BLIND IMPROVE TEST GEAR FOR ALL — SEE SERVICING SECTION
In big-picture tubes, more than ever, fine-line focus — clear across the screen — is an important function of the electron gun.

In newer, wide-angle picture tubes, only proper gun design can correct the defocussing effects which deflection has on the cathode-ray beam.

For uniform resolution, the control of beam-size by the new Du Mont Bent-Gun keeps the beam in focus from top to bottom and corner to corner.

For better performance in bigger pictures, Du Mont Teletrons are your best buy.

ALLEN B. DU MONT LABORATORIES, INC.
CATHODE-RAY TUBE DIVISION
Clifton, N.J.

First with the Finest in T-V tubes
You Practice COMMUNICATIONS
I send you parts to build this transmitter

As part of my Communications Course you build this low power broadcasting transmitter, learn how to put a station "on the air," perform procedures demanded of Broadcast Station operators make many tests.

This is just part of the equipment my students build. You keep all parts I send.

You Practice Radio SERVICING
on this modern radio you build with parts I send

As part of my Servicing Course, I send you the speaker, tubes, chassis, transformer, loop antenna, EVERYTHING you need to build this modern, powerful Radio Receiver! I also send parts to build many other Radio circuits. You use equipment for practical experience and to earn EXTRA money in spare time.

Be a Radio-Television Technician

NOW! Advanced Television Practice

New, special TV kit furnished to build high-definition ..... SCPE-oscillator with high-power supply. Complete TV set ..... many other stuff. Get valuable PRACTICAL EXPERIENCE locating and correcting TV trouble. Mail and correct TV troubles. Mail coupon for tests and pictures.

I Trained These Men

"I have been operating my own Service business. In two years I did $14,000 worth of business; net profit $6,856. Have one full time employee, an NRI student."—PHILLIP L. BROOKS, Louisville, Ky.

"Four years ago I was a bookkeeper, made $1,000 a month salary. Now I am a Radio Engineer, working for a key station of the American Broadcasting Company network."—HUNNIN N. WARD, Edison Park, New Jersey.

"When halfway through the NRI course, I made $5 to $6 a week fixing sets in my spare time. I'm now selling and installing Television sets and antennas."—JOE STREET, ENFORSTER, New Boston, O.

"My first job was operator with KDKA, received 'me by my Graduate Service Dept. I now am Chief Engineer of police Radio Station WOIO. I never hesitate to endorse NRI."

S. NORTON, Marion, Ohio.

Veterans

Get this training under G. I. Bill.

MAIL COUPON

Have Your Own Business

Many N.R.I. trained men start their own Radio-Television sales and service business without capital. Let me show you how you, too, can be your own boss, have a good income from your own shop. Send coupon for FREE book now.

Tested Way to Better Pay

Learn Servicing or Communications Practice at Home in Spare Time

Do you want good pay, a job with a bright future and security? Would you like to have a profitable shop or store of your own? If so, find out how you can realize your ambition in the fast growing, prosperous RADIO-TELEVISION industry. Even without Television, the industry is bigger than ever before—90 million homes and auto Radios, 3,700 Broadcasting Stations, expanding use of Aviation and Police Radio, Micro-wave Relay, Two-way Radio for buses, taxis, etc., are making opportunities for Servicing and Communications Technicians and FCC-Licensed Operators.

Television is TODAY'S Good Job Maker

In 1950, over 5,000,000 TV sets sold. By 1954, 25,000,000 TV sets estimated. Over 100 TV Stations now operating. Authorities predict 1,000 TV Stations. This means more jobs, good pay for qualified men all over the United States and Canada.

Many Make $10 Extra a Week in Spare Time

Keep your job while training. Hundreds of successful RADIO-TELEVISION TECHNICIANS I trained had no previous experience, some only a grammar school education. Learn Radio-Television principles from illustrated lessons. Get PRACTICAL EXPERIENCE-build valuable multistation-experience with circuits common to Radio and Television. Keep all equipment. Many students make $5, $10 extra a week fixing neighbors' Radios in spare time. SPECIAL BOOKLETS start teaching you the day you enroll.

Send Now For 2 Books FREE—Mail Coupon

Send now for my FREE DOUBLE OFFER. You get actual Servicing lessons to show how you learn at home. Also my 64-page book, "How To Be a Success in Radio-Television." Read what my graduates are doing, earning; see equipment you practice with at home. Send coupon in envelope or paste on postal. J. E. SMITH, President, Dept. 1, NATIONAL Radio Institute, Washington 9, D. C. Our 38th Year.

Good for Both—FREE

The ABC's of SERVICING

MR. J. E. SMITH, President, Dept. 1, National Radio Institute, Washington 9, D. C.

Mail me Sample Lesson and 64-page Book about How to Win Success in Radio-Television. Both FREE. (No Salesman will call. Please print plainly.)

Name__________________________Age________

Address________________________

City_________________________Zone____State____

Check if Veteran__________Approved for training under G. I. Bill________
MARCH, 1951

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Try This One

New Patents

Radio-Electronic Circuits

ON THE COVER:

Bob Gunderson and test gear in his radio lab, sound studio and ham shack at the Institute for the Education of the Blind, New York, N. Y. Kodachrome by Avery Stock
GET INTO

ELECTRONICS

By

Shop-Method Home Training

GOOD JOBS AWAIT THE
TRAINED RADIO-TV TECHNICIAN

There is a place for you in the great Radio-Television-Electronics industry when you are trained as National Schools will train you at home.

Trained technicians are in growing demand at good pay—in manufacturing, broadcasting, television, communications, radar, research laboratories, home Radio-TV service, and other branches of the field. National Schools Master Shop-Method Home Training, with newly added lessons and equipment, trains you in your spare time, right in your own home, for the fascinating opportunities. OUR METHOD IS PROVED BY THE SUCCESS OF NATIONAL SCHOOLS TRAINED MEN, ALL OVER THE WORLD, SINCE 1905.

EARN WHILE YOU LEARN

Many National students pay for all or part of their training with spare time earnings. We'll show you how you can do the same! Early in your training, you receive “Spare-time Work” Lessons which will enable you to earn extra money servicing neighbors' and friends' Radio and Television receivers, appliances, etc.

National Schools training is all-embracing

National Schools prepares you for your choice of many job opportunities. Thousands of home, portable, and auto radios are being sold daily—more than ever before. Television is sweeping the country. Too. Co-axial cables now under construction will soon bring television to every city, town, and farm! National Schools' complete training program qualifies you in all fields. Read this partial list of opportunities for trained technicians:

- Business of Your Own
- Broadcasting
- Radio Manufacturing, Sales, Service
- Telecasting
- Television Manufacturing, Sales, Service
- Laboratories: Installation, Maintenance of Electronic Equipment
- Electrolysis, Call Systems
- Garages: Auto Radio Sales, Service
- Sound Systems and Telephone Companies, Engineering Firms
- Theatre Sound Systems, Police Radio
- And scores of other good jobs in many related fields.

TELEVISION TRAINING

A complete series of up-to-the-minute Television lessons is an important part of your course. They cover all phases of television, repairing, servicing and construction. The same lesson texts used by resident students in our own modern and complete Television broadcast studios, laboratories and classrooms!
BONDED ELECTRONIC TECHNICIANS

have the answer to articles like this. Their cash bond of protection and code of ethics inspire customer confidence in their integrity and ability. Ask your Raytheon Tube Distributor if you can qualify for this vitally important sales asset.
Jobs are looking for men again!

Qualified Technicians

EARN MORE MONEY

IN TELEVISION SERVICING & INDUSTRIAL ELECTRONICS

Whether you're headed for essential industry, or the Armed Services, you can qualify for better paying jobs with CREI Home Study

A S ONE well-informed industry spokesman puts it, "Technicians are becoming as scarce as certain tubes." Growing military needs are cutting into the available supply of skilled personnel. The electronics industry, already a giant with normal civilian demands, is expanding daily to take care of military orders. With supply of men diminishing, and need for qualified men increasing, good jobs are truly plentiful—for the qualified man.

Now is certainly the time to improve your electronics know-how. If you're already in the field of TV servicing you must realize that hit-and-miss methods are time-consuming and unprofitable. CREI Home Study offers exactly the practical course you need to qualify for well-paid technical jobs. And if you're headed for the Armed Services, your improved technical ability can be recognized and rewarded with interesting supervisory work at higher ratings in vital radar, navigation, or communications units.

If you want to take advantage of today's opportunities . . . if you want promotion, more money, and the kind of training that is respected by industry and the Armed Services, investigate CREI. Send for—and study—the free booklet offered below. The sooner you begin your training, the better off you'll be—in TV servicing, in the vital Electronics Industry, or in military service. Start preparing at once—while there is still time to cash in on a better-paying job in this booming field. The cost of this famous home-study training is nominal, the terms easy. Send for complete data—right now!

THE THREE BASIC CREI COURSES:

* PRACTICAL RADIO ENGINEERING
  Fundamental course in all phases of radio electronics
* PRACTICAL TELEVISION ENGINEERING
  Specialized training for professional radio men
* TELEVISION AND FM SERVICING
  Streamlined course for men in "top-third" of field

ALSO AVAILABLE AS RESIDENCE SCHOOL COURSES

CAPITOL RADIO ENGINEERING INSTITUTE

An Accredited Technical Institute Founded in 1927
Dept. 143C, 16th & Park Rd., N. W., Washington 10, D. C.

Branch Office: San Francisco, 700 Market St.

MAIL COUPON FOR FREE BOOKLET

CAPITOL RADIO ENGINEERING INSTITUTE
Dept. 143C, 16th & Park Rd., N. W., Washington 10, D. C.

Gentlemen: Send booklet, "Your Future in the New World of Electronics," together with details of your home study training, CREI self-improvement program, and outline of course. I am attaching a brief resume of my experience, education and present position.

Check Field of Greatest Interest:
- Aeronautical Radio Engineering
- Broadcast Radio Engineering
- Practical Television Engineering
- Practical Radio Engineering
- Radio-Electronics Industry

If Residence School Preferred, Check Here □

NAME

ADDRESS

CITY ZONE STATE

MARCH, 1951
"CALL-BACKS CAN WIPE OUT PROFITS!"

"Quality tubes mean fewer call-backs—protect income. That's why we use G-E."

Says

Joseph F. Lauinger, President
CONLAN ELECTRIC COMPANY
1042 Atlantic Ave., Brooklyn, N.Y.

Typical of General Electric tube quality, is the glass beading of the electron gun in G-E picture tubes. Unlike cheaper, porous ceramics often used, glass will not readily contaminate. Results: much less chance of voltage breakdowns.

"Call-backs on TV-service customers consume working time, and working time is what we have to watch at Conlan Electric. With 40,000 owners on our contact list in Greater New York, extra service calls can multiply to a cost figure that changes black to red...Tube failures are a common cause of call-backs. We've found that good tubes—quality tubes—perform better, give much less trouble. G-E tubes have a top record with Conlan Electric. We feature them. We know that when one of our men installs a G-E picture tube or receiving type, chances are that customer will stay satisfied!"

FOR QUALITY TUBES TO CUT DOWN YOUR CALL-BACKS, SEE YOUR G-E TUBE DISTRIBUTOR!
NOW... GET EVERYTHING YOU NEED TO LEARN AND MASTER

TELEVISION
RADIO-ELECTRONICS

...AT HOME!

Use REAL commercial-type equipment to get practical experience

Your future deserves and needs every advantage you can give it! That's why you owe it to yourself to find out about one of the most COMPLETE, practical and effective ways now available to prepare AT HOME for America's billion dollar opportunity field of TELEVISION-RADIO-ELECTRONICS. See how you may get and keep the same type of basic training equipment used in one of the nation's finest training laboratories... how you may get real STARTING HELP toward a good job or your own business in Television-Radio-Electronics. Mail the coupon today for complete facts—including 89 ways to earn money in this thrilling, newer field.

D.T.I., ALONE, INCLUDES BOTH MOVIES and HOME LABORATORY

In addition to easy-to-read lessons, you get the use of HOME MOVIES—an outstanding training advantage—plus 16 big shipments of Electronic parts. Perform over 300 fascinating experiments for practical experience. Build and keep real commercial-type test equipment shown at left.

MODERN LABORATORIES

If you prefer, get all your preparation in our new Chicago Training Laboratories—one of the finest of its kind. Ample instructors, modern equipment. Write for details!

MILITARY SERVICE!

If you're subject to military service, the information we have for you should prove doubly interesting. Mail coupon today.

ACT NOW! MAIL COUPON TODAY!

DeFOREST'S TRAINING, INC., Dept. RE-3H
2333 N. Ashland Ave., Chicago 14, Ill.

Without obligation, I would like your late News-Bulletin showing 89 ways to earn money in Television-Radio-Electronics... and how I may prepare to get started in this thrilling field.

Name............................................ Age............................................
Street.......................................................... Apt............................................
City............................................................... Zone............................................ State............................................

De FOREST'S TRAINING, INC.
CHICAGO 14, ILLINOIS
A De VRY INSTITUTION

MARCH, 1951
New Round Shaft

Saves Valuable

Single Section
Mallory Midgetrol

Now you can have the outstanding electrical characteristics of the time-proved Mallory Midgetrol...with two new time-saving features that make carbon control installation faster and simpler than ever before!

This sturdy $\frac{1}{16}$" control is supplied with a permanently fixed, tubular brass shaft. It is easily cut to required length. It can be adapted for split-knurl or flatted type knobs in a few seconds by inserting one of the two steel shaft-ends packaged with every Mallory Midgetrol. It has been designed to give you utmost convenience—without sacrificing the important advantage of a stable, permanently secured shaft.

In addition, switch attachment is made simple and sure by positive indexing and a design that permits secure locking in position without removing the control housing.

The Mallory Midgetrol gives you fast, sure, simple installation— with electrical characteristics specially engineered for critical applications in both television and radio. Precision-controlled carbon element assures smooth tapers, quiet operation, accurate resistance values and less drift in TV sets.

Make Sure! Make it Mallory!
Mallory Midgetrol

Installation Time

Dual Concentric
Mallory Midgetrol

This revolutionary new control can be assembled in five easy steps, in less than five minutes—makes it possible for you to match a wide range of combinations immediately from convenient distributor stocks, and without the high "time" costs involved in more complex assembly operations.

The "exploded" view below illustrates the parts and assembled control sections supplied with each control. Extremely simple, brief instructions show you how to assemble them quickly and surely— without soldering— with only the simplest of tools.

As with the single Mallory Midgetrol, an AC Switch can be attached quickly—with no question of proper position, without removing the control housing.

The control is so designed that both front and rear sections are factory-assembled and carefully inspected. You can be sure that your final dual assembly will give the performance you want!
UNLICENSED BROADCASTING in Marysville, Ohio, was stopped suddenly by the FCC Jan. 5 last. Operating on 650 kc with a power of 150 watts, “Station WKGR” had been on the air for three months before an FCC representative walked in and told its surprised operators and audience “this is the FCC and this station is off the air.”

The only licensed member of the station’s youthful staff (two are too young to vote) held a second class radio operator’s ticket. Programs consisted almost entirely of recordings and news items from local papers.

TV AIDS MICROSCOPE to extend the possible range of microscopic study. In demonstrations conducted by scientists from Princeton University and the RCA laboratories, a Vidicon, RCA’s industrial television camera, was mounted on an ordinary light microscope. The televised microscopic scene was transmitted to nearby receivers by cable (See photo below.)

Shown in the demonstration were the details of an amoeba, which appeared clearly on the screen, including breaking and reforming of membranes and movement within the cell. Movement inside a plant cell, magnified at 2,800 times, was also shown.

Besides giving sharper images than any previously available, the televised microscopy has the advantage that many specimens need not be stained to become clearly visible. Staining often kills a specimen, and in many cases a specimen must be killed before it will take stain. Previous highly magnified motion could be seen only by motion picture photography. This technique required intense lights which often killed the specimen, and of course also required processing a film, while the television cameras operate at relatively low light levels.

PRIORITY of invention of basic magnetron strapping has been awarded by the U. S. Patent Office to Dr. Percy L. Spencer, vice-president of the power tube division of the Raytheon Manufacturing Company. This action was based on a concession of priority by the United States by Dr. James Sayers of England and marks the end of a patent suit that has been in the courts many years.

FM TRUNK LINE, involving nearly two million miles of circuits, has been put into successful operation by the Western Union Telegraph Company. Described by two of the Company’s engineers at the recent winter General Meeting of the American Institute of Electrical Engineers, the circuits use automatic switching that will virtually do away with manually handled messages, except in small towns. Message transmission will be speeded up, time lost because of system trouble and maintenance costs will be notably reduced.

ANNUAL CONVENTION of the Institute of Radio Engineers will be held this year in New York City from March 19 to March 22. Technical session will be 43 in number, with more than 200 papers to be read. The technical sessions will be held simultaneously at the Waldorf-Astoria Hotel and the Grand Central Palace, the latter also housing the exhibits as in previous shows.

A feature of the 1951 convention will be the large number of symposiums. Fourteen will be held; eleven of them by IRE professional groups. The other three will include a symposium on color television at which engineers of the chief systems will describe their techniques, an educational symposium on the problem of “matching schools to industry” and one on air traffic control problems.

Dr. A. K. Parpart of Princeton University and L. E. Flory of RCA Laboratories using the new microscope. The equipment is of the binocular microscope type.
IT'S "LOADED" WITH BETTER TELEPHONE SERVICE

Twenty of the Bell System's newest small loading coils—like the one at the left—are housed in the long black case, mounted in a cable splice. This type of installation permits the economical extension of city cables to serve out-of-town subscribers.

Many more wires can be crowded into a cable sheath when the wires are fine. But normally, wires don't transmit as well when they are fine and closely packed.

Bell engineers long ago learned to make wires do better work by loading them with inductance coils at regular intervals. The coils improve transmission and let messages travel farther. But originally the coils themselves were large, heavy and expensive. The cases to hold them were cumbersome and costly too.

So year after year Bell scientists squeezed the size out of coils. To make magnetic cores of high permeability they developed Permalloy. Tough but extra-thin insulation permitted more turns to a core.

New winding machines were developed by the Western Electric Company. Coil size shrunk to one-fiftieth. Some—like the one shown above—can be mounted right in cables themselves.

The 15,000,000 coils in the Bell System today mean thinner wires, more wires in a cable—more economical service for you. They demonstrate once more how Bell Telephone Laboratories work continually to add to your telephone's value.

MARCH, 1951
A NATIONAL association of electronic technicians and radio-television service dealers was formed in Washington January 28 by representatives of some 24 electronic technicians' associations. Charter members include the member societies of the New York and the Pennsylvania federations and other associations in Washington and New Jersey. The aims of the new National Electronic and Service Dealers Associations will include improvement of the radio- television servicing industry and promotion of better understanding between electronic service technicians and dealers and the rest of the electronic industry; securing good relations with the public; raising the technical standards of the electronic technician; and cooperation with federal, state and municipal agencies in matters affecting radio-television servicing and the electronic service technician.

Temporary officers elected were: president, Max Liebowitz, New York City; vice-president, Norman Selinger, Washington, D. C.; corresponding secretary, Richard Devaney, Philadelphia; recording secretary, Roger Haines, Haddonfield, N. J., and treasurer, Vance E. Beachley, Harrisburg, Pa.

Next meeting of the new association was set for March 4 at Philadelphia.

FOUR-WAY TRAIN RADIO, an important adjunct to safe and efficient railroad operation, was demonstrated recently to FCC staff members who went on a 200-mile freight train ride through the Erie Railroad's most difficult terrain—from the standpoint of radio reception. Over 90% of the Erie's main line between New York and Chicago is covered by the radio system, with 51 wayside transmitting stations spaced at intervals from 6 to 30 miles. Mobile stations are used in 108 diesel locomotive cabs and in 42 cabooses. Yard and terminal operations have four base stations and 30 mobile units.

TV SERVICE PROBLEMS, long a headache to the industry, are due for Federal investigation if a resolution now before Congress is passed. Sponsors of the resolution are seeking a thorough probe of "false and misleading" TV service contracts on the ground that TV service constitutes an interstate commerce. The New York State Legislature has a similar bill before it, and the New York City Council has been considering a bill to license firms that install or repair TV sets.

Almost nothing has been done to stabilize the service industry in the past year, and service technicians have had to cope with a spate of deterioration of new sets because of careless workmanship, substitute parts, and poor inspection at the factory. Service firms also charge that distributors fail to meet their warranty obligations. Frank J. Moch, president of the Television Installation and Service Association of Chicago, stated that in that city alone distributors owe about $120,000 in replacement parts covered by warranty agreements to service firms. He also charged that a large part of the replacement parts, especially tubes, supplied by distributors would not perform satisfactorily. "At least 50% of receiver tubes sent to us in recent months have been worthless," Mr. Moch said. "Many of these tubes carry no code numbers and are out of the cartons—but we have strong suspicions that tubes sent in by some other dealer or service man are being sent back out to us. When these replacements fail to work, we are left holding the bag."

Latest stalling technique, according to service technicians, is that some distributors are issuing credits on defective tubes, but the credit is based on prices which have not been in effect for over nine months.

1950 EDISON MEDAL, annual award for high achievement in engineering, has been given to Otto B. Blackwell, of Plandome, L. I., retired assistant vice-president of the American Telephone and Telegraph Co. The award was given for "his pioneer contributions to the art of telephone transmission."

In addition to his work in telephone communications, including world-wide telephones linked by radio, Mr. Blackwell has been a leader in schools for training transmission engineers and was responsible for the first comprehensive transmission engineering bulletin for field use. He is also author and co-author of several important technical papers in the communications field.

The Edison Medal was established in 1904 by friends and associates of Thomas A. Edison to serve as an "honorable incentive to scientists, engineers and artisans to maintain by their works the high standards of accomplishment" of Edison. It is awarded annually by the American Institute of Electrical Engineers for meritorious achievement in electrical science, electrical engineering, or the electric arts. Recipients of the award include George Westinghouse, Alexander Graham Bell and other outstanding scientists.

ROBOT CHESS PLAYER suddenly gave up the game when it was beating its master, Professor Torres Quevedo of Spain. "I broke the rules three times, and it's disgusted," the professor said. The game took place at the first International Congress of Machine Communications in Paris.
FEEL LIKE THIS AGAIN TODAY? Back in '43, when Hytron first ran this ad, Hytron tubes were worth their weight in gold. T'aint that bad today. But, despite quadrupled production, it's bad enough. Hytron tubes are more in demand than ever before.

Defense...TV...radio...industry want more tubes than all the tube manufacturers can make. We know how it is. And how vital your needs for replacements are.

Despite the crazy demand...and the irritating shortages of materials, we're straining every effort to increase production for you. We'll give you more Hytron replacement tubes yet, or "bust a gut" trying.

Probing made Natural...Quick...Safe!

Pestered by elusive intermittents, shorts, opens, noise, feedback? Want to probe for them — with set operating? Without danger? Without detuning effects? Try new Hytron Probing Tweezers. The precise...safe...natural extension of your own fingers long sought for this job. Of rich, tough polystyrene with ideal electrical and mechanical characteristics. This contest prize winner saves time, money...maybe your life. Only $3.50 from Hytron jobbers. Get your Probing Tweezers today.

It's a Cinch! As natural as using your bare fingers. With set on, Hytron Probing Tweezers probe, grasp, and manipulate suspected wiring and components. Easily, surely ferret out: intermittents, shorts, opens, noise, feedback from adjacent wiring, etc. Free from danger of accidental shorts and shocks. Without disturbing normal performance of set.

Jaws of Probing Tweezers grip firmly. Have fine and coarse serrations for different sizes of wires, condensers, resistors, etc. High dielectric constant of polystyrene minimizes capacitive detuning. No pull by strong magnetic fields. Safely long for TV. Handily compact for burrowing into tight spots. Heat resistant, too, if you avoid very hot irons and components. You'll like this unique Hytron tool "by servicemen, for servicemen."

NEW!

HYTRON Probing Tweezers
35¢ net

EIGHTH MEMBER OF THE HYTRON SERVICE TOOL KIT!
Merchandising & Promotion
Sylvania Electric Products has established the Sylvania Television Awards Foundation in an effort to improve the quality of TV programs. The company will make awards of “Sylvias” for the best TV program and to the best writer, producer, director, etc. Deems Taylor will serve as chairman of the committee of judges.

The Centralab Division of Globe-Union Inc., Milwaukee, Wis., announces a new volume control reference chart as an aid to the service technician. This new Adashaft chart shows the varied shaft and switch combinations available for Centralab replacement controls. It is printed on durable card stock and may be tacked on the wall.

The M. A. Miller Mfg. Co. announces two new packages for its replacement needles. One is an individual package for each Miller needle; the second is a handy dispenser box for counter and sales display.

Clarostat has a new bluish-green carton which supersedes the company’s familiar kelly green package. Simple in design and free from excess copy, it is attractive and easy to recognize.

Jensen Industries has introduced a new phonograph needle display card. It holds fifty packages of thirty needles each. The display is available through local distributors or direct from the company.

Servicing Business
Allen B. Du Mont Laboratories, Inc. is demanding that all its authorized TV service organizations and dealers who take on contracts provide notarized proof that they have established escrow accounts to insure funds paid out for service contracts.

RCA Service Company district managers were told that greater demands for servicing electronic equipment would put even heavier stress on the servicing industry which is already hard pressed by shortages.

The company also announced that it had more trained men in the field working on military installation, instruction and servicing in theaters of operation and at bases in the United States than at the peak of World War II.

General Electric vice-president Dr. W. R. G. Baker stated that the electronics industry can fulfill needed military requirements if permitted to convert on the basis of sound planning. He stated that TV-radio technicians are a reservoir of skilled labor that would be a great asset in time of all-out military production.

Sales and Production
The RTMA reported that TV picture tube production in the month of November continued at a peak rate. 914,804 tubes were produced, of which 98% were 16-inch or larger and over 60% rectangular. The association reported that 61,938 tubes were sold for replacement purposes in November.

RTMA president, Robert C. Sprague, stated that the radio-TV industry broke all records in production and sales of TV and radio sets in 1950. Preliminary estimates show that close to 7,500,000 TV receivers and over 14,000,000 radios were manufactured during the past year. Manufacturers' sales amounted to $1,700,000,000, an increase of 90% over 1949 sales.

NBC-TV Sales Planning and Research Bureau reported that TV set installations in the U. S. as of December 1, 1950, were 9,845,300, or 670,000 more than the previous month.

Show Notes
The committee of the 1951 Parts Distributors Show, which will be held in the Stevens Hotel in Chicago May 21-23,
**Where Will You be in ELECTRONICS?**

6 Months from Today?

**ADD TECHNICAL TRAINING TO YOUR PRACTICAL EXPERIENCE**

**GET YOUR FCC LICENSE IN A HURRY!**

**THEN—Use Our Amazingly Effective JOB-FINDING Service**

Get this Valuable Booklet FREE

**TELLS HOW—**

WE GUARANTEE

TO TRAIN AND COACH YOU AT HOME IN SPARE TIME UNTIL YOU GET YOUR FCC LICENSE

If you have had any practical experience—Amateur, Navy, Radio repair, or experimenting.

**TELLS HOW—**

Employers make JOB OFFERS Like These to Our Graduates Every Month

Telegram, August 9, 1950, from Chief Engineer, Broadcast Station, Pennsylvania. "Here is an opening for one transmitter operator to start immediately, contact me at once."

Letter, August 12, 1950, from Dir., Radio Div., State Highway Patrol. "We have two vacancies in our radio Communication division. Starting pay $100; $20 after six months satisfactory service. Will you recommend graduates of your school?"

These are just a few examples of the job offers that came to our office periodically. Some licensed radio men filled each of these jobs. . . . it might have been you!

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS OF STUDY WITH OUR Coaching AT HOME in Spare Time.

<table>
<thead>
<tr>
<th>Name and Address</th>
<th>License</th>
<th>Lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee, Walter H.</td>
<td>2205 E. 1st St., Bakersfield, Calif.</td>
<td>2nd Phone 10</td>
</tr>
<tr>
<td>Taylor, E. V.</td>
<td>4715 E. 1st St., Cleveland, Ohio</td>
<td>1st Phone 25</td>
</tr>
<tr>
<td>Box 1064, Dallas, Tex.</td>
<td>312 Broadway, New York City</td>
<td>1st Phone 30</td>
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<td>New York, N.Y.</td>
<td>312 Broadway, New York City</td>
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<td>West 1st St., H.</td>
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CLEVELAND INSTITUTE OF RADIO ELECTRONICS

Desk RE-27, 4900 Euclid Bldg., Cleveland 3, Ohio

Approved for Veteran Training Under G. I. Bill

**MAIL COUPON NOW**

**GETS JOB WITH CAA**

"I have had a half dozen offers since I mailed you one copy of the two hundred examination questions that I compiled a problem with the Civil Aeronautics Administration as a Maintenance Technician. Thank you very much for your recommendation and help your organization has drawn me in finding a job in the radio field."

Dee D. Young, 320 Holbrook St., Orono, Me.

**GETS FIVE JOB-OFFERS FROM BROADCAST STATIONS**

"Your Chief Engineer's Bulletin is a great help in obtaining employment for your graduates who have obtained their 1st Class License. When my name has been on the list I have received calls or letters from five stations in the southern states, and one new employed as Transmitter Engineer at WMMS."-Berger Powell, Box 104, Spartan, Tenn.

**GETS CIVIL SERVICE JOB**

"I have obtained a position at Wright Patterson Air Force Base, Dayton, Ohio, as Junior Electronic Equipment Repairman. The Employment Application you prepared for me had a lot to do with me landing this desirable position."-Charles E. Lomas, 1534 Grove Ave., Dayton, Ohio

Your FCC Ticket is always recognized in all radio fields as proof of your technical ability.

**MAIL COUPON NOW**

Cleveland Institute of Radio Electronics

Desk RE-27—4900 Euclid Bldg., Cleveland, 3, Ohio

Address to Desk No. 27 to avoid delay

Approved For Veteran Training Under G. I. Bill

I want to know how I can get my FCC license in a practical way. Please send me your FREE booklet, "How to Pass FCC License Examinations," which contains exams for Amateur License, as well as a sample FCC-type exam and the valuable and helpful, "Money-Making FCC License Information."

NAME:

ADDRESS:

CITY:

STATE:

Zone:

Parts are not our post card or send no mail.
you can have perfect reception when you know your TV A-B-C's

Here's the System that makes perfect TV reception available in every fringe area — and it's as simple and inexpensive as A-B-C. Your first step — A — is the famous Tel-a-Ray Model 7 antenna — the durable, non-corrosive antenna that consistently receives fine reception from stations as much as 200 miles away.

Second in the simple Tel-a-Ray A-B-C System is the Tel-a-Ray Pre-Amplifier. This ingenious, powerful pre-amplifier — the only one of its kind in the low price range — mounts right to your Model T antenna to bring in sharper, stronger, clearer images without increasing the line noise or other distracting sounds.

The "C" of the A-B-C System is your receiver. That's all you need to give you evening after evening of wonderful, clear television. The Tel-a-Ray A-B-C System is working for fringe area TVers throughout the country. It will work for you. Write today for complete information.

Your best bet for good primary area reception is the Tel-a-Ray Butterfly antenna. The Butterfly receives 13 channels and FM radio — is completely guaranteed against wind and weather damage. It sells for just $2.95 (suggested list).
announced that, as in former years, all booths in the Exhibition Hall have been sold.

The National Electronic Distributors Association announced plans for its second Jobber Sales Show to be held in Cleveland, Ohio, September 10-13.

The Pacific Electronic Exhibit will be held from August 22 to August 24, a week earlier than the date originally scheduled.

**New Plants and Expansions**

General Electric officials okayed the construction of a new million-dollar electronics plant on a 60-acre site in Auburn, N. Y. The new plant is expected to be ready by early Fall. It was originally scheduled for TV receiver parts manufacture, but the present international situation may make a change in plans necessary.

General Electric also announced the purchase of a major part of the Union Bag & Paper Corp. plant in Hudson Falls, N. Y. It will use the plant to manufacture capacitors.

Thomas Electronics, Inc. has acquired 100,000 square feet of additional floor space in its present location in Passaic, N. J.

Westinghouse Electric Corp. announces the formation of an electronics tube division. The new division is planning three new plants to manufacture various types of tubes.

Stewart-Warner Electric, the radio-TV division of the Stewart-Warner Corp., has acquired a 100,000-square-foot plant at North Kostner Ave., Chicago. It will transfer manufacturing operations now located at its main plant to the new building in April.

Electronic Measurements Corp. has moved its offices and factory to new and larger quarters at 280 Lafayette St., New York, N. Y.

General Cement Mfg. Co., Rockford, Ill., announces the acquisition of a new 30,000-square-foot plant which will be devoted to the manufacture of TV antennas and accessories.

U. S. Electronics Corp. has moved from Los Angeles to a new 6,000-square-foot plant in Santa Monica, Cal.

Gertsch Products, Los Angeles, has acquired additional facilities adjoining its present plant. The new floor space will be used for offices and engineering development laboratories.

Best Vue Products, TV antenna manufacturer, has moved its factory and offices to Brooklyn, N. Y.

Synthane Corp. of Oaks, Pa., fabricator of plastics for industry, has moved its New York district office to Bronxville, N. Y.

Pioneer Electronics Corp. has begun the production of TV picture tubes on the West Coast. The company occupies a 15,000-square-foot building in Santa Monica, Cal.

**Financial Reports**

<table>
<thead>
<tr>
<th>Year</th>
<th>1949</th>
<th>1950</th>
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<tr>
<td>Earnings</td>
<td>$450,785</td>
<td>$1,757,524</td>
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<tr>
<td>Sales</td>
<td>$13,678,971</td>
<td>$23,927,117</td>
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**BEST BEFORE.... NOW EVEN BETTER THAN EVER**

**Astatic TV and FM Boosters**

Yes, Astatic engineering research has found a way to improve still further its BT Series Boosters, in ability to sharpening quality of TV reception. From the first, these Astatic entries in the low-cost booster field have won top preference of the trade in virtually every instance where performance has been compared. So, it's a matter of yesterday's best made even better today—thanks to constant Astatic research and engineering progress. This continuing search for better methods and products is also your greatest assurance of first quality in phonograph pickups and cartridges, microphones and related equipment.

**Model BT-2**

List Price: $34.95

**Model BT-1**

List Price: $32.50

**QUALITY FEATURES**

1. Mallory Induetuner for continuous variable tuning.
2. High gain, very uniform on both high and low channels.
3. Simplified controls—single tuning knob with continuous tuning through both TV and FM bands.
4. Band width adequate over entire range.
5. Low noise design and construction.
6. No shock hazard to user.
7. Off-on switch for easy cutting in and out of the circuit.
8. Selenium rectifier.
10. Provide for either 72 ohm or 300 ohm impedance input and output.
11. Model BT-2 has handsome, dark brown plastic cabinet.
12. Model BT-1 has metal cabinet in rich mahogany woodgrain finish.
13. Large dial face is easy to see in tuning.
14. Model BT-2 has recessed pilot light to show when booster is on.

**THE Astatic CORPORATION**

*CONNEAUT, OHIO*

*IN CANADA: ASTATIC LTD. TORONTO, ONTARIO*
Radio Business

Hallcrafters Company
(November quarter)
Earnings $481,636  $220,766
Sales not given

Dividends:
Hoffman Radio Corp. announced a regular quarterly dividend of 25¢ a share on common stock.
Howard W. Sams Co. announced a common stock dividend of 10¢ a share. Western Electric Company gave a dividend of 50¢ a share on outstanding capital stock.

Business Briefs
. . . RCA Board Chairman Brig. Gen. David Sarnoff declared 1950 was the company's biggest year in history, with television accounting for about 75% of the total gross income.
. . . Sylvania Electric Products president Don G. Mitchell announced that the company closed 1950 with sales volume in excess of $156,000,000, or over 50% more than the previous year.
. . . Admiral Corp. head Ross D. Siragusa stated that the long-term outlook for TV is sound but the immediate future is uncertain. He anticipates a poorer year in 1951 than for the record 1950. He estimated Admiral's 1950 sales at approximately $250,000,000, of which TV accounted for $173,000,000.
. . . Allen B. Du Mont Labs., has established a cabinet styling department under the direction of the receiver sales division.
. . . RCA Victor Division has a new mobilization planning department to co-ordinate the division's activities with the needs of the Government in the national emergency.
. . . General Electric has created a departmental committee to offer aid in the electronics field to civil defense organizations. E. H. Vogel, manager of marketing, heads the committee.
. . . NEDA will now mail its weekly Washington report to any distributor who requests it. Previously it has been limited to NEDA members only.
. . . Electro-Voice, Inc., Buchanan, Mich., is the twenty-second electronics firm to participate in the engineering services of Howard W. Sams & Co., Inc.
. . . Zenith Radio Corp. reports that tests on Phonevision subscriber television, which began January first, were favorably received by Chicago viewers.
. . . Bendix Home Appliances, Inc., has become a division of the Abeo Mfg. Co.
. . . RCA Victor Division admitted 106 employees who had completed a quarter century of service in 1950 into the company's 25-Year Club.
. . . Clarostat Mfg. Co. reported shipments of over $4,000,000 for the first nine months of 1950. The company anticipates a profit for this period of over $450,000.
. . . The Allison Radar Corp., New York, was formed recently to manufacture and sell radar products for military and commercial use.
"MY CUSTOMERS BUY IT WITH CONFIDENCE!"

"MY CUSTOMERS BUY IT WITH CONFIDENCE!"

VARIABLE RELUCTANCE CARTRIDGE

MORE than 100,000 sold in 1950! Outsells all other brands of VR cartridges combined. That's why dealers like to sell it — people like to buy it; it's dependable, it offers more listening pleasure per dollar than any other cartridge on the market.

Orders from manufacturers are 'way up — you will see more and more G-E cartridges in new record players and combinations. Dealers and servicemen, too, are placing orders now for adequate stocks of these quality cartridges. Your customers deserve the best audio equipment you can give them. Phone or wire your distributor today, or write: General Electric Co., Electronics Park, Syracuse, New York.

NEW CATALOG...GET YOURS FREE!

Every dealer and serviceman needs one of these catalogs...complete specs and photos on G-E cartridges, styli, tone arms, pre-amps.

MARCH, 1951

General Electric Company — Section 4531 Electronics Park, Syracuse, New York
Rush me the new G-E Phono-Accessory Catalog.
NAME
ADDRESS
CITY
STATE

MARCH, 1951
For Laboratory Precision at Lowest Cost—the Leaders Look to EICO!

In the whole world of electronics, no taskmasters enforce more stringent standards of test equipment performance than the factories making TV sets. Fiercely competitive, they daily train sharp critical eyes on their production efficiency, quality and economy. Of their test equipment they demand the highest precision, utmost speed, lowest cost and certain dependability—without compromise.

In the new giant Bayway, New Jersey television plant of the great Tele-Tone Radio Corporation—at the many vital constant-duty testing positions along the production line—EICO instruments stand guard. One of the world's foremost volume manufacturers, Tele-Tone knows that for speed, accuracy and day-after-day dependability, at maximum economy, EICO instruments always deliver the fullest measure of value.

From coast to coast, in one leading TV factory after another, this is the experience—this is the proof of EICO superiority—that is demonstrated again and again. The top-flight TV set makers have discovered—just as over 65,000 servicemen have learned—that for the industry's greatest instrument values, at the industry's lowest costs—it's EICO!

Be sure you look at the EICO line before you buy any higher-priced equipment! Each EICO product is jam-packed with unbelievable value. YOU be the judge—compare EICO at your local jobber today—and SAVE!

See the complete EICO line at Booth 362, IRE Show, Grand Central Palace, N.Y.C., March 19-22.
Military Inventions Wanted

...The radio-electronic inventor can render a service to his country...

By HUGO GERNSBACH

THE state of emergency proclaimed by President Truman on Dec. 16 makes it necessary for us to reorient our thinking on American security. The time when we could sit smugly behind our own "Maginot wall"—the atomic bomb—has now passed into history. We no longer have a monopoly on atomic weapons. The Russians now have them too, so our former exclusive weapon now is a commonplace.

We must realize what we should have known all along.Wars cannot be won by atomic bombs alone! We also must deliver them first in the face of determined air opposition by the enemy.

Yes, atomic bombs can be used successfully against armies and men in the field. A-Bombs are not only too wasteful, but by saturating the ground with deadly radiation, stand in the way of the attacking army as well. In the end it is the foot soldier who must do the job. For this reason it is doubtful that atomic bombs will be used in the field.

Meanwhile your country needs new weapons of a more prosaic type. It is here that you can help your country. We are giving most of this page over to the National Inventors Council appeal for military inventions. It should be studied by every reader of this magazine.

We give only four radio-electronic war devices now asked for by the Council and we shall print others from time to time as the Council announces them.

Government agencies are often slow in making their wants known, so we readers who have talent for new inventions need to scan the daily news items from the various war theaters and form our own opinion on required weapons.

We are only excerpting the vital data from the INFORMATION BULLETIN of the National Inventors Council. This monthly is secret, writing to the Department of Commerce, Office of Technical Services, Washington 25, D. C.

Information Bulletin

1. GENERAL INFORMATION—The National Inventors Council functions in an advisory capacity to the Department of Defense and other departments, agencies, and offices of the Government in evaluating, guiding, and analyzing inventions for the national defense and welfare. The Council membership comprises outstanding American inventors, scientists and industrial research experts having specialized experience in the development and utilization of inventions, together with the Commissioner of Patents and a representative of each of the three branches of the Armed Services.

The Council was originally created in the fall of 1941 by the Secretary of Commerce with the concurrence of the President. During the war years the Council screened over 200,000 inventions for the Armed Services. Many of them played an important part in the war—the magnetic mine detector, for example. The Council functions to:

1. Assist the public in submitting inventions or inventive ideas of value in the defense and welfare of the nation.
2. Acquaint the public with the problems confronting the Armed Services.
3. Refer all potentially valuable ideas to the Department of Defense or other appropriate agencies.

The Council restricts its activities to inventions relating to the Armed Services and other Government agencies. It does not assist individuals and firms in obtaining development contracts, nor does it finance the development of inventions. The Council will, however, place the inventor in contact with the proper authorities if its proposal appears to meet a need of the Armed Forces or some other Government agency.

2. PROCEDURE FOR SUBMITTING PROPOSALS—In order that inventions may receive prompt and fair consideration it is essential that the objectives and advantages of the invention be readily apparent. The inventor, should, in his own interest, completely disclose the whole method and principle underlying the operation of the apparatus or invention.

2a Form of Submission: No special forms are required for submitting proposals to the Council and the services of an attorney are not required. Consideration of inventions is facilitated if each proposal is submitted as a separate document, preferably typewritten, containing the following information in numerical order:

1. Name and address of inventor.
2. Title of the invention.
3. A brief statement as to the general nature and specific use of the invention.
4. A discussion of the particular point of novelty or superiority of the invention as compared with existing devices and/or practices.
5. A brief outline of any tests which have been conducted on the invention.
6. A summary of the present status of the invention and the steps which have been taken to develop the invention or bring it to the attention of other Government agencies.
7. A complete description of the invention which includes any necessary sketches, drawings and photographs.

2b All suggestions should be addressed as follows: National Inventors Council, 500, Department of Commerce, Washington 25, D. C.

2c For prompt and accurate service all material should be typewritten in English.

2d. Personal Interviews and Demonstration: The National Inventors Council cannot provide funds for the transportation of an inventor or his representative to Washington or to other Government installations. While the Council's staff is always available for personal interviews when an inventor is in Washington, it is usually not possible to make any formal action on a proposal until it has been made in writing.

2e Submission of Models: Models SHOULD NOT be forwarded unless specifically requested after a written description of the suggestion has been submitted and examined.

3. PROTECTION OF INVENTOR'S RIGHTS—While the Council receives and examines all inventions and suggestions submitted, it cannot give the protection afforded by a granted patent. Submission of an idea to the Council does little more than establish a date on which the idea was disclosed to a responsible Government agency. All inventions are held in secrecy and in confidence, and all possible safeguards are imposed to protect the inventor's rights. But the United States Patent Office is the sole statutory agency which can grant an inventor a limited monopoly in respect to his discoveries.

4. COMPENSATION—The submission to the National Inventors Council of the provision contained herein, of any description, drawing or other data pertaining to this invention is solely for the purpose of determining its possible interest to the Government. Acceptance of a disclosure by the Council does not legally obligate the United States Government or act as an estoppel under the patent statutes. Likewise, the submission of an idea does not obligate the inventor to any described course of action and he is entirely free to dispose of his ideas elsewhere.

The Council is not directly concerned with compensation or rewards to inventors, nor in the development of a product idea into a useful device. Those agencies which might use a promising suggestion, such as the Army, Navy, Air Force, etc., are usually very cooperative. Typically, no encouragement is given prior to the consideration of the idea and the use of the invention. This direct method of procedure, by much experience, has been found to be mutually satisfactory. The Council works closely with all agencies and finds them able and willing to give full credit to all who present original useful suggestions.

Inventors are warned that they must assume all expenses incurred in preparing and presenting their ideas for consideration unless some Government agency specifically indicates in writing that expenses will be paid.

INVENTIONS WANTED

449 NEW TYPE OF COMMUNICATION. Scope: The development of a revolutionary new method or apparatus for obtaining and transmitting military information. Military Application: To augment or replace present systems. Status: Present systems in general depend on electromagnetic waves, electromagnetic waves, sound waves, etc. A system utilizing completely new concepts is desired.

450 DESTRUCTIVE RAY. Scope: To develop equipment of usable size capable of producing destructive or death rays effective at 500 yards without excessive power input. Military Application: To augment conventional weapons. Status: Investigations to date indicate that tremendous amounts of power would be required using present techniques and that a completely new approach is necessary.

451 LIGHT-EIGHT EQUIPMENT FOR TRANSLATING SPEECH INTO WRITING. Scope: To develop equipment of size suitable for general use, capable of translating ordinary speech into the written word. Military Application: General use in speeding up communications and in intercepting radio and wire communications. All suggestions to date have indicated that apparatus required using existing techniques would be too complexly complicated and in the aggregate, extremely bulky.

452 RADIATION INDICATING AND MEASURING EQUIPMENT. Scope: To develop a convenient pocket size instrument that will give continuous indications of radio and wire communications. Military Application: General use by individuals. A device not presently employed in commercial instruments. Military Application: General use, by individuals.

Status: See current literature on commercial type instruments.

MARCH, 1951
Midget Set Uses Subminiatures

A Tom Thumb set that has excellent reception over the entire broadcast band

By WILLIAM A. KUMM

Now that subminiature radio components are generally available, it is possible and fairly easy to build pocket radios. The object of a personal portable is to have as small a set as possible that will still give us good reception. This can be achieved up to a point with the standard 4-tube miniature sets, so the question then arises: why not use subminiature?

This little receiver, shown in Fig. 1 and the photos, has a converter-oscillator, an i.f. stage, a crystal diode detector, and three audio stages which operate a hearing-aid earphone. It is 4 inches long, 3% high, and 1½ inch thick.

Because each tube in this set has less gain than the tubes of a larger set, an extra stage is necessary. The best place for this extra stage seems to be in the audio-frequency amplifier, from both the point of view of battery drain and that of physical size. An experimental set was built with two i.f. stages, but because the components are so close together, it was practically impossible to keep the set from oscillating. Even the present set has a slight tendency to oscillate in the i.f. stage. A resistor of approximately 500,000 ohms across the secondary of the first i.f. transformer will reduce this tendency.

A tuned r.f. stage was also considered, but this requires an extra gang on the tuning capacitor, so the idea was rejected. One commercial subminiature receiver, the Belmont Manhattan, has a tuned r.f. stage for added gain, but it is tuned by a slug in each of the three coils and it uses an untuned antenna which, incidentally, is the cord to the crystal earphone.

The added audio stage requires only three more resistors and three more capacitors, and as the filament voltage of the CK505's is only 0.6 volt, the two tubes are put in series for the filament voltage of 1.35 volts. This saves a good 50 milliamperes drain on the A-battery, because ordinarily an extra tube would require an extra 50 ma for its filament. The audio stages use a standard hearing-aid circuit with the usual values of resistors and capacitors. It is feasible to use a 2-stage amplifier, in which case the diode-pentode in the subminiature series, the 2E41, would be used, but of course some gain is sacrificed by doing this. A CK505 is used for the output tube because it gives slightly more undistorted output than the 2E36 output tube normally used in the subminiature receivers.

The variable capacitor is one of the smaller ones that are used in the personal portables, with a capacitance of the antenna gang of 260 µf approximately, and of the oscillator gang about 170 µf. The appropriate oscillator coil was purchased along with the variable capacitor and it has a slug adjustment for tracking the low end of the broadcast band.

The i.f. stage uses two miniature transformers and is a conventional circuit. These are mounted behind the tubes in Photo B. A 1N34 crystal diode is the detector and the supply for a.v.c. voltage which is used to bias the converter and the i.f. stage.

A magnetic type of hearing-aid earphone is used so it requires an output transformer (mounted between the i.f. cans and the variable capacitor) to match its impedance of 11 ohms to that of the plate circuit which is on the order of 20,000 ohms. A crystal earphone might be used instead and this would do away with the output transformer because the crystal earphone is resistance-coupled. However an advantage to the magnetic earphone is that it is not effected by heat or humidity in the manner that a crystal phone would be.

The earphone, output transformer, and the volume control for this set were all obtained from a hearing-aid center. The earphone sells officially for $25, but some of the radio parts houses now have them at much more reasonable prices. This particular earphone was a gift from an obliging hearing-aid technician because it was burned out. A little work restored it to its original state. The output transformer was purchased
through a resistance of 1,000 ohms, there will be a 1-volt drop across the resistor. If 100 ma flows through 10 ohms, there will also be a 1-volt drop. The voltage across the resistor is tuned against the voltage of the potentiometer, with a similar null indicator.

Such a milliammeter can be made to replace the movement in your v.l.m.v., grid-dip oscillator, tube checker, or other instrument. The Wheatstone bridge can be made into an inductance or capacitance bridge by replacing the fixed arms with inductance or capacitance. (See “Simple Bridges for Inductance Checks” in the February, 1948, issue of this magazine for a number of circuits that can be used to measure inductance and capacitance.) The battery of course is removed and replaced by a source of audio frequency such as an oscillator or even the output of your communications receiver. The vibrator is removed and the phone connected center-to-center. As before, the bridge is adjusted for null or minimum signal.

We have combined voltmeter, ohmmeter, and milliammeter in a number of pieces of equipment, using the circuits of Figs. 1, 2, and 3 with suitable switching. Another useful gadget is a capacitor checker which consists of a capacitor decade and a relaxation oscillator made up of a neon tube, a resistor, and a 90-volt battery. The circuit is given in Fig. 4. Here we compare the pitch of the signal produced by the oscillator with the unknown capacitor in the circuit with that produced by one of the capacitors in the decade. This does not measure the capacitance exactly, but it does tell the operator whether the capacitor is between say 100 and 200 µf. This is sufficiently accurate for many applications.

**A precision meter**

A more precise capacitance meter is shown in Fig. 5. This is our most recent development and will measure down to 1 µf or lower. It consists of two crystal oscillators feeding into a common mixer. These two oscillators are a kilocycle apart, so that the resulting beat note is 1 kc. A variable-frequency oscillator also feeds this mixer, and we have used the upper sideband as the indicating beat. The variable oscillator may be adjusted so that it will produce a beat note of 1 kc with the oscillator on its low-frequency side. This 1-kc note will zero-beat with the 1-kc note provided by the crystal oscillators. This is used as the reference or zero point for the measurement.

If a variable capacitor of the straight-line capacitance type is used and if say a 10-µf capacitor is connected across the tank circuit of this oscillator, the capacitance of the main tuning capacitor must be decreased by 10 µf to obtain the steady 1-kc note. Thus the decrease in tuning capacitance can be read in terms of the unknown capacitor. Any straight-line capacitance tuning capacitor may be used, and the coil L1 should be chosen so that zero-beat occurs when the capacitor is fully meshed.

This unit will also measure the drift and therefore will indicate the temperature coefficient of any particular type of capacitor. It is gratifying to note the great interest shown by sighted technicians that the blind can make such infinitely small measurements in capacitance.

**Other circuits**

A volume-level meter has been devised by one of the former students of the Institute, David Heavner, W2USQ. This device makes use of the principle that a neon tube is practically a short circuit when ionized and an open circuit when not ionized. An output transformer having two secondaries, one low-impedance for a headest and the other high-impedance, as for a crystal recording head, is used. When the neon tube is connected across this high-impedance secondary winding, the voltage across the winding ionizes the tube, producing practically a short circuit. This increases the load on the plate circuit. Therefore, the signal in the headest is distorted. The input to the device is arranged with a calibrated control, calibrated in terms of db or volume units, etc. Therefore, we have a peak-reading voltmeter which serves better than most V1 meters. The circuit appears in Fig. 6.

The grid-dip oscillator (Fig. 7) consists of the standard oscillator commonly used for such a circuit. The indicator, however, is an auditory device. We have used a multi-grid tube working at audio frequencies and employing one of the dual triodes such as the 12AU7 or 6N7. The bias for the multivibrator is supplied by the grid circuit of the r.f. oscillator, so that loading the grid-dip meter causes the bias on both oscillators to decrease and changes the

![Fig. 3—An auditory milliammeter. This type of circuit can replace the movement of most common test instruments.](image-url)

Interior of the volt-ohm-milliammeter. The large potentiometer is a piece of war surplus—a smaller one will work!

![Fig. 4—A simple capacitance checker. Accuracy of this circuit is poor, but it is adequate for most service needs.](image-url)

![Rear view of capacitance meter of Fig. 5.](image-url)

screen-grid tube with its screen and control grids connected together so that the tube becomes a high-mu triode. This grid and screen connection is returned to the cathode and bias on the tube is zero and the resistance of the plate circuit of the tube (from plate to cathode)
is extremely high. This resistance is used as the resistance element of a relaxation oscillator, with a neon lamp and a headset in the plate circuit along with a 90-volt battery, and a capacitor connected from plate to cathode. When r.f. energy is rectified, the grid is driven positive and the plate resistance is decreased, with a consequent increase in oscillation frequency. This gives an auditory indication of the power output of the transmitter and also provides a means of making excitation, loading, and other adjustments. It also will indicate whether the transmitter is being modulated upward or downward.

It is gratifying to note the ever-increasing interest being shown by the blind electronics technician. Many of them are being employed in the industry or operate service businesses of their own. The Braille Technical Press, published monthly, carries the only radio and electronics information printed in Braille. Included are articles taken from leading radio and electronics magazines. This magazine is supported by contributions from persons and corporations who are interested in the problems of the blind radio technician. It contains departments for the various interests—the amateur, the radio service man, the sound-recording technician, the beginner, etc.

The response of many sighted persons to this measuring equipment is highly interesting. Apparatus that will signal the operator when he is approaching the desired measurement or frequency is attractive to the amateur and the test-bench man especially. He need not look out for a v.t.v.m. or a capacitance meter

**Fig. 5**—A precision capacitance meter that measures down to 1 μf or better.

**Fig. 6**—An auditory volume level meter. This novel circuit produces distortion in headphones when signal is too high.

Sensitivity can be poor in sets having tapped oscillator coils, like that shown in the diagram, even when all voltages are correct and alignment is perfect. Connect a v.t.v.m. between B-minus and point X, the ground side of the mixer or antenna coil. A small negative voltage may be indicated. If this voltage is reduced greatly when the oscillator section of the tuning gang is shorted, the oscillator is too strong.

The full oscillator voltage appears across L2. The signal grid G3 is grounded for r.f. through L1 and C1. Therefore a part of the oscillator voltage is between G3 and the cathode. When positive peaks of the oscillator voltage are greater than the delayed a.v.c., if any, G3 acts as a diode plate. The rectified oscillator current flows to ground through R1, R2, and the remainder of the a.v.c. network to produce a negative voltage in series with the a.v.c. voltage. The sum of these voltages is sufficient to seriously reduce the gain of the stages connected to the a.v.c. line. (Tune to a no-signal spot.)
Radio Set and Service Review

Rod antenna of RCA R-411 portable
Is new departure in radio technique

NEWEST of RCA's battery-operated personal broadcast receivers, the B-411 weighs less than 3 pounds complete with batteries. It is only 5 1/4 inches high, 7 1/2 inches wide, and 2 1/2 inches deep, fitting conveniently into a man's overcoat pocket, a woman's handbag, or the glove compartment of the family automobile. Tuning dial and volume control project slightly above the top of the case so the set can be tuned and its volume adjusted with the right thumb while holding the set by its handle.

Tested in downtown New York, it compared favorably with many much larger portables. Sensitivity was good and seemed uniform from one end of the band to the other. Selectivity on the high-frequency end was surprisingly good for a set of this type. A number of local stations between 1400 and 1600 kc popped in without a sign of oscillation, squeals, heterodynes, or cross-talk common to the high end of the band on many sets.

Unlike most other portables, this set does not use a loop. Its antenna is a ferrite rod 1 1/4 inch in diameter and 7 inches long with one end inserted in the antenna coil. Hand-capacity effects were not noticeable. The directional characteristics of the antenna do not seem to be as sharp as a loop antenna but there is a very pronounced null when the end of the antenna rod is pointed in the direction of the transmitter.

The circuit

The model B-411 is a 4-tube superheterodyne powered by one 67.5-volt B-battery and a single 1.5-volt standard flashlight cell. It uses a 1R5 converter, 1V4 i.f. amplifier, 1U5 first audio, second detector, and a.v.c. rectifier; and a 3V4 power amplifier working into a 2 x 3-inch PM loudspeaker.

As will be seen from the diagram, the low side of the volume control is connected to ground through a 1,000-ohm resistor. This makes it impossible to turn the audio all the way down on a powerful local station. It is not clear why this resistor is used; however, its use may prevent the set's being accidentally left turned on when not in use. When tuned to a strong local, enough signal rides through at minimum volume to let you know the set is operating.

Grid-leak bias is used on the i.f. amplifier and contact bias on the first audio. The converter has some grid-leak bias plus the a.v.c. voltage which is applied when a station is tuned in. Approximately 3 volts of fixed bias is applied to the 3V4 output tube. Its 3.3-megohm grid resistor is returned to the negative side of the B-battery which is 390 ohms below ground. The combined cathode currents (approximately 8.45 ma) flow through the 390-ohm resistor to develop the bias.

Alignment procedure

Alignment procedures are simple. An output meter is connected between the 3V4 plate and ground and the volume control turned to maximum. To align the i.f.'s, connect the high side of a signal generator to the antenna section of the tuning gang through a .01-µf capacitor and the low side to the chassis. Set the generator to 455 kc and the receiver to a quiet spot near 1600. Adjust C18, C19, C16, and C17—in that order—for maximum output.

Set the receiver and signal generator to 1400 kc. Use a small loop to couple the generator to the antenna coil. Use coupling loose enough so the loop will not disturb the inductance of the coil. Rock the tuning gang while adjusting

Front view of RCA's new personal set.

the oscillator trimmer for maximum output. Tune the set and generator to 600 kc. Rock the gang and adjust the oscillator slug for peak output. Repeat the procedure as a double check. Always keep the signal generator output low to avoid a.v.c. action in the receiver.

Inside view. The antenna rod is at top.

The ferrite antenna rod is one of the unusual features of RCA's B-411 battery-operated personal portable broadcast set.

March, 1951
New opportunity for profit from drive-in movies

By AARON NADELL

BEGINNING November, 1933, and continuing into the spring of 1934, the author wrote in this magazine, then known as Radio-Craft, a series of articles entitled "Servicing the Talkies," which set forth the opportunities then open to radiomen in placing their skilled knowledge of electronics at the service of their local motion picture theater.

Time and change eliminate some opportunities, but usually bring others instead.

The opportunity for the radioman to offer his services to the local motion picture theater is very greatly reduced today, compared with the conditions of 1933-1934. That business has been stabilized. Nationwide professional organizations now service the motion picture theater at low rates, and under a variety of contract arrangements among which the theater owner can pick and choose to suit himself.

By compensation, however, the drive-in theater has sprung up everywhere since the war like a rash of gold mines peck-marking the whole country. Drive-ins are highly profitable. In some cases they pay back their entire investment in a couple of years. No conventional indoor theater can do anything like that. Drive-ins being profitable, their owners have money to spend, and they offer the radioman more opportunities than can be listed here.

The drive-in theater is a number of other things beyond just a theater. For example, and obviously, it is a parking lot, in need of traffic-control facilities. Next, it is a carnival, since practically all drive-ins today have—or are putting in—playgrounds for children, with opportunity for selling small public address systems for use with the playground features. Many of these playgrounds are rather elaborate and include pony rides, miniature train rides, and even boat rides. Some drive-ins are now adding swimming pools.

Again, the drive-in is a kind of restaurant. All theaters sell popcorn, candy, and the like, but most drive-ins also sell frankfurters, hamburgers, tamales, and other cooked foods—and candies, soft drinks and popcorn as well. Refreshment sales in drive-ins average three to one higher per patron than in indoor theaters. Where the radioman fits into that picture is that drive-in managers, anxious to promote their very profitable refreshment business, plug it extensively via microphone and special recordings.

The above refers to the drive-in of today. Today it is a theater, plus parking lot, plus carnival, plus restaurant. What it will be tomorrow nobody knows. These enterprises are not only growing furiously in number, they are also branching out into all sorts of auxiliary activities. Swimming pools have been mentioned. Some drive-ins also are putting in cocktail lounges. Many such theaters, particularly in the East, are now open to the public free during the afternoon as playgrounds and community centers, and numbers of them are offered to local churches for Sunday morning outdoor religious services.

Whoever concerns himself with drive-ins while they are still so new is walking over a newly found gold field where no one can say what nuggets may still be picked up. All anyone can say is that the field has not yet been picked over—it has scarcely been scratched.

Traffic must be directed. Cars wait in what is called the hold-out area until there is room for them in the theater proper. Ushers give instructions—direct the cars to the ramp and places where there is room for them. Traffic must be carefully directed also on leaving the theater, since local authorities do not want 500 or so unregulated automobiles suddenly dumped on a high-speed highway, and the theater owner cannot permit a situation in which the local authorities might take action against him as a public nuisance. A considerable staff of ushers is therefore necessary. If a small knapsack PA can enable one usher to direct more cars, the advantage and economy are obvious. The PA need not have tubes; there is now a carbon-microphone amplifier on the market in the form of a portable, battery-operated PA unit. The output is only 1.5 watts; but even that could help the usher make himself heard over the noise of racing motors. And any radioman, if he had reason to, could build a tube-operated, battery-powered, portable or knapsack PA system.

Such equipment would be useful also for general policing. Don't let anyone tell you that a drive-in is a glorified...
lovers' lane, because that is the very last thing its owner can afford. Any complaints of that nature will get him into serious trouble with the local church and civic groups. The owner has a subtle investment, too; he is vulnerable. It is an axiom of the drive-in business that misconduct cannot be tolerated, and the grounds are continuously policed accordingly. The same ushers who do the policing also direct traffic at the end of the show, and the same portable PA equipment would be of use to them in both jobs.

Small PA units, not necessarily portable, can be useful at the playground, particularly where the drive-in collect machine operates for which the pictures goes on the screen. A microphone obviously would be useful to the barke who sells such rides and help him sell more rides.

Recordings are often used for selling refreshments. A tempting sales talk is put on the in-car speakers to get more people to buy popcorn, burgers, and soft drinks. Such recordings, supplied by a national source, cannot be expected to fit exactly any individual theater or its particular needs at any given moment. The local radioman, if he has a recorder, can make records exactly suited to the occasion,spiced with local remarks and references, and stressing just that particular article—frankfurters, tamales, or what not—while the owner wants to push at that time. The recordings in a more general vein, made on a national basis, cannot do this; therefore it is generally agreed among drive-in operators that the management is of a microphone is more effective in increasing sales than use of a record. But if the manager records his own patter via the local radioman's equipment he is no longer tied to the microphone, but is free to attend to other matters.

Recordings or microphone talks are also used for general audience control, such as to remind patrons to put the speakers back on the hooks before driving off, to wait for instructions from the ushers, and to use the restrooms. The ushers take severe punishment and frequently need repairs.

The driver demonstrates how drive-in patrons take speaker from its post.

The audio amplifier rack for a drive-in. Its 500-watt class-A audio output is enough to feed 1,000 in-car speakers at a standard 1/2-watt per loudspeaker.

The driver demonstrates how drive-in patrons take speaker from its post.

The driver demonstrates how drive-in patrons take speaker from its post.
Tools to him that can handle them," said Napoleon; and nowhere else are tools and knowledge more mutually dependent upon each other than in radio servicing. The skilled technician, without instruments with which to trace the invisible electricity through an ailing circuit, is helpless; and an unskilled person, although surrounded by every imaginable servicing aid, is equally at a loss.

Each tool mentioned in the paragraphs that follow will pay for itself many times over in a small owner-operated service shop, doing enough business to make time saved an important element of income. Radio servicing equipment falls naturally into two broad classifications: trouble-locating tools and trouble-repairing tools. Let us first consider those that are used to ferret out the causes of receiver failure. These trouble-detecting devices are essentially "electronic" in the broad sense of that word; that is, they are actuated by or produce electrical voltages and currents that are, in turn, manifestations of electron behavior.

A versatile instrument

The old standby of the technician is the volt-ohm-milliammeter abbreviated v.o.m. This instrument has a variety of forms, but it is essentially a low-current meter that can be switched into suitable circuits for measuring alternating or direct voltages, direct current, resistance. Volt-ohm-milliammeter ranges are ordinarily provided for measuring each of these components. For example, the favorite v.o.m. used by the writer has the following ranges for indicating d.c. milliamperes, d.c. volts, or a.c. volts: 0 to 5, 25, 125, 250, 500, 1,250. The ohms scales run: 0 to 2,000, 20,000, 200,000, 2,000,000 and 20,000,000.

A choice of several ranges is an aid to accurate measurement. Service instruments are usually rated at an accuracy of 2% of the full-scale reading. That means the permissible error on the 1,250-volt scale is 25 volts; but on the 125-volt scale it is only 2.5 volts. To insure good accuracy, the value being read should be at least 50% of the full-scale reading of the meter. This can be arranged with a wide variety of values to be measured, by having several meter ranges available.

Figs. 1-a, 1-b, 1-c and 1-d are diagrams of the basic circuits of a d.c. milliammeter, a d.c. voltmeter, an a.c. voltmeter, and a d.c. ohmmeter, respectively. The meter itself (M in all of the diagrams) is a d.c. meter with a sensitivity such that 1 ma or less of current will make it read full scale.

In Fig. 1-a, all the current passing through the probes must also pass through the meter, and the maximum current that can be measured is simply that of the meter rating. It is possible, as indicated, however, to switch shunt resistors across the meter so that the probe current can divide, part going through the resistor and part through the meter. By proportioning the resistance of the shunt to that of the meter, we can allow any desired fraction of the total current to flow through the meter.

For example, if our meter has a resistance of 45 ohms and the shunt has a resistance of 5 ohms, 9/10 of the probe current will go through the shunt and 1/10 will go through the milliammeter. Thus, every reading on our shunted meter scale now indicates exactly 10 times that amount of current is flowing in the probes, and we can arrange a new scale to show this amount with shunts of decreasing resistance, the meter can indicate increasing ranges of current.

In the voltmeter circuit of 1-b, suppose K1 has a resistance of 5,000 ohms. Neglecting the small resistance of the meter, that means that 5 volts across the probes will send exactly 1 ma of current through the meter, 2.5 volts will send 0.5 ma, etc. The current through the meter varies directly with the voltage across the probes. If we increase the value of the series resistance to 50,000 ohms, 50 volts will be needed to make 1 ma of current go through the meter, as you can see for yourself by applying Ohm's law. All we need do is make a new scale in which meter current is translated into volts-across-the-probes, and we have a voltmeter. Increasing the range of the voltmeter is simply a matter of increasing the value of the series resistance.

Measuring a.c. voltages looks as though it might present a problem (since our meter will react only to direct current) but it really isn't. We simply put a rectifier ahead of the meter; it jerks the zig-zag kinks out of the a.c. and makes it over into d.c. that our meter can handle. By employing proper values of resistance in the circuit of Fig. 1-c, our current-reading meter can be made to indicate the r.m.s. value of an a.c. voltage applied across the test prods.

Fig. 1-d is the diagram of a simplified ohmmeter. It consists of a battery, a fixed resistance, our meter, and a pair of test prods all connected in series. Suppose our battery is 4.5 volts and the resistor is 4,500 ohms. When our prods are shorted together the battery sends 1 ma of current through the meter, making the pointer swing over to the full-scale mark, which we label "0 ohms." Now, if we place a resistor between the prods, the current will be reduced and our pointer will not swing over so far. The scale of our meter can be marked so that the pointer will indicate the exact value of the resistance between the probes, for there is a fixed relationship between the value of this resistance and the amount of current flowing through the meter. While ohmmeters actually used in v.o.m. circuits are not this simple, they follow the same general principle.

A service shop without a v.o.m. is as

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Servicing—Test Instruments

Part XXV—Instruments and Tools

By JOHN T. FRYE

Fundamentals of Radio Servicing
unfurnished as a boudoir without a mirror, but it must be admitted that this instrument, used as a voltmeter, has one serious objection: it draws appreciable power from the circuit being tested. Consider, for example, the typical screen-supply circuit of Fig. 2. The screen draws 1.5 ma of current and is fed through a series dropping resistor of 100,000 ohms from a 250-volt source. If we now measure the screen voltage with our voltmeter, the current used by the meter will have to be added to that already flowing through the dropping resistor. Even if this current is only 0.5 ma, its value added to the 1.5 ma drawn by the screen will reduce the normal screen voltage of 100 to an indicated voltage of 50.

**Other trouble finders**

The vacuum tube voltmeter, abbreviated v.t.v.m., is designed to correct this. Basically, it employs the amplifying properties of a vacuum tube so that the voltage being measured is applied to the grid of a tube with the current-reading meter being in the plate circuit. Since no current flows in the grid circuit, no appreciable power is absorbed from the circuit being tested, and a much more accurate indication of voltage is had. In addition, the v.t.v.m. can easily measure resistance values up to one billion ohms and it is practically impossible to injure the meter by employing too low a range for measuring a voltage—an easily made mistake that has sent many a v.t.v.m. to its last windup!

The v.t.v.m. is growing increasingly popular with service technicians, and if it were not for its two main disadvantages—most v.t.v.m.’s will not measure current, and all of them must have their vacuum tubes supplied with power either from the power line or from batteries—it would be suggested that they be purchased instead of a v.o.m. As it is, the purchase of such an instrument out of the shop’s first profits is a sound investment.

The signal generator is another most important service instrument. Essentially it is a tiny portable transmitter that will produce an r.f. signal on any desired frequency from about 100 kc to at least 30,000 kc. This signal can be used in its pure r.f. form or with a 400-cycle tone modulation, and its strength can be varied from virtually zero to a value considerably stronger than would be put into a receiver by even a powerful power. This signal generator can produce the proper signal for exciting any stage of a receiver. It is absolutely necessary for the proper alignment of the i.f. stages of a superheterodyne receiver and never let anybody tell you different! A good signal generator is one whose dial readings of frequency are accurate and stable, whose output can be precisely and smoothly controlled, and whose construction is such that it will retain these virtues year after year.

Some radiomen insist that a tube tester is not really a service instrument—it is just to sell tubes! What they mean is that a good technician can quickly spot an under-par tube by its effect on the receiver itself. While that is partly true, a tube tester often permits the discovery of a bad tube without removing the chassis from the cabinet; furthermore, the public has a beautiful and childlike faith in the infallibility of tube testers and are likely to be suspicious of a service technician without one, so you must have it.

These instruments vary widely in price and in simplicity of operation. None, unfortunately, will do a 100% job of revealing tube shortcomings; but even a low-priced tester will reveal 90% of the bad tubes. It is regrettable, thanks to the steady stream of tubes hatched up by the tube engineers, a tube tester becomes out of date faster than a risque story at a salesmen’s convention. That is one reason why many technicians are slow to buy the more expensive types of testers, preferring to use tube substitution to reveal the few defective tubes that a low-priced tester will not catch.

The most recent electronic bloodhound in the trouble-locating kennel is the signal tracer. This instrument in its most popular form consists of a high-gain audio amplifier preceded by a probe that contains a detecting or rectifying device at its business end. This detector may be either a vacuum tube or a germanium crystal, but its purpose is to strip away the modulation from any r.f. signal it encounters. The modulation can then be handled by the amplifier and heard in the tracer speaker. With such an instrument a strong modulated signal actually can be followed stage by stage through the receiver right from the antenna to the speaker. The exact stage where trouble starts is thus revealed, and then the v.o.m. or v.t.v.m. can take it from there.

The writer strongly feels that the less experience you have the greater is your need for a signal tracer. It will do for the inexperienced trouble-shooter what a good rabbit dog will do for a poor hunter—flush the game right out into plain sight! By all means have a signal tracer on your bench when you open the doors of your shop.

**Other tools you need**

A great deal more on the use of these various trouble-shooting tools will be said in the next chapter, but now let us turn to the tools that repair the trouble once it has been located. While these mechanical tools are more likely to be familiar to the average person, a few facts about their peculiar use in radio are worth mentioning.

The radio technician can never have too many screwdrivers. He needs them in all sizes from the tiny, long-bladed job used to loosen deep-set knob set-screws to the stubby, broad-bitted driver for tightening radio knobs. A good mechanic always selects the proper-sized screwdriver for use on a particular screw-head, and he must have the proper driver for use on Phillips screws that are being used more and more in radios. In addition, he should have a driver with a screw-holding feature for placing screws and bolts in the cramped quarters so often found in radio work; and he must have two or three of the special-insulation aligning screwdrivers for adjusting i.f. and r.f. trimmers.

A good set of hex-nut drivers is another required tool for the radio technician. The walls of the sockets should be thin so that the wrench may be slipped over a nut at an angle, and the stems should be hollow so that the wrenches can be used to tighten speaker-holding nuts on the extra-long bolts that are often used. A set of small end wrenches are also fine for adjusting speaker cone spiders and for working in places that will not allow even a hex-nut driver to be used. Finally, a small adjustable wrench should be available for handling the nonstandard nuts that are encountered all too often in radio work. A 1-inch vice-grip wrench is excellent for this purpose, for it can also serve as a small vise to hold parts together while they are being soldered.

Every service bench should have a pair of lineman’s pliers, a pair of needle-nose pliers, a pair of flat-nose pliers, a pair of ignition pliers, and a pair of eyebrow tweezers. Time and again jobs will be found in service work that only one of these tools can do.

What the electric clippers are to the barber the electric soldering iron is to the service technician, and he should have good ones. The majority of service technicians today use a solder gun for most of their work because of such features as being always ready, quick cooling, safety, and economy of operation. At the same time, every serviceman needs a heavy-duty conventional iron, say of 200 watts, for soldering to the chassis and for doing other jobs requiring lots of heat.

In addition, where are many miscellaneous tools used in service work: speaker shims for centering speaker voice coils about pole pieces; wire-strippers for doing a quick, neat job of re-
FIVE SERVICE AIDS

Eyes, ears, fingers, nose and brain
are five excellent test instruments

By JESSE DILSON*

THE next time you reach for a
whodunit to see how your favorite
private eye catches the killer, just
think of the radio repair business.
Why? Your detective props, probes, and
theorizes to catch the menace to society;
the radioman does the same thing—
without headlines and hungry blondes—
but he does it. His job is even tougher—
he can’t give a bum capacitor or tube
the third degree and make it talk!
Service technicians and detectives
alike have equipment that can’t be sup-
plied by instrument manufacturers.
Noses, for instance. Most beginners are
stumped right at the start in coping
with a radio set: “What do I do first?”
One good answer is to notice if the
darned thing smells. If it does, and
smells bad, something’s been burned to
a crisp. Sniff at the set’s innards like a
bloodhound, until your nose leads you to
the guilty party. Then your brain
comes into play. If it’s a transformer,
what could cause it to get all hot and
bittered like that? Obviously, too much
current. A short, maybe. Then out with
the old ohmmeter and start to eliminate
the innocent until you’ve sprung the
trap on the guilty.
Finding a short can be troublesome—
understatement if ever there was one.
Suppose you trace a short to a point at
which unpeeled leads are connected. At
that point, your ohmmeter tells you,
there’s a short to chassis (and you’d
better use the lowest resistance scale on
your meter to check that short, or you
may find you’ve been sweating for
nothing). Which is the lead that’s
sneaking off to ground? A detective
knows how to deal with that one—a
process of elimination. Disconnect each
lead, put one probe of the ohmmeter on
it and the other on ground—on the
lowest resistance scale, remember, and
carefully zeroed—and if the needle
doesn’t swing to zero, that lead is inno-
cent of wrongdoing. When the mis-
creant is found, follow its path to the
chassis, and don’t give up until you
have located the point of contact.
Suppose your nose takes you to a
resistor. You take a look at it. It’s been
burned to a frazzle. Again, too much
current. And why? You guessed it,
from a short. Suppose it’s a screen-
dropping resistor. Every screen grid
must have its bypass capacitor; and if
that’s shorted, the resistor is sure to
fry. The capacitor may appear harm-
less. But many a wide-eyed innocent
has knocked off his fellow man, so check
it and make sure.
Speaking of smells, have you ever
come across a set that exudes an aroma
of rotten eggs? No matter how you
describe it, it’s a real bold Phenol! Noth-
ing like the crisp smell of a burned
transformer, for example. It can be
cased by a selenium rectifier develop-
ing a high-resistance “short” and over-
heating. I’ve seen service technicians
try everything on this, including dous-
ing it with Chanel No. 5.

Use your eyes, too!
The human eye may not be an elec-
tronic instrument, but it can do a good
job on a radio. G.I. repairmen will re-
member that the first thing to do in
maintenance “by the numbers” was
“visual inspection.” In English, that
meant looking over the scene of the
crime carefully, above and below the
chassis, for things like broken connec-
tions, charred resistor and wax-dripp-
ing capacitors. It takes only a moment
and may pay off. The best way to in-
spect a receiver is with the power off—
don’t just open the receiver switch, but
pull the line plug out of the wall socket!
That way you’ll avoid unpleasant
shocks. Even with the switch in off
position, line voltage is still present
somewhere in the set. If, to save time,
you prefer to do your inspection with
the set alive, a plastic highball stirrer
makes a convenient tool for pushing
aside wires while you’re doing it. These
stirrers (flicked from a bar when the
bartender is looking elsewhere) also
picture as one example, suppose you
find a wisp of smoke trailing from a
set chassis. One of the components in
the neighborhood is getting a bit too
hot for comfort, obviously. Your nose
confirms this but won’t point definitely
to the sufferer. A fingertip laid on each
component in turn (on its insulated por-
tion, need we add?) will track it down.
It may be difficult to tell if a set is
really dead, especially if the room
you’re working in is noisy. The finger-
tips placed lightly on the speaker cone

moving insulation from wires; a metal
saw for cutting volume-control shafts
to proper length; a pair of good, sharp
diagonal cutters that will bite a wire
cleanly in two instead of just “gum-
mill” it; an electric drill to drill out
rivets and make holes in the chassis for
mounting parts; a bottle of carbon tet-
nachloride for cleaning volume controls,
switch contacts, etc.; a tube of Duco
cement for repairing speaker cones and
for fastening coil turns securely; and a
bottle of acetone for softening this
cement whenever necessary.
In addition, if you are going to do
auto-radio servicing you will need a way
of powering these sets on the bench:
either a battery-and-charger combina-
tion or a battery supply manufactured
from the light line. And there are such
things as capacitor checkers, audio-
signal generators, cathode-ray oscillo-
scopes, distortion analyzers, impedance
bridges, etc., that are very fine to have
and which can be quite useful around
the shop after you have acquired enough
experience to use them and enough
money to buy them, but you do not need
them to start up business.
If you have the hand tools mentioned,
and if your bench is decked out with a
good v.o.m., a reliable signal generator,
and an up-to-date tube tester, you will
be starting out with as much equipment
as most of the old-timers had when they
began. Put the rest of your capital in a
good set of service manuals, as the
writer advised at some length in his ar-
ticle on this subject in the November,
1941, issue of Radio-Electronics. The
manuals will give you much more help
than a whole room full of “advanced”
serviceing instruments when you are
starting up in business—and for some
time thereafter, too. These are a really
worthwhile investment.
In the next and final chapter we shall
discuss how a good technician uses all
of these devices to locate and repair
radio faults.

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FUNDAMENTALS OF RADIO SERVICING

(Continued from page 35)
Servicing—Test Instruments

...such the way a

...to...light

...filter capacitors

...tuning

...to...tune, especially

...former and...secondary

...speaker

...ever since

...MARCH,

...Suggested

...Excessive substitution will...trouble will...dialogs...changes checking them is...won't change in...dead...heater, and...taste. When a...and...tube lightly, it's...easy to check...power...tracks...out...sufficient... analyzed...will...to...the...heating...showing...two...the...tubes...lit...there should...some...hum, sound...kind, however faint, issuing from the speaker. And since there isn't, the...proven section of the set has gone wrong. That section is made up of the speaker working with the output transformer. A continuity check on the speaker voice coil and both primary and secondary of the output transformer will show which of your two suspects has done the job.

Excessive hum may be another...distinguish in intensity with changes in the position of the tuning dial. One logical spot to look for...for this trouble is the...filter, since its job is to avoid such...the...filter capacitors are the weakest...Use the substitution check—temporarily...replace, until the hum disappears, each capacitor with one known to be...be...If this fails, replacing the...will usually...cathode resistor, and leakage developing between heater and cathode within the tube will place a 60-cycle voltage on the...cathode with respect to ground—equivalent, of course, to a 60-cycle voltage on the grid with respect to...Hence the hum. In receivers using full-wave power supplies the filter ripple is 120 cycles, so...harm will be an octave above the 60-cycle note that a bad output tube would cause.

Don't be too critical

There is such a thing as being too...critical, even for the most...worker. If you find that a...can...heard faintly by poking your ear directly into the speaker grill cloth, don't start tearing the thing apart to find a hum component. The chances are you won't find any. A...very conservative...fading...in the...filter amperes...design...to attenuate the hum level so the ear can't hear it, but in the...quality...set it isn't disturbing enough to warrant elaborate...After listening acutely to a set's...for a while it may seem loud enough to...across the street. Try to listen to it from the point of view of a...critical...an...anti-hummer.

Bad filters and bypasses

Faulty...filters can be...for...another kind of...offender. In the...amplifiers use...cathode...capacitor...with no...biasing...or...hum. If...the...amplifier...is...not working as a proper...stages will oscillate. The...etched...as an...line, and...appearing...of the...mechanical vibration. The sound from the...tube...starts...vibrating, which...the...sound...electronically, and...simplified the...grid...and......existing...is...not...the...vibration...of...as...to...the...amplification...tube...of...an...oscilloscope; but he...has...shells...high...cash, a...the...senses.1...For that...no others can provide an adequate substitute.

1 With the exception of the...of...taste. When...sticks...in...to...him...a...a...sheet and call for the men in...
Sightless Technicians Learn Radio Servicing

By GEORGE B. MILLER

I didn't get rich servicing radios, but I can stand on my own hind legs and live independently. I had to have the guts, but I needed the training just as desperately. The quote is from a letter by Melvin Rothmiller who operates a successful radio service shop in Walthill, Neb. He is totally blind.

Mr. Rothmiller says further, "I know it is difficult for a person with vision to understand how a complicated mechanism like a radio could make sense to a blind person, but a blind person who has never handled the insides of a radio is at a greater loss. This one factor is the hardest obstacle for a blind person to overcome. I saw Von Peterson work with a radio, design special equipment, and operate so independently that the prospect of a similar existence carried me through those days Mama never told me there would be.

"I would do the whole thing over the second time if necessary, but I would rather see another blind person do it the first time."

Along with many other blind and otherwise handicapped persons, Mr. Rothmiller took his training at the Radio Engineering School in Omaha, Neb. Included among the students are multiple amputees, paraplegics, polio victims, arthritics, paralytics, and others with lesser handicaps. A deaf-mute has recently started training in the appliance repair course. In all cases where the graduate has intended to use his training to earn a living the results have been gratifying.

The school was originated and is directed by LaVon Peterson, cited in Mr. Rothmiller's letter. Blind himself, he has developed special test equipment to enable blind students to make accurate measurements and repair all types of radios, record players, PA systems, and similar equipment. Their notes, taken down in Braille, serve as both study and reference books. They also have a Braille tube manual for identifying tubes and biasing arrangements. In most cases the students can identify a radio by name and by circuit and call off the tube lineup merely by sticking their fingers in the back of the set.

The training covers public relations, business practices, bookkeeping, and stock maintenance as well as radio servicing. In the appliance repair course, which includes armature and motor rewinding, it is impossible to tell whether a sighted or a blind person has done a rewind job, and in this work extreme neatness and accuracy is required. Blind students, through necessity, will do a better soldering job than a sighted person.

Charles G. Gibson, who lost his sight at the age of nine, graduated from the school early in 1949 and went home to Ogden, Utah, to open up his own shop. "I searched the town for a suitable location but could not find what I wanted, so I remodeled the garage at my home into a service shop and put up a 3 x 5-foot sign in the front of the business. The people in town have been very kind to my work to me."

"I had handbills and business cards printed and got a couple of people in the local paper to tell every one of my friends. I'm not rich, but business continues to pick up, making a good living in another way."

With less than an eighth-grade education, but plenty of personality, ability, and aggressiveness, Robert E. Freemole is running a successful radio service shop in Houston, Tex. "I installed a five-speaker PA system in one of our supermarkets, am attending TV schools, and have been working twelve to fifteen hours on repair work. I have recently added winding speaker fields and transformers and am doing very well." Bob Freemole and his wife are both totally blind.

Don's Radio Sales & Service in Waterloo, Neb., is another successful shop run by a blind technician, Don Misfeldt, who lost his sight in a hunting accident while attending college. "After almost two years my business has been accepted in the town just as any other business would have been. A reputation for fast and complete service with a guarantee to back it up brings in repeated business."

"It is a great satisfaction to me when a customer does not realize my pet nuisance—blindness. I have learned of customers leaving the shop and finding out later that their radios had been serviced by a blind technician."

These men, and many others like them, have accomplished what to the rest of us seems impossible, asking only that they be given a fair chance to demonstrate their ability.
Electronics and Music

Part IX—Circuits of the Thyratone, a solo-type electronic instrument

By

RICHARD H. DORF*

In this and the next article of our series we shall describe the Thyratone, an electronic musical instrument designed and constructed by the writer. The Thyratone is purely an experimental instrument, first designed on paper, then built and modified as various weak points showed up. It still has weak points, but each of these will be discussed as the description progresses and solutions to the problems will be suggested for the benefit of other experimenters.

The primary virtue of the Thyratone is that it is more truly a musical instrument than most of those which have been offered before to the individual constructor in the technical press. It not only provides a series of tones of the correct pitches but—more important—it includes genuine tone-shaping circuits to make the tones sound musical and to give a variety of tone colors both singly and in combination. The theory and background of tone-shaping methods is much too large a subject to discuss in a construction article, so the circuits will be described here only for construction purposes. Several articles later in the series will be devoted to tone-coloring.

What is the Thyratone?

The Thyratone is a monophonic or solo-type instrument, appearing, at first glance, to be much like the Hammond Solovox. It is similar in that its three-octave keyboard of foreshortened keys (Photo A) may be fastened to the front of a piano and the instrument can be played at the same time as the piano. Another likeness is that only a single key may be played at a time. But there the resemblance ends.

The block diagram of Fig. 1 gives an over-all view of the instrument. There are three tone generators operating at octave separation. The 8-foot generator produces three octaves of tones ranging from C40 (middle C—261.7 cycles—see frequency chart on page 42 of the Au-

* Audio Consultant, New York City

March, 1951

Photo A—Thirty-seven keys control the 5-octave range of the Thyratone. Buttons at right are used to select the tone color combinations.

Photo B—Entire electronic circuit is on this 10 x 17 chassis. This unit is normally mounted inside the cabinet which houses the speaker.

gust, 1950, issue) to C76 (2,093 cycles). The 16-foot generator produces a three-octave range from C9 (130.8 cycles) to C10 (1,047 cycles). The 32-foot generator produces pitches from C16 (65.41 cycles) to C24 (525.5 cycles). The nomenclature for the ranges is taken from organ practice for convenience.

When the Thyratone keyboard is fastened to the front of a piano the lowest key coincides with the position of middle C on the piano. Therefore, in the 8-foot range, sounding this note will produce an actual pitch of middle C. (For those not familiar with organs, the 8-, 16-, and 32-foot measurements refer to the lengths of organ pipes.) Pressing the same key but using the 16-foot range, the tone heard is one octave below what one would normally expect from that key. The 32-foot pitch is an octave below that. The Thyratone therefore has a total range of five octaves (plus one note—the top C).

The generators are all keyed simultaneously so that pressing any one key produces three notes an octave apart.

Fig. 1—Block diagram gives an over-all picture of how the Thyratone functions.
The tones from each generator are fed to a series of L-R-C filters which alter the waves in such a way as to give a more or less close approximation of a standard organ tone. The three ranges are filtered separately, as Fig. 1 indicates, so that a bourdon tone, for example, is produced only in the 32-foot range, and an oboe is available only in the 16-foot register. There are four 8-foot tone stops, six 16-foot stops, and two 32-foot stops, a total of 12 tone qualities or stops in all. One or several may be in use simultaneously to give any type of mixture desired, just as in an organ. The tone colors will be described later in the discussion of playing.

The tones from the outputs of all the filters are mixed and amplified, then fed to a push-pull output stage. This stage is normally biased to cutoff. The cutoff bias is removed each time a key is pressed and an R-C time-constant network provides keying delay to eliminate clicks and thumps and give a good musical attack and decay. An expression pedal, consisting of a foot-operated 8-ohm T-pad, is placed between the output transformer secondary and the speaker. A preset volume control in the amplifier section allows the player to set maximum desired level so that the pedal can be operated over its entire range.

What it looks like

The physical appearance of the Thyratone is illustrated by the photographs. Photo A shows the keyboard unit. There are three octaves of keys and, at the right, a control board. On the control board there are 14 push-button switches to control the stop combinations and the vibrato. At the upper left is the a.c. power switch. In this experimental model the front has been left open for access; in the finished product, of course, it will be closed. The wood will also be finished and the hole at the upper right will probably be filled with another push button. The entire keyboard unit may be fastened to the front of a piano with metal brackets in the same way as the Solovox is mounted. Because of the nonavailability of compactly built keyboards the writer did not bother to keep the keyboard unit especially small. Other constructors should try to do better in that respect, as long-legged players may find that there is not enough room underneath.

The chassis appears in Photo B. The entire electronic equipment, with the exception of the generator-tuning capacitors, is mounted on it, and the keyboard unit serves only for control. Normally the chassis is mounted within an ordinary loudspeaker enclosure along with the speaker. Photo C shows the expression pedal in position on the floor. A cable from it plugs into the chassis. The keyboard unit connects to the chassis through a 20-conductor cable terminating in a standard Amphenol 20-pin plug. An additional 2-wire line serves for the a.c. power switch.

The tone generators

Because of the type of tone-color filters used in the Thyratone, sawtooth waves are required from the tone generators. An additional requirement is three generators which will synchronize easily in exact octave relationships without having any of the synchronizing frequency appear in the output. In an experimental mood, 6SN7 and 6550 tubes (from which the instrument gets its name) were chosen. Gas-filled tubes are not the most stable oscillators, as they vary in characteristics with temperature and various tubes of the same type differ. A main tuning control was included, however, and operation is satisfactory as long as the tubes are not interchanged among the three genera.
tors. Replacements for burned-out 884’s must be selected on a trial basis from a stock of them.

The diagram of the main chassis is given in Fig. 2. Each of the three 884’s is used in much the same way as it would be for the sweep oscillator of an oscilloscope. A lead from the plate of each is brought to the keyboard unit, diagrammed in Fig. 3, where it is connected to one end of a string of capacitors. Pressing a key grounds the string at some point, giving a certain net capacitance between plate and ground to tune the oscillator.

The 8-foot oscillator is the “master.” Its string has one capacitor for each note. When the junction between the leftmost capacitor and the next one (Fig. 3) is grounded, there is maximum capacitance between plate and ground, and the lowest 8-foot tone (middle C) is produced. When the next key is pressed, there are two capacitors in series between plate and ground, resulting in a lower net capacitance and raising the pitch. When no keys are pressed, the capacitance is the series net of all the units in the string, giving the highest tone. This system avoids off-color tones caused by accidentally pressing two keys at a time. With the string arrangement, only the lowest note of any several that might happen to be keyed at one time will sound.

There are four small contact springs under each key. A piece of flat metal is attached to the key bottoms and is grounded by contact with a square metal bar at the rear of the keyboard, on which the keys are mounted. When the key is pressed, this metal strip contacts all the springs, grounding each. Three of the springs under each key are connected to junctions between capacitors for tuning the 8-, 16-, and 32-foot generators. The fourth keys the output stage.

Since it is very difficult to represent this exact arrangement in a schematic diagram, the system of representation as in Fig. 3 is used. The four arrows for each key connected with a dashed line represent the single grounded metal strip. The small circles connected to the capacitors represent contact springs.

The output from the plate of the 8-foot 884 generator (Fig. 2) is connected to the grid of one triode of a 6SN7-GT amplifier through a 2-megohm attenuating resistor and a 0.1-uf blocking capacitor. Output is taken from the unbypassed cathode of the 6SN7-GT triode to form the 8-foot bus carrying 8-foot tones to the 8-foot filters. Output from the plate of the 6SN7-GT triode is fed through a 680,000-ohm attenuating resistor to the grid of the 16-foot 884 to provide synchronizing voltage. The plate of the 16-foot 884 is carried to the keyboard and a string of capacitors for tuning.

Referring again to Fig. 3, note that in the 16-foot string there is not a capacitor for every note but only one for every six or seven notes. This saving in capacitors is allowed by the fact that the 16-foot generator is synchronized. For each group of six or seven notes, the natural frequency of the oscillator is made slightly higher than the highest note; when the synchronizing voltage is fed to the 884 grid from the 6SN7-GT the frequency is brought to exactly one octave below the 8-foot tone. For greater stability, constructors may find it wise to use a few more capacitors, say one for every four notes.

The plate output from the 16-foot 884 is fed to the other triode section of the first 6SN7-GT. The cathode output of the triode is fed to the 16-foot filters and the plate output is applied as sync voltage to the 32-foot 884. The latter is tuned exactly as is the 16-foot gen-

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**Fig. 3—The keyboard unit tunes the tone generators and controls the tone colors. A cable connects it to main chassis.**

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erator. It feeds one triode of a second 6SN7-GT, the cathode of which provides 32-foot tone for the 32-foot filters.

The cathodes of all three 884's are common and are placed a few volts above ground by a voltage divider between the B-supply and ground. The lower portion of the divider (15,000 ohms in parallel with 25 µf) is paralleled by a 1,000-ohm resistor, the lower end of which goes to a 50-ohm wire-wound rheostat on the keyboard unit. Varying the resistance of the rheostat varies the grid-bias voltage of all the thyratrons and changes their pitch. It is used as a main tuning control to compensate for aging and heating. Its range is a little over a half-tone; if it were more it would materially upset the frequency spacing between notes.

The vibrato is provided by a variation of the standard neon-lamp oscillator, which includes a high-value inductance as well as the usual resistor and capacitor. B-voltage for the neon oscillator is taken from the junction of the 38,000-ohm and 1-megohm resistors in the Thyrate because of the desire to avoid unnecessary complexities, but even here they do produce uncannily realistic imitations of many of the instruments of a pipe organ. Briefly, they provide electrical resonances and rolloffs equivalent to the body resonances and acoustic absorption properties of ordinary instruments. For details see U.S. Patent No. 2,295,948.

The inputs to the filters in each register are obtained from the corresponding bus and all filter outputs are paralleled. Because of the long lines involved in the Thyrate as it now exists, switches to select the tone colors or stops was found impractical. The stop buttons therefore are normally closed switches which short out the filters. Punching a button removes the short on the corresponding filter and allows the tone color to come through. The short circuit is made in the "middle" of the filter so that it will not appreciably affect input or output busses.

Amplifier

The outputs of all filters go to the grid of a 6SJ7. The amplified tones go to a volume control which is preset for the desired maximum level. From here the tone goes to the second triode section of the same 6SN7-GT used to feed the 32-foot bus. The plate transformer is coupled to a push-pull 6G6-G output stage.

There are two reasons for keying this output stage. First, when no keys are pressed, all oscillators are tuned to their highest pitches by the capacitor strings. Second, a slow attack and decay must be provided so that the instrument does not sound like a code-practice oscillator. It is difficult to key a single-ended stage because, unless the attack is too slow for musical comfort, the rush of electrons from cathode to plate when cutoff bias is removed—even with a delay circuit—makes a thump in the speaker. This hazard is removed by using a balanced push-pull stage; the rush of electrons is in the same direction in both outputs and the two cancel in the output transformer (if the tubes are fairly similar).

To provide a negative bias, the bleeder of the power supply is tapped and the tap grounded. Thus the lower end of the bleeder is more negative than ground. In the model shown the power transformer produced insufficient d.c. voltage at the filter output (about 250 volts). Other constructors should use with at least 400 volts each side of center-tap. This allows the tap on the bleeder to be moved up higher, giving more bias for good cut-off of the final stage, while still providing enough B-voltage for reliable operation of the OD3 (which provides regulated voltage for the thyratron tone generators).

The negative end of the bleeder is wired to the center-tap of the driver transformer through an R-C network. A lead from the network goes to the keying contact springs on the keyboard unit. When a key is pressed the junction of the 100,000-ohm and 270,000-ohm resistors in the delay network is grounded. This removes negative bias from the output tubes. It takes a certain time, however, for the 0.05-µf capacitor to discharge the bias voltage, and the output tubes do not conduct fully at once. When all keys are released the bias voltage is applied again, but delay of the sound decay is caused by the 0.1-µf capacitor, across which the bias voltage must build up.

The delays are a little shorter than would be musically optimum, particularly the decay. The reason is that the sound must have disappeared by the time the key rises enough to take ground away from the tuning-capacitor contacts. The keying contact spring is purposely adjusted under each key so that it is the last to be grounded when the key is pressed and the first to be removed from ground when the key is released.

The expression pedal operates an 8-ohm T-pad which is placed between the output transformer and the speaker. This is the simplest way to control volume in the plate without running a high-impedance line to a grid potentiometer. A high-impedance line could easily pick up enough hum or other undesirable noise to be objectionable, even if well shielded. The pedal itself is simply two hinged boards with the attenuator sandwiched in between. A cable strung around its knob rotates the attenuator when the pedal is depressed. Pushing down on the pedal increases the volume.

Next month, we shall describe the construction, adjustment, and operation of the Thyrateoner.

Simple Filter for Scratchy Records

It is easy to construct and install a filter which will make scratchy records sound much better. It consists of a coil and capacitor connected in series across the pickup leads. Almost any small choke will do—a shielded r.f. choke is excellent. Try small capacitors of different values until you find one which gives the greatest reduction in scratch with the least reduction in volume. If your coil is around 80 to 100 mh, try a .003-µf capacitor and work up and down from there. Use large steps at first, and gradually work down to smaller ones.

The filter attenuates some of the highs, so it is advisable to wire in a switch as shown in the diagram. Avoid hum pickup by keeping the leads short and well away from a.c. leads.—R.C. Sandison

Photo C—Volume of the music is controlled by this specially made expression pedal. It rests on the floor in a convenient position for the player's foot.

in the plate circuit of the 8-foot 884. The capacitor across the lamp is normally ungrounded. To produce vibrato, that capacitor is grounded through a switch on the keyboard unit. The oscillations produced are nearly sine waves because of the storage action of the inductor. They vary the plate voltage of the 8-foot generator slightly at the oscillation rate, which is about 7 cycles; since gas-tube oscillators change pitch with a change in supply voltage, a frequency vibrato is produced. The 15-megohm resistor across the 0.25-µf capacitor discharges it after the bottom end is ungrounded (when the vibrato switch is turned off). Without the discharge the neon will not oscillate again when the switch is closed.

Tone Filters

The theory of formant filters, as these are called, will be discussed in future articles. Suffice it to say here that they are due principally to Winston E. Kock, the principal designer of the Baldwin organ, and that they analogize electronically the acoustic action of an ordinary musical instrument. Their capabilities are not realized fully
Audio Feedback Design

Part VI—Using the stability margin for amplifier testing

By GEORGE FLETCHER COOPER

In the earlier articles of this series the stability of the amplifier has been expressed in terms of the phase margin and the gain margin. These two ideas, which are very widely accepted, are extremely useful in designing an amplifier, but they are rather a nuisance when it comes to testing it. Even if you only make one amplifier, it is worth while to test it properly, because it may go unstable owing to tube aging or supply variations just when you are showing it off to an admiring aunt. And of course, if you make amplifiers for money you will not find many customers who want unstable ones.

Measuring the phase and gain margins is a difficult job, because the measurements have to be extended to a very high frequency, where the gain has fallen 20-30 decibels. Phase meters are available commercially, but I think that only the best equipped industrial laboratories have them. An oscillograph can be used, but it is a tedious and inaccurate method of measurement. An elegant way out has been described by W. T. Duerdoth, of the British Post Office. He has introduced a new quantity, the stability margin, which is easy to measure and which gives a clear indication of the stability conditions. This quantity is related to the shape of the Nyquist diagram, and although it cannot be used in the design stage so easily as the gain and phase margins, it does seem to be the answer to the testing problem.

To have something concrete to talk about, a typical high-end-response characteristic has been constructed, and is shown as Figs. 1 and 2. According to what we have seen in the earlier articles, the permissible feedback for an amplifier with this characteristic would be about 18 db, giving a phase margin of 25° and a gain margin of 6 db. The important part of the Nyquist diagram is plotted as Fig. 3.

To plot this we start by drawing a circle with center O, and a radius of, say, 20 cm. We also draw a line OX, to the left. This first circle is the zero circle, and we next draw a number of smaller circles, with the same center O. The circle with a radius of 10 cm, half the radius of the zero circle, corresponds to a drop of 6 db; the next, radius 2.5 cm, to a drop of 18 db; and so on. We can also draw the circle of radius 2 cm (= 20/10), corresponding to a drop of 20 db. The figure actually does not include the zero circle, because the region outside the 12-db circle is not of much interest to us.

Polar response curve

We must now plot the amplitude-phase-frequency response as a polar diagram. For each value of amplitude we can determine a frequency from Fig. 1, and the corresponding phase from Fig. 2. Thus in Fig. 1, 4.5 db gives us a frequency of 32, and in Fig. 2 a frequency of 32 gives us 72°. In tabular form:

<table>
<thead>
<tr>
<th>Fig. 1</th>
<th>Fig. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5 db</td>
<td>32 (f)</td>
</tr>
<tr>
<td>7.5 db</td>
<td>32 (f)</td>
</tr>
<tr>
<td>10 db</td>
<td>32 (f)</td>
</tr>
</tbody>
</table>

Now draw a line OP, such that angle XOP = 100°, and fix P on this line at the 7.5 db level. This is actually at a radius of 0.422 × 20 cm (The 0.422 comes from the voltage ratio-decibel table to be found in most reference books, e.g., Terman's Radio Engineers' Handbook, page 1). The point P therefore corresponds to the amplitude and phase given in Figs. 1 and 2 at a frequency of 50. This we plot in Fig. 3. Repeating the process at 6, 12, 18 and 24 db we have enough points to plot the solid line. On a larger scale we can draw the dashed line, for which the original zero circle, if I had drawn it, would have had a radius of 160 cm. Going back to the full line, which is part of the Nyquist diagram—the rest, over on the left, does not concern us—we see that it crosses the 180° axis, OY, at the point L, where the response is 24 db down.

As we have already seen, the condi-

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tion for stability is that we should have less feedback than the drop of response at 180° here we must have less than 24 db feedback. This is a restricted case of a rule which is known as Nyquist's criterion. We define the point N as the point, lying on the line OY, at which the response has dropped 1 db, where F is the feedback. Then the curve must not encircle N. Usually this just means a smooth run-in above N, like the curve we have shown, but the Nyquist diagram may take the form shown in Fig. 4-a without the amplifier being unstable. This particular form is called "conditionally stable" and it is a rather difficult form to use, because the amplifier becomes unstable if the gain falls. As a result, when first switched on, with the heaters warming up, the circuit will sing, and the resulting grid current may keep the amplifier in the unstable low-gain condition. These "conditionally stable" circuits are therefore used only rarely, and in applications where they are kept switched on permanently.

Stability margin

The important idea which Duerdoth has introduced is this: it is not just the pair of points L and M in Fig. 3 which matter, but how close the curve gets to N. The two points define the gain margin (L) and the phase margin (M), but the same values of these quantities would be given by the little dotted spline on this curve. Yet an increase of gain of 0.1 db, and 1° of phase, would make the dotted loop encircle N.

Looking back to the first article, we had an equation for the gain with feedback K1, in terms of the gain without feedback K and the feedback network attenuation β:

\[ K_1 = \frac{K}{1 + \beta K} \]

We can write this as

\[ K = \frac{1 + \beta K}{K_1} \]

In Fig. 3, the distance OP is βK, and OP is actually a vector, which includes the phase of K (and of β, if the feedback path is not a pure resistance network). By taking the right account of the signs, and doing a little vector mathematics, we can show that NP = 1 + βK, so that the length NP is the ratio of the gain without feedback to the gain with feedback. In Fig. 5 the circles of constant NP are drawn for the same Nyquist diagram. The 0-db circle passes through O, the 6 db circle bisects the line NO, and the 12 db circle has a radius equal to 1/4 × NO. It will be seen that the OP cuts almost touches the 12 db circle, so that the stability margin is 12 db.

By now the reader may be getting a little impatient: where is the simplification? The answer was hidden in the last paragraph. The stability margin is the amount by which the gain with feedback exceeds the gain without feedback at the critical points. To illustrate this I have calculated the effect of applying 18 db of feedback to the characteristics of Figs. 1 and 2. Fig. 6 shows the result. With feedback the response peaks up to 12 db above the response without feedback. With less feedback the peak would be flatter; with more feedback it would get higher until it went right up off the paper—instability. To find the stability margin all we need to do, therefore, is to measure the effect of connecting the feedback at a number of frequencies until we find where the gain increases meet with feedback.

The actual measurement is carried out using the circuit of Fig. 7. The os- How much stability?

We must have a criterion for a satisfactory value of stability margin. It is not too difficult to see that a smooth Nyquist diagram, like the one we have considered, will give a stability margin of 6 db if the phase margin is 30°. This figure of 6 db is quite a good working limit for test purposes; for design work, however, it is desirable to adopt a figure of about 4.5 db, to allow for errors in component values and high transconductance tubes. Very often, however, a still lower figure is forced on the designer by another consideration. Looking at Fig. 6 we see that with feedback we get a 9 db peak at the top end. Usually we should add a small capacitance across the feedback resistor to round off this peak. Automatically we should improve the stability margin, and without calculation we should estimate that in this circuit we could easily make it 2 db. Stability margin is thus closely associated with response: a flat response with a smooth curve will usually have a very good stability margin.

Looking only at the stability margin, a Nyquist diagram like the one shown in Fig. 9 would be ideal. The amplitude response here would be flat up to the edge of the band, where it would drop sharply about 8 db, and then follow a slope of 11 db per octave. When the feedback factor was reached there would be a small flat step, giving the arc of a circle round N, and then down the response would plunge. By the phase area thereon this response is very efficient: you can read more about this in Terman's Radio Engineer's Handbook, page 212 et seq. It is not easy to control the response exactly as this if there is an audio transformer in the circuit. There is another disadvantage, too. Suppose the forward gain changes: it may rise or fall as the supply voltage changes, or with tube aging. The effect is equivalent to moving N to the left or to the right. Decreasing the gain by 6 db will bring the corner C very close to N, and although the amplifier is still stable, this does not improve the response. Increasing the gain by
6 db will make the amplifier unstable. A more sophisticated diagram is that shown in Fig. 10. This allows more room for manoeuvre when the gain increases. Any reader who has reached the point of using circuits giving complicated diagrams of this sort can refer to Daedoth's paper and the discussion on it, in Proceedings of the Institute of Electrical Engineers, Vol. 97, Part III.

Fig. 7—Circuit for checking stability.

Component tolerances
It is appropriate to point out here what the effect of component tolerances will be. If you use commercial capacitors and resistors you cannot, with economy, get values better than 10%. The effect of a 10% change in either capacitance or resistance is a phase shift of 3° at the characteristic frequency, where the phase shift is 45°. In a 3-stage amplifier, if all resistors and capacitors are 10% wrong in the most harmful direction, the phase will be in error by 28°. On top of this there may be a small error due to the decoupling circuits, so that at the worst we may expect 20°. Of course, it is not likely that we shall have all components at the limit values. If we do we must either use others or else select sets of upper- and lower-limit resistors, using upper-limit resistors in one stage and lower-limit resistors in another. Alternatively, R-C sets can be chosen to give the right characteristic frequencies. This problem arises only if you are making a number of amplifiers which have rather tight specifications.

The most important practical case of component tolerances arises in the push-pull transformer design at low frequencies. Care must always be taken to allow for an unbalanced d.c. component in the plate windings due to differences between the tubes. All the discussion of the stability margin has been devoted to the high-frequency stability. At low frequencies, which the region around 1 cycle is usually the important one, there seems to be no really satisfactory solution. My own method is to increase the feedback until the amplifier becomes unstable. If the instability is at high frequencies the stability margin is used as the test criterion; if the instability is at low frequencies, working feedback is used as the criterion. There is now available a range of very low-frequency test equipment, mainly intended for servo mechanisms (which are feedback amplifiers built around machinery), but we just don't have any. Most of my amplifiers do seem to rest against the high-frequency limit.

In the next article I hope to discuss the use of positive feedback for improving amplifier performance. This is a powerful but rather dangerous technique. Used carefully it can give very good results.

Improving Radio Fidelity

By HERBERT MICHELS

If you want to improve the response of an audio amplifier without purchasing an expensive high-fidelity output transformer, you'll probably find that two inexpensive transformers will meet your needs. In an actual test, an amplifier having a response of 200 to 8,000 cycles with a single output transformer was made flat within 2 db from 50 to 12,000 cycles merely by using two output transformers in series as shown in the diagram. The upper limit of the frequency range of an output transformer is determined by the distributed capacitance of the primary winding. This capacitance being high in inexpensive transformers, appears as a low-capacitive-reactance shunt across the primary, and signals above approximately 8,000 cycles are attenuated. Using two transformers in series halves the distributed capacitance, doubles the capacitive reactance, and extends the upper limits of the response curve.

The low-frequency response is also improved through the use of two transformers. The primary inductances add to produce twice the inductance of a single winding. The higher inductance increases the inductive reactance shunting the primary and lowers the point at which the lows begin to fall off. In this way you can save the cost of a transformer having a high-inductance primary and a heavy iron core and still get a good response.

The transformers preferably should be of the same type. Each—if used alone—should match the output tube to the speaker.

Although this method of improving fidelity can be a great help, always remember that the response of a system is no better than that of its components. The input to the amplifier, whether it be from a tuner, phono pickup, or microphone, should have high fidelity. The speaker should faithfully reproduce the audio signals fed into it.

At first glance, it may seem strange that two identical transformers connected in series will match the same source and load as either of them alone. This is true because the impedance ratio does not change when they are connected in series.

Assume that a transformer is to match a 4,000-ohm load to an 8-ohm speaker. The transformer turns ratio should equal the square root of Z2/Z1, where Z1 is the impedance of the primary (4,000 ohms) and Z2 is the secondary impedance (8 ohms). The turns ratio is \(\sqrt{500} = 22.4\) to 1.

If we assume that the voice coil winding of T1 or T2 has one turn, then the primary will have 22.4 turns. When the transformers are connected in series as shown in the diagram, the number of turns in the effective primaries and secondaries are doubled so that there are now two turns on the secondary and 44.8 on the primary. Although the number of turns on both windings has been doubled, the impedance ratio remains constant.

This method may increase fidelity but will not minimize distortion caused by core saturation.—Editor
Accurate Scope Calibrator

Increase the usefulness of your scope with this simple peak calibrator

By ROBERT F. SCOTT

Front panel photo of the peak-to-peak voltage calibrator. The meter can be any with a movement of 1.5 ma or less.

TELEVISION, radar, loran and many other types of electronic equipment use nonsinusoidal voltages. If the wave-form or amplitude of these voltages is wrong, the equipment does not work right. For example, if the picture on your television screen does not extend to its full width or height, low deflection voltage may be the reason.

Manufacturers commonly supply oscilloscope waveforms and list their peak-to-peak voltages, as an aid to the service technician. It is easy to observe the waveforms on a scope, but measuring peak-to-peak voltages is another story. You cannot get accurate readings on conventional v.t.v.m.'s or a.c. voltmeters because they are not designed or calibrated to measure pulses, square waves, or other nonsinusoidal voltages.

The peak-to-peak voltage calibrator whose circuit appears in Fig. 1 provides known square-wave voltages which are fed into the scope and compared with the positive and negative tips of the signal under test.

The constant voltage used for calibrating is not affected by normal line voltage fluctuations because the two diodes connected back-to-back act as clipper-limiters. Diode D1 of the 6AL5 has its cathode biased positive at 150 volts. Approximately 300 volts a.c. is applied to its plate. This diode does not conduct until the positive half-cycle of the alternating voltage exceeds 150 volts. D2 is connected in reverse with its plate biased 150 volts negative and a.c. applied to its cathode. It does not begin to conduct until the negative peak of the sine wave is above the bias voltage.

If the diode load—the voltage control and multiplier in parallel—is very large and R1 is comparatively small, the voltage across the load will be a square wave because of excessive drop across R1 during periods of conduction in the diodes.

The resistors in the multiplier are the only critical components in the calibrator. The capacitor in series with R1 may be as low as .005 uf. The values of R1, the voltage control, and the multiplier resistor may vary widely from those shown on the diagram. These can be determined experimentally as will be shown later. The diode load should not be too low. If it is, the a.c. will be bypassed around the diodes. Furthermore, the rise time of the square wave increases as the load decreases. If R1 is too high or too low, the diodes do not limit the peaks during conduction. You can select a value for this resistor by substituting a 250,000-ohm variable resistor and varying it through its range while observing the waveform on the scope. Measure the resistance in the circuit at points where the peaks start to round off.

Select a fixed resistor somewhere around the center of this range. The diode load may be as low as 50,000 ohms if the values of the coupling capacitor and R1 are selected to produce a good square wave.

Calibration

Before deciding on values for the voltage control and multiplier resistors, connect a variable resistor and high-resistance voltmeter between the a.c. line and scope as shown in Fig. 2.

Fig. 1—Schematic of the peak-to-peak calibrator. It has four voltage ranges which supply known square waves that are used to calibrate an oscilloscope.

RADIO-ELECTRONICS for
Adjust the horizontal gain for convenient deflection—2 and 4 inches for 3- and 5-inch scopes. Leave the gain control set—don’t move it. Disconnect the meter and variable resistor. Connect leads across the diode load and note the deflection and wave shape on the scope. Adjust the load resistor and R1 for 100 volts or more peak-to-peak. Replace the load resistor with a potentiometer having approximately twice its value. Make up the multiplier from resistors having a total value approximately equal to twice the value of the original load resistor.

The meter has a basic movement of 1.5 mA or less. Ours is a surplus 500-ohm instrument having 15- and 60-ohm scales. We selected the 15-ohm scale and jockeyed values in the calibrator for a 150-ohm peak-to-peak square wave.

Connect the calibrator to the scope, set the multiplier to MULTIPLY BY 10, and adjust the voltage control to 100 volts peak-to-peak deflection on the scope. Replace R2 with a variable resistor of 150,000 ohms or more and vary it until your meter reads exactly 100 volts. Turn off the calibrator and measure the resistance remaining in the circuit. Replace this with fixed resistors hand-picked to make the meter read correctly.

If the calibrator delivers more than the full-scale voltage of the meter, insert resistor R3 and vary its value until the meter is at exactly full scale when the voltage control is set for maximum voltage. If you use care in selecting resistors for the multiplier, the output voltage can be reduced in four steps—each being one-tenth the one above it.

The multiplexer values in Fig. 1 are nominal values only. The calibration will be exact if each resistor is one-tenth the value of the one above it in the multiplier string, except for the lowest range (470 ohms in the diagram). This resistor should be one-ninth the next high value. The precision of the multiplier will depend on the precision with which these resistors are selected.

The frequency of the calibrator output is 60 cycles (or the same as the line frequency). The instrument therefore calibrates the oscilloscope for that frequency. If the calibration is to be accurate for other frequencies, the response of the vertical amplifier must be flat to 60 cycles.

**Operating instructions**

Connect your probe or test leads to the IN terminal of the calibrator and connect the output (OUT) terminal to the scope. The GND terminal is a common return for the scope and equipment under test. In the TEST position, the signal feeds from the receiver directly to the scope. Adjust the vertical gain control for a convenient deflection. Set the vertical positioning control so the signal under observation is centered on the screen. Throw the function switch to the calibrate (CALIB) position and adjust the multiplier and voltage control for the same peak-to-peak deflection. Multiply the meter reading by the setting of the multiplier.

If the voltage being observed is symmetrical, the operation may be speeded up by flipping the function switch rapidly while adjusting the voltage control until the peaks of the signal and standard voltage are equal. An enterprising constructor could work out a combination of a calibrator and electronic switch so that technicians unknown voltages can be superimposed.

When you have completed the calibrator, you will find it worth while to check the tubes in your scope and record the deflection for at least one setting of the vertical and horizontal gain controls. By making periodic checks with the calibrator, it will be easy to detect changes in the performance of the scope. Weak or gassy amplifier tubes will produce less deflection for a given input voltage and setting of the gain controls. A weak high-voltage rectifier will show up in the form of greater deflection and less brightness for a given voltage input.

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**Fig. 2—Hookup for meter calibration.**

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**Materials for Calibrator**

Resistors: 100, 1,000, 2,000, 75,000 ohms, 1/4-watt (selected for multiplier); 1-75,000 ohms, 1/2 watt; 1-2,000, 2-25,000 ohms, 10 watt; 1-50,000-ohm potentiometer. R2 and R3 depend on meter used.

Capacitors: 1-0.1 µf, 600 volt, paper; 1-20 µf, 450 volt, electrolytic.

Miscellaneous: 1-power transformer, 300-0-300 v. a.c., at 60 ma; 1-4kl, 1-4als, 2-001 tubes and sockets; 1-meter, 1.5 ma or less; 1-meter rectifier; switches, hookup wire and assorted hardware.
**TV Advances in Britain**

By R. W. HALLOWS

In Britain today the emphasis is emphatically on bigger television pictures. Progress toward this goal seems, though, to be on a different line than in the United States. Our tube manufacturers don't turn out standard types of cathode-ray tubes bigger than 15 inches. Larger ones are made, but in small quantities; their use in televisions is so limited (to a few sets specially made to the orders of millionaire enthusiasts or research laboratories) that for practical purposes they may be said to play no part in British TV receiving technique.

Rightly or wrongly, tube manufacturers here have chosen to concentrate on the small, superbrilliant tubes required for projection reception. And I'm not at all sure that they haven't got something there. Give the designer of big-picture TV receivers a reliable, long-lived projection tube plus a low-priced corrector lens for the Schmidt optical system, and he's likely to produce something that gives a fine large picture, doesn't cost overmuch, and can be fitted into a neat and not too bulky cabinet.

That's how our designers see it. They have the tubes, for our manufacturers have got over most of the difficulties and are now turning out projection tubes which are not giving many headaches to users or to service technicians. Also, they've got the right sort of corrector lens at the right sort of price, thanks to the newest processes of molding Perspex.

**Low cost projection**

An example of what can be done is the Philips 600A console which gives a 140-square-inch picture with the accompanying sound and costs the equivalent of $185. In this and other prices, by the way, I have taken no account of purchase tax, for that is a government charge and not one made by manufacturers. To obtain the local equivalent prices add the sales tax prevailing in your area.

I can testify personally to the quality of the images obtained by projection methods. Not long ago, I had the opportunity of seeing the same TV program reproduced on two screens of identical size placed side by side. One was a standard projection set, costing less than $200; the other, a special model, was the finest direct-viewing receiver that could be made, regardless of cost. With a 19½-inch tube and providing nothing but TV sound and vision, its price came out at around $2,000. I admit that the expensive receiver gave rather better images; you'd expect that. But the projection televiser was so nearly as good that I was in no doubt that, in the unlikely event of my having the equivalent of $2,000 in my pockets, I'd far rather have the projection receiver and $1,800 (or even quite a bit less) than the big-tube televiser and no change on the transaction.

**Typical British sets**

From the picture of the Dynatron "Ether Sovereign" you'll see that what I call the complete-home-entertainer type of apparatus includes some handiness. This model contains an all-waveband radio receiver, a phonograph with automatic record changer, and a televiser showing an image of about 120 square inches. The price? About $1,200.

Another noteworthy outfit of this kind is the HMV model 2901, offering all-wave radio, record changer-phono, and a 150-square-inch picture for $700. Between these big fellows and the "poor man's" televisers (giving vision and accompanying sound only and priced at $72 to $115) there's a big choice of receivers, none with less than a 12-inch tube. The tendency is for the medium-priced equipment to include an all-waveband radio receiver and to cost somewhat about $180-220.

An interesting set in the middle-price class is the Ambassador TV2 table model, at $126, which is what we call an SV (sound and vision) type—a straight television receiver without radio or phonograph. Stand a televiser in a cabinet of the usual shape on a table with its back next the wall and it dictates where you must sit, if you want good viewing. But the back of this Ambassador set is an arc of a circle: no matter if it's within a ¼ inch of the wall, you can swing the set, which is mounted on a turntable, so that it suits the chair that you have chosen. At least a dozen manufacturers offer televisers at less than $100. Most of these have 9- or 10-inch tubes and all are of the SV kind. The lowest priced televiser is offered by the Baird Co. With a 50-square-inch picture, it costs $72. About a dozen other models, some with 12-inch tubes, are obtainable at $100-120. One of these, the Pye V30 has a very effective single-tube line time base. Details haven't yet been released, but I hope to have them for you before very long.

Our national TV chain is going ahead
Relays and Their Operation

Part II—How relays can be used in a number of remote control circuits

The R11 switch is closed to operate RY1, turning on the filaments of the transmitter through contacts 1 and 2. Contacts 3 and 4 on this relay close the battery circuit to the bias winding of RY2 through the A coil of RY2. The purpose of this winding is to neutralize the magnetizing effect of the line current which flows through the windings of both RY1 and B of relay RY2. Both of these windings should have approximately the same resistance. For ease of adjustment, both windings of RY2 should be of the same resistance also. They should be wound simultaneously, so that the magnetizing effect of each winding is the same. The current through A is then adjusted by means of the R2 resistance to be the same as the current through the B winding with the telegraph key open.

Fig. 12—Simple relay locking circuit. Connected to an earth ground, but general practice is to do so. Battery usually denotes 24 or 48 volts of direct current—the common source of power for all relays, whether obtained from an actual battery or a low-voltage rectifier. The positive pole is normally grounded, except where otherwise required.

In a nonoperated condition a relay usually stands with either battery or ground on one terminal of its coil. To operate the relay it is necessary only to complete the circuit and cause the relay to pull up momentarily or to lock up, whichever is desired. A lock-up circuit is shown in Fig. 12. To cause the relay to release it is necessary to do one of three things momentarily—remove ground or remove battery, breaking the lockup circuit, or short-circuit the relay coil, in which case a resistor would be inserted in the battery lead to the coil.

Fig. 13 shows a control circuit suitable for a c.w. transmitter which controls filament, plate, and keying functions over a single control wire, using the ground as return. The system operates as follows.

MARCH, 1951
effect between the two. The current in this case, however, should be limited to a maximum of about 60 ma.

shown. The chokes, L, are about 2 h. each. The current here should be limited to about 30 ma. If straight-open-and-

Fig. 16—Phone-c.w. transmitter remote control circuit with an audio circuit.

A composite circuit is shown in Fig. 15, which allows one voice circuit and two d.c. circuits on one pair of wires. Here T1 and T2 may be the same as Fig. 11-a, but need not be center-tapped. Line capacitors are 2-uf and should be as near as possible the exact same capacitance as the other capacitors, as close or neutral operation of the control circuits is used, operation is apt to be sluggish, due to the large capacitance involved. Therefore, to key a telegraph transmitter over this circuit, a polar relay should be used, as shown in Fig. 16. The spring of RY1 is adjusted to make the armature operate at twice the current required for RY2.

Radio control
Where wire facilities are not available, radio control circuits must be used. Perhaps the simplest control source is the rectified carrier voltage from a half-wave detector, such as the type 6H6 or 7S.

Such a circuit does not lend itself to the same type of operation as illustrated in Fig. 13. However, by using the carrier voltage to operate relay RY1 in Fig. 13, and a superimposed tone to operate RY2 and RY3 relays, the same result is achieved. The essential features are shown in Fig. 17.

As previously pointed out, control circuits become exceedingly complicated when they perform several operations, unless selective switching, using some form of rotary switch controlled by impulses, is used.

Rotary selectors
The fundamentals of a rotary selector circuit are shown in Fig. 18. In this particular circuit it is possible to obtain nine separate selections, in any order, reserving the tenth digit, or zero, as a master release. The operation is as follows, all relays except RY1 being shown in the nonoperated position.

Assume that we wish to operate the equipment associated with RY6 contacts. The digit 5 is dialed and the impulse contacts of the dial open three times, releasing the armature of RY1 three times. The RY1 contacts are closed three times. On the first closure RY2 is operated, opening the normally closed back contact and removing ground from the wiper arm of the selector. RY2, being a slow-release relay, does not respond to the dial pulses, but remains operated. This prevents relays on contacts 1 and 2 from being falsely operated as the wiper arm passes over them. As soon as RY3 operates it closes the circuit to RY4, which operates, opening its contacts, and prevents the battery, which is now standing on the reset magnet RY5 through the closure of the off-normal contacts, from operating the RY6 magnet. The off-normal contacts close as soon as the wiper arm operates, to prepare the reset magnet path.

The wiper has progressed to the third contact, and the dial has stopped. Since RY2 no longer receives pulses, it releases, putting ground on the wiper arm. The wiper, standing on contact 3, connects ground to the winding of RY6, operating the relay. RY6 remains operated, through the lockup contacts on its coil.

When RY2 releases, it also removes battery from the RY4 coil, but this relay, being slow-releasing also, for a moment does not put ground on the reset magnet through the RY4 contacts. It is during this short space of time, about half a second, between the release of RY2 and the release of RY4 and subsequent operation of RY5, that control relays are operated. Were the RY4 not included, the ground would stand on the wiper for too short a time to operate the control relays. When the reset magnet operates, its armature disengages the pawl from the ratchet on the wiper arm shaft, and the wiper restoring spring returns the wiper arm to its normal position, below the number 1 contact.

By the same procedure, all the control relays may be locked up, and in any order. After any or all of the control relays have been operated and it is desired to release them, the digit 5 is dialed, momentarily energizing the master-release relay RY1. The battery supply to all the control relays flows through the normally closed contacts of RY7. When the digit 5 is dialed, RY7 operates for the space of time between the release of RY2 and the release of RY4, which is sufficient to release all relays locked up.

A standard phone dial is used in conjunction with equipment of this type. The pulsing contacts are designed to open when the dial is operated, the number of pulses corresponding to the digit dialed. Auxiliary contacts are usually supplied to accomplish other functions during the operation of the dial; however, these vary with different dials.

Since minor switches usually are supplied with two or more banks of contacts, we need not be limited to just nine choices.

At first contemplation of the above, you may throw up your hands in despair at the complexity of the circuits, but if you analyze them one part at a time, studying its operation thoroughly, you should have no trouble. All the relays described in this article are obtainable on the surplus market. The telephone-type relays are standard items stocked by the Automatic Electric Company or the Graybar Company, both of which have offices in the principal cities.
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EVERYTHING IN ELECTRONICS

MARCH, 1951
How an Electric Brain Works

Part VI—Although no genius himself, Simon now helps us to understand how an electric brain is put together

By EDMUND C. BERKELEY* and ROBERT A. JENSEN

Fig. 1—A photo of Simon with his top cover off. He has 120 relays that make up his gray matter, as well as a few spares for development in the future.

MOST of the operations that are essential for an electric brain have now been explained and illustrated. In previous articles, we have covered relay circuits for storing and transferring information; performing arithmetical operations; and arranging automatic control.

Now, how do we put all these operations together, so that we actually succeed in making a complete electric brain that will work successfully?

As usual in this discussion, we shall keep to a simple example and leave out the more complicated sides of questions, so that principles may be made clear. But instead of having to talk about hypothetical examples, this time we can talk about an actually existing example—the baby mechanical brain Simon that we have described previously.

The machine Simon was pictured in the October, 1950, issue of RADIO-ELECTRONICS, and some more pictures of it are given here. A top view is shown in Fig. 1, and a bottom view in Fig. 2. Because Simon does not have covers in these pictures, some idea of what the machine is really like may be gained from them.

From the top view we can see that Simon has:

- A front panel, with lights, buttons, switches, and a meter;
- A tape feed for feeding 5-hole paper tape;
- A stepping switch, for timing the machine; and—
- Some 120 active relays, for operations.

The bottom view shows:

- Some banks of small rectifiers;
- Some capacitors, for spark suppression; and
- A lot of wiring.

When finished in May 1950 Simon knew only the numbers 0, 1, 2, and 3. As a result of changes of his circuits made in August 1950, however, Simon now can take in numbers from 0 to 15 and can report numbers from 0 to 51.

With some more changes, Simon could handle bigger numbers still.

Earlier we said there were five parts to every mechanical brain: input, output, storage, computer, and control. Where are these various parts in Simon located?

Input

The input of Simon consists of 5-hole paper tape, the tape-feeding mechanism (see Fig. 1), and switches and buttons (see Fig. 3). These are all the ways in which you can give information to Simon so that he will know exactly what to do and in what order to do it.

Ordinarily, when you want to run a problem on Simon, you write out the commands (with 1's and 0's, using binary notation) cycle by cycle on a piece of paper. This is called the coding for the problem. Then you punch this coding onto a piece of tape, put the tape into the tape feed, and turn on the power. The tape runs, and Simon clicks away, “thinking,” as he works out the answers to his problems.

You may, if you wish, give Simon general instructions applying to any one or more numbers, and then put the numbers into the machine by hand from...
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THE RADIART CORPORATION CLEVELAND 2, OHIO

MARCH, 1951
Fig. 3—Diagram of Simon's front panel showing his controls and indicators.

time to time at appropriate points. You can tell Simon to stop at an appropriate place, by punching into the tape an indication for a "programmed stop," as it is called. When Simon makes a programmed stop, you press any one or more of the buttons numbered 8, 4, 2, 1 (see Fig. 3). This action inserts the number which is the sum of the figures selected, into the button relays (register BR in Fig. 4). Then to transfer the number from the button register into Simon's regular input register (register button (see Fig. 3), and Simon runs on, automatically reading and obeying the tape.

Output

The output of Simon also is on the front panel (see Fig. 3). It consists of five lights, called OUTPUT LIGHTS 16, 8, 4, 2, 1. In these lights any number from 0 (no lights shining) up to 31 (all five lights shining) can be indicated. For example, if five lights 16, 4, 1 are shining, the number indicated is 16 plus 4 plus 1, or 21. You program Simon so he will stop when a result has been delivered. You can examine and, if you wish, copy the result, and then, when you press the STEPPER J O G button, Simon will run on.

The sixth light on the front panel is a red pilot light which shines when the power is on; and the meter reads the voltage at which Simon is operating. Simon will operate at 20 to 30 volts d.c.

Storage, computer, and control

The functions of storage, computing, and control in Simon are carried out by relays. Of course, a good deal of the control is also expressed in the tape, but relays take the information from the tape and operate with it.

A diagram showing all the 129 relays of Simon is given in Fig. 4. Each relay is represented by a rectangle placed in the correct physical location (compare Fig. 4 with Fig. 1). There are 19 columns, corresponding to the columns shown in the photograph. Fig. 1, and 8 rows (the two bottom ones incomplete) corresponding to the rows shown in Fig. 1.

The relays in Simon may be designated in either one of two ways, according to location in the machine, and according to function.

For wiring purposes, the relays are designated by location, that is, by row (a single letter C, D, E, F, G, H, N, or P) and by column (a number 1 to 19). But for purposes of understanding Simon, the functional designations are useful. To designate a relay by its function, each relay has an abbreviation that may have three parts. Part 1 is two or more letters, to tell the kind of register. Part 2, if any, is a number, used to number off registers all of the same kind. These numbers are not always consecutive, for reasons that will be explained later. Part 3, if any, is a number in parentheses, used to tell the binary digit being handled by that relay.

Table of Relay Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Name of Group</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASR</td>
<td>Auxiliary Stepping Relay</td>
<td>Slow down the stepping switch.</td>
</tr>
<tr>
<td>BR</td>
<td>Button Register</td>
<td>Temporarily record numbers in instructions from buttons.</td>
</tr>
<tr>
<td>CR</td>
<td>Computer Registers</td>
<td>Compute</td>
</tr>
<tr>
<td>ER</td>
<td>Entrance Relays</td>
<td>Allow information to enter registers.</td>
</tr>
<tr>
<td>IR</td>
<td>Input Registers</td>
<td>Temporarily record numbers from the tape or the buttons.</td>
</tr>
<tr>
<td>OR</td>
<td>Output Registers</td>
<td>Hold answers, to be shown in the output lights.</td>
</tr>
<tr>
<td>PR</td>
<td>Program Relays</td>
<td>Record programming information from the tape or from the buttons, and control Simon.</td>
</tr>
<tr>
<td>RR</td>
<td>Reset Relays</td>
<td>Reset, release, or clear registers, so that new information may be stored in them.</td>
</tr>
<tr>
<td>SPR</td>
<td>Step-Position Output Relay</td>
<td>Allows the position of the stepping switch to be read in the output lights.</td>
</tr>
<tr>
<td>SR</td>
<td>Storage Registers</td>
<td>Store information until used.</td>
</tr>
<tr>
<td>SYR</td>
<td>Synchronism Relays</td>
<td>Arrange that the tape and the machine cycles shall be automatically in synchronism.</td>
</tr>
</tbody>
</table>

Fig. 4—A plan of the relay layout in Simon. The red lines group together relays which have the same function. The table explains each group's functions.
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Modern Styling
Kits THAT MATCH

Heathkits are styled in the most modern manner by leading industrial designers. They add beauty and utility to any laboratory or service bench. There is a complete line of Heathkit instruments allowing a uniformity of appearance.

An attractive service shop builds a feeling of confidence. Many organizations have standardized on Heathkits providing uniform service departments.

There is no waste space or false effort to appear large in Heathkits—space on service benches is limited and the size of Heathkit instruments is kept as small as is consistent with good engineering practice.

Accuracy Assured by Precision Parts

Wherever required, the finest quality 1% ceramic resistors are supplied. There is no scaling and do not shift. No matching of common resistors is required. You find in Heathkit the same quality voltage divider resistors as in the most expensive equipment.

The transformers are designed especially for the Heathkit unit. The scope transformer has two electrostatic shields to prevent interaction of AC fields.

These transformers are built by several of the finest transformer companies in the United States.

Used by Leading Manufacturers

Leading TV and radio manufacturers use hundreds of Heathkits on the assembly lines. Heathkit scopes are used in the alignment of TV tuners. Impedance bridges are serving every day in the manufacture of transformers. Heathkit VTVM's are built into the production lines and test benches. Many manufacturers assemble Heathkits in quantity for their own use thus keeping purchase cost down.

Complete KITS WITH PARTS THAT FIT...

When you receive your Heathkit, you are assured of every necessary part for the proper operation of the instrument.

Beautiful cabinets, handles, two-color panels, all tubes, test leads where they are a necessary part of the instrument, quality rubber line cords and plugs, rubber feet for each instrument, all scales and dials really printed and calibrated. Every Heathkit is 110 V 60 Cy. power transformer operated by a husky transformer especially designed for the job. Heathkit chassis are precision punched for ease of assembly. Special engineering for simplicity of assembly is carefully considered.

Complete Instruction Manuals

Heathkit instruction manuals contain complete assembly data arranged in a step-by-step manner. There are pictorials of each phase of the assembly drawn by competent artists with detail allowing the actual identification of parts. Where necessary, a separate section is devoted to the use of the instrument. Actual photos are included to aid in the proper location of wiring.

Heathkit are found in every leading university from Massachusetts to California. Students learn much more when they actually assemble the instrument they use. Technical schools often include Heathkits in their course and these become the property of the students. High schools, too, find that the purchase of inexpensive Heathkits allows their budget to go much further and provides much more complete laboratories.

 YOU SAVE BY ORDERING DIRECT FROM MANUFACTURER—USE ORDER BLANK ON LAST PAGE

The Heath Company

...Benton Harbor 20, Michigan
The new 1951 Heathkit Push-Pull Oscilloscope Kit is again the best buy. No other kit offers half the features — check them.

Measure either AC or DC on this new scope — the first oscilloscope under $100.00 with a DC amplifier.

The vertical amplifier has frequency compensated input stage, the gain control is of the non frequency discriminating type — accurate response at any setting. A push-pull stage feeds the C.R. tube. New type positioning control has wide range for observing any portion of the trace.

Horizontal amplifiers are direct coupled to the C.R. tube and may be used as either AC or DC amplifiers. Separate binding posts are provided for AC or DC.

The multivibrator type sweep generator has new frequency compensation for the high range it covers; 15 cycles to cover 100,000 cycles. The new model 0-6 Scope uses 10 tubes in all — several more than any other. Only Heathkit scopes have all the features.

New heavy-duty power transformer has 50% more laminations. It runs cool and has the lowest possible magnetic field. A complete electrostatic shield covers primary and other necessary windings and has lead brought out for proper grounding.

The new filter condenser has separate filters for the vertical and horizontal screen grids and prevents interaction between them.

An improved intensity circuit provides almost double previous brilliance and better intensity modulation. A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing.

The magnetic alloy shield supplied for the C.R. tube is of new design and uses a special metal developed by Allegheny Ludlum for such applications.

The Heathkit scope cabinet is of aluminum alloy for lightness of portability.

The kit is complete, all tubes, cabinet, transformers, controls, grid screen, tube shield, etc. The instruction manual has complete step-by-step assembly and pictorials of every section. Compare it with all others and you will buy a Heathkit. Model 0-6. Shipping Wt., 30 lbs.
New 1951 - - MODEL V-4A

Heathkit

VTVM KIT

HAS EVERY EXPENSIVE FEATURE

* Higher AC input impedance, (greater than 1 megohm at 1000 cycles).
* New AC voltmeter flat within 1 db 20 cycles to 2 megacycles (600 ohm source).
* New accessory probe (extra) extends DC range to 30,000 Volts.
* New high quality Simpson 200 microampere meter.
* New 15 mV voltage divider resistors (finest available).
* 24 Complete ranges.
* Low voltage range 3 Volts full scale (1's of scale per volt).
* Crystal probe (extra) extends RF range to 250 megacycles.
* Modern push-pull electronic voltmeter on both AC and DC.
* Completely transformer operated isolated from line for safety.
* Largest scale available on streamline 4½ inch meter.
* Burn-out proof meter circuit.
* Isolated probe for dynamic testing no circuit loading.
* New simplified switches for easy assembly.

New LOW PRICE $235.00

The new Heathkit Model V-4A VTVM Kit measures to 30,000 Volts DC and 250 megacycles with accessory probes — think of it, all in one electronic instrument more useful than ever before. The AC voltmeter is so flat and extended in its response it eliminates the need for separate expensive AC VTVM's + or - db from 20 cycles to 2 megacycles. Meter has decibel ranges for direct reading. New zero center on meter scale for quick FM alignment.

There are six complete ranges for each function. Four functions give total of 24 ranges. The 3 Volt range allows 1/3 of the scale for reading one volt as against only 20% of the scale on 5 Volt types. The ranges escalate for quick reading.

New 1/8" ceramic precision are the most accurate commercial resistors available — you find the same make and quality in the laboratory equipment selling for thousands of dollars. The entire voltage divider decade uses these 1/8" resistors.

New 200 microampere 4½" streamliner meter with Simpson quality movement. Five times as sensitive as commonly used 1 MA meters.

Shatterproof plastic meter face for maximum protection. Both AC and DC voltmeter use push-pull electronic voltmeter circuit with burn-out proof meter circuit.

Electronic ohm-milliammeter circuit measures resistance over the amazing range of 1/10 ohm to one billion ohms all with internal 3 Volt battery. Ohmmeter batteries mount on the chassis in snap-in mounting for easy replacement.

Voltage ranges are full scale 3 Volts, 10 Volts, 30 Volts, 100 Volts, 1000 Volts. Complete deadening coverage without pops.

The DC probe is isolated for dynamic measurements. Negligible circuit loading. Gets the accurate reading without disturbing the operation of the instrument under test. Kit comes complete, cabinet, transformer, Simpson meter, test leads, complete assembly and instruction manual. Compare it with all others and you will buy a Heathkit. Model V-1A. Shipping Wt. 8 lbs. Note new low price, $2350.

New 30,000 VOLT DC PROBE KIT

Beautiful new red and black plastic high voltage probe. Increases input resistance to 1,000 megohms, reads 10,000 Volts on 300 Volt range. High input impedance makes it perfect for minimum loading. Good for chokes, transformers, measuring large plastic insulation rings on high voltage equipment. Comes complete with PL55 type plug.

No. 3166 High Voltage Probe Kit

Shipping Wt., 2 pounds

Heathkit RF PROBE KIT

Crystal diode probe for extends range to 250 megacycles - 100 times complete cable and PL55 type plug.

No. 509 RF Probe Kit

Shipping Wt., 3 lbs

$550

YOU SAVE BY ORDERING DIRECT FROM MANUFACTURER—USE ORDER BLANK ON LAST PAGE

The Heath Company

...BENTON HARBOR 20, MICHIGAN

MARCH, 1951
**Healthkit TV ALIGNMENT GENERATOR KIT**

- New simplified circuit for easy calibration and assembly.
- New 2 band built-in marker covers 19 to 75 Mc.
- New dual spider sweep motor for long life.
- New blanking circuit gives base line for better alignment.
- New variable oscillator gives high output fundamentals on high TV band.
- New standby switch keeps instrument ready for instant use.
- New 6 to 1 slow speed drive on both master oscillator and marker tuners.

The new Healthkit TV Alignment Generator incorporates the new developments required for modern TV servicing. An astigmatic marker circuit covering all possible IF bands and even several of the RF bands. The new blanking circuit provides a basic reference line which is invaluable in establishing proper traces. The new sweep motor incorporates dual spindles in the speaker frame assuring better alignment and long life. The mounting of the speaker sweep motor has been simplified for easy alignment.

The variable master oscilator covers 140 to 250 Mc, thus giving high output fundamentals where they are most needed - low band coverage 2.5 Mc to 50 Mc.

A new step attenuator provides excellent control of output. Planetary 6 to 1 drives on both oscillator and marker provides smooth easy control settings. A heavy duty pick-up is provided making the instrument always instantly available.

Horizontal sweep voltage with phase control is provided. No other sweep generator under $100.00 provides all these features - comes complete with instruction manual. Model TV-2.

---

** Heathkit CONDENSER CHECKER KIT**

*Only $19.50*

- Power factor scale.
- Measures resistance.
- Measures leakage.
- Checks paper-mica-electrolytics.
- Shorts-type circuit.
- Points eye indicator.
- 110 V. transformer operated.
- All scales on panel.

Checks all types of condensors over a range of 400010 MFD to 1600 MFD. All 14 readily readable scales that are read directly from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condensor checker has more uses and saving voltages for 20 to 500 Volts provided. Measures power factor of electrolytics between 0.4 and 1.0. Power factor and leakage resistance is measured and the magic eye tube cabinet calibrated against 5000 V. The most complete condensor checker for the service man. Complete selection of tube types - blank for future types. Complete set of sockets for all types of condensors and blank for future types. Complete set of sockets for all types of condensors and blank for future types. Complete set of sockets for all types of condensors and blank for future types.

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** Heathkit TUBE CHECKER KIT**

- Sockets for every modern tube - blank for new types.
- Gear driven roller chart gives instant setup for all types.
- Tests each element separately for open or short and quality.
- Beautiful 3 color meter - reads good-bad and line point.

Rugged counter type birch cabinet.

Test your tubes the modern way - dynamically - the simplest yet fastest and surest method - your Heathkit has a switch for each tube element and measures that element - no chance for open or shorted elements slipping by, all the advantages of the modern condenser tube without the same cumbersome time consuming setup.

Your Healthkit Tube Checker has all the features: a beautiful 3 color BAD-GOOD meter - complete selection of voltages - roller chart listing hundreds of tubes including the new 9 pin minatures - tube quality Centrallab lever switching element - high grade birch counter type cabinet - continuously variable line adjust control - every feature you need to sell tubes properly. The most modern type tube checker with complete protection against overload. The best of parts - rugged oversize 110 V. 60 cycle power transformer - frame of Mahogany and Centrallab switches and controls, complete set of sockets for all types of tubes with blank for future types. Full action brass gear driven roller chart quickly locates the setting for any type tube. Simplified switching can necessary testing time to minimum and saves valuable service time. Store open element check. Simple method allows instant setup of new tube types without waiting for factory data. No matter what the arrangement of tube elements, the Heathkit fuses the switching arrangement easily handles it. Order your Healthkit Tube Checker Kit today. See for yourself that Heath just saved you thousands and yet retains all the quality - this tube checker will pay for itself in a few weeks - better assemble it now. Complete with instructions - pictorial diagrams - all parts - cabinet - ready to wire up and operate. Model TC-1 Shipping Wt., 7 lbs.

---

** Heathkit SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT**

*Only $19.50*

- High sensitivity.
- Complete set of speaker impedances.
- Tests microphones and PA systems.
- Tests both single and push-pull speaker circuits.

The popular Heathkit signal tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer sensitive parts - no sparkles - saves valuable service time - gives greater TV pleasure. The test speaker has aversion of switching ranges to pick-up, PA systems - comes complete - cabinet, 110 V. 60 cycle for assembly and use. Model TS-2. Shipping Wt., 8 lbs.

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**YOU SAVE BY ORDERING DIRECT FROM MANUFACTURER—USE ORDER BLANK ON LAST PAGE**

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**The Heath Company**

... BENTON HARBOR 20, MICHIGAN

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**RADIO-ELECTRONICS** for
NEW 1951
Heathkit
SIGNAL GENERATOR KIT

Features

- Sine wave audio modulation.
- Extended range 160 Kc to 50 megacycles fundamentals.
- New step attenuator output.
- New miniature HF tubes.
- Transformer operated for safety.
- Calibrated harmonics to 150 megacycles.
- New external modulation switch.
- 4 to 5 vernier tuning for accurate settings.

A completely new Heathkit Signal Generator Kit. Dozens of improvements. The range on fundamentals has been extended to over 50 megacycles, makes this Heathkit ideal as a marker oscillator for TV. New step attenuator gives controlled outputs from very low values to high output. A continuously variable control is used with each step. New miniature HF tubes are required for the high frequencies covered.

Uses 6G4 master oscillator and 6C4 sine wave audio oscillator. The set is transformer operated and a bulky selenium rectifier is used in the power supply. The coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for safety testing of receivers.

A best buy — think of all the features for less than $20.00. The entire coil and tuning assembly are assembled on a separate card for quick assembly — comes complete — all tubes — cabinet — test leads — every part. The instruction manual has step-by-step instructions and pictorials. It’s easy and fun to build a Heathkit Model 6G-6 Signal Generator. Shipping Wt., 7 lbs.

$19.50

THE NEW Heathkit
HANDITESTER KIT

Features

- Beautiful streamline Bakelite case.
- AC and DC ranges to 5,000 Volts.
- 1% precision ceramic resistors.
- Convenient thumb type adjust control.
- 400 microampere meter movement.
- Quality Bradley AC rectifier.
- Multiplying type ohms ranges.
- All the convenient ranges 10-30-100-1,000-5,000 Volts.
- Large quality 2 built-in meter.


$13.50

NEW Heathkit
BATTERY ELIMINATOR KIT

Features

- Provides variable DC voltage for all checks.
- Voltmeter for accurate check.
- Has 400 MFD Mallory filter for ripple-free voltage.

Even the smallest shop can afford the Heathkit Battery Eliminator Kit. A few auto radio repair jobs will pay for it. It’s fast for service; the voltage can be lowered to 6 and sticky vibrators or raised to ferret out intermittents. Provides variable DC voltage 5 to 71/2 Volts at 10 Amperes continuous or 15 Amperes intermittent. Also serves as storage battery charger. Ideal for all auto radio testing and demonstrating.

$22.50

THE HEATH COMPANY
... BENTON HARBOR 20, MICHIGAN

MARCH, 1951
HEALTHKIT IMPEDANCE BRIDGE AS STANDARD

Features
- Measures inductance 10 microhenries to 100 henries
- Measures resistance 01 ohms to 16 megohms
- Measures capacitance .0001 MFD to 100 MFD
- Measures "Q" and power factor.

Measures inductance from 0.1 microhenries to 100 henries, capacitance from .0001 MFD to 100 MFD. Resistance from 0.1 ohms to 10 megohms. Dissipation factor from .001 to 5 "Q", from 1 to 1000. Ideal for schools, laboratories, service shops, serious experimenters. An impedance bridge for everyone — the most useful instrument of all, which heretofore has been out of the price range of serious experimenters and service shops. Now at the lowest price possible. General Radio main calibrated control. General Radio 1,000 cycle hummer. Mallory ceramic switch with 60 degree indexing — 200 microamp type binding posts with standard 3/8" centers. Beautiful birch cabinet. Directly calibrated "Q" and dissipation factor scales. Ready calibrated capacity and inductance standard of Silver Mica, accurate to 1/2 of 1% and with dissipation factors of less than 50 parts in one million. Provision on panel for external generator and detector. Measure all your unknowns the way laboratories do — with a bridge for accuracy and speed.


$695.00

HUNDREDS OF LABORATORIES USE

NEW HEALTHKIT LABORATORY

RESISTANCE DECADE KIT

Features
- 1/96 Accuracy
- Birch Cabinet
- Ceramic Switches
- Covers 01 ohms to 99,999 ohms

The new Heathkit Resistance Decade Kit is a hand tool for laboratory, school and service shop. Ideal for test setups, calibrating instruments, bridge measurements, selecting multipliers, etc.

$19.50

NEW HEALTHKIT LABORATORY

POWER SUPPLY KIT

Features
- Supplies 6.3 V AC or 4.5 Amps.
- Heavy duty construction.
- Ready for schools, labs., and service shops.
- Supplies variable DC 50-200 Volts.
- Shows voltage or current on 3½" meter.

This new Heathkit Variable Power Supply Kit fulfills hundreds of needs — use it for experimental circuits — no need to build a separate power supply circuit — use it for a new voltage to determine proper coefficients in unknown circuits — calibrate instruments with its variable voltages, etc. This new Heathkit supplies 50 to 100 Volts continuously variable DC together with an AC filament voltage of 6.3 Volts at 4.5 Amperes. A built-in 1½" 1/2" 515" meters has proper shunts to read 0-500 Volts and 0-500 Microamps. The circuit uses a SY's rectifier, two 1619 tubes as electronic control. Has instruction manual for assembly and use. Model PS-1.

$29.50

NEW LABORATORY INSTRUMENT KITS

HEALTHKIT RECEIVER & TUNER KITS FOR AM AND FM

TWO HIGH QUALITY HEALTHKIT SUPERHETERODYNE RECEIVER KITS

Model BR-1 Broadcas Model Kit covers 550 to 1600 KC. Shipping Wt., 10 pounds.

$19.50

Model AR-1 3 Band Receiver Kit covers 550 KC. to over 35 Mc. continuous. Extremely high sensitivity. Shipping Wt., 10 lbs.

$23.50

Truth FM FROM Healthkit FM TUNER KIT

Model FM-2 was designed for best possible reception. The circuit incorporates the most desirable FM features — true FM — ready wound and adjustable coils — 3 stages of 10.7 Mc. L.F. (including limiter).

Model FM-2. $22.50

Tube lineup: 7557 oscillator, 6SH7 mixer, two 6SH7 I.F. stages, 6U87 limiter, two 7C4 grids as discriminator, G0X rectifier. The instrument is transformer operated making it safe for connection to any type receiver or amplifier. The R.F. coil is ready wound and mounted on the tuning condenser and the condenser is adjustable — no R.F. coil to wind or adjust.

A calibrated six inch slide rule dial has a carrier drive for easy tuning. The finest parts are provided with all tubes, punched and formed chassis, transformer and complete construction manual. Model FM-2. Shipping Wt., 10 lbs.

THE HEATH COMPANY
BENTON HARBOR, MICHIGAN

RADIO-ELECTRONICS
ENJOY MUSIC AT ITS FINEST WITH Heathkit AMPLIFIERS

NEW Heathkit AMPLIFIER KIT

HIGH FIDELITY 20 WATT

**Features**
- Push-pull 6SL6's.
- Full 20 Watts output.
- Fully enclosed chassis.
- Provisions for reluctance pickup compensation steps.
- Cased high fidelity output transformer.
- Treble and bass boost tone controls.
- Full range of output impedences 3.2 ohms to 500 ohms.

**Price**
$21.50

The finest amplifier kit we have ever offered — check the features. This inexpensive amplifier compares favorably with instruments costing five times as much. Nothing has been spared to provide the best reproduction — an ideal amplifier for the new Heathkit FM Tuner listed below.

Dual tone controls for control of both treble and bass. Bass control is of the boot type for maximum listening pleasure. Optional preamplifier stage for use with G.E. pickup microphone or microphone. Uses inverse feedback to give excellent response over entire range. Tube lineup: 6SL7 preamplifier stage, 6SL7 phase splitter stage, two 6SL6's in push-pull and 5Y3 rectifier. (6SL7 as optional compensation stage).

Uses highest quality Chicago Transformer Corporation cased output transformer with taps of 3, 5, 15, 60 and 300 ohms to match any speaker combination. Power transformer is conservatively rated for continuous operation in sound systems. Tone control gives maximum bass boost of 6 db at 70 cycles. Amplifier has maximum gain of 75 db. Response within 3 db to 20,000 cycles. Shipping Wt., 17 lbs. Complete with all parts, tubes and instruction manual.

Model A-5A Amplifier with preamplifier for G.E. cartridges or microphone $23.50
12" 20 Watt Speaker, No. 326 7.50

Heathkit RECEIVERS and TUNER CABINETS

Blonde birch veneer cabinet for either the receivers or tuner. Modern styling is an asset in any room. 5" speaker fits in end of cabinet when used with receivers. Size, 7 x 13 1/2 x 8 1/4 inches. Shipping Wt., 5 lbs.

Order No. 350 for FM tuner.

Metal professional type communications receiver cabinet. Finished in deep grey to fit the panel supplied with Heathkit BR-1 and AR-1 Receivers (panel shown not included with cabinet). 3" speaker mounts in end of cabinet. Gives professional appearance to Heathkit receivers. Size 7 x 14 x 7 1/4 inches. Shipping Wt., 6 lbs.

Order No. 345 for either receiver.

5" Permafoam Speaker for either cabinet for use with either Heathkit Receivers. No. 320 5" Speaker...

$2.75

No. 335 Cabinet for receivers only.

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<td>Heathkit Oscilloscope Kit — Model O-6</td>
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<td>Heathkit T.V. Alignment Gen. Kit — TS-2</td>
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<td>Heathkit FM Tuner Kit — FM-2</td>
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On Parcel Post Orders, include postage for weight shown and insurance. (We insure all shipments.)

On Express Orders, do not include transportation charges — they will be collected by the Express Agency at time of delivery.

Enclosed find [ ] Check [ ] Money Order for ___________.

Please ship C.O.D. [ ] Postage enclosed for _________ lbs.

7-a HEATH COMPANY
BENTON HARBOR 20, MICHIGAN

MARCH, 1951
New Tubes of the Month

An important advance in television picture tube design is a 17-inch rectangular metal kinescope announced by RCA. Its shell can be produced on high-speed automatic machinery to reduce production costs and it is much less fragile and considerably lighter in weight than similar glass tubes.

Designated as the 17CP4, the new metal tube has a picture area of 14% × 11 inches with slightly curved sides and rounded corners. It has a frosted Filterglass faceplate to reduce stray reflections and increase picture contrast. Electrical characteristics of the tube are similar to those of the 16GP4; it has 16 kv as maximum anode rating; 410 volts maximum on grid No. 2; a 6° horizontal deflection angle; and 100 ma current in the focus coil.

A unique low-cost radiation counter tube, the CK1026, has been announced by Raytheon. The tube has its cathode on the outside of the glass shell in the form of an electrically conductive graphite coating called “dag” dispersion No. 154. It operates with 900 volts on the anode, and the glass shell acts like a high resistance in series with the tube. Maximum counting rate is 10,000 counts per minute and its total life is greater than 10⁷ counts. The tube is designed for detecting gamma radiation in prospecting equipment.

G-E has a new thyatron, the GL-5855, for general control circuit operation over a wide temperature range. Its maximum ratings are: peak anode voltage, 1500; cathode current, peak 150 amp; average 12.5 amp; negative control-grid voltage, 250 volts before conduction and 10 volts during conduction.

The new outside-cathode counter tube, the GI-5855, is a 17-inch rectangular metal kinescope with a frosted Filterglass faceplate. It is much less fragile and considerably lighter in weight than similar glass tubes. The tube has a picture area of 14% × 11 inches with slightly curved sides and rounded corners. It has a frosted Filterglass faceplate to reduce stray reflections and increase picture contrast. Electrical characteristics of the tube are similar to those of the 16GP4; it has 16 kv as maximum anode rating; 410 volts maximum on grid No. 2; a 6° horizontal deflection angle; and 100 ma current in the focus coil.

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DYNAMIC NEUTRALIZATION OF CLASS C AMPLIFIERS

By MARVIN H. KRONENBERG, W2IU

The need for neutralization is one of the disadvantages of using triodes and pentodes, which yielded tetrodes as r.f. amplifiers in transmitters. The usual procedure for neutralizing an amplifier is to remove its plate-supply voltage and apply normal r.f. grid drive. Set the neutralizing capacitor or capacitors so grid current is constant and there is no indication of r.f. in the plate tank when the plate tuning capacitor is tuned through resonance. Although this method takes considerable time, it is satisfactory when performed correctly on an amplifier which is operating properly. A considerably faster and more accurate neutralization method is used by many commercial operators. This operation, which may best be described as dynamic neutralization, is carried out while the amplifier is operating with normal load and plate voltage.

As most amateurs and commercial operators have noticed, the maximum grid current and minimum plate current (resonant peaks) occur at the same setting of the plate tank capacitor when the amplifier is fully neutralized. All too often, this does not happen when the rig is neutralized using the method just described. Instead, the grid current may peak when the plate circuit is tuned slightly above or below resonance. It is possible to tell if there is too much or too little neutralizing capacitance by noting whether the peak occurs on the lower or higher-capacitance side of the plate circuit resonance. The procedure for dynamic neutralization is based on these observations.

Follow these rules when neutralizing any r.f. amplifier by the dynamic method:
1. Set the neutralizing capacitors to a reasonable value. If the amplifier has been neutralized previously, the approximate settings will be known. Otherwise it may be necessary to determine the approximate settings by the usual neutralizing method.
2. Apply normal excitation, then turn on the plate supply and adjust the plate load to normal. Carefully tune the plate circuit on both sides of resonance and note the grid current. (a) If the grid-current maximum coincides with plate-current minimum leave it alone. The stage is fully neutralized. (b) If the grid current peaks on the low-capacitance side of plate-circuit resonance, more neutralizing capacitance is needed. (c) Reduce the neutralizing capacitance when the grid current peaks on the high-capacitance side of resonance.

Only a few trial settings are required to reach perfect neutralization as indicated by maximum grid current and minimum plate current occurring at the same setting of the plate tuning capacitor. Any amplifier neutralized by this method will pass any test for neutralization, fiers in observations.

... MAKES IT EASY TO REALLY UNDERSTAND TODAY'S RADIO & TV CIRCUITS!

Untold thousands of men now in electronics got their start from A. A. Ghirardi's world-famous "Radio Physics Course" and "Modern Radio Servicing" books. Now comes this great new book, RADIO AND TELEVISION RECEIVER CIRCUITRY AND OPERATION so all a long felt need by getting right down to earth in helping you really understand every detail of the design and circuit fundamentals of present day equipment. Actually, there are only a few really basic circuits in radio and TV receivers. Learn these from A to Z and even the most complicated of the countless modern circuit variations won't bother you. You'll work faster, better—and a lot more profitably!

Do You Know?

Why is a high-transducerance, low-capacitance tube best for TV and FM receiver r.f. amplifiers? How is a grounded-grid r.f. amplifier connected? Why is this circuit so popular in TV? What is a "squish" system? How many types of discriminators are used in FM receivers, and what are their circuits. Such are just a few of thousands of questions answered in this great book.

Here are the basic circuit and design fundamentals covered:
- Amplitude Modulation and AM Signals
- Frequency Modulation and FM Signals
- RF Amplifiers and TRF Receivers
- AM Superheterodyne Receivers
- AM Detectors and AFC Systems
- FM Receivers
- Pushbutton Tuning and AFC Systems
- Audio Frequency Amplifiers
- Loudspeakers
- Radio Receiver Power Supply Systems
- Television Receivers
- Receiving Antenna Systems
- Home Recorders
- Phone Pickups & Transformers
- Automatic Record Changers
- Mechanical Construction of Receivers, etc.

HELPS YOU HANDLE TOUGH JOBS IN HALF THE USUAL TIME

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Radio and Television Receiver Circuitry and Operation

MARCH, 1951
Yes, the revolutionary new TRIO TV Yagi — the only yagi that provides 10 DB gain on each of two channels — is America’s most wanted antenna in weak signal areas. This lightweight, compact array, which gives metropolitan quality TV reception in fringe areas, is available for channels 4 and 5 in the low band, and channels 7 and 9 in the high band.

OUTSTANDING FEATURES
- Provides gain on both channel 4 and 5 (or 7 and 9).
- Equal to any two conventional 4-element yagis!
- One bay replaces bulky stacked array!
- One lead replaces old-style 2-lead systems!
- Less weight-per-gain than any other TV antenna!
- Greatly reduced installation costs for complete TV coverage!
- Can be stacked for additional gain.

HOW IT WORKS
Antenna consists of 4 elements whose function is different on the two channels. In Model 445, the elements, on Channel 4, act as reflector, dipole, director, in that order. On Channel 5, the same elements act as reflector, reflector, dipole and director. Careful design insures proper impedance match with standard 300ohm lead.

Eliminates Co-Channel Interference - Venetian Blind Effect ... When Used With Trio “Controlled Pattern” System

This unique, “Controlled Pattern” system uses 2 bays, offset stacked and tuned with the remarkable TRIO “Phasedout”. High gain and front to back ratio of the new single or stacked yagi eliminates most co-channel interference.

When the TV receiver is located in the center of several TV stations operating on the same channel, co-channel interference CAN BE COMPLETELY eliminated with the use of the “Controlled Pattern” system.

When other antennas fail, try TRIO — America’s MOST WANTED TV Antenna

Model 445 - Single bay Yagi for Channels 4 and 5.
Model 445-2 - Conventional 2 bay stacked array for Channels 4 and 5.
Model 479 - Single bay Yagi for Channels 7 and 9.
Model 479-2 - Conventional 2 bay stacked array for Channels 7 and 9.
Model 485 - “Controlled Pattern” System for Channels 4 and 5, and Model 679 for Channels 7 and 9.

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Model HIR Tenna-Rotor

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The new TV booster with one simple
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MARCH, 1951
SUPERIOR'S new model 770 AN ACCURATE POCKET-SIZE VOLT- OHM MILLIAMMETER (SENSITIVITY: 1000 OHMS PER VOLT)

FEATURES
★ Compact-measure 3 1/8" x 5 1/2" x 2 1/4".
★ Uses latest design 2% accurate 1 Mil. D'Aromval type meter.
★ Some zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range.
★ Housed in round-cornered, molded case.
★ Beautiful black etched, molded case. Depressed letters filled with permanent white, insure long-life even with constant use.

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

SPECIFICATIONS
6 A.C. VOLTAGE RANGES:
0—15/30/150/100/1500/3000 VOLTS
6 D.C. VOLTAGE RANGES:
0—7.5/15/75/150/750/1500 VOLTS

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

SPECIFICATIONS
D.C. VOLTS: 0 to 7.5/15/75/150/1500/250/1,000/7,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/1500/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/1500/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5 Ampers
RESISTANCE: 0 to 500/100,000 Ohms 0 to 10 Megohms
CAPACITY: 0.001 to 2 Mfd. 0.1 to 4 Mfd. (Quality test for electrolytics)
REACTANCE: 700 to 27,000 Ohms 13,000 Ohms to 3 Megohms
INDUCTANCE: 1.75 to 70 Henries 35 to 8000 Henries
DECIBELS: —10 to +18 +10 to +38 +30 to +58

20,000 OHMS PER VOLT MULTI-METER
AND TELEVISION KILOVOLTMETER

The Model TV-20 was designed to provide all the multi-meter measurement requirements of A.M., F.M. and Television. Unlike other recent models, which are actually standard V.O.M.'s converted to test the new Television Voltages, the Model TV-20 is a completely new unit. It provides the sensitivity, ranges and accessories which are needed to service F.M. and Television in addition to A.M. Radio. The High Voltage Probe for example, with a range of 50,000 volts and designed to withstand 100,000 volts, is an integral part of the instrument with a special compartment for housing it when not in use.

SPECIFICATIONS
★ 9 D.C. VOLTAGE RANGES: (at 20,000 ohms per Volt)
0.5/1.5/3/6/10/20/50/200/2000/10,000 Volts
★ 8 A.C. VOLTAGE RANGES: (A 1,000 ohms per Volt)
0.5/1.5/3/6/10/20/50/200/2000/10,000 Volts
★ 5 D.C. CURRENT RANGES
0.15 micromamps
0.5/5/50/500 Milliamperes
5 Amps
★ 4 RESISTANCE RANGES:
0.1/1/10/100/1000/10,000/20,000 Megohms
★ 7 D.B. RANGES: (All D.B. ranges based on ODb = 1 Mv. into a 600 ohm line)
— 5 to +10 db +10 to +20 db +20 to +30 db +30 to +40 db +40 to +50 db +50 to +60 db +60 to +70 db +70 to +80 db +80 to +90 db +90 to +100 db +100 to +110 db +110 to +120 db
★ 7 GUARD VOLTAGE RANGES:
0 to 15/30/105/250/500/1000/1000 Volts

The Model TV-20 includes an Ultra High Frequency Voltmeter Probe. A Silicon V. H. F. Diode together with a resistance capacity network provides a frequency range up to 1,000 MEGACYCLES. When plugged into the Model TV-20's V. H. Probe converts the unit into a Negative Peak-Reading V. H. F. Voltmeter which will measure gain and loss in all circuits including F. M. and T. V. Check capacity and impedance; test efficiency of all oscillator circuits; measure bandwidth of F.M. and T. V.; etc.

ADDED FEATURE: The Model TV-20 includes an Ultra High Frequency Voltmeter Probe. A Silicon V. H. F. Diode together with a resistance capacity network provides a frequency range up to 1,000 MEGACYCLES. When plugged into the Model TV-20's V. H. Probe converts the unit into a Negative Peak-Reading V. H. F. Voltmeter which will measure gain and loss in all circuits including F. M. and T. V. Check capacity and impedance; test efficiency of all oscillator circuits; measure bandwidth of F. M. and T. V.; etc.


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TUBE TESTER

SPECIFICATIONS:

- Tests all tubes including 6, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing-aid, Thyratron, Miniatures, Sub-Miniatures, Novals, etc. Will also test Pilot Lights.
- Tests by the well-established emission method for tube quality, directly read on the scale of the meter.
- Tests for "shorts" and "Leakages" up to 5 Megohms.
- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the BMA base numbering system, the user can instantly identify which element is under test.
- Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-10 as any of the pins may be placed in the neutral position when necessary.
- The Model TV-10 does not use any combination type sockets. Separate individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
- Free-moving built-in roll chart provides complete data for all tubes.
- Newly designed Line Voltage Control compensates for variation of any line voltage between 105 Volts and 130 Volts.

The Model TV-10 operates on 105-130 Volts 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover. $3950 NET

AM and FM SIGNAL GENERATOR

SPECIFICATIONS

- R.F. FREQUENCY RANGES: 100 Kilocycles to 150 Megacycles.
- MODULATING FREQUENCY: 400 Cycles. May be used for modulating the R.F. signal. Also available separately.
- ATTENUATION: The constant impedance attenuator is isolated from the oscillating circuit by the buffer tube. Output impedance of this model is only 100 ohms. This low impedance reduces losses in the output cable.
- OSCILLATORY CIRCUIT: Hartley oscillator with cathode follower buffer tube. Frequency stability is assured by modulating the buffer tube.
- ACCURACY: Use of high-Q permeability tuned coils adjusted against 1/10th of 1% standards assures an accuracy of 1% on all ranges from 100 Kilocycles to 10 Megacycles and an accuracy of 2% on the higher frequencies.
- TUBES USED: 12AU7—One section is used as oscillator and the second is modulated cathode follower. T-2 is used as modulator. G-4 is used as rectifiers.

The Model 200 operates on 110 Volts A.C. Comes complete with output cable and operating instructions. $2185 NET

TELEVISION SIGNAL GENERATOR

ENABLES ALIGNMENT OF TELEVISION I. F. AND FRONT ENDS WITHOUT THE USE OF AN OSCILLOSCOPE!

FEATURES

- Built-in modulator may be used to modulate the R.F. Frequency, also to localize the cause of trouble in the audio circuits of T. V. Receivers.
- Double shielding of oscillatory circuit assures stability and reduces radiation to absolute minimum. Provision made for external modulation by A. F. or R. F. source to provide frequency modulation. All I. F. frequencies and 2 to 13 channel frequencies are calibrated direct in Megacycles on the Yenrier dial. Markers for the Video and Audio carriers within their respective channels are also calibrated on the dial.
- Linear calibrations throughout are achieved by the use of a Straight Line Frequency Variable Condenser together with a permeability trimmed coil.
- Stability assured by cathode follower buffer tube and double shielding of component parts.

SPECIFICATIONS


Audio Modulating Frequency: 400 cycles [Sine Wave]. Attenuator: 4 position, ladder type with constant impedance control for fine adjustment. Tubes Used: G-4 as Cathode follower and modulator, buffer, 6G as R. F. Oscillator, 6SN7 as Audio Oscillator and power rectifier.

Model TV-30 comes complete with shielded co-axial lead and all operating instructions. Measure 9" x 7" x 9". Shipping Weight 10 lbs. $99.95 NET

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**WIDE-BAND AMPLIFIER EXTENDS SCOPE RANGE**

A wide-range a.f. oscillator can be used to adjust the compensating capacitors in the attenuator. Feed in a signal around 20 cycles and measure the deflection on the scope. Measure the voltage at the input to the attenuator. Change the oscillator to around 20,000 cycles and adjust its output to the same voltage level as the low-frequency signal. Adjust the capacitor so the deflection on the scope is the same for the high- and low-frequency signals. Use this procedure for each capacitor. When the adjustment is made, the calibration will hold for all frequencies.

If the cathode of the C-R tube is grounded or near ground potential, C1 and C2 should be rated at 2,000 volts or more. When the cathode is returned to a high negative voltage, C1 and C2 may be rated at 600 volts.

Use noninductive 10-watt resistors in the plate leads of the push-pull 6AG7's.

**COIL DATA FOR COMMUNICATIONS RECEIVER**

To build the communications receiver described in the June, 1950, issue. Being in Brazil, I am not able to purchase the BC-153 and BC-154 receivers which supply some of the hard-to-get components. Can you recommend substitutes or tell me how I can make my own coils for L11, L12, L13, and L14? Where is the tap placed on L6?

E. D. S., Rio de Janeiro

L11 and L12 are antenna and r.f. coils respectively for the 5-mc tuner. L11 and the secondary of L12 may be 12 turns of No. 24 enamelled wire wound around the ground end of the secondary.

L13 may be a standard broadcast oscillator coil shunted with a 300-µf trimmer to tune it to 1340 kc. L14 may be a Miller type 212-M5 or 612-M5 132-kc b.f.o. transformer with enough capacitance lumped across it to tune to 85 kc. If these transformers are used, the b.f.o. must be changed to the electron-coupled type. You can use a 4-pie, 5-mh r.f. choke as a substitute for L14 in the original circuit. Break the lead between the second and third pies. Two pies can be shunted with a .001-µf fixed capacitor and a 500-µf variable capacitor to adjust the circuit to 85 kc. The remaining pies are connected to the grid circuit. It may be necessary to reverse the connections to the grid winding to make the circuit oscillate.

Let in the attenuator at approximately the sixth turn from the ground end. If you wish to experiment with the circuit, set the tap at a point which gives least variation in grid current over the tuning range.

**AMPLIFIER AND POWER SUPPLY FOR 2-TUBER**

I have had good results with the two-tube receiver shown on page 84 of the January, 1949, issue, as well as with a number of crystal sets. I would like to construct a small unit to use as a power amplifier for the crystal sets and a combination power supply and amplifier for the two-tuber. I want to use an 117L7 as power amplifier and rectifier if possible.—K. E. McG., Toronto, Ont.

The circuit is shown. If you want to
incorporate the unit in the two-tube set, replace the 1T4 a.f. amplifier in the two-tuber with this 1US or 16S in the circuit. The 117L7 is the power amplifier and B-supply. The 1BR4 (Mallory) rectifier supplies A-voltage for up to five 50-ma tubes. Adjust the 5-ohm resistor to deliver 1.4 volts under load and set the tap on the 15,000-ohm voltage divider to deliver the desired B-

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MODIFYING G-E PREAMP

G-E recommends 6,800 to 15,000 ohms as the input resistor in preamplifiers for variable-reluctance pickups. While increasing the high-frequency response, the higher value reproduces scratch on old records. I have replaced this fixed resistor with a 10,000-ohm potentiometer connected as shown. This control can be adjusted to suppress scratch on old records or reduce the boosted highs on high-fidelity recordings. —Albert L. Sohl

ARC-5 CONVERSION

Some hams use ARC-5 and SCR-274-N command transmitters on two bands by switching out the ganged potentiometer tuning capacitor and using the paddler to tune the plate circuit to the second harmonic of the oscillator. The slotted shaft on the paddler is hard to get at.

A fellow ham developed this simple method of coupling an extension shaft to the paddler: A 3- or 4-inch piece of 1/4-inch shafting is tapered at one end so it fits into the end of the slotted capacitor shaft. Insert this end of the shaft through the hole provided for screwdriver adjustments then slip a 1/4-inch coupling over it. Force the shaft into the slot, then slide the coupling against the transmitter wall and tighten it so the wall is forced slightly outward. The springiness in the wall holds the shaft in the slot. Place a knob on the shaft to complete the job. The drawing shows this modification. —Wm. Muesing, Jr., W7OKH

COOLING A TV SET

Before I worked out this method of cooling it, my TV set would get very warm after operating for a couple of hours. A replacement phonograph motor was purchased and fitted with a 4-inch fan. I cut the bottom out of a 5-pound syrup can and mounted the motor in it. Small angle brackets were used to fasten the assembly to the perforated back of the set. With the motor leads connected across the primary of the power transformer, the fan draws out the warm air and set runs cool. —Melvin Youngman

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The new 1951 TV manual is the most remarkable value offered by Supreme Publications in the 17 years of their fine television servicing manual at only $3, or the TV manuals for previous years for only $5 and $2 each, are amazing bargains and defy competition. There is nothing else like them. Each manual is a virtual treatise on practical television repairs. By normal standards, the whole series is a giant bargain. Here is practical facts, hundreds of illustrations, diagrams, charts, photographs, and expensive extra-large blueprints, should sell for $10—but as SUPREME special values they are priced at $3 and $2 each. Only a publisher who sold over one million TV and radio manuals can offer such bargains based on tremendous volume-sales.

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MARCH, 1951

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79
SAVING APPLIANCE CORDS
Soldering irons, electric Toasters, irons, and hair dryers often have a heavy spring to protect the line cord at the point where it enters the body of the appliance in question. After some time, the insulation of the cord begins to wear at the point where it enters the coil spring. As soon as the wear is visible, stretch the spring until the worn spot in the insulation is well within the coils. This can be done several times before it becomes necessary to replace the cord.—Carl Lane

IMPROVING FRIDGE PICKUP
TV or FM installations at some distance from the transmitter are often on the fringe of good reception where precise tuning of the antenna system will increase the signal enough to make it usable. Frequently this is inconvenient or difficult. A simple method of tuning which may produce satisfactory results is to wrap a piece of tin foil around the lead-in—this idea applies only to ribbon lines—and adjust its size and position for best performance. Fasten it permanently in place with cement or Scotch tape. In television fringe installations it is usually desirable to have several individually tuned antennas rather than to try to make one work for all stations.—Gray Trembly

INTERMITTENT HEATER CHECKER
Intermittent heaters in a.c.-d.c. sets are hard to locate and have caused many service technicians to waste lots of time hunting for them. This little gadget will enable you to locate intermittent heaters in a comparatively short time.

It consists of one tube socket for each type of tube base and heater connections. The filament or heater terminals are wired in series with a 117-volt lamp. A 25-watt size will do the job for testing most tubes used in a.c.-d.c. sets. Check the wattage of the lamp to be sure that the drop across the tube will not exceed its normal voltage rating.

The lamp will remain lighted as long as there is continuity through the tube socket. An intermittent heater will cause the lamp to go off and on or flicker.—Robert C. Sanford

EXTENDING BATTERY LEADS
Servicing farm and portable battery radios can be hard on your nerves when the batteries are connected to the chassis through a short cable which does not permit them to be moved out of your way. Avoid this trouble by making 2-, 3-, or even 4-foot extension leads for the batteries most commonly used. Remove the screw or receptacle from an old battery. Mount it on one end of the extension cable and a male battery plug on the other. This makes it easy to shove the batteries to one side where they won't crowd the working area. Male and female snap-on connectors are used to make leads for batteries used in personal portables.—H. A. Blake
FIXED BIAS SUPPLY

Hearing-aid batteries are a handy source of bias voltage for audio amplifiers. I find that they weigh less and require much less space than the line-operated supplies they replace. Because of their low internal resistance, voltage regulation is just about perfect for all practical purposes.

They are available in 15-, 22.5-, 30-, 33-, and 45-volt sizes which make it possible to use one or more to come within 5 to 10% of the required grid voltage. Their life is long, particularly in circuits which do not draw grid current. Always mount batteries in the easiest part of the chassis because heat considerably shortens their useful life.

—M. Ort

MARKING METAL PANELS

It is easy to make attractive, permanent, legible labels on aluminum, galvanized iron, copper, and other bright metals. Remove dirt and grease from the surface with carbon tetrachloride, then use a medium pen and a good grade of India ink for the markings. Take your time and make the lettering as neat as possible. You will be proud of the job when it’s finished. When the ink is dry, apply a thin coat of lacquer or clear nail polish to preserve the lettering.

It is a good idea to mark the tube number next to the socket on all your equipment. This makes trouble-shooting easier and you can be sure of returning the tubes to the correct sockets when you remove them for testing.—Frank J. Lutz, Jr.

SPOTTING PA MICROPHONES

The public-address or remote broadcast operator frequently encounters a setup in which he must control the levels of a number of mike’s, and pick-ups, and other devices. While the same situation exists in the studio, even an excellent operator occasionally cuts in the wrong mike on a remote job, because he is not familiar with the controls and mike locations in the temporary layout. Embarrassment may be prevented and a smoother program will result if each mike or other source is positively identified with its respective gain control.

Place a small dot of colored paint on or near each gain-control knob, a different color being used for each control. Each mike, pickup, etc., is marked with a color matching that of its control. The color labels should be temporary so that each new layout can be “tailored” to suit the circumstances.

An excellent material for such labeling is colored cellulose tape, which may be purchased in most office-supply stores. A strip of tape of the proper color wrapped around a mike stand, or a small square of tape stuck on the top of a phone pickup will be easily visible in a hurry.

Such a marking system is also convenient in similar fields, such as stage lighting, sound effects, experimental electronic work, and others requiring rapid association of controls.—Richard H. Houston

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VARIABLE COUPLING FOR IRON-CORE TRANSFORMER

Patent No. 2,519,426
Dwight W. Grant, Bloomfield, N. J.
(Assigned to Bell Telephone Labs., Inc.)

This method provides a variation of transformer coupling from maximum to zero as desired, with no moving parts. The degree of coupling depends upon how much of the primary flux is permitted to link the secondary. Linkage is controlled by a current through a coil which biases or saturates part of the core and governs the linkage flux. The invention has possibilities as a magnetic amplifier or as a transformer of the variable type.

Fig. 1—Diagram of the transformer.

One form of the new transformer is shown in Fig. 1. Two a.c. coils are used, of which either one may be chosen as primary. Power is then available from the other a.c. coil. One coil is split in equal parts, B and E. The other is wound over the vertical leg G. These coils can be coupled only by flux linking them through the core.

The control coil has two equally spaced windings, G and H. They are wound in opposite directions and are energized by d.c.

Fig. 2a shows flux conditions with no d.c. input to the control coil. In this figure BR is used as the primary. Each half of it, B and E, generates the same amount of flux. At a certain instant the left half generates flux along DAB and down through C. The right half of this coil generates flux through G and H in parallel, then along F and up through C. There is no resultant flux through C because the two fields in it are equal and opposite. Coupling between primary and secondary is zero.

Fig. 2b shows what happens when the control coil is energized. The core legs G and H are magnetically biased. The d.c. flux flows in a closed path and does not enter the remainder of the core. H can accommodate practically no additional flux (from E) without saturating. Flux from E enters G, however, because its direction is opposite to that of G. Because of the limited path, flux generated by E is considerably reduced. This leaves a net downward flux through G. The a.c. coils now partially coupled.

If the d.c. is increased past the saturation voltage, no primary flux can enter either G or H. The entire primary flux is now generated by E alone. This flux flows downward through C without opposition, and achieves maximum coupling.

This invention thus not only provides a control device that effectively varies the coupling between two a.c. windings, but it also varies the coupling over a very wide range—from zero to maximum possible. Thus the invention might be used as a modulation device, with the modulation voltage applied to the control winding.

Fig. 2—Flux paths in transformer core.

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  Glass 17" Rectangular (Blk.) $42.50, Glass 19" Round (Blk.) $69.50
  Glass 24" Rectangular (Blk.) $77.50

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**NEW PATENTS**

**PHONO PICKUP**

Patent No. 2,522,870  
John W. Hammond, Towson, Md.  
(Assigned to Bendix Aviation Corp.)

Like other pickups of this type, this improved capacitance pickup has a small vibrating mass (stylus and associated parts) which provides excellent high-frequency response and reduces record wear.

An r.f. oscillator which may be located at a remote point feeds a transformer through a low-impedance line. The transformer secondary is center-tapped and tuned to the oscillator frequency by a small dual capacitor. C1, C2, the center plate of this capacitor is a tiny piece of metal fixed to the stylus, and this plate is normally positioned mid-way between the outer plate. The r.f. voltage therefore divides equally across C1, C2, and equal voltages appear across the latter. The sidesbands are fed to push-pull T1, T2 are at the same potential so there is no output.

When a record is played, the stylus vibrates at an audio rate and carries with it the centering capacitor plate. This plate is alternately displaced first towards one outer plate and then towards the other. For example, at some instant, capacitances C1 and C2 decrease. The r.f. voltage is not varied appreciably but the voltage across C1 is reduced and the voltage across C2 is increased. There is a corresponding change in the rectified voltages across R1, R2. During the next half-cycle of vibration the load voltages vary in the other direction.

Push-pull a.f. is available between T1 and T2. This may be amplified directly without need for an F.M. discriminator as in previous capacitance pickups.

**SINGLE SIDEBAND MODULATOR**

Patent No. 2,507,178  
George L. Uselmann, Port Jefferson, N. Y.  
(Assigned to Radio Corp. of America)

An improved single-sideband transmission system, in which the need for a large number of filters is eliminated, is claimed in this patent. Most single-sideband transmitters require several filters, this system uses only one. One sideband is progressively increased in frequency until it is in the desired band. The other sideband is eliminated without filters.

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New Patents

METER PROTECTION
Patent No. 2,516,755
Groo W. Cowley, Lincoln Park, N. J., and Donald E. Thomas, New York, N. Y. (Assigned to Bell Telephone Labs., Inc.)

This circuit protects sensitive meters against current overload in either direction. A large series resistor R2 limits current during an overload period. When normal conditions are restored this resistor is shorted out.

M is a d.c. instrument. A.C. signals must be rectified. A balancing circuit consisting of the battery and shunt resistor R1 sends a reverse current through M. When the signal is normal, R1 is adjusted for mid-scale meter deflection and the meter can safely indicate within its range above and below normal.
The meter must be protected against overload-
ing currents in either direction. If the signal exceeds a given level up-scale the meter is engi-

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75,000-ohm resistor in series across L1. Set the generator to 200 kc and connect a v.t.v.m. across the coil. Adjust the capacitor for maximum meter reading. The unit should be turned off for this adjustment. Turn on the unit and ad-

The triode section of the 6K8 is a 200-kc crystal oscillator and the hexode section is a 200-kc amplifier which drives the first 6SC7, a 100-kc multivibrator. The second 6SC7 is a 20-kc multivibrator synchronized with the signal from the 100-kc unit. Since the latter is stabilized by the 200-kc crystal, the interval between pulses is constant for the 100- and 20-kc multivibrators.

In the original model, L1 and L2 were tuned to 200 kc by varying the positions of the tuning slugs. Construction of the calibrator may be simplified by replacing L1 and L2 with 2.5-mh chokes or other suitable inductors and tuning them with 300-μf paddles.

The oscillator circuit L1 is adjusted by connecting a signal generator and a just the tuning of the amplifier plate circuit for maximum voltage across L2. If a v.t.v.m. is not handy, make both adjustments with the calibrator on. Touch a small neon lamp to the plate terminals and adjust for maximum brightness, or insert a milliammeter at A and B successively and adjust for minimum plate current.

Connect the calibrator to the antenna post of a receiver and check the 100-kc beat against WWV or a broadcast station on 60 kc or any even-hundred frequency. Adjust the 50-μf variable capacitor in the crystal circuit for zero beat between the marker and the standard.

Set the INTERVAL switch to 20 kc and adjust R1 so there are four beats—20 kc apart—between the 100-kc markers.

SWEEP GENERATOR FOR SMALL OSCILLOSCOPE

A novel hard-tube sweep generator which doubles as a horizontal amplifier is used in the Philco model 7019 2-inch oscilloscope. In this circuit, the 6J6 is connected as a variable-frequency multivibrator adjustable from 10 cycles to 50 kc per second.

The oscillator can be synchronized with an external signal, with the signal being applied to the vertical plates, or with the 60-cycle line; depending on the position of the FUNCTION switch. When this switch is in the HORIZONTAL position, one half of the 6J6 is inoperative and the other operates as a straight amplifier. Horizontal or synchronizing voltages are applied to the HORIZ-SYNC input terminals.
PROTECTIVE RELAY CIRCUIT

I had lots of trouble keeping filter, decoupling, and bypass capacitors in my amplifier and tuners which operate from a common 400-volt power supply. The rectifier tube reached operating temperature long before the cathodes of the other tubes. During the interval when the other tubes were not drawing current the rectifier was without a load and its output voltage was high enough to blow capacitors rated for normal operating voltages. A slow-heating rectifier wouldn't handle the load.

The relay-controlled time-delay circuit was developed to protect the capacitors against higher-than-normal voltages. A type 56 tube was connected as a rectifier on the 70-volt bias tap of the power transformer. Its load is an 8,000-ohm normally open relay with its contacts between the transformer center-tap and ground. A 0.56-ohm resistor is inserted in series with the 2.5-volt filament transformer to drop the voltage so the 56 does not conduct and close its relay until the slow-heating tubes in the tuner and amplifier have reached operating temperature.

A second relay, RY2 in the diagram, was added to eliminate the speaker thump produced when the first one closed. The 8,000-ohm coil of this relay was connected across the B-supply through a resistor of 100,000 to 150,000 ohms, and its normally closed contacts were connected across the voice coil on the speaker. When this relay is energized the short circuit is removed from the voice coil. The series resistor is adjusted so the relay does not close until the output tubes are drawing current.

M. W. Harvey

SMALL BATTERY RADIO

We don't claim that this set has high gain, good selectivity, etc., but it will provide lots of fun for beginners and experts alike. You can use almost any diode-triode that you like as long as you supply the necessary filament voltage. We used a 75 because it happened to be handy.

The tuning capacitor is a single-section job having a range of 11.2 to 381 μf. Almost any single-section broadcast tuning capacitor will work.
Ralph J. Cordiner was elected president of the General Electric Company to succeed Charles E. Wilson who was appointed chairman of the Defense Mobilization Board by President Truman. Mr. Cordiner has served with the General Electric Company for 24 years. He had been executive vice-president and a director of the company since 1949.

Mr. Cordiner began his career in the electrical industry in Walla Walla, Wash., where he worked his way through Whitman College by selling electrical appliances for the Pacific Power and Light Company on a part-time basis. A year after graduating with high honors, he was offered a position with the Edison General Electric Appliance Company, which in 1932 was consolidated with General Electric's Appliance and Merchandise Department at Bridgeport. After a series of promotions, he succeeded Mr. Wilson as manager of the Appliance and Merchandise Department in 1938. In the post war years, Mr. Cordiner has been closely associated with the retiring president in planning the present organizational structure of G-E.

Julius Haber, former advertising and sales promotion manager of the RCA Tube Department, was appointed director of advertising and sales promotion for RCA technical products. In his new activities he co-ordinates the advertising and sales promotional functions of all RCA technical products, comprising those of the tube and engineering products departments. He is attached to the staff of L. W. Teegarden, vice-president in charge of technical products. Mr. Haber has been with RCA since 1922 except for one year when he organized the publicity department for Lord and Thomas, then RCA's advertising agency.

John P. Taylor continues as manager of advertising and promotion for the engineering products department.

Captain David R. Hull, U.S.N. (ret.), assistant manager of the equipment divisions of Raytheon Mfg. Co., was promoted to the post of manager of the department. He was also elected a vice-president of the company. Captain Hull had a distinguished career in the U.S. Navy from 1921 to 1948, specializing in electronics engineering work. He joined Raytheon in May, 1949.

MARCH, 1951
Sylvania Electric Products, Inc., raised four top executives to the post of vice-president. They are: Arthur L. Chapman, general manager of the Radio and Television Division and of the Parts Division; Curtis A. Haines, general manager of Operations of the Radio Tube and Television Picture Tube Divisions; John B. Merrill, general manager of the Tungsten and Chemical Division, and Howard L. Richardson, Director of Industrial Relations.

Frank Marshall, former sales manager of the Manufacturers Division of Aerovox Corp., Bedford, Mass., was appointed director of national sales for Circulator sales of Aerovox and its subsidiary, Electrical Reactance Corp. A. E. Quick, former sales manager of Electrical Reactance, succeeds Mr. Marshall as sales manager of the Aerovox Manufacturers Sales Division. Karl Bretz was promoted from assistant sales manager of the Electrical Reactance Corp. to sales manager. James M. Kramp, former assistant to Mr. Quick was made assistant sales manager. Charles Colenpaal continues to direct Aerovox jobber sales.

Sidney E. Warner joined the Lapontem/Plascomold Corp. in Windsor Locks, Conn. as director of engineering and research. Mr. Warner was formerly partner and chief engineer of the Aircraft Electronic Associates.

Major Ray A. Morris joined L.D.E.A., manufacturers of the Regency Booster, as assistant sales manager. Mr. Morris was formerly a factory representative of Edwin I. Guthman Co., Inc., of Indianapolis. He served in the Signal Corps during World War II and has been in sales and engineering in the electronic field for over twelve years. Gilbert C. Knoblock has been promoted to the position of general sales manager of the Standard Transformer Corporation, Chicago, manufacturers of Stancor transformers, according to an announcement by Joseph H. Kahn, president of the company. Mr. Knoblock has been associated with Standard Transformer for several years as advertising and sales promotion manager. He was formerly with a prominent Chicago advertising agency.

Robert A. Seidel was given the newly created post of vice-president and special assistant to the vice-president and general manager in a reassignment of duties made by the RCA Victor Division. The reassignments were made to assure effective operation under the
Floyd Makstein, field engineering manager at Emerson recommends

Simpson MODEL 480 GENESCOPE

FOR TV-FM SERVICING

This is what Floyd Makstein of Emerson says about the Simpson Model 480 Genescope: "The Simpson Model 480 Genescope far surpasses the standards required in the servicing and aligning of all TV-FM receivers. The wide frequency response and the 25 millivolt sensitivity of the oscilloscope, combined with the required fundamental signal sources which are provided in the AM & FM oscillator sections, simplifies the accurate aligning of all TV receivers, including those with intercarrier systems. In addition, the large, easy-to-read dials, having a 20:1 vernier control and 1000 division logging scale, cut down on servicing time."

Mr. Makstein concludes: "The compactness of the complete unit will be a big factor in many of the service shops where space is at a premium. We are sure that the whole TV industry appreciated your efforts in raising the engineering standard in servicing." Emerson Service personnel know that modern FM and TV development and servicing demand test equipment made to the most exacting standards. They prefer the Simpson Model 480 Genescope because it is the most accurate, flexible and convenient instrument available. The Genescope will render many years of uninterrupted service and always produce accurate results.

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Sweep rate 60 cycles per second
Sweep width variable from zero to 15 megacycles

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Band A: 3.3-15.6 megacycles
Band B: 15-75 megacycles
Band C: 75-250 megacycles
30% modulation at 400 cycles or unmodulated
Continuously variable attenuator
Visual method of beat frequency indication

OSCILLOSCOPE
Vertical sensitivity: 25 mv per inch
Horizontal sensitivity: 70 mv per inch
Linear sweep frequency: 2 cycles to 60 kilocycles
60 cycle sine sweep
Frequency essentially flat to 200 kc, usable to over 3 megacycles

Simpson Model 480 Genescope: size 22" x 14" x 7½". Weight 45 lbs. Shipping weight 54 lbs.
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People

fast changing national economic conditions. Harold M. Winters was made director of consumer products distribution, and H. V. Sommerville was named director of technical products distribution. Administration of the Regional Offices were placed under Charles M. Odorizzi, operating vice-president for the division. Ralston H. Coffin was made director of consumer products advertising and sales promotion.

Personnel Notes

... Robert A. Mueller has been appointed distributor sales manager of the CENTRALAB DIVISION of GLOBE-UNION, INC.
... Neal P. Harmon, former sales engineer in Atlanta, Georgia, has been appointed to the post of civil defense planning co-ordinator of GENERAL ELECTRIC.
... Stanley P. Lovell, chemist, inventor, and 1948 recipient of the Presidential Medal for Merit, was elected a director of the RAYTHEON MANUFACTURING COMPANY.
... Benjamin Ozaroff was elected president of the FIDELITY TUBE CORP. of East Newark, N. J. The company also announced the appointment of Matthew A. Camber as national representative for the Manufacturers' Division and Leon L. Adelman as Metropolitan New York representative for the Jobber Division.
... Ray F. Sparrow, former vice-president in charge of sales of P. R. MALLORY Co., was elected senior vice-president.
... John P. Boksenbom was elected vice-president and Donald H. Kunzman was made treasurer and controller of the RCA SERVICE COMPANY.
... J. B. Lindsay, formerly with RCA Victor, joined the engineering department of THOMAS ELECTRONICS, INC.
... Jim F. Smith joined the Jobber Division staff of CLAROSTAT MFG. Co.
... Rollie J. Sherwood, was elected vice-president in charge of sales of the HALLICRAFTERS CO. J. Harry La Brum was elected a director. All other officers of the company were re-elected.
... Al Bauer, formerly with Emerson Radio & Phonograph, joined the TELEVISION EQUIPMENT CORP. as director of purchases.
... Jerome Hollander joined the engineering staff of OAK RIDGE PRODUCTS. He was formerly with Du Mont Labs. and General Electric.
... J. D. Van der Veer was elected sales manager for the Electron Tube Initial Equipment Division of TUNG-SOL LAMP WORKS, INC.
... William P. Lear was awarded the coveted 1950 Collier trophy for contributions to the advancement of the science of aeronautics. Mr. Lear won the award for his invention of a 36-pound automatic pilot and automatic approach control coupler which permits the safe landing of jet planes regardless of weather.
... Robert B. Barnhill was appointed to the post of manager of mobile radio sales for Bendix Radio Communications Division of BENDIX AVIATION CORP.
Special Relays—
OVER A MILLION IN STOCK!

Whether you require large quantities of relays for production runs or single units for laboratory or amateur work, Wells can make immediate delivery and save you a substantial part of the cost.

<table>
<thead>
<tr>
<th>STOCK NO.</th>
<th>VOLTAGE</th>
<th>OHMAGE</th>
<th>CONTACTS</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-103</td>
<td>12V VDC.</td>
<td>100</td>
<td>3A, 2C Max. 28 Amps.</td>
<td>$2.25</td>
</tr>
<tr>
<td>R-749</td>
<td>300 VDC.</td>
<td></td>
<td>1B, 38 Amps.</td>
<td>$5.95</td>
</tr>
<tr>
<td>R-250</td>
<td>115 VDC.</td>
<td></td>
<td>Adj. Cir. Breaker .04-.16A</td>
<td>$3.50</td>
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<tr>
<td>R-257</td>
<td>220 VDC.</td>
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<td>1B</td>
<td>$4.25</td>
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<td>R-294</td>
<td>273 VDC.</td>
<td>200</td>
<td>1C</td>
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<td>R-406</td>
<td>115 VDC.</td>
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<td>1A</td>
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<tr>
<td>R-216</td>
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<td>R-26A</td>
<td>115 VDC.</td>
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<tr>
<td>R-611</td>
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<tr>
<td>R-283</td>
<td>12 VDC.</td>
<td></td>
<td>1A, 1B, 1C</td>
<td>$5.95</td>
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<tr>
<td>R-614</td>
<td>18V/18VDC.</td>
<td>60</td>
<td>1A, 1B, 1C</td>
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<tr>
<td>R-202</td>
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<td>1C</td>
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<tr>
<td>R-215</td>
<td>12 VDC.</td>
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<tr>
<td>R-537</td>
<td>6/12 VDC.</td>
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<tr>
<td>R-544</td>
<td>12/24VDC.</td>
<td></td>
<td>1C</td>
<td>$5.95</td>
</tr>
</tbody>
</table>

This list represents only a few types of Special Relays. We also have huge stocks of Standard D.C. Telephone Relays, Midget Relays, Contactors, Keying Relays, Rotary and Slow Acting Types as well as many others. Write or wire us about your requirements.

Write For New Wells Catalog

TELEPHONE: SEaley 8-4143

833 W. CHICAGO AVE., DEPT. Y, CHICAGO 22, I.I.L.
SESSIONS SWITCH TIMER

Designed for turning radios, TV sets, Air conditioners, and other household appliances on and off automatically. Easily installed. All control-on front of clock face. "Wake-up" feature turns radio on at pre-set time within 12 hour period. Special safety feature turns off controlled appliance within 1-1/2 to 2 hours should a fuse go in turn off manually "Sleep SLEEP-ter" lets you sleep with your radio playing and turns it off at pre-set elapsed time up to 95 minutes. Has lower speed long life motor. Size: 3-1/2" dia. 1/2" deep from clock face. Bezel finished in polished brass with mounting bracket and instructions. Switch rating 10 amps at 115 volts. For 110, 60 cycles AC. UL-approved. Shop Wt. 3 lbs.

- Model W-31 - Net 6.50
- Model W-26, same as W-31 except without "Sleep Switch" and has switch rating of 15 amps at 115 volts. - Net 5.50
- All Concord single phase, 150 hp motor can be utilized to drive fans in the building, lighting sections, and for hundreds of other applications known to radioay and builders. 1500 RPM motor has been designed to provide quiet service at 3/16" shaft. 3-1/2" x 3-1/2" bezel. Can be ordered with bezel and mounting brackets. For 115 volts, 60 cycle AC.

- 33-254623 - As above except with 3-1/2" square face and bezel. - Net 6.50
- 33-254632 - Model W-26, same as W-31 except without "Sleep Switch" and has switch rating of 15 amps at 115 volts. - Net 5.50
- 33-254633 - As above, except with 3-1/2" square face and bezel. - Net 5.50

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WHERE THE WORLD SHOPS

Mail Order Center and Showroom
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FOR PROMPT SERVICE ON EXPORT ORDERS, INQUIRIES ADDRESS TO CONCORD RADIO CORP., EXPORT DIVISION, 901 W. JACKSON BLVD., CHICAGO 7, ILLINOIS.

HELP-FREDDIE-WALK FUND

Readers' activities continue in high gear with the Help-Freddie-Walk Fund and we are happy to announce that the Fund this month has reached $6645.93.

As our readers know by this time, Freddie Thomason, is the 21/2-year-old son of the Arkansas radio technician, born with both arms and legs. His parents report that Freddie is now becom-
very large circulation of this magazine (2,404,633 A.B.C.) we are certain that a good many contributions will be collected for Freddie.

We sincerely hope that our readers will join us in their efforts to help make Freddie an able radio man when he grows up.

Please send in your contributions from time to time. Even the smallest donation will be gratefully accepted.

Make all checks, money orders, etc., payable to Herschel Thomas. Please address all letters to:

Help-Freddie-Walk Fund
c/o RADIO-ELECTRONICS
25 West Broadway
New York 7, N. Y.

R. A. SNYDER, General Manager
Coyne Electrical and Television
Radio School

If you want to get ahead faster in big pay Television work—so you won't have to time-saving, money-making TV data at your finger-tips—then you need COYNE'S NEW GIANT TELEVISION CYCLOPEDIA. 750 fact-packed pages cover every phase of Television. 450 photos, charts, diagrams make it easy to understand. All subjects in alphabetical order for quick reference. Prove to yourself that this is the world's handiest, most complete and up-to-date book yet published in Television by taking advantage of COYNE'S 7 DAY FREE EXAMINATION OFFER.

PICTURE PATTERNS, COLOR TV, UHF, ALIGNMENT, CONVERTERS, ADAPTERS, TELEVISION FROM A Z

Written by H. P. Manly, author of the Nationally famous "CYCLOPEDIA of RADIO" and edited by the COYNE instruction staff, the "TELEVISION CYCLOPEDIA" is a "must" for every radio-television man. This brand new book tells you "how to do it"—why things happen in television receivers—how to handle any TV problem. If you want to know about television patterns you'll find a complete section on the subject. You get complete information (with dozens of actual Picture Patterns on how to use them in analyzing TV sets). Complexity cover ALIGNMENT, AMPLIFIERS, ANTENNAS, FREQUENCIES... UHF and COLOR TV... CONVERTERS, adapters, television circuits... ion traps and every other TV subject. Every subject is discussed in a-h-c order with full descriptions and explanations. Mathematics limited to easy arithmetic... formulas simplified... truly television from a Z.

USE THE CYCLOPEDIA 7 DAYS... FREE

See this great "COYNE TELEVISION CYCLOPEDIA" absolutely FREE for 7 days. Send no money! Just fill in and mail FREE TRIAL COUPON. Look the book over for 7 days. If you keep it send us $5.95 plus postage—or return the book and owe nothing. But act now—offer may be withdrawn at any time.

COYNE ELECTRICAL AND TELEVISION-RADIO SCHOOL
An Independent Organization Not for Profit
500 So. Paulina St. • Dept. 31-51 • Chicago 12, Ill.

MARCH, 1951

AMPERITE
Studio Microphones at P.A. Prices

Ideal for Broadcast Recording
PUBLIC ADDRESS

"The ultimate in microphone quality," says even Rushing, sound engineer of the Hotel New Yorker.
- At right into the new Ampere Microphone—or stand feet away—reproduction is always perfect.
- Not affected by any climatic conditions.
- Guaranteed to withstand severe "knocking around.

Models
R8LG—280 ohms
R8HG—Hi-imp.
List $42.00

"Kontak" Mikes
Model SKM, list $12.00
Model KH, list $18.00

Special: Write for Special Introductory Offer.
Offer: 500-450 illustrations—Premium.

AMPERITE COMPANY, Inc.
561 BROADWAY • NEW YORK 12, N. Y.
Canada: Atlas Radio Corp., Ltd., 550 King St. W., Toronto
FAMOUS MAKE 630 COIL KIT
50% OFF NET
(Equal to 70% off List)

TELEVISION IF AND VIDEO COIL KIT—TYPE 204x2
A kit of all the coils used in the picture t.f. lines (350 to 25.25 Mc), sound f. (40 to 21.25 Mc) and video circuits of a high-quality television receiver. This 630 Coil Kit contains:
- Video Series—Peaking Coil type 203L
- Video Shunt—Peaking Coil type 203L
- Second Video—Peaking Coil type 204L
- First and Second Sound IF Transformers type 20KI
- First IF Transformer type 20KZ
- First Picture IF Transformer type 20K2
- Second Picture IF Transformer type 20K2
- Cathode Circuit Trap type 20K4
- Third and Fourth Picture IF Transformers type 20KI
- Filament Choke 20KI.

Our Price 50c Off $5.97

VIBRATOR POWER SUPPLY AIRCRAFT TYPE
Vibrator power supply delivering 300 V. D.C. at 80 mA. Filtered in full, wired, tested and guaranteed new.

OIL FILLED CONDENSERS
Leading Brand Names
All Bread New—Guaranteed

Input

<table>
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<tr>
<th>VOLT</th>
<th>MFD.</th>
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<th>N. EAC.</th>
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Modeling

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<td>40</td>
<td>125</td>
<td>125</td>
<td>125</td>
<td>1.25</td>
</tr>
</tbody>
</table>

New Low Price
Niagara Famous High Pass Filter

Bouf Interference with Niagara’s High Pass Filtration. Positive protection against interference from amateur transmitters, harmonics, and other devices.

radio frequency interference between 400 and 3000 ohms. Designed for 300 ohm lead-in. No loss in brightness or clarity. Wired and tested.

Postpaid if entire amount is included with order.

$5.20

Total contributions received to January 23, 1951...
$6445.93

URGE POOL FOR ENGINEERS

Technical talent pool to create a reserve of engineering talent through registration with the Selective Service System is being urged by engineers of the Joint Council, an organization of five engineering societies. All men to the age of 70 holding engineering degrees, or working toward such degrees, in any of a list of "critical fields" would be required to register.

RADIO-ELECTRONICS for
MARCH, 1917

ELECTRICAL EXPERIMENTER

Using Gas Balloons to Support Wireless Antennae
Controlling Toys by Radio
Spark Gaps in Running Liquids
New Undamped Wave Tuner Has Adjustable Disc Core
Is Radio Transmission Due to Magnetism?, by J. S. Clemens
The Quenched Spark Gap, by Chas. S. Ballantine
A Wireless Lead-in, by Oliver F. Black
Radio Condenser Hints, by Walter D. Sholl
A Batteryless Electrolytic Detector, by L. Mott-Smith

MARCH, 1951

Be First in TVCOLOR PROFITS!
new sensational HY-GRADE TV COLOR ADAPTER
at the LOW, LOW Price of only
ALL TAXES AND POSTAGE PAID $12.95
Send Check M.O. or C.O.D.


SUPPLY IS LIMITED! RUSH YOUR QUANTITY ORDER—NOW!

Hy-Grade Electronics, Inc.
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National Distributors of Electronic Parts and Equipment

FREE! BOOK OF TV PICTURE PATTERNS & WAVE FORMS

If you want to "go places" in Television and Radio Servicing today, COYNE'S NEW 5-vol.
volume set APPLIED PRACTICAL RADIO-TELEVISION can help you. It is the most complete, up-to-date
set of reference books in America, giving you the practical working knowledge that brings big
money. 1500 jam-packed pages full of latest facts on television and radio—5000 subjects,
1000 illustrations and diagrams, COMPLETE SECTIONS on COLOR TV with 1951 data on color TV
adapters and converters—also new UHF channels. Shows how to install, service, shoot trouble,
align all types of radio and television sets. "Break-down" photos help you understand quicker. Use this set free for 7 days—get FREE book of Television Picture Patterns for examining set. See sensational offer below.

FREE BOOK OF TV PICTURE PATTERNS if You Act At Once

Here's a sensational "get acquainted" offer, if you act at once, a brand new TV servicing book, "TV SERVICING WITH PICTURE PATTERN," is YOURS FREE. Shows dozens of actual TV picture tube photo and wave forms with clear explanations of what they mean and how to analyze and service the trouble faster. Now you can get a COPY ABSOLUTELY FREE just for asking to examine COYNE'S great 5-volume set APPLIED PRACTICAL RADIO-TELEVISION for 7 days. This offer is limited—mail coupon now!

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An Institution Organized "Not for Profit"
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CHICAGO 12, ILLINOIS

TUBE—OHM—CAPACITY TESTER!

Quick Reference TV Servicing Book Yours Free Just For Examining Coyne's New 5-Volume Set APPLIED PRACTICAL RADIO-TELEVISION

ON 7 DAYS' FREE TRIAL!

OFFER LIMITED—SEND COUPON TODAY!

Mail coupon for 7 days' free trial on COYNE'S 5-volume set. I'll include the book of TELEVISION PICTURE PATTERNS. If you keep the set you pay $3.00 after 7 days trial and $3.00 a month until $33.00 plus postage is paid. If not 100% satisfied with the set return it and you owe nothing. EITHER WAY, HOWEVER, THE BOOK OF TELEVISION PICTURE PATTERNS IS YOURS FREE TO KEEP. Coupon is in just a request to see the set and get the free book of picture patterns. This sensational offer is limited—SEND THE COUPON NOW!

SEND NO MONEY • MAIL COUPON NOW!

COYNE ELECTRICAL & TELEVISION-RADIO SCHOOL, Dept. 31-T1
500 S. Paulina St., Chicago 12, Ill.
O.K. Rush "APPLIED PRACTICAL RADIO-TELEVISION" for 7 days' FREE TRIAL as per above. Include copy of TELEVISION PICTURE PATTERNS book as my free gift for examining this set.

NAME ____________________________ AGE ____________________________
ADDRESS ____________________________ ZIP ______________ STATE ______________
CITY ____________________________ ZONE ______________
WHERE EMPLOYED: ____________________________

Check here if you want set sent COD. You pay postman $15.00 on delivery. Same money-back guarantee of satisfaction.
Polished mahogany cabinets and good picture tubes are important . . . But don't let customers forget the rig on the roof! Everyone — manufacturer, jobber, dealer, service-man and customer — benefits when a TV set produces the best possible picture. Precise engineering laboratory and field tests prove Amphenol's patented INLINE Antenna gives the greatest over-all channel coverage, the best pictures, regardless of station location . . . so don't overlook the rig on the roof!

RESONANT CAPACITOR
Aerovox Corp.
New Bedford, Mass.
The new type BC resonant capacitors are available as 0.1, 0.2, and 0.4 uf units with 400-volt d.c. ratings. They are designed to operate on series-resonant circuits which present a short circuit to frequencies between 425 and 485 kc.

LIGHTNING ARRESTER
LaPointe-Plascomold Corp.
Windsor Locks, Conn.
The model RW-200 is the latest addition to the VEE-DX line of TV antennas and accessories. It is similar to the structure RW-104, but is constructed with only two separate contacts instead of four. The RW-200 is designed to provide positive protection of all standard TV installations.

CORNER LOUDSPEAKER
Sun Radio & Electronics Co.
New York, N.Y.
The Real-O, a new corner speaker system, features a 12-inch woofer and an 8-inch tweeter mounted back-to-back. This arrangement is said to reduce hangover of the bass notes, while treble notes are reflected from the corner and distributed throughout the room. The system is available with a wide selection of speakers. The cabinet available in modern or traditional design, is 36 inches high, 30 inches wide, and 18 inches deep. Standard finishes are natural, or lacquer, mahogany, walnut, and blond.

RECORDING TAPE
Amplifier Corp. of America
New York, N.Y.
A new recording tape called Magna-Ribbon is the latest addition to the line of magnetic tape recorders and accessories produced by Amplifier Corp. of America. Red or black oxide coatings are available on paper and plastic tapes. All tapes are in the standard 1/2-inch, 200-foot lengths on 7-inch nonwarping aluminum spools. A metal leader facilitates threading the tape onto standard take-up reels. Tapes are boxed in cardboard containers having cloth-covered sides and tabs for indexing the contents of single- or double-track reels. Manufacturing processes insure against matting of the coating and lateral wear, and insure uniform high sensitivity, greater signal-to-noise ratio, and lower random noise.

YFD TV ANTENNAS
J.F.D Manufacturing Co., Inc.
Brooklyn, N.Y.
Available in 12 models, each cut exactly to the frequency of a different TV channel, the new 5-element YFD antennas are designed to provide high gain in fringe and remote areas. Three directors and a reflector produce a high front-to-back ratio which reduces reflections from the rear and minimizes co-channel interference when the antenna is on a line between two stations on the same channel.

A high-impedance driven element provides a good match to 300-ohm transmission lines. A speaker inter-connector is available for connecting boxes when a stacked array is required. Heavy corrosion-resistant aircraft aluminum is used throughout, 1-inch tubing being used for the boom and larger conductor of the driven element.

RADIO-ELECTRONICS for
**Oscillation Eliminator**

Perfection Electric Co.
Chicago, Ill.

Vertical black bars appear in TV pictures when Barkhausen oscillations occur in the horizontal sweep output tube. Oscillations set up near the screen grid of the tube are radiated to the input of the tuner and cause the dark bars to appear. These are especially noticeable in weak signal areas. However, a concentrated magnetic field near the source of the oscillation will usually eliminate it.

**New Booster Design**

I.D.E.A.
Indianapolis, Ind.

Because of allocation difficulties, the Regency TV Signal Booster has been redesigned to use less critical metal. The new model has horizontal and vertical iron core coils which are wound in series to give a balanced circuit and simplify the layout. The new model will have a larger and more rigid coil housing than the original.

**Potential Tap**

Industrial Devices, Inc.
Edgewater, N. J.

The new type 40P potential tap consists of a water-thin plate which slips over the prongs of a standard line plug and two insulated tips stuck on flexable leads. The appliance to be checked is plugged into the potential tap into the power receptacle. Any voltmeter having phone tips may be used to check the voltage with the appliance on or off. In this way, voltage drop on the line under load can be read without removing the plug or wire in the voltmeter.

**TV Mast Coupling**

Technical Appliance Corp.
Sherburne, N. Y.

The new face mast coupling (catalog No. 198) is designed to couple evenly wood or metal mast sections ranging from 1/8 to 1/2 in. thick. Made of heavy gauge steel, it is clamped to the mast sections by three 3/8-in. bolts through the flange. The bottom of the clamp may be used as an anchor for guy wires. The design of this coupling is particularly suitable for wood masts because it distributes the pressure over a larger area than that covered by U-bolt clamps.

**New Booster Design**

I.D.E.A.
Indianapolis, Ind.

Because of allocation difficulties, the Regency TV Signal Booster has been redesigned to use less critical metal. The new model will have much the same appearance, the only change being a new color. The gold colored metal panel for the dial face. The new model will have a larger and more rigid coil housing than the original.

**Potential Tap**

Industrial Devices, Inc.
Edgewater, N. J.

The new type 40P potential tap consists of a water-thin plate which slips over the prongs of a standard line plug and two insulated tips stuck on flexable leads. The appliance to be checked is plugged into the potential tap into the power receptacle. Any voltmeter having phone tips may be used to check the voltage with the appliance on or off. In this way, voltage drop on the line under load can be read without removing the plug or wire in the voltmeter.

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**High Score**

every time with

“Safe Centers!”

In basketball there's no better assurance of victory than a lengthy led jumping center... and there is nothing that scores higher in radio, TV and other electronic circuits than SELETRON miniature rectifiers with "Safe Center" plates.

When you specify SELETRON Selenium Rectifiers you eliminate arc-over danger, short circuits and heating at the contact point. Assembly pressure, or pressure applied in mounting the rectifier cannot affect its performance—a SELETRON feature accomplished by defeating the area of the stack under the contact washer.

The millions of SELETRON Selenium Rectifiers in satisfactory service in original equipment in the products of leading manufacturers are millions of reasons why you can specify SELETRON and be safe!

Look for Howard W. Sam's Red Book
R-E IS NO SLOUCH

Dear Editor:

This is my first letter to Radio-Electronics despite the fact that I have been a devoted R-E fan since early Radio-Craft days. This magazine has always featured those certain special topics not to be found elsewhere in newstand periodicals, thus making it one of my most impatiently awaited journals.

I agree most enthusiastically with the opinions held by Mr. V. Phillips who urged your continuation of experimental articles. The majority of experimenters need only a key idea in some instances or a slight push in the right direction to set them in motion. Radio-Electronics certainly is no slouch when it comes to presenting food for thought.

The current computer principles articles by Mr. Berkeley are most informative. He has done once again, as he did with his fine book Giant Brains, a wonderful job making clear just how simple it is for a group of relays to perform various mathematical operations. Let's see this fine series run for many more months to come.

JOHN W. SPONSBERG
Cambridge, Mass.

TUBE DATA ON CARDS

Dear Editor:

We need a tube chart which is printed on cards like a deck of ordinary playing cards. Good quality. We can then select the suitable cards and put them on the bench beside the set we are working on. The tube's casing diagram should be large enough to be seen easily, and maximum ratings for each tube element should be clearly marked. The back of the card might contain other technical characteristics, as well as substitution data.

Such cards can be filed in a card index. Lost cards could be easily replaced, and cards for new tubes easily added. I for one would pay a good price for a gadget like this. It would pay for itself within just a few weeks just in the time it would save in thumbing through tube handbooks and trying to find data on new tubes.

J. R. WOLLARD
Nashville, Tenn.
COYNE TELEVISION CYCLOPEDIA, by Harold P. Manly. Published by Edu-
cational Book Publishing Division, Coyne Electrical and Televi-
sion-Radio School, Chicago, Ill. 534 x 63/4 inches, 727 pages. Price $5.95.

Students and beginners in television will find that the alphabetical arrange-
ment of television terms and their def-
initions makes this encyclopedia easy
to use. The author covers the subjects in
a clear, easy-to-read style without
resorting to complex formulas or engi-
neering terminology. It is not uncom-
non to find six pages of text and illus-
trations devoted to a single topic while
more than 18 pages are
devoted to some subjects.

Television students, set constructors,
experimenters, and others seeking clear
non-technical definitions of technical
television terms will find this book a
useful addition to their technical li-
braries.—RFS

TRAILBLAZER TO TELEVISION, by Terry and Elizabeth P. Korn. Illustrated
by Elizabeth P. Korn. Published by
Charles Scribner's Sons, New York,
N.Y. 6 x 9 inches. Price $2.50.

In this human-interest biography of
Professor and Mrs. Korn, early work-
er in the electric transmission of images
and the inventor of the first facsimile
system, is told the story of his attempts
to transmit pictures electrically, his
first successes with wire transmission,
and his struggle toward the wireless
transmission of pictures, with television
as the ultimate goal.

The book is written by the late Dr.
Korn's wife and daughter-in-law and
illustrated by his wife.

WORLD-RADIO HANDBOOK FOR
LISTENERS, edited and published by
O. Lund Johansen, Copenhagen,
Denmark. Distributed in U.S.A. by Ben E.
Wilbur, East Orange, N. J. 6 x 9

This handbook can be a valuable aid
to shortwave listeners who delight in
prowling the international radio lanes
in search of elusive dx stations or
voices from their home lands. It lists
the call signs, frequencies, power, pro-
gram schedules, location, street address
or apartment number, musical phrases for
the interval signal or musical signa-
ture, and names of leading station
personalities.

Other books of interest to SWL's
(directed by Mr. Wilbur) are How
to Listen to the World, by O. Lund
Johansen (Price 30c) and Ham's In-
terpreter, by OH2SQ (Price $1.00).

The first discusses antennas for dx,
differences in time, effects of atmos-
pheric conditions on reception, and
other subjects of interest to budding
SWL's.

The latter book is written to assist
amateur radiotelephone operators to
remember numbers, letters, and phrases
common to ham radio in English,
French, Italian, German, Swedish, Fin-
nish, and Spanish. With the aid of this
book, many English-speaking hams
should be able to carry on long enough
to get a QSL from many foreign
stations.—RFS

MARCH, 1951
BOOK REVIEWS

PRACTICAL RADIO AND ELECTRONICS COURSE FOR HOME-STUDY (1951 Edition), prepared under the direction of M. N. Beitman. Published by Supreme Publications, Chicago, Ill. 8 x 10½ inches, 331 pages. Price $3.95.

All lessons previously issued in three small volumes of the Practical Radio and Electronics Course are published in this one large edition. It is prepared as a home-study course which we feel will make good supplementary reading for anyone who is just beginning to study radio and electronics. All the material is one wide and one narrow column. The former contains the text material and most of the illustrations. The latter carries the author's comments and suggestions and additional illustrations to simplify matters for the reader.

Volume 1, "Fundamentals of Radio and Electronics," covers 13 lessons designed to acquaint the reader with radio components, their values, and functions in electronic circuits. Volume 2, "Receivers, Transmitters, and Test Equipment," has lessons devoted to such subjects as receiver and transmitter circuits, automatic frequency control, FM, TV, antennas, and wave propagation.

We feel that Volume 2 can stand some revisions and corrections. In lesson 16, a listing of present amateur frequencies shows the 160-meter band to be 1715 to 2,000 kc. The 5-meter band which has not been used by amateurs since before the war is listed as 56 to 60 mc. Hams are now using 6...
substitutions for approximately two years ago, several blocks of frequencies between 1800 and 2000 kc were allocated for amateur use with limitations on locations, power, and hours.

Lesson 28 (Volume 3—"Applied Electronics and Radio Servicing") contain the second, and a machine, welding controls, strain gages, and other electronic equipment. In this volume, the section on radio servicing consists of three pages of case histories on various makes and models of present receivers.

Although the book will serve its purpose, as an introduction to radio and electronics, we feel that many of the diagrams and photographs are obsolete and should be replaced with illustrations of equipment more familiar to today's radio newcomer.—RFS


A new and enlarged addition of Wireless Radio Service, published in 1944, this book lists pertinent information as to substitutions for approximately 750 receiving tubes.

The information is listed in four columns. The first lists the original tube, the second lists more possible substitutes when it is practical to replace the original, and the third lists the comparable performance of the replacements in terms of excellent, good, and poor. The fourth column lists the changes required for the substitution.

Following the 115-page substitution chart is a 28-page section giving heater wiring diagrams and pertinent heater-circuit data on many current TV sets which are listed by make and model. Charts of tube characteristics, base diagrams, ballast-tube and resistor numbering codes, and other useful servicing information conclude the book.

Although we feel that this book is far from fool-proof, we are sure that it will save considerable time for the thinking service technician who may be called upon to substitute tubes to keep radios, amplifiers, and other electronic equipment in working order.—RFS


The title of this book is somewhat misleading, because it's an explanation of the intricacies of television in terms that anyone with a basic knowledge of radio can understand rather than an explanation of simplified television circuits. Following the lines of the two previous editions, this new edition is brought up to date with the latest color television and the intercarrier system. For those who wish to gauge their progress through the book, a set of self-check questions has been added for each chapter.

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The third edition of this standard work is considerably expanded and revised. All types of electrical communication, from the wire telegraph to television, are discussed, and there is even a historical chapter devoted to earlier forms of our present systems, and to systems no longer in use.

The space devoted to all types of radio, and also to dial telephony, has been increased, as has the number of illustrations and problems. The student will find the list of questions at the end of each chapter very helpful, and the extensive list of references also appended to each chapter will be useful to those seeking more information on the subjects discussed.

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