1% precision resistors in multiplier circuits, high level output across entire frequency range, etc., readily qualify this instrument for audio experimentation and development work. Special circuit design consideration features thermistor operation for good control of linearity.

Heathkit AUDIO FREQUENCY METER KIT

The Heathkit Audio Frequency Meter provides a simple and convenient means of checking unknown audio frequencies from 10 cycles to 100 kc at any voltage level between 3 and 300 volts rms with any non-critical wave shape. Instrument operation is entirely electronic. Just set the range switch, feed an unknown frequency into the instrument, and read the frequency directly on the calibrated scale of the Simpson 4½" meter.
### Heathkit WILLIAMSON TYPE AMPLIFIER KIT

**MODEL W-2**

<table>
<thead>
<tr>
<th>Prices of Combinations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-2 Amplifier Kit including main amplifier, power supply, and WA-1P Preamplifier Kit. Shipping Weight 37 lbs. Shipped Express only.</td>
<td>$69.50</td>
</tr>
<tr>
<td>W-2M Amplifier Kit includes main amplifier and power supply. Shipping Weight 29 lbs. Shipped Express only.</td>
<td>$49.75</td>
</tr>
<tr>
<td>WA-1P Preamplifier Kit only. Shipping Weight 6 lbs. Shipped Express or Parcel Post.</td>
<td>$19.75</td>
</tr>
</tbody>
</table>

When selecting an amplifier for the heart of your high fidelity audio system, investigate the outstanding advantages offered by the Heathkit Williamson Type Amplifier. Meets every high fidelity audio requirement and makes listening to recorded music a thrilling new experience. This outstanding amplifier is offered with optional output transformer operation, providing either the conventional triode output circuit or the new extended power circuit in which the screen supply voltage is obtained from separate transformer primary taps. Frequency response within 1 db from 10 cycles to 10,000 cycles. Sum harmonic distortion under 1% (at 3 db below rated output). Tube complement—6SN7 cathode type and phase splitter, (SG7) push pull driver, two 3881 push pull power amplifiers, one 5V4G cathode type rectifier.

### New Heathkit 20 Watt High Fidelity Amplifier Kit

**MODEL A-9A**

- Price: $35.50
- Shipping Weight: 18 lbs.

A new 20 watt high fidelity amplifier, designed especially for custom audio installations demanding clean reproduction, adequate power, and flexibility to meet individual requirements. Separate treble and bass tone controls provide up to 15 db boost or cut. Four switch selected inputs, each with the necessary compensation for the service desired. Output transformer impedances of 4, 8, and 16 ohms. Preamplifier, tone control, and phase splitter circuits utilize pin twin triode miniature tubes for low hum and noise level. Two 6L6 push pull power output tubes provide full 20 watts power. Frequency response ± 3 db, 20-20,000 cycles. Total harmonic distortion under 1% (at 3 db below rated output). Tube complement: 12AX7 preamplifier, 12AU7 voltage amplifier and tone control, 12AU7 voltage amplifier and phase splitter, two 6L6 push pull power output, 3U4G rectifier. Truly outstanding amplifier performance coupled with low cost.

### New Heathkit Receiver Kit

Another new Heathkit for the student, beginner, or hobbyist. If you have ever had the urge to build your own radio receiver, this kit warrants your attention.

- New high gain miniature tubes and IF transformers provide excellent sensitivity and good signal to noise ratio. A built-in ferrite core rod type antenna has been provided. A chasis mounted 51/2 inch PM speaker provides excellent tone and volume. Convenient phone input. Can be operated either as a receiver or tuner. Simplified construction manual outlines circuitry ideal for student. Tube line-up: 12BE6 mixer oscillator, 12BA6 IF amplifier, 12AV6 detector AVC first stage, 12A6 beam power output, 513GT rectifier.

### New Heathkit Economy 6 Watt Amplifier Kit

**MODEL A-7B**

- Price: $15.50
- Shipping Weight: 10 lbs.

The Heathkit Model A-7B Amplifier Kit incorporates many unusually fine features not normally expected in this low price range. Either of the two input circuits may be individually switched selected for phono or tuner operation. Separate bass and treble tone controls. Output impedances of 4, 8, and 16 ohms. Push pull beam power output stage for balanced reproduction. Excellent voltage gain characteristics, good frequency response, and full 6 watts power output. 1213 power, 12L57 second amplifier and phase splitter, two 12A6 beam power output, one 5Y5 GT rectifier.

### Heathkit FM Tuner Kit

**MODEL FM-2**

- Price: $22.50
- Shipping Weight: 9 lbs.

The Heathkit FM-2 Tuner was specifically designed for simplified kit construction. Can be operated through the "phono" portion of your radio or with a separate amplifier. The kit features a pre-assembled and adjusted tuning unit, three double tuned IF transformers, and a discriminator transformer in an 8 tube AC operated circuit. Frequency coverage 88 to 108 mc. Experience the thrill of building your own FM tuner and at the same time enjoy all of the advantages of true FM reception.

### Free Catalog

Write for free catalog containing latest price information, schematics, specifications, and descriptions of all Heathkits.

---

**The Heath Company**

...BENTON HARBOR 20, MICHIGAN...
CHECK THESE NEW Features

- Plays all record sizes, all speeds
- Newly developed ceramic cartridge
- Automatic shut-off for both changer and amplifier
- Acoustically correct cabinet enclosure
- Modern attractive styling
- Two 6" PM matched speakers
- Compensated volume control
- Easy to assemble

An entirely new introduction to quality record reproduction, a simple to operate, compact, table top model with none of the specialized custom installation problems usually associated with high fidelity systems. Two matched, synchronized speakers mounted in an acoustically correct enclosure reproduce all of the music on the record. Musical reproduction with the unique sensation of being surrounded by a halo of glorious sound. This spectacular characteristic is possible only because of the diffused non-directional properties of the matched dual speakers. The Heathkit Dual makes listening to fine recorded music a thrilling new experience through naturally clear, life-like reproduction of sound at all levels throughout the tonal system. The performance level is vastly superior to that of the ordinary phonograph, or console selling for many, many times the price of the Dual.

Record Changer plays all sizes—all speeds—automatic shut-off for changer and amplifier after the last record is played. A wide tonal range ceramic cartridge features an ingenious turn-under twin sapphire stylus for LP or 78 records without turning the cartridge.

Simplified, easy to assemble, four tube amplifier features compensated volume control and separate tone control. Proxylin impregnated fabric covered cabinet supplied completely assembled. You build only the amplifier from step-by-step construction. No specialized tools or knowledge required, as full recognition has been given to the fact that many purchasers of this kit enjoy good musical reproduction on a purely non-technical basis, and the construction manual has been simplified to the point where even the complete novice can successfully construct the Heathkit Dual. The price of the Heathkit Dual includes cabinet. — Record Changer, two 6" PM speakers, tubes, and all circuit components required for amplifier construction.

HEATH COMPANY • Benton Harbor 20, Mich.
SERVICING—TEST INSTRUMENTS

NON-DESTRUCTIVE METHOD OF PRESERVING ARTICLES

Radio-Electronics and other magazines for technicians are goldmines of useful servicing information, often containing hints that can't be found in the most complete files of Sams' or Rider's manuals (even if every technician were fortunate enough to have complete sets of these manuals). The information contained in these magazines can be much more useful, however, if you can locate it quickly when you need it. Haven't you often run across a servicing or experimental problem that you remember was discussed in a back issue of a publication; but rather than search through several years' issues, you went ahead and solved it the hard way, perhaps wasting several hours?

I use a card-index system similar to that found in most libraries. An ordinary 3 x 5-inch kitchen-recipe file box with alphabetical dividers and standard ruled file cards is ideal for this purpose. A basic unit of this type can be obtained complete for as little as fifty cents at many "five-and-dime" stores, and additional units can be purchased as required.

I have indexed all articles that I may want to refer to in my collection of back issues, and I bring my file up to date regularly with each new issue. This method has paid for itself many times over.

New TELE-VOLTER by Jackson
15 reasons why VEE-D-X IS YOUR BEST CHOICE

UHF ANTENNAS

MODEL BT-U - The aristocrat of Bow-Tie antennas. Superior in both construction and performance. Can be stacked for extra gain. Compare!

MODEL CA-U - Famous Co-linear that has highest gain of all bread band fringe area UHF antennas. Also available in Dual Jr. models for specific area requirements.

MODEL COR-U - The Corner Reflector has 40% higher gain than a single Bow-Tie. Finest construction with rugged Fiberglas boom and solid aluminum elements. Minimizes probing.

MODEL LI-U - The UHF Long John. Single-channel, 8-element yagi for primary and fringe areas. Compact, efficient, pre-assembled, easy-to-install.

MODEL LLI-U - The most powerful of all single channel UHF antennas. Has rugged Fiberglas boom and solid aluminum elements.

MODEL QTR - Famous Ultra Q-Tee all-channel (2-83) UHF-VHF antenna. Has printed circuit filters - ideal for primary areas.

*ALL, A.A.E. Ports. 2,422,458; 2,282,292; 2,419,296; others pending.

VHF ANTENNAS

MODEL JC - For the most powerful single channel performance. A popular 3-element yagi. Easy-to-Install.

MODEL DC - The famous VEE-D-X low cost 3-element yagi with original VEE-D-X Delta Match construction.

MODEL DX - The famous economy super power yagi. Has 30% higher gain on high channels than any other 10-element yagi. Delta Match and boom braced.

NEW BROAD BAND YAGIS - Finest of all. Available in both 10-element "X" series and 5-element "V" series, each in 3 cuttings, cover entire VHF channel range.

NEW VEE-D-X ANTENNA ROTATOR


FREE

Write for your copy of this complete new 36 page pocket guide to the world's finest antenna systems.
New Volt-Ohm-Microammeter

A new 33-range multimeter challenges the v.t.v.m. for top honors in TV and electronic maintenance.

Front view of the Simpson 269 volt-ohm-microammeter.

Fig. 1—Photo of the meter movement used in the 269 multimeter.

The new Simpson model 269 volt-ohm-microammeter is an ultrasensitive instrument. Its sensitivity of 100,000-ohms-per-volt is greater than that of a vacuum-tube voltmeter on all the higher scales. For this and other reasons it has a number of advantages over the v.t.v.m., usually considered the basic test instrument for radio, TV, and industrial electronic servicing and maintenance. The 269 is built around a 10-microampere movement of radically new design, which makes the meter as rugged in portable use as former instruments with a much higher current drain.

The electronic technician is more or less familiar with the standard D'Arsonval meter movement. It consists of a horseshoe magnet filling the greater part of the meter case, and a coil of wire which turns in the field between the poles of the magnet. The wire is wound on a very light frame and pivoted on jewel bearings, and shaped soft iron pole pieces are added to the magnet for even distribution of magnetic flux. Another piece of soft iron, circular in shape, is mounted inside the coil to decrease the magnetic air gap. The coil is so positioned that when current flows through it, it turns on its bearings, bringing the pointer or indicator around with it. Spiral springs resist the tendency of the coil to turn. These springs return the indicator to zero when no current flows through the meter, and varying their tension varies the meter range within limits, thus making it possible to calibrate it.

In the new movement, Fig. 1, the coil is the same as before, but the magnet is now the round center slug. Outside the coil is a round soft-iron ring, which acts to decrease the magnetic gap as before, and also confines the field of the magnet and protects the coil from stray magnetic fields.

Advantages of the 269

1. No external power is required. Therefore it may be used to service industrial apparatus in plants which use d.c. or a.c. Being free from the need for a power line, the problem of finding an outlet close to the equipment to be serviced also disappears.

2. The meter is always ready to use. There is no warmup or stabilization period.

3. The accuracy of the meter is often greater than that of a v.t.v.m. covering the same range. The accuracy of an electronic meter may vary because of weak or bad tubes, low line voltage, or troubles in the electronic circuit.
by an extensive consumer campaign in TELEVISION and NEWSPAPER...in KEY ROTOR MARKET AREAS*

*coming to your city too!

The TR-12 is a special combination value consisting of complete rotor including thrust bearing, handsome modern design plastic cabinet with meter control dial—the same unit without the thrust bearing.

The TR-11 is the same unit without the thrust bearing.

The TR-2 is the HEAVY DUTY rotor especially suited for special TV antenna installations. Complete rotor with "Compass Control" cabinet having illuminated "perfect pattern" dial.
Since the nonelectronic meter is free from these weaknesses, its inherent accuracy is higher.

4. Simple operation. There are two controls, one for range and function selection and one for bringing the indicator to zero on resistance measurements. Reduction in the number of controls reduces the chance of error in making measurements.

5. The meter's extreme sensitivity makes it possible to measure the direct output of thermocouples, photocells, and other types of low-output transducers and reproducers without using preamplifiers.

6. The input resistance, higher than that of a typical v.t.v.m. (usually about 11 megalohms) when the 269 is used on its 160-volt or higher range, loads circuits very lightly. Even on the 40-volt d.c. range where the input resistance is 4 megalohms, a.g.c. and a.v.c. voltages can be read with accuracy approaching

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<table>
<thead>
<tr>
<th>Key to Switch Positions</th>
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<tbody>
<tr>
<td>Position Number</td>
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Fig. 2—Schematic of the model 269 multimeter. D.c. voltages are measured with a sensitivity of 100,000-ohms-per-volt.
WE BELIEVE Norman Foster's recent advertisement in the Chicago "TV Guide" is of interest to the entire television and radio industry. Consequently, with Mr. Foster's permission, we are reprinting it here as a public service for every television and radio service technician in America.

UNFORTUNATELY

Because of the Greed of a Few,
THE ENTIRE TV SERVICE INDUSTRY MUST SUFFER

HERE IS WHAT I HAVE DONE TO GUARANTEE YOU HONEST TV SERVICE

1. The name, Foster Television is not taken from a street, a deck of cards, or a country, and it is not an adjective. It comes from the name of its sole owner, Norman Foster. I have spent 22 years in the Radio, Electronics and Television service business, and in these years I have worked for just about every type of Operator, good, bad and indifferent. When the time came that I could open my own business, I decided that because of the reputation that the Radio and Television repair business has always had, a company operating so honestly that they could invite their customers into the shop to watch their work being done could be a success. The volume of business we did last year proves I was right.

2. The reason that a service man would attempt to sell you something you do not need is because he had something to gain personally. Many Television service operators hire men, driving their own cars, on a percentage basis. This is advantageous because the service company can be in business with practically no investment. Under these conditions if this man needs money, it's only human nature that he is going to want to do the thing to your television set that will make him the most money—whether it be 5 tubes or haul it to the shop.

3. Every man that I have, works by the hour and punches a time clock. He drives a company owned new truck bearing my name and his equipment and uniforms are furnished to him without charge. He has orders to repair your set in your home whenever possible. He receives the same amount of money whether he repairs 1 set or 10, and whether he charges $1 or $10. His rate of pay and his advancement are based on the number of sets he can repair in the home.

4. Our service call price is a flat $3 and covers all labor necessary to make any repair possible in your home except cleaning a screen, for which we charge $1 extra. It is evident that on this basis we do not make money on every job, but with the large volume of business we do, it has averaged out to a modest profit at the end of the year. You can bring your set into our shop and not only save this service charge, but also see it repaired while you wait. There is no minimum charge on this service. You pay only for the actual time spent on your set.

5. How fast can service be? I have a large fleet of trucks operating throughout Chicago from 9:30 A.M. to 11:00 P.M. I do not advertise one hour service and I do not believe that anything but a coincidence could give such fast service. Because it is impossible to predict in advance how long each job will take a man, the best we can do is to offer same day service. Occasionally at this time of the year, bad weather causing slow driving, makes it necessary to postpone calls received late, until the next day.

6. Quality of parts. I use only nationally advertised tubes and parts. Every tube I sell is new, fresh and cartoned, bearing a name and a date, and is coded by the manufacturer to indicate that it is a tube manufactured and guaranteed for replacement use. I do not use bulk or surplus tubes. Every picture tube I sell bears a serial number and a factory registration certificate to guarantee that it is a new first quality tube. I do not sell rebuilt or rejuvenated picture tubes. I use only Sprague plastic sealed condensers, which are far superior to the parts used in many TV sets.

7. I guarantee every part I replace for 90 days. If a part or tube I have replaced fails, it is replaced at absolutely no charge to you. Our guarantee is further underwritten by the American Mutual Liability Insurance Co. by arrangement with the Raytheon Manufacturing Co.

8. I have not satisfied everybody and I do not claim to. I cannot repair a set that needs a new picture tube for $3 and I cannot give a $60 service contract with each call. Nothing less would satisfy certain people. However, if you hear a complaint against Foster Television, that same person will generally have one against the plumber, the auto mechanic, the dentist and nearly everyone else who is unfortunate enough to do business with him. I need and value your patronage and I will sincerely respect it.

Open 9:30 am-8:30 pm
- Home Service to 11 pm
- Sundays 11 am-3 pm
- Humboldt 9-0911

YOU CAN DEPEND ON
Foster TV
2922 Milwaukee Avenue
Chicago
SEE SKYLINE IN 3 D

Get these amazing facts on the finest all-channel antenna ever made! Your Skyline gives you better pictures, better sound—peak performance all around!

- No spraying! The patented "Skyline" eliminates most element connections from this type. Our continuous elements give greater gain, quicker resputing.
- Every day, everywhere, those who care demand the Skyline, with its exclusive Parts and Performance Warranty. Fast replacing all other types in fringe areas.

Get all channels—all frequencies. Only one lead-in. Get all the TV you want—50 miles is indicated. The Skyline, with its 32 driven elements, gives you better pictures, better sound—peak performance all around!

SERVICING—TEST INSTRUMENTS

that of a v.t.v.m. With the 269, the input resistance on the 40-volt range is the same as on the 200-volt range of a conventional 20,000-ohms-per-volt instrument. At low voltages, the 269 can be read with greater accuracy on the 40-volt scale which is calibrated with 0.5-volt divisions.

On the 160-volt range, the resistance (16 megohms) is nearly half again as large as the input resistance of a typical v.t.v.m. On the 400-, 1,600- and 4,000-volt ranges, the input resistances of the 269 are 40, 160, and 400 megohms, respectively.

The circuit of the 269 is shown in Fig. 2. Full-scale d.c. voltage ranges are: 1.6, 8, 40, 160, 400, 1,600, and 4,000. A 240-megohm resistor in a screw-on prod adapter is supplied with the instrument for measuring voltages on the 4,000-volt range. A special high-voltage probe is being manufactured as an accessory to permit the 269 to be used to measure voltages on the second node of present-day germanium transistors.

A.c. voltages are measured with 5,000-ohms-per-volt sensitivity on full-scale ranges of 3, 8, 40, 160, and 800 volts. Resistance ranges are 2,600, 20,000, and 200,000 ohms; and 2, 20, and 200 megohms with center-scale readings of 18, 180, 1,800, 18,000, and 180,000 ohms, and 1.8 megohms. Full-scale current readings are 16 and 160 µa, 1.6, 16, and 160 ma, and 1.6 and 16 amp.

Although the meter has a 10-µa movement, its lowest full-scale current range is 16 µa. Since the meter is shunted on all current ranges, the shunt damps it and minimizes the chances of damaging the meter when it is used on the lowest range.

A separate tip jack is used to insert a 0.1-nf blocking capacitor in series with one of the test leads when measuring a.f. output voltages. The ranges are the same as on a.c. except that the maximum voltage is 160. Audio volume level can be read by using the a.c. voltage circuits and a decibel scale. The scale is calibrated from -12 to +11 db and is based on a zero power level of .001 watt across 600 ohms. The scale is read directly with the selector in the 3-volt a.c. position. When the selector is in the 8, 40, and 160-volt a.c. positions, the readings are corrected by adding 8.5, 22.5, and 34.5 db respectively to the scale readings.

“IT plays only when the plug is out”
this TV set IMPROVES WITH AGE

Five years old next week—and now better than ever. When the original...
... to servicemen
who really want to
learn to use the
OSCILLOSCOPE
fully and accurately!

A complete
guide to using
the handiest
service instru-
ment of all... ...On all kinds
of jobs!...
Written so you
can really
understand it

MODERN OSCILLOSCOPES
AND THEIR USES
By JACOB H. RUITER, Jr.
of Allen B. DuMont Laboratories, Inc.
326 pages, 370 illustrations, $6.00

Like most servicemen, you're probably read a
lot about oscilloscopes—but still don't
know how to use them as well as you'd like to.
If so, here's the book you've been look-
ing for!

In MODERN OSCILLOSCOPES AND THEIR USES,
Mr. Ruitner starts right at the beginning. He traces how
oscilloscopes are designed and how they work. Then he ex-
plains exactly how, why, and where to use them.

This inspired mathematics. So polished theoretical dia-
grams illustrated. This world famous authority gets right
into the heart of the matter from the start. No doubt 
quickly, you'll find yourself following Mr. Ruitner's clear
lines and drawings. And before long you'll be ab-
solutely sure you know exactly what you're doing.

HOW TO HANDLE TOUGH JOBS
EASIER AND FASTER

From routine troubleshooting to handling the toughest rcli
alizing and adjusting jobs. Such operation is carefully explained. The
an full results. This book includes determining where and how to use
the oscilloscope; how to make connections; how to diagnose
problems quickly; how to find and correct faults. Once you know
how to handle oscilloscopes, you'll find yourself handling
service, problems, and difficulties, more rapidly, more effec-
tively, and more accurately.

SAVE HUNDREDS OF DOLLARS
IN AM-FM TV SERVICE TIME!

Busy servicemen have told us that the tele-
vision service section of MODERN OSCIL-
LOSCOPES alone is worth the entire price of
the book. Here you get exact procedures for
analyzing the I-F stages; analyzing V-F-tuned
circuits in the mixer stage; checking gain
of the picture I-F stage by stage; troubleshooting
the sweep circuits, and dozens of other
problems. Similar big sections cover use of the oscilloscope
in servicing and other electronics.

Above—Front view of the Zenith Crest.
The set measures 7 x 4 x 4½ inches, and
weighs a little less than 3 pounds. Right—
Rear view of the same receiver.

New Features in Midget Set

Some new techniques have been used in
one of the latest small a-c-d.c. re-
ceivers. Zenith's Crest, smaller than the
average portable, employs some features
normally found only in portables, but
for special reasons.

The Zenith K412 (chassis 4K01) is a
4-tube plus selenium rectifier set, with
a ferrite rod antenna. In this, it follows
the general trend in modern radi-
ceivers. But the tubes are not the mini-
ature 12- and 50-volters expected in such
a set. The oscillator is a 1R5, the i.f.
 amplifier a 1U4, the detector-first audio
 amplifier a 1U5, and the audio tube a
3V4.

The main reason for the tube comple-
ment is instant warmup. Since there is
no time lag in the selenium rectifier, it
is possible with filament-type cathodes,
to have the set start immediately it is
turned on.

Now that the television set is being
increasingly used for long-term (in
minutes) entertainment, and the radio
more important as a source of news
reports, weather bulletins and similiar
material, perhaps this start-up-and-go
feature will assume considerable im-
portance.

The antenna is in the handle, where it is
clear of the set when the handle is
raised. Wires entering the ends of the
handle can be seen in the ends of the
handle bearings in the rear photograph.

The receiver uses printed-circuit tech-
niques. The audio coupling unit enclosed
in dashed lines and marked U-1 is a
Centralab Complete.

Other than the antenna and printed
circuit unit, the most impressive feature
is the external appearance of the set,
which is possibly the most highly styled
unit of its size on the market. This can be
seen plainly from the photo at the
top of this page.

Schematic diagram of the Zenith chassis 4K01, including stage voltage gain figures.

END
Get the picture!

Transistors, UHF, color will make sweeping changes in television. High fidelity is revolutionizing audio. Day by day, electronics is striding forward. How can you keep up with it? Read RADIO-ELECTRONICS regularly and get the over-all picture. Subscribe now at these low rates. Assure yourself of getting the best technical articles on TV, radio, audio and high fidelity every month.

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You can see the difference... hear the difference in the new Brillante.

A NEW HIGH IN HIGH FIDELITY BY Utah.

Write today for complete details.

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OPPORTUNITY ADLETS
Rates—5¢ per word. (Including name, address and initials.) Minimum ad 10 words. Most commonly used words reduced 15% for 12 issues. Misspelled or objectionable ads not accepted. Copy for November issue must reach us before October 21, 1953.

Radio-Electronics, 25 W. Broadway, New York 7, N. Y.


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SERVICING—TEST INSTRUMENTS

SOME UNUSUAL SERVICE JOBS

The Missing-Coil Case

I was called in to repair a small Canadian console combination AM radio and phonograph. The owner explained that it had been repaired only a short while before and that it had not given good service since. The set was dead. It took almost 30 minutes to get at the set. The chassis, two speakers, and record player were all crowded into close quarters.

At first glance, there seemed to be something radically wrong with the circuit or chassis but I couldn’t put my finger on it. On one side of the r.f. end of the chassis was the SCR A7 with a wave-trap coil and trimmer capacitors. On the rear were two more capacitors which appeared to be padders. At the antenna end of the chassis were three upright coils with trimmers and a mica trimmer capacitor mounted on what seemed to be the fragment of a coil form. Although I studied this closely, I could not confirm my suspicions just by looking. Two-band sets like this one may have up to eight coils or only two. There was nothing to indicate that the set had an r.f. stage, so I concluded that the three coils were all that were needed in the set.

Studying these coils closely, I noticed that one coil form had a replacement-type antenna primary coil pressed down over it and, strangely enough, both ends of the primary were grounded. The tubes checked good, so I set to work with the signal generator. A 455-ke signal applied to the SCR A7 signal grid went through the i.f. transformers with very little peaking being required. So far, so good.

A check of the SCR A7 circuit showed two leads going to the control grid. One went through a 1-megohm resistor to the secondary of the first i.f. transformer. (This was probably the a.v.c. lead.) The other lead went to the tuning capacitor and band-switch through a 250-µf capacitor and 55-ohm resistor connected in series.

A 1,450-ke signal would pass through the set when applied directly to the grid of the SCR A7 but it would not pass through the 250-µf capacitor. Close observation showed that both ends of the resistor were grounded. This effectively grounded the stator of the tuning capacitor. Removing the grounds from the resistor made it possible to feed an r.f. signal into the set from either side of the resistor or the stator of the tuning capacitor. The signal could not be pushed through from the antenna post.

Finally, I was able to pull in a strong local station at about 1,420 kc. The short-wave band was still dead. Tuning toward the low end of the band I received weak signals at 1,000 and 700 kc.

RADIO-ELECTRONICS
This year the Bell System is putting 800,000 new telephone poles into service. How effectively are they preserved against fungus attack and decay?

Once the only way to check a preservative was to plant treated wood specimens outdoors, then wait and see—for seven years at least. Now, with a new test devised in Bell Telephone Laboratories most of the answer can be obtained in seven months.

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SERVICING—TEST INSTRUMENTS

The 1420-ke signal came in again at 600 on the dial. The low-frequency paddlers had no effect on the performance of the set. Suddenly, I realized that my first guess was correct. There was no antenna coil for the broadcast band. Obviously it had broken off and had not been replaced.

I installed a midget broadcast antenna coil and was about to wire it into the circuit when I noticed that there was a ground across the short-wave antenna coil. I completely rewired the band-switch and connected the new broadcast antenna coil and trimmer to it. The broadcast antenna trimmer was the one which was mounted on the stub of the original antenna coil form.

Realizing that the front end restored normal operation on both bands.—S. O. Harris

The Persistent Buzz

I plugged the set in for a warmup. After listening for a minute from one end of the band to the other, I advised the customer, his set would be ready in ten minutes if he cared to wait.

It was an a.c.-d.c. table model emitting an annoying buzz which changed in pitch with slight taps on the chassis. A microphonic tube, loose connection, or at worst a rubbing voice coil in the speaker, I quickly surmised.

After about thirty minutes of continuous checking, the customer reluctantly left on other business. The problem intrigued him also, and I promised to call him when the set was ready.

Another hour and a half and I was ready to begin tearing hair. However, other sets had priority, so I began to tackle them. Then I could devote full time later to the puzzle.

That night was a fitful one, but I awoke with a hankering to attack this little job with vigor. The set was stripped piece by piece, including the i.f. cans.

Now, satisfied that I had completely overhauled the set from antenna to speaker, I plugged it in again. What's that? The same old buzzing sound!

I grabbed for the telephone to call the customer and tell him in no uncertain terms to come and get his radio or relieve me of responsibility for my acts. We radio technicians must be a curious lot, for I released my hold on the handset. After all, admitting defeat on a simple job like this? Pushing the radio over to one end of the workbench, I continued work on other jobs at hand.

About two days later while servicing another a.c.-d.c. set I reached over and switched the '47 pilot from "Il" rather than walk to the stockroom for a replacement. I turned on this other set, and almost jumped out of my shoes when I heard the familiar buzz again!

Afterward I was sorry my temper had run loose enough to allow me to crush that little pilot light to bits! My only conclusion was that the filament must have been minutely intermittent, close enough to glow and yet arc over.

That a ten-cent service job could unnerve a guy so much!—Don Luoma

RADIO-ELECTRONICS
Servicemen!

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Model 7052. Tests more different type tubes than any unit on the market, from subminiature to acorn low power transmitting tubes. Shorts on tube elements can be easily determined, employs roll chart instead of cards, for use as a portable or counter top unit.

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Model 8102. A general purpose voltmeter that challenges comparison. Utilizes 1% resistors throughout to insure maximum accuracy. Tests AC voltage ranges of audio and high impedance AC circuits where a vacuum type voltmeter would normally be required.

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SERVICE—TEST INSTRUMENTS

SOME IMPROVEMENTS FOR CLOCK-CONTROLLED RADIOS

By S. WALD

CLOCK-CONTROLLED radio receivers, popularly known as "clock-radios," are making a strong bid to supplant the time-honored alarm clock as a means of rousing people out of their morning slumber. According to the glowing advertising descriptions of these devices, we may now be lulled gently to sleep to the soothing strains of soft music and in the morning be awakened by the cheerful voice of our favorite announcer. These are worthy objectives and should reduce nighttime insomnia and jangled nerves in the morning.

In practice, however, it has been found that a volume level low enough to induce sleep is quite inadequate to insure reliable morning awakening. (We have the reverse problem: a low level at bedtime sounds too loud in the morning! — Editor.)

This article describes three simple modifications, any of which may be added to any clock-controlled radio to provide two volume levels—one soft for the bedtime operation and the other loud for morning operation.

In Fig. 1, a double-pole, single-throw relay is connected so that it may be electrically latched in by a manually operated push-button when the radio is set for SLUMBER. The closed relay contacts shunt a resistor across the voice-coil terminals of the loudspeaker to yield the desired low-volume range. After a short time interval the clock turns the radio off and the relay is deenergized. When the clock turns the set on again in the morning, the relay remains unenergized, and the volume level is up to normal.

In Fig. 2, a ratchet-sequence relay is employed to eliminate the necessity for the night-time push-button opera-
tion for low volume. The relay (a Struthers-Dunn type A11AXA or equivalent) is connected to give low volume on the first operation, normal volume on second operation, low volume on third operation, and so on. These relay coils are designed for intermitent duty, so it is advisable to insert a resistor R2 in series with the coil to prevent overheating.

In Fig. 3, an ordinary single-pole, single-throw relay (RY) is modified to increase the air gap to the point where it is unable to pull in when the coil circuit is closed, yet will remain pulled in when the armature is manually pushed down. Then the relay may be closed manually at night, and once released, will not pull in again in the morning. This method saves a push-button switch. If desired, additional relay contacts may be utilized to light a lamp for the morning operation only, as described below.

RI in Figs. 1, 2, and 3 may be adjusted experimentally to give the desired slumber level when the volume control is turned up high enough for positive awakening in the morning.

![Fig. 3—Another two-level control job.](image)

When the set is tuned to the favorite station. The resistance will vary from several times the voice-coil impedance to only a fraction of its value. S1 is the line switch, which may be controlled manually or automatically by the clock mechanism.

The relays in Figs. 1 and 3 may be fitted with an extra set of contacts which turn on a table lamp in the morning. Fig. 2 shows how the normally open contacts may be used to control the light. The lamp must, of course, be operated from the "radio" side of the clock-operated line switch, so that it will light only when the radio is turned on in the morning.

**ERRATUM**

Through an error, the price of the Simpson model 480 Genoscope, advertised on page 85 of our July issue, was listed as $395. The correct price of this instrument is $475 (four hundred seventy-five dollars). We regret any inconvenience our readers may have been caused by this mistake.
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National Electric Products

(RADIO & TELEVISION DEPARTMENT, PITTSBURGH, PA.)

SEPTEMBER, 1953
ELECTRONIC methods of fishing are being increasingly (and most successfully) used in the waters around Great Britain and some other northwest European countries. The skippers of the many fishing vessels that now carry electronic fish-finding equipment no longer have to search blindly for their quarry. They don't put out their trawls or their nets in places which experience tells them are likely to be good, simply in the hope that fish may be there. Instead, the up-to-date skipper sees schools of fish on the screen of a cathode-ray tube by means of what may be called radar television. He is even able to tell with fair certainty what kind of fish they are. If they are the sort he wants, he has them located exactly and can set about hauling them in with as much certainty of success as there can be in any human enterprise.

But let me begin at the beginning and show how the systems now in use have been developed—for they did not just appear suddenly in a state of perfection.

It started during World War II when thousands of British fishermen served in the Royal Navy. Not only individual fishermen, but large fishing vessels as well. A great number of these vessels were used for mine-sweeping and rescue work and were fitted with echosounding apparatus.

In the early days of the war echosounder operators often gave false alarms, for the returning echoes would sometimes suddenly indicate a depth, not of the several hundred fathoms below the ship's bottom, but of something far less. When recording echo-sounders were installed it became clear (as you can see from Fig. 1—a photograph of an actual echo recording) that besides the true echo from the seabed, there was frequently a secondary echo from some intermediate source below the surface.

A few of the men who were fishermen in civil life realized that these secondary echoes could be nothing but schools of fish. They didn't talk about their discovery, but resolved to make full use of it when the war was over.

They had their reward. Back in their old jobs, they bought, almost for the proverbial song, surplus echo-sounding gear of the recording type and installed it in their own fishing vessels. They had already observed that the fish echoes showed big differences. Some were clear-cut, some rather fuzzy; some had raged top or bottom edges; some showed a striped effect; some came from near the surface, some from mid-water, some from near the bottom.

From their knowledge and experience of the habits of fish they figured out the species that each kind of echo indicated. The ex-naval equipment wasn't ideal for the job and they weren't always absolutely right in the beginning. But they found fish more quickly than others could and they made far bigger hauls. Electronic fish-finding had proved itself.

Then the Marconi Company took a hand by bringing out its Seagraph, a compact and moderately priced echo-sounding recorder, specially developed for small fishing craft and designed, so to speak, to keep one eye on the seabed and the other on the fish lying between it and the surface. This met at once with remarkable success.

Meantime, other countries had not been idle. A great deal of research and experimental work was done on the continent, and a German firm—Elektroacustic G.m.b.H.—developed the Fischlupe, one of the finest and most successful fish-locators yet devised.

The German word Lupe means literally "magnifier" but "Fishscope" is perhaps not a bad translation of "Fischlupe." The instrument works broadly on echo-sounder lines—but with a big difference. The supersonic echoes are applied as voltage waveforms to a cathode-ray tube. See Fig. 2. In the SURVEY position of the large dial the screen of the tube shows a small-scale cross section of the water from seabed to surface. The screen is calibrated for a maximum depth of 300 fathoms (1,800 feet). A shoal of fish appears as a bright blob, and the depth at which the school is swimming can be read off from the scale on the screen.

A turn of a knob gives a large-scale picture of a 45-foot layer of water at any depth desired. A "SHIFT" (vertical positioning) knob allows the shoal blob to be centered on the screen. Adjustment of the focus knob changes the picture from a blob to a large number of individual points, each representing the echo from one fish. From the depth, the size of the luminous points, their arrangement, and their movements, experienced fishermen can tell with almost absolute certainty what kind of fish they are. If they are the kind wanted, a good haul is practically in the net.

In the United States, both Bendix and Raytheon make echo-sounding equipment for navigation and fish-location. Both companies make two types of instruments—models in which a pointer or a spot of light shows the depth directly under the vessel on a dial calibrated in feet or fathoms (See Fig. 3); and chart-recorder models (Fig. 4), which draw a continuous map of the seabed and also show the extent and depth of submerged obstacles or schools of fish (Fig. 5). Prices range from about $450 up to CONTINUED ON PAGE 102
FOR TOMORROW...  AS WELL AS TODAY!

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3 INSTRUMENTS IN 1
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**300 OHM**

$4.89
several thousand dollars, depending on range and accuracy.

While the dial-indicator type shows the depth only at a particular position, experienced fishermen can use it for locating schools of fish by comparing its readings with the depth given on a standard navigation chart. For example, if the chart shows a bottom of 50 fathoms over a certain area but the echo sounder shows, say 30 fathoms over the same area, the fisherman's experience will tell him whether or not it pays to drop his nets for a haul.

All echo-sounding instruments operate by measuring the time required for an ultrasonic pulse to travel from the hull of the vessel to the bottom and back again. Since sonic waves—and ultrasonic waves, of course—travel at a speed of approximately 4,800 feet per second in salt water, the total distance traveled by the pulse is directly proportional to the elapsed time. Ultrasonic frequencies are used not only because their short wavelengths allow the transmitting and receiving heads to have small dimensions and high dihretivity, but also because they can draw a more accurate picture of the bottom than longer waves (lower frequencies), just as a sharp-pointed pencil can depict finer detail than a house-painter's brush.

As an example, the Bendix model D1-1 depth indicator starts with a 50-kc oscillator which is turned on and off 240 times per minute by a motor-driven keyer. It is on for only a few thousandths of a second each time, so that the effective interval between successive pulses is approximately 1/4 second, or long enough to allow each pulse to travel a total distance of 1,200 feet. Since the pulse has to travel to the bottom and back in this time, the maximum depth it can indicate is 600 feet (100 fathoms).

This model uses the same transducer head—a magnetostriction unit mounted in a waterproof housing on the outside of the hull—for transmitting and receiving, but some types of equipment have separate heads for each purpose.

Electricity catches them, too

Apart from purely electronic methods of fish location much progress has been made in actually catching fish by electrical methods. These are now in regular use in many inland waters in Britain, and much experimental work is going ahead both here and in other European countries with a view of finding new and better ways of catching fish by electricity. The basic principle of the electrical fish trap is to use an alternating current (not a direct current) of a frequency too high to affect man...
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*Write for literature.
Fig. 3—Raytheon Fathometer dial-indicator type echo sounder. The pointer shows the depth of seabed or underwater objects directly under the vessel.

to applying them to sea fishing. Briefly, the principle is this: When an electric field is set up in water around them, fish of all kinds are irresistibly repelled from the cathode, or negative pole, and attracted toward the anode. In a weak field of only a few volts the fish merely align themselves head-to-anode along the lines of force. Raise the voltage somewhat and they move toward the positive pole. Make it still higher and they are stunned—though only temporarily, for they recover quickly when released from the field.

This method is regularly employed nowadays in many British trout streams for ridding the waters of cannibal fish and other undesirables. The negative pole of a gas-driven generator is connected by cable to a metal plate set upright in the water. A second cable connects the positive pole to t.c. wire meshes of a kind of landing net operated by a man in a boat. Fish swim toward the net and the unwanted specimens are easily eliminated. In some streams a more intense electric field is used for short spells. All fish then come to the surface in a stunned condition. The undesirable sort are picked out with landing nets; then the generator is switched off and the others are soon none the worse for the shock.

Larger-scale use of this method at sea is still only in the experimental stage, though the experiments are distinctly promising. One system in particular shows most signs of being capable of useful development. When a shoal of fish has been located by the echo-sounding method already described, a metal plate, carried by a buoy and connected by a cable to the ship, is dropped on one side of the shoal. The ship then steams to the other side of the shoal and her generators establish an electric field between the plate supported by the buoy and her own metal hull.

An extension of this method, on which experimental work is already in progress, is to fit the fishing vessel with a suction pump connected to a large underwater tube in her side, and to polarize the hull positive. Moving irresistibly toward her in the electric field, fish are then drawn into the tube and onto a grating. The water drains away over the side of the vessel.

Some fear has been expressed that the combination of electronic and electrical fishing may rapidly deplete the seas and leave us with no fish at all. Just the opposite is more likely to happen. Trawling and similar indiscriminate methods lead inevitably to the destruction of millions of immature fish, too small to be of any value as food. Electronic fishing means selective fishing. Only the shoals whose members are seen to be of useful size will be dealt with. If the catch is pumped onto a grating, the undersized fish will pass through its meshes and return unharmed to the sea.
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**Machine Stenographer Types Speech Direct**

The Swiss physicist Jean Dreyfus-Graf here presents another of his steps toward a way of recording speech directly on paper in common type. Readers may remember his "Electron-Tube Stenographer" in the September, 1950, issue of this magazine. It wrote down the sounds it heard in a kind of shorthand. The new instrument, called the Phonograph, transforms spoken language directly into phonetic script on an electric typewriter. It breaks up all speech sounds into groups of 9 impulses, one in each of 9 frequency ranges. An electronic brain compares these impulses with standard impulses, recording the results in a trinary system of notation (+, -, 0, or greater, less, equal).

A group of 9 impulses gives 8 elements, and makes it possible for the machine to distinguish a maximum of 6,561 "informations" from which it selects the several dozen phonetic elements which actuate the typewriter.

The prototype I, shown here, contains only six sets of filters instead of the nine used in prototype II, now in the breadboard stage.

The machine can distinguish a large number of sound combinations. While it often substitutes closely related sounds for those intended, occasionally producing a bizarre effect, the results are such as to encourage further development.

While neither prototype I nor any other near it in the series appears likely to become an efficient automatic stenographer, there are many applications for such a machine even though it falls far short of that degree of perfection. Applications could include secret or personal messages where occasional alternate spellings of similar sounds (or identical spellings of slightly different sounds) would be unimportant; automatic voice-actuated telephone control (see "The Radio Monthly", March 1953 RADIO-ELECTRONICS); elevator control, or other operations demanding an "open sesame" of only a few short, clear, words.
Radial type projectors and paging speakers with 360° dispersion for maximum coverage at lowest cost and ease of installation.

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AN ECONOMICAL NOVICE TRANSMITTER

By RICHARD GRAHAM, W1VJV

Simple circuitry and TV components reduce the cost of this 2-band rig

NOW that the Novice class license is available, there remains no serious obstacle to keep anyone interested enough to take the FCC exam from getting on the air. Of course equipment must be obtained, but the cost can be held to a minimum by purchasing and constructing wisely. Before the novice undertakes a project, he should ask himself three important questions:

1. Does this unit adequately fill my present need economically?
2. Are there any unnecessary frills in the design or construction that can be done away with for the present?
3. How will this piece of equipment fit in with my future operating plans?

I asked myself these questions and obtained satisfactory answers before constructing this rig designed specifically for the novice.

The transmitter shown in the diagram and photographs has a power input of approximately 35 watts which is adequate for novice needs. Actually the difference in the signal strengths of the legal-limit 75-watt and the 35-watt power input of this rig is barely noticeable at the receiving end. The difference is only a little more than 3 decibels which is about ½ S unit on the S meter of the receiver on the receiving end. This difference is difficult to detect by ear. If your receiver doesn’t have an S meter, check the difference by tuning in signals of various strengths the next time you visit a ham with a

Front view of the transmitter. Low-cost components and simple circuitry enable the novice to put a station on the air with the least expense and trouble. The pilot lamp L1M replaces an expensive millimeter as the tuning indicator.

Schematic diagram of the 35-watt Novice transmitter for operation on the 80- and 40-meter c.w. bands. The Pierce oscillator simplifies the circuit. The Pi network matches the rig to almost any type of antenna using single-wire feed.

Top view of the Novice transmitter. Note the placement of the major components on the book-size chassis.

Under-chassis view showing parts layout for short, direct r.f. wiring. The selenium rectifier is a voltage-doubler type.

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AMATEUR RADIO
receiver that has an S meter.

A power input in the 35-watt bracket offers additional economy in that ordinary receivers and TV-type components can be used. They are very much cheaper than their transmitting equivalents. Power inputs very much in excess of 35 watts would require a more expensive line of transmitting components throughout, yet little is to be gained in signal-strength reports.

The economics become more apparent when we consider the choice of the r.f. output tube. The 6BQ6-GT is similar in construction and power-handling capabilities to the 2E26 transmitting tube. It can be purchased from some suppliers at less than one-third the price of its transmitting equivalent. The cost of construction was held down also by television-type high-capacitance filters and a bridge-type selenium rectifier to make an efficient and compact power supply.

Another feature which rightfully comes under the heading of economy is that this rig is complete. No special antenna tuner is needed. The π output network allows almost any random length of wire to be used as an antenna.

Furthermore this network is capable of tuning to either 80 meters or 40 meters with the same coil. Thus when you obtain your General class ticket you'll be all set to operate anywhere on 80- or 40-meter c.w.

Meters on the front panel of a rig certainly are impressive, and — in the higher power rigs — necessary for proper and safe operation. They are unnecessary in a transmitter of this power. A pilot lamp in the plate circuit performs all the essential functions of a meter at a cost of only 10 cents for the lamp.

The circuit

The transmitter uses only two tubes and is quite straightforward, as you can see from the schematic. Two tubes were used rather than combine the functions of oscillator and power amplifiers into one tube as is often done. This assures better keying characteristics and better frequency stability. The 1-tube jobs often have a tendency to chirp when keyed.

The oscillator uses a 6C4 tube in a Pierce oscillator circuit, chosen because it requires no additional controls for the oscillator, thus simplifying operation of the transmitter.

The output of the oscillator is capacitively coupled through a 100-muf capacitor to the grid of the r.f. power amplifier. The positive peaks of this r.f. voltage cause current to flow from the grid end of R1 to ground and develop a negative voltage on the grid of the 6BQ6-GT. This grid voltage should measure approximately 45 to 55. The exact value will depend upon the activity of the crystal in the oscillator circuit.

If the bias on the 6BQ6 grid is not in the neighborhood of 50 volts, it may be indicative of a weak or dirty crystal. Careful but thorough cleaning of the crystal with a mild soap and water is...
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SEPTEMBER, 1953
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1. 1800 installations without a single antenna mast failure.
2. Not a single claim for rusted, bent, twisted, or broken masts since PERMA-TUBE was adopted in 1949.
3. PERMA-TUBE installations show no wear after 41 months (average antenna life 27 months).
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**AMATEUR**

then in order. Handle the crystal by the edges after cleaning.

The amplified r.f. signal appearing on the 6BQ6 plate is coupled through the .001-uf blocking capacitor to the output network. This capacitor prevents the high-voltage d.c. from appearing on any of the exposed parts of the coil L1 or the capacitors C1 and C2, but allows the r.f. to pass.

The parallel resistor and coil shown in the 6BQ6 plate circuit is a parasitic suppressor. The coil consists of 30 turns of No. 30 enamel wire wound on any 1-watt insulated resistor of 100,000 ohms or larger. Without this suppressor, the amplifier has a tendency to oscillate all by itself. With it the amplifier is completely stable and free from any spurious oscillations.

The output coupling network is composed of the two variable capacitors C1 and C2 and a B & W Miniductor L1. L1 is made semivariable by a shorting jumper. This process of shorting out turns to tune L1 does nothing more than vary the inductance. Although a current will flow in the shorted turns, no appreciable power will be wasted.

The power supply consists of a transformer-fed voltage-doubler circuit. This supply delivers both 330 and 150 volts. The lower voltage conveniently eliminates the need for the voltage-dropping resistor for the 6BQ6 screen grid and the oscillator plate. These voltages are higher than is normally obtained from a voltage-doubler operating directly off the line because of the slight step-up in the power transformer. This transformer is a half-wave type having a secondary voltage of 135. Because of this the selenium rectifiers should have a 100-volt rating. The selenium rectifier used in this unit is one specifically designed for voltage-doubler service and is actually two rectifiers built into one unit. We used a Sarkes Tarzian type 108D.

The 100,000-ohm resistor across the output of the supply serves as a bleeder to discharge the filter capacitors when the set is turned off. These high values of capacitance can give you a nasty shock if you happen to come across them.

The transformer is rated at 75 milliamperes. Since the transmitter is designed for cw operation this unit can be safely used at 100 ma. This is because the transmitter actually draws power from the transformer only when the key is down (except for the filaments). Thus the transformer is idle for a great part of the time even when the transmitter is in operation.

**Construction hints**

The rig is constructed on a standard aluminum open-end chassis 9 ½ x 5 x 1 ½ inches, similar to the T.A.S. No. 39001. Unless one has had previous experience in transmitter construction, it might be well to follow the general layout of parts as shown in the photographs. R.f. circuits have a peculiar way of developing spurious oscillations all their own—often depending on the layout. This is something that can't be predicted before construction is begun.
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SEPTEMBER 25

AMATEUR

Keep all r.f. leads short and direct. Thus, connect the three 0.01-uf bypass capacitors right at the tube sockets to ground. Connect the parasitic suppressor close to the plate cap of the 6BQ6-GT tube. The d.c. and a.c. power and filament wiring can be run to suit the builder's own aesthetic tastes.

The lamp L1 can be soldered directly into the circuit if desired. It is forced into a 1/2-inch grommet on the front edge of the chassis. This makes a simple and practical holder for the bulb. Don't try to dress up the front by buying a colored glass jewel lamp holder. Lamp L1 is a type No. 44 pilot rated at 250 ma for full brilliance. At 100 ma the filament just gives off an orange glow which couldn't be seen if a colored jewel were used. Off resonance the lamp glows very brightly making the use of the smaller current pilot lamps impractical.

Output coil L1 is mounted by soldering the last turn of each end to lugs mounted on two small 5/8-inch ceramic standoffs. The shorting clip is a Mueller No. 88 Wee Pee Wee phosphor bronze clip. The thin jaws just manage to slip in between the turns of the coil.

A National type 100S 2-b-mh r.f. choke is used in the 6BQ6 plate circuit. It is mounted upright on its standoff insulator to provide the short leads desirable in this circuit.

Tuning the rig

Perhaps the most difficult problem that the beginning amateur has to solve is that of providing an efficient transfer of r.f. energy from the transmitter to the antenna. This problem is eliminated by using a $\pi$ type tank circuit and antenna tuner. The $\pi$ network is a variable-impedance tuning system which will match random lengths of wire as well as almost any type of antenna which uses single-wire or unbalanced feed.

The only adjustments necessary to place the rig in operation are those in the output circuit, C1, C2 and L1. First place the shorting clip on the coil L1 somewhere near the antenna end. Its actual and final position will depend on the length of the antenna used. Turn C2 to maximum capacitance (the plates fully meshed). Connect the antenna and turn on the a.c. to the rig. After the filaments have warmed up, press the key down and tune C1 for a dip in the brilliance of lamp L1. Don't leave the key down too long without tuning C1 to the dip. Now turn C2 and redip C1 to produce an orange glow in the lamp. Move the shorting clip in toward the tube end of the coil to produce the correct bulb brilliance if it cannot be obtained with C2 alone. Usually, the tuning process consists of a simultaneous juggling of these three.

If you're really out to squeeze the most out of the rig, place a pilot lamp in series with the antenna lead. The type of pilot lamp used will depend upon the antenna current and hence, the antenna length. Now tune C1, C2, and L1 to produce the maximum brilliance on the series antenna lamp for a given brilliance on the plate-circuit.
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Sensitivity—1000 ohms per volt

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- OUTPUT VOLTS: 0 to 15/30/50/100/150/200/500/1000 Volts
- D.C. CURRENT: 0 to 1.5/15/150 Ma.
- RESISTANCE: 0 to 1,000/100,000 Ohms to 10 Megohms
- CAPACITANCE: 0 to 10 Mfd. 1 to 90 Mfd.
- IMPEDANCE: 5 to 2,500 Ohms 2,500 Ohms to 5,000 Ohms, 2,500 Ohms to 5,000 Megohms
- BATTERY: 1.5, 7 Batteries 7 or 10 Batteries (optional)
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Please send me the units checked below. 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 other charges paid. I hereby authorize Moss to charge my account, if not paid in full when due.

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[ ] MODEL 670-A Total Price $28.40
[ ] $7.40 down payment. Balance $21.00 monthly for 6 months.
[ ] TELEVISION BAR GENERATOR Total Price $37.95
[ ] $9.75 down payment. Balance $28.25 monthly for 6 months.
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[ ] $12.95 down payment. Balance $30.00 monthly for 6 months.

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SUPER MARKER INJECTOR SMI-53
saves up to 75% alignment time

SCALA RADIO CO., 2814-19th St., San Francisco 10, California

AMATEUR

lamp. This indicates that the most power is being put into the antenna for a given input to the final tube in the transmitter. This is the point of greatest efficiency.

One further point should be made with regard to tuning, especially when tuning the rig on 80 meters. The shorting clip on L1 can be moved down the coil toward the tube where the amplifier will be doubling the crystal frequency, thus producing 40-meter output with an 80-meter crystal. Thus, after tuning up the rig, double-check the output frequency by tuning the receiver to both 80 and 40 meters and noting the stronger signal. Short out the receiver antenna terminals to reduce overloading. The stronger signal will appear on 80 meters if the transmitter has been tuned correctly. A simple wave-meter as described in the ARRL Handbook will provide a more certain and quicker check of the transmitter output frequency. Such a check should be made a habit regardless of the transmitter being tuned.

Materials for transmitter

- Resistors: 1-47.000 ohms, 1 watt; 1-47.000, 100-
000 ohms, 1 watt

- Capacitors: 1-10, 1-10 uF, 500 volts, mica; 2-
000 pF, 500 volts, mica; 2-01, 100 volts, molded tubular, 600 volts; 2-325 uF, variable, 1000 volt spacing; 1-60 uF at 1-30 = 30 or 250 volts, 1-46 uF, 450 volts, electrolytic.

Miscellaneous: 1-2.5 m. I.F. r.f. choke, National R1000 or equivalent; 1-2.5 m. r.f. choke, National 1000S or equivalent; 1-8.8 W Miniductor type 305; 1-power transformer, 35 volts at 75 ma or more, 4.3 volts at 500 ma; 1-100 ma, 18-volt voltage-doubler type selenium rectifier; 1-4C4, 1-4005 tube; 1-Muller type III clip. Sockets, switch, No. 44 pin lamp, open-circuit key jack, crystal, standoff insulators, binding posts, hardware.

You can work this rig on 40 meters simply by plugging in a 40-meter crystal and moving the shorting clip on the coil down toward the tube. Once again, remember, its exact position depends upon the antenna in use. The general tuning procedure is the same as before. You'll find this rig fine for use as a stand-by or portable rig even after you've advanced on to a higher power. Perhaps you could even use it as a driver for that higher power rig when the time comes. In any event, it's a rig sure to please and serve you well long after you've passed the novice stage.

SUPER MARKER INJECTOR SMI-53
Designated to work with your present signal generator marker and oscilloscope.

SAVE TIME—Marker size determined by instrument setting only. Not affected by characteristics or defects of circuits being aligned. Only one setup for each section (video I.F., sound I.F., detector or tuner) regardless of number of stages.

MORE ACCURATE—Marker will always be the same size whether on top of I.F. curve, on slope, bottom, in middle of ratio detector, or in sound trap. Marker cannot overload receiver or circuit being tested. Marker completely bypasses unit being tested.
PHOTOTUBE CONTROL CIRCUIT

In many photoelectric applications, the d.c. output of the phototube must be amplified to a comparatively high level before it is applied to control or alarm circuits. To eliminate the disadvantages of multistage direct-coupled amplifiers, the phototube output is usually connected to a.c. by modulating the light source with a chopper or by applying a.c. to the phototube electrodes. These methods have disadvantages which may make the photoelectric control impractical in some applications. Electronic Engineering (London, England), describes a method of converting the d.c. output of a phototube to a.c. by periodically varying the input impedance of a direct-coupled phototube amplifier. Fig. 1-a shows the basic circuit.

If we disregard the 6T7 triode, the circuit becomes a conventional phototube and direct-coupled cathode follower. The plate-to-cathode impedance of the 6T7 is shunted across the 15-megohm grid resistor of the 6SJ7. When light falls on the phototube, it conducts, and a positive voltage appears on the plate of the 6T7. The grid of the 6T7 is fed approximately 1 volt of 60-cycle a.c. from a potentiometer connected across the 0.3-volt heater line. When the grid of the 6T7 is negative, the plate impedance rises and a positive pulse appears on the grid and cathode of the 6SJ7. The pulse amplitude varies with the light on the phototube. When the 6T7 grid is positive, the plate-to-cathode impedance is low and the 15-megohm grid resistor is nearly short-circuited, so little or no signal is applied to the grid of the 6SJ7. The potentiometer (R1) is adjusted so there is no output when the phototube is dark.

When the ambient light level is high, it may be necessary to modify the circuit to provide proper operation. The modification is shown in Fig. 1-b. Points X and Y connect to corresponding points in Fig. 1-a.

One-half of a 6H6 is used as a biased diode in series with the output of the cathode follower. R2 is adjusted so the diode does not conduct until the illuminating light is concentrated on the phototube.

CONSTRUCTION

USE IT FOR:

- TV SETS
- RADIOS
- TRANSMITTERS
- BROADCASTING EQUIPMENT
- HOME APPLIANCES
- TWO-WAY RADIO COMMUNICATIONS SYSTEMS
- PHONE LINES
- AIR CONDITIONING SYSTEMS
- STARTER CONTROLS
- AUTO IGNITIONS, GENERATORS, BATTERIES
- MOVIE EQUIPMENT
- PANEL INSTRUMENTS
- TV CAMERAS
- AUTO LIGHTING SYSTEMS
- GENERATORS
- VOLTAGE SOURCES
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- CABLES
- CONNECTORS
- AUDIO FREQUENCY SOUND CURRENTS

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5,000 OHMS PER VOLT AC
VOLTS, AC AND DC: 2.5, 5, 10, 50, 250, 1,000, 5,000
OUTPUT: 2.5, 5, 10, 50, 250, 1,000
MILLIAMPERES: DC: 10, 50, 100
MICROMAMPERES: DC: 200
AMPERES, DC: 10
DECADES (5 RANGES): -2.0 TO +10.0 OR
OMHS: 0-200; 2,000 (12 OHMS CENTER); 5,000,000 (100,000 OHMS CENTER)

SIMPSON ELECTRIC COMPANY
5200 W. Kinzie St., Chicago 44 - Eebrook 9-1121

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END

A CORRECTION

In our advertisement in the May and June issues of RCA-ELECTRONICIAN, there appeared to error a 500A ammeter pictures with incorrect prices of parts. Listed by us as models 520, 520X, 520A and 1450. These cabinets & chassis are not manufactured or sold by us, but are in fact manufactured by the Stationary TV & Radio Repair. We regret these inadvertant errors, and have taken steps to prevent their recurrence.

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an Amphenol antenna on the roof means a satisfied customer for you!

What is the reason that AMPHENOL antennas are not only maintaining but increasing their front position as the finest antennas ever offered? The answer, of course, is that the name AMPHENOL has become synonymous with quality—to more and more dealers and servicemen. They know, first, that antenna quality is measured in performance and that the performance of AMPHENOL antennas is outstanding. Dealers in cities where there have been severe ice storms or high winds feel proud that the AMPHENOL antennas they have installed are still standing when other antennas have collapsed.

They like, also, to hear the satisfied comments of customers about the fine picture quality they are getting on their TV sets—and dealers know how much that picture depends on the AMPHENOL antenna.

Important to dealers, and further proof of performance, are published antenna measurements. Making all such measurements in accordance with current RTMA standards, AMPHENOL provides accurate information that can be relied on. Dealers realize they can read the db gain of an AMPHENOL antenna and believe it.

See the new UHF-VHF Antenna Film

AMPHENOL has prepared an attractive new folder with Kodachrome illustrations from the new AMPHENOL film "The UHF-VHF Television Antenna Story". Besides giving a short version of the important facts in the film, it also encloses AMPHENOL antenna and accessories catalog sheets—and is designed to hold new sheets as they are issued. Write AMPHENOL today for your copy of "The TV Antenna Folio".

See this complete antenna folder

The new AMPHENOL film "The UHF-VHF Television Antenna Story" is now available for you to see by just contacting your distributor. Done in slide-film and full color, it gives helpful information on UHF and VHF television. It discusses, fully and frankly, antenna characteristics for the different frequencies—shows gain charts and radiation patterns. Be sure and see "The UHF-VHF Television Antenna Story".
SIMPLE GEIGER COUNTER
By EDWIN A. KUCHARSKI

THIS Geiger counter uses standard parts, employs a built-in speaker, and has a meter which serves as a high-intensity indicator. Headphones can also be employed, if one encounters a noisy environment. It has no tricky circuits and has actually been test-proven in the field. Last summer we took this instrument all over New York State and located radioactive ore near an old quarry in Bedford, N. Y. Although the quantity was very small there is a possibility that other locations might prove more worthwhile.

The heart of the counter is a self-quenching Amperex 1-N GM tube, which operates at 600 volts, supplied by two Burgess 300-volt batteries. A 5-megohm resistor (R1 in the schematic) is connected in series with the high-voltage batteries. This resistor also limits the current in case one should accidentally short the GM tube. C1 and R2 control the waveshape and quenching time. C1 should be varied to obtain a clearly audible strong hiss. It is coupled to an ordinary high-gain audio amplifier designed to eliminate low-frequency response. A 250,000-ohm potentiometer hooked in series with a 67½-volt battery also controls the radiation sensitivity by varying the high voltage. The 354 power pentode is biased 7 volts by a 850-ohm negative return resistor. This pentode supplies power through an output transformer to a speaker or a high-intensity metering circuit.

This metering circuit is unique and operates as follows: The output transformer is used as a high-impedance choke and delivers alternating current to a 1N34 crystal diode which in turn rectifies these pulses into d.c. voltage, charging a 100-µf, 15-volt electrolytic capacitor. A voltmeter consisting of a 22,000-ohm resistor and a 0-100-micro-

The schematic. Two 300-volt batteries in series are used; not one as shown above.

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PHOTO TRANSISTORS

Point Contact Transistors Available in a variety of stable controlled types suitable for both fast and medium speed switching circuits and high-frequency amplifiers.

Junction Power Diodes Useful in power supplies, magnetic amplifiers and telephone systems, etc., they have the characteristics of large plate-type type rectifiers and size and weight of a small circuit component.

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The Hi-Lo UHF antenna adapter is available separately for all proven Hi-Lo antennas. List Price $3.00. Sold by recognized jobbers.

U.S. Patents Nos. 2,495,379 Canadian patent 1515 — other patents pending

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September, 1953
ampere meter is placed across this capacitor, measuring the voltage which is directly proportional to the number of counts. When the radiation sensitivity control has minimum resistance, cosmic rays can be indicated on the meter. When maximum resistance is approached very high radiation can be measured. An 820,000-ohm resistor is used as a voltage-dropping resistor. Experiment showed that with this resistor in circuit and with the potentiometer set at zero, the meter is converted to a 0-100 voltmeter. Since the voltage of the 67½ battery drops with age, before each measurement is taken the sensitivity control is set to read 50 volts on the voltmeter, thus a constant voltage is assured. Voltage change in the 300-volt batteries is not so critical, as the tube operates on a long plateau. If accurate measurements are not desired, the negative end of the two 300-volt batteries can be connected to the positive terminal of the 67½-volt battery thus adding 67½ volts to the high voltage source.

Materials for Geiger counter
Resistors: 1-850, 1-10,000, 1-100,000, 1-820,000 ohms; 1-1 megohm; 1-2, 1-3-1, 1-7 megohms; ½ volt: 1-22,000 ohms, ½ volt; 5½, 1-250,000-ohm potentiometer. Capacitors: 1-4.30 ufd ceramic trimmer; 1-0.52 uf, 150-volt; 1-0.25 uf, 450-volt, paper; 1-100 uf, 15-volt electrolytic. Tubes and crystals: 1-Geiger-Mueller tube, Ampera I-N; 1-544, 1-1544 crystal diode. Batteries: 2-300-volt, Burgess V 200 or equivalent; 1-47.5-volt, 1-3.5 volt. Miscellaneous: Transformer, Stancor A-3239 or equivalent; closed-circuit jack, speaker (2-inch or similar); meter: 100 ufd ceramic selector switch, Mallory 178C or equivalent.

The Geiger counter is housed in a 9½ x 5 x 3-inch steel chassis, which had one of the sides cut out. This chassis was later chromium-plated. The speaker and the Geiger tube are mounted on a piece of ½-inch aluminum, as are the meter and the selector switch, etc. A piece of aluminum, 2 x 3 inches, was bent and fastened by two screws. This houses two tubes and the output transformer. The whole unit is very compact and light. Practically all of the weight is made up by the necessary dry batteries.
NEW WALSCO Imperial

* PROVEN THE MOST ADVANCED UHF CONVERTER IN AMERICA

UP TO 98% GREATER POWER GAIN
UP TO 88% LESS NOISE FACTOR

* FACTS from one of America's leading, independent research laboratories proved the WALSCO Imperial will out-perform all other UHF converters anywhere!

<table>
<thead>
<tr>
<th></th>
<th>WALSCO Imperial</th>
<th>Converter A</th>
<th>Converter B</th>
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<tbody>
<tr>
<td>500 mc</td>
<td>10.0</td>
<td>6.0</td>
<td>7.0</td>
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<tr>
<td>650 mc</td>
<td>9.5</td>
<td>5.4</td>
<td>6.5</td>
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<tr>
<td>800 mc</td>
<td>9.5</td>
<td>3.5</td>
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Average Power Gain (in db)

Average Noise Factor (in db)

WRITE FOR COMPLETE INFORMATION

WALSCO ELECTRONICS CORPORATION
3602 Crenshaw Blvd. • Los Angeles 16, California
LIGHTNING ARRESTER

MODEL TA5 Real protection against lightning and static charges - the RADIART Lightning Arrester has all the features! Fits anywhere ... inside or out ... handles standard or jumbo leads ... no wire stripping necessary ... does not unbalance the line ... low internal capacity ... no loss of signal ... internal resistance "leaks off" static discharged! UNDERWRITERS LABORATORIES APPROVED.

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CLEVELAND 13, OHIO

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AMERICA'S FASTEST GROWING
ANTENNA MANUFACTURER
BOX 1247 BURBANK, CALIFORNIA

FM RECEIVER FROM
SMALL-SCREEN TV

WHAT to do with small-screen TV sets? This problem is sometimes solved by converting to larger kinescopes. This often works out well, even though changes may be needed in the high-voltage power supply and deflection circuits. Conversion is hardly worth while when the set has only a 7-inch kinescope.

We bought a new large-screen TV and had to decide how to dispose of the old one, an RCA 621TS with 7DP4 kinescope. It had been giving satisfactory results since early 1947. This set had a trade-in value of only a few dollars, so we decided to keep it for parts.

The kinescope (still working) was given to the local TV service technician for window display. Various capacitors and transformers were reserved for future experimental work. The high-voltage cage became a shield for a small transmitter. The sound I.F. channel seemed too good to "cannibalize." We felt that it might work out as an FM receiver. Its circuits include a 6AT6 first i.f., 6AU6 second i.f., 6AL5 discriminator, 6AT6 first a.f., and 6KG-GT power stage.

The 621TS has a sound i.f. carrier of 21.25 mc, and its discriminator bandwidth (between peaks) is 350 kc. The sound channel width is 250 kc, measured 80% down from the peak.

We cut around the i.f. strip with a hacksaw, using the chassis only. The
power tube or volume control could not be included. The tube is too far from the tuner, and the control is mounted on the TV panel. When completely cut, we had an FM tuner on an irregular-shaped chassis about 6½ inches wide and 7 inches deep. Angle brackets and long screws were added as mounting feet to hold the chassis straight.

A single-tube 6J6 converter-oscillator was added. See the schematic. L1 is 7 turns of any convenient size wire, wound to ½-inch diameter and spaced to ½-inch long. L2 is 6 turns, wound to same diameter and length. It is tuned 21.25 mc below the FM signal with the 3-plate variable midget C, the only tuning adjustment. L3 is a video i.f. coil from the 621TS, returned to 21.25 mc. This coil is held by a metal bracket which also shields it. Capacitors in the tuner may be ceramic or mica. A volume control also was mounted on the chassis.

Diagram of the set's converter-oscillator.
A 6AQS power stage and a simple a.c.-d.c. power supply, using standard circuitry, were incorporated into this new FM set. The audio output transformer from the TV was used also. We use a 10-inch PM loudspeaker and the quality is excellent. Output from the first a.f. may be stepped down and made available for tape recording. We find that a 23-t-o stepdown is satisfactory. This may be provided by a 330,000 and a 15,000 ohm resistor, hooked up across the output as a voltage divider, with the recorder input tapped in at the junction of the resistors.

This FM receiver does not look much like a commercial product, since the final layout had to depend on the original TV design. However, we can pick up more than a dozen stations in the metropolitan New York area. Most can be received on a 5-foot straight-wire antenna. And the sound quality is excellent.
**NEW DEVICES**

**VU METER**

Top Master, Inc., 12 W. Hubbard St., Chicago 10, Ill., has introduced a VU meter, model 100V, for visual recording control of any recorder. The meter has a standard VU scale and sensitivity, color differentiated with percentage modulation (in black) on the top arc from 0% to 100%, and volume unit (in red) on the bottom arc from 0-0 to 4-1 VU. (0 VU equals 100%). Basic sensitivity is 200 microamperes. It uses a full-wave instrument bridge rectifier and has dual impedance for use with either high or low-impedance circuits.

The VU meter comes in 3½-inch rectangular semiflush mounting complete in black bakelite case ready to connect. Instructions and calibration data are supplied for use with all makes and models of recorders.

**TV SET COUPLER**

Mosely Electronics, Inc., 1625 St. Charles Rock Rd., St. Louis 14, Mo., has combined a multiple TV set coupler and lead-in socket in one unit. Each Tiny Mite unit will operate two sets from one antenna, and under suitable conditions several couplers may be used for four or five sets simultaneously.

The coupler is designed for use with flat or tubular transmission line and is installed on the bidetboard or back of set.

**SELENIUM RECTIFIERS**

Radio Receptor Company's Selectron Division, 251 W. 19th St., New York, N. Y., has developed a line of encapsulated selenium rectifiers which operate as self-contained units at normal voltage and current ratings. The stack can be exposed to temperatures ranging from -55° C. to over 150° C.

**WINDOW ANTENNA**

Radio Merchandise Sales, Inc., 3016 Bronxdale Ave., New York 60, N. Y., has developed a window still bowtie antenna for v.h.f. The Swivel-Rod model 8W-10.

The antenna has a rotating head and a swivel-action extension arm. It accommodates window sills from 13 to 42 inches wide. Extension mounts are available for windows up to five and six feet.

**SELENIUM RECTIFIERS**

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The coupler is designed for use with flat or tubular transmission line and is installed on the bidetboard or back of set.

**INDOOR ANTENNA**

Tricore Products Co., 1535 N. Ashland Ave., Chicago 22, Ill., has announced a v.h.f. indoor antenna, the model 210. The antenna consists of a 2-element array with a plane reflector and measured 12 inches from side to side. Model 210 has a beam width of 60°, 3-dB gain, a front-to-back ratio of 18-dB, and a standing wave ratio under 2.4:1 average.

**GENERATOR ADAPTER**

Philo Corp., Tulsa and C. S., Philadelphia, Pa., has announced the model GE9000 v.h.f. to u.h.f. signal generator adapter. The unit permits measurements to be made at v.h.f. while controls, markers and attenuators are located at the common v.h.f. frequencies.

As the output of any v.h.f. signal generator of 0.01 microvolt is fed into the adapter, the v.h.f. sweep or marker signal beats against the u.h.f. oscillator of the u.h.f. producing u.h.f. signals at the sum of the two frequencies, and having the same characteristics as the v.h.f. input signal.

**TRANSMISSION LINE**

Fretco, Inc., 40 N. Craig St., Pittsburgh 13, Pa., has announced a new v.h.f.-u.h.f. transmission line for lead-in. The insulator is made of low-loss material called polyethylene. Impedance is 300 ohms.

**LIGHTNING ARRESTER**

J.P. Manufacturing Co., Inc., 3101 16th Ave., Brooklyn 1, N. Y., is producing a v.h.f.-u.h.f. lightning arrester, the 20-A model 1210. The unit grounds static and lightning from flat ribbon tubing, available as double-barrel or open-wire twin lead.
THE GREATEST UHF-VHF ANTENNAS EVER BUILT!
FAR-REACHING and PHOTO-CLEAR RECEPTION!
HIGHER GAIN on all Channels 283

Original, revolutionary design... FIXED IMPEDANCE* Feed System provides All-Channel, High-Gain reception with a single transmission line.

Kay-Townes' BJU Antennas are the recognized leaders in the field of ever picture, high-gain, trouble-free UHF-VHF antenna performance! Simplified, but more exacting and effective engineering has resulted in "bug-free" antennas that provide photo-clear reception. One lead-in wire only. No matching pads or isolation filters...no coils or condensers...which tend to cut down signals.

THE BEST SET IS ONLY AS GOOD AS ITS ANTENNA! *Pat. Applied for

BATTERY
The Tube Dept., RCA Victor Division, RCA, Harrison, N. J., has announced a new, low-priced 75-volt B battery for portable radios. It has conventional Leclonche cell construction and measures 6 1/2 x 2 1/2 inches.

2-CHANNEL YAGI
Channel Master Corp., Elkhart, Ind., has announced the model 525 Twin-Tuned Yagi, for channels 2 and 5. The antenna, which features a transformer-type dipole, has a gain of 2/5 db on channel 2 and almost 3 db on channel 5 for a single bay. Stacking provides higher gain.

UHF BOWTIE
Brach Manufacturing Corp., Division of General Bronze Corp., 200 Central Ave., Newark, N. J., has introduced their UHF bowtie antenna, model 489. Designed to meet the requirements of primary, ghost-free u.h.f. areas, the model 489 can be stacked for fringe-area reception. Special features include air-space terminals and a molded resilient phenolic insulator. One stockir bar is included with each unit.

DESK STAND
Atlas Sound Corp., 1410 39th St., Brooklyn 8, N. Y., has released a desk stand, model DS-10 for all types of microphones. The microphone cable is concealed in a slot underneath the center section of chromium trim and is directed out at the rear of the base. No removal of plugs or connectors is necessary. All parts are die-cast and finished in gun metal enamel and chromium.

VIBRATOR TESTER
P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., has announced a vibration tester, the model 12VT1D for radio raisors. The instrument will test 6- or 12-volt vibrators of the most popular types and all auto radio vibrators used since 1940. In conjunction with a filtered d.c. power supply, it will test self-rectifying or filter-rectified vibrators at any frequency from 100 to 250 cycles.

A push-button switch adjusts d.c. input voltage for START and CONDITION test. Condition of the vibrator is determined by the reading on the GOOD-BAD scale. The vibrator tester measures 4 1/4 x 10 1/2 x 5 1/2 inches.

TEST INSTRUMENT
Electronic Measurements Corp., 280 Lafayette St., New York 13, N. Y., has announced a new tube-type battery-aim capacity tester, model 201, features a 7 1/2-inch meter for counter use. The tester has 4-position lever type switches and is housed in a portable oak case with removable hinge cover.

CRYSTAL CARTRIDGE
Webster Electric Co., 1900 Clark St., Racine, Wis., has announced a 2-needle, dual-output cartridge, the model FX, for replacement use. It is adaptable to high-or low-output ap-
NEW DEVICES

Applications by means of a tuning 'capacitor.

Without the capacitor the cartridge develops 4.4 volts at 78 r.p.m. and 2.6 volts at 33 1/3 r.p.m. With the capacitor it develops 1.2 volts at 78 r.p.m. and 2.6 volts at 33 1/3 r.p.m.

The tracking pressure is 1.5 grams and the cut-in frequency is 1,500 cycles.

announced a speaker baffle kit for mounting on extra speaker in automobile package shelves.

The kit includes a dashboard switch which permits operation of the car radio speaker alone, rear speaker alone, or both simultaneously; a stamped baffle plate with tamper-proof perforated metal, mounting screws and instructions. It is designed for 6 x 9-inch oval car speakers. A metal adapter is available for round speakers.

CAPACITOR TESTER

Lee Electronic Labs, Inc., 233 Dudley St., Boston 19, Mass., has developed an electronic capacitor tester, and leakage indicator, model CT-1. The unit features a built-in power supply which provides a.c. and d.c. test voltages. It contains a miniature selenium rectifier and a dual capacitor R.C. filter network with a neon lamp leak- age indicator.

BAFFLE KIT

Lowell Manufacturing Co., 3010 La- clide Station Rd., St. Louis, Mo., has

A new high in science fiction!

All specifications given on these pages are from manufacturers' data.
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WARD will give you the "HI" in sales — the "HI" in profits you seek. WARD Antennas always create greater customer satisfaction. Remember, WARD will keep your inventory lower and cut your "call backs"...

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There's a choice of 5 different models for any recording need. High fidelity units, meeting primary and secondary NARTB standards, which record and play back frequencies up to 15,000 cycles, are available for broadcast stations, critical music lovers, and scientific research. For investigation, missionaries, reporters, and general dictation while traveling, there are units which play up to 2 hours per reel of tape.

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DIVISION OF GENERAL MOTORS CORPORATION, KOKOMO, INDIANA
A GENERAL MOTORS PRODUCT
DISTRIBUTED BY ELECTRONICS WHOLESALERS EVERYWHERE

SEPTEMBER, 1953
FRSAP HOLDS PICNIC

The Federation of Radio Service men's Associations of Pennsylvania held its July meeting at Lily Lake, Luzerne County. The meeting was held in conjunction with the Luzerne chapter's annual clam bake and outing. This event, which has now become famous among radio-television technicians, was attended by upwards of 200 people from the area and surrounding states, including a delegation of several cars from New York City. The regular July meeting of the National Electronic Service Dealers Associations was also held during the outing.

Further plans were detailed for an Eastern Conference to be held during the fall in Philadelphia, and other routine business was transacted.

The Television Service Dealers Association of Philadelphia is a member of the Pennsylvania Federation. Louis J. Smith heads the new Philadelphia chapter.

ROCHESTER ELECTIONS

The Radio Technicians Guild of Rochester, N. Y., elected the following officers at their annual meeting:

Alfred L. Best, president; William de Vries, vice-president; Francis G. Stoffel, secretary; and Bertram Lewis, treasurer. Harold Eskin, the past president, and William Brewerton were elected to serve three years on the board of directors, and Donald Snell and Norman McGovern to serve one-year terms. The board is completed by the unexpired terms of Abraham Ander, Theodore Cornish, Ed Fisk and Bertram Lewis.

NATESA FALL MEET

The National Alliance of Television and Electronic Service Associations announces definitely that the annual NATESA fall convention will be held on October 9, 10, and 11 at the Morrison Hotel in Chicago. The Television Installation and Service Association (TISA) of Chicago will be the host.

Plans have been laid for display booths, seminars, discussions, banquets, and a show floor, with the idea of combining business and pleasure at what should be the biggest convention NATESA has yet held.

G-E RECEIVES AWARD

John T. Thompson of General Electric's Tube Department, left, receives plaque from the Radio Television Technicians Guild of Boston, Mass., at a regular meeting. Plaque is presented by Guild president Ben Sims, right, for the Tube Department's work in instituting and carrying out a nation-wide public relations program for the TV service industry. In center, veteran radio-television teacher and service technician organizer A. C. W. Sanders.

END

Officers of the RTG of Rochester, N. Y. Left to right: Bertram Lewis, Wm. de Vries, Alfred L. Best, Francis G. Stoffel and Harold Eskin (past president).
COMPARE THESE FEATURES WITH ANY SWEEP GENERATOR

There are 16 additional features incorporated, which make it a "must" for the radio technician. All, together, emphasize the superiority in dollar value of Triplett 3434-A. See this tester at your distributor's.

And now compare the Quality per dollar

TRIPLETT ELECTRICAL EQUIPMENT CO., BLUFFTON, OHIO
SEPTEMBER, 1953
STROMBERG-CARLSON TV SETS

No picture, weak high voltage, and lower than normal screen voltage on the 6BG6-G horizontal output tube may be caused by an open resistor in the voltage-doubler supply in 19C, 110R, and 119M receivers.

Check the four 680,000-ohm resistors which are connected in series between the plate of one 1X2 and the filament of the other as shown in the diagram.

Replace the defective resistor with a high-grade 1-watt unit. Take care to make smooth soldered connections to minimize corona. —Clarence J. Tabor

ZENITH 23G22 TV SETS

We have had several sets come in with shorts between one of the tapped windings and the core of the flyback transformer. In these and several other makes and models, the output transformer is mounted on its side instead of as its manufacturer intended.

Wax is used to insulate the winding and keep it centered in the core. When the transformer is mounted on its side, heat softens the wax, and the weight of the winding and core vibration cause the winding to slide down until it shorts against one of the sides of the core.

If the windings have not been damaged by the short, the transformer can be repaired as follows: Remove the transformer from the set and hold it over a hot soldering iron to soften the wax. Push the winding back to its original position and fill the space at the sides with fish cloth or other high-voltage insulation. Use coil dope to hold the new insulation in place. Check with a 20-megohm or higher ohmmeter to see that windings are not shorted to each other or to core before replacing the transformer.—Fairbanks Tryon

G-E 16T3, 16T4, 17C102

Sync instability and loss of contrast may be the complaint on these and similar models. The trouble is often caused by leakage in the coupling capacitor, C354, connected to pin 1 of the 6SL7-GT sync amplifier and clipper.
GET CLEAR SHARP RECEPTION WITH THE NEW LL300 OPEN WIRE LINE

300 OHMS IMPEDANCE
This results in maximum signal transfer from antenna to set.

EXTREMELY LOW LOSS
Air dielectric plus clear polystyrene spacers results in the lowest possible loss of signal.

LESS NOISE PICKUP
Close spacing plus perfect impedance match results in lowest possible noise pickup.

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Conventional hardware for 300 ohm ribbon lines are perfect for LL300 open wire line.

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Copperweld conductors, polystyrene spacers, plus light weight and low wind resistance result in virtually indefinite life.

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Packaged on 100, 150, 200, 250' convenient, easy to use spoons.

If not available through your regular dealer, order direct, immediate shipment via parcel post. Dealer cost $4.95 per 100 feet.

PERFECT FOR VHF - UHF INSTALLATIONS

The diagram shows the location of this capacitor. Replace this capacitor with a 600-volt unit selected for low leakage.

—Herman F. Hooe

GENERAL ELECTRONIC SIG GEN
If all the tubes blow, check the leakage resistance of the input filter capacitor. Since the rectifier is a 6C4, it doesn't take much current to damage the cathode structure so that it shorts to the heater and burns out the 12AU7 oscillator tube.

I had to learn the hard way by replacing the line cord and blowing two new tubes before spotting the defective filter capacitor as the source of the trouble.—G. P. Oberto

ADMARIL 19E1, 19G1, 19N1
In some 19E1, 19G1, and 19N1 Radio- TV chassis, the ½-amp fuse (M401) may blow when the function switch is rotated from the radio to TV position. In some type 77B84 function switches, the rotor contact of switch section S701C is wide, and during rotation there is one position where all contacts of this section may short. The resulting current surge blows the fuse.

This difficulty can be corrected by revising the circuit as shown in the under-chassis pictorial in Fig. 1 and in the partial schematic in Fig. 2. All series 19 chassis with built-in radios stamped RUN 18 or above have this change.

To make the change in 19E1, 19G1, and 19N1 chassis, proceed as follows:
1. Disconnect the blue wire from lug 4 of terminal strip A. This is the blue wire from terminal g of section S701C.

2. Connect the blue lead removed from terminal strip A to pin 3 of M201.
3. Disconnect the red wire which goes to fuse M401 from the positive terminal of the 80-ft electrolytic capacitor C502. (Two red wires connect to C502. Be sure to disconnect only the one connected to the fuse.
4. Connect the red wire removed from the positive terminal of C502 to lug 4 of terminal strip A.)

These changes are illustrated in the diagrams Figs. 1 and 2.—Admiral Radio & Television Service Bulletin

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CHANNELS 2 TO 83

UHF & VHF RECEPTION IN
METROPOLITAN AND PRIMARY AREAS

BE "ALL SET" WHEN UHF COMES TO YOUR CITY!

- One lead-in wire for all channels.
- Reception up to 50 miles, depending on terrain and power of transmitter.
- Quality construction throughout...double plate dipole rotators... heavy cast aluminum mast clamp... heavy gauge aluminum cross arms... 7/16" aluminum tubing for extra strength and long life... micarta insulator... over-all lightweight and partial pre-assembly mean easy assembly and erection.

The "best by test"...according to leading technicians in areas now receiving both UHF and VHF! No matching pads or isolation filters... no coils or condensers which tend to cut down signals and increase cost of installations. K-T Engineering has eliminated the "bugs" and the possibilities of frequent service call-backs.

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BOX 586, ROME, GA.
THE BEST SET IS ONLY AS GOOD AS ITS ANTENNA.
Sealed against heat, humidity!

NOW AVAILABLE ESPECIALLY FOR SERVICEMEN

Now you can get the identical C-D compact size metal-cased tubular electrolytic capacitors that have been used by the millions for the past three years by the original equipment manufacturers.

- Dual-Triple and Quadruple section units.
- Direct-to-terminal internal lead construction reduces possibility of shorts (pure aluminum wires crimped securely together with outer leads within aluminum stud terminals.)
- New high-insulation vinylite covered leads.

CORNELL-DUBILIER
World's Largest Manufacturer of Capacitors.

PAY LESS FOR TUBES ★ INDIVIDUALLY BOXED ★ FULLY TESTED ★ EACH TUBE GUARANTEED FOR SIX MONTHS

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Each tube is performance-proven. 25% deposit must accompany all orders. Balance C.O.O.D. All prices F.O.B. As U.S. Representatives in main with order, you can deduct 25c. 50.00 handling charge. 2500.00. Subject to Prior Sale. Fabrity, Incense inquired.

WESTINGHOUSE MODEL H-217

Insufficient width and picture tearing may be the result of a poor connection between the Aquadag coating on the picture tube and its grounding spring. To assure a permanent ground contact, procure a 1 x 1/4-inch piece of aluminum foil and coat one side with an adhesive. Fold one edge 1/4 inch over the adhesive side of the foil. Place the foil between the coating and the grounding spring so that the adhesive holds the foil to the Aquadag, the spring bears against the uncoated surface of the foil, and the uncoated side of the 1/4-inch fold presses against the Aquadag.

The foil is stocked in 20-foot rolls which may be ordered by part number V-6237.

SENTINEL MODELS 412, 413, AND 415

A number of production changes have been made in these models to reduce smear and increase picture resolution. The changes are:

1. The 5-muf capacitor C-45 has been eliminated from across the 6,800-ohm plate load resistor R-47 in the 6AU6 video amplifier circuit.
2. A 47,000-ohm, 1/2-watt resistor has been added in parallel with R-47.
3. The video load choke L-7 has been changed and resistor R-24—a part of the choke assembly—has been increased to 10 megohms.
4. The 47-ohm resistors R-29 and R-31 in the cathode returns of the first and second i.f. amplifiers have been changed to 10- and 100-ohm, 1/2-watt units, respectively.
5. The 680,000-ohm a.g.c. load resistor R-20 has been replaced by a 330,000-ohm, 1/2-watt unit.
6. The 470,000-ohm a.g.c. filter resistor R-14 has been changed to a 220,000-ohm, 1/2-watt unit.

These changes have been made on all chassis starting with series YD. If they are made in chassis YA, YB, or YC, realign i.f. transformers T-3.

Connect a 4.5-volt battery, with positive side to ground, across the 1-muf a.g.c. filter capacitor C18. This capacitor is located in the center of the chassis opposite the second 6AG5 i.f. amplifier tube.

Connect a v.t.v.m. through a 47,000-ohm resistor across the 8,200-ohm diode load resistor R-35. This resistor is connected to a tie-strip in the center of the chassis opposite the 6AL5 video detector socket. Turn the contrast control to minimum position.

Connect signal generator to adapter and attach adapter to pin 1 on 6AG5 mixer as described in the service manual on these models. Set the generator to 25.75 mc and adjust the fourth i.f. transformer T-5 for maximum output; set generator to 24.9 mc and adjust second i.f. transformer for maximum; set the generator to 23.4 mc and adjust third and first i.f. transformers, T-2 and T-4 respectively for maximum reading on the v.t.v.m. Attenuate generator output so voltage never exceeds 1 volt on the meter—Sentinel Service Bulletin.

END
A NEW damper diode for 90-degree deflection systems and a new B supply rectifier are the only home-receiver tubes announced this month. The damper is the Tung-Sol 6AU4-GT, which was developed to handle the high-amplitude sweep voltages associated with 24-, 27-, and 30-inch picture tubes. The 6AU4-GT has 6.3 volt, 1.8-amp heater, a maximum peak-inverse plate-voltage rating of 4,000 volts, and a peak-current rating of 1,050 ma. It can handle a maximum average d.c. load of 175 ma. The heater-cathode insulation will withstand 900 volts d.c. (heater negative with respect to cathode) and a combined d.c. and a.c.-pulse voltage of 4,500. This eliminates the need for a separate damper-filament winding on the power transformer. The 6AU4-GT has an average voltage drop of 25 volts. Basing is the same as the 6W4-GT.

The 5TV4 B plus booster manufactured by Workman TV, Inc., is a mercury-vapor rectifier designed to replace a 5U4-G in a television receiver operating under low line-voltage conditions. According to the manufacturer, the drop across the 5TV4 at full load is only 120 volts, compared with 150 volts across a 5U4-G. This raises the B plus output 30 volts when the new tube is substituted.

The new tube has special temperature-sensitive resistors installed in the base which delay the application of full output to the receiver for 60 to 90 seconds. This prevents sudden surges which might blow the filter capacitors before the heater-type tubes in the set have warmed up enough to draw current from the rectifier.

A graphite shield coating on the glass envelope of the 5TV4 reduces radiation of the r.f. hash produced by all mercury-vapor rectifiers.

Transistors
Raytheon has revised and expanded the operating data on its CK721 and

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Yes, you get this big, brand new book, "150 Radio-Television Picture Patterns and Diagrams Explained", absolutely FREE! Just off the press! Gives complete wiring circuits and diagrams on the latest Radio and Television Sets. Easy-to-read, large 8½ x 11" pages, with full instructions on how to read and use the diagrams. A "must" in every Radio and Television service-man's repair kit. You get this valuable book as a FREE gift for asking to see Coyne's great new 6-volume set, "Applied Practical Radio-Television"!

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Yes, the LOWELL is handsome in appearance and is easily installed in the "package shelf" of any auto. Highest quality throughout to give a real "custom look" and reproduce high fidelity, "Ear Level" sound!

NEW DESIGN

CK722 junction transistors. In addition to the characteristics given in Radio-Electronics for February, 1953, data is now available on both types for operation with ±6 volts on the collector and ±12 volts on the emitter, at a junction temperature of 25°C. This is the new data on the CK721 as follows:

- Grounded-emitter operation—input resistance, 650 ohms; load resistance, 20,000 ohms; power gain, 38 db.
- Grounded-collector operation—input resistance, 300,000 ohms (may be increased without reducing gain by operating at lower collector current); load resistance, 20,000 ohms; power gain, 12 db.
- Grounded-base operation—input resistance, 70 ohms; load resistance, 100,000 ohms; power gain, 29 db.

Following are the new ratings for the CK722:

- Grounded-emitter operation—input resistance, 325 ohms; load resistance, 20,000 ohms; power gain, 34 db.
- Grounded-base operation—input resistance, 50 ohms; load resistance, 100,000 ohms; power gain, 29 db.

The current-amplification factors given in the original Raytheon data and reprinted in the February issue were erroneous. All junction transistors have current gains (alpha) of less than 1. The actual current gains of the Raytheon transistors are 0.975 for the CK721, and 0.9 for the CK722.

Sylvania has announced commercial production of a tetrode transistor for computer circuits. Details will appear in this column next month.

Plasmatron

Bendix Aviation Corporation has announced an unusual helium-filled current amplifier, the RXB-103005 Plasmatron. Still classed as a developmental type, the Plasmatron apparently combines the grid-control characteristics and linearity of a vacuum-type triode with the extremely low internal impedance of a thyratron. In addition to the above and general beta-type cathode, the Plasmatron has an auxiliary hot cathode almost completely surrounded by a control electrode called a garrote. A negative bias of about 50 volts on the garrote sets up a gas discharge between the garrote and the main cathode, and the flow of plate current. As in all gas-filled tubes, bombardment of the gas atoms by plate-current electrons produces positive ions, which neutralize many of the electrons and form a space charge, or plasma, which prevents any increase in plate current. In the Plasmatron, extra electrons from the auxiliary cathode combine with the positive ions and effectively cancel out the current-limiting space charge.
Send for Cannon Bulletin RJC-6
... a special condensed catalog
Covers the Radio, Sound and Miniature Connectors that are available to you through Franchised Distributors, Electrical Wholesalers and Radio Parts Distributors.

NEW DESIGN:

**CANNON PLUGS**

Train IN Great COYNE shops for big pay jobs

**IN Television**

A varying signal voltage or impedance inserted between the grid and the main cathode will modulate the electron stream emitted by the auxiliary cathode. This varies the space charge and modulates the plate current.

The RXR-10380S has a flat current gain of about 150 from zero to 10 kc (down 50% at 14 kc), and can handle an average d-c. plate current of 300 ma. Only enough anode voltage is required to ionize the gas—about 25 volts maximum for helium.

A typical circuit setup for the Plasmatron is shown in the accompanying figure. The grid and auxiliary cathode are tied together and function like the control grid in an ordinary triode. Since the drop across the tube may be as low as 1 volt, it can feed a low-impedance load directly.

**Subminiatures**

General Electric has introduced two new subminiature twin triodes in its "5-Star" high-reliability series for military and heavy-duty industrial service. Both types have 0.3-amp, 0.3-amp heaters, separate cathodes for each triode, and a maximum plate-voltage rating of 165 volts.

**Basing of new General Electric subminiature types GL-6111 and GL-6112.**

The GL-6111 is a medium-mu general-purpose type for audio circuits, multi-vibrators, or oscillator-mixer service in high-frequency receivers. Its average characteristics as a class A1 amplifier (each triode) are: Plate voltage, 100; cathode-bias resistor, 220 ohms; plate current, 8.5 ma; amplification factor, 50; gm, 5,000 microhms; plate resistance, 4,000 ohms; maximum noise-output voltage across a 10,000-ohm plate load resistor, with 15 g vibrational acceleration at 40 cycles, 0.05 volt.

The GL-6112 is a high-mu, low-microphonic type for audio and phase-inverter applications. Each triode section has the following characteristics in class A1 service: Plate voltage, 100; cathode-bias resistor, 1,500 ohms; plate current, 0.8 ma; gm, 1,800 microhms; amplification factor, 70; maximum noise output voltage (same conditions as GL-6111) 0.05 volt. Both types have a life expectancy of 5,000 hours at 30° C ambient, and 1,000 hours at 175° C.

**NEW DESIGN:**

**Rack-chain**

**sealed**

**portable radio**

**for**

**SUB-Meeks**

**SUB-Specialized**

**phones and**

**tacles,**

and

**GL-6111**

**GL-6112**

**OR**

**Electricity**

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SEPTMBER, 1953
This is an improved musical instrument designed for high stability. It uses 12 master oscillators, each of which generates a tone for the upper octave of the organ. These feed into slave or subharmonic oscillators which generate all other frequencies. Thus 12 adjustable oscillators provide all frequencies for the 88 notes of an organ.

Fig. 1—Stabilized master oscillator.

The multivibrator in Fig. 1 shows one form of master oscillator. V2—the right half of the triode in Fig. 1—is the output triode, connected as a cathode follower. A large silver mica capacitor C1 (about .02 µf) loads the grid of V1—the left-hand half of the triode above—to mask possible tube vari-tiendos. The oscillation frequency is controlled and adjusted by a high-Q coil L. Fig. 2 shows one series of slave oscillators for generating all "A" tones for the organ. The master oscillator feeds 1,560 cycles, the highest "A," into the first slave V1. This frequency is transferred from L1 to L2 by inductive coupling, to energize V2, a blocking oscillator. Output of V2 is 1,760 cycles, the next lower "A" note. In the same way, the signal is transferred from each inductor to the adjacent one. Each triode is a subharmonic generator of the frequency fed to it. Each triode is connected as a cathode follower to prevent interaction between signals.

All inductors in Fig. 2 are wound on the same core. Coupling between them is very critical. It should be sufficient for transfer of signal from one to the next. If it is too high, however, more than one stage will be affected by the same frequency.

A series of slaves similar to Fig. 2 is used to generate the other notes of the keyboard. Each frequency is passed through filters to shape the waveform. Thus various orchestra instruments may be simulated. Then the signals are amplified and reproduced on a loud speaker.

The instrument also provides for a tremolo effect. Frequencies differing by a few cycles are taken from two slave oscillators. The best is used to control the gain of the amplifier. This gives a vibrato result that may be used where desired.

PULSE STEP COUNTER

Patent No. 2,619,618
Bernard Adler, Haddon Heights, N. J.
(Assigned to Radio Corp. of America)

Most pulse counters show errors when fed pulses of different amplitudes. For example, a few large pulses may produce the same count as many smaller ones. The accuracy of this improved circuit is not affected by the size of the pulses.

The negative pulses to be counted are fed in across C1 and C2 in series, through D2. This diode is biased to conduction by the signals. The pulses also charge C3, but this capacitor is so large that its potential remains low. Between pulses, C1 discharges through C3, R1 and D1, but the charge on C2 is trapped. The polarity of the voltage across C2 blocks D3, so the charge cannot leak off through the diode. The thyratron TH is normally nonconducting, so there is no discharge path through the tube either. Each signal pulse adds to the negative charge on capacitor C2. (See stepped waveform.) When the total charge on C2 reaches a predetermined voltage level TH fires and the capacitor discharges. This may take place, for example, after 10 pulses have accumulated on C2.

In previous counter circuits, TH had a fixed grid bias, and firing was controlled by the voltage across C2 alone. This circuit has an auxiliary grid bias that varies with the pulse strength. If the pulse amplitude is large, there is a voltage drop across R1 and diode D3 feeds a large current into C4. This provides a high negative grid bias for TH. Under this condition, the tube will remain off until a much larger negative potential accumulates across C2. On the other hand, if the signal pulses are small, the bias across CH is reduced, and TH will fire with a lower voltage on C2.

By setting R3 correctly, TH will always fire after a predetermined number of pulses have arrived at C2 regardless of their amplitudes.
FM WITH TURRET TV TUNERS

The Standard Coil 12-channel turret tuner is an excellent unit, but it doesn’t cover the FM band like many continuous tuners. Channel 6 is just below the FM band and it is sometimes possible to tune in one or two FM stations with the fine-tuning control. I have found that the FM band can be covered by substituting an iron slug for the brass one in the channel 6 coil. This stunt will not work on intercarrier sets.

The slug is made from a 10-22 or 10-34 screw about 1 inch long. Saw off the head, cut a slot in the end with a hacksaw, and then insert the slug into the center of the oscillator coil. If the slug is adjusted to bring in an FM station with the fine-tuning control centered, it is often possible to tune in additional station on each side of the center position of the tuning control. If all of the unused channel strips are replaced with modified channel 6 units, it will be possible to cover the major portion of the FM band. Unused channel strips can also be adapted for reception of other services in the v.h.f. range.—Hyman Herman

(Channel 2, 7, and 13 coil strips can be used for amateur reception on 50, 144, and 220 mc, respectively by making slight changes in the oscillator inductance. Fire, police, taxi, truck, emergency, and similar services in the 150-175-mc band can be received with modified channel 7 coil strips. Although many of these are AM, the FM sound system of most TV sets will pick them up.

Removing the brass slug decreases the resonant frequency of the oscillator coil while substituting an iron slug decreases the frequency still further. The inductance can be varied also by altering the spacing between the turns. The antenna, r.f. amplifier, and mixer coils can be modified to peak the signal on the desired band.—Editor

ALIGNMENT SCREWDRIVER

When you want to touch up a trimmer capacitor experimentally, mark the position of the screw slot so that the original position may be restored. In case of a slug, measure the exposed length of screw or you could count the threads. For slug adjustment, an easier trick is to use a small screwdriver with a square handle (bought that way or filed to shape). Then hold your hand steady, turn the screw and count the number of quarter turns as the flat sides move between thumb and finger. Count clockwise or counterclockwise so many flats and you can always come back exactly to the original setting, even when the slug is almost out of reach.—Nicholas B. Cook

REPLACING LINE CORDS

I ran into difficulties while replacing a defective lamp cord with a cord of better quality and larger diameter. When I attempted to push the cord through the metal tube into the lamp socket, the wire buckled and resisted all efforts to insert it. After several tries, I found the following procedure to work nicely: Wrap the cord tightly

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OUTLET of TUBE TESTER

Many tube testers have a blank space for installing a new tube socket to prevent obsolescence. Until an entirely new type of tube comes into popular use, this space need not be wasted. The black plug in this new tube can be removed easily and replaced with a retainer-ring-type a.c. receptacle. A v.t.v.m. or other piece of equipment can now be plugged into this receptacle, which is wired directly across the tube-checker line cord. This brings test equipment closer to the television set or radio under test. Only one plug need be removed from the wall to make room for test equipment. After replacing tubes in a small radio, the set can be plugged right into the tube checker for a final test.

The use of this receptacle will prove to be a time and temper saver, and a great convenience.—Milton P. Persily

RECORD-PLAYBACK CARTRIDGES

When confronted with a worn-out cartridge used for both recording and playback in some of the inexpensive dictaphones, recorders, recorders, or even a functional permanent repair may be made by using any type of high-output crystal phonograph cartridge which will fit the arm. Use a magnet rate at about 2 to 3 volts output—the higher, the better.—V. C. Wyckoff

HANDY CHEATER CORD

A three-way cube tap spliced to a cheater cord (interlock line test cord) makes a handy electric outlet into which I can plug my soldering iron and other electrical equipment. When servicing a set in the customers' home this is a real time saver, for it eliminates the necessity of hunting for a wall outlet.—John A. Comstock

WORKBENCH BLACKBOARD

A blackboard over the service bench is very useful. When removing transformers, and multi-section capacitors, merely sketch the parts and wiring on the blackboard. Rewiring from it is easier than from a pencil-and-paper sketch.—T. F. Prosser
MULTIPLE VOLTAGE SUPPLY

In experimental work, it is often desirable to get a wide range of output voltages from a single power supply. This circuit shows how a standard full-wave type power transformer can be used in a supply which delivers d.c. voltages approximately equal to one-half, one, and two times the r.m.s. voltage across the full secondary winding. If the transformer delivers 700 volts center-tapped, it is possible to get 350, 700, or 1,400 volts d.c. by throwing the switches to the correct position.

When both switches are in position 1, the circuit operates as a full-wave power supply using V1 and V4 as rectifiers. V2 and V3 are inoperative. The d.c. voltage is approximately equal to one-half E<sub>1</sub>, the total secondary voltage of the transformer.

Throwing S1 to position 2 transforms the circuit into a bridge which supplies a d.c. voltage equal to E<sub>1</sub>. With both switches in position 2 the d.c. voltage will be approximately 2E<sub>1</sub>. The switches should be insulated to handle the circuit voltages without breakdown. Small d.p.d.t. knife switches will work nicely in most applications. C1 and C2 should have equal capacitance and their voltage ratings should be higher than the peak value of E<sub>1</sub>. The voltage rating of C3 should be more than twice the peak value of E<sub>1</sub>. The filament transformers must be insulated for voltages higher than twice E<sub>1</sub>-Herbert L. Hardy, W2YCU

(The choice of rectifier tubes depends on the current and voltage to be supplied. With a receiving-type power transformer the rectifiers may be 83's, 5U4's, 5R4-GY's, or similar types. For a transformer delivering up to 1,500 volts center-tapped at not more than 300 ma, the rectifiers may be three 5U4-G's. Use one for V1 and V4. Use separate tubes with plates strapped together for V2 and V3.

Remember that the transformer wattage rating remains the same regardless of the rectifier circuit. So, the product of output voltage and current in any circuit connection should not exceed the wattage rating of the transformer for full-wave operation.—Editor)

MODIFIED VOLTAGE DOUBLER

Half-wave voltage doublers are usually connected as in Fig. 1. This makes it necessary to use a separate capacitor for C1, while C2 and C3 may be a dual unit with a common negative terminal. If this circuit is used, C1 should have an insulated can, and special precautions must be used to avoid shock hazard or a short-circuit.

The circuit in Fig. 2 is a modification.

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The Editor, RADIO-ELECTRONICS
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In the 630, excellent retrace blanking can be provided by substituting a 6SN7-GT for the 6J5 in the original circuit. Rewire the socket as shown in the diagram so that one half of the 6SN7-GT is the vertical oscillator and the other half is the blanking amplifier. The blanking amplifier plate (pin 5) and the first anode of the picture tube are connected to the 275-volt line through a 150,000-ohm resistor. The positive retrace spike is tapped off the plate of the vertical output stage and fed to the grid of the blanking amplifier, causing it to conduct heavily. This reduces the first anode voltage and blanks the picture tube.

George DeLaMater
CONVERTER FOR 30 TO 50 MC

? I have been looking for the diagram of a 30-50 mc converter to operate into a receiver which tunes from 18 to 36 mc. The Question Box in the December 1952 issue carries a diagram of a tuner of this type which works into a 10.7 mc i.f. strip. Can this circuit be modified to work into my receiver?

F. F. D., West Medway, Mass.

A. You can use the converter described in the December 1952 issue by modifying the oscillator circuit so that it tunes from about 12.7 to 32.3 mc and feeding the converter output into the receiver tuned to 18 mc. A Cambridge Thermionic LS-3 10 mc coil can be substituted for the 10 mc converter-output coil used in the original model. The coil should be tuned by a capacitor of between 10 and 20 µf. The oscillator coil (L3) should be increased to about 16 turns, with the tap about one-third the way up. Vary the number of turns, the setting of the tuning slug, and the tuning capacitors so that the main tuning capacitor (C) tunes over the desired range. You can check the range of the oscillator with a grid-dip meter or by listening for its signal on an all-wave receiver.

You can also convert the unit to use a crystal-controlled oscillator so that the receiver can be used for tuning. The diagram shows how the oscillator section of the converter tube (a 6BE6, not a 6H6 as shown in the original diagram) can be modified for crystal control.

In a crystal-controlled converter the maximum tuning range is equal to the tuning range of the receiver. Your receiver covers only 18 mc (18 to 36 mc) so you will lose 2 mc of the 20 mc in the 30-50 mc band. If you use a 12-mc crystal in the oscillator, you can tune up to 48 mc. A 13-mc crystal will limit the tuning range to 31 to 49 mc. Use a 14-mc crystal if you prefer to lose the 2 mc at the low end of the band. Use fundamental-type crystals rather than those of the harmonic or overtone varieties.

The circuit tuned to 10.7 mc in the converter output should be replaced by an r.f. choke which works well between 18 and 36 mc or by a broad-banded circuit that is self-resonant at about 27 mc. Signals in the 30-50 mc band are tuned in with the receiver's main tuning control when the bandswitch is set to the 18 to 36 mc band. The signal can then be peaked with the converter antenna tuning knob.
INTERCOM SWITCHING

I am planning to construct an intercom and paging system with one master and seven substations. I would like to install a switching system like some commercial intercoms which have one button or switch for each station and an extra button for paging all stations simultaneously. Also, I want to include circuits which permit any station to call the master even when its switch is open. Please prepare a diagram of a suitable switching system.—J. J. M., St. Johns, Newfoundland.

A. Fig. 1 shows the switching circuits for the master station. The multiple push-button switch will probably have to be a special unit because of the eighth section which ties all remotes together. You can probably have one made to order by General Control Co., 1203 Soldiers Field Road, Boston 34, Mass., or P. R. Mallory & Co., Inc., Indianapolis 6, Ind. Fig. 2 shows the wiring of the CALL-LISTEN switch for each substation.

The amplifier should have plenty of gain and enough output to deliver the desired volume level at each remote point when the unit is used for paging, because the available output is divided between the seven speakers. To prevent power losses through mismatch when paging, we recommend that you use 50-ohm intercom-type speakers and an output transformer with a 50-ohm secondary tapped at 8 ohms. In this case, break the connection at X in Fig. 1 and wire the transformer as in Fig. 3 so that the 8-ohm voice-coil tap connects to terminal 1 on the PAGE button. (The line “to term. 8 on page button” in diagram above is incorrect. Use an input transformer with 50-ohm secondary.

The TALK-LISTEN switch should be an anti-capacity type to minimize feedback between the input and output circuits. To eliminate hum pickup, feedback, and cross-talk, you may have to shield all audio leads in the amplifier and use shielded cable for the CALL line and the hot leads to each station.

Fig. 1

Fig. 2

Model FX for twist mechanisms high or low output

The new Model FX Featheride is a lightweight, two-needle crystal cartridge especially designed for replacement installation in WEBSTER ELECTRIC and other twist mechanisms. Although furnished as a high-output cartridge, each Model FX is provided with a shunting capacitor for adaptation to low-output applications. Model FX—complete with needles, capacitor, spacers and installation instructions—comes packed in a handsome, useful clear-plastic box for protection during shipping and handling.

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- 3500 CPS.
- Needles: one 1-mil osmium, one 3-mil osmium, furnished. Push-in needles are held in friction-type chucks.

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SEPTEMBER, 1953
INSTALLING CASCODE TUNER

I plan to install a Standard Covel cascode tuner on a TV set which has a split-sound i.f. system. Since this tuner is designed for intercarrier sets and others in which the sound and video signals are separated outside of the tuner, I am at a loss as to how it should be connected to my set. Can you show me how to do it?—R. R. McC., Savannah, Ga.

The diagram shows how Standard Covel's pentode and cascode tuners can be installed in sets where sound and

video separation takes place in the plate circuit of the mixer. Simply connect a Standard Covel type XM-752 sound take-off coil between the output side of C18 and ground as shown. The 2-μuf coupling capacitor may be a gimmick which is to be adjusted for best performance.

If more sound output is desired from the receiver, the sound take-off coil may be moved to the plate circuit of the set video i.f. amplifier. In this case, the coupling capacitor or gimmick connects to the plate of the i.f. amplifier.

TV LEAD-IN PROBLEM

I have a 6,300-foot transmission line connecting a 4-bay all-channel conical antenna to my TV receiver. The lead-in is No. 12 wire spaced 8 inches for an impedance of 600 ohms. The matching sections at the ends are 82-foot lengths of No. 12 wire spaced 1½ inches apart.

This arrangement works all right on some channels and does not on others. I believe that there is a mismatch between the line and the antenna and receiver. Please give the correct dimensions for the matching section to work between 600 and 400 ohms.—W. P. B., Dobbins, Calif.

A. A transmission-line type matching transformer is effective only at frequencies at which it is an odd number of quarter-wavelengths long. For all-channel reception, design the matching sections so that the odd number of quarter-wavelengths long at the frequency of the weakest channel, or you can try using tapered matching sections which are at least two wavelengths long at the lowest channel you expect to use. The tapped conductors should be spaced for an impedance of 600 ohms at the end which connects to the transmission line and spaced for 400 ohms at the opposite end which connects to the antenna or receiver. No. 12 wire should be spaced approximately one-half inch apart at the low-impedance end.
SOUND-POWERED PHONES

? I have a pair of sound-powered phones which operate over a 2-wire line 2 miles long. I would like to install a buzzer-and-battery signaling system which will not require any additional wires. Can you show how I may do this with one buzzer at each station?—F. P., Plymouth, N. H.

A. Two signaling circuits are shown.

In each, one side of the voice circuit is isolated and is used to carry the signaling current. A good earth ground must be used as the return. The grounds may be made to cold-water pipes, a bare wire running down in a well, or to a ground rod driven 5 or 6 feet into moist earth. Be sure to isolate one of the lines so the battery current does not flow through either of the handsets. To isolate the lines, tempo-

![Diagram of signaling system]

Fig. 1—One type of signaling system. Rarely ground one line at station 2 and then use an ohmmeter or flashlight bulb and battery to check continuity between each line and ground at station 1. The line which shows a reading on the meter or causes the lamp to light is used for signaling. This is shown as line B on the diagrams.

Both circuits require a battery and bell at each station. In Fig. 1, the batteries must have the same voltage and must be wired in with both positives or negatives connected to line B. When

![Diagram of signaling system]

Fig. 2—The preferred signal system. Bells won't ring if line B is grounded.

connected in this manner, the voltages oppose and no current flows when the switches are open. If either battery is dead, the good battery forces current through it and both bells ring continuously. Closing either switch causes both bells to ring.

In Fig. 2 closing one switch causes the bell to ring at the other station. The bells do not ring simultaneously as in the circuit in Fig. 1. This circuit requires push-button s.p.d.t. switches which are wired so the circuit is completed through the bells when in the normal position. If push-button switches of this type are not readily available, you can use spring-return s.p.d.t. toggle switches.

If you use the circuit in Fig. 1, take care that line B is not grounded. A direct short will cause both bells to ring until the batteries run down or the short is cleared. A high-resistance short circuit cuts battery life.
The Fund Reaches $10,768.59

When the Help-Freddie-Walk Fund was organized in 1950 to give assistance to Herschel Thomson, radio technician of Magnolia, Arkansas, in behalf of his now five-year-old son, Freddie, who was born without arms and legs, we here at RADIO-ELECTRONICS were sure the response would be generous and sincere. This belief has been justified by the hundreds of contributions amounting to over $10,700 received by us since that time and forwarded to Freddie and his grateful parents.

Some three years later, we are still continuously amazed and humbled by the quality and quantity of the response to our appeals. The following excerpts from letters received during the past month will best illustrate what we mean.

From a letter received from Eghiche Harout, of Hollywood, California: "Enclosed you will find two checks from the Har-Omar Restaurant as our personal contribution to the 'Help-Freddie-Walk' Fund. Please send us a number of reprints of your original story of 'Service to Freddie' which appeared in the June, 1950, edition of RADIO-ELECTRONICS magazine. We would like to circulate these articles and establish a fund here in Hollywood. All proceeds would be sent to your organization.

"We note that all checks should be sent to your magazine, but since a restaurant is an ideal place to collect money for any charity, we would like to accept cash or check donations from our patrons, deposit them in a bank, and then send you a certified check to cover all donations which we have collected. This is one of the most heart-breaking cases I have ever encountered and has received very little publicity here on the West Coast. I would personally like to congratulate you for the wonderful work you are doing to help this unfortunate boy."

And from G. Carroll Utermahlen, of Baltimore, Maryland, who has written us before (see the July, 1953, issue), we received the following letter: "I always think I have troubles until I compare myself with brave little kids like Freddie Thomason. So, by gum, I soaked off the dried-up mimeo pad and cut out a stencil and ran it off the same night that my copy of the July issue of RADIO-ELECTRONICS arrived.

"My C.O. in the Civil Air Patrol says he will talk it up with the entire squadron and, even if all of them don't come through, some surely will. And my pals will receive their copies of my mimeo memos the same time you receive this letter. The mimeo thing will also go to at least two club publications having considerable circulation, not so much in quantity as sin-
cerity of response to pleas such as little Freddie's."

We have been happy to supply both of the above readers with reprints of the Freddie front of June, 1950, entitled "Service for Freddie," and if we can co-operate in any other way with them or anyone else wishing to set up a sort of subsidiary action on the Freddie front, we shall most certainly be happy to help out.

We would also like to say "thank you" to C. V. Passantino, of the Passantino Printing Company, New York, who donated as "service for Freddie" the work on the reprints. And may we just add to the above a note of urging each and every reader to send in his contribution, whenever possible. No amount is too small to receive our sincere thanks and acknowledgment. Make all checks, money orders, etc., payable to Herschel Thomason.

Address letters to:
HELP-FREDIE-WALK FUND
c/o RADIO-ELECTRONICS Magazine
25 West Broadway,
New York 7, N. Y.

FAMILY-CIRCLE CONTRIBUTIONS
Balance as of June 16, 1953 $602.50
FAMILY CIRCLE Contributions as of July 17, 1953 $602.50

RADIO-ELECTRONICS CONTRIBUTIONS
Balance as of June 16, 1953 $10,191.09
A Father, Silver Spring, Maryland 1.00
Anonymous, Montreal, Canada 3.00
Anonymous, Utica Park, New York 1.00
Colin Covert, Iselin, New Jersey 1.00
H. T. Dug, San Angelo, Texas 1.00
Har-Omar Restaurant, Hollywood, California 15.00
William Kieson, Jr., Bernalillo, New Mexico 20.00
Ray Martin, Baltimore 5, Maryland 1.00
Don Usserman, Troy, Ohio 2.00

RADIO-ELECTRONICS Contributions as of July 17, 1953 $10,166.09
FAMILY CIRCLE Contributions 602.50

TOTAL Contributions as of July 17, 1953 $10,768.59

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNBSACK
Founder
Modern Electrics 1908
Wireless Association of America 1916
Electrical Experimenter 1913
Radio Trouble 1917
Science & Invention 1918
Radio News 1920
Amateur Radio News 1921
Short-Wave Craft 1930
Television News 1932

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

September 1919
ELECTRICAL EXPERIMENTER

Possibilities of High Frequency Currents, by John E. Pritchard
"Fog Warning" Radio-Telephone
1 K.W. Quenched Gap Transmitter, by Lester F. Ryan
Valves, by Prof. A. U. Dion
Vacuum Valve Construction, by R. H. Shaw
How to Use the Potentiometer
The How and Why of Radio Apparatus, by H. Winfield Secor

END

SEPTEMBER, 1953

With this new TRI-dimension colored Instruction Book you can build this powerful 5-tube superhet.

ARKAY, world's finest radio TV kits, shows you how—even if you have no technical knowledge or background—to build a fine radio with their new, easy, yet foolproof method.

3-D Color Diagrams

Step by step, you follow the 3 simplified wiring diagrams printed in different colors on transcribed sheets. Each forms a complete circuit and when completed—you have a top quality radio worth much more than your cost.

ARKAY Kits and Parts are fully guaranteed!

Book includes:

- 15 pages, fully illustrated
- Voltage and resistance chart
- Photos of set before & after wiring. Latter is in full color to check your wiring
- Reviews of radio receiver theory
- Schematic plus photographs of all parts for easy identification
- Complete parts list for checking
- Complete, detailed instructions from unpacking your kit to alignment without signal generator
- Standard color code for resistors and capacitors

LIMITED TIME OFFER: Get this TRI-dimensional Instruction book from your local jobber for only 10c. Regular price: 50c. Get yours today!

ARKAY world's finest radio kits
RADIO KITS, INC., 120 Cedar St., N. Y. 8

JUST OFF THE PRESS — A NEW SPEED TV SERVICING SYSTEM

This new book is a money-making time saver for TV Novices and Ex-

perts alike!

Tells in plain words exactly which tubes to replace to eliminate each and every expense caused by burned out or defective tubes and shows the exact location of the particular tube or tubes which must be replaced.

Over 135 common TV troubles listed with explicit directions for locating the defective tubes which cause each of these faults.

PRICE ONLY $1

TV TUBE LOCATOR

70 Common TV Troubles traced to source and cured
Copyrighted trouble indicating tube location guides of over 500 most popular TV models. Many models different from those shown in TV TUBE LOCATOR.

Contains over 70 illustrations and tube location guides. Forty most common picture troubles illus-

trated, with symptoms described, causes given and remedies prescribed.

PRICE ONLY 50c

SINC.e520

SINC.e520

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SERVICEMEN! FREE SPECIAL OFFER

If your ports jobber has not as yet stocked these new TV

books ask him to sign

"REQUEST FOR FREE INFORMATION"

Send this in with your order and we will include val-

uable TV BOOK AS A FREE GIFT FOR YOU.

ARKAY, world's finest radio kites

RADIO KITS, INC., 120 Cedar St., N. Y. 8

G. C. CISIN, Consulting Engineer, Dept. E-Z-1
200 Clinton St., Brooklyn 1, N. Y.

Rush following postpaid

[ ] TV Tube Locator [ ] Trouble Tracer

Enclosed find $ .

Full Payment

Name

Address

City & Zone

State

JOBBER REQUEST FOR FREE INFORMATION

Without obligation send us full information about H. G. Cisin's Television Service Books.

Name of Jobber

Address

City Zone State

By Title
E. Finley Carter was appointed vice-president and technical director, and Howard L. Richardson was appointed vice-president in charge of engineering operations of SYLVANIA ELECTRIC PRODUCTS, New York City. Carter was formerly vice-president in charge of engineering, and Richardson was vice-president in charge of industrial relations.

Vernon A. Dupy and Edward L. Lape were named general sales manager and general merchandising manager, respectively, of UNITED MOTORS SERVICE DIVISION of General Motors Corp., Detroit. Dupy, who had been general mer-

Hughes Research and Development Laboratories, one of the nation's large electronic organizations, are now creating a number of new openings in an important phase of operations.

Here is what one of these positions offers you.

Our company located in Southern California, is presently engaged in the development of advanced radar, electronic computers and guided missiles.

These new positions are for men who will serve as technical advisors to the companies and government agencies purchasing Hughes equipment.

You will be trained (at full pay) in our Laboratories for several months until you are thoroughly familiar with the equipment that you will later help the Services to understand and properly employ.

After training you may (1) remain with the Laboratories in Southern California in an instruction or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Adequate traveling allowances are given, and married men keep their families with them at all times.

Your future in the expanding electronics field will be enhanced by the all-around experience gained. As the employment of commercial electronic systems increases, you will find this training in the most advanced techniques extremely valuable.

How to apply
If you are under 35 years of age and have an E.E. or Physics degree and an interest or experience in radar or electronics, write to

HUGHES RESEARCH AND DEVELOPMENT LABORATORIES

Scientific and Engineering Staff

Culver City,

Los Angeles County, California
Martin Bettan, director of sales and engineering for Radio Merchandise Sales, was elected president of the ANTENNA MANUFACTURERS ASSOCIATION. Other officers include Benjamin Snyder, Snyder Manufacturing Co., vice-president and Anthony J. Frank, JFD Manufacturing Co., secretary-treasurer.

Obituaries

Charles H. Caine, vice-president in charge of Midwest sales for CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., died in Chicago.

Near Admiral Cyril A. Rumble, USN (Retired), director of Government Relations for ERIE RESISTOR CORP., Erie, Pa., died in Washington, D. C.

Personnel Notes

... Glen McDaniel, who served as the first paid president of the RTMA, was elected temporary president of the association pending the selection of another full-time paid president. He will continue as general counsel. Robert C. Sprague of SPRAGUE ELECTRIC CO. was elected chairman of the Board. Other officers include Leslie F. Muter, MUTER CO., treasurer; Dr. W. R. G. Baker, GENERAL ELECTRIC, director of the Engineering Department; and James D. Secrest, executive vice-president and secretary.

... Neal W. Welch and Dr. Wilbur A. Lazier were appointed vice-president in charge of sales and vice-president and technical director of research and engineering, respectively, for SPRAGUE ELECTRIC CO., North Adams, Mass. Mr. Welch was formerly director of sales and Dr. Lazier was formerly with Charles Pills & Co. Dr. Preston Robinson, former head of the Research and Engineering Department and a member of the Board of Directors, will continue with Sprague as a consulting engineer. Paul J. Crittenden and Hollis R. Wagstaff were elected assistant treasurers of the company.

... Robert O. Bullard, formerly head of industrial tube operations of the GENERAL ELECTRIC Tube Department, was named general manager of the newly formed Industrial and Transmitting Tube Subdepartment. Managers of other newly-formed subdepartments include L. Berkley Davis, former head of receiving tube operations, as manager of the Receiving Tube Subdepartment, and Robert E. Lee, former cathode-ray tube operations head of the Cathode-Ray Subdepartment.

... Elise Harmon was appointed head of printed circuit activities of ANDOVER CORP., New Bedford, Mass. Miss Harmon was formerly a chemist and engineer at the Bureau of Standards.

... A. Cameron Duncan was named manager of merchandise operations of the Home Instrument Department of RCA Victor. Joseph K. Kearney, former...
manager of the East Central renewal sales district of the RCA Tube Department, succeeds Duncan as renewal sales manager for RCA radio batteries.

- C. R. Hammond and O. P. Susmeyan were named assistant vice-presidents of the Receiving Tube Division of Raytheon Manufacturing Co., Waltham, Mass. W. M. Thompson was appointed assistant vice-president of the Raytheon Power Tube Division. Hammond was formerly equipment sales manager of the Receiving Tube Division, and Susmeyan was plant manager. Thompson directed purchasing operations of the Receiving and Power Tube Divisions.

- Milton R. Schulte, vice-president in charge of the Electronics and Flash divisions of Tung-Sol Electric, Inc., Newark, N. J., was elected to the Board of Directors.

- Maury R. Jungman joined BRACH Manufacturing Corp., Division of General Bronze Corp., Newark, N. J., as distributor sales manager. He will report to Ira Kamen, vice president in charge of TV sales. Jungman was formerly sales manager of Oak Ridge Products.

- Arnold Lettkeken was named sales manager of MERIT COIL & TRANSFORMER CORP., Chicago. He has been with Merit for 10 years in charge of industrial sales in Chicago and also served as purchasing agent.

- Jacob J. Repetto was promoted to assistant sales manager of CLAROSTAT Manufacturing Co., Dover, N. H. He was formerly superintendent of design and drafting.

- Dr. W. R. G. Baker, vice-president of GENERAL ELECTRIC and director of the RTMA Engineering Department, was awarded the 1953 Medal of Honor by the RTMA at its June convention in Chicago.

- Gordon D. Ferrell was named personnel director of ERICK RESISTOR CORP., Erie, Pa. Richard F. Paulsen succeeds him as employment manager.

- Berne Fisher was appointed director of engineering of STANDARD COIL PRODUCTS CO., INC., Chicago. He was formerly chief engineer and production manager for General Instrument Corp.

- George R. Fraser was elected president of ASTATIC CORP., Chicago, manufacturer of phono pickup arms, cartridges, microphones, TV converters and boosters, and other electronic devices. He was formerly vice-president and general manager. He will also retain his title as treasurer of the company.

- Joseph F. Bozzelli, formerly with Haydu Bros., joined the Special Purpose Electronic Tube Department of BENDIX RADIO DIVISION, Eatontown, N. J.

- Donald W. Pease was promoted to the position of chief draftsman of CLAROSTAT MANUFACTURING Co., Dover, N. H. He was formerly assistant chief draftsman of the company.

- A. Raymond Bermond was appointed advertising manager of the Radio Division of HALLICRAFTERS, Chicago. He was formerly assistant advertising manager for the company. END
WHY PAY MORE! COMPARE! Don’t be misled by other offerings similar in appearance to these original TELE Sound creations—but not in quality! Our cabinets are massively constructed, fully reinforced, smartly styled, and offered to you at THE LOWEST PRICES for quality cabinets of this type. Prompt Factory-to-you shipments. Buy with confidence! All cabinets illustrated available in Ribbon stripe Mahogany. Add 10% for Blonde finish. Complete catalog on request.

Save Money With TELE Sound "Package Deals":

Famous TELE 300X TV Chassis. Super-powered, complete with receiving tubes, OWN LUMP PRICE, new picture tube.

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FOR OTHER TV CHASSIS, ADD: for Video 330- $5; Video 330-DX, $15; TeleMaster C-30, C-10, 150, 404, 2421-D, $6. These models equipped with Video 330-2427 chassis.

TV CHASSIS SPECIAL VALUES!

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STANDARD BRANDS TUBES ALL RADIO & TV TYPES

Standard Warranty ... Bulk Packed or Individually Boxed

**SET MFR'S SURPLUS**

STANDARD WARRANTY... Bulk Packed in Original Mfr's. Nestled Cartons or Individually Boxed—BRANDED. Every tube meter & chassis tested for top quality.

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**IT'S TERRIFIC!**

**GREYLOCK'S**

**BIG NEW BARGAIN FLYER**

**JUST OUT!**

for every

- Radio
- TV Serviceeman
- Amateur
- Experimenter
- Technician

LIMITED QUANTITY

UNPRECEDENTED SPECIAL ANTIEN OFFER! BROAD BAND* ANTENNAS

for all Hi-Band channels 7 thru 13.

Snyder Hi-Band Folded Dipole and Amplifier, Channels 2 thru 13. Each $8.25

Vee-DX 5-element Yagi Channels 7 thru 13. Each $5.25

Vee-DX 4-element Yagi Channels 7 thru 13. Each $1.89

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FREE——Big 68-page GREYLOCK 1953 CATALOG "The essential Buying Guide" of the Radio & TV Industries——free to all purchasers from our new Bargain Flyer... Sey.

GET YOUR FREE COPY TODAY!

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15 Liberty St., N. Y.

Phone 83-3024

S E P T E M B E R, 1 9 5 3
COMMUNICATIONS

DON'T SHOOT!

Dear Editor:

Along about 1926 or '27 I was in the radio game in Dallas. That was the time console radios were just coming in. We sold a console set to a customer and about two days after Xmas I got a rush call to see why this set had suddenly developed a very disagreeable speaker rattle. An inspection revealed that the cone was full of small holes and the reason was found in the bottom of the cabinet—a barrelful of B-B shot.

Father had bought little Junior an air rifle for Christmas, so Junior propped up a target in front of the nice, round speaker grille. Result: one very bad case of rattles from said speaker.

Here's hoping no Junior ever sets up a target in front of a 27-inch television set. There might be a big bang.

Doc Miller

Keller, Texas

(Junior would probably have more sense, but Pop might not. In fact, one New York State father put a "38" slug through the family TV picture tube only a few months ago, because the kids kept the set going while he was trying to get some sleep. But wait till next Christmas, when Junior tries out his new Hypergalactic Interfibrillator-Ray pistol! —Editor)

DAME NATURE'S TRICK

Dear Editor:

For several years now Old Dame Nature has been playing a sly and very troublesome trick on an important radio-telephone wire-line link on Vancouver Island, feeding into the city of Nanaimo, an important communication center.

On rainy days—and there are a lot of them in this region—interference on the line caused much trouble.

Yet patrol linemen, with great experience in detecting even the most obscure trouble spots, went over and over the line with this arbutus tree always in plain view. They never suspected it due to an optical illusion.

They always saw it from the road—the opposite side to that shown by this picture—and the wires appeared to pass behind the tree, without touching it. But, as the picture shows, the tree had grown completely around the wires, causing a considerable change in resistance when the wood was wet.

Francis Dickie

Heviot Bay, B.C.
MINIATURE TUBES

The 6th edition of the CBS-Hytrons Reference Guide for Miniature Electron Tubes lists all miniatures to date, regardless of make. Characteristics are given for 250 miniatures, 87 of them new since the 5th edition. The Guide also includes 111 biasing diagrams and indicates similar larger prototypes. Numerous operating conditions for individual tube types are described. Copies gratis from CBS-Hytron, Danvers, Mass.

STANDBY POWER

Onan's Electric Power for Communications Systems shows examples of portable and mobile electric power for mobile TV stations, radio remote broadcasting units, television maintenance trucks and mobile civil defense centers. Other illustrations describe the units used as standby in county police departments, taxicab dispatching offices, telephone companies, and radio stations.

Request Form A-307 from D. W. Onan & Sons, Inc., Minneapolis 14, Minn.

BATTERY INDEX

NEDA has released the 1953 edition of its Battery Index, a cross-reference of competitive and interchangeable numbers. This index supplies a practical method of numbering for identification of the various battery types. Free on request to National Electronic Distributors Association, 228 N. LaSalle St., Chicago 1, Ill.

CERAMIC CAPACITORS

Sprague has released catalog C-650 describing its ceramic capacitors. It covers more than 375 models with 11 different voltage ratings from 300 to 20,000 volts d.c., and with physical types ranging from subminiatures to molded plastics. New listings include precision cup ceramics, precision metal-clad tubulars, and ceramic trimmers for industrial instruments.

Available at no cost from Sprague Products Co., 81 Marshall St., North Adams, Mass.

OUTPUT TRANSFORMERS

Acrosound's new output transformer catalog contains 6 full schematic diagrams of audio amplifiers, including the Ultra-Linear, 6V6, 6L6, and Williamson amplifier circuits.

Available free on request to Acro Products Co., 369 Shars Lane, Philadelphia 28, Pa.

BARGAINS • BARGAINS • BARGAINS

Famous STEVE-EL BRANDED TUBES

Now you can own an intercom that has a thousand uses at a price you would normally pay for a kit. This intercom comes housed in wooden cabinets completely wired and ready to operate. Outfit consists of one master, one sub station and fifty feet of two wire cable. Ideal for home or baby sitter. Perfect for office or factory. Order now as quantities are limited.

For complete specs and local jobbers' names, write Dept. RE

ELECTRONICS SALES CO IRVINGTON, N.Y.

BARGAINS • BARGAINS • BARGAINS

INTERCOM SPECIAL

Model 600—Tub & Set Tester $89.95
Model 616—Tub & Battery Tester $69.95

MINIMUM ORDER $5.00

Visit our New Store 144 Washington St., N.Y.C.

Sweep Replacement Line.

Simplify your replacement problems with the RAM combination of vertical components, horizontal output transformers, deflection yokes, width and linearity coils. RAM, as original manufacturers, assures you the highest quality and performance standards.

For complete specs and local jobbers' names, write Dept. RE

ELECTRONICS SALES CO IRVINGTON, N.Y.
TRANSFORMER CATALOG
United Transformer's Catalog 530 is a 22-page booklet listing the company's transformers, reactors, filters, and magnetic amplifiers. It is illustrated with photographs, diagrams, and charts and contains an index and price list.

Free on request from United Transformer Co., 150 Varick St., New York 13, N. Y.

REPLACEMENT GUIDE
Replacements for transformers and coils in all makes of automobile radios are listed in Thordarson-Meissner's 1953-1954 Automobile Radio Replacement Guide. Parts include vibrator, interstage and output transformers, oscillator coil, and input, output, and ratio detector i.f. transformers.

Copies available on request to Thor- darson-Meissner, Dept. C, Mount Carmel, Ill.

TUNER DATA
Standard Coil's 8-page Tuner brochure gives parts, prices, descriptions, and installation and performance data on their TV tuners and u.h.f. coil strips.

The booklet has circuit diagrams of the Standard cascode and pentode tuners, trimmer locations, and mounting dimensions. How to adapt the tuners to split sound i.f. systems is also explained.

Available free from Standard Coil distributors.

TUBE PICTURE BOOK
RCA Tube Dept. has published a picture booklet of photographs, cutaway drawings, and exploded views showing structural details of electron tubes used in home entertainment, industrial, and military electronic equipment.

The RCA tubes "dissected" in the booklet include: typical glass, metal, and miniature types; a subminiature triode; a thyratron; a high-voltage rec- eiver; a c.r.t.; a power-supply triode; television picture tubes; studio and industrial types of television camera tubes; and pencil-type tubes.

Available for $0.25 from Commercial Engineering, RCA Tube Dept., Harrison, N. J.

COMMUNITY TV
Four booklets on Ampli-Vision have recently been issued by International Telemeter. These are "Planning an Ampli-Vision Community TV System", "Antenna Site Equipment for Community Distribution Systems", "Pole Line Equipment for Community Distribution Systems", and "Engineering Services by ITC for Community Television Systems".

All four are free on request from International Telemeter Corp., 2000 Stoner Ave., Los Angeles 25, Calif.

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TUBE PICTURE BOOK
RCA Tube Dept. has published a picture booklet of photographs, cutaway drawings, and exploded views showing structural details of electron tubes used in home entertainment, industrial, and military electronic equipment.

The RCA tubes "dissected" in the booklet include: typical glass, metal, and miniature types; a subminiature triode; a thyratron; a high-voltage rec- eiver; a c.r.t.; a power-supply triode; television picture tubes; studio and industrial types of television camera tubes; and pencil-type tubes.

Available for $0.25 from Commercial Engineering, RCA Tube Dept., Harrison, N. J.

COMMUNITY TV
Four booklets on Ampli-Vision have recently been issued by International Telemeter. These are "Planning an Ampli-Vision Community TV System", "Antenna Site Equipment for Community Distribution Systems", "Pole Line Equipment for Community Distribution Systems", and "Engineering Services by ITC for Community Television Systems".

All four are free on request from International Telemeter Corp., 2000 Stoner Ave., Los Angeles 25, Calif.

TRANSFORMER CATALOG
United Transformer's Catalog 530 is a 22-page booklet listing the company's transformers, reactors, filters, and magnetic amplifiers. It is illustrated with photographs, diagrams, and charts and contains an index and price list.

Free on request from United Transformer Co., 150 Varick St., New York 13, N. Y.

REPLACEMENT GUIDE
Replacements for transformers and coils in all makes of automobile radios are listed in Thordarson-Meissner's 1953-1954 Automobile Radio Replacement Guide. Parts include vibrator, interstage and output transformers, oscillator coil, and input, output, and ratio detector i.f. transformers.

Copies available on request to Thor- darson-Meissner, Dept. C, Mount Carmel, Ill.
Eliminate major mechanical changes

with TRIAD TRANSFORMERS

Triad doesn't expect a serviceman to recon-struct or re-engineer a television chassis to accommodate a replacement part. For that reason every Triad television component is circuit tested.

As an example, Triad's R-BS Series Power Transformers, listed below, are tube socket types for use where rectifier tub is mounted directly on the transformer. They are made for under-chassis or top-chassis mounting and are exact replacements for many popular chassis.

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Plate Supply</th>
<th>Filaments-Watts and Amperes</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-45*</td>
<td>75 V.C.T.</td>
<td>225 5V - 3A</td>
<td>6V - 33A, low-voltage.</td>
</tr>
<tr>
<td>R-205*</td>
<td>250 V.C.T.</td>
<td>100 5V - 2A</td>
<td>6V - 3A, low-voltage.</td>
</tr>
<tr>
<td>R-305*</td>
<td>630 V.C.T.</td>
<td>270 5V - 3A</td>
<td>6V - 3A, low-voltage.</td>
</tr>
<tr>
<td>R-355*</td>
<td>1100 V.C.T.</td>
<td>30 5V - 1A</td>
<td>6V - 3A, low-voltage.</td>
</tr>
</tbody>
</table>

*T means Horizontal Mount. S. Socket Type

Triad Television Components will simplify and speed your service work. See your jobber for Triad Television Components, catalogs and replacements guides, or write for Catalogs TR-53B and TV-53B.


This book crowded much information into little space. It is written for those who understand physics and mathematics but who have not specialized in radio. Because of its pocket size and concise manner, it is also handy as a review or reference work for radio engineers. Algebraic equations are given frequently.

Early chapters discuss the construction and characteristics of various types of vacuum and gas tubes. The presentation is largely theoretical. A chapter on amplification includes material on the cathode follower, grounded grid amplifier, and negative feedback. This is followed by a short chapter on circuit and tube noise. Subsequent topics include rectifiers, voltage multiplication, tube voltmeters, etc., all briefly but basically. Converters, oscillators, and uhf tubes are covered in the final chapters. —IQ

TECHNOGRAPH PRINTED CIRCUITS. Distributed by Technograph Printed Electronics, 191 Main St., Tarrytown, N. Y. 5 1/2 x 8 1/2 inches, 47 pages. Price $1.00.

Printed circuits are used in hearing aids, TV front ends, and other miniaturized assemblies. They are also available, ready-made, as coupling and output a.f. assemblies and attenuators for TV frequencies. This booklet gives an outline of the Technograph printing process and lists some applications.

One chapter discusses the advantages over conventional wiring. Briefly, printing permits saving of space (where the entire circuit may be rolled up or folded), automatic assembly, self-support without metal chassis, and low loss at uhf where skin effect is important.

Several photos show the applications of the process to hearing aids, transformer windings, pocket radios, and other devices. —IQ

TV TUBE LOCATOR. Published by Harry G. Cisin, 200 Clinton St., Brooklyn 1, N. Y. 8 1/2 x 11 inches, 26 pages. Price $1.00.

Many set troubles are due to defective tubes. This booklet has been prepared to help locate inoperative or weak tubes. The author has prepared layout charts showing the exact location of each tube in over 3,000 TV models from more than 110 manufacturers. Sets made between 1947-1953 are represented. The function of each tube is indicated by a letter like V for vertical, S for sound, G for background. Tubes having high voltage are designated by an asterisk. Fuses and rectifiers are also shown.

In addition to the tube charts, a table lists various picture faults and shows which tubes to replace. Troubles include non-linearity, jitter, vertical bars, excessive brightness, and others. —IQ

BOOK REVIEWS

L. Veltri, busy service-dealer of Westchester, N. Y., reports:

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FREE: Sample copy of "TV and Electronics Notes," Or send 50¢ for year's subscription.

10 DAY TRIAL

Buy and try this fine instrument for 10 DAYS. Then, if you wish, return it. Your payment of deposit will be promptly refunded.

Speakers and enclosures seem to be the least understood links in any sound system. This is due to the many factors involved in reproduction, some of which are difficult to measure exactly. This author recognizes the empirical nature of the subject and has made numerous tests and comparisons involving baffles, cabinets, vents, horns, damping factors, etc. Actual results are shown by oscillograms and frequency curves, throughout Part I which is entitled "Loudspeakers."

The first part also includes various related topics such as intermodulation, the mechanism of the ear, and crossover networks. The latter topic illustrates typical circuits so there is no need for calculation by the reader.

Part II discusses recording. The treatment of tape recording is brief but clear. Technique, amplifying systems, and mixture are described. A more lengthy discussion is provided for disc recording. Photomicrographs show the effects of wear on needles and records. The last chapter compares pickups and microphones.

Throughout the volume this author uses an easy-to-read style and a practical approach.—IQ


Those of you who have at times thumbed through your well-worn copy of the third edition of the Radiotron Designer's Handbook can get a vivid idea of just how far we have progressed in radio design just by holding this new edition in your hand. This work (monumental is the only word that will fit) bears about the same relationship to the first edition, brought out in 1934, as a tree would have to its seed.

Covering the design of radio and audio (but not TV) circuits and equipment, containing over 1,000 illustrations and more than 2,500 references, cross-referenced with an index of more than 7,000 entries, this book could be dubbed the "bible" of radio art. The section on radio tubes alone would make an ordinary book. Fairly early in the book, we go through chapters on tube testing, network theory, transformers, wave motion and theory of modulation, tuned circuits, and inductance calculation.

The audio engineer will find here enough design material to keep his slip-stick fully employed. And since mathematics can slip away from us easier than the proverbial dollar, we have an entire chapter starting with arithmetic and the slide rule, through differential and integral calculus, and ending with Fourier series and harmonics. That isn't all. We still have transmission lines, r.f. amplifiers, etc.

CONTAINED pages, $3.50

SEE THEM ON APPROVAL

THE NEW REPRINT of this widely used service guide includes new data on the cascode tuner, servicing newer types of f.f. systems, automatically focused tubes, UHF station listing and antenna calculations, transistors and other recent developments. All faults likely to occur, including those hard-to-find troubles, are dealt with in the clearest, most practical way. A master of the art enables you to turn directly to procedures for locating and correcting any particular flaw in sound or picture.

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